VEHICLE ENGINE OVERHAULING III

Based on Nov 2016, Version 2 Occupational standards (OS)

Module Title: - Performing Engine Tune up

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LG #33	LO #1- Prepare for work

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Making workstation ready for tune up activities
- Identifying and making ready necessary tools, equipment and materials
- Checking and making ready Injection system components for tune up(Ignition, Fuel and Engine system)
- Positioning engine parts injection required in setting injection timing
- Detecting/reading injection timing setting with no error
- Re-checking Injection timing setting

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Make workstation ready for tune up activities
- Identify and making ready necessary tools, equipment and materials
- Check and making ready Injection system components for tune up(Ignition, Fuel and Engine system)
- Position engine parts injection required in setting injection timing
- Detect/read injection timing setting with no error
- Re-check Injection timing setting

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Making workstation ready for tune up activities

1.1. Engine

- An IC engine is a mechanical machine which is designed to convert the chemical energy of fuel (gasoline, diesel...) into heat energy and then to mechanical energy.
- device that burns fuel to produce mechanical power; sometimes referred to as power plant

Engine tuning

Engine tuning is the adjustment or modification of the internal combustion engine or Engine Control Unit (ECU) to yield optimal performance and increase the engine's power output, economy, or durability. These goals may be mutually exclusive; an engine may be de-tuned with respect to output power in exchange for better economy or longer engine life due to lessened stress on engine components.

Tuning can include a wide variety of adjustments and modifications, such as the routine adjustment of the carburetor and ignition system to significant engine overhauls. Performance tuning of an engine can involve revising some of the design decisions taken during the development of the engine.

Setting the idle speed, air-fuel ratio, carburetor balance, spark plug and distributor point gaps, and ignition timing were regular maintenance tasks for older engines and are the final but essential steps in setting up a racing engine.

On modern engines equipped with electronic ignition and fuel injection, some or all of these tasks are automated but they still require periodic calibration.

The term "tune-up" usually denotes the routine servicing of the engine to meet the manufacturer's specifications. Tune-ups are needed periodically according to the manufacturer's recommendations to ensure the vehicle runs as expected.

Modern automobile engines typically require a small number of tune-ups over the course of an approximate 250,000-kilometre (160,000 mi) or a 10-year, lifespan. This can be attributed to improvements in the production process in which imperfections and errors reduced by computer automation, and significant improvement in the quality of consumables such as the availability of synthetic engine oil.

Tune-ups may include the following:

- Adjustment of the carburetor idle speed and the air-fuel mixture,
- Inspection and possible replacement of ignition system components like spark plugs, contact breaker points, distributor cap and distributor rotor,
- Replacement of the air filter and other filters,
- Inspection of emission controls,
- Valvetrain adjustment.

The term "Italian tuneup" denotes the driving of a performance car, such as a Ferrari, by mechanics finishing the tune-up to burn out any built-up carbon.

Tune-up procedures

Step I

1. Know the system.
2. Ask the driver or the owner of the car for the problem.
3. Get hold of the Repair Manual.
4. Inspect the Engine (fuel, engine oil, coolant, battery, wirings, drive belts, Valve clearance etc.).
5. Run the Engine.
6. List the possible causes or troubles.

Common engine troubles

- Engine does not crank.
- Engine cranks but does not start.
- Engine runs but misses.
- Engine Lacks power, acceleration,…
- Engine consumes more fuel.
- Engine consumes more oil.
- Engine overheats.
- Engine backfires.
- Engine emission high.

Step II

- Inspect the starting system & ignition system
- Inspect the intake system & fuel system
- Inspect the lubrication system & cooling system
- Inspect the exhaust system
- Inspect the charging system
- Check cylinder compression

CARE IN THE USE OF HAND TOOLS

- Hand tools can cause accident when an incorrect or defective tool is used
- Make sure you select the correct type and size of tool for the job.
- Check the condition of any tool before you use it.
- Do not use tools that are worn out or damaged.
- Do not use a hammer to assist the turning movement of a spanner.
- Do not use spanners or any tools that are coated with grease or oil.
- Do not carry screwdrivers, chisels or pointed tools in the pockets of overalls, etc

Self-check 1	**Written test**

Name…… ID…… Date…….

Test I Short Answer Questions

1. List some of Common engine troubles?(5pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Test I

Information Sheet 2- Identifying and making ready necessary tools, equipment and materials

2. Identifying Engine Testing Equipment

Measuring tools

Feeler/Thickness Gauge

A feeler gauge is a tool used to measure gap widths. Feeler gauges are mostly used in engineering to measure the clearance between two parts.

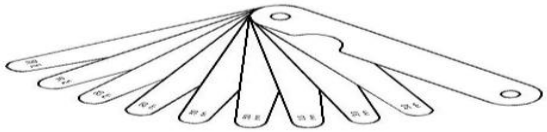


Fig. 2.1.Feeler/Thickness Gauge

Wire Gauges

Wire gauge is a measurement of how large a wire is, either in diameter or cross sectional area. This determines the amount of electric current a wire can safely carry, as well as its electrical resistance and weight per unit of length.

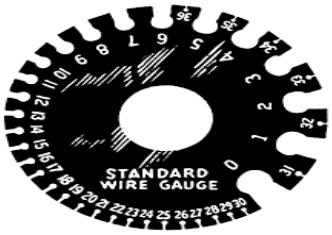


Fig.2.2.Wire Gauges

Ignition Spark Tester

The HEI spark tester helps in the diagnosis of the Ignition System by stress testing the ignition coil and any other component between it and the spark plug (like: a distributor cap, distributor rotor, ignition cables, etc.).

Fig.2.3. Ignition Spark Tester

Sparkplug Gap Gauge

Universal Spark Plug Gap Gauge is a handy tool for easily confirming and adjusting proper spark plug gap. The Gauge is scaled from 0.50 mm to 2.55 mm (0.020" to .100")

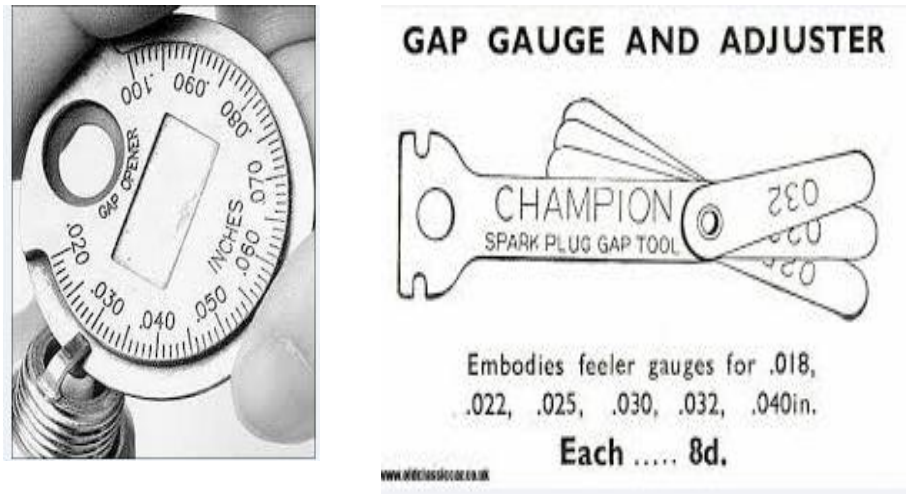


Fig.2.4. Sparkplug Gap Gauge

1. **Dwell-Tach Meter**

   A tachometer (revolution-counter, tach, rev-counter, RPM gauge) is an instrument measuring the rotation speed of a shaft or disk, as in a motor or other machine. The device usually displays the revolutions per minute (RPM). The word comes from Greek (**tachos "speed")** and (**metron "measure").**

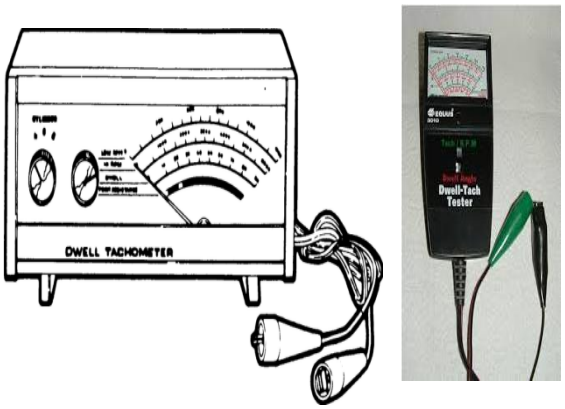


Fig. 2.5.Dwell-Tach Meter

2. Tachometer

Electric or optical tachometers are used in the shop. The electric tachometer connects to the engine primary circuit. The tach counts the number of times per second the primary circuit opens and closes. The optical tachometer has light beam focused on a rotating part such as the engine crankshaft pulley. The tach counts how many times per second a mark on the pulley passes by.

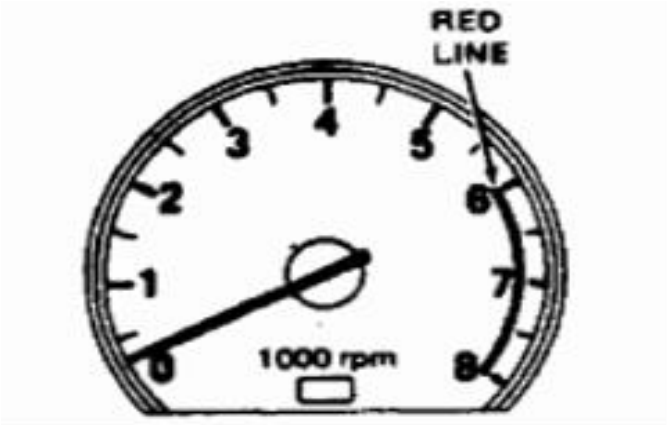


Fig.2.6.Tachometer

3. Dwell meter

The dwell meter electrically measures how long the contact points remain closed during each ignition cycle of a contact-point ignition system. The average for all cylinders is then displayed in degrees of distributor-cam rotation. The technician can also use the dwell meter to set contact-point gap and to check for unwanted

dwell variation as engine speed increases. Excessive variation indicates mechanical trouble in the distributor.

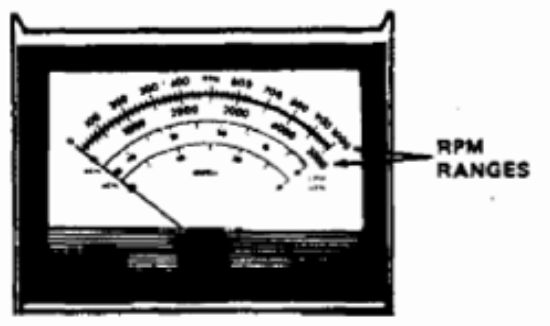


Fig. 2.7.Dwell meter

4. Strobe Timing Light

Timing light is a stroboscope used to **dynamically set** the ignition timing of internal combustion engine **equipped with a distributor**.

The apparent position of the marks, frozen by the stroboscopic effect, indicates the current timing of the spark in relation to piston position.

A reference pointer is attached to the flywheel housing or other fixed point, and an engraved scale gives the offset between the spark time and the top dead center position of the piston in the cylinder. The **distributor can be rotated slightly** until the reference pointer aligns with the specified point on the timing scale.

Fig.2.8. Strobe Timing Light

5. Compression Tester

The cylinder compression tester measures the ability of the cylinders to hold compression while the starting motor cranks the engine. The compression tester is a pressure gauge

that **measures the amount of pressure or compression**, built-up in the cylinder during the compression stroke.

Fig.2.9.Compression Tester

6. **Cylinder Leakage Tester** – The cylinder leakage tester checks compression but in a different way. It applies air pressure to the cylinder with the piston at TDC on the compression stroke. In this position, the engine valves are closed. Very little air should escape from the cylinder if the engine is in good condition.

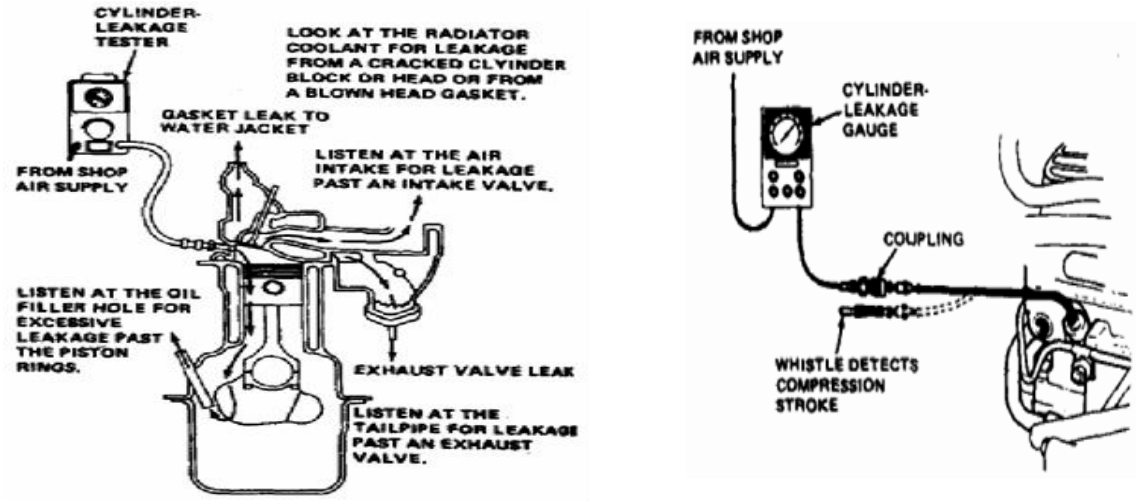


Fig.2.10 Cylinder Leakage Tester

7. **Engine Vacuum Gauge**

The engine vacuum gauge measures intake-manifold vacuum. The intake-manifold vacuum changes with the load on engine defects. The way the vacuum varies from normal indicates what could be wrong inside the engine. Before making

the test, check that all vacuum hoses are properly connected and not leaking. Make a backpressure test if a restricted exhaust system is indicated.

8. **Exhaust Gas Analyzer** – The exhaust gas analyzer measures the amount of various gases in the exhaust.
   There are two main types:

A**.Two-gas** analyzer that measures HC and CO.

B. **Four-gas** analyzer that measures HC, CO, O2 and CO2

The purpose of making these measurements is to help determine the condition of the engine, ignition system, fuel system and emission controls. On a car with a catalytic converter, tail pipe readings made with a two-gas analyzer are often of little value. Normal action of the catalyst reduces the HC and CO nearly to zero.

Four-gas analyzers provide more complete analysis of the tail pipe exhaust gas. Carbon dioxide (CO2) and oxygen (O2) in the exhaust gas from the cylinder pass unchanged through the catalytic converter. Measuring these gases at the tail pipe gives a more complete picture of the air-fuel mixture entering the cylinder and the combustion process.

Fig.2.11.Exhaust Gas Analyzer

9. **Cylinder-Balance Test** – The cylinder – balance test determines if each cylinder in a running engine produces the same amount of power. Disabling a cylinder should cause a change in engine speed. The change should be about the same for all cylinders.

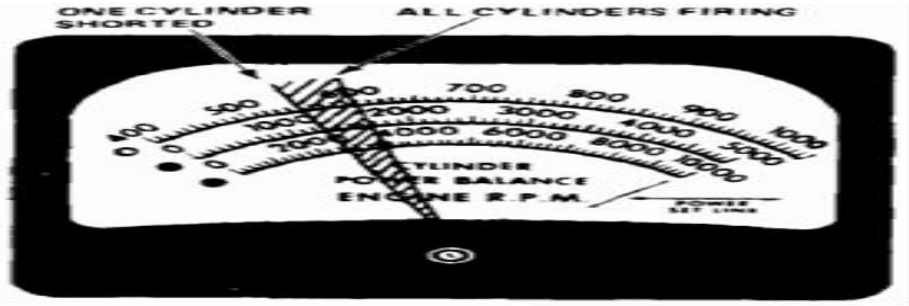


Fig.2.12. Cylinder-Balance Test

10. **Engine Analyzer**

An engine analyzer combines several testers, meters and gauges into a single piece of portable shop equipment. When connected to the vehicle, the analyzer provides quick and accurate testing and diagnosis of various engine and vehicle systems.

Most shop engine analyzers include an oscilloscope. It displays voltage patterns of the ignition system and electronic fuel injectors. Some computerized analyzers include a second screen.

This displays information needed by the technician, such as steps in a test procedure or the test results. The analyzer may have a printer to provide a written report.

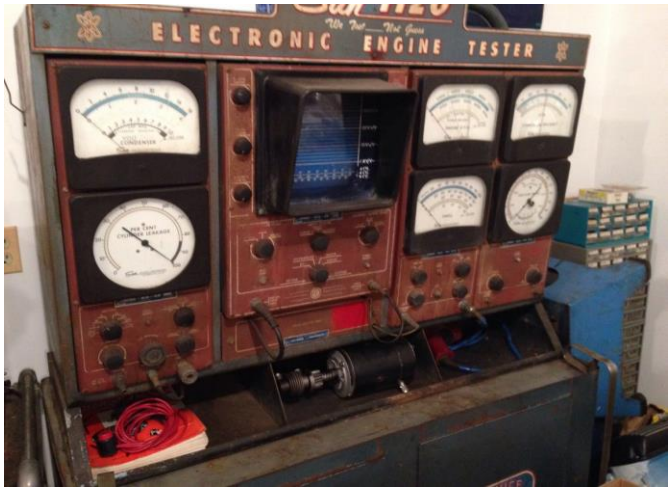


Fig. 2.13.Engine Analyzer

11. Diesel engine timing device

diesel engine timing device and more specifically pertains to a timing indicator attachment for the injection nozzle of a fuel injection system of diesel engines for accurately indicating the time and duration of the fuel injection.

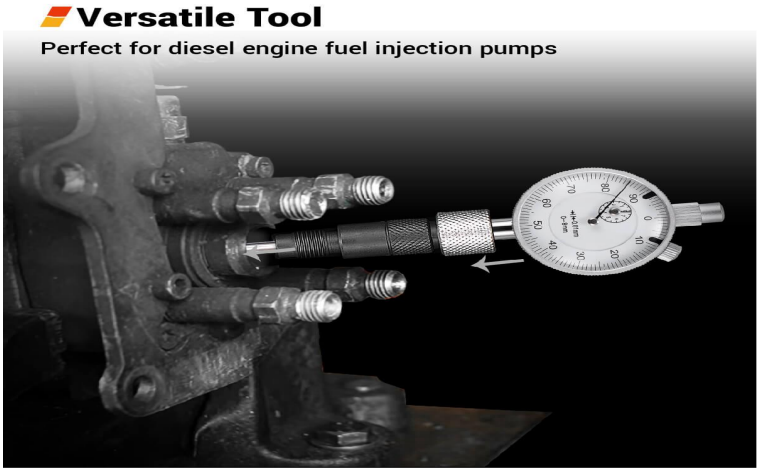


Fig .2.14.Diesel engine timing device

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. What is Engine Analyzer (2pts)
2. What is Exhaust Gas Analyzer?(2pts)

3. List the **Engine Testing Equipment** (6pts)

Note: **Satisfactory rating - 10 points** **Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating:

Answer sheet

Test I

1._____

2._____

Test II

1._____

2._____

Information Sheet 3-Checking and making ready Injection system components for tune up(Ignition, Fuel and Engine system)

3.1. Components of diesel injection system

The fuel injection system can be divided into low-pressure and high-pressure sides. The low-pressure components include the fuel tank, fuel supply pump and fuel filter.

The high-pressure side components include a high pressure pump, accumulator, fuel injector and fuel injector nozzle. A number of injection nozzle designs and different actuation methods have been developed for use with different types of fuel injection systems.

1. Low-Pressure Side Components
    - Fuel Tank and Fuel Supply Pump
    - Fuel Filter
    - Fuel Heaters & Coolers
2. High-Pressure Side Components
    - High Pressure Pump
    - Accumulator
    - Fuel Injector and Fuel Injection Nozzle
    - Fuel Metering
    - Nozzle Needle Control Actuators
    - Injection pump
        - high-pressure mechanical pump
        - meters fuel to each injector nozzle at the proper time
        - Provide a means of shutting off the engine

Fig.3.1. Injection pump

- Injection lines/high pressure line
    - carry fuel to each injector nozzle

Fig.3.2. Injection high pressure line

- Injector nozzles
    - spring-loaded valves
    - spray fuel into each combustion chamber

Fig.3.3.Injector nozzles

- Glow plugs
    - electric heating elements
    - warm air in the cylinder pre combustion chambers
    - aid starting of a cold engine

Fig.3.4.Glow plugs

- Diesel fuel supply system

- feeds fuel from the fuel tank to the injection pump
- other components fuel supply system

- inline electric pump or engine-driven mechanical pump
- filters and water separator to clean the fuel
- fuel return lines to carry unused fuel back to the tank

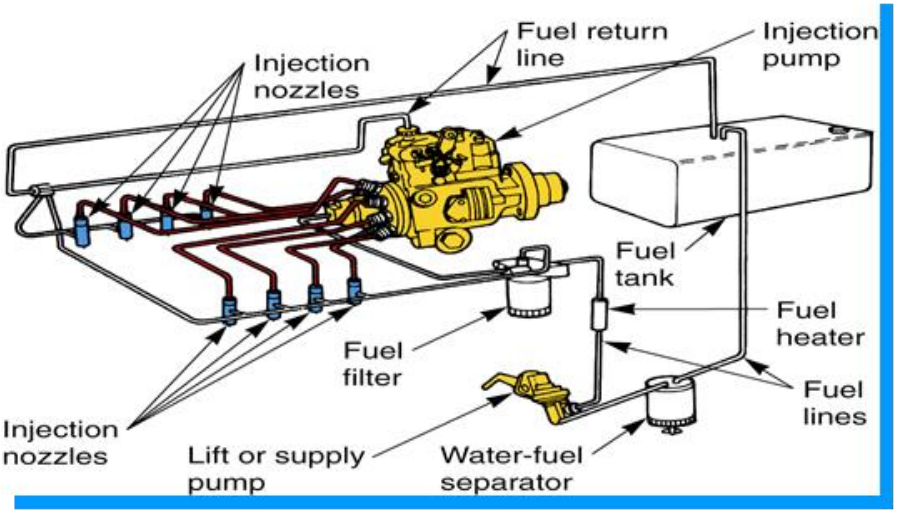


Figure.3.5.Diesel Fuel System

Self Check-1	Written test

Short answer

1. list Components of High-Pressure Side(5pts)
2. list Components of Low-Pressure Side (5pts)

Information Sheet 4- Positioning engine parts injection required in setting injection timing

4.1. Positioning engine parts injection required in setting injection timing

Checking and Adjusting Injection Pump Timing

Precise injection timing is critical, since it also determines when combustion begins. Checking and adjustment of injection timing is necessary any time the injection pump or the timing belt have been loosened or replaced, and may be necessary at other times to maintain precise timing.

Injection timing is checked by measuring the injection pump plunger's stroke at TDC with a dial indicator. Adjustment, if necessary, is based on this measurement. Before adjusting injection pump timing, the cold start cable must be all the way in, and the camshaft drive belt must be properly installed and tensioned. See

To check and adjust:

1. Using a socket on the front crankshaft bolt, hand-turn the engine clockwise until No. 1 cylinder is at TDC. Both valves should be closed and the TDC mark on the flywheel should be aligned, as shown in Fig. 5-18 if the engine is installed and in Fig. 5-19 if it is not installed.

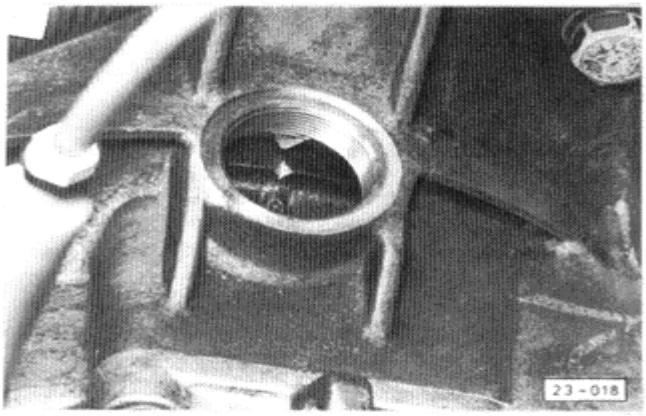


Fig.4.1. TDC mark on flywheel aligned with pointer in hole in bellhousing

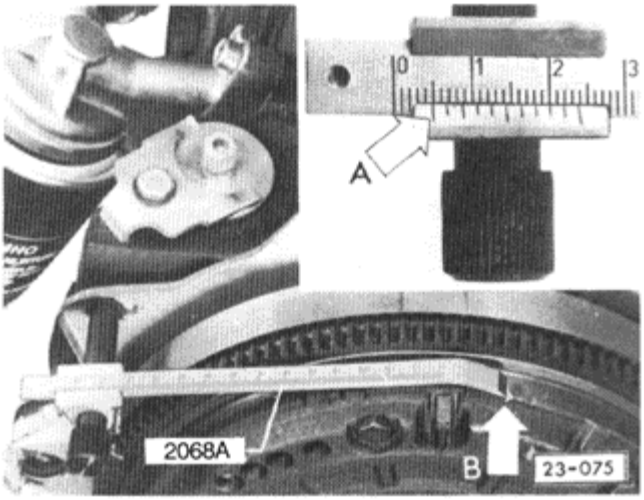


Fig.4.2.Volkswagen special tool no. 2068A (order no. T02 068 A00 23 ZEL) being used to align TDC mark on flywheel (B) with engine removed. Use left notch (A) as measurement point. TDC is indicated when scale reads 5 mm for vehicles with manual transmission; 85 mm for vehicles with automatic transmission.

2. Remove the timing-check plug from the pump cover, shown in Fig. 5-20, and install a dial indicator with (3 mm range) as shown in Fig. 5-21. The gauge should be installed so that it indicates about 2.5 mm (preload).

WARNING-

Fuel will be expelled when the timing plug is removed. Do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy.

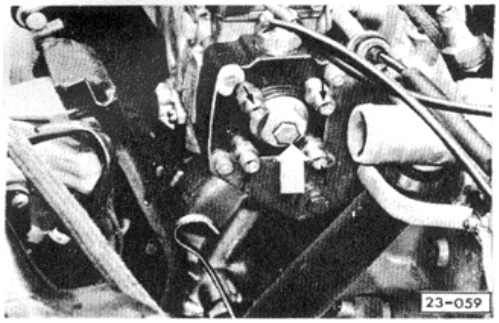


Fig.4.3. Volkswagen special tool no. 2068A (order no. T02 068 A00 23 ZEL) being used to align TDC mark on flywheel (B) with engine removed. Use left notch (A) as measurement point. TDC is indicated when scale reads 5 mm for vehicles with manual transmission; 85 mm for vehicles with automatic transmission.

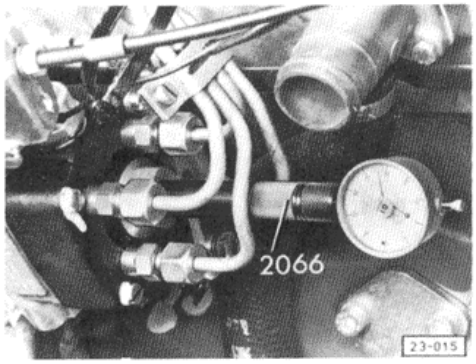


Fig.4.4.Timing check plug (white arrow) to be removed for installation of dial indicator. Only the small central plug and its gasket should be removed. The black arrows indicate the fuel injection pump check valves.

3. Hand-turn the crankshaft counterclockwise (opposite normal engine rotation) until the dial indicator stops moving. Zero the dial indicator.
4. Hand-turn the crankshaft clockwise (normal rotation), stopping precisely at TDC. With the engine at TDC, the dial indicator should read within the checking limits given in **Table b.**
5. If the dial indicator reading is within the checking values given, it is not necessary to adjust the injection timing.

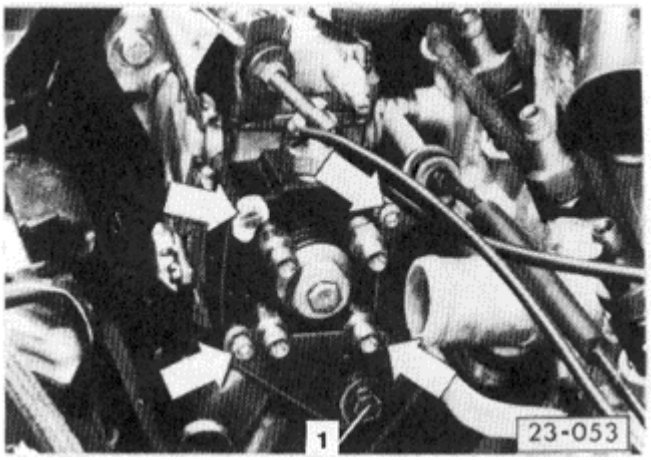


Fig.4.5.Injection pump rear support bolt (1). To avoid damage to the distributor plunger, do not loosen the bolts (arrows) on the fuel distributor head.

6. If the dial indicator reading is out of specification, a timing adjustment is necessary. With the engine at TDC, slightly loosen the injection pump rear support bolt, shown earlier in Fig. 5-15, and the front mounting plate bolts as shown in Fig. 5-22. Rotate the pump, either clockwise or counterclockwise, until the dial indicator reading is within the adjusting specification tolerance.

Table b. Injection Pump Timing

Engine code	Timing
ME (diesel)	
1985	
checking	0.90–1.05 mm
adjusting	0.95±0.02 mm
1986 and later	
checking	0.83–0.97 mm
adjusting	0.90±0.02 mm
MF (Turbo diesel)	
checking	0.95–1.05 mm
adjusting	1.00±0.02 mm
1V (ECO diesel)	
checking	0.93–1.07 mm
adjusting	1.00±0.02 mm

Table 4.1. Injection Pump Timing

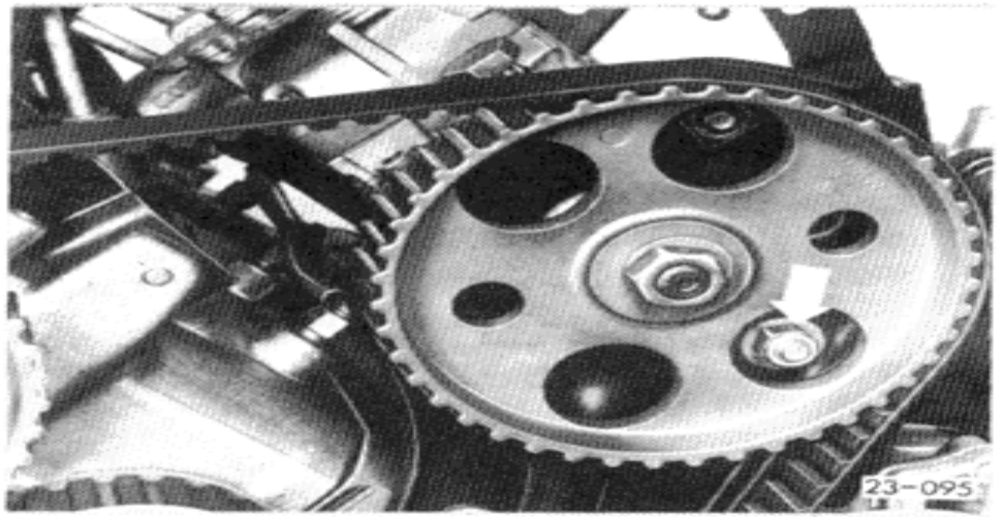


Fig.4.6. Lower mounting plate bolt (arrow) accessible through hole in the injection pump sprocket.

7. Tighten the mounting bolts and torque them to 25 Nm (18 ft. lb.). Rotate the engine by hand through two complete revolutions (clockwise), and then repeat the checking procedure. Repeat the timing adjustment if necessary.
8. Remove the dial indicator. Reinstall the timing check plug with a new gasket, and torque it to 15 Nm (11 ft. lb.).
9. Start the engine and check for leaks around the timing check plug. If any is seen, the timing check plug may be retorqued to 25 Nm (18 ft. lb.).

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. Injection timing is checked by measuring?(3pts)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating:

Answer sheet

Test I

1._____

Information Sheet 5- Detecting/reading injection timing setting with no error

5.1. Detecting/reading injection timing setting with no error

Safety

Because of the need for positive injection into a very high-pressure environment, the pump develops great pressure—typically 15,000 psi (100 MPa) or more on newer systems. This is a good reason to take great care when working on diesel systems; escaping fuel at this sort of pressure can easily penetrate skin and clothes, and be injected into body tissues with medical consequences serious enough to warrant amputation.

How will the engine perform when the injection timing is incorrect?

Incorrect fuel **injection** pump **timing** leads to reduced performance of the **engine** and **can** cause **engine** misfiring or other less obvious symptoms. It also causes over-consumption of fuel, excessive smoke production, loss of power and problems starting the **engine** as well.

What does advancing timing do on a diesel?

For a **diesel** "**advancing** the **timing**" refers to injection **timing**. **Advancing** the **timing** means that fuel is injected earlier in the engine cycle. Generally **advancing timing** will get you better fuel economy, lower EGT's, higher peak cylinder pressures, and higher NOx emissions

How do you advance the timing on a diesel pump?

There are several ways you can adjust **injection timing**, depending on the type of engine you have and how old it is. The most common ways to adjust **injection timing** are programming the ECM, adjusting the fuel **injection pump**, replacing the camshaft, and replacing the cam followers or gaskets.

What happens if timing is too far advanced?

Advancing the **timing** means the plug fires earlier in the compression stroke (farther from TDC). Advance is required because the air/fuel mixture does not burn instantly. It takes time for the flame to ignite the all the mixture. However, **if** the **timing** is **advanced too far**, it will cause an Engine Knock

What is ignition delay in diesel engine?

The **ignition delay** in a **diesel engine** is defined as the time interval between the start of injection and the start of combustion. This **delay** period consists of (a) physical **delay**, wherein atomisation, vaporization and mixing of air **fuel** occur and (b) of chemical **delay** attributed to pre-combustion reactions.

It is well known that injection strategies including the injection timing and pressure play the most important role in determining engine performance, especially in pollutant emissions.

However, the injection timing and pressure quantitatively affect the performance of diesel engine with a turbo charger are not well understood.

It has been concluded that the use of early injection provides lower soot and higher NOx emissions than the late injection.

it has been tried using the change of fuel injection time at these two next steps: before top dead center (BTDC) and after top dead center (ATDC) in order to achieving optimum emission and power in a specific point.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Test I: Short Answer Questions

1. What happens if timing is too far advanced?(3pts)
2. What is ignition delay in diesel engine?(2pts)

Note: **Satisfactory rating - 7 points** **Unsatisfactory - below 7 points**

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating:

Answer sheet

Information Sheet 6- Re-checking Injection timing setting

6.1. checking Injection timing setting

Fuel injection pump is heart of engine, it supplies fuels to the cylinders at desired pressure and time. Timing and pressure at which fuel is supplied to various cylinders is very important. diesel engines are equipped with in-line fuel injection pumps. Time setting of one of such fuel injection pump is described as follows.

Low idle speed setting:

a) Slacken the low idle screw locknut and turn the low idle screw to set low idle speed as specified.

b) Tighten the locknut after setting the speed.

c) Recheck the low idle speed after tightening the locknut.

High idle speed setting:

a) Slacken the high screw locknut and press the accelerator pedal fully down to set high idle speed as specified.

b) Tighten locknut after setting the speed.

c) Recheck the high speed after tightening the locknut.

Self-Check – 1	Written test

Name……ID…… Date…….

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Short Answer Questions

1. Write Fuel injection pump operations / tasks?(3)

Note: Satisfactory rating - 3 points Unsatisfactory - below 3 points

Score = _____ Rating:

You can ask you teacher for the copy of the correct answers.

Answer sheet

1._____

LG #34	LO #2- Installing injection pump to engine

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Re-checking timing marks, torque and injection pump moving parts motion
- Setting-up Injection pump requirement in installing injection pump
- Tightening mounting bolts following torque sequence, pattern

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Re-check timing marks, torque and injection pump moving parts motion
- Set-up Injection pump requirement in installing injection pump
- Tighten mounting bolts following torque sequence, pattern

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
- Accomplish the “Self-checks” which are placed following all information sheets.
- Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
- If you earned a satisfactory evaluation proceed to “Operation sheets
- Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
- If your performance is satisfactory proceed to the next learning guide,
- If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Re-checking timing marks, torque and injection pump moving parts motion

1.1. Re-checking timing marks, torque and injection pump moving parts motion

How do you test an injection pump?

Solution There is an easy do-it-yourself way to test your injectors & pump. 1- remove the injector from your engine. 2- hook the steel fuel line back up the the injector with the injector facing away from the engine. 4- turn the engine over and let the fuel spray out of the injector onto a piece of cardboard

How do you check the timing on a fuel pump?

The primary method of checking fuel pump timing would be using the manufacturer's instructions of setting the fuel pump with the engine stopped. For the Bosch type fuel pumps, a small window is present at the base of the fuel pump. Within this window an engraved line can be seen on the spring holder of the fuel pump.

When should I calibrate my injection pump?

Fuel pressure and volume, for each individual engine cylinder, are adjusted at specific speeds. Usually, this is only done if the injector pump has been repaired or rebuilt. Modified engines often have the injector pump recalibrated to take advantage of greater air and exhaust flow.

Injection Timing

- Relationship between the moment fuel is injected into cylinder and piston position
- Controlled by spring-loaded weights in an inline injection pump
- As engine speed increases, weights fly outward to advance injection timing, providing more time to ignite and burn fuel.

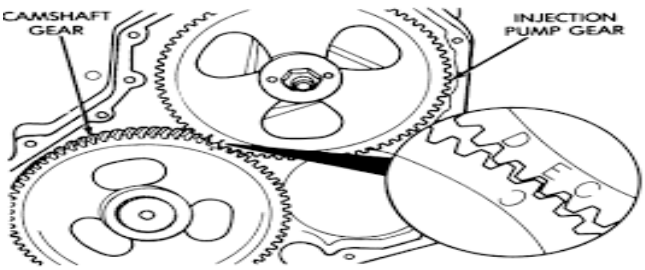


Figure. 1.1 Inside front end cover timing mark

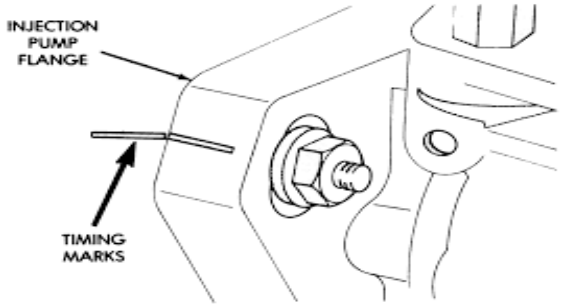


Figure.1. 2. External timing mark on gear housing and injection pump

Self-Check – 1 Written test

Name……ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Short Answer Questions

1. When should I calibrate my injection pump?(5pts)
2. How do you check the timing on a fuel pump?(5pts)

You can ask you teacher for the copy of the correct answers.

Answer sheet

Note: Satisfactory rating - 3 points Unsatisfactory - below 3 points

Score = _____
Rating:

You can ask you teacher for the copy of the correct answers.

Information Sheet 2 Setting-up Injection pump requirement in installing injection pump

1.1 Setting-up Injection pump requirement in installing injection pump

How do you install an injection pump on an engine?

1) Rotate the engine until the #1 piston rises to its highest point.

2) Connect the new pump to all fuel lines, except for the top hard lines that connect to each injector. Do not connect pump yet.

3) Press the primer pump to build pressure, open bleeder valve to release air, then close bleeder valve.

Install fuel injection pump on to engine.

A. Install gasket (17) onto fuel injection pump (16).

B. Locate position of dowel pin through boreon fuel injection pump gear.

C. Rotate drive hub of fuel injection pump (16)to line up slot in drive hub with dowel pin infuel injection pump gear.

D. Install fuel injection pump on engine timing gear case. Ensure dowel pin in fuel injection pump gear mates with slot in drivehub of fuel injection pump.

E. Install flat washers (15), lockwashers (14), and hex nuts (13). Do not tighten hex nuts

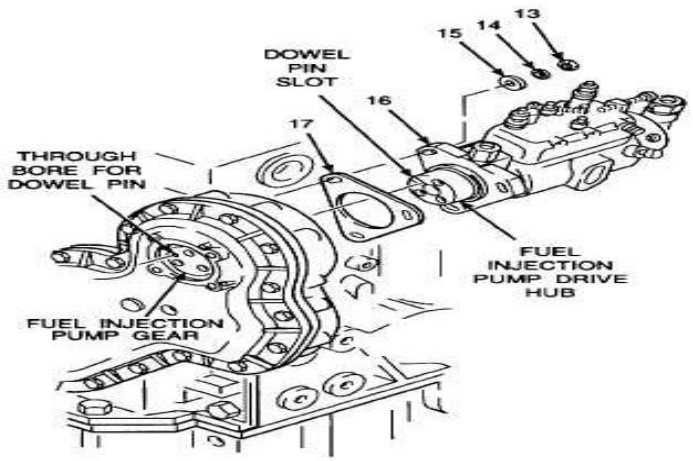


Fig 2.1 Install fuel injection pump on to engine

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. How do you install an injection pump on an engine? (5pts)

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating:

Answer sheet

Test I

1.

……

……

……

……

3.1 Tightening mounting bolts following torque sequence, pattern

Definition of Torque

Torque is defined as a measure of the force required to turn an object such as a bolt or a flywheel. Torque is measured in foot-pounds, inch-pounds or in the metric equivalent of Newton-meters. A torque of 90 foot-pounds means that if you had a wrench that was 1 foot long and applied a force of 90 pounds perpendicular to the wrench, you would get 90 foot-pounds of torque. When talking about automobiles, torque is often associated with engines. In this instance, torque is the force that gets a vehicle moving from a complete stop and helps to pull it up steep hills.

Torque Wrenches

When a specific torque is required to tighten a bolt, a torque wrench is needed. There are three types of torque wrenches: beam, click and dial. Beam-type torque wrenches have two beams attached to the socket. A lever beam applies the force and an indicator beam points to the torque on a scale on the lever. Click-type torque wrenches use an indicator on the handle that can be set to a desired torque; once the desired torque is reached the ratchet moves freely, and a spring causes the wrench to make a clicking noise. Dial-type torque wrenches have a display on a dial or a digital readout on the handle. The display indicates the torque as the wrench is turned. Dial-type torque wrenches are the most accurate and the most expensive. You can find torque wrenches in auto parts or hardware stores.

Torque Specifications

Manufacturers provide torque specifications to guide mechanics in properly tightening the bolts connecting the cylinder heads to the main engine. Improper tightening of the bolts on a cylinder head results in uneven distribution of tension across both the bolts and the head gasket. Inadequate seals may result in gasket failure, whereas bolts that are too tight may lead to failure of the threads holding the cylinder head to the engine. Over-tightening cylinder head bolts may lead to stripped threads, damaged gaskets or cylinder head damage.

Torque Purpose

Torque is typically measured in foot-pounds for vehicles available in the United States. Torque is a measure of the rotational force required to properly secure the bolt in the

bolt hole. The foot-pound measure refers to the amount of pressure in pounds required to rotate the bolt from a point one foot away from the pivot point. For example, if a bolt is torqued to 50 foot-pounds, it will take 50 pounds of force--from a leverage point one foot from the bolt--to rotate the bolt. By providing a uniform measure of force required to turn the bolts to proper tightening, manufacturers are able to ensure mechanics provide sufficient tension on the bolts without damaging the cylinder head, bolt holes or gasket.

Torque Sequencing

The tightening sequence on a cylinder head is a critical part of ensuring your cylinder head is tightened in a way that evenly distributes the tension and pressure across the cylinder head correctly. Many cylinder heads require multiple torque sequences to achieve proper tension. For example, a 10-bolt cylinder head may require you to tighten them all first to 42 foot-pounds in a specified order, then to 75 foot-pounds in the same order. Improper sequencing or torquing of the bolts may result in damage.

How to Set a Click Style Torque Wrench

Setting the correct torque on a click style torque wrench is pretty easy. There are generally two different types of torque measurements on a click style torque wrench, depending on its size and purpose. There are standard American inch- or foot-pound settings and Newton meter settings. Once the torque wrench is properly set for the correct setting, when it tightens the nut or bolt to that specification, it clicks to alert you that you've achieved the proper tightness.

Step 1

Look on the handle of the click style torque wrench. You may notice two different settings. They may be side by side or there may be Nm settings on one side and foot-pound or inch-pound on the other.

Step 2

Determine what setting the bolt or nut you're tightening requires for a torque specification. An automotive torque wrench for lug nuts and large bolts is measured in foot-pounds and higher Nm, where smaller bolts and nuts use a smaller torque wrench with inch-pound and lower Nm.

Step 3

Adjust the torque specification on the wrench by turning the handle of the torque wrench while holding the shaft of the torque wrench. The dial indicator will move up or down the inch-pound, foot-pound or Nm scale as you turn the handle clockwise or counterclockwise.

Step 4 Notice the inch/foot pounds and the Newton meter scale are broken into increments. In other words, depending on the torque wrench, the inch/foot pounds may be broken into increments of ten. There is another dial indicator at the top of the handle on the torque wrench that is numbered from 0 to 9. This is to set offset torque settings between the increments. In other words, to set 36 foot-pounds, you turn the handle while holding the shaft until the handle indicator lines up with 30 foot-pounds and then continue to turn the handle until the number 6 on the other dial indicator is set in the middle. Set the torque wrench to the proper torque setting and tighten the nut or bolt until the torque wrench clicks. When it reaches the setting programmed into the wrench, it will collapse -- click -- at that inch-pound, foot-pound or Nm setting.

What Is a Torque Angle?

Torque Torque is a way to measure force. Specifically, it is how much force it takes to turn an object. Torque is commonly used when describing tools or mechanics in terms of how much torque would be needed to turn a bolt on a machine.

Angle An angle is a mathematical term used to describe the shape made when two lines diverge from a common point. If you place a dot on a page, and draw two lines going in different directions, you would create an angle.

Torque Angle Torque is commonly used to measure the security of fasteners. However, there are some fasteners that when measured, give off a relatively high level of torque, but fail when you measure the clamp force. To bridge the gap between the two tests, a measurement technique has been developed called torque angle. Torque is measured and plotted on a graph as the fastener is installed and uninstalled. The arch that is created is the torque angle, and is a visual way of measuring the security of a fastener.

Metric Torque Specifications for Bolt

Fig 3.1 Bolt

Manufacturers of bolts and/or machines establish torque specifications for their components and the nuts and bolts that hold them together. Bolt torque, the amount of force required to tighten a bolt, is listed according either to the Society for Automotive Engineers (SAE), which uses U.S. measurements, or to metric units.

Identification

Metric bolt sizes are listed according to diameter, distance between threads and length. A bolt might be listed as 12 x 1.75 x 30. This indicates that the bolt has a diameter of 12 mm, that the distance between each bolt thread is 1.75 mm and that the bolt is 30 mm long. In the metric system, bolts are given grades according to its size, composition and design. The grades, or classes, include such common ones as Class 8.8 and Class 10.9.

Torque

Different bolt sizes and grades have different torque specifications. For example, 6 mm bolts with a 10.9 grade have a maximum torque value of 10 foot-pounds, while the same-size bolts with a 12.9 grade have a maximum torque value of 12 foot-pounds. Consult your shop manual for the most precise listings.

Formula To determine torque yourself, follow the formula T = K x U x D x P, where T is torque, K is 1.33, U is the coefficient of friction, D is diameter and P is preload. Use 0.2 as the coefficient of friction for un-lubed bolts and 0.09 for lubed bolts. To determine preload, take the published ultimate strength of the bolt, multiply it by the bolt's thread area and by 2/3.

How to Measure Torque & the Tightening of Bolts

Torque is a measure of rotational or "twisting" force. Measuring torque while installing a bolt prevents the overtightening of bolts. Torque wrenches are the most commonly used measures for this torque. They measure the torque applied to the fastener as the wrench tightens the bolt. In the early 20th century, engineers used analog meters. Nowadays, many torque wrenches either are digital wrenches or are calibrated to sense when torque has exceeded a certain level and stop tightening.

Step 1 Choose a torque wrench for your bolt. A "click wrench" tightens bolts to a particular specification, but cannot measure the torque of existing bolts directly. A mechatronic or digital torque wrench provides a readout of torque, but may prove difficult to read in tight spaces such as a car's interior.

Step 2 Loosen the bolt with an ordinary wrench, if you are using a click-type torque wrench. Set the dial on the torque wrench's handle to the desired level of torque.

Step 3 Fix the torque wrench over the bolt whose torque you want to measure and begin to tighten. Keep an eye on the digital readout, if you are using a digital wrench.

Step 4 Tighten the bolt until the desired level of torque is reached, or just until you see the bolt turn if you are using a digital wrench. A click torque wrench will slip once the torque becomes greater than the preset amount, with a cracking sound.

Fig.3.3.Torque wrenche

Properly setting the torque on a nut or bolt requires you to use a torque wrench. The nuts or bolts you are working with, though they are steel or metal, are designed to stretch when tightened. A specific amount of torque applied to them will stretch them to the required amount, keeping them tight. Torque is used on fasteners from lug nuts to bolts in the engine or interior of your car. Applying that torque properly is critical to the success of the fastener in its intended use

Step 1 Locate the torque specification for the fastener you are working with. In most applications, the manufacturer will supply these specs and publish them in repair or owner's manuals. The specification may be in foot-pounds, inch-pounds or a metric equivalent. Make sure you have a torque wrench to fit your needs.

Step 2 Set your torque wrench to the specified torque. On most modern torque wrenches, the torque is set by turning the handle of the wrench until the top edge lines up with a mark on the barrel of the wrench. The torque wrench may be marked in standard and metric units, so double check the scale you are using on the wrench or you may over-torque the fastener.

Step 3 Choose an appropriate-size socket to fit the fastener you are working with and install it on the torque wrench. Snap the socket onto the square drive of the torque

wrench just like you would on a ratchet. Make sure the socket fits the fastener correctly, as applying torque will damage or strip the fastener.

Place the socket and torque wrench on the fastener and tighten the bolt, holding the torque wrench by the handle at the end of the wrench. Rotate the torque wrench slowly and smoothly, continuing through the arc until the wrench clicks. The click indicates that you have reached the desired torque. Do not tighten beyond this point or damage with occur to the fastener.

Self-Check – 3	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test: Short Answer Questions

1. Write the Definition of Torque? (5pts)

2. Write the Definition of Torque Angle? (5pts)

Note: Satisfactory rating - 10 points Unsatisfactory - below 10 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer sheet

Test I

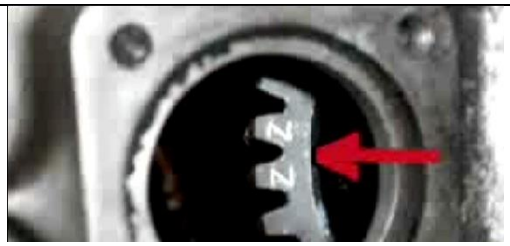
1. ……

Operation Sheet-1	Set timing mark and Installing Injection Pump

Resource requirment

- Combination wrench set
- Screwdriver
- Gasket maker
- Rag

Installing injection pump

a. Remove the timing mark cover.	
b. Find the marks on the idler gear and the injection pump gear.	 

c. Return the injection pump and align the timing marks of the injection pump gear and the idler gear.	
d. Inspect the position of the injection pump gear timing mark. It must be between the idler gear timing marks.	
e. Install the bolts holding the injection pump and tighten.	
f. Re-check timing mark and Return the timing mark cover.	

LAP Test-1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Request necessary tools and materials you are required to perform the following tasks.

Task 1. Install injection pump

Task 2. Recheck injection pump timing mark.

LG #35 LO #3- Inspecting injection timing

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Using Injection re-checking timing device without error
- Interpreting result without error
- Checking timing advance operation

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Use Injection re-checking timing device without error
- Interpret result without error
- Check timing advance operation

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
- Accomplish the “Self-checks” which are placed following all information sheets.
- Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
- If you earned a satisfactory evaluation proceed to “Operation sheets
- Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
- If your performance is satisfactory proceed to the next learning guide,
- If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1-Using Injection re-checking timing device without error

1.1. Using Injection re-checking timing device without error

How do I check my injection timing?

Hair line Test is a method of checking fuel pump timing by looking for the crank angle when the marking on plunger and its body coincides. When the unit is at TDC with both markings on plunger and its body coincide; the crank angle marking on flywheel will tell the exact position of fuel injection on timing diagram

1) Rotate the engine until the #1 piston rises to its highest point.

2) Connect the new pump to all fuel lines, except for the top hard lines that connect to each injector. Do not connect pump yet.

3) Press the primer pump to build pressure, open bleeder valve to release air, then close bleeder valve. Repeat until fuel comes out the bleeder valve.

4) Slowly rotate the fuel injection pump shaft. Stop rotating as soon as fuel rises to the top of the #1 hardline port.

5) Install the pump onto the fuel injection pump gear and bolt pump to the timing gear case.

6) This procedure should get your tractor running, but some fine-tuning may be required to achieve optimum performance.

7) Some timing gears have a set of two dots, which are the timing marks. The single dot on the idle gear should meet between the 2 dots on the timing gear.

8) Important: Be sure to check the pump oil after installation. Use 15W40 Rotella for both the engine and the pump. There are normally two small bolts on the back side of the pump that are used for fill levels. Remove the bottom bolt, then add oil until it comes out of that hole.

TIMING TOOL KIT for Bosch fuel injection pumps

This kit enables you to set the correct timing position on

Bosch VE type fuel pumps and compatible pumps manufactured by Kikki and Nippon Denso.

This kit adjusts and calibrates the diesel injection pump to adjust the injection timing and oil volume of the oil pump. Similar to the gasoline engine calibration carburetor and ignition timing, it helps to improve the power of the diesel engine, save fuel and prevent diesel explosion.

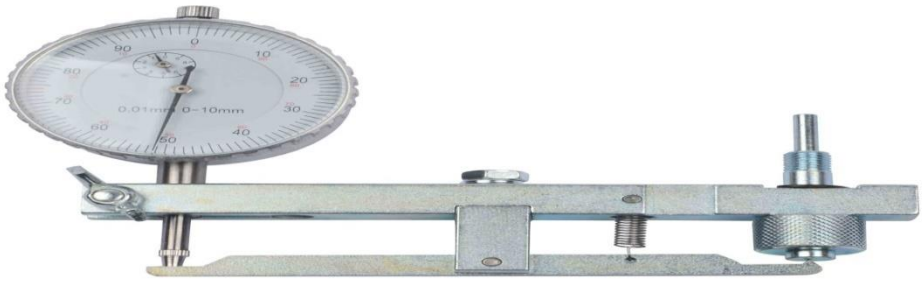


Fig.3.1. Injection timing checking device

1. Unscrew the standard tip from the dial test indicator and fix the correct extension in its place.
2. The short extension (F) is used with the short M8 adaptor (E), and the long extension (C) is used with the long M8 adapter (A).
3. Select the correct length M8 adaptor and attach the dial test indicator with extension.
4. Tighten the adaptor to the dial test indicator shank by using the nut and secure.

Some fuel pumps have a M12 threaded port,

5. Item (D) can be fitted to either adaptor and converts the M8 thread to M12 – (Fig 1)
6. Clean the fuel injection pump around the service port.
7. Remove the plug and attach the adapter and dial test indicator. You can turn the dial test indicator to make it easy to read – (Fig 2)
8. Loosen the nut on the adapter to enable you to bring the dial test indicator and extension into contact with the pump plunger. This will pre-load the dial test indicator by approximately 1mm.
9. Tighten the nut to prevent the indicator sliding within the adapter.
10. Zero the dial test indicator bezel and lock it in position with the thumbscrew.
11. Turn the crankshaft backwards until the pointer on the dial test indicator stops moving. Check that the small scale on the face of the dial test indicator shows a 1mm pre-load and re-zero the bezel.
12. Turn the crankshaft forward to the static timing point and compare the reading on the dial test indicator with the manufacturer's specified timing data.

13. When the reading is correct, remove the dial test indicator, adapter and any extensions.

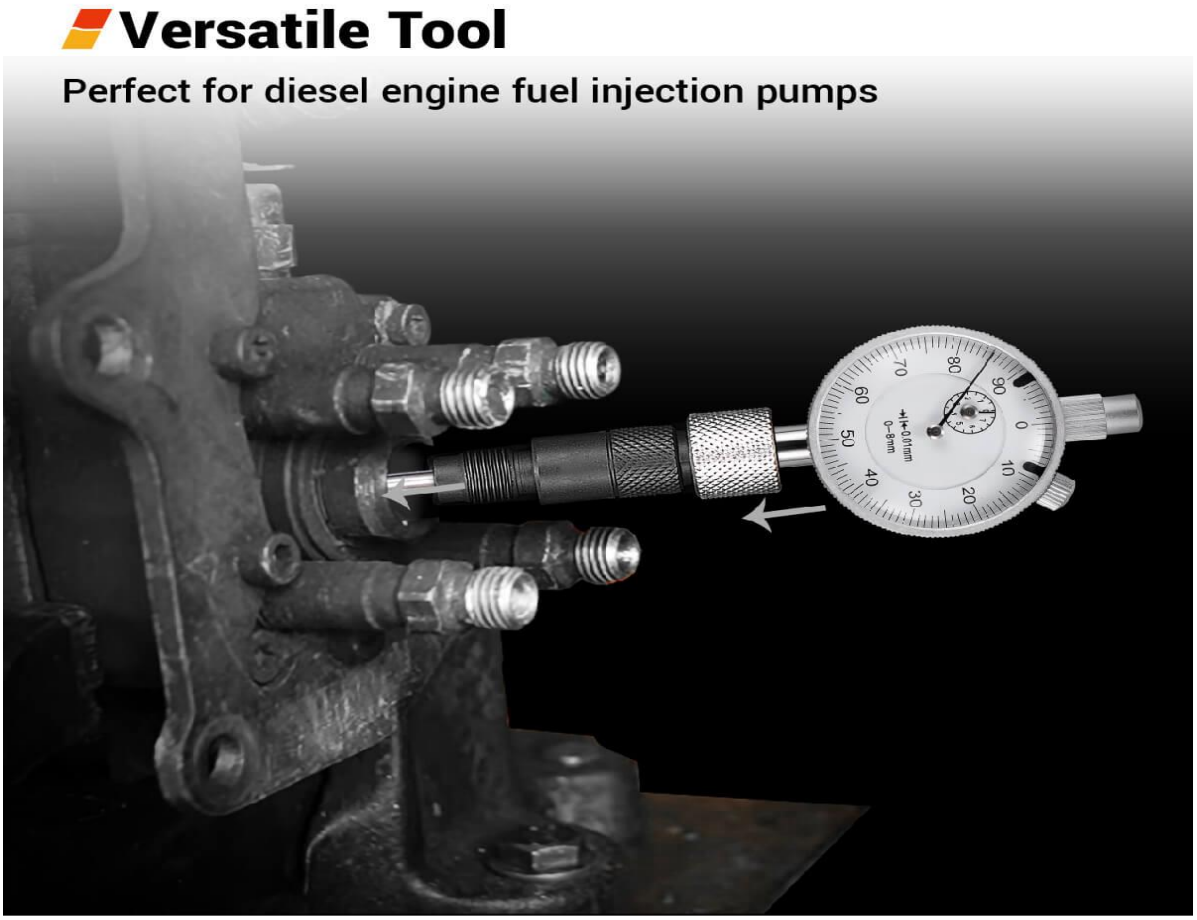


Fig.3.2.Injection timing checking device

Self-Check – 1	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. Write The funcation of Injection timing checking device?(5pts)

Note: Satisfactory rating – 5 points Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

Information Sheet 2- Interpreting result without error

1.1. Interpreting result without error

Injection Timing — What You Need to Know

The internal components of a marine engine are complex and rely on precise movements to deliver efficient and reliable power. You may not understand everything that occurs within the system, but if you have an idea of how an internal combustion engine operates, you can make comprehensive timing injection adjustments.

In an internal combustion engine, thermal energy transfers into mechanical energy. The created power moves an engine's pistons, therefore, moving the crankshaft, then the marine unit itself. Thermal energy comes from the combusted air-fuel mixture inside the cylinder.

The head of a cylinder contains the system's valves, camshafts, valve return springs, valve buckets and injectors. The engine block, connected below the cylinder, contains the crankshaft, connecting rod and piston. A piston moves inside the cylinder from the bottom dead center to the top dead center during combustion.
There are a few terms you'll need to know to understand how the piston moves inside the cylinder, including:

- **Top Dead Center (TDC):** Top dead center is when the piston is at the top of the cylinder, positioning itself farthest from the crankshaft.

- **Bottom Dead Center (BDC):** Bottom dead center is when the piston is closest to the crankshaft at the cylinder's lowest point.

- **Before Top Dead Center (BTDC):** Before top dead center is the point right before the piston reaches the highest area of the cylinder.

Why You May Want to Adjust Your Injection Timing

The primary purpose of a fuel injection system is to provide diesel to an engine's cylinders — but how and when the fuel is delivered can impact an engine's performance, sound and emissions.

Advancing or retarding an engine's timing is possible. Advancing an engine's timing causes the injection process to occur earlier than the manufacturer's settings.
In opposition, retarding is when you make changes, so the fuel releases after the recommended time. Although retarding is less common compared to advancing, it can repair a lag or smoking problem within a marine engine. It can also support performance and fuel economy issues.

Reasons to Adjust Injection Timing

You can adjust injection timing if your marine engine is past its prime running days or has had work done. For example, if you've installed a new timing belt or injection pump, you will need to adjust the system to ensure it's at factory standards. Or, you can choose to adjust it to your specific needs. Over time, the injection pump timing retards, resulting in problems, such as:

- **Difficult starting**
- **Hot engine temperatures**
- **Poor fuel economy**
- **Smoke during startups and acceleration**

Making the proper adjustments can get the system back to its original performance levels or better.

Be aware that upping your engine's power isn't always the right move. Sometimes, more power can result in excessive smoking from the exhaust and delay boost. It can

also increase the engine's output of vibration and cause more emissions, which may not be up to par with EPA standards.

Make sure you look at your marine engine as a whole and whether it's a wise decision. Know what your equipment can handle and what it requires. If you're not sure, your best bet is to work with a mechanic that knows the ins and outs of an engine's injection timing.

Advantages of Adjusting Diesel Engine Injection Timing Systems

Because a timing component delivers diesel under intense pressures, the parts and materials can withstand high levels of stress and heat. With high tolerances, the injection system can perform well when the engine runs for an extended time. Diesel injection timing also has more in-depth controls.

When you combine all its properties, an injection timing system can make up about 30 percent of a diesel engine's total costs.

If you're looking to advance the timing injection of your marine devices, you want to ensure the engine makes full use of the fuel injection process. Make sure the correct amount of diesel releases at the right time to meet your power requirements. You need both the injection timing and metering to be controlled. Several benefits of advancing your engine's ignition timing control include:

Boosted engine power capabilities

- **Higher peak cylinder pressure**
- **Lower exhaust temperatures**
- **Higher NOx emissions**
- **Increased fuel efficiency**

Although manufacturers set the injection timing in a way that balances both emissions and power, it doesn't mean the marine engine system is set to its maximum potential.

You can advance the timing of your engine to increase your machine's power when you want to operate at faster speeds or tow more weight.

If you're looking to adjust the injection after BTDC occurs, you can reap other benefits such as preventing premature combustion, reducing smoke and repairing lag.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. Reasons to Adjust Injection Timing?(6pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

1.

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Information Sheet 3- Checking timing advance operation

3.1 Checking timing advance operation

Checking the angle of advance of fuel injection

The angle of advance of injection and the angle of advance of fuel supply. Dimensions of timing advance

The most important criteria for optimizing the operation of a diesel engine are as follows:

- low toxicity of exhaust gases;
- low noise from the combustion process;
- low specific fuel consumption.

The point in time at which the high-pressure fuel pump starts to supply fuel is called the beginning of the supply (or closing of the channel). This point in time is selected in accordance with the ignition delay period (or simply the ignition delay). They are variable parameters that depend on the particular operating mode. The injection delay period is defined as the period between the start of the feed and the start of the injection, and the ignition delay period is the period between the start of the injection and the start of combustion.

The start of injection is defined as the angle of rotation of the crankshaft in the TDC area, in which the nozzle injects fuel into the combustion chamber.

The start of combustion is defined as the moment of ignition of the fuel-air mixture, which can be affected by the start of injection. In the high-pressure fuel pump, the adjustment of the beginning of the feed (closing the channel) depending on the number of revolutions is best carried out using the injection advance device.

Purpose of the injection timing device

Due to the fact that the injection advance device directly changes the moment of the start of the feed, it can be defined as a regulator of the start of the feed. The injection advance device (also called the injection advance clutch) of the eccentric type converts the drive torque supplied to the injection pump, at the same time, carrying out its regulatory functions.

The torque required by the injection pump depends on the size of the pump, the number of plunger pairs, the amount of fuel injected, the injection pressure, the diameter of the plunger and the shape of the cam. The fact that the drive torque has a direct effect on the timing of the injection advance should be considered when designing along with the possible power output.

How to set the injection advance angle on a diesel engine

The need to install ignition on a diesel engine with your own hands often arises in such cases:

- the ignition of the diesel engine needs to be adjusted in parallel with the replacement of the timing belt;
- after dismantling the injection pump, it is not possible to install the fuel pump pulley according to special marks;

One of the recommendations before starting any work related to the analysis of diesel fuel equipment is an urgent need to clearly note and refresh all marks. To do this, it is enough to apply small strokes with paint or a high-quality marker. This will facilitate subsequent reassembly and installation of the high pressure fuel pump pulley, which will automatically eliminate or minimize potential ignition malfunctions.

There are several ways to set the ignition on a diesel engine:

- strictly by tags (subject to availability);
- empirical selection method;

Mark angle

The first way to independently set the angle of ignition of a diesel engine (the moment of injection of diesel fuel) according to marks involves shifting the fuel pump. This method is suitable for diesel ICEs in which mechanical fuel equipment is installed.

The injection advance angle is adjusted by turning the injection pump around the axis. A method is also possible when the camshaft pulley rotates in relation to the hub. This method is suitable for those designs in which the pump and pulley do not have a rigid mount.

1. To adjust the ignition on a diesel engine with your own hands, you need to turn to the rear of the engine and get to, if necessary, remove the protective cover from it.
2. Next, you need to find the stopper on the flywheel, which is lowered into a special slot.
3. After that, the hand-wheel must be turned manually (using a key or other device). Turning the flywheel means that the engine rotates. You need to twist clockwise until the upper stopper latch works.
4. Then we pay attention to the drive shaft of the injection pump. It is possible that the scale on the drive clutch, through which rotation is transmitted, is in

the upper position. In this case, the mark on the flange of the injection pump coincides with the zero mark on the drive.

5. After aligning the tags, the mounting bolts can be tightened. The position of the adjustment scale on the drive clutch different from the upper one means that the flywheel stopper must be raised, after which the engine crankshaft rotates again by one revolution. Next, the position of the scale is again controlled.
6. After tightening the bolts of the drive coupling, the stop on the flywheel rises, the crankshaft rotates 90 °, then the stop is placed in the groove.

The final step is to install the flywheel protection in place and tighten the mounting bolts. Then the engine starts, its operation is analyzed. The unit at idle should work smoothly and smoothly, without failures and twitches. Hard work of the diesel engine, accompanied, is unacceptable.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. Write ways to set the ignition on a diesel engine(6)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

1.

……..

……..

……..

LG #36	LO #4 Bleeding injection system components

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Checking fuel level, line leakage and fuel strainer/filter
- Determining air lock free fuel system without error
- Identifying bleed screw and primer pumps without error

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Check fuel level, line leakage and fuel strainer/filter
- Determin air lock free fuel system without error
- Identify bleed screw and primer pumps without error

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
- Accomplish the “Self-checks” which are placed following all information sheets.
- Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
- If you earned a satisfactory evaluation proceed to “Operation sheets
- Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
- If your performance is satisfactory proceed to the next learning guide,

- If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1-Checking fuel level, line leakage and fuel strainer/filter

1.1. Checking fuel level, line leakage and fuel strainer/filter

Types of Fuel Gauge

1. A.C. electric fuel gauge with balanced coils.
2. Bimetal type electric fuel gauge.
3. Thermal type electric fuel gauge.
4. Thermostatic-type electric fuel gauge

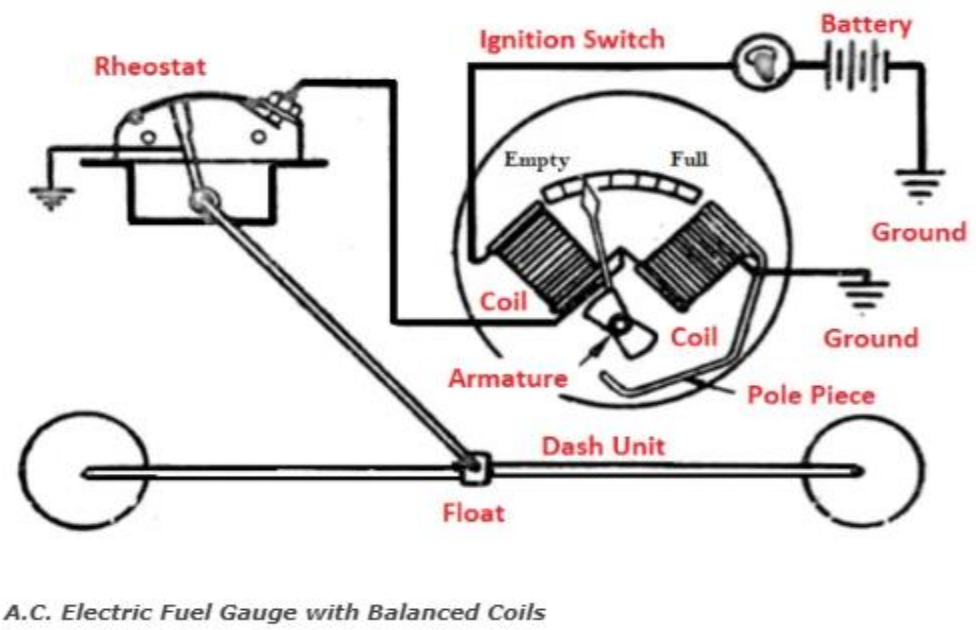
electric fuel gauge with balanced coils. It consists of two units-tank unit and dash unit. The two units are connected by a single wire. In these types of fuel gauge, the tank unit comprises a rheostat (resistance coil and movable contact) and a float.

The rheostat contact is operated by float to assume a position on the resistance corresponding to the position of the float in the fuel tank. This movable contact is earthed.

The dash unit or the instrument board unit consists of two coils spaced 90° apart with an armature and pointer assembly provided at the intersection of the coil axes. The right-hand coil is earthed.

Working

When the ignition switch is turned on, current from the battery flows through the two coils. This produces a magnetic field that acts on the armature to which the pointer is attached.



A.C. Electric Fuel Gauge with Balanced Coils

Fig 1.1. electric fuel gauge

When the tank is full and the float is up, the resistance in the tank unit is high. The current flowing through the *E* (empty) coil also flows through the *F* (full) coil. Thus the armature is pulled to the right so that the pointer indicates on the *F* (full) side of the dial. When the tank begins to empty, the float goes down and resistance of the unit drops. Thus, more of the current flowing through the *E* coil passes through the tank unit. Since less current is flowing through the *F* coil, its magnetic field is weaker and the armature is pulled to the left so that the pointer indicates towards the *E* (empty side of the dial).

The fuel gauge operates only when the ignition switch is turned on. The current consumption of the gauge is so low (0.15 amp) as to cause no appreciable drain on the electric system.

Vibrations in voltage depend supplied to the gauge do not affect their accuracy as their operation depends upon the proportion of electric current flows through the coils of the dash unit, rather than on the actual strength of their magnetic fields.

The construction of the fuel gauge depends upon the tank. For small tanks, the movable contact is actuated directly by the float arm. The float may be either single or double.

For large tanks, the movable contact may be mounted on a vertical axis and driven from the float arm by bevel gears.

2. Bimetal-Type Electric Fuel Gauge

The figure shows a bimetal-type electric fuel gauge. It also consists of two nits-the the sender unit and the dash unit or receiver unit. The sender unit is placed in the fuel tank. It consists of a heating coil wound around a bimetal strip and on external float mechanism which acts through a cam and flexible diaphragm so that the position of the float varies the height of earthed contact which in turn varies the tension in the bimetal strip.

The receiver unit located on the instrument panel in front of the driver. The two units are connected by a wire and receiver current from the battery of the generator.

Working

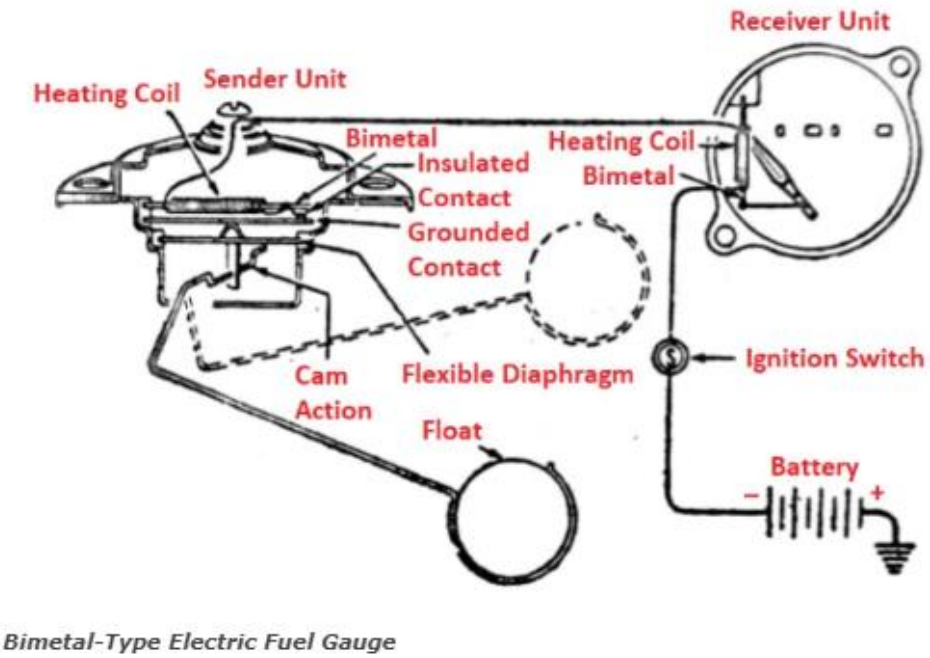


Fig.1.2. Bimetal-Type Electric Fuel Gauge

When the fuel tank is empty, the float is down and the two contacts in the sender unit are just touching. In this position, when the ignition switch is turned on, the current flows through the circuit, and heat is generated in the heating coil causing the bimetal to bend. As soon as the bimetal bends it opens the contact and the circuit breaks.

Then the heating coil and bimetal cool and the spring returns to its former position where contact is again made. Since the heating coils of the sender and receiver units are connected in series, similar slight bending of the bimetal in the receiver unit takes place, which pulls the pointer to zero position of the receiver unit.

When the fuel tank is full, the float is up, the eccentric shaft raises the earthed contact against the insulated bimetal contact, bending the bimetal in the sender unit. As the bimetal is under tension, more current is required to heat it so as to bend is sufficiently to break contact.

Due to the increased current, a similarly increased bending of the bimetal in the receiver unit occurs which pulls the pointer to “full” position. The cycle of opening and closing of the contacts is continuously repeated.

3. Thermal-Type Electric Fuel Gauge

The figure shows a thermal-type electric fuel gauge. It consists of two units-dash and tank unit. The dash unit is exactly like the receiver unit of the bimetal electric fuel gauge. The tank unit consists of a rheostat in the form of a sliding contact on a resistance wire, which is moved by the float. The two units are connected in series to a contact voltage regulator, which is energized when the ignition switch is turned on.

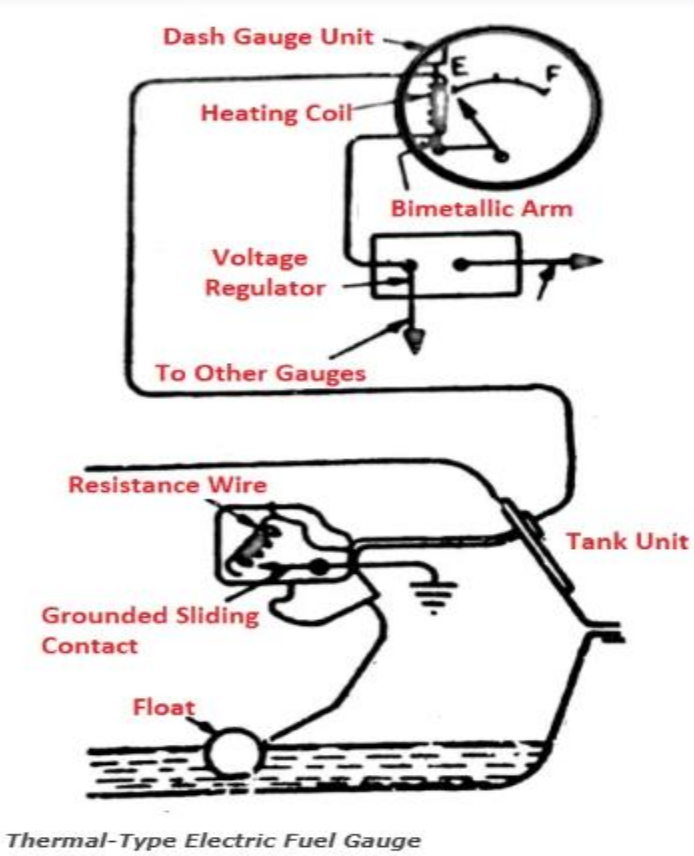


Fig.1.3.Thermal-Type Electric Fuel Gauge

Working

When the fuel tank is full and the float is up the circuit has the least resistance in the tank unit resistance wire and more current flows through the circuit. This causes heating the bimetal arm so that it bends the moves the needle towards a “full” position.

When the tanks begins to empty, the float drops. It increases the resistance which reduces the current to a value that causes the bimetal arm to force the needle towards “empty” position.

4. Thermostatic Type Electric Fuel Gauge

The figure shows a thermostatic type electric fuel gauge. It is an early type gauge still used on some late model cars. It uses two wires to connect the dash unit and tank unit, instead of one wire in other gauges. The dash unit consists of a pair of thermostat blades, each with a heating coil.

The coils are connected in series through the ignition switch to the battery. When the ignition switch is turned on, the current passing through the coils beats them. The heat causes the blades to bend so as to move an indicator over a scale. The tank unit consists of a float that actuates a cam. The cam, on turning, imposes bending on the tank thermostat blade.

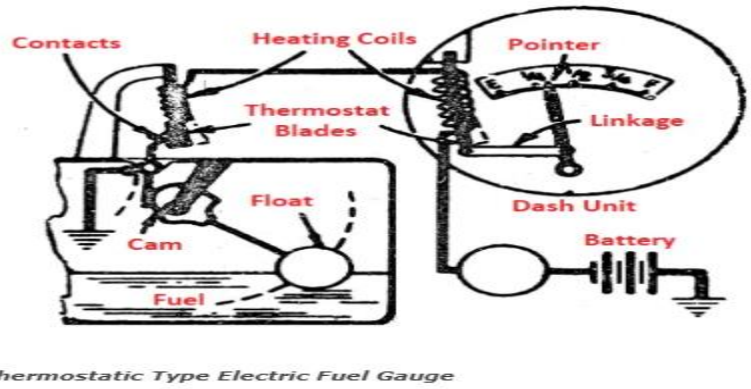


Fig.1.4. Thermostatic Type Electric Fuel Gauge

Working

When the tank is full, and the float is up the cam puts a considerable bend in the blade. The current flowing through the heater coils, when the ignition switch is turned on, heats the tank blade, it bends farther so that the contact separates. Then the blade cools and the points reopen.

This action continues as long as the ignition switch is on. Meanwhile, the blade in the dash unit is heated and bends the same amount. Movement of this blade is carried through linkage to the pointer which moves to indicates “full” position.

When the tank is empty, the float is down, the cam bends the tank thermostat blade only a little. Thus, only a small amount of heating is enough to bend the blade farther and open the contacts. The dash unit blade bends only a little and the pointer indicates towards the “empty” position.

As used in vehicles, the gauge consists of two parts:

- The sending unit - in the tank
- The indicator - on the dashboard

The sending unit usually uses a float connected to a potentiometer, typically printed ink design in a modern automobile. As the tank empties, the float drops and slides a moving contact along the resistor, increasing its resistance.

In addition, when the resistance is at a certain point, it will also turn on a "low fuel" light on some vehicles.

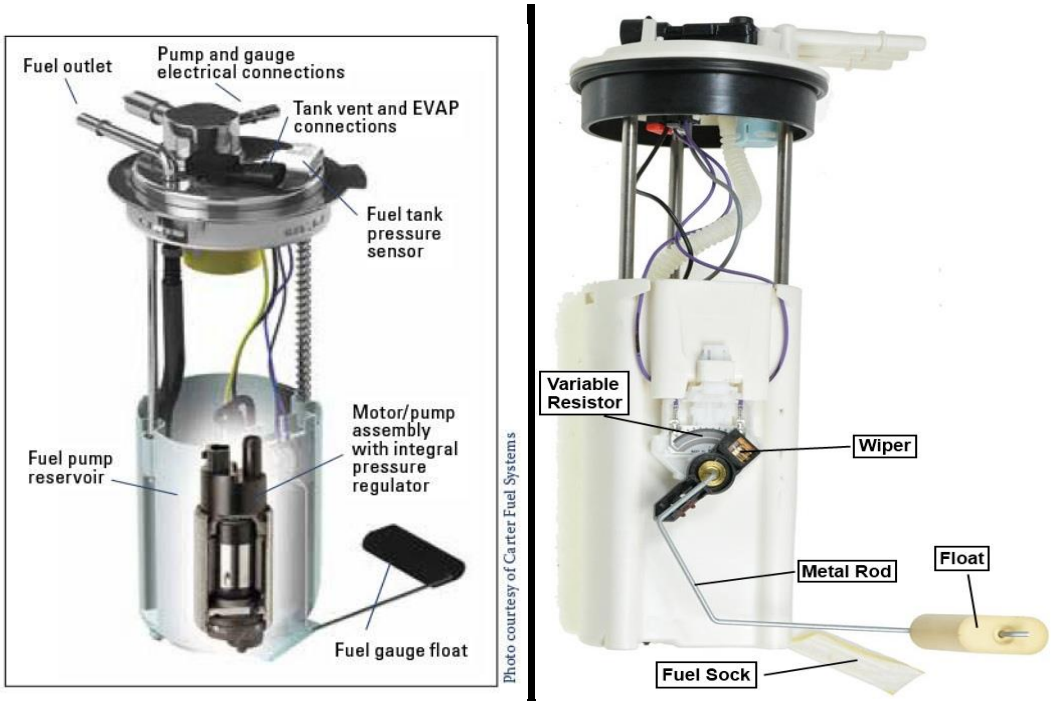


Fig.1.5. fuel level sending unit

Meanwhile, the indicator unit (usually mounted on the dashboard) is measuring and displaying the amount of electric current flowing through the sending unit.

Fig.1.6.Fuel level display unit

When the tank level is high and maximum current is flowing, the needle points to "F" indicating a full tank.

When the tank is empty and the least current is flowing, the needle points to "E" indicating an empty tank; some vehicles use the indicators "1" (for full) and "0" or "R" (for empty) instead.

The digital fuel gauge in a 2018 Mazda 3 showing a nearly-empty tank along with a distance to empty display.

The system can be fail-safe. If an electrical fault opens, the electrical circuit causes the indicator to show the tank as being empty (theoretically provoking the driver to refill the tank) rather than full (which would allow the driver to run out of fuel with no prior notification).

Corrosion or wear of the potentiometer will provide erroneous readings of fuel level. However, this system has a potential risk associated with it.

An electric current is sent through the variable resistor to which a float is connected, so that the value of resistance depends on the fuel level.

In most automotive fuel gauges such resistors are on the inward side of the gauge, i.e., inside the fuel tank. Sending current through such a resistor has a fire hazard and an explosion risk associated with it.

These resistance sensors are also showing an increased failure rate with the incremental additions of alcohol in automotive gasoline fuel. Alcohol increases the corrosion rate at the potentiometer, as it is capable of carrying current like water.

Potentiometer applications for alcohol fuel use a pulse-and-hold methodology, with a periodic signal being sent to determine fuel level decreasing the corrosion potential. Therefore, demand for another safer, non-contact method for fuel level is desired.

many fuel gauges have included an icon with a fuel pump and an arrow, indicating the side of the vehicle on which the fuel filler is located.

Fuel strainer

Fuel strainer protects rest of car's fuel system

There is a strainer that filters the fuel and keeps particles out prior to it entering the fuel line.

It is usualy a woven plastic fabric in the shape of a tube with the ends heat-sealed shut. It slides over the fuel pick-up tube.

The filter keeps relatively large sediment and suspended particles from entering the fuel line. It is your first line of defense.

This is especially important when there is an electric, in-tank pump directly above the filter. Electric pumps are usually very intolerant of dirt as it will cause rapid wear.

If there is an electric fuel pump failure, the strainer should always be changed. This is not to assume the strainer caused the failure. It would just be foolish to put an old strainer back on. They can cause a fuel restriction if partially clogged. When they are wet with fuel, much of the contamination may appear transparent. If the filter is allowed to air dry the blockage usually becomes opaque and more visible.

Checking fuel leakage

What causes fuel to leak?

Fuel leaks happen over time because the **fuel** tank rots, gets old, or fails. If this happens, the entire thank may need to be replaced. ... Some **fuel leaks** happen because of a small hole in the **fuel** tank. If this happens, a mechanic can repair the hole without having to replace the entire tank.

Preliminary Inspection

Raise the vehicle and support it on jack stands. Using a flashlight, trace the fuel lines from the tank to the engine. Look for evidence of the leak, to include spots with a greater accumulation of dust and road grime, wet spots or streaks and clean spots where the fuel washed away all of the grime. If you find evidence of fuel dripping from a frame member or other structural component, follow that member to discover the source. Bear in mind that gravity, as well as wind pressure, can affect the path of travel and the fuel may be running along a series of members before it drips out.

Dyes

Several products are safe to add to your gasoline or diesel fuel to help locate the source of a fuel leak. Essentially, these products contain a dye that will glow under florescent or ultra-violet light. Check the instructions for the dye to see which type of light makes it visible. Add the dye to the fuel and run the engine so that it leaks some of the treated fuel, then perform a visual inspection with a hand-held light. These products are available under brand names such as Cliplight Incorporated Multi-Purpose Dye, Gas-Glo 32 by Spectronics Corporation and AutoPRO Dye by Interdynamics, among others.

Fuel Detectors

Some leaks can be well hidden and defy attempts to find them visually. In these cases, use a device known as a leak detector to zero in on the source. The device has a probe that you insert into areas that aren't readily visible, and it detects the presence of compounds within both gasoline and diesel.

Safety Concerns

Fuel leaks can be very dangerous when left untreated. The most obvious danger is the possibility of a fire or explosion, but fuel can cause other damage as well. Both gasoline and diesel will attack and degrade the rubber in your tires, as well as any rubber bushings in the frame. It can also damage the finish on painted sheet metal, as well as any plastic components it contacts. Do not delay in effecting repairs once you determine that you do indeed have a fuel leak.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. What causes fuel to leak?(4pts)
2. List types of Fuel Gauge?(5pts)

Note: Satisfactory rating - 9 points Unsatisfactory - below 9 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

1. ……

   ……

2. ……

   ……

   ……

Information Sheet 2- Determining air lock free fuel system without error

2.1. Determining air lock free fuel system without error

How do you clear an airlock in a fuel line?

The first **way to clear** an **airlock**, involves attaching a **hose** pipe to the hot and cold taps at a sink in your home and turning the cold tap on so that the water flows through the **hose** pipe, into the hot water tap, **removing** the air.

A **vapor lock** being drawn into the **fuel** pump could disrupt the **fuel** pressure long enough for the float chamber in the carburetor to partially or completely drain, **causing fuel** starvation in the engine.

Similarly, how do you get an airlock out of your car?

The simplest remedy for an **air lock** is cycling the system. Start the engine run it up to temperature, shut it off, allow the engine to cool and repeat as required.

Beside above, should a fuel filter have air in it?

A **fuel filter** is going to **have air in it** unless you can bleed it. It starts out with **air** and then fills up. You can do a lot of parts changing or you can see if the problem is really what you think it is or something all together different.

How do you bleed air from a fuel line?

To **purge air** from the low-pressure side of the **fuel** system, open **fuel**-**line** unions and **bleed** ports downstream of the pump, one at a time, beginning with those closest to the pump, and continue pumping until **fuel**, and not **air**, runs out.

When you change a diesel fuel filter, run out of fuel or disturb the fuel system, air is trapped.

When you try to start the engine this air acts as a lock, preventing the normal supply of fuel into the cylinder.

Here are the steps to take in bleeding air from a diesel fuel system:

1. Turn off fuel valve.
2. Clean outside of filter housing.
3. Install new filter element and new gaskets. A little oil on the gasket will aid a tight seal.
4. I'd suggest that you fill a spin-on filter with clean fuel before installation.
5. Open the bleed plug on the filter closest to the fuel tank.
6. Open fuel supply valve so that the fuel is available to the filter and pump.
7. Most all equipment has a hand priming pump lever to pump fuel through the system and replace trapped air. (Check operator's manual.) Pump several times until full flow, without air bubbles, escapes from the bleed plug holes.

8. You may need to bleed filters, fuel pump and lines to the injectors.

9. Close bleed plugs after all air is removed from the fuel tank, filters, settlement bulb, and fuel pump (only one at a time working through all bleed screws beginning closest to tank and ending at nozzles if necessary).

10. Try the engine; if it doesn't start or runs poorly, you may have to bleed the injection line.

11. Loosen injection lines at the injectors about one turn. The use of two wrenches will prevent the binding or twisting of the steel lines. Usually, it is enough to bleed just half of the lines at a time.

12. Crank the engine until all air is forced out and fuel is present.

13. Engine will start to pop on one or two cylinders.

14. Tighten the injector lock nut one at a time to tell by sound which cylinders are firing properly.

15. Run the engine until it runs smoothly. This will bleed the other injectors.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. How do you clear an airlock in a fuel line?(6pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

Information Sheet 3- Identifying bleed screw and primer pumps without error

3.1. Identifying bleed screw and primer pumps without error

How do you bleed air out of a diesel fuel system?

To purge air from the low-pressure side of the fuel system, open fuel-line unions and bleed ports downstream of the pump, one at a time, beginning with those closest to the pump, and continue pumping until fuel, and not air, runs out.

Bleeding System

- Remove air bubbles from a brake system, a fuel injection system, or a cooling system so that they won't impede the flow of liquid through that system.

BLEEDING THE FUEL SYSTEM

It will be necessary to bleed the fuel system to achieve a steady air free-flow of fuel if any of the following have occurred.

1. Running out of fuel.
2. If fuel shut off valve is left closed and engine runs out of fuel.
3. Replacing fuel filter.
4. Fuel injector nozzle or injector pump repair/service.
5. After repairing or replacing any fuel line.
6. Replacement of electric or mechanical fuel pump.
7. Any time air is permitted to enter the fuel system.

Visual Inspection

Check hoses, lines, filters, and linkages

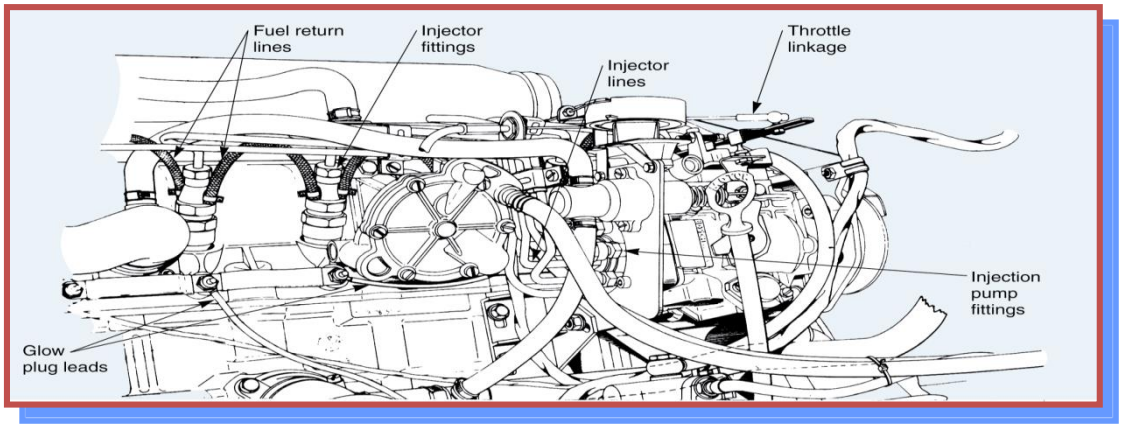


Fig.3.1. Check hoses, lines, filters, and linkages

Cleanliness

- Use clean, lint-free shop rags
- Use compressed air to blow dirt from fittings before disassembly
- Always cap a fitting that is disconnected
-

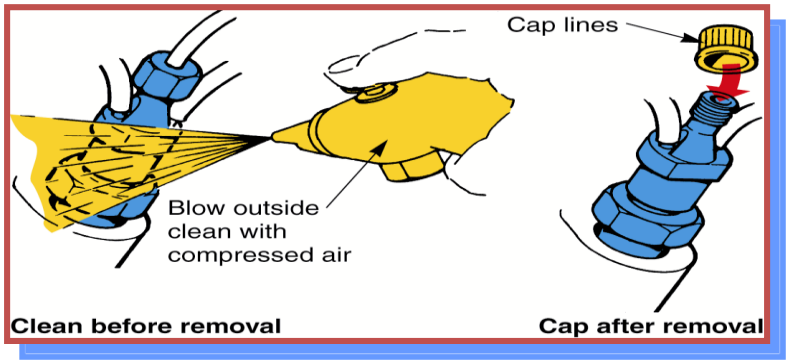


Fig.3.2.clean hoses, lines, filters

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. **How do you bleed air out of a diesel fuel system?(6)**

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

1. _____
2. _____
3. _____

Operation Sheet-1	Servicing Diesel Injection Pump(Bleeding the Fuel System)

BLEEDING PROCEDURE: (In-line Injection Pump)

Be sure to have some means available to catch or absorb any fuel escaping during the bleeding process so that it will not accumulate in the engine compartment or the work station.

1. Remove the cap that covers the priming pump ②
2. Turn the priming pump ② counterclockwise.
3. Loosen the air vent screws ①.
4. Move the priming pump ② up and down until no further air-bleed comes out of the air-vent screws ①.
5. Tighten the air vent screws ①.
6. Push and turn the priming pump clockwise.

7. Install the cap.

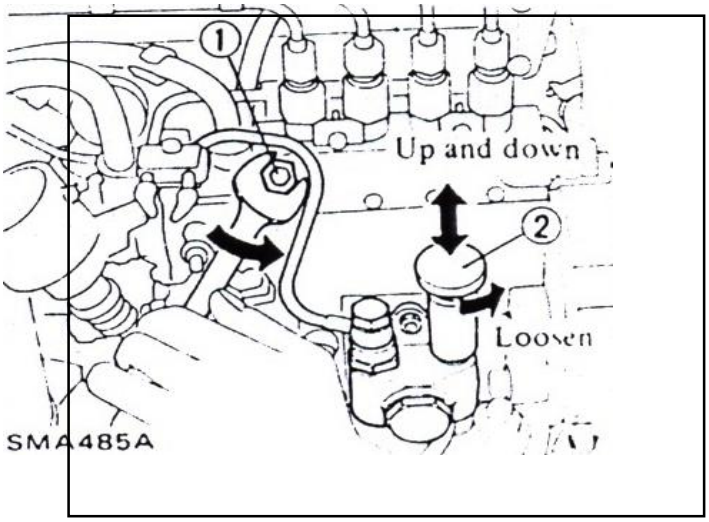


Fig 1. In-line Injection Pump

If engine will not start, loosen injection tubes at nozzle side and crank engine until fuel overflows from injection tubes. Tighten injection tubes flare nuts.

BLEEDING PROCEDURE: (Rotary Injection Pump)

1. Loosen the air vent screw and priming. Make sure that fuel overflows at vent screw hole.

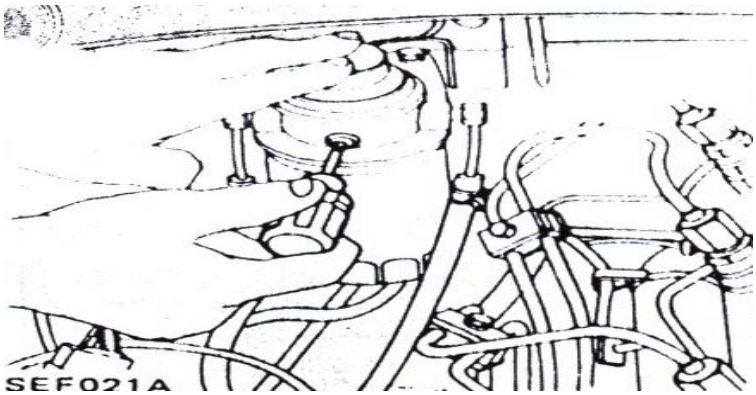


Fig.2 Rotary Injection Pump

2. Tighten vent screw.

3. Loosen injection pump bleeder screw/or disconnect return hose and priming.

Protect pump and engine mounts from fuel splash with rags.

4. Make sure that fuel overflows at bleeder screw/tube end, then tighten it/connect hose.

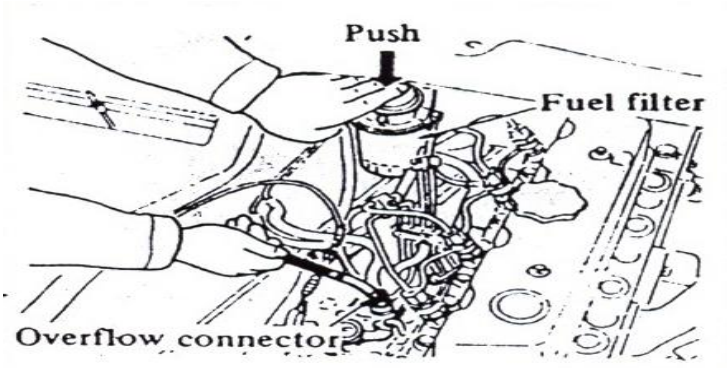


Fig.3 fuel overflows at bleeder screw

If engine will not start, loosen injection tubes at nozzle side and crank engine until fuel overflows from injection tube. Tighten injection tube flare nut.

LAP Test-1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Request necessary tools and materials you are required to perform the following tasks.

Task 1. Bleed the inline and rotary injection pump

LG #37	LO #5- Checking/adjusting tappet valve clearance and spark plug

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Setting valve tappet clearance
- Performing checking and adjustment
- Adjusting spark plug clearance
- Testing spark plug
- prescribing spark plug test result analyzed and appropriate recommendations

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Set valve tappet clearance
- Perform checking and adjustment
- Adjust spark plug clearance
- Test spark plug

- prescrib spark plug test result analyzed and appropriate recommendations

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
- Accomplish the “Self-checks” which are placed following all information sheets.
- Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
- If you earned a satisfactory evaluation proceed to “Operation sheets
- Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
- If your performance is satisfactory proceed to the next learning guide,
- If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1. Setting valve tappet clearance

1. Setting valve tappet clearance

What is Tappet Clearance ?

It is a gap between the top of the stem of the valve and the rocker arm.

Or

This is the space /clearance available between the tip of the rocker arm and the valve stem when the valves are closed when the engine is in cooled conditions , i.e. in compression stroke.

Why are we require to measure tappet clearance?

There is no real mechanical linkage between the valves and the rocker arm in four-stroke engines. When you open the cover of the cylinder head for inspection, you will find a gap/clearance in between.

There is no physical connection; valves are operated by the movement of push rod operating (pushing) rocker arm in one or another direction.

When there is a change i.e “increase or decrease” in this clearance due to thermal or mechanical expansion; valve timing is adversely affected so are the power cycle.

An increase in clearance will lead to late operation and early closure of exhaust and inlet valves. A valve that will open late and close early will have adverse effects on the engine; such as loss of power, improper combustion, hammering, high exhaust temperature, and engine failure.

On another hand, a decrease in tappet clearance will lead to early operation and late closure of valves.

A valve that will open early and close late will have a negative impact on the performance of the engine; such as power loss, leakage of scavenging air, high fuel consumption, heavy shoot formation, loss of compression pressure, and even burning or total valve failure.

So tappet clearance is regularly measured and adjusted based on manufacturer data to ensure the positive operation of inlet and exhaust valves.

In general, the clearance taken is between 0.2mm to 0.6mm depending upon inlet and exhaust valves and engine manufacturers.

How are Tappet Clearance Taken?

Taking tappet clearance for an engine unit is an easy but skillful task. Ensure that the unit is on the TDC, turning the turning gear clockwise up-to-the appropriate markings. Re-insure about the position by checking the fuel cam as well as the freeness of pushrod.

The engine unit is kept at TDC or compression stroke to ensure the availability of both exhaust and inlet valves for the measurement of clearance.

Checking freeness of push rod ensures that the unit is on the compression stroke and not on power stroke; as in the four-stroke engine, two units are at TDC at any given time. Now, once you are ready to measure the tappet clearance; go through your manufacturer manual to ensure the correct clearance settings.

Try to insert a filler gauge of different sizes in between the gap of the valve stem and rocker arm. Select a different set of filler gauge until you find the right one; which just passes through the tappet clearance without much resistance.

A gauge that can’t pass is just too big but no resistance means the size of the gauge is small so try another one. Once you find the right gauge; look for the dimension marked on it. Now compare it with the manufacturer recommendations; Adjust if necessary.

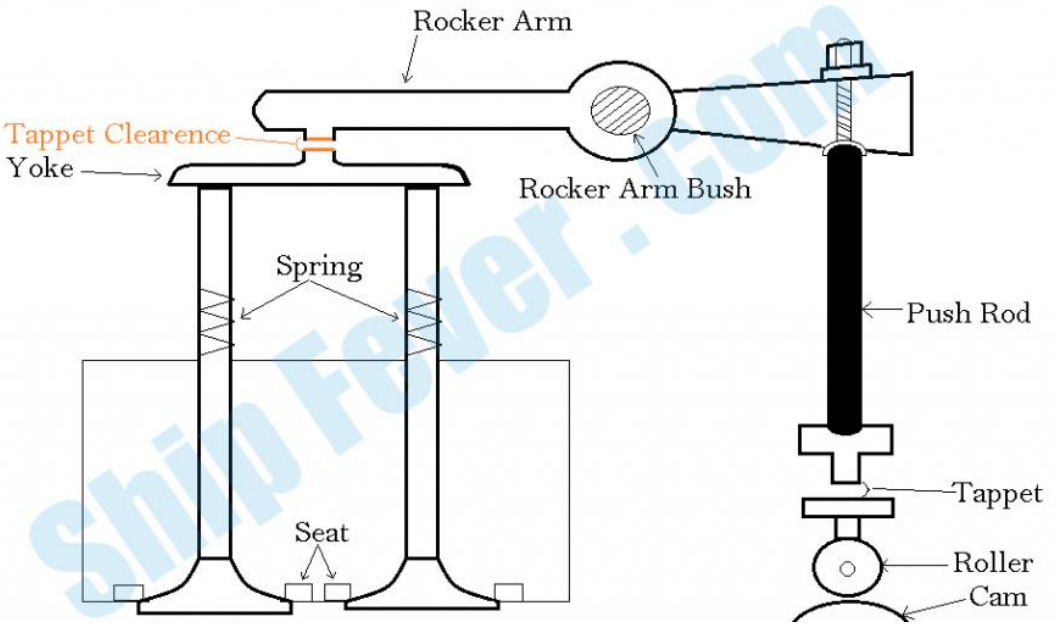


Fig.1.1. Tappet Clearance

Adjusting Tappet Clearance

Now after correct measurement of tappet clearance; you know whether to increase or decrease to set it at manufacturer recommendation. All you need is to adjust the clearance; but how?

Tappet clearance is adjusted after opening the lock nut above the rocker arm. This lock nut restricts the movement of tappet to ensure proper clearance setting. Open the nut using spanner of appropriate size (Normally Ring Spanner are Used).

Once the locknut is disengaged; tappet is free to move up and down. Adjust the tappet clearance by adjusting the position of the tappet. To ensure the correct clearance setting; it is a common practice to place the filler gauge of the desired dimension in the clearance area during adjustments.

Make sure you can slide the filler gauge smoothly once it is set; Too easy to pass is a clear indication of high clearance. This is sometimes hard to judge making it a job of skill and experience.

A small turn will ensure movement up to one-hundredth of a millimeter. Place the lock nut in place once done; re-tighten it without affecting the new clearance setting by the accidental movement of the tappet.

Recheck the clearance if necessary and made a record of maintenance for future purposes. Make sure all is right otherwise any misadjustment can lead to severe conditions such as push rod bending or valve failure.

Overview valve clearance

A **four stroke** engine has **intake**, **compression**, **combustion** and **exhaust** strokes, but valve operation is necessary in only **two of these strokes**: the intake and exhaust strokes.

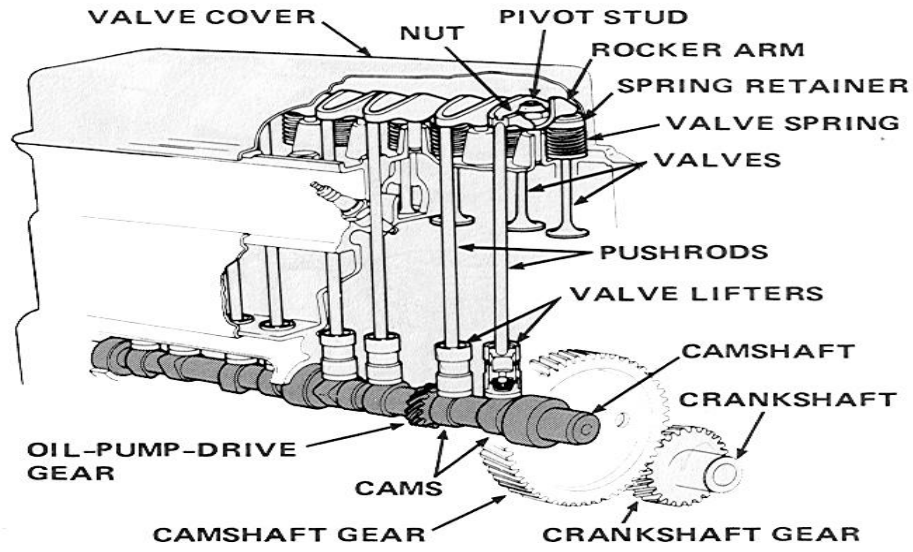


Fig.1.2. valve mechanis Construction

Rocker arm and shaft

The rocker arm is fitted to the rocker arm shaft. When the rocker arm is pushed up by the pushrod, it pivots about the rocker shaft and opens the valves.

The rocker arm is provided with a screw and lock nut for adjusting the valve clearance.

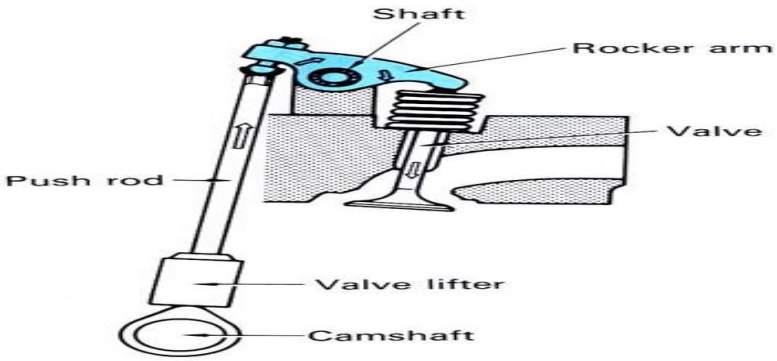


Fig.1.3. Rocker arm and shaft

Valve Clearance

A small clearance is provided between the **rocker arm** & the **valve stem**. This is called the valve clearance. This clearance allows the expansion of the valve & insures complete closing of valve.

This **valve clearance** or making a tappet or **lash adjustment**. "Lash" means free play or clearance.

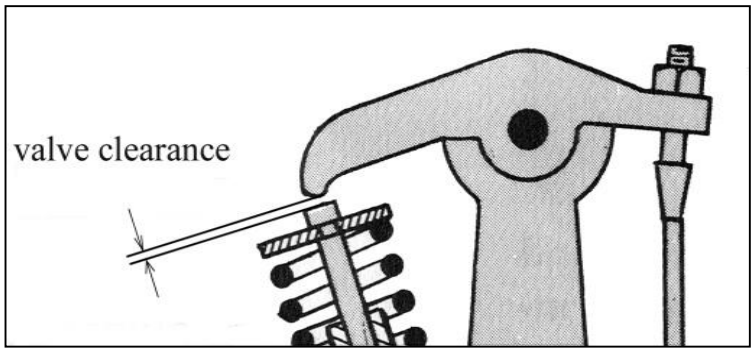


Fig.1.4. Valve Clearance

Valve Lifter (Tappet)

A valve lifter (Tappet) is a cylindrical component on OHV engine or OHC engine that connects each cam with its corresponding valve.

In engines having conventional valve lifters, the valve clearance must be adjusted properly because of thermal stress due to thermal expansion of valve operating components.

Maintenance-free hydraulic valve clearance is absorbed to maintain it at 0mm at all times.

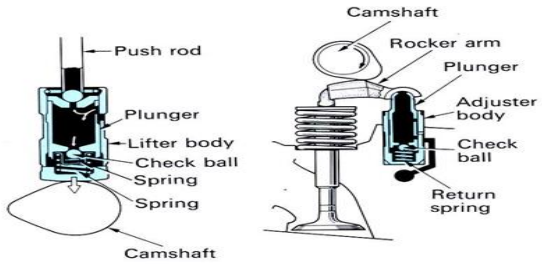


Fig.1.5. Valve Lifter (Tappet)

An excessive valve clearance has an effect of:

1. Presence of a regular taking sound

- The noise can become more of a general clatter emanating from the top of the engine, if more than one valve clearance is excessive.

2. The valve is not fully open.

(The valve opens too late & closes two early)

3. The valve is returned to its seat match faster than it would normally do.

Insufficient valve clearance:

1. The valve do not close completely, resulting in loss of compression & power
2. Due to incomplete closing the valve face and its seat will be burnt & may have to be renewed
3. If the valve concerned happened to be intake valve, it could be possible back fairing (burning gasses could find their way back into the intake manifold) with a consequent risk of fire.
4. Valve open early & close late.

Different Valve Arrangements

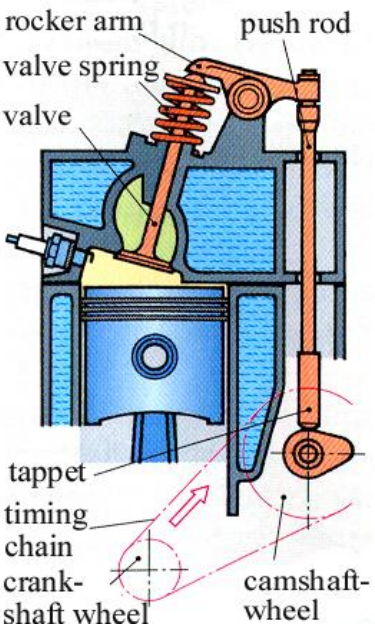
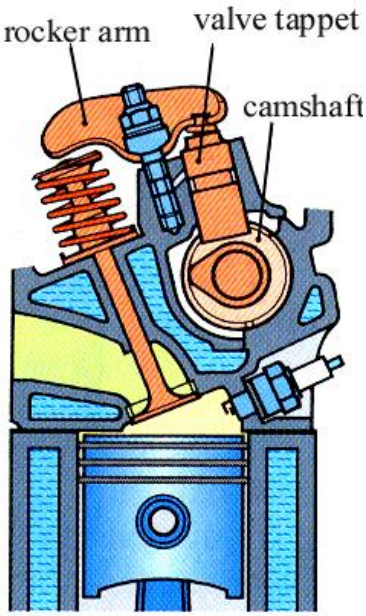
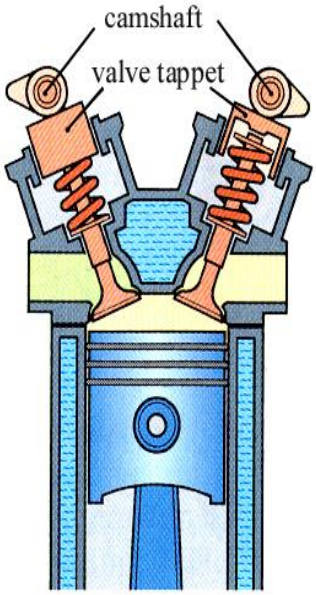
		
OHV (OVER HEAD VALVE) **- engine**	**CIH** (CAMSHAFT IN HEAD) **– engine**	**OHC** (OVER HEAD CAMSHAFT) **– engines DOHC (DOUBLE OVER HEAD)**

Table .1.1. Different Valve Arrangements

Basics Theoretical 4 strokes of Otto-engines	
STROKE	**EVENTS/CONDTION**
INTAKE	• intake valve opens (theoretical stroke: at TDC) • exhaust valve is closed (theoretically: since TDC) • piston moves downward • distance TDC to BDC = 180° crank angle • suction occurs / partial vacuum (0.1 to 0.3 bar) • air-fuel mixture (14.8 : 1) is drawn into the cylinder
COMPRESSION	• intake valve closes (theoretical: at BDC) • exhaust valve still closed • piston moves upward (BDC ➔ TDC = 180°) • air-fuel mixture gets compressed • air-fuel mixture is heated up (molecular motion) • increasing heat causes higher pressure (18 bar)

POWER	• both valves are still closed (theoretically: until BDC) • combustion is initiated by the spark from the spark plug • time from start of combustion till complete combustion • highest combustion pressure about 30 - 60 bar. • expansion of hot gases (up to 2500° C) forces the piston downward (TDC ➔ BDC = 180°) • heat energy is transferred into mechanical energy
EXHAUST	• exhaust valve opens (theoretically: at BDC) • intake valves remains closed (theoretically: till TDC) • due to rest pressure from combustion of 3-5 bar exhaust gases leave the cylinder with sonic sound • piston moves upward (BDC ➔ TDC = 180°)
SUMMARY:	• 4 strokes complete 720° crank angle & 360° camshaft angle (2 crankshaft rotations & 1 camshaft rotation) • each theoretical stroke is 180° crank angle • spark ignition takes place at or before TDC

Concerning difference between **theoretical** and **actual** stroke (event):

- ✓ **intake valve** opens already before TDC (45°-0° B. TDC) and closes after BDC (35° - 90° A. BDC)
- ✓ **exhaust valve** opens before BDC (90° - 30° B. BDC) and closes after TDC (0°-30° A. TDC).
- ✓ since intake opens already before TDC meanwhile exhaust closes after TDC we get **Valve Overlap**, a short period of time during both valves are open.

VALVE OVERLAP occurs at the TDC-position at which the exhaust valve closes and the intake valve opens, therefore a short period of time, during which both valves are open.

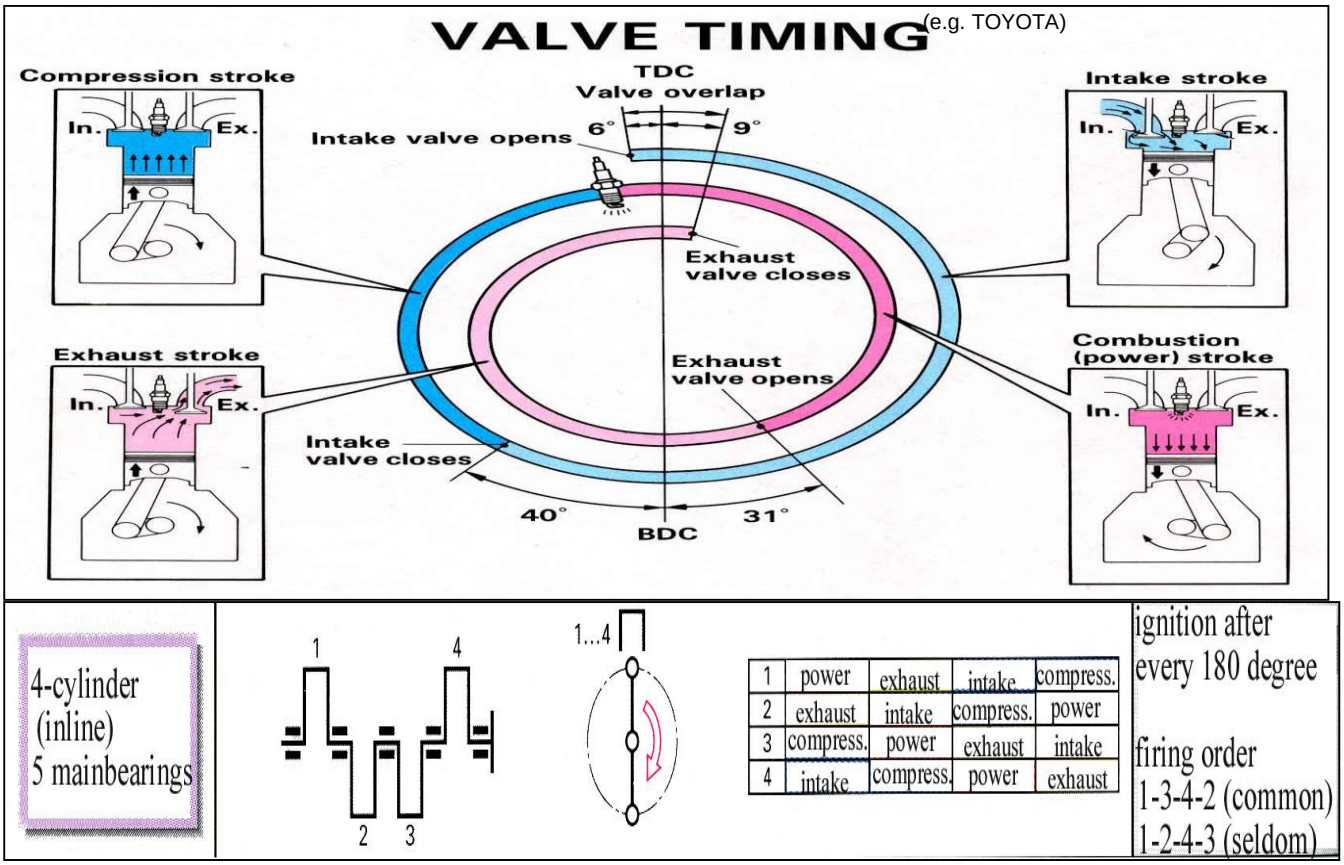


fig.1.6. valve overlap

One must be aware that **1st** and **4th** cylinder as well as **2nd** and **3rd** cylinder are running **parallel (=pair cylinders**). This implies that if e.g. cylinder No. 4 is at overlap (= begin of intake stroke) No. 1 will be at beginning of power stroke.

The table below shows different values of the "TOYOTA 3K-ENGINE" as some *examples only* for the influence of the valve clearance to the valve timing.

Valve timing with **correct** valve clearance (**hot** engine, **intake 0,20 mm, exhaust 0,30mm**), according to the manual

Intake opens	Intake closes	Exhaust opens	Exhaust closes	Overlap
10° - 5° Before TDC	45° - 50° After BDC	50° - 45° Before BDC	10° - 15° After TDC	15° - 25°

Table 1.2. Valve timing

Self Check-1	Written test

Short answer

1. excessive valve clearance has an effect of:
   - A. _____
   - B. _____
   - C. _____
2. Insufficient valve clearance has an effect of
   - A. _____
   - B. _____
   - C. _____
   - D. _____
3. Write and discuss the Different Valve Arrangements

Information Sheet 2- Performing checking and adjustment

What is valve tappet clearance?

The **clearance** in between the **valve** stem and rocker arm is termed as **tappet clearance**. They facilitates the operation of rocker arm in four stroke engine; by providing sufficient space for thermal expansion

When should I take tappet clearance?

Tappet clearance is one of the most important **clearance** in a 4 stroke engine. it should **be taken** every month as **clearance** may change due to continuous running of auxiliary engine. to **take** a correct **tappet**, the position of inlet and outlet valves is very important.

How To Check Tappet Clearance

1. Taking all safety precautions.
2. Make sure the piston is on TDC. ...
3. Make sure the engine has cooled down.
4. Loosen the lock nut of the rocker arm.
5. Now **adjust** the **tappet clearance** between the rocker arm & **valve** stem by tightening or loosing the nut below the lock nut.

How do you adjust tappet clearance?

Tappet clearance is **adjusted** after opening the lock nut above the rocker arm. This lock nut restricts the movement of **tappet** to ensure proper **clearance setting**. Open the nut using spanner of appropriate size (Normally Ring Spanner are Used). Once the locknut is disengaged; **tappet** is free to move up and down.

Tappet clearance is one of the most important clearance in a 4 stroke engine. It should be taken every month as clearance may change due to continuous running of auxiliary engine.

To take a correct tappet, the position of inlet and outlet valves is very important. The valves should be fully closed i.e the engine should be in compression while taking the tappet.

There are 3 ways to check that unit is under compression:-

- The fuel cam should be at its peak.
- The push rods of both the valves should be free to rotate.
- The flywheel marking.

Out of all three the fuel cam at its peak is the best and most reliable. And it should be noted that tappet to be taken when the engine is cold.

Procedure to set the tappet:-

1. Rocker arm to be removed from place.
2. The bridge/yoke placed at the inlet and outlet valves are removed from place and the screw provided on the bridge/yoke is loosened.
3. Then we have to first adjust the clearance at the two ends of each bridge so that it is same for both the valves for each bridge/yoke i.e both inlet or exhaust valves must open simultaneously and equally.
4. This can be done by the help of a dial gauge and slowly rightning the screw on the bridge/yoke
5. Once done, then rocker arm is placed back and tightening screw is loosened after loosening the tightening screw nut.
6. Place the filler gauge of required thickness on between the bridge and the rocker arm.
7. Slowly tighten the tightening screw of rocker arm.
8. Feel the tightness of the feeler gauge. If ok then lock the locking nut and then repeat for the other valve.
9. Once done for all units, rotate the flywheel to check proper operation.

Self-Check – 1	Written test

Short answer

1. **When should I take tappet clearance?(5)**

Answer Sheet

Name: _____ Date: _____

Test I

1. _____

_____

Information Sheet 3- Adjusting spark plug clearance

3.1. Adjusting spark plug clearance

SPARK PLUG BASICS:

The spark plug has two primary functions:

- To ignite the air/fuel mixture
- To remove heat from the combustion chamber

Spark plugs transmit electrical energy that turns fuel into working energy. A sufficient amount of voltage must be supplied by the ignition system to cause it to spark across the spark plug's gap.

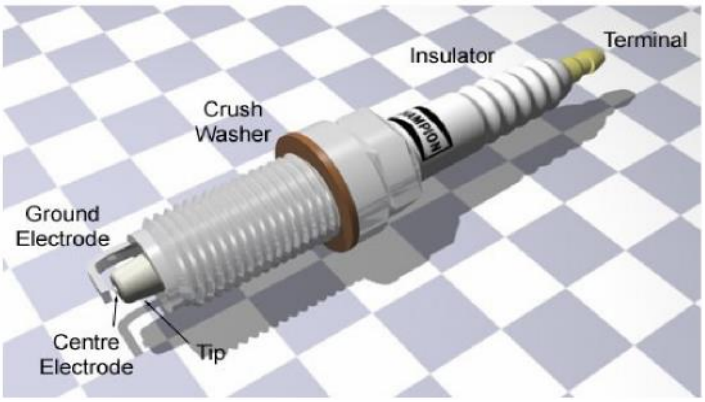


Fig.3.1. SPARK PLUG BASICS

It is important to remember that spark plugs **do not create heat**, they can only **remove** heat. The spark plug works as a **heat exchanger** by pulling unwanted thermal energy away from the combustion chamber, and transferring the heat to the engine's cooling system.

The rate of heat transfer is determined by:

- The insulator nose length
- Gas volume around the insulator nose
- The materials/construction of the center electrode and insulator

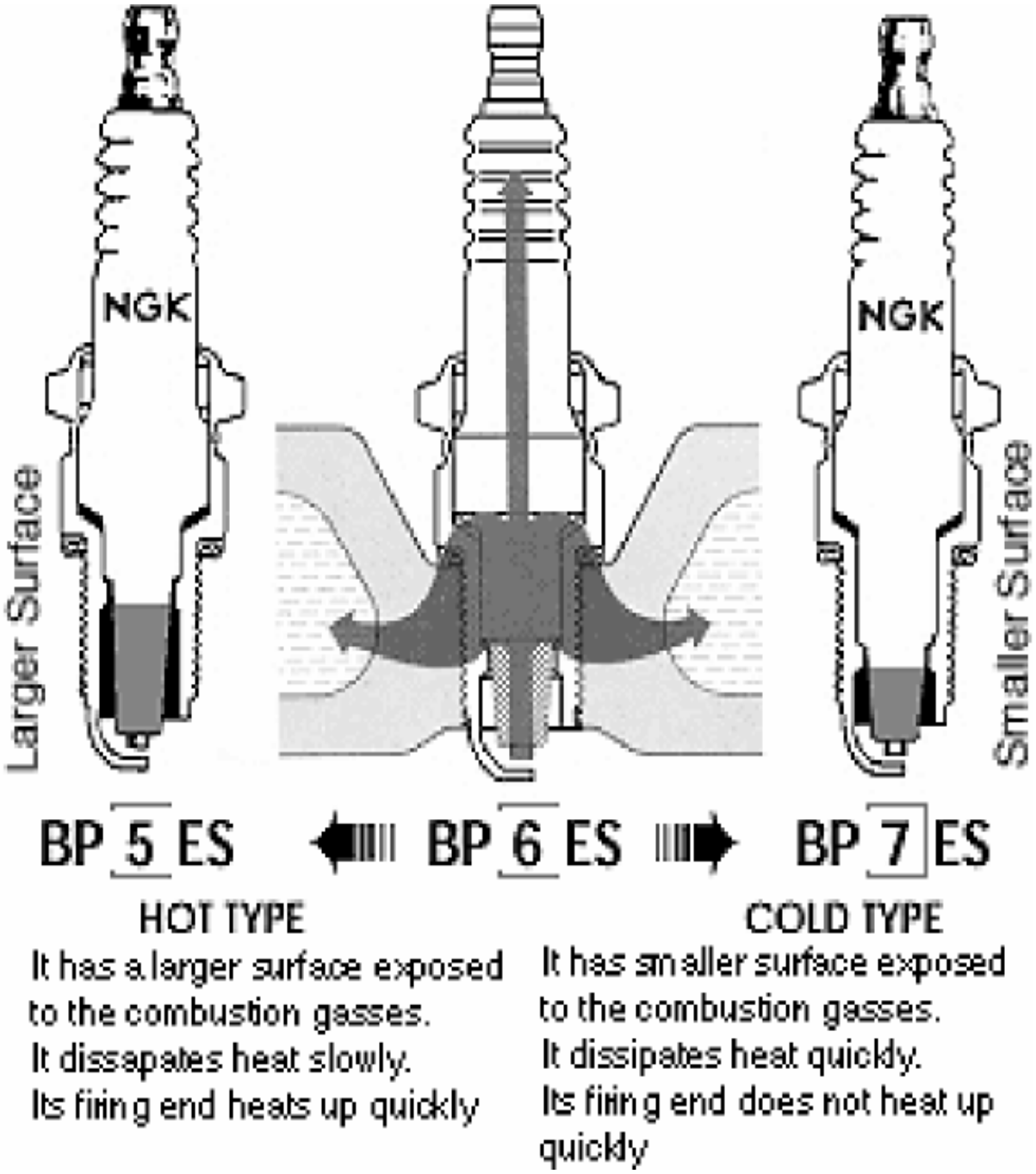


Fig.3.2. SPARK PLUG BASICS

Fig.3.3. SPARK PLUG BASICS

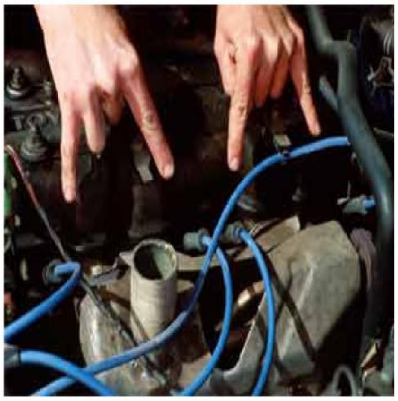
Tools and equipment

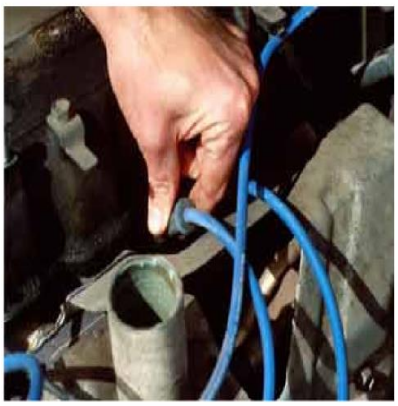
- Spark plug wrench
- Flat Screw driver
- Cleaning tools
- Rag

- Sand paper

Cleaning and adjusting the Spark Plugs

1. Open the Vehicle engine hood.
2. Find the spark plugs, located in a row along one side of the engine (on an in- line four-cylinder engine) and attached to thick wires, called spark plug wires.
3. Blow or wipe away any dirt or debris around the spark plugs.
4. Dismantle one spark plug at a time, always putting the plug wire back on after adjusting spark plug.
5. You do not want anything to fall into the cylinder while the spark plug is out.
6. With the spark plug socket and a ratchet, remove the spark plug by turning it in a counterclockwise direction.
7. Check the spark plug to make sure it needs replacing. A good spark plug should be lightly coated with grayish brown deposits.





If heavy deposits are present, if the spark plug is black or if the electrode or core nose is damaged, the plug needs to be replaced.

8. Clean the plug. Insert the spark plug gapping tool in the gap between the metal center electrode and the metal side electrode of the plug's tip.

   Note: - Spark plug gap mostly 0.6 – 1 mm

9. After adjusting the gap correctly install spark plug on the engine.

Fig.3.4. Cleaning and adjusting the Spark plug

Self-Check – 1	**Written test**

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. Explain primary functions of spark plug

Answer Sheet

Name: _____ Date: _____

1. ----------

Score = _____

Rating: _____

Information Sheet 4- Testing spark plug

Testing spark plug

spark plug tester

How to Use a Spark Plug Tester

1. Disconnect the **spark plug** lead from the **spark plug**.
2. Connect your **spark plug tester** to the **spark plug** lead.
3. Connect the **spark plug tester** to the **spark plug** creating a link from the lead to the **spark plug**.
4. Start the engine and watch the gap in the **spark plug tester** to see if there is inconsistent timing.

How do you test for weak spark?

The engine will be weak, the unburned fuel will foul the spark plug, and the exhaust will pop. If the mixture is excessively lean, the engine will misfire since the fuel molecules in the intake air are too far apart.

What causes weak spark?

Loss of spark is caused by anything that prevents coil voltage from jumping the electrode gap at the end of the spark plug. This includes worn, fouled or damaged spark plugs, bad plug wires or a cracked distributor cap.

As the name suggests this tests the spark plug, or more accurately it tests whether there is an electrical current capable of generating a spark. The devices are very simple to operate, and safe.

You simply remove the HT lead and plug the device in-line, so it connects to the end of the HT lead and the base of the spark plug. Operate the engine as usual, and the tester will illuminate if it is receiving a strong electrical input.

If no light is illuminated further diagnostic work is needed. First swap the plug, then the HT lead. If you get no joj, then work back down the ignition system until you find the fault.

You can test a plug for a spark by 'earthing it'. To do this removing the plug, but reconnect the HT lead – hold the HT rubber boot with insulted pliers and almost touch the engine block with the spark plug.

Get someone to attempt to start the engine and you should see a strong blue spark jump from the plug to the engine. If this is a weak spark it may not be sufficient to overcome the immense cylinder pressures – which is why an in-line tester is a more reliable method of diagnosis.

fig.4.1 spark plug tester

Features:

- Tests for lack of spark condition.
- Essential for trouble shooting all internal combustion engines.
- Easy to use, get results in seconds.
- Finds dirty spark plug connections, defective points, bad cables or connections, and more.
- Bulb flashes when spark circuit is completed, indicates ignition system or fuel delivery problem.
- Simply connect between spark plug and spark plug wire.

Check spark plug

- Remove it.
- Keep it plugged into the spark plug cable.
- Ground it on the frame.

- Start and check if sparks happen.
- If they are blue, the spark plug is ok. Else if the sparks are yellow or there is no spark at all then the spark plug is bad.

While this method may work in most of the case, it does assume that the wiring/spark plug cable etc. are doing their job properly.

Basically, I'm looking for a way that would confirm that I get no fire because the spark plug are bad and not because there is any other background problem such as bad spark plug cable etc.

Self-Check – 1	**Written test**

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. How to Use a Spark Plug Tester(5pts)

Answer Sheet

Name: _____ Date: _____

1. ----------

Score = _____

Rating: _____

Information Sheet 5 -prescribing spark plug test result analyzed and appropriate recommendations

Prescribing spark plug test result analyzed and appropriate recommendations

Symptoms of Bad or Failing Spark Plugs

1. Slow acceleration.
2. Poor Fuel Economy.
3. Engine is Misfiring.
4. Engine Surging or Hesitating.
5. Rough Idle.
6. Hard to Start.

Carbon fouling

Appearance	The insulator foot section and electrode section are covered with dried, soft black carbon.
Results	Poor starting, misfiring, acceleration defect.
Cause	Repeated short-distance driving (driving with the engine cool), incorrect choking (overly rich air-fuel mixture), injection timing delay, plug heat range too high.

Oil fouling

Appearance	The insulator section and electrode section is black and lustrous with wet oily deposits.
Results	Poor starting and misfiring.
Cause	Oil leaking due to piston ring, cylinder, or valve guide wear (occurs easily to new engines and engines that have just been overhauled), high oil content in air-fuel mixture.(2-stroke engines)

Fuel fouling

Appearance	The spark plug is wet with gasoline immediately after it is removed, but it soon dries off.
Results	Poor starting and misfiring.
Cause	The air-fuel ratio is too rich and is not igniting. (Among the ways this can happen is if the driver presses the accelerator over and over while starting the vehicle.)
Handling	Remove all the spark plugs, crank the starter motor to bring fresh air into the cylinder and make the air-fuel ratio leaner.

Extreme electrode wear

Appearance	The center and ground electrodes are rounded and the gap has become too wide.
Results	Poor starting and acceleration.
Cause	Inadequate maintenance. (spark plug has exceeded its service life.)

Spark plug gap too large

Appearance	The gap is wider than appropriate.
Results	Poor starting and acceleration.
Cause	The gap is inappropriate; the wrong spark plug was selected.

Insulator breakage

Appearance	Insulator cracked
Results	Shorts due to insulation defect, causes poor idling and misfiring during acceleration.
Cause	Spark plug removed/installed incorrectly. (spark plug turned too far with spark plug wrench, excess tightening torque, or other inappropriate work.)

Diagnosis 2

＜Case 2＞

- Misfiring only when running at high speed or when accelerating suddenly

Lead fouling

Appearance	The insulator leg section has yellow or yellowish-brown burnt on deposits or is covered with a glossy surface.
Results	Misfiring during rapid acceleration or under high load, but no problem in normal running.
Cause	Use of gasoline with much lead.

Diagnosis 3

＜Case 3＞

- Loss of power when running at high speed or under high load
- Piston breakdown

Overheating

Appearance	The insulator leg section is scorched extremely white with small black deposits. Rapid electrode wear.
Results	Loss of power when running at high speed or under high load.
Cause	Spark plug incorrectly tightened, engine cooling problem, ignition timing too early, spark plug heat range too low, severely abnormal combustion.

Pre-ignition

Appearance	The center electrode or ground electrode is melted or scorched. There are spots on the insulator leg section and deposits of aluminum or other metal powder.
Results	Power loss due to engine damage.
Cause	Often this is due to overheating; pre-ignition is a phenomenon in which combustion occurs before ignition. The plug heat range is too low, the injection timing is too advanced, etc.

Insulator breakage

Appearance	The insulator leg section is cracked or broken.
Results	Misfiring
Cause	Severely abnormal combustion, lack of attention to gap adjustment.

Housing installation screw section melting

Appearance	Housing installation screw section melting.
Results	Power loss due to engine damage.
Cause	Incorrect spark plug tightening.

Physical damage to ignition tip section

Appearance	The electrode is bent and the insulator leg section is broken. Indentations are sometimes seen on the electrode.
Results	Misfiring.
Cause	The spark plug thread reach is too long for the engine head or there is some kind of foreign matter (a small bolt, nut, or the like) in the combustion chamber.

Ground electrode damage & breakage

Appearance	Ground electrode is broken in the middle or at the base; much of the cross section shows fatigue fracturing.
Results	Ignition failure, damage to the engine or auxiliaries from the grounding terminal fragment.
Causes	Increased stress on the ground electrode due to high-output, high-torque engine or tuning, modification, etc.; excessive vibration due to poor

	maintenance, severe operating environment, etc.; insufficient fastening ⇒ excessive vibration due to loose plug
Countermeasures	(1) Spark plug selection ・ As a countermeasure to increased stress on the ground electrode, changing to a spark plug with a small ground electrode is an effective way to handle the problem from the plug side. Examples: 2-ground electrode plug, small ground electrode plug (taper cut), racing plug, surface discharge plug, etc. However, fundamentally, it is necessary to select a spark plug that matches the vehicle's level of tuning. (2) Engine and vehicle body maintenance ・Reduction of excessive vibration through engine and vehicle body maintenance ・Tightening plugs with the recommended torque

Diagnosis 4

＜Case 4＞

- Trouble other than with the engine

Corona soiling

Appearance	Brown deposits on the insulator directly above the housing
Results	No impact on the spark plug performance
Cause	This occurs due to electrical stress in the air near the insulator. (This is not a spark plug gas leak, for which it is sometimes mistaken.)

Table 5.1. spark plug test result analyzed

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. **List Symptoms of Bad or Failing Spark Plugs?(6pts)**

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

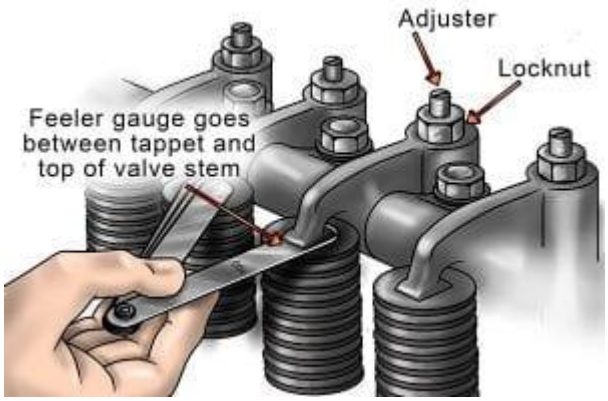
Answer Sheet

Name: _____ Date: _____

Test I

Operation sheet 1	adjust tappets with a feeler gauge

Step 1 – Insert Feeler Gauge



Before adjusting tappets you should always refer to the manufacturer's instructions for the correct tappet gap clearance setting, and how to position the tappet for measurement. Place the feeler gauge between the tappet and valve stem.

Step 2 – Read Measurement

Read the measurement on the feeler gauge for a description of the clearance. If you are trying to set a gap of 0.102mm (0.004″), for example, begin with this gauge.

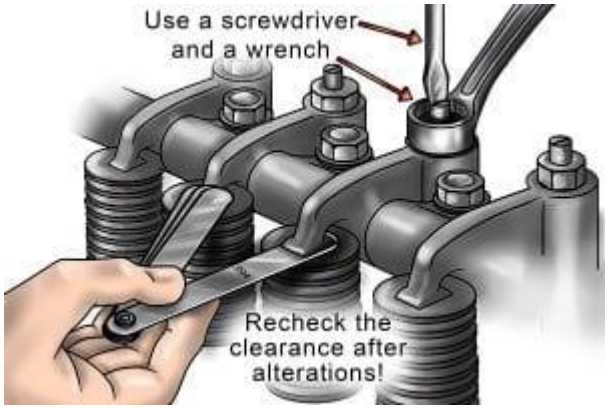
If the gauge will not go in, the tappet will require adjusting. See step 4.

Step 3 – Select Next Size Up

If the gauge enters without resistance, use a gauge the next size up to make sure the tappet clearance gap is no larger than required.

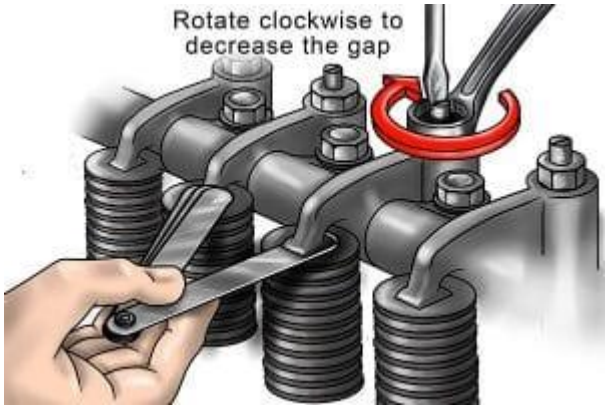
Here, for example, the clearance is too large because the 0.127mm (0.005″) feeler gauge is easily inserted and so the tappet will require adjusting.

Step 4 – Adjust Valve



To adjust the valve, place a ring spanner over the nut and a screwdriver into the tappet. The nut is used to lock the tappet at the correct setting.

Loosen the nut just enough to allow adjustment of the tappet.



Turning the tappet clockwise with the screwdriver will decrease the clearance (counter-clockwise to increase clearance if clearance is too small).

Only a small turn is needed to adjust the clearance by a few thousandths of an inch or hundredths of a millimetre.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary workshop, tools and materials you are required to perform the following tasks within 20 min.

Task 1: **Check/Adjust Tappet Valve Clearance**

Operation sheet 2Check spark plug

Check spark plug

- Remove it.
- Keep it plugged into the spark plug cable.

- Ground it on the frame.
- Start and check if sparks happen.
- If they are blue, the spark plug is ok. Else if the sparks are yellow or there is no spark at all then the spark plug is bad.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary workshop, tools and materials you are required to perform the following tasks within 20 min.

Task 1: **adjusting the Spark Plugs**

LG #38 — LO #6-Checking/replacing fuel filter, air cleaner, contact point and condenser

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Replacing fuel filter and air cleaner

- Freeing fuel filter of sediments and impurities
- Inspecting Contact point gap
- Testing and replacing condenser

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Replace fuel filter and air cleaner
- Free fuel filter of sediments and impurities
- Inspect Contact point gap
- Test and replacing condenser

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
- Accomplish the “Self-checks” which are placed following all information sheets.
- Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
- If you earned a satisfactory evaluation proceed to “Operation sheets
- Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
- If your performance is satisfactory proceed to the next learning guide,
- If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1-Replacing fuel filter and air cleaner

1.1. Replacing fuel filter and air cleaner

Changing the fuel filter

Changing the fuel filter is a part of regular maintenance. Keeping your fuel system properly maintained by changing the fuel filter prolongs the life of the fuel pump. Dirt in the fuel is captured by the filter which clogs over time, causing it to operate less efficiently. The clogged filter reduces fuel pressure and volume in the fuel system. If your vehicle is losing power, it could be a sign of a clogged fuel filter. Replace the filter at the manufacturer's recommended interval.

Fig.1.1. fuel filter

5 Signs of a Bad Fuel Filter

- Poor Engine Performance.
- Hard Starting.
- Stalling.
- Random **Misfire** or Rough Idle.
- Fuel System Part Failures.

What happens if fuel filter is not changed?

Without the **filter**, your **fuel** could end up tainted by all kinds of crud, including dirt and paint chips. **Not** only does the **filter** help to shield your **fuel** pump and injectors, it also plays a significant role in ensuring that you are achieving the highest **fuel**-efficiency possible.

How can I tell if I need to replace my fuel filter?

1. Engine Struggles to Start. While this symptom could be due to a variety of different issues, it is indicative of a partially-clogged **filter**.
2. Car Won't Start At All. ...
3. Rough Idle. ...
4. Struggling at Low Speeds. ...
5. Car Dies in Traffic.

How to change a fuel filter, step by step

Even the smallest piece of dirt can damage a fuel injector, resulting in erratic performance, poor gas mileage and, in some cases, complete engine shutdown. That's why most car-care experts recommend replacing the fuel filter in your vehicle approximately every 16,000 kilometres—or once a year—for peak performance.

Most fuel-injected vehicles use a stainless steel in-line fuel filter located either ahead of the rear wheels on the underside of the vehicle or in the engine compartment. Since the majority of newer cars use electronic fuel-injection systems, this guide covers how to change a fuel filter in a fuel-injection system.

To change your fuel filter, you'll need:

- Drive-on car ramps or jack stands (with sufficient capacity for vehicle weight). Depending on the location of your fuel filter, these may not be required
- Open-end wrenches designed for use with filter connections and pliers
- The correct replacement fuel filter for your specified vehicle and engine
- A supply of clean rags
- Safety glasses
- An approved container to catch spilled fuel

Before you begin

Locate the fuel filter (refer to your vehicle's service manual or contact your **NAPA Auto Parts store** for more information about the exact location on your vehicle). The filter has two hose connections: the fuel inlet, which runs in from the fuel tank, and the fuel outlet, which runs out to the engine. Make sure to note the orientation of the filter for proper installation of the new filter. Let your engine and exhaust system sit for at least three hours, or until cold. If necessary, raise the vehicle using drive-on car ramps or jack stands.

Step 1

- Place an approved container under the filter
- Remove any bolts attaching the fuel filter bracket to the vehicle
- Place a clean rag near the end of the fuel inlet hose to catch spilled fuel

Step 2

- Wearing safety glasses, carefully remove the inlet hose from the filter. Caution: The fuel system is charged with 15-60 pounds of pressure, and the fuel will flow out of the hose forcefully! Wear safety glasses and be prepared to catch the fuel as it spurts out.
- Carefully remove the outlet hose from the filter

Step 3

- Remove the filter
- Install the new filter, and reattach the inlet and outlet hoses
- Reattach the filter and fuel filter bracket to the vehicle

Step 4

- Start the engine and check for leaks immediately
- Properly dispose of the old filter, spilled fuel and rags

3.1. **Fuel Filters**

- Used to stop contaminants such as rust, water, and dirt from entering the fuel lines, hoses, throttle body, injectors, pressure regulator or an other part that could be damaged
- "Sock" filter on the tank pickup tube is used to filter out debris
  Figure 1 Variations of fuel filters
- Second filter is usually located in the main fuel line

Fuel Filter Service

- Involves periodic replacement or cleaning of system filters
- Clogged fuel filter
    - ❍ can restrict flow to the injectors, diesel injection system, or carburetor
- Clogged in-tank strainer
    - ❍ when clogged, the strainer can collapse and stop fuel flow

A clogged air or fuel filter can cause poor performance, cost you at the fuel pump, and shorten engine life. This simple procedure guards against that. A good rule of thumb is once or twice a year, or roughly once every 12,000 miles (20,000 km).

AIR CLEANER

The combustion air filter prevents abrasive particulate matter from entering the engine's cylinders, where it would cause mechanical wear and oil contamination.

Most fuel injected vehicles use a pleated paper filter element in the form of a flat panel. This filter is usually placed inside a plastic box connected to the throttle body with duct work.

Older vehicles that use carburetors or throttle body fuel injection typically use a cylindrical air filter, usually between 100 millimeters (4 in) and 400 millimeters (16 in) in diameter. This is positioned above or beside the carburetor or throttle body, usually in a metal or plastic container which may incorporate ducting to provide cool and/or warm inlet air, and secured with a metal or plastic lid. The overall unit (filter and housing together) is called the **air cleaner**.

NEW **AIR FILTER**

A new **air filter** allows your vehicle's **engine** to get clean **air**, a key component in the combustion process. The **air filter** prevents airborne contaminants such as dirt, dust and leaves from getting pulled into your car's **engine** and potentially damaging it.

Types of air filter

- Paper
- Foam
- Cotton
- Stainless steel
- Oil bath
- Water bath

8 Signs Your Air Filter Needs Replacing

1. Reduced Fuel Economy. ...
2. Misfiring Engine. ...
3. Unusual Engine Sounds. ...
4. **Check** Engine Light Comes On. ...
5. **Air Filter** Appears Dirty. ...
6. Reduced Horsepower. ...
7. Black, Sooty Smoke or Flames Exiting **the** Exhaust. ...
8. Smell of Gasoline **when** Starting **the** Car.

Here are seven common problems that could be solved by replacing your air filter:

- Strange engine noises. ...
- Decreased performance. ...
- Decreased fuel economy. ...
- Black smoke or flames in the exhaust. ...
- Smell of petrol in the exhaust. ...
- **Air filter** looks **dirty**. ...
- Check engine light comes on.

The **engine air filter should** be replaced between 15,000 and 30,000 miles, depending on driving conditions. ... If you don't drive a lot, an **air filter should** be replaced at least every 3 years, as with age it becomes brittle. An old **filter** can tear, allowing dirt and sand to enter the **engine**. Replacing an **air filter**

HOW TO REPLACE A AIR FILTER

Need to change your engine air filter? We are a team of ASE certified mechanics that have created this guide to help you save money when doing the job yourself or at least see what you are paying for when having the job done. Let's jump right in.

A vehicle's engine air filter is a replaceable cleansing unit. This filter should be changed between 6,000 and 12,000 miles depending on how dirty your roads conditions are. In most cases this filter can be replaced in under 10 minutes.

There are many levels of quality when it comes to air filters. We recommend that you get an OEM (factory) unit. It costs a little more but its the best way to protect your investment.

If you choose a cheaper filter you maybe allowing dirt particles to enter the engine which can cause premature wear.

STEP 1: LOCATE THE AIR FILTER

Locate the air filter which is connected to the air intake tube that comes off of the throttle actuator of the engine. Most of the time the air filter housing will be located either on the right or left side of the engine bay and mounted to the fender or on the engine itself.

STEP 2: REMOVE THE FILTER

There are a series of screws or clips that holds the upper lid to the lower half of the housing. The air intake boot may need to be removed or loosened to help in the removal of the filter housing lid.

Once all of the hold down bolts or clips have been removed or released gently pull up and remove the lid to expose the filter.

After exposing the filter reach into the housing and grasp it. Sometimes it can be stuck in the housing due to the filter seal which is made of rubber and has been pressed into place by the housing lid. If the filter is stuck use a standard screwdriver it break it loose this will aid in its removal.

Grasp the filter as you remove it and hold the housing lid upward to make clearance for the removal. If you notice engine oil on the old filter and in the housing itself this can be caused by two different reasons. The first is that the PCV (positive crankcase ventilation) system is plugged or broken. This system features a PCV valve or diaphragm. When the system is not working it forces crankcase pressure and oil onto the air filter. The second reason is that the engine is worn out and the positive crankcase pressure is too excessive and beyond the systems capabilities. This condition is due to worn out piston rings (blow-by) which overpowers the PCV system.

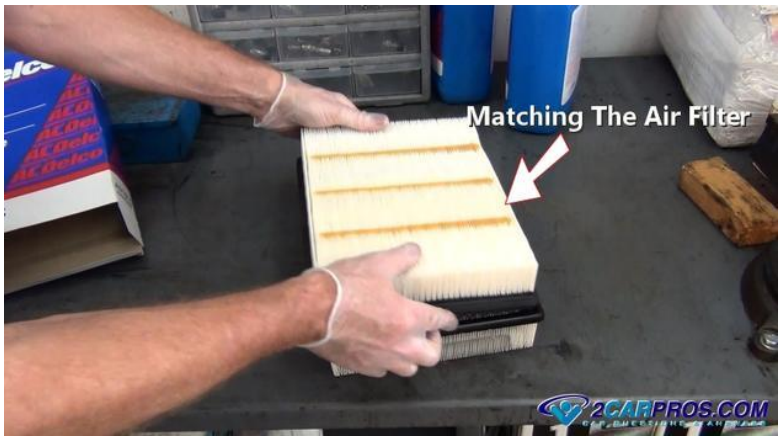
STEP 3: CLEAN THE AIR FILTER BOX

Once the filter has been removed clean the housing with a damp shop towel or compressed air. This ensures that any debris that has been knocked into the housing when the filter was removed will be cleaned out before the new filter is installed. This is necessary to keep loose dirt from entering the engine intake.

STEP 4: INSTALLING THE NEW FILTER

Remove the new filter from the box. We suggest using OEM replacement parts for quality and a proper fit as you know. To determine if your air filter needs to be changed gently tap it on the ground while watching for dirt and particles coming off of the filter meaning it is filled to capacity and replacement is required.

Now match the new filter to the old unit they should be an identical in length, height and thickness.



When installing the new filter use caution as not to bend or disfigure it in anyway. This could cause the filter to not seal completely within the housing. Make sure to hold the lid of the filter upward to aid in the installation.

When installing the new filter confirm a positive placement by checking at the seal point of the filter to the housing then install the lid or cover. It's important that the seal of the filter is not cut or crushed due to improper installation. It's worth taking an extra few seconds to do the job right or it will leak unfiltered air into the engine.

Lower the lid and start tightening the mounting screws or installing the clips. You want to do this in a cross pattern. This will help the lid seal squarely into the new filter. Now you are all set.

You did the job right while saving money and ensuring a top quality replacement part. We always like to wipe the filter housing off with a shop towel when complete. This makes us feel that the job was done to the best of our ability.

Air Filter Service

- An air filter removes dirt and dust from the air entering the engine intake manifold
- Air filter service involves replacing or cleaning the filter element
- Paper elements are usually replaced with a new unit

Air Filter Service

When replacing a filter element, wipe out the filter housing.

Changing the air filter should be part of any major tune-up, but if you drive on dirt roads or in other dusty conditions, you will need to replace it more frequently. On most cars, this is a fairly simple procedure. You should change your car's air filter every 15,000 miles (25,000 km).

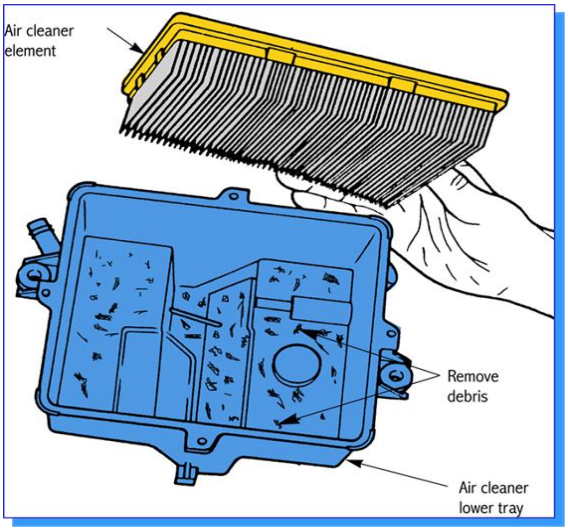


Figure 3.2. Variation of Air Cleaner/Filter

Self-Check- 1	Written test

Give a short answer

1. What is fuel filter?

2. Discuss about service of fuel filter.
3. What is air cleaner?
4. Discuss about service of air cleaner.

Information Sheet 2- Freeing fuel filter of sediments and impurities

2.1. Freeing fuel filter of sediments and impurities

Signs Of A Clogged Fuel Filter

- Trouble Starting the Engine. The most common sign of a clogged fuel filter is trouble starting the car, since it depletes the oil supply going to the engine. ...
- Issues Accelerating. ...
- Frequent **Idling** and Sputtering. ...
- Strong Odors. ...
- **Engine Misfires**/Low Performance. ...
- When to Replace the Fuel Filter.

What is inside a fuel filter?

A fuel filter is a filter in a fuel line that screens out dirt and rust particles from the fuel, and is normally made into cartridges containing a filter paper. They are found in most internal combustion engines. Fuel filters serve a vital function in today's modern, tight-tolerance engine fuel systems.

A fuel filter prevents debris from entering your vehicle's engine, and changing or cleaning it regularly is essential. If your filter is nylon or paper, you should just replace it with a new one. If it's made of metal and isn't too grimy, you can clean and reuse it.

Cleaning a dirty fuel filter

Once you have drained the fuel filter of any excess liquid, you can start to clean the dirty fuel filter. If you have an old glass fuel filter, then you can unscrew both ends and clean the individual parts with a rag. However, you will be unable to unscrew most fuel filters, so you will want to flush it out. The best way is to invest in a carburetor cleaner like B-12 chemtool, but ask the store or mechanic if it is suitable for fuel filter cleaning.

Using a B-12 chemtool

The pressurized B-12 chemtool will come with a red straw which you affix to the nozzle. Hold the fuel filter over the jar or basin. Start by spraying the B-12 chemtool into the fuel-in side while the fuel-out side is over the basin. Carefully knock the side of the fuel filter so that any debris is loosened then repeat the spraying. Turn it around so that you spray the fuel-out side with the fuel-in side over the basin, knock the debris loose and repeat. You can use the handle of your screwdriver to knock the dirt and debris loose. Don't be overzealous in knocking out the dirt, otherwise you might damage the filter, especially if it is glass.

fig.2.1. banditfiles.wordpress.com

Dry the fuel filter

Once you have cleaned the fuel filter as best you can with the B-12 chemtool and you see that less dirt is coming out either end, then set the fuel filter aside so that it can dry out for about an hour. If you don't dry it properly beforehand, then it can further contaminate the fuel line.

Reattach the fuel filter

Replace the fuel filter into the bracket or cradle so that it pops back in. Again, it is very important to make sure you have it the right way round according to the arrow or picture you took before. Insert the fuel line hose back onto the in and out nozzles of the fuel filter. Screw the clamps tight with a flat-head screwdriver. Unscrew the clamps which were securing the fuel line only once the other clamps have been tightened properly. Now your fuel filter should be cleaned and reattached to work as it did before. If you have not properly reattached the clamps, then you run the risk of a fuel leak which is very dangerous.

Fig.2.2.Cleaning a diesel fuel filter

For those who own a diesel car, there may be an even easier way to clean the engine's fuel filter. Many diesel engine fuel filters have a design whereby there is a bowl at the bottom of the filter. The fuel filter is placed upright, so gravity allows for contaminated water (which shouldn't be in the fuel system) to be drained out. To do this, you simply place a jar underneath to collect the contaminated liquid. When you see diesel fuel in the jar, then trun the valve off.

Water in a diesel engine is particularly harmful. Since water is more dense than diesel, the water will automatically go to the bottom. Water is also more dense than gasoline, but these types of fuel filter in gas-powered vehicles are not as common.

Replacing your fuel filter

The above method is the best way to clean your fuel filter. Unfortunately, not all fuel filters can be cleaned. Most are designed to be replaced rather than cleaned, especially those which use paper filter fans. Replacing the fuel filter may be the best option for you. If you have already cleaned the fuel filter once, then it is even more likely it will simply need to be replaced.

Replacing your fuel filter is important, but it is not expensive. If you don't want to clean it, you can purchase a replacement quite cheaply. This should be done at least every 100, 000 miles, regardless of how many times you have cleaned the fuel filter. How dirty the fuel filter becomes will also depend on various factors (contamination of the fuel tank, driving the car in adverse weather conditions, etc.). If your filter gets dirty more regularly, then you may have another engine issue which needs to be taken care of.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. What is inside a fuel filter?(3pts)
2. List Signs Of A Clogged Fuel Filter(3)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

1. _____

Information Sheet 3- Inspecting Contact point gap

Inspecting Contact point gap

The contact-breaker setting is often neglected, but it is vital to good running. Ideally, check and set the gap, between every major service, and replace the contact breaker after 6,000 miles or 10,000 km, or twice a year.

What happens if point gap is too small?

When the points open, the light will come on. ... Also, having too small of a point gap increases point "dwell" and can cause the points and coils to overheat. Too wide of a point gap can lead to a weak spark. The procedure, in a nutshell, is you set point gaps between 0.014" and 0.16".

How do I adjust a contact breaker point?

Adjust the points by locating the heel of the rubbing block of the contact breaker points so it rides on the cam of the distributor shaft. Using a feeler gauge of the correct manufacturers' specifications, gently adjust the points with a screwdriver until the points gap is in accordance with specifications.

What is the point gap on a 4 cylinder engine?

Around 60 degrees

Around 60 degrees for a 4 cylinder engine**.**

- Burned, pitted, misaligned, or worn points can cause no start, missing, or loss of power
- A condenser may leak (electrically), become open, or short to ground

Testing Points

- Perform a visual inspection for burned or pitted contacts or a worn rubbing block
- Measure point resistance
- Connect an ohmmeter between the positive point lead and ground
- Compare to specifications
- If the resistance is too high, replace the points

Adjusting Points

- Use a feeler gauge or tach-dwell meter
- When using a feeler gauge, set the point gap to specifications with the points fully open

- When using a tach-dwell meter, crank the engine with the meter leads connected between the coil's negative terminal and ground
- Adjust the point gap while cranking

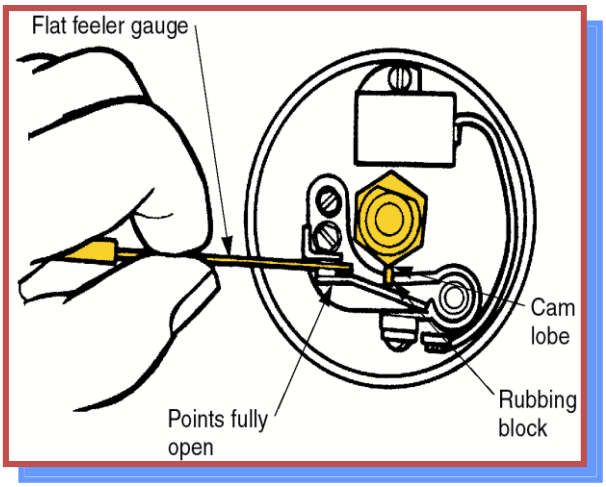


Fig 3.1 Adjusting Points

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Write true if the statement is correct and false if the statement is incorrect

1. What is the point gap on a 4 cylinder engine?(3pts)
2. What happens if point gap is too small?(3pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

1. _____
2. _____
3. _____

Information Sheet 4- Testing and replacing condenser

4.1 Testing and replacing condenser

How does points and condenser ignition work?

Conventional Ignition System. ... Instantaneously, when the points open (separate) current flow stops through the primary windings of the ignition coil. This causes the magnetic field to collapse around the coil. The condenser absorbs the energy and prevents arcing between the points each time they open.

A 12-volt condenser is part of an automotive ignition system. The battery provides power to the primary side of the ignition coil, which in turn produces high voltages across the secondary windings of the ignition coil.

The voltage from the secondary winding is fed to the spark plugs as required to start the engine. The purpose of the condenser is to protect this ignition system from stray voltages that can interfere with the efficiency of the ignition coil. It does this by functioning as an insulator between the stray voltages and the ignition system.

Step 1 Put on electrical safety gloves as part of the safety precaution necessary to protect yourself from electrical shock.

Step 2 Disconnect and remove the condenser from the associated circuitry. Ensure the condenser and all parts are dry since dampness may cause misleading results.

Step 3 Connect a megger across the condenser terminals. The megger will produce a high voltage as required to measure resistance of the condenser in megohms. Put the positive lead of the megger on the positive terminal of the condenser and the negative or ground end of the megger to the negative terminal of the condenser.

Start up the megger. Select the 500-volt range using the voltage range dial on the megger. Be sure you are not touching the condenser while doing this step. You should get an initial reading of 10 megohms or more on the megohm meter located on the front panel of the megger.

Within a few seconds, the resistance should increase to several hundred megohms as the condenser charges up. You should quickly obtain a stable resistance of infinity or at the highest level of the megohm meter.

This high resistance will validate the condenser is functioning as an insulator because an insulator has infinite resistance.

If the initial reading is less than 10 megohms or if the resistance doesn't increase significantly within a few seconds, this means the insulation in the condenser is failing and the condenser needs to be replaced.

Materials Needed

- Feeler gauges
- Replacement set of points
- Replacement condenser
- Screwdriver (magnetic preferably)

Step 1: Disconnect battery. Disconnect negative battery cable to cut power to the vehicle.

- **Note**: For safety reasons when working on your vehicle, always disconnect battery when working on electrical systems.

Step 2: Locate and remove distributor cap. Open the hood and locate the distributor cap. It will be small, black and round (nearly always). It will be located near the top of the engine, with ignition cables running from it.

Remove the cap by unclipping the retaining clips around the perimeter. Set cap aside.

Step 3: Disconnect and remove the set of points. To remove the set of points, locate and disconnect the terminal leads at the back of the points. To disconnect, remove bolt or fastener holding the lead into the terminal.

Once the set of points has been disconnected, you can remove the retaining bolt. Remove the bolt, on the side of the points themselves, holding the set of points onto the distributor base. The points will then lift out.

Step 4: Remove condenser. With the leads and contact points disconnected, the condenser will also be disconnected from its wiring and ready to be removed. Using your screwdriver remove the retaining bolt holding the condenser to the base plate.

- **Note**: If the condenser is located outside of the distributor the removal process is exactly the same. In this case you will most likely have a second lead connecting to its own terminal that you will have to disconnect as well.

Step 5: Install new condenser. Place the new condenser in place and route its wiring under the plastic insulator. Hand tighten down retaining screw to the base plate. Route leads under the plastic insulator.

Step 6: Install new points set. Reinstall the new set of points. Secure the hold down or retaining screws. Reattach the lead from the points set to the distributor's terminal (include the lead from the condenser if they utilize the same terminal).

Step 7: Grease distributor. Once the points have been installed, grease the distributor shaft.Use a small amount, but enough to adequately lubricate and protect the shaft.

Step 8: Adjust point gap. Using your feeler gauges, adjust the gap between points. Loosen the retaining screw. Use feeler gauge to adjust gap to proper spacing. Finally hold gauge in place, and again tighten retaining screw.

For proper spacing of the points, check the owner's manual or repair guide. If you do not have these available a general rule of thumb for V6 engines is.020, and .017 for V8 engines.

- **Note**: Assure yourself after you have tightened down the retaining screw, that your gauge is still where you need it to be.

Step 9: Reassemble distributor. Reassemble your distributor. Do not forget to put your rotor back if you chose to remove it from the distributor during this process. Return clips to closed position and lock distributor cap into place.

Step 10: Restore power and test. Restore power to the vehicle by connecting the negative battery cable. Once power is restored, start the vehicle. If the vehicle starts and idles properly for 45 seconds, you may test drive the vehicle.

Ignition systems in your vehicle are vital for operation. There was a point in time when these ignition components were serviceable. Today's ignition systems are completely electronic and usually do not have serviceable parts. However, replacing the serviceable parts on older models adds to the value of their rebuild. Keeping up maintenance with these fast moving mechanical parts is vital for the operation of the vehicle. If the process of replacing your points and condenser is too prehistoric for you, count on a certified technician to replace your points condenser at your home or office.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Write true if the statement is correct and false if the statement is incorrect

1. How does points and condenser ignition work? (6pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

Operation Sheet-1	Removing a Fuel Filter

Disconnect the negative cable at the battery.

Loosen the fuel tank filler cap to relieve any fuel tank vapor pressure.

Wrap a shop towel around the Schrader valve on the fuel rail and remove the dust cap from the valve.

Connect the fuel pressure gauge to the Schrader valve.

Install the free end of the gauge bleed hose into an approved gasoline container, and open the gauge bleed valve to relieve the fuel pressure.

Place the vehicle on the hoist and position the lift arms according to manufacturer's recommendations. Then raise the vehicle.

Flush the fuel filter line connectors with water, and use compressed air to blow debris off and away from the connectors.

Follow the recommended procedures for disconnecting the fuel inlet connector.

Follow the recommended procedures for disconnecting the fuel outlet connector. Then remove the fuel filter.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary workshop, tools and materials you are required to perform the following tasks within 5 min.

Task 1: remove and replace fuel filter

Task 2: remove and replace air cleaner

operation sheet 2

Servicing Air Cleaner

CONDITION OR SITUATION FOR THE OPERATION:

- When the air cleaner clogged, it has effect of reducing the cross-section and increasing resistance to air flow.
- When the engine performances gradually decrease

- For effective power must be periodically inspecting and servicing

Material Required**:**	Tools and Equipment Required:
➢ **Gasoline engine vehicle** ➢ **Shop manuals** ➢ **Rag**	➢ **Box wrench 13,12, & 10** ➢ **Pliers** ➢ **Air compressor** ➢ **Other tools as needed**

PROCEDURE:

1. Unscrew the wing nut and release the clips
2. Remove the air cleaner cover and takeout the element from the engine
3. Visually inspect filter element for crack, moisturize, worn, damage and any sign
4. Clean air cleaner filter element by using compressed air in proper direction (blow compressed air from inside to outside of the element)
5. Used rag wipe out the dust from inside the case, then blow with compressed air to clean the case properly
6. Check that the sealing on the case or cover is not peeling. If it necessary repair it
7. Install the element correctly in the air cleaner case and assemble the case cover
8. To install the element, align the tab on the case, element and cover
9. Fasten or the clamps and tighten the wing nut by hand

PRECAUTION: Protect your healthy during blow dust and dirty from the element by respiration

LAP Test	**Practical Demonstration**

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary workshop, tools and materials you are required to perform the following tasks within 5 min.

Task 1: Servicing Air Cleaner?

LG #39	LO 7- Testing /adjusting dwell angle and ignition setting, engine idle speed and mixture

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Adjusting Dwell angle
- Ignition timing is set
- Checking engine speed (rpm)
- Performing testing and checking without damage

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Adjust Dwell angle
- Set the set
- Check engine speed (rpm)
- Perform testing and checking without damage

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
- Accomplish the “Self-checks” which are placed following all information sheets.
- Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
- If you earned a satisfactory evaluation proceed to “Operation sheets
- Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
- If your performance is satisfactory proceed to the next learning guide,
- If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Adjusting Dwell angle

1. Purpose & types of the Ignition System

The purpose of the ignition system is to produce the high voltage surges required to ignite the compressed air fuel mixture in the engine combustion.

There are two types of ignition systems. These are the

I. Contact Point Ignition System

II. Electronic (Transistorised) Ignition System

2. Function of Contact Point Ignition System Components

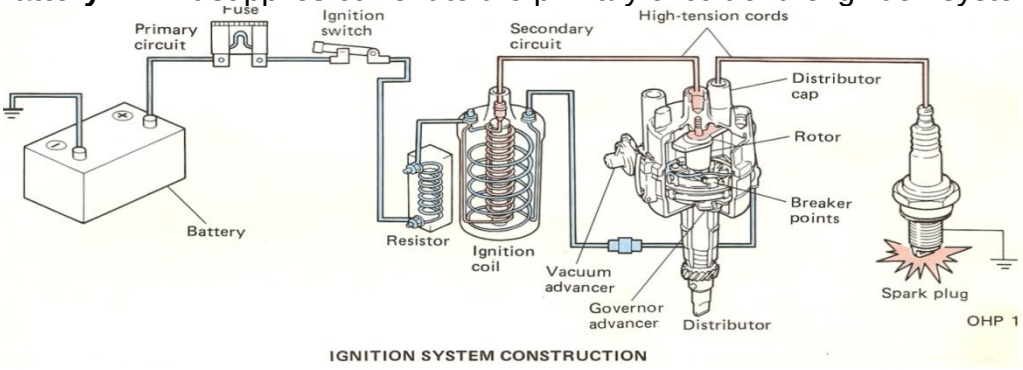
2.1. Operation of the Contact Point Ignition System

The distributor shaft is driven by a gear on the camshaft and it has cam lobes equal in number with the number of cylinders of the engine. As the distributor cam rotates it opens and closes the contact points.

When the contact points are closed the primary circuit is completed and current flows through the coil causing magnetic field collapses creating a short pulse of high voltage in the secondary coil the high voltage flows through the distributor cap and rotor to the spark plug in the cylinders that is ready to fire.

The **Ignition System components and their function**

A. Battery: - It supplies current to the primary circuit of the ignition system.



IGNITION SYSTEM CONSTRUCTION

B. Ignition switch: to open and close the primary circuit of the ignition System.

C. Ignition Coil: - It is used to produce high voltage surges by the principle of induction in the secondary winding.

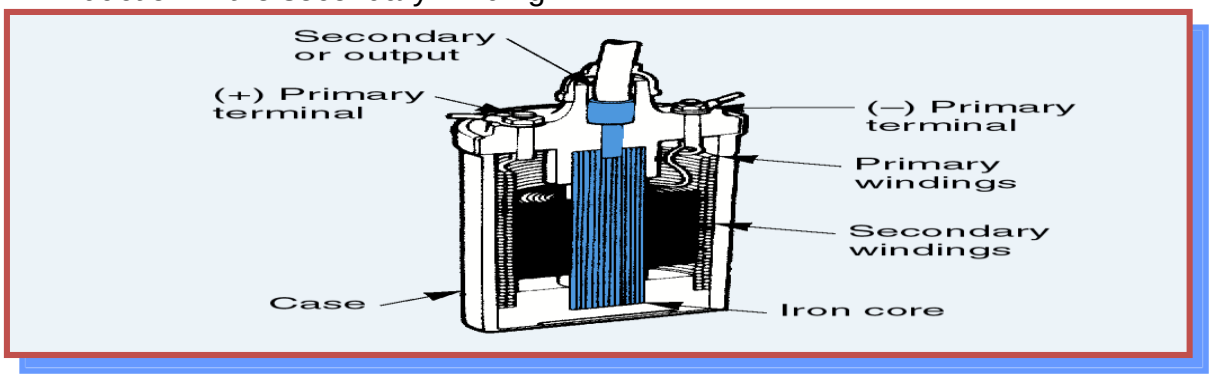


Fig.1.1.Ignition Coil

D. Ignition Distributors

The ignition distributor performs two functions in the ignition system.

First, its breaker or contact points are as a switch to open and close the primary ignition circuit.

Secondly, it distributes the high voltage current to the proper cylinder at the proper time.

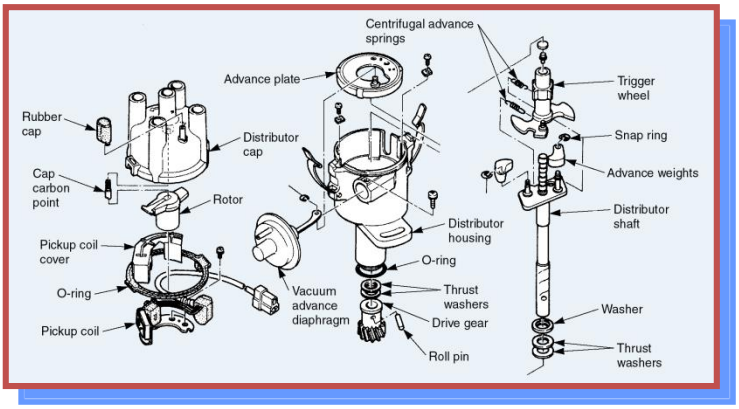


Fig.1.2.Ignition Distributors

E. Distributor cap and Rotor

The rotor and distributor cap form a rotary switch to distribute the high voltage surges induced in the secondary winding of the ignition coil. As the shaft rotates, the blade of the cap moves past the terminals which are arranged in a circular around the cap. Each of this outside terminals is connected to a spark plug cable to a spark plug.

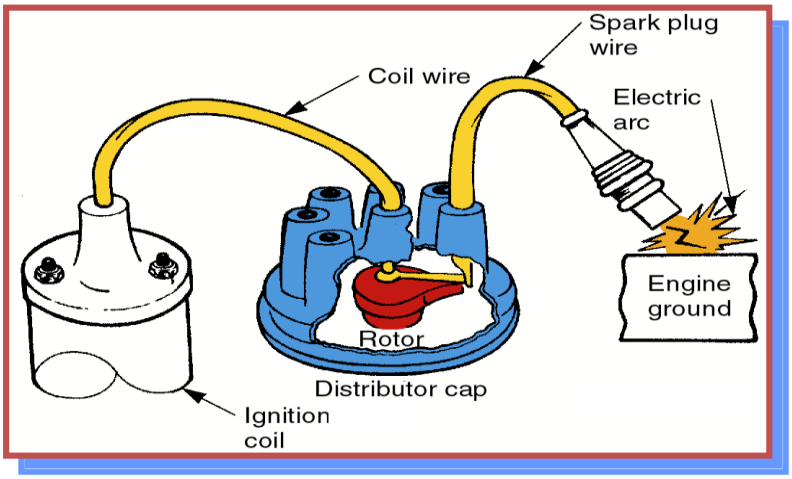


Fig.1.3.Distributor cap and Rotor

F. Secondary Wiring

The secondary wiring consists of the cables that connect the secondary winding of the coil to the cap centre terminal and the outer cap terminals to the spark plugs.

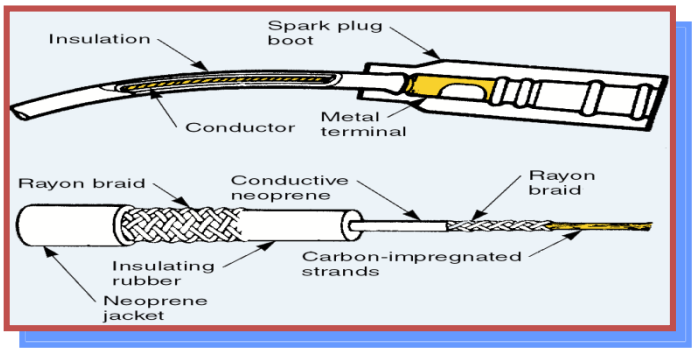


Fig.1.4. Secondary Wiring

G. Spark plugs

When the engine is operating the high voltage current produced by the igntion coil arcs across the gap and creates spark that ignites the air fuel mixture in the cylinder.

H. Ballast resistor

Ballast resistor or resistance wire connected between the ignition switch and the positive terminal of the coil. This resistor limited the voltage and current to the coil.

I. Capacitor(Condenser)

The function of the capacitor or condenser is to **reduce the arcing** at the contact points by storing current.

Test dwell angle and adjust it

What is dwell angle in ignition system?

Dwell angle is the amount of time, measured as degrees of rotation, that contact breakers close in a distributor. Unless dwell angle is accurate, ignition timing won't be accurate. The period, measured in degree of cam rotation, during which the contact points remain closed is called the dwell angle.

How do you check ignition dwell angle?

Measuring the dwell angle

If you have just fitted new contact-breaker points, set them to approximately the right gap with a feeler gauge . With the dwell meter connected, start the engine and let it settle to a smooth tickover. If it will not tick over steadily, check the cause(s) and rectify any faults .**Dwell (Cam Angle)**

- Amount of time, in degrees of distributor rotation that the points remain closed between each opening. (The dwell angle, or cam angle, is the angle turned by the cam in the distributor from the time the points close until they open again.)
- Dwell angle is inversely proportional to point gap, that is, increasing the gap decreases the dwell, and vice versa.
- Insufficient dwell may cause ignition failure at high speed, while too much dwell increases the total average current which the points must handle, particularly at low speed. This usually leads to very short point life.

Dwell Angle

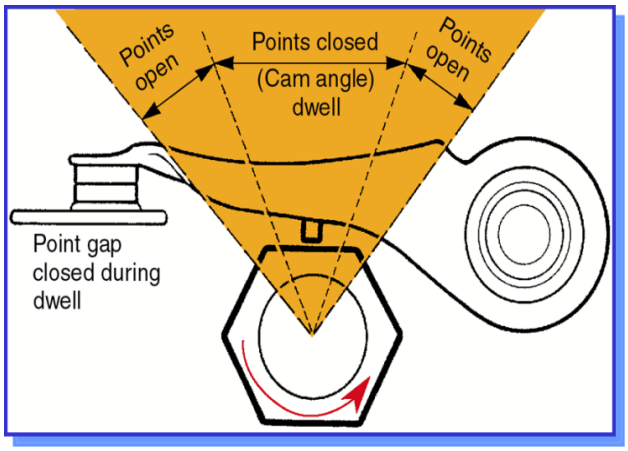
1 When you change dwell, your timing will change.

2 When you change timing, dwell is not affected.

3 Always set dwell before timing.

4 Adjust dwell angle if necessary by increasing or decreasing the contact point gap.

- wider/bigger point gap - smaller dwell
- Smaller point gap - bigger dwell



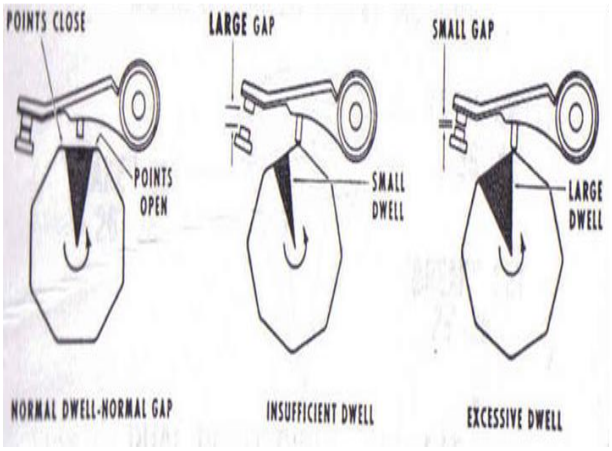


Fig.2.1.contact point gap and dwell angle relationship

No. of Maximum cylinders dwell angle (100% dwell)

4 cylinder = 90°	6 cylinders = 60°	8 cylinders = 45°

Comparison of percent of dwell and dwell angle

Percent of Calculation	Corresponding dwell	dwell angle
60% (.60)	4cyl.(90°)	54°
60% (.60)	6cyl.(60°)	36°
60% (.60)	8cyl.(45°)	27°

Table 2.1. No. of Maximum cylinders dwell angle (100% dwell)

Dwell angle large(Gap too small)	Dwell angle less(Gap too more)
➢ Points will burn rapidly	➢ Less high voltage
➢ Engine misfires at all speeds	➢ Ignition failure at high speed
➢ Spark retards	➢ Advance spark

Table 2.2. Dwell angle

CHECK/REPLACE CONTACT POINT

Testing/inspect Contact Points

- Perform a visual inspection for burned or pitted contacts or a worn rubbing block
- Measure point resistance
- Connect an ohmmeter between the positive point lead and ground
- Compare to specifications
- If the resistance is too high, replace the points

Adjusting Points

When using Feeler gauge method, set the point gap to specifications with the points fully open

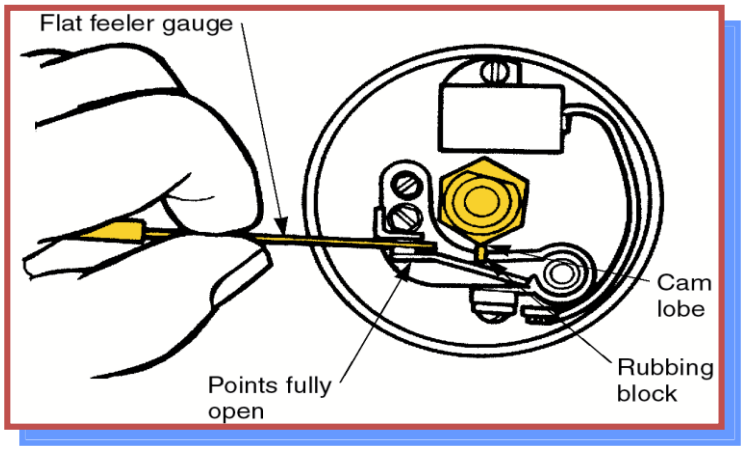


Fig.2.2. Adjusting Points

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. What is dwell angle in ignition system? (6pts)

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Name: _____ Date: _____

Test I

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. write Purpose & types of the Ignition System? (6pts)

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Name: _____ Date: _____

Test I

Information Sheet-2	Test ignition timing and adjust it

3.1. Test ignition timing and adjust it

What happens if ignition timing is too advanced?

If ignition timing is too far advanced, it will cause the fuel-and-air mixture to ignite too early in the combustion cycle. This can cause the amount of heat generated by the combustion process to increase and lead to overheating of the engine.

How do you reset ignition timing?

Set the first cylinder to top dead center on the compression stroke. Set the distributor to fire at the top (this is considered 0 degrees advance/retarded). If you want to advance/retard timing, turn the crank an angle amount equal to what you want, or place a timing tape and use a timing light.

Where to find Ignition Timing marks

The first step in timing the ignition is to find the timing marks or, if the manufacturer has failed to provide any, to make some. Pictures below show the most likely places for the marks to be.

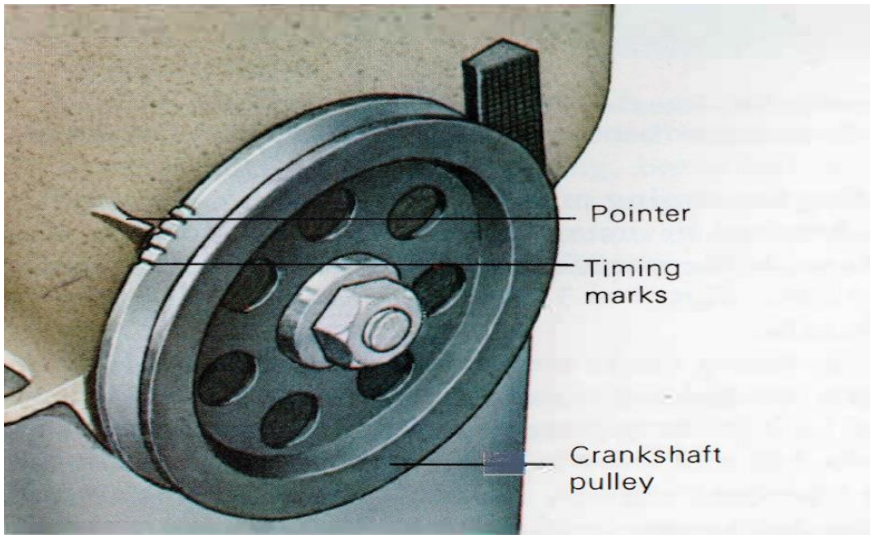


Fig.2.1. timing mark

If the timing marks are on the flywheel, they can usually be seen by removing a small plate bolted to the bell housing at the back of the engine. This plate is generally at the top or side, but on a few cars it is at the bottom.

On some cars with transverse engines, the marks can be seen only with a small hand-mirror and a torch. Stick the mirror to the flywheel housing with a piece of chewing gum and a suitable support while you work.

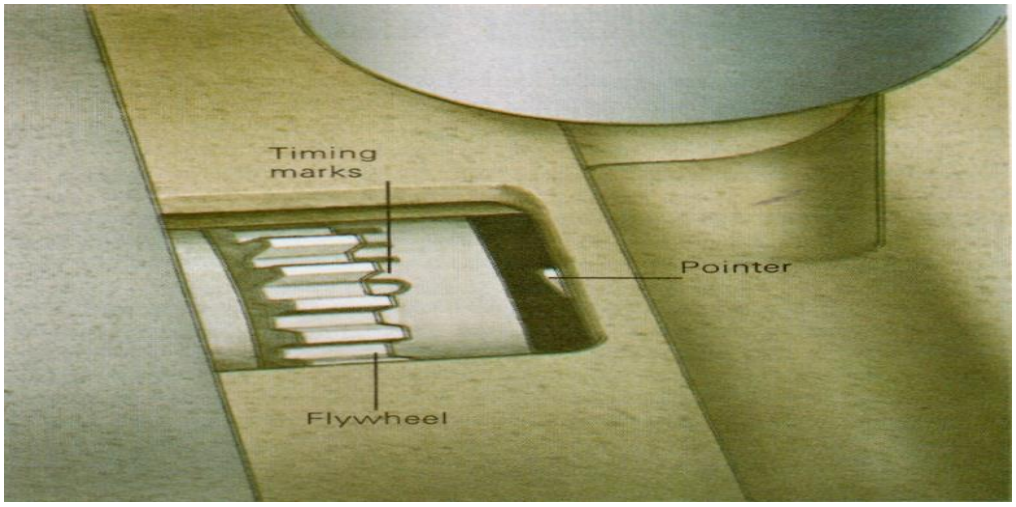


Fig.2.2. timing mark

The timing marks may be on the flywheel. visible through a hole in the top, side or bottom of the bell housing around the clutch

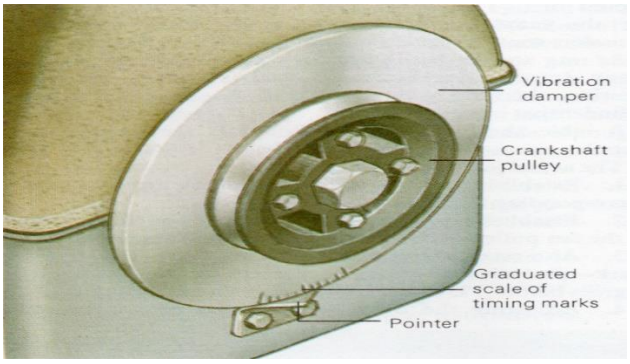


Fig.2.3. timing mark

Some cars are fitted with vibration dampers on the crankshaft. These are mounted behind the pulley and may carry a timing scale

Alternatively, the timing marks may be on the fan pulley or on cars with crankshaft vibration dampers behind the fan pulley on the dampers.

Meaning of Ignition Timing

- The position of the point of firing relative to TDC is known as the ignition timing and is expressed in degrees of crank-angle movement. It is set by positioning the distributor body relative to one of the cam lobes so that the contact points have just opened
- How early or late the spark plugs fire in relation to piston position

Timing Advance

- The plugs fire earlier, before top dead center (BTDC)
- Gives combustion enough time to develop pressure on the power stroke

Timing Retard

- The plugs fire later
- Used in low speed, high load conditions

2.1. How to Set the Ignition Timing with No Timing Marks

1. Mark the spark plug wires for the cylinder number using a short piece of masking tape on each wire. ...
2. Rotate the engine clockwise and observe the valves on the number one cylinder. ...
3. Locate the number one spark plug wire on distributor cap and make a tic-**mark** of this position with a marker pen on the distributor housing.

What causes ignition timing to be off?

The ignition timing error is typically caused by damage internally like the pistons or valves inside the engine. A loose or weak engine timing belt that jumps time can cause the ignition timing to be off.

How do I know if my ignition timing is too advanced?

How do you know if your timing is too advanced? Symptoms of incorrect ignition timing are poor fuel economy, sluggish acceleration, hard starting, backfiring, or "pinging" or "spark knock". Too little spark advance will cause low power, bad gas mileage, backfiring, and poor performance

What are the symptoms of bad timing?

Symptoms Of A Failing Or Broken Timing Belt

- You Hear Odd Noises Coming From The Engine. ...
- Your Check Engine Light Is On And Flashing. ...
- Your Car Starts Hard And Occasionally Misfires. ...
- You Notice A Loss Of Power And Your Car Runs Or Idles More Roughly Than Normal.

What problems can occur if the ignition timing is too early?

Incorrect ignition timing can cause several engine problems such as; Knocking or Pinging. Difficult Starting. Excessive Engine Heat

What should timing advance be at idle?

In addition, the WSM says **spark advance should** be between 6 to 18 degrees BTDC at **idle**

What is the best ignition timing?

If the mixture is ignited at the correct time, maximum pressure in the cylinder will occur sometime after the piston reaches TDC allowing the ignited mixture to push the piston down the cylinder with the **greatest** force. Ideally, the time at which the mixture should be fully burnt is about 20 degrees ATDC.

Dieseling

"Dieseling" in a spark ignition engine is a term used to describe a run-on condition which occurs after the ignition is turned off. It can be caused by a number of things, but your

initial timing setting is not one of them. "Dieseling" occurs when the ignition is off, and therefore no spark is present

Advancing ignition timing

Advancing ignition timing increases engine temperatures. As you increase towards MBT you get more power but temperatures may get so high that you melt a through the combustion temperature + compression increasing temperatures.

What is normal ignition timing?

That is typically 15-35 degrees before TDC (top dead center) of the power stroke depending on the engine speed. Best power is achieved when ignition timing is set to fire the spark ahead of time to reach that peak pressure at about 2 degrees after TDC.

Understanding Timing Numbers

Before we jump into adjusting the timing, we need to know the standards. Timing adjustments are measured in degrees. You will advance or move back your timing by a few degrees during this process. You can find these numbers on the engine's crankshaft pulley or flywheel.

How to Use a Timing Light

At last we're to the inductive timing light (or gun). You can set it up with the engine off to help avoid accidents. The gun should have a few plugs or clamps.

You want to attach the corresponding cables to the power and ground terminals of the car's battery. A third wire will attach to the number one spark plug wire.

Make sure you have the right plug as this will majorly impact your timing readings. When everything is attached, start the car and let it idle. Shine the light at the timing numbers on the marks on the crankshaft pulley and you'll see a number.

The timing gun works on a simple principle. When the spark plug fires, the current tells the gun to flash. This strobing effect should cause one of the timing numbers to appear steady as the engine runs. Compare the number to manufacturer recommendations.

Once you've checked the idle timing, you want to rev the engine (a friend is necessary for this part). While in neutral, rev the engine up to approximately 3500 RPMs. As the engine turns faster, the timing will change. This creates a timing range, and you want to compare the whole range to manufacturer listings.

Make your adjustments in small increments until the timing is in the correct range. The first time you do it will take some practice, but you'll get a feel for it pretty quickly. At this point you might be wondering which way to rotate the distributor, but that actually depends on the car.

As a rule, you advance the timing by rotating it opposite the rotor. If the rotor turns clockwise, you want to spin the distributor counterclockwise if the engine needs to advance. If this feels confusing, you can just use a small twist and a little trial and error.

When you've made adjustments, tighten the distributor and make sure vacuum hoses are attached and check the timing again. Rinse and repeat until the numbers are correct.

Self-Check- 1	**Written test**

Give a short answer

1. What is the purpose of ignition system?
2. Write the components of ignition system.
3. Write two types of ignition system?
4. What is relation between dwell angle and contact point gap?
5. What is the meaning of ignition system?

Note: Satisfactory rating - 9 points Unsatisfactory - below 9 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Information Sheet 3- Checking engine speed (rpm)

3.1 Checking engine speed (rpm)

What is engine speed?

Engine "Revs" are a measure of the engines speed. Engines are rotating machines and the speed is measured in revolutions per minute - that is how many full turns the engine

does every minute. ... 1500 Revolutions per minute (RPM) or 3000 (RPM) revolutions per minute for 50Hz generator and 1800 RPM or 3600RPM for 60hz.

How is engine speed measured?

A tachometer (revolution-counter, tach, rev-counter, RPM gauge) is an instrument measuring the rotation speed of a shaft or disk, as in a motor or other machine. The device usually displays the revolutions per minute (RPM) on a calibrated analogue dial, but digital displays are increasingly common.

How many RPMs is normal?

The idle speed should feel consistent without skipping or slipping. In most of today's cars, an idle speed of 600 to 1000 **RPMs** is average. If your car is idling rough, though, it won't feel smooth. The **RPMs** will jump up and down, for example, or they'll fall below 600 **RPM** (or whatever is **typical** for your vehicle).

How is RPM related to speed?

RPM is the number of revolutions the drive shaft of your car is making per minute. Speed is the linear velocity of the vehicle. ... Different gears give different rates of rotation to the wheels of the car for the same number of RPMs of the car's drive

RPM, or revolutions per minute, refers to the vehicle's engine speed--or rotational force--in your vehicle. The RPMs in your automobile are measured by a rev counter called a tachometer.Though some vehicles are not equipped with a tachometer from the factory, most vehicles are. To check your engine speed, or RPMs, you'll need to have one of these gauges installed on your vehicle. The tachometer can also serve as a simple diagnostic device, letting you know whether the engine is spinning too fast. Every tachometer is equipped with a "redline," the number on the gauge that indicates the engine is spinning faster than it was mechanically designed to. To ensure you maintain optimum engine speed and that you do not damage your engine, you'll need to know how to check your vehicle's engine RPM.

Step 1 Turn your vehicle's ignition key to the "II" position on the face of the ignition cylinder and lock assembly. This will illuminate all of the dash lights in front of you. Turn the key to the "III" position, and the engine will begin to crank. When the engine starts, let go of the key.

Step 2 Look directly in front of you on the dash, behind the steering wheel. There will be two large gauge faces. The gauge face on the right is normally the speedometer and

measures the speed of your vehicle. The gauge face on the left is your tachometer. Normally, in the center of the tachometer you will see "x 1000," or the designation "RPM," or both printed on the gauge face.

Press the accelerator pedal (the right-most pedal in the driver's side foot well) while the vehicle is still in neutral or park. You will see the needle on the left gauge face moving. This indicates engine speed. For example, if the needle is pointing to the "1" on the tachometer, it means your engine is spinning at 1,000 revolutions per minute. Most engines spin at roughly 1,200 to 1,500 RPMs when the engine is first started in order to warm up the engine cylinders. The engine speed will then drop to about 800 RPM. As you drive, periodically check your engine RPM by glancing at the left gauge.

How to Read an Rpm Gauge

The rpm (revolutions per minute) gauge is an integral part of most vehicles. Whether

you are operating your vehicle in a standard fashion or you are attempting to troubleshoot a problem, the rpm gauge can come in handy. Revolutions per minute refers to how many full revolutions something has made, such as an engine in your on the driver's dashboard.car. In an automobile, the rpm gauge is referred to as a tachometer and it is often found

Fig.3.1. Rpm Gauge

Step 1 Look at your rpm gauge and notice that it is composed of a needle and ascending numbers from left to right. The needle moves as the rpm change to indicate the current speed of your engine.

Step 2 Inspect your rpm gauge to see if it has been scaled down. For example, most rpm gauges in cars will say something along the lines of "RPM x1,000."

Multiply the number indicated by your rpm gauge needle with the proper scale if necessary. If your scale was 1,000 and your needle pointed at the number 3 on your gauge, then your total rpm would be 3,000.

Self-Check – 1	Written test

Name…… ID…… Date…….

Write true if the statement is correct and false if the statement is incorrect

1. What is engine speed? (4pts)

2. How is RPM related to speed?(2pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

Information Sheet 4- Performing testing and checking without damage

4.1. Performing testing and checking without damage

What is a dwell angle?

Dwell angle is the amount of time, measured as degrees of rotation, that contact breakers close in a distributor. Unless dwell angle is accurate, ignition timing won't be accurate. The period, measured in degree of cam rotation, during which the contact points remain closed is called the dwell angle.

When fitting new contact-breaker points in the distributor , the normal way of checking the gap between them is with a feeler gauge .

Using a dwell meter

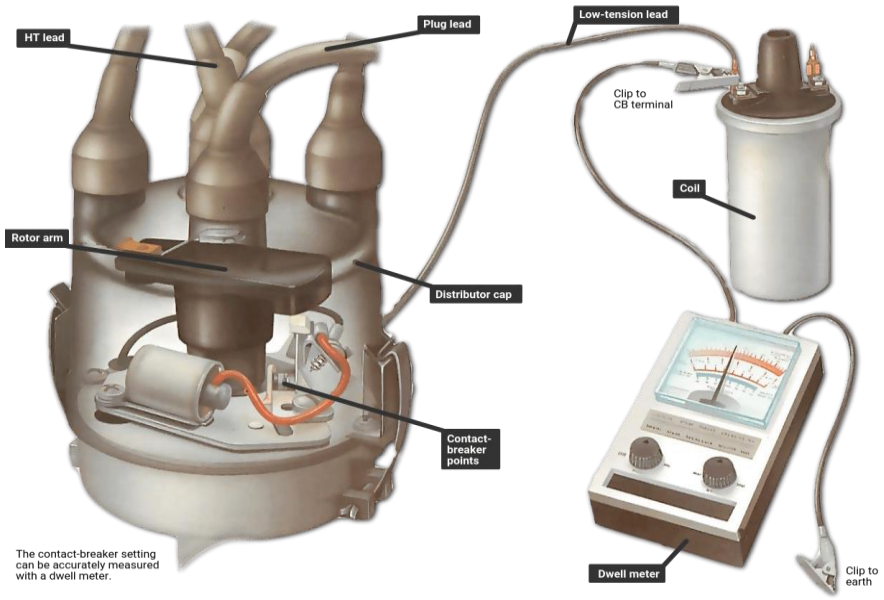


Fig.4.1.Using a dwell meter

Points that have been in use for some time develop a peak on one face that corresponds with a crater on the other, caused by spark erosion as the points open. When this happens, a feeler gauge no longer gives an accurate measurement of the gap.

A dwell meter measures the angle of rotation of the cam through which the points are opened and closed, and registers the dwell angle - the period when they are closed.

It can therefore be used to check the gap on worn points with more accuracy than a feeler gauge, and can be used without removing the distributor cap and with the engine running. The meter can also, of course, be used when fitting new points.

A dwell meter is usually part of an instrument used for various mechanical checks. Such instruments may be sold as analysers or test meters, and have to be switched to *dwell* for a reading.

How a dwell meter works

When the distributor shaft is rotating, the contact-breaker points open as the heel of the moving point is pushed outwards by a lobe of the cam, and close while it is over the flat area between two lobes.

Dwell angle

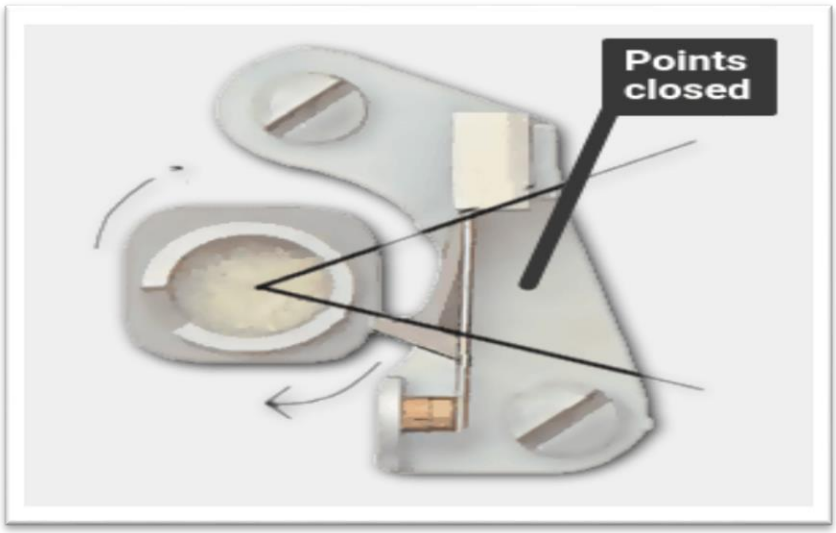


Fig 4.2.Points fully closed during dwell angle.

If, for example, the angle of rotation between the centres of the lobes on the cam is 90 degrees, the dwell angle - the period with the arm over the flats and the points closed - may be 52 degrees; the remaining 38 degrees are taken up by the action of opening and closing. This would be a typical dwell angle for a four-cylinder engine .

A dwell meter connected between the distributor or ignition coil and earth registers the dwell angle on a scale , and must remain steady at the prescribed figure while the engine is running. If the dwell angle is not the same for all cylinders , the result is rough running and poor fuel economy because the moment the spark-plug fires varies from cylinder to cylinder.

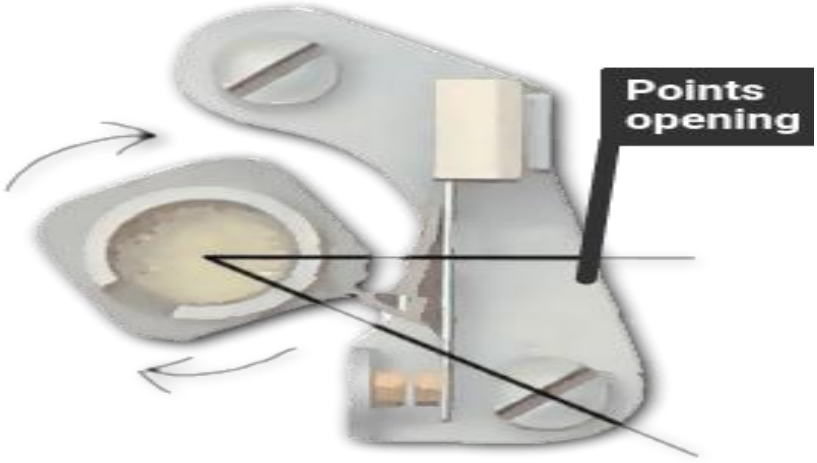


fig.4.3.Points opening as the lobe of the cam starts to lift the contact-breaker heel

The dwell angle varies according to the make of car; check it in a service manual. There are two scales on the meter, one for four-cylinder engines and one for six-cylinder engines. Eight-cylinder vehicles are taken from the four-cylinder scale and halved.

Connecting the meter

Follow the maker's instructions. Normally one lead is connected to the side terminal of the distributor if it is outside the distributor body, or the CB (contact-breaker) terminal on the coil , and the other to earth.

Most modern cars have negative earth: connect the black (negative) lead to earth and the red (positive) lead to the distributor or coil.

On a vehicle with positive earth, connect the red (positive) lead of the meter to earth and the black (negative) lead to the distributor or coil.

Measuring the dwell angle

If you have just fitted new contact-breaker points, set them to approximately the right gap with a feeler gauge.

With the dwell meter connected, start the engine and let it settle to a smooth tickover. If it will not tick over steadily, check the cause(s) and rectify any faults .

The meter reading should stay steady at a steady engine speed. If it does not, increase the idling speed slightly until it does (See Preparing for carburetor adjustment).

Compare the steady reading on the appropriate scale with the desired dwell angle for your make of car.

If it is too high, the contact-breaker gap is too small. If it is too low, the gap is too wide.

Before you switch off the engine to adjust the gap, make the following checks. First ask a helper to press the accelerator to increase the engine speed slowly to about 1,000 rpm , then let it drop back to idling speed while you note the reading.

The angle should remain about the same, with no more than two or three degrees deviation.

Secondly, increase the engine speed quickly to about 1,500 rpm, then let it drop back to idling speed while you again note the reading.

The angle should again remain the same, fluctuating by no more than two or three degrees.

Carry out these two tests several times so that you can take an average of any differences in the readings.

If the reading constantly fluctuates more than two or three degrees, the distributor-shaft bearing or advance-retard plate may be worn, or the cam itself damaged. Fit a new distributor (See Removing and refitting the distributor).

Switch off the engine before making any adjustments necessary to the contact-breaker gap.

Adjusting the gap

With the meter still connected, remove the distributor cap.

Using a spanner on the crankshaft pulley, turn the engine by hand in its normal direction of rotation until the contact-breaker points are held fully open by one of the cam lobes .

Loosen the contact-breaker fixings slightly (See Fitting and adjusting contact-breaker points), on some distributors you may have to remove the rotor arm to do this, and adjust the gap as needed. Reduce it to increase the angle if the reading was too low; increase it to lower the angle if the reading was too high.

Replace the rotor arm if removed, and the distributor cap. Switch on the engine and check the dwell-meter reading again. If the figure is still not correct, switch off and reset the gap.

Continue the procedure until you obtain the correct reading.

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. List the three type of shutdowns used in equipment or machine?(3)

Test II Write true if the statement is correct and false if the statement is incorrect

1. What is a dwell angle? (2pts)

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

LG #40	LO #8- Checking advance mechanism and adjust ignition timing

1. _____

Instruction sheet
This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics: • Adjusting ignition timing • Checking advanced timing

- Observing safety using tools and equipment
- Performing checking and adjustment without damage

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Adjus ignition timing
- Check advanced timing
- Observ safety using tools and equipment
- Perform checking and adjustment without damage

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
- Accomplish the “Self-checks” which are placed following all information sheets.
- Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
- If you earned a satisfactory evaluation proceed to “Operation sheets
- Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
- If your performance is satisfactory proceed to the next learning guide,
- If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Adjusting ignition timing

1.1. Adjusting ignition timing

How do you adjust ignition timing?

To adjust your timing, all you need to do is turn the distributor housing one direction or the other, depending on whether or not you want to advance or move back the timing. If the rotor turns clockwise, you'll advance the timing by rotating the distributor counterclockwise, and vice versa.

How do you adjust the ignition timing without a timing light?

to set your base timing without a light, you just turn the motor over in it's normal direction of rotation until the mark lines up with where you want it.. loosen up the distributor and hook up a spare spark plug to the #1 plug wire.. turn the distributor until it sparks..

Ignition Timing Test and Adjustment-With Test Lamp (Static Method)

How to Static Time an Engine

If you're timing the engine as part of a larger repair process (like replacing a timing belt), you'll want to start by getting off on the right foot -- make sure you can locate the timing marks (or notches) on the flywheel and cam. If they're worn or hard to see, you might want to mark them with a bit of white paint so they're easier to see. You don't want to be hunting for them later while you're struggling to get everything lined up.

All you need is a test light and a socket or wrench (the size of the socket will depend on your specific engine). A test light is a small hand-held tool that resembles a screwdriver with wires coming from the end. One of the wires is hooked up to the power source of whatever is being tested (in the case of engine timing, it is usually the distributor) and the other wire provides ground. (Some cost-cutting versions of the test light omit the ground wire, but they're so inexpensive anyway that it seems like a really inefficient way to save a few bucks.) The "screwdriver" tip is then touched to whatever is being tested for voltage -- if there's power, the test light will show results by illuminating a small light bulb embedded in the handle. This simple little setup is insanely useful for static timing, and also often handy when trying to troubleshoot irregularities in the electrical system.

Locate the top dead center mark on your crank pulley. (From here on out, this will be referred to as TDC, just like the repair manuals do it.) TDC can be marked on the crankshaft pulley or the flywheel, and is often found on both. Check your car's repair manual to identify the proper timing for your engine -- in degrees. It'll be in reference to TDC, such as directly at TDC or several degrees before or after TDC. The proper timing varies from car to car, so always check your owner's manual or shop manual. (At the correct number of degrees before TDC, both the intake and exhaust valves will be closed. Not crucial for setting the timing, but helpful for general understanding of how the engine works and why timing is set the way it is.)

Use your wrench or sprocket to hand crank the engine clockwise so that the number one piston is at the top of its compression stroke. Make sure the correct timing mark is lined up with the seam in the crankcase. If you turn too far clockwise, rotate it about 30 degrees back (counterclockwise) before moving forward again to find the correct position. Go more slowly next time!

Take off the distributor cap and take a peek inside. Identify the rotor and look for a small notch inscribed on the inside wall of the distributor. This is where the rotor should be aligned when the number one piston is in firing position, but if your engine's ever been disassembled before, this might not be the case. So take the time to properly align it by loosening the distributor drive clamp bolt.

Next, turn your ignition on, but don't start the car. Switch it on as if you were sitting in a parking lot listening to the radio. Don't crank it. If the engine cranks, you'll have to switch it off, get back under the hood, and start over from the beginning. The goal is to simply provide battery power so the test light will work.

Hook up your test light. Clip it to the distributor wire, make sure it has a good ground, and touch the positive terminal to the ignition point. If the light illuminates, you've done it right. Now, gently turn the distributor back (clockwise) until the light goes out. Then turn it forward (counterclockwise) until the light comes on. Don't go past the point it comes on and call it good -- you want to identify the closest spot possible to when the test light actually illuminates. Do it again if you're not sure. Then tighten the distributor back into place. Remember, this is just a starting point -- you'll also need to have your engine dynamically timed for optimal performance or fuel economy.

If your engine is new, you'll probably want to check and reset the timing after your engine's break-in period is complete. The heating and cooling down of the metal parts will affect the timing (which is totally normal and not a cause for concern). And if your engine it isn't new, it might be a good idea to warm it up before you set the timing (if possible, and assuming it's running) for the same reasons. Be careful lifting the hood and poking around a hot engine bay, though!

You can ensure the timing is set properly by hand-cranking the engine counterclockwise a quarter turn, and then, returning it very slowly clockwise. If the engine is timed correctly, the test light will flash as the timing marks line up. If so, congratulations. If not...well, start over. At least it wasn't that hard.

Material:
- Test lamp bulb, 12v
- Engines with repair manual
- Appropriate hand-tools, box-or socket wrench to rotate the crank

Procedure: Ignition timing check

A. Connect the test lamp with one end to terminal number 1 of ignition coil and put the other one to good ground
B. Switch on the ignition switch without running the engine
C. Turn crankshaft in direction of engine rotation by hand until no-1 cylinder reaches the end of its compression stroke
D. Carefully watch the test bulb and stop crankshaft rotation in the moment the lamp lights
E. Now check position of the timing marks and adjust if necessary-

Procedure: Ignition timing adjustment

a. Turn the Crankshaft in its direction of rotation until the timing marks of No-1 cylinder match in TDC position
b. Now, loosen distributor mounting clamp-
c. Turn distributor in its mounting until the timing lamp bulb just starts to light – ignition switch must be in its " on" position-
d. Tighten distributor mounting clamp-
e. Turn the crankshaft opposite its direction of rotation for about ¼ of one rotation-

f. Again, rotate the crankshaft its direction of rotation until the bulb light appears-Now the timing mark on pulley or flywheel should align with the stationary timing pointer or timing mark on the engine casing-

g. Repeat steps b) to f) until the position described in f) is attained-

h. Turn ignition switch in it's " off" position and disconnect the test lamp-

i. Run engine for test-

Shop Safety:

- Beware of high tension of the ignition system. It can be dangerous for your life!
- Only use the correct tools-
- Before starting the engine for test take away all tools from the engine
- Test run the engines only with instructor present-
- Exhaust gases must be lead to the outside-
- Apply hand or parking brake and put gear shift lever in to natural position before starting the engine when working on vehicles.

Dynamic method Ignition Timing adjustment by using Stroboscopic light

Understanding Ignition Timing

1.

1

Fig 1.1.Understanding Ignition Timing

Learn if your car needs to be adjusted or not. Modern cars that are controlled by electronic ignitions don't need to have their timing adjusted, but old-style 4-stroke

engines require that the timing be adjusted periodically to optimize the efficiency of the engine, making sure that the spark fires at the appropriate moment in the ignition cycle. If you hear telltale signs of the timing of your car not being quite right, such as pinging, backfiring, or if the car runs too rich or too lean, you will need to either take it to a mechanic or adjust the timing yourself.

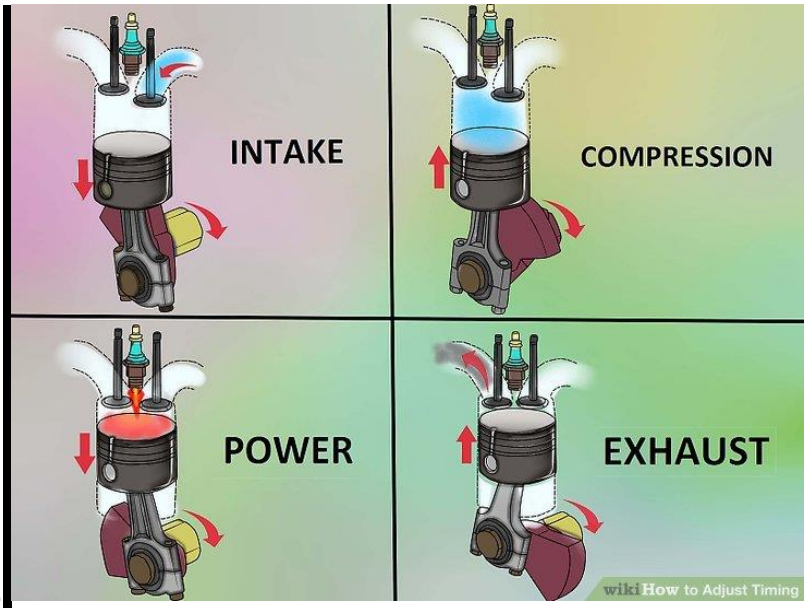


Fig 1.2. Understand the ignition cycle

Understand the ignition cycle. The four "strokes" in the 4-cycle engine refer to the process of intake, compression, power, and exhaust. The timing of the ignition refers to the point between the compression and the power strokes at which the spark plug fires, creating the combustion that results in your horsepower, forcing the piston down into the cylinder.

- When the piston comes up during the compression stroke, just before the piston gets to the top of its compression stroke (which is called "top dead center"), the spark plug should fire. Over time, this tends to get misaligned somewhat, resulting in a less-than-optimum spark plug firing time. The distance before the "top dead" center is the ignition

timing, and it's represented by a row of graded numbers on the balancer or flywheel through an access hole.

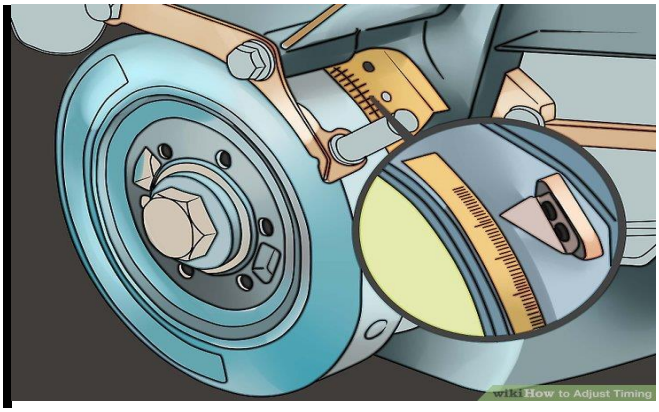


Fig 1.3. Learn the ignition timing number

Learn the ignition timing number. Look for the ruler-style row of numbers on the front of the engine's harmonic balancer (or flywheel), which should have numbers above and below *zero*. Typically, when your car comes from the manufacturer, ignition base idle timing is set to a manufacture specification before top dead center. The timing advances as the engine's speed accelerates, however, resulting in a variable that will need to be periodically adjusted using a timing light.

- Numbers to the left of zero on the timing tape refer to the piston as it travels down, while numbers to the right of zero refer to the piston's upward motion. Moving the wheel right is called "advancing" the timing, while moving the wheel left is "moving back" the timing.

Part2

Checking Your Timing

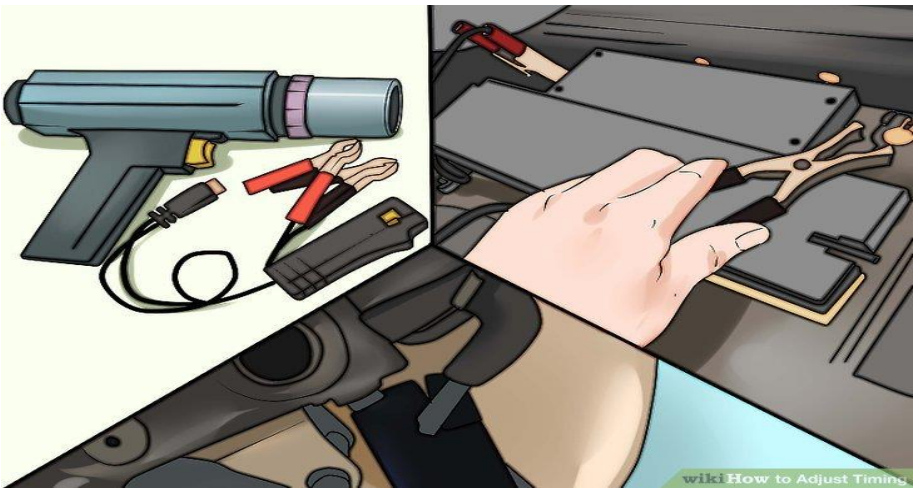


Fig 1.4. Hook up your timing light or timing gun

Hook up your timing light or timing gun. Hook your timing gun up to the power and ground terminals on your car's battery, and hook the sensor that accompanies the timing gun to your number one cylinder spark plug wire. Follow the instructions particular to the timing light you're using to hook it up properly.

- The "gun" works by illuminating the timing marks in a strobe fashion as it spins, allowing you to see the point at which the spark plug is firing on the timing index. When the spark plug fires, the sensor sends a signal to the light, which strobes in the gun, illuminating the numbers at the proper moment.

Fig 1.5. Have a helper rev the engine

Have a helper rev the engine. To check your timing number and see how it is firing, have someone rev the engine while you illuminate the timing numbers with your light. You obviously want to make sure the car is in neutral, and keep your hands a safe distance from the engine as it revs.

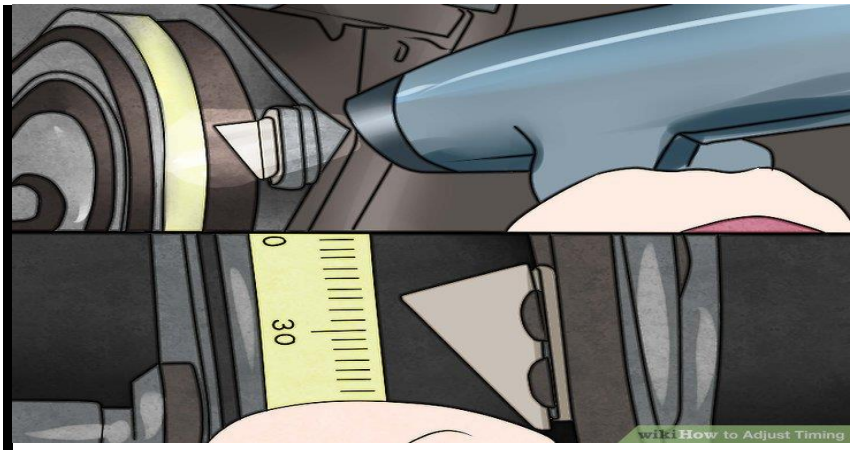


Fig.1.6. Shine the light directly onto the harmonic balancer and find the number

Shine the light directly onto the harmonic balancer and find the number.

Though the wheel is turning, the light should seem to "freeze" it at a particular number. This is the timing number. Note the number of degrees to the right or left of zero.

- As the RPMs increase, the point at which the spark plug is firing should also increase somewhat. This is normal, because ignition works on a curve, allowing for the speed increase and adjusting the timing accordingly.
    - To check for total timing, you want to be sure to rev the engine to at least 3500 RPMs. This will allow you to make sure the curve of the ignition timing is being set, as well as the initial timing.

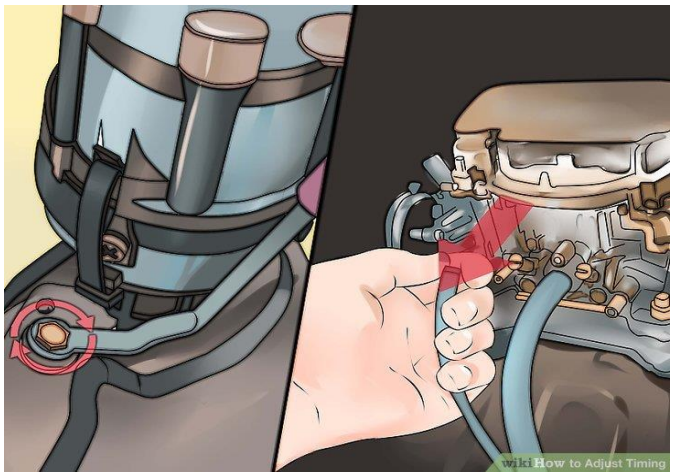


Fig.1.7.Account for vacuum timing, if necessary

Account for vacuum timing, if necessary. If your car features vacuum timing advance in addition to mechanical timing, and you'll need to loosen the distributor adjustment bolt before you start the engine. Next, remove the vacuum advance hose from the carburetor and plug it with a rag to check your timing.[5]

- Vacuum timing works by making minor adjustments at at low RPM by rotating slightly to adjust for the timing.

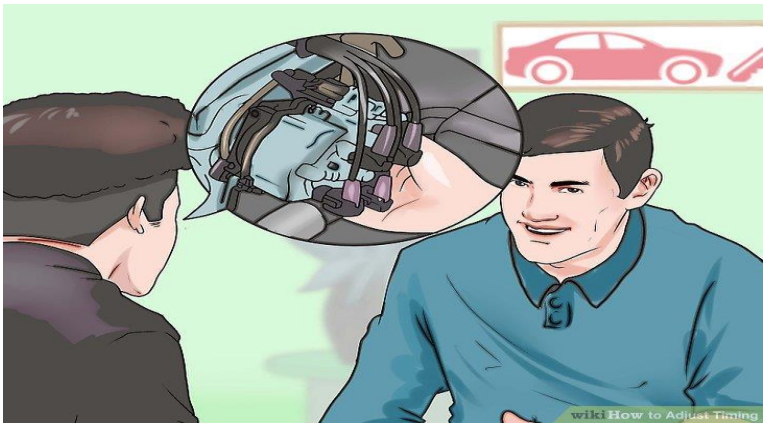


Fig.1.8.Adjust the timing, if necessary

Adjust the timing, if necessary. Now that you've found your ignition timing number, how do you know if you need to adjust it? All models of cars will have differing timing values, depending on the year it was manufactured and the variety of transmission used. To learn whether or not you need to adjust your timing, find the optimum timing number for your make and model and adjust if necessary.

- If you don't know your timing number, talk to a licensed mechanic or employee at your local auto parts store to consult their manuals and find the proper timing number.

Part3

Adjusting the Timing

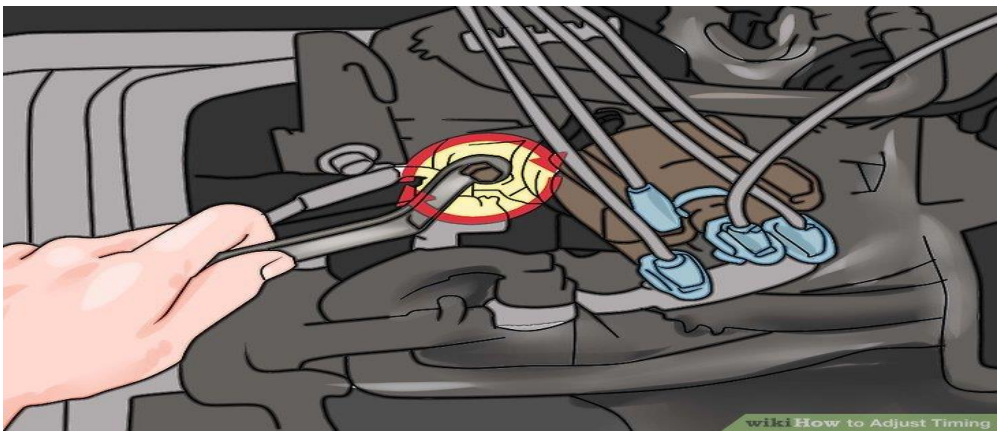


Fig.1.9.Loosen the bolt that secures the engine's distributor enough so that the distributor can be turned

1 Loosen the bolt that secures the engine's distributor enough so that the distributor can be turned. To adjust your timing, all you need to do is turn the distributor housing one direction or the other, depending on whether or not you want to advance or move back the timing.[6]

- If the rotor turns clockwise, you'll advance the timing by rotating the distributor counterclockwise, and vice versa. It'll take some touch to get it right, so it helps to have someone to rev the engine, check the number, and twist the distributor.

Fig 1.10.Adjust while the engine is at idle speed

Adjust while the engine is at idle speed. Grab the distributor firmly and rotate it slowly to one side or the other. Continue rotating until the timing mark is in the correct position.

Align the timing marks by continuing to move the distributor and checking with your timing light. When you've got it set where you want it, lock it back down by tightening the distributor bolts.[7] Reconnect vacuum hoses.

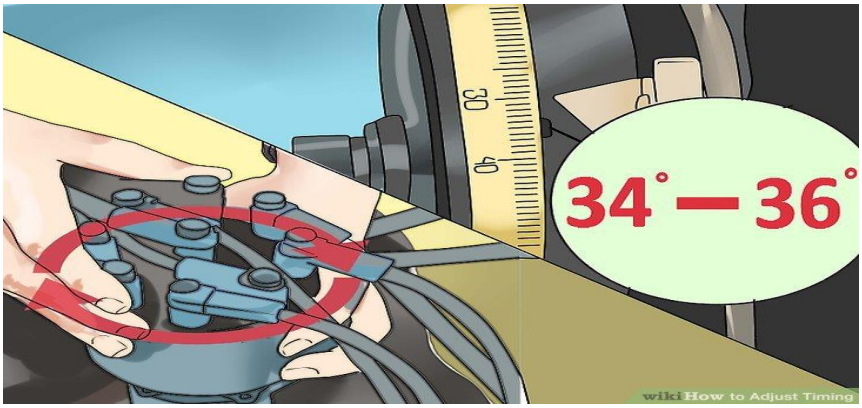


Fig.1.11.When in doubt, total timing should be somewhere between 34 and 36 degrees

When in doubt, total timing should be somewhere between 34 and 36 degrees. A typical small-block Chevy's timing curve needs to be set somewhere in this range for maximum performance, when the engine is being revved at 3500 RPM. At this point, the timing should stop advancing and should remain steady.[8]

- Total timing minus your base timing number should meet your engine specification for total advance degrees. If the number is not as specified then you may have a distributor mechanical advance problem.

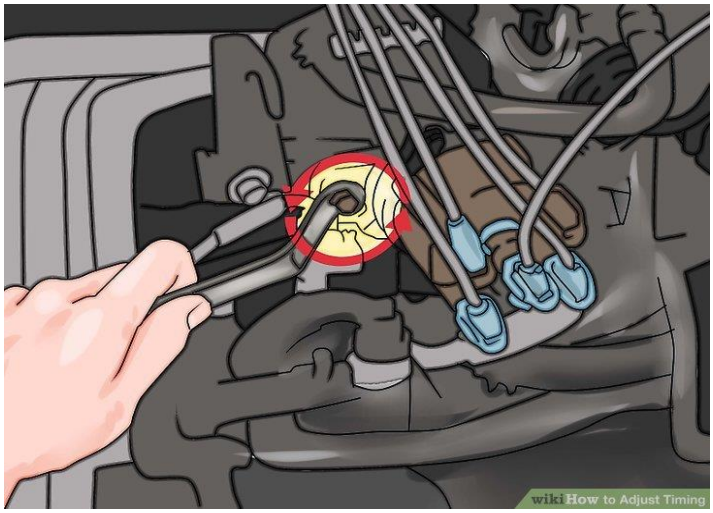


Fig.1.12. Tighten the distributor bolt when you are satisfied the timing is set correctly

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. How do you adjust ignition timing?(5pts)

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

Information Sheet 2- Checking advanced timing

2.1. Checking advanced timing

What happens if you advance timing too much?

SYMPTOMS OF INCORRECT IGNITION TIMING

Too little spark advance will cause low power, bad gas mileage, backfiring, and poor performance. Too much advance will cause hard starting and pre-ignition. Pre-ignition can be caused by too much spark advance or too low octane gas.

Also know, what does advancing your timing do?

Advancing the timing means the plug fires earlier in the compression stroke (farther from TDC). Advance is required because the air/fuel mixture does not burn instantly. It takes time for the flame to ignite the all the mixture. However, if the timing is advanced too far, it will cause an Engine Knock.

Likewise, does advancing timing increase horsepower? Optimum timing from a fixed (locked) ignition advance occurs at only one engine speed. The engine speed operating range affects where the timing is the best. Increasing the timing advance raises the high-end power, reducing the low-end. Decreasing the timing advance raises low-end power, reducing the high-end.

Symptoms Of A Failing Or Broken Timing Belt

- You Hear Odd Noises Coming From The Engine.
- Your Check Engine Light Is On And Flashing.
- Your Car Starts Hard And Occasionally Misfires.
- You Notice A Loss Of Power And Your Car Runs Or Idles More Roughly Than Normal.

Does advancing timing increase idle?

Advance timing, and response increases, easier to start, more power(torque) off idle. Some engines use the vacuum advance to advance timing at idle. This allows the engine to be able to start without kicking back against the starter since the base timing is actually retarded slightly.

Timing advance is required because it takes time to burn the air-fuel mixture. Igniting the mixture before the piston reaches TDC will allow the mixture to fully burn soon after the piston reaches TDC.

If the mixture is ignited at the correct time, maximum pressure in the cylinder will occur sometime after the piston reaches TDC allowing the ignited mixture to push the piston down the cylinder with the greatest force.

Ideally, the time at which the mixture should be fully burnt is about 20 degrees ATDC. This will maximize the engine's power producing potential.

If the ignition spark occurs at a position that is too advanced relative to piston position, the rapidly combusting mixture can actually push against the piston still moving up in its compression stroke, causing knocking (pinking or pinging) and possible engine damage, this usually occurs at low RPM and is known as pre-ignition or in severe cases detonation.

If the spark occurs too retarded relative to the piston position, maximum cylinder pressure will occur after the piston is already too far down in the cylinder on its power stroke. This results in lost power, overheating tendencies, high emissions, and unburned fuel.

The ignition timing will need to become increasingly advanced (relative to TDC) as the engine speed increases so that the air-fuel mixture has the correct amount of time to fully burn.

As the engine speed (RPM) increases, the time available to burn the mixture decreases but the burning itself proceeds at the same speed, it needs to be started increasingly earlier to complete in time.

Poor volumetric efficiency at higher engine speeds also requires increased advancement of ignition timing. The correct timing advance for a given engine speed will allow for maximum cylinder pressure to be achieved at the correct crankshaft angular position.

When setting the timing for an automobile engine, the factory timing setting can usually be found on a sticker in the engine bay.

The ignition timing is also dependent on the load of the engine with more load (larger throttle opening and therefore air:fuel ratio) requiring less advance (the mixture burns faster).

Also it is dependent on the temperature of the engine with lower temperature allowing for more advance. The speed with which the mixture burns depends on the type of fuel, the amount of turbulence in the airflow (which is tied to the design the cylinder head and valvetrain system) and on the air-fuel ratio. It is a common myth that burn speed is linked with octane rating.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

test i short answer

1. symptoms of incorrect ignition timing?(2pts)
2. Does advancing timing increase idle?(4pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

1. _____

_____

Test II

Information Sheet 3- Observing safety using tools and equipment

3.1. Observing safety using tools and equipment

10 Basic Safety Rules For Using Hand Tools

Inspect regularly. Regularly inspect your tools to make sure that they are in good condition.

Wear gloves. Always wear appropriate personal protective equipment.

Carry with care. Never carry tools up a ladder. ...

Don't pocket sharp objects. ...

Be aware of your surroundings. ...

Use the right tools. ...

Follow instructions. ...

Clean and return.

What is the tool and equipment?

Tools and equipment means all hand tools, implements, camp equipment, drawing office and survey instruments, medical and surgical instruments and all articles of similar nature, whether or not they are of an expendable nature, which are not normally issued to officers personally for use in carrying out their official

How do you classify tools and equipment?

- Classifications of tools and equipment according to their uses:

Measuring tools.

Holding tools.

Cutting tools.

Driving tools.

Boring tools 6. Electrical equipment 7. Miscellaneous tools/instrument/equipment.

Why is it important to use correct tools and equipment?

Each **tool** is precisely designed for a specific purpose, so choosing the **correct tool** will also decrease the amount of effort required to get a job done **right** without causing damage to either the **equipment** or the surface being worked on.

Safety procedures in using hand tools and equipment

1. The use of hand tools in accomplishing task and job orders greatly increase the productivity and accuracy of a worker. Although hand tools provide convenience and ease in completing any task, it may also cause injuries and infirmities.

2. 1. A worker must always be aware of the task he must accomplish so that he would know the hand tools that he needs. 1.1 WAYS TO UTILIZED TOOLS : A. Cutting tools must always be kept sharp. B.Gripping tools must maintain a strong grip.

3. c. Driving Tools must always be kept straight. d. A striking tool's handle must be well attached to its head to avoid it from flying away. e. Diagnostic tools must always be calibrated before use. Safety Procedures

4. 2. Work space must also be observed properly. 3. Correct posture must be practiced when using hand tools. 4. Use the proper PPE necessary to protect you from exposure to potential hazards. Safety Procedures

5. Occupational Safety and Health procedures are not the sole task of the management. Everyone in the workplace must be vigilant and smart so that accidents and unwanted damages will be avoided. REMEMBER

6. 1. The work are must always be kept neat and clean. 2. All tools and equipment must be placed in a clean and dry place. 3. Clean tools and equipment work more efficiently. 4. Before cleaning any tools make sure to use the proper PPE. 5. Only use cleaning agents as prescribed by the tool or equipment's manufacturer. PROPERLY ORGANIZED WORKPLACE

7. 6. Cleaning tools after use is highly recommended. 7. Tools with moving parts often suffer loosening of its parts remember to keep them together and replace ones that's not functioning well. 8. Lubricants must also be applied after tightening to reduce the friction. 9. Driving tools handles must also be tightened to reduce hand strain when turning. PROPERLY ORGANIZED WORKPLACE

8. Tools help in the completion of the different job requirements, keeping them well preserved will make work easier and more efficient. REMEMBER

9. 1. In using a driving tool, screws may slip the tip of the screw driver. 2. Small objects tend to fall down. MALFUNCTIONS 1. In using striking tools the heads are separating from the handle. 2. Mishaps in using cutting tools and power tools is also dangerous. Ex. Slippage of materials to be cut COMMON MALFUNCTION IN HAND TOOLS, EQUIPMENT AND PARAPHERNALIA

10. 3. In diagnostic tools inaccurate reading may occur if this tools is not properly calibrated. COMMON MALFUNCTION IN HAND TOOLS, EQUIPMENT AND PARAPHERNALIA

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. Why is it important to use correct tools and equipment?2pts)

2. How do you classify tools and equipment?(6pts)

Note: Satisfactory rating - 8 points Unsatisfactory - below 8 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 4-Performing checking and adjustment without damage

Performing checking and adjustment without damage

ADVANCE MECHANISM

- Dynamometer tuning
- Mechanical ignition systems
- Mechanical timing advance
- Vacuum timing advance
- Computer-controlled ignition systems

Dynamometer tuning

Setting the ignition timing while monitoring engine power output with a dynamometer is one way to correctly set the ignition timing. After advancing or retarding the timing, a corresponding change in power output will usually occur.

A load type dynamometer is the best way to accomplish this as the engine can be held at a steady speed and load while the timing is adjusted for maximum output.

Using a knock sensor to find the correct timing is one method used to tune an engine. In this method, the timing is advanced until knock occurs. The timing is then retarded one or two degrees and set there.

This method is inferior to tuning with a dynomometer since it often leads to ignition timing which is excessively advanced particularly on modern engines which do not require as much advance to deliver peak torque.

With excessive advance, the engine will be prone to pinging and detonation when conditions change (fuel quality, temperature, sensor issues, etc). After achieving the desired power characteristics for a given engine load/rpm, the spark plugs should be

inspected for signs of engine detonation. If there are any such signs, the ignition timing should be retarded until there are none.

The best way to set ignition timing on a load type dynamometer is to slowly advance the timing until peak torque output is reached. Some engines (particularly turbo or supercharged) will not reach peak torque at a given engine speed before they begin to knock (pinging or minor detonation).

In this case, engine timing should be retarded slightly below this timing value (known as the "knock limit"). Engine combustion efficiency and volumetric efficiency will change as ignition timing is varied, which means fuel quantity must also be changed as the ignition is varied. After each change in ignition timing, fuel is adjusted also to deliver peak torque.

Mechanical ignition systems

Mechanical ignition systems use a mechanical spark distributor to distribute a high voltage current to the correct spark plug at the correct time. In order to set an initial timing advance or timing retard for an engine, the engine is allowed to idle and the distributor is adjusted to achieve the best ignition timing for the engine at idle speed. This process is called 'setting the base advance'.

There are two methods of increasing timing advance past the base advance. The advances achieved by these methods are added to the base advance number in order to achieve a total timing advance number.

Mechanical timing advance

An increasing mechanical advancement of the timing takes place with increasing engine speed. This is possible by using the law of inertia. Weights and springs inside the distributor rotate and affect the timing advance according to engine speed by altering the angular position of the timing sensor shaft with respect to the actual engine position.

This type of timing advance is also referred to as centrifugal timing advance. The amount of mechanical advance is dependent solely on the speed at which the distributor is rotating. In a 2-stroke engine, this is the same as engine RPM. In a 4-stroke engine, this is half the engine RPM. The relationship between advance in degrees and distributor RPM can be drawn as a simple 2-dimensional graph.

Lighter weights or heavier springs can be used to reduce the timing advance at lower engine RPM. Heavier weights or lighter springs can be used to advance the timing at lower engine RPM. Usually, at some point in the engine's RPM range, these weights

contact their travel limits, and the amount of centrifugal ignition advance is then fixed above that rpm.

Vacuum timing advance

The second method used to advance (or retard) the ignition timing is called vacuum timing advance. This method is almost always used in addition to mechanical timing advance. It generally increases fuel economy and driveability, particularly at lean mixtures.

It also increases engine life through more complete combustion, leaving less unburned fuel to wash away the cylinder wall lubrication (piston ring wear), and less lubricating oil dilution (bearings, camshaft life, etc.). Vacuum advance works by using a manifold vacuum source to advance the timing at low to mid engine load conditions by rotating the position sensor (contact points, hall effect or optical sensor, reluctor stator, etc.) mounting plate in the distributor with respect to the distributor shaft.

Vacuum advance is diminished at wide open throttle (WOT), causing the timing advance to return to the base advance in addition to the mechanical advance.

One source for vacuum advance is a small opening located in the wall of the throttle body or carburetor adjacent to but slightly upstream of the edge of the throttle plate. This is called a ported vacuum.

The effect of having the opening here is that there is little or no vacuum at idle, hence little or no advance. Other vehicles use vacuum directly from the intake manifold. This provides full engine vacuum (and hence, full vacuum advance) at idle.

Some vacuum advance units have two vacuum connections, one at each side of the actuator membrane, connected to both manifold vacuum and ported vacuum. These units will both advance and retard the ignition timing.

On some vehicles, a temperature sensing switch will apply manifold vacuum to the vacuum advance system when the engine is hot or cold, and ported vacuum at normal operating temperature.

This is a version of emissions control; the ported vacuum allowed carburetor adjustments for a leaner idle mixture. At high engine temperature, the increased advance raised engine speed to allow the cooling system to operate more efficiently.

At low temperature the advance allowed the enriched warm-up mixture to burn more completely, providing better cold-engine running.

Electrical or mechanical switches may be used to prevent or alter vacuum advance under certain conditions. Early emissions electronics would engage some in relation to oxygen sensor signals or activation of emissions-related equipment. It was also common to prevent some or all of the vacuum advance in certain gears to prevent detonation due to lean-burning engines.

Computer-controlled ignition systems

Newer engines typically use computerized ignition systems. The computer has a timing map (lookup table) with spark advance values for all combinations of engine speed and engine load. The computer will send a signal to the ignition coil at the indicated time in the timing map in order to fire the spark plug.

Most computers from original equipment manufacturers (OEM) cannot be modified so changing the timing advance curve is not possible. Overall timing changes are still possible, depending on the engine design.

Aftermarket engine control units allow the tuner to make changes to the timing map. This allows the timing to be advanced or retarded based on various engine applications. A knock sensor may be used by the ignition system to allow for fuel quality variation.

Checking and adjustment without damage

Set timing with a vacuum gauge

Loosen the bolt securing the distributor so you can turn the distributor to adjust the timing. ... While watching the vacuum gauge, slowly turn the distributor clockwise (advance timing) and look for a maximum reading on the gauge.

How to Set the Ignition Timing With No Timing Marks

1. **Mark** the spark plug wires for the cylinder number using a short piece of masking tape on each wire. ...
2. Rotate the engine clockwise and observe the valves on the number one cylinder. ...
3. Locate the number one spark plug wire on distributor cap and make a tic-**mark** of this position with a marker pen on the distributor housing.

How does ignition timing affect vacuum?

If vacuum is steady at idle but lower than normal, the ignition or valve timing may be retarded. Low compression, an intake leak or tight valves also can cause low vacuum at idle. ... Higher-than-normal vacuum at idle is a common clue to overly advanced ignition timing, while low vacuum can indicate retarded timing

Vacuum-advance canisters move the plate in the distributor when vacuum is applied to the internal diaphragm. Vacuum applied to the diaphragm advances the pickup position, altering the timing. Adjustable vacuum canisters are available for most popular distributors and are usually identified by their octagonal shape. This one uses a 3/32-inch Allen wrench to adjust the rate at which advance is applied

Self-Check – 1	Written test

Name…… ID…… Date…….

Write true if the statement is correct and false if the statement is incorrect

1. How does ignition timing affect vacuum?. (2pts)

2. List advance mechanism?(4pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Operation Sheet-1	Centrifugal and vacuum advance check

Centrifugal advance check

1. With engine operating at specified timing speed and distributor vacuum line disconnected, aim timing light at timing pointer and press trigger while watching position of timing mark.
2. Slowly increase and decrease engine speed from timing speed to about 2000RPM while watching position of timing mark.
   - If the timing mark moves away from and returns to its original position, gradually and without hesitation as speed is increased and decreased, the centrifugal advance mechanism is operating satisfactorily.
   - If the timing mark moves away from its original position rapidly with little change in engine speed, or moves very little with considerable change in speed, or fails to return to its original position when speed is decreased, the centrifugal advance mechanism is in need of service.
   - Jerky changes may indicate sticking advance weights in the distributor.

VACUUM ADVANCE CHECK

1. With engine speed adjusted to idle at about 1000 rpm and distributor vacuum line connected, aim timing light at timing pointer and press trigger while observing timing mark.

NOTE: Be aware that some engines equipped with emission control devices may prevent the vacuum advance mechanism from operating when the transmission is in the neutral position.

Refer to manufacturer's specifications for special instructions.

2. Suddenly open and close the throttle, causing the manifold vacuum to momentarily fall, while observing the position of the timing mark.
   - If the timing retards when the throttle is opened and advances when the throttle is closed, the vacuum advance mechanism is operating satisfactorily.
   - If the timing mark moves very little or there is no change other than that caused by the centrifugal advance, operation of the vacuum advance mechanism is in need of service.

LAP Test-1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Request necessary tools and materials you are required to perform the following tasks.

Task 1. Check centrifugal and vacuum advance

Operation sheet 2	adjustment Ignition timing

Procedure: Ignition timing adjustment

- **a.** Turn the Crankshaft in its direction of rotation until the timing marks of No-1 cylinder match in TDC position
- **b.** Now, loosen distributor mounting clamp-
- **c.** Turn distributor in its mounting until the timing lamp bulb just starts to light – ignition switch must be in its " on" position-
- **d.** Tighten distributor mounting clamp-
- **e.** Turn the crankshaft opposite its direction of rotation for about ¼ of one rotation-
- **f.** Again, rotate the crankshaft its direction of rotation until the bulb light appears-Now the timing mark on pulley or flywheel should align with the stationary timing pointer or timing mark on the engine casing-
- **g.** Repeat steps b) to f) until the position described in f) is attained-
- **h.** Turn ignition switch in it's " off" position and disconnect the test lamp-
- **i.** Run engine for test-

LAP Test-2	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Request necessary tools and materials you are required to perform the following tasks.

Task 1. Adjust dwell angle

Task 2. Adjust igntion timing

LG #41	LO #9- Conducting compression testing

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Setting up engine requirements in compression testing
- Conducting compression test without damage
- Readying and interpreting specific compression test result
- Giving corresponding recommendation/prescription based on the test result.
- Setting up engine requirements in leakage testing
- Conducting leakage test without damage
- Reading and interpreting specific leakage test result
- Giving recommendation based on the test result
- Setting up engine requirements in power balance test
- Reading and interpreting specific power balance test result
- Giving recommendation based on the test result
- Setting up engine requirements in vacuum test
- Conducting vacuum test without damage
- Reading and interpreting specific vacuum test result
- Giving recommendation based on the test resu

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Set up engine requirements in compression testing
- Conduct compression test without damage
- Ready and interpreting specific compression test result
- Give corresponding recommendation/prescription based on the test result.
- Set up engine requirements in leakage testing
- Conduct leakage test without damage
- Read and interpreting specific leakage test result
- Give recommendation based on the test result
- Set up engine requirements in power balance test
- Read and interpreting specific power balance test result
- Give recommendation based on the test result
- Set up engine requirements in vacuum test
- Conduct vacuum test without damage
- Read and interpreting specific vacuum test result
- Give recommendation based on the test resu

Learning Instructions:

- Read the specific objectives of this Learning Guide.
- Follow the instructions described below.
- Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
- Accomplish the “Self-checks” which are placed following all information sheets.
- Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
- If you earned a satisfactory evaluation proceed to “Operation sheets
- Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
- If your performance is satisfactory proceed to the next learning guide,

- If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1-Setting up engine requirements in compression testing

Setting up engine requirements in compression testing

What types of fuel are used in automotive engines?

Currently, the majority of motor vehicles worldwide are powered by gasoline or diesel. Other energy sources include ethanol, biodiesel, propane, compressed natural gas (CNG), electric batteries charged from an external source, and hydrogen.

Types of Fuels:

Solid Fuels.

Liquid Fuels.

Gaseous Fuels.

An engine compression test is one of the fundamental engine diagnostic tests that can be performed. For smooth engine operation, all cylinders must have equal compression. An engine can lose compression by leakage of air through one or more of only three routes.

- Intake or exhaust valve
- Piston rings (or piston, if there is a hole)
- Cylinder head gasket

For best results, the engine should be warmed to normal operating temperature before testing.

COMPRESSION TEST (PETROL ENGINE ONLY)

BEFORE TESTING

To ensure that compression readings are accurate, perform the following pre-test procedures.

1. Make sure the vehicle battery is fully charged, and the starter system is in good condition.

2. Warm up the engine until normal operating temperature is reached.

3. Make sure to remove ALL spark plugs before performing the compression test.

4. On carbureted models, open choke plate to allow air flow through the carburetor during testing.

COMPRESSION TEST (DIESEL ENGINE ONLY)

BEFORE TESTING

To ensure that compression readings are accurate, perform the following pre-test procedures.

1. Make sure the vehicle battery is fully charged, and the starter system is in good condition.
2. Warm up the engine until normal operating temperature is reached.
3. Make sure to remove all glow plugs before performing the compression test, or for nonglow plug diesel engine remove all the fuel injectors.

Self-Check – 1	Written test

Name…… ID…… Date…….

Test I short answer

2. What are the two types of fuel?(3)

Note: Satisfactory rating - 3 points Unsatisfactory - below 3 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

Information Sheet 2-Conducting compression test without damage

Conducting compression test without damage

What is the compression test?

Compression tests are used to determine a material's behavior under applied crushing loads, and are typically conducted by applying compressive pressure to a test specimen (usually of either a cuboid or cylindrical geometry) using platens or specialized fixtures on a universal testing machine.

What is the purpose of compression test?

Compression tests are used to determine the material behavior under a load. The maximum stress a material can sustain over a period under a load (constant or progressive) is determined. Compression testing is often done to a break (rupture) or to a limit.

An accurate compression test should be performed as follows:

STEP 1 Remove all spark plugs. This allows the engine to be cranked to an even speed. Be sure to label all spark plug wires. CAUTION: Disable the ignition system by disconnecting the primary leads from the ignition coil or module or by grounding the coil wire after removing it from the center of the distributor cap. Also disable the fuel-injection system to prevent the squirting of fuel into the cylinder.

STEP 2 Block open the throttle. This permits the maximum amount of air to be drawn into the engine. This step also ensures consistent compression test results.

STEP 3 Thread a compression gauge into one spark plug hole and crank the engine. Continue cranking the engine through four compression strokes. Each compression stroke makes a puffing sound. NOTE: Note the reading on the compression gauge after the first puff. This reading should be at least one-half the final reading. For example, if the final, highest reading is 150 PSI, then the reading after the first puff should be higher than 75 PSI. A low first-puff reading indicates possible weak piston rings. Release the pressure on the gauge and repeat for the other cylinders.

STEP 4 Record the highest readings and compare the results. Most vehicle manufacturers specify the minimum compression reading and the maximum allowable variation among cylinders. Most manufacturers specify a maximum difference of 20% between the highest reading and the lowest reading.

Fig.2.1 Conducting compression test

NOTE: During cranking, the oil pump cannot maintain normal oil pressure. Extended engine cranking, such as that which occurs during a compression test, can cause hydraulic lifters to collapse. When the engine starts, loud valve clicking noises may be heard. This should be considered normal after performing a compression test, and the noise should stop after the vehicle has been driven a short distance.

WET COMPRESSION TEST

If the compression test reading indicates low compression on one or more cylinders, add three squirts of oil to the cylinder and retest. This is called a wet compression test, when oil is used to help seal around the piston rings.

CAUTION: Do not use more oil than three squirts from a hand-operated oil squirt can. Too much oil can cause a hydrostatic lock, which can damage or break pistons or connecting rods or even crack a cylinder head.

Perform the compression test again and observe the results. If the first-puff readings greatly improve and the readings are much higher than without the oil, the cause of the low compression is worn or defective piston rings. If the compression readings increase only slightly (or not at all), then the cause of the low compression is usually defective valves.

NOTE: During both the dry and wet compression tests, be sure that the battery and starting system are capable of cranking the engine at normal cranking speed.

RUNNING (DYNAMIC) COMPRESSION TEST

A compression test is commonly used to help determine engine condition and is usually performed with the engine cranking. What is the RPM of a cranking engine? An engine idles at about 600 to 900 RPM, and the starter motor obviously cannot crank the engine as fast as the engine idles. Most manufacturers' specifications require the engine to crank at 80 to 250 cranking RPM. Therefore, a check of the engine's compression at cranking speed determines the condition of an engine that does not run at such low speeds. But what should be the compression of a running engine? Some would think that the compression would be substantially higher, because the valve overlap of the cam is more effective at higher engine speeds, which would tend to increase the compression.

A running compression test, also called a dynamic compression test, is done with the engine running rather than during engine cranking as is done in a regular compression test. Actually, the compression pressure of a running engine is much lower than cranking compression pressure. This results from the volumetric efficiency. The engine is revolving faster, and therefore, there is less time for air to enter the combustion chamber. With less air to compress, the compression pressure is lower. Typically, the higher the engine RPM, the lower the running compression. For most engines, the value ranges are as follows:

- Compression during cranking: 125 to 160 PSI
- Compression at idle: 60 to 90 PSI
- Compression at 2,000 RPM: 30 to 60 PSI

As with cranking compression, the running compression of all cylinders should be equal. Therefore, a problem is not likely to be detected by single compression values, but by variations in running compression values among the cylinders. Broken valve springs, worn valve guides, bent pushrods, and worn cam lobes are some items that would be indicated by a low running compression test reading on one or more cylinders.

PERFORMING A RUNNING COMPRESSION TEST

To perform a running compression test, remove just one spark plug at a time. With one spark plug removed from the engine, use a jumper wire to ground the spark plug wire to a good engine ground. This prevents possible ignition coil damage. Start the engine, push the pressure release on the gauge, and read the compression. Increase the engine speed to about 2,000 RPM and push the pressure release on the gauge again. Read the gauge.

Stop the engine, reinstall the spark plug, reattach the spark plug wire, and repeat the test for each of the remaining cylinders. Just like the cranking compression test, the running compression test can inform a technician of the relative compression of all the cylinders.

COMPRESSION TEST (PETROL ENGINE ONLY)

SAFETY TIPS

1. Always wear safety eye protection. 2. Put transmission in “park” (for automatic) or “neutral” (for manual). Set parking brake and block drive wheels. 3. Make sure the ignition system is disable to prevent the car from accidental starting.

TEST PROCEDURES

CAUTION: Engine parts and surrounding areas will be hot.

The tools and equipment needed to perform a compression test include a compression gauge, an air nozzle, and the socket ratchets and extensions that may be necessary to remove the spark plugs from the engine.

1. To prevent ignition and fuel-injection operation while the engine is being cranked, remove both the fuel-injection fuse. If the fuses cannot be removed, disconnect the wiring connectors from the injectors and the ignition system.
2. Block open the throttle (and choke, if the engine is equipped with a carburetor). Here a screwdriver is being used to wedge the throttle linkage open. Keeping the throttle open ensures that enough air will be drawn into the engine so that the compression test results will be accurate.
3. Before removing the spark plug, use air nozzle to blow away any dirt that may be around the spark plug. This step helps prevent debris from getting into the engine when the spark plugs are removed.
4. Remove all spark plugs. Make sure to mark the spark plug wires so that they can be reinstalled onto the correct spark plugs after the compression test has been performed.
5. Select the proper adaptor for the compression gauge. The treads on the adapter should match those on the spark plug.
6. If necessary, connected a battery charger to the battery before starting the compression test. It is important that consistent cranking speed be available for each cylinder being tested.

7. Make a note of the reading on the gauge after the first “puff”, which indicates the first compression stroke that occurred on the cylinder as the engine was being rotated. If the first puff reading is low and the reading gradually increase with each puff, weak or worn piston rings may be indicated.
8. After the engine has been cranked for four “puff”, stop cranking the engine and observe the compression gauge.
9. Record the first puff and the final reading for each cylinder. The final readings should all be within specification of each cylinder. (at least 20% of each cylinder)
10. If a cylinder(s) is lower than most of the others, use an oil can and squirt two squirts of engine oil into the cylinder and repeat the compression test. This is called performing a wet compression test.
11. If the gauge reading is now much higher than the first test results, then the cause of the low compression is due to worn or defective piston rings. The oil in the cylinder temporarily seals the rings which causes the higher readin

COMPRESSION TEST (DIESEL ENGINE ONLY)

SAFETY TIPS

1. Always wear safety eye protection. 2. Put transmission in “park” (for automatic) or “neutral” (for manual). Set parking brake and block drive wheels. 3. Make sure the fuel system is disable to prevent the car from accidental starting.

TEST PROCEDURES

CAUTION: Engine parts and surrounding areas will be hot.

1. The tools and equipment needed to perform a compression test include a compression gauge, an air nozzle, and the socket ratchets and extensions that may be necessary to remove the glow plug or fuel injectors from the engine.

2. To prevent ignition and fuel-injection operation while the engine is being cranked, remove the fuel pump fuse. If the fuses cannot be removed, disconnect the wiring connectors from the injectors (for non-common rail diesel engine, disconnect the pressure pipe from the injector – this is to prevent overfeeding).

Block open the throttle. Here a screwdriver is being used to wedge the throttle linkage open. Keeping the throttle open ensures that enough air will be drawn into the engine so that the compression test results will be accurate.

4. Before removing the glow plug or injectors, use air nozzle to blow away any dirt that may be around the mounting. This step helps prevent debris from getting into the engine when the components are removed.

5. Remove all glow plugs or injectors. Make sure to mark the injector nozzles so that they can be reinstalled onto the correct location after the compression test has been performed.

6. Select the proper adaptor for the compression gauge. The treads on the adapter should match those on the glow plug or injectors.

7. If necessary, connected a battery charger to the battery before starting the compression test. It is important that consistent cranking speed be available for each cylinder being tested.

8. Make a note of the reading on the gauge after the first “puff”, which indicates the first compression stroke that occurred on the cylinder as the engine was being rotated. If the first puff reading is low and the reading gradually increase with each puff, weak or worn piston rings may be indicated.

9. After the engine has been cranked for four “puff”, stop cranking the engine and observe the compression gauge.

10. Record the first puff and the final reading for each cylinder. The final readings should all be within specification of each cylinder. (at least 20% of each cylinder)

WARNING: DO NOT perform the wet compression test on any diesel engine. The higher compression in a diesel engine may cause engine damage or injury to the technician.

Self-Check 1	Written Test

Name…… ID…… Date…….

***Instructions**:* Answer all the questions listed below.

1. What is compression test?(2pts)
2. Write two types of compression test.(4pts)
3. What is the purpose of compression test?(2pts)

Answer Sheet

Name: _____ Date: _____

Test I

Note: Satisfactory rating - 8 points Unsatisfactory - below 8 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Information Sheet 3-Readying and interpreting specific compression test result

The amount of pressure produced by the piston depends on:-

1. The amount of air present in the cylinder
2. The compression ratio of the cylinder
3. How will the cylinder is sealed

The expected cylinder pressures of an engine are usually given in the specification for the engine manual. If this specification is not available, use the following formula to determine the amount of pressure expected from the cylinder during the compression stroke.

Compression Pressure = Atmospheric pressure X Compression ratio +

Atmospheric pressure + 10psi

= 14.7psi X 8 +14.7_{psi} +10psi

Compression pressure =142.3 psi. for 8:1 compression ratio

To measure the compression pressure in a cylinder, a compression tester is used. The tester is inserted into the spark plug hole of the cylinder for gasoline engine (in to glow plug hole of the cylinder for diesel engine) the pressure of that cylinder is registered on the gauge of the tester.To product the compression pressure test, the engine warm up to its

operating temperature first, The tester should be placed in the spark plug hole (glow plug hole/ of the cylinder.

For example: If the high reading is 150 PSI Subtract 20% _30 PSI Lowest allowable compression is 120 PSI

NOTE: To make the math quick and easy, think of 10% of 150, which is 15 (move the decimal point to the left one place). Now double it: 15 x 2 = 30. This represents 20%. Or simply multiply 150 x 0.20 = 120psi.

What to do with lowest cylinder

- If you get a cylinder that reads low, there is a leak somewhere
- You can confirm or eliminate the rings as a source of leakage by conducting a wet compression test.
- Wet Compression Test
  - Squirt oil into sparkplug hole
  - Crank engine over several times
  - Retest compression
- If compression increases, rings are worn
- If No change, the leak is somewhere else

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. The amount of pressure produced by the piston depends on? (5pts)

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 4-Giving corresponding recommendation/prescription based on the test result.test result

Types of compression test

1. **Dry** :-this types of test perform only without oil inside the engine cylinder.
2. **Wet** :- adding oil on defective engine cylinder helps to seal the piston rings temporarily.

The compression test measures the amount of pressure that is formed by the piston moving up on its compression stroke.

WET COMPRESSION TEST

If the compression test reading indicates low compression on one or more cylinders, add three squirts of oil to the cylinder and retest. This is called a wet compression test, when oil is used to help seal around the piston rings.

CAUTION: Do not use more oil than three squirts from a hand-operated oil squirt can. Too much oil can cause a hydrostatic lock, which can damage or break pistons or connecting rods or even crack a cylinder head.

Perform the compression test again and observe the results. If the first-puff readings greatly improve and the readings are much higher than without the oil, the cause of the low compression is worn or defective piston rings. If the compression readings increase only slightly (or not at all), then the cause of the low compression is usually defective valves.

NOTE: During both the dry and wet compression tests, be sure that the battery and starting system are capable of cranking the engine at normal cranking speed.

RUNNING (DYNAMIC) COMPRESSION TEST

A compression test is commonly used to help determine engine condition and is usually performed with the engine cranking. What is the RPM of a cranking engine? An engine idles at about 600 to 900 RPM, and the starter motor obviously cannot crank the engine as fast as the engine idles. Most manufacturers' specifications require the engine to crank at 80 to 250 cranking RPM. Therefore, a check of the engine's compression at cranking speed determines the condition of an engine that does not run at such low speeds. But what should be the compression of a running engine? Some would think that the

compression would be substantially higher, because the valve overlap of the cam is more effective at higher engine speeds, which would tend to increase the compression.

A running compression test, also called a dynamic compression test, is done with the engine running rather than during engine cranking as is done in a regular compression test. Actually, the compression pressure of a running engine is much lower than cranking compression pressure. This results from the volumetric efficiency. The engine is revolving faster, and therefore, there is less time for air to enter the combustion chamber. With less air to compress, the compression pressure is lower. Typically, the higher the engine RPM, the lower the running compression. For most engines, the value ranges are as follows:

- Compression during cranking: 125 to 160 PSI
- Compression at idle: 60 to 90 PSI
- Compression at 2,000 RPM: 30 to 60 PSI

As with cranking compression, the running compression of all cylinders should be equal. Therefore, a problem is not likely to be detected by single compression values, but by variations in running compression values among the cylinders. Broken valve springs, worn valve guides, bent pushrods, and worn cam lobes are some items that would be indicated by a low running compression test reading on one or more cylinders.

PERFORMING A RUNNING COMPRESSION TEST

To perform a running compression test, remove just one spark plug at a time. With one spark plug removed from the engine, use a jumper wire to ground the spark plug wire to a good engine ground. This prevents possible ignition coil damage. Start the engine, push the pressure release on the gauge, and read the compression. Increase the engine speed to about 2,000 RPM and push the pressure release on the gauge again. Read the gauge. Stop the engine, reinstall the spark plug, reattach the spark plug wire, and repeat the test for each of the remaining cylinders. Just like the cranking compression test, the running compression test can inform a technician of the relative compression of all the cylinders.

Self-Check – 4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. Types of compression test?(2pts)

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 5-Setting up engine requirements in leakage testing

Setting up engine requirements in leakage testing

cylinder leakage test

An internal combustion engine makes power by first drawing air and fuel into the combustion chamber. Next is the compression of the mixture and ignition by spark or compression. The harnessing of the resulting contained explosion is ultimately what powers the car. As an engine gets on in miles, the containment of this power can be lost due to piston ring, valve or cylinder wall wear. Engine performance will suffer as a result.

Before sending air into the engine, the cylinder being tested must be placed at Top Dead Center (TDC). The piston must be at the top of its travel. The intake and exhaust valves must be closed. When the air is compressed into the cylinder, the leak-down tester will measure any loss of air escaping past valves or piston rings. If the cylinder is not at TDC, air escaping past an open valve will give a false reading.

Cylinder Leakage Set-up

- Connect air supply to the tester and calibrate the tester.
- Remove the spark plug, attach the adapter and get the cylinder at TDC between the compression and power strokes.
- Connect the air supply to the cylinder and listen for where the air escapes.

Hearing Problems

Beyond getting an overall picture of engine condition, the engine leak-down test is an excellent way to pinpoint where problems are before tearing down the engine. Listening for where the air is escaping by ear can isolate the problem.

- Intake valve: Air whistling out of the intake, carburetor or throttle body indicates a leak at the intake valve.
- Exhaust valve: Air heard hissing out of the tailpipe, turbocharger or exhaust manifold means an exhaust valve leak.

- Piston rings: Whistling or hissing out of the PCV valve, oil filler cap hole or dipstick tube means the air is pushing past the rings.
- Suspect ring or cylinder wall wear.
- Head gasket: Air bubbles in engine coolant seen at the radiator filler cap could mean air escaping into the coolant past the head gasket.
- Cracked cylinder head: Bubbles in coolant or coolant being pushed up out of the radiator neck can also indicate cracks in the cylinder head or cylinder walls.

Tools, supplies and instructions

You will need a compressed air source, a leak-down gauge kit, spark plug socket, basic hand tools, vehicle service manual and a notepad to record results.

- Step 1: Remove the spark plugs or glow plug and rotate the engine to put the cylinder to be tested at TDC. Tip: Set the crankshaft pulley/ flywheel timing mark to Zero. That will make piston number 1 or the running mate at TDC compression.
- For four cylinder turn the crankshaft 180 degrees for the next piston to TDC compression.
- For six cylinder turn the crankshaft 120 degrees for the next piston to TDC compression.
- For 8 cylinder turn the crankshaft 90 degrees for the next piston to TDC compression

Step 2: Figure out which adapter works best and connect the gauge into the hole.

- Put the vehicle in gear and set the parking brake to prevent the engine from turning when air is compressed into the cylinder.
- Start with the regulator turned counterclockwise to zero the incoming pressure. Connect compressed air.
- Turn the regulator clockwise to pressurize air into the cylinder.

Step 3: Record leakage percentage for the cylinder.

- Remove the oil dipstick,
- radiator cap and oil filler cap.

- Open the throttle body or remove the air cleaner.
- Listen and watch.
- Wherever air is escaping will indicate where the problem is.
- Disconnect the gauge and move to the next cylinder.

CYLINDER LEAKAGE TEST

One of the best tests that can be used to determine engine condition is the cylinder leakage test. This test involves injecting air under pressure into the cylinders one at a time. The amount and location of any escaping air helps the technician determine the condition of the engine. The air is injected into the cylinder through a cylinder leakage gauge into the spark plug or glow plug hole. To perform the cylinder leakage test, take the following steps:

STEP 1: For best results, the engine should be at normal operating temperature (upper radiator hose hot and pressurized).

STEP 2: Remove the radiator cap, oil filler cap, dipstick tube, air filter cover, and all spark plugs or glow plugs.

NOTE: Take precaution when removing the radiator cup, because the engine is warm – pressure has been develop in the cooling system. Refer to service manual on how to release radiator pressure.

STEP 3: Connect the tester input port to the air compressor and calibrate the cylinder leakage unit as per manufacturer's instructions.

NOTE: Set the leakage gauge to zero by turning the pressure regulator knob.

STEP 5: Inject air into the cylinders one at a time, and take note of the result (Job Sheet 3).

Evaluate the results:

- Less than 10% leakage: good
- Less than 20% leakage: acceptable
- Less than 30% leakage: poor
- More than 30% leakage: definite problem

NOTE: If leakage seems unacceptably high, repeat the test, being certain that it is being performed correctly and that the cylinder being tested is at TDC on the compression stroke.

STEP 6: Check the source of air leakage.

a) If air is heard escaping from the oil filler cap, the piston rings are worn or broken.
b) If air is observed bubbling out of the radiator, there is a possible blown head gasket or cracked cylinder head.
c) If air is heard coming from the throttle body or air inlet on fuel-injectionequipped engines, there is a defective intake valve(s).
d) If air is heard coming from the tailpipe, there is a defective exhaust valve(s).

STEP 7: Repeat process to all cylinders by following the firing order.

- For four cylinder turn the crankshaft 180 degrees for the next piston to TDC compression.
- For six cylinder turn the crankshaft 120 degrees for the next piston to TDC compression.
- For 8 cylinder turn the crankshaft 90 degrees for the next piston to TDC compression

STEP 4: Connect the leakage tester with the appropriate adaptor into the spark plug or glow plug hole. Make sure the cylinder being tested must be at top dead center (TDC) of the compression stroke.

NOTE: The greatest amount of wear occurs at the top of the cylinder because of the heat generated near the top of the cylinders. The piston ring flex also adds to the wear at the top of the cylinder.

Cylinder Leakage Tester

- Use this tester to pin-point specific malfunctions in the cylinder.
- This tester pumps air into the cylinder.
- You listen to where it leaks out.

Evaluating the Results

- If the leakage is 20% or less the cylinder is OK. If not check the following:
- Air escaping from the tail pipe.
  - Burnt exhaust valve.
- Air escaping from the throttle body.
  - Burnt intake valve.
- Air Escaping from the oil filler.

- Bad piston rings.

- Air escaping from radiator cup
  - Defective gasket or crack
- Air escaping from adjacent cylinder
  - Worn gasket or crack

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. cylinder leakage test? (2pts)

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 6-Conducting leakage test without damage

THE CYLINDER LEAKAGE TEST

Purpose of cylinder leakage test

- To determine the cause of low compression.
- It helps to pinpoint places where air escapes or leakage occurs.
- It is an additional test executed when the compression test has given a bad result for one or more cylinders.

During this test, the cylinder is put under air pressure while the piston is placed at TDC position at the end of its compression stroke (both valves are closed). Escaping or leaking air from the cylinder is indicated by a pressure gauge or meter. The test is executed with engine "hot" that is, under normal operating temperature.

The leakage tester usually is connected to the workshop air supply system which in general makes available compressed air of 5 to 10 bars. Air pressure from the shop supply is applied in to the cylinder.

A pressure drop caused by leakage is indicated by a manometer. The manometer shows the percentage of air leaking from the cylinder. The specification given by the testing equipment manufacturer should not be exceeded by the test data.

CYLINDER LEAKAGE TEST

Another test that measures how well the cylinder seal is the cylinder leakage test.

To use the tester, warm up the engine, then remove all the spark plugs, remove the air cleaner assembly, oil filler cap or dipstick, and radiator cap, and block the throttle to a full wide open position check the coolant in the radiator & fill it to the proper level.

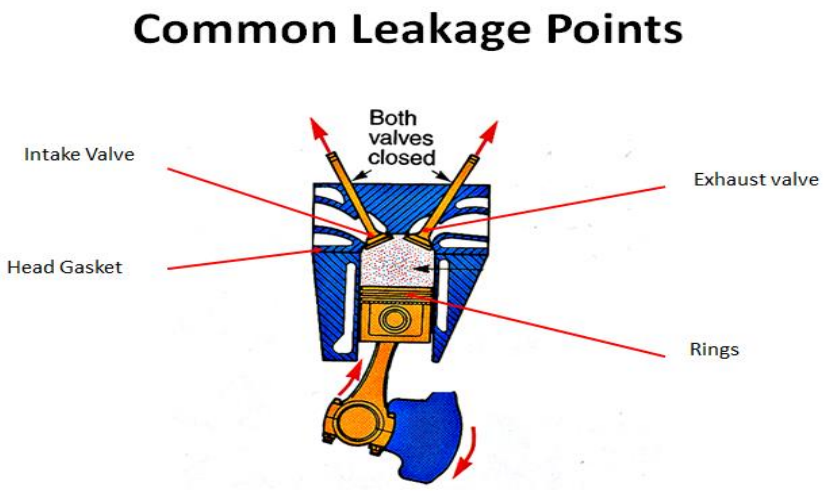
The tester is equipped with a hose that threads in to the spark plug hole and fastens to the taster. Bring the engine to TDC of compression stoke, at this point the valves are closed. Now connect the shop air supply to the tester.

The gauge on the tester should show a reading, This reading indicates the amount of air that is leaking out of the cylinder.

To determine where is the leakage listen at the radiator, oil filler, carburettor, and tailpipe for the escaping air check also to see if air is leaking from a cylinder next to one being tested, If air is escaping from an adjoining cylinder, the head gasket lakes between cylinders.

Test the other cylinders in the same way. Make sure that each cylinder on TDC of the compression stroke before applying into the cylinder.

The cylinder leakage tester has an advantage over the compression tester because it allows for precise identification of the problem area. Carbon build-up also does not influence the readings, which allows for a truer picture of the mechanical condition of the engine. The biggest disadvantage of this test is that it test is requires more time to conduct than does the compression test



Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. What is the purpose of leakage test?(4pts)

2. Discuss about methods of leakage test?(6pts)

Note: Satisfactory rating - 10 points Unsatisfactory - below 10 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 7-Reading and interpreting specific leakage test result

Reading and interpreting specific leakage test result

What is compression pressure in engine?

The process of compression confines and presses a mixture of air and fuel into a small volume within the area of the engine's cylinder. This process presses together all the molecules under very high pressure. ... As a result, the compression required in a diesel engine is very high, usually about 350 PSI or more.

What are signs of low compression?

If you have car engine compression problems, your car will either misfire when you start the engine, perform poorly or, if you have low or no compression in all cylinders, won't start at all. You can't drive your car for long, if at all, with low compression.

Compression Pressure Reading

A common test of an engine's ability to compress the air-fuel mixture or air is an engine compression test. A pressure gauge is connected in place of the spark plug for petrol engine or in the glow plug/ fuel injectors. The engine is then cranked to create a pressure reading. A compression test is a good way to check the engine's ability to create pressure. The gauge reads the positive pressure created by the cylinder.

Compression Loss Reading

An engine leak-down test is a compression test in reverse. Instead of measuring the engine's ability to create pressure, compressed air is introduced into the cylinder through the spark plug hole or glow plug/ fuel injector. One gauge on the tester measures the pressure of the air entering the cylinder and the other measures the percentage of the air escaping (or leaking) from the cylinder. The loss percentage will indicate the condition of the cylinder and overall condition of the engine.

Reading Results

No engine will have perfect sealing with 0 percent loss.

- Five to 10 percent (5-10%) loss indicates an engine in great to good running order.
- An engine between 10 and 20 percent (10-20%) can still run OK, but it'll be time to keep an eye (or ear) on things.
- Above 20 percent (20%) loss and it may be time for a teardown and rebuild.

- Thirty percent (30%)? Major problems. The percent of leakage should also be consistent across the cylinders. Any great differences indicate a problem in that cylinder.

Self-Check – 7	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. What is compression pressure in engine? (3pts)

2. What are signs of low compression?(3pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 8-Giving recommendation based on the test result

8.1 Two methods of measuring leakages are used:

A. Measuring of time in which the pressure has dropped a certain limit

Example: Cylinder is filed with compressed air of about 7 bars pressure

Test result: Pressure drops from 7 to2 bars in,

→ $t \geq 10$ sec $\Rightarrow$ cylinder in good condition,

→ $t = 8$ sec $\Rightarrow$ still acceptable condition,

→ $t < 8$ sec $\Rightarrow$ indicates excessive leakage

B. Measuring the percentage of the rate of pressure drop (Δp in %).

$\Delta p \leq 10\ \% \Rightarrow$ cylinder is in good condition.

$\Delta p \leq 25\ \% \Rightarrow$ still acceptable condition.

$\Delta p > 25\ \% \Rightarrow$ possibly serious defect is indicated.

Self-Check – 1	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. Giving recommendation if Test result: Pressure drops from 7 to2 bars in(6pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 9-Setting up engine requirements in power balance test

9.1. POWER BALANCE TEST / Cylinder Balance Test (Petrol Engine)

What is a cylinder power balance test?

The engine power balance test measures; the power that a particular cylinder contributes to the total power of the engine. The engine power balance test uses the cylinder's effect on the engine's speed to determine this power. While the engine is running, either a spark plug or primary circuit is grounded.

What can be learned by making a cylinder balance test?

A cylinder power balance test locates the cylinder causing a lack of power and not contributing to the engine's balance and performance. Use this test along with a cylinder compression and cylinder leakage test to pinpoint the problem.

There are several ways that a power balance test can be performed. Knowing each of the option will allow you to choose the easiest one for the vehicle you are diagnosing. Which is easiest is determined by the capabilities of the PCM, the ease of accessing the required components, and the tools available. For many OBDII vehicles, you can identify which cylinders are misfiring by using a scan tool to access stored diagnostic trouble codes (DTS) in the PCM. In some cases, you can also use the scan tool to command the PCM to perform an automatic power balance test and report the results right on the scan tool. On most new vehicles, using the scan tool is by far the best method of performing a power balance test.

If the system is not setup to perform the test automatically, you will have to do it manually.

- You will need to determine whether to disable the ignition or the fuel injectors that are accessible, disconnecting the electrical connector from each injectors one at a time will shut off the fuel to the cylinder.

- Shutting off the fuel to the cylinder is preferred method since it stop injecting fuel to the cylinder.
- If the ignition system is disabled for a cylinder, the fuel will still be delivered but will not be burned in the cylinder.
- However, it will burn in the catalytic converter, which can cause it to overheat and possibly be damaged.
- Therefore, shutting down the fuel is preferable if it is an option on the engine you are working on.
- If the engine has an individual ignition coils on each spark plug, you can disconnect the primary electrical connector, which will shut off the spark to the spark plug.
- If the vehicle has coils that share cylinders (waste spark system), then you can place a 1inch (25mm) section of vacuum hose between each coil tower and spark plug wire. Then connect the alligator clip from a non-powered test light to a good engine ground and touch the tip of the test light to each length of vacuum hose to short out each spark plug one at a time.

If the vehicle is equipped with distributor, disconnect one spark plug at a time from the distributor cap (it is good to use a test lead to ground the spark at the distributor cap terminal to prevent the spark from damaging the ignition module in the distributor), which shuts down the spark for the cylinder being tester.

To perform a cylinder power balance test, follow the steps / procedures:

Step 1: Visually inspect the engine to determine the best method to disable the cylinders. If this involves connecting a scan tool, installing vacuum lines on each coil, or removing spark plug wires, prepare the engine accordingly. If necessary, disable the idle control system. Step 2: Start the engine and allow it to idle. Record the idle rpm. Step 3: Using the method chosen to disable cylinders, disable the first cylinder and record the rpm. (Do not leave the cylinder disabled for more than a few seconds). Step 4: Reactivate the cylinder and allow the engine to run for approximately 10 seconds to stabilize. Then leave the engine to idle for another 10 seconds before proceeding to the

next cylinder. Step 5: Repeat the steps on each of the cylinders and record your readings. Determine any necessary action.

Analyzing the Power Balance Test Results

When the engine is running properly each cylinder should cause very close to the same rpm drop when disabled. Cylinder that are lower by more than 50 rpm should be analyzed.

Engine idle speed 700 rpm			
Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4
560rpm	550rpm	555rpm	670rmp

Cylinder number 4 is definitely not contributing equally to the power of the engine. The rpm change very little when it was disabled, meaning that the engine speed is barely affected by that cylinder. There could be many causes of the problem, but now you know which cylinder to investigate.

The problem could relate to fuel delivery; perhaps the fuel injector was not delivering adequate fuel to support combustion. An ignition system problem, something as simple as a spark plug with a very wide gap from a worm electrodes. A mechanical problem such as cylinder with low compression will produce less power, faulty valve or worn piston rings, faulty head gasket, cracked head, or block as a possible cause for low results on adjacent cylinders and should be suspected during a power balance test.

Self-Check – 1	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. **What is a cylinder power balance test?(3pts)**
2. **What can be learned by making a cylinder balance test?(3pts)**

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 10-Reading and interpreting specific power balance test result

10.1. Reading and interpreting specific power balance test result

What does a power balance test do?

The engine power balance test measures; the power that a particular cylinder contributes to the total power of the engine. The engine power balance test uses the cylinder's effect on the engine's speed to determine this power. While the engine is running, either a spark plug or primary circuit is grounded.

When performing a cylinder power balance test the variance between cylinders should not exceed?

The variance between cylinders should not exceed

Analyzing the Power Balance Test Results

When the engine is running properly each cylinder should cause very close to the same rpm drop when disabled. Cylinder that are lower by more than 50 rpm should be analyzed.

Engine idle speed 700 rpm			
Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4
560rpm	550rpm	555rpm	670rmp

Cylinder number 4 is definitely not contributing equally to the power of the engine. The rpm change very little when it was disabled, meaning that the engine speed is barely

affected by that cylinder. There could be many causes of the problem, but now you know which cylinder to investigate.

The problem could relate to fuel delivery; perhaps the fuel injector was not delivering adequate fuel to support combustion. An ignition system problem, something as simple as a spark plug with a very wide gap from a worm electrodes. A mechanical problem such as cylinder with low compression will produce less power, faulty valve or worn piston rings, faulty head gasket, cracked head, or block as a possible cause for low results on adjacent cylinders and should be suspected during a power balance test. Cylinder number 4 is definitely not contributing equally to the power of the engine. The rpm change very little when it was disabled, meaning that the engine speed is barely affected by that cylinder. There could be many causes of the problem, but now you know which cylinder to investigate.

The problem could relate to fuel delivery; perhaps the fuel injector was not delivering adequate fuel to support combustion. An ignition system problem, something as simple as a spark plug with a very wide gap from a worm electrodes. A mechanical problem such as cylinder with low compression will produce less power, faulty valve or worn piston rings, faulty head gasket, cracked head, or block as a possible cause for low results on adjacent cylinders and should be suspected during a power balance test.

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. What does a power balance test do? (2pts)
2. The variance between cylinders should not exceed?(4pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 11-Giving recommendation based on the test result

What does a cylinder power balance test measure?

The engine power balance test measures; the power that a particular cylinder contributes to the total power of the engine.

The engine power balance test uses the cylinder's effect on the engine's speed to determine this power. While the engine is running, either a spark plug or primary circuit is grounded

Engine Power Balance Test – Total Power Output Of The Engine

Fig.11.1. Engine Power Balance Tester

The engine power balance test can be a great way to pinpoint a cylinder that's underperforming.

This is an indication a cylinder is not working as well as the other cylinders in the engine.

The engine power balance test measures; the power that a particular cylinder contributes to the total power of the engine.

The engine power balance test uses the cylinder's effect on the engine's speed to determine this power. While the engine is running, either a spark plug or primary circuit

is grounded. As a result, this prevents the spark plug from firing in the cylinder; which prevents combustion in that cylinder.

Cylinder Power Balance Test

Engine speed should decrease when the cylinder is inoperative. Record the drop in speed and compare it to the other cylinders. Therefore, If all the cylinders produce the same amount of power; all engine rpm drops would be the same.

The drop in engine speed during the power balance test; becomes much more for that cylinder than for the other cylinders. When an engine is running rough; it is usually caused by one or more cylinders that are not producing as much power as the others.

As A Result, The Cylinder Power Balance Test Identifies The Less Productive Cylinders.

Also, If the engine has an (EGR) valve; the vacuum line must be disconnected and plugged. Changes in engine vacuum may cause the (EGR) valve to cycle on and off. This can vary the engine speed and interfere with the readings.

The cylinder power balance test is quick and easy to perform. The results of this test alone do not specify where the problem is.

Compare these results to the results of a compression test and cylinder leakage test.

- The compression test determines the maximum pressure in the cylinder on the compression stroke.
- The cylinder leakage test measures how well the cylinder seals.

Fig.11.2. cylinder leakage tester

If The Results Of The Tests Show That It Has:

- Good compression
- Proper leakage
- Good power balance

A leaking cylinder would not be the cause of the imbalance. The fuel system of most engines is common to all cylinders; and therefore would not cause a power balance problem.

Other Things That Might Cause The Problem Are:

- A non-common system
- An ignition problem (typically in the secondary)
- By a vacuum leak that does not affect all cylinders
- Mechanical Failure Or Defect
- Bent Pushrod
- Broken Rocker Arm
- Worn Camshaft Lobe
- Collapsed Hydraulic Lifter

Furthermore, All these faults do not affect the sealing of the cylinder; but affect the opening of the valves.

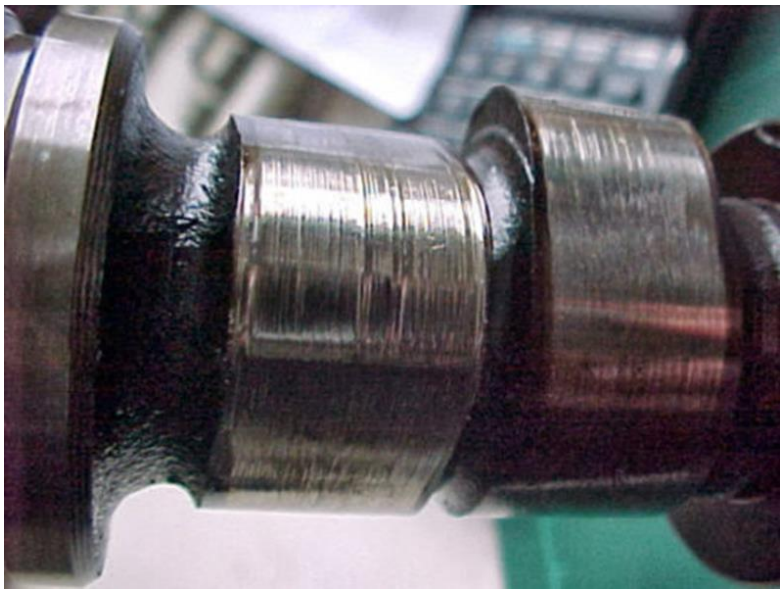


Fig.11.3. Camshaft Damage

So, to determine the exact cause of the poor imbalance, one should test the ignition system. Consequently, An engine with good compression, good power balance, and excessive cylinder leakage is typically an evenly worn high-mileage engine. An engine with poor compression, proper leakage; and good power balance usually has a valve timing problem.

Conclusion

Use the combination of results for further testing from:

- The compression test
- Cylinder leakage test
- Cylinder power balance test

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. A leaking cylinder would not be the cause of the imbalance?(6pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 12-Setting up engine requirements in vacuum test

12.1 Setting up engine requirements in vacuum test

How much vacuum should an engine have?

Idle vacuum for most engines is about 18 to 22 in. -Hg, but some may produce only 15 to 17 inches at idle. (Remember what we said about experience.) If vacuum is steady and within these ranges, the engine and fuel and ignition systems are operating normally.

What are the symptoms of a vacuum leak?

What Signs Will Indicate a Vacuum Leak?

Your Idle is Running High or is Sporadic. Your engine's RPM goes up as more air cycles through your engine. ...

Stalling or Hesitating Engine. ...

Loud Hissing, Squealing or Sucking from the Engine.

Vacuum Tests Measuring intake manifold vacuum is another way to diagnose the condition of an engine. Vacuum is formed by the downward movement of the pistons during their intake stroke. If the cylinder is sealed, a maximum amount will be formed. Manifold vacuum is tested with a vacuum gauge. The gauge's hose is connected to a vacuum fitting on the intake manifold. Normally a "tee" fitting and short piece of vacuum hose are used to connect the gauge.

Self-Check – 1	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. What Signs Will Indicate a Vacuum Leak?(6pts)

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Name: _____ Date: _____

Information Sheet 13	Conducting vacuum test without damage

VACUUM TESTS

Vacuum is pressure below atmospheric pressure and is measured in inches (or millimeters) of mercury (Hg).

An engine in good mechanical condition will run with high manifold vacuum. Manifold vacuum is developed by the pistons as they move down on the intake stroke to draw the charge from the throttle body and intake manifold.

Air to refill the manifold comes past the throttle plate into the manifold. Vacuum will increase anytime the engine turns faster or has better cylinder sealing while the throttle plate remains in a fixed position.

Manifold vacuum will decrease when the engine turns more slowly or when the cylinders no longer do an efficient job of pumping.

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. Manifold vacuum is developed by ……(2pts)

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Information Sheet 14- Reading and interpreting specific vacuum test result

Reading and interpreting specific vacuum test result

Vacuum gauge readings can be interpreted to identify many engine conditions, including the ability of the cylinder to seal, the timing of the opening and closing of the engine's valves, and ignition timing.

Ideally each cylinder of an engine will produce the same amount of vacuum; therefore, the vacuum gauge reading should be steady and give a reading of at least 17 inches of mercury (in. Hg).

If one or more cylinders produce more or less vacuum than the others, the needle of the gauge will fluctuate.

The intensity of the fluctuation indicates the severity of the problem.

For example, if the reading on the vacuum gauge fluctuates between 10 and 17 in. Hg we should look at the rhythm of the needle. If the needle seems to stay at 17 most of the time but drops to 10 and quickly rises, we know that the reading is probably caused by a problem in one cylinder.

Fluctuating or low readings can indicate many different problems.

For example, a low, steady reading might be caused by retarded ignition timing or incorrect valve timing. A sharp vacuum drop at regular intervals might be caused by a burned intake valve.

Other conditions that can be revealed by vacuum readings follow:

- Stuck or burned valves
- Improper valve or ignition timing
- Weak valve springs
- Faulty PCV, EGR, or other emission-related system
- Uneven compression
- Worn rings or cylinder walls
- Leaking head gaskets
- Vacuum leaks

- Restricted exhaust system
- Ignition defects

Self-Check – 1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. Write Other conditions that can be revealed by vacuum readings?(6pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Test I

1. _____
2. _____
3. _____

Information Sheet 15-Giving recommendation based on the test result

Vacuum tests include testing the engine for cranking vacuum, idle vacuum, and vacuum at 2,500 RPM.

CRANKING VACUUM TEST

Measuring the amount of manifold vacuum during cranking is a quick and easy test to determine if the piston rings and valves are properly sealing. (For accurate results, the engine should be warm and the throttle closed.) To perform the cranking vacuum test, take the following steps.

STEP 1 Disable the ignition or fuel injection.

STEP 2 Connect the vacuum gauge to a manifold vacuum source.

STEP 3 Crank the engine while observing the vacuum gauge. Cranking vacuum should be higher than 2.5 in. Hg. (Normal cranking vacuum is 3 to 6 in. Hg.) If it is lower than 2.5 in. Hg,

then the following could be the cause.

- Too slow a cranking speed
- Worn piston rings
- Leaking valves
- Excessive amounts of air bypassing the throttle plate (This could give a false low vacuum reading. Common sources include a throttle plate partially open or a high-performance camshaft with excessive overlap.)

IDLE VACUUM TEST An engine in proper condition should idle with a steady vacuum between 17 and 21 in. Hg.

NOTE: Engine vacuum readings vary with altitude. A reduction of 1 in. Hg per 1,000 ft (300 m) of altitude should be subtracted from the expected values if testing a vehicle above 1,000 ft (300 m).

LOW AND STEADY VACUUM

If the vacuum is lower than normal, yet the gauge reading is steady, the most common causes include:

- Retarded ignition timing
- Retarded cam timing (check timing chain for excessive slack or timing belt for proper installation)

FLUCTUATING VACUUM

If the needle drops, then returns to a normal reading, then drops again, and again returns, this indicates a sticking valve. A common cause of sticking valves is lack of lubrication of the valve stems. If the vacuum gauge fluctuates above and below a center point, burned valves or weak valve springs may be indicated. If the fluctuation is slow and steady, unequal fuel mixture could be the cause.

NOTE: A common trick that some technicians use is to squirt some automatic transmission fluid (ATF) down the throttle body or into the air inlet of a warm engine. Often the idle quality improves and normal vacuum gauge readings are restored. The use of ATF does create excessive exhaust smoke for a short time, but it should not harm oxygen sensors or catalytic converters.

Self-Check – 1	**Written test**

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

1. if Normal cranking vacuum is lower than 2.5 in write the cause?(6pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

Operation Sheet-1	Perform dry and wet compression test

I. Material Requirements

No	Tools/ Equipment	Specification
1.	Spark plug spanner	No. 17, 19, 21
2.	Glow plug wrench/ Injector nozzle wrench	No. 10,12,13,17,19
3.	Hand tool	
4.	Compression tester	
5.	Repair manual	
6.		

II. Primary Check

- Battery is fully charge
- Air Cleaner is well.
- Tools and equipment are functionality
- Vehicle manufacturer's recommendations first, weather the engine has to be tested when "hot or cold ". **Usually the test is executed with engine "Hot**".

III. Testing procedure:

1. Based on manufacturers' recommendation, run the engine until warm-up temperature is over(85^0C - 95^0C) (Warm-up the engine to normal operating Temperature)
2. Disconnect and insulate glow plugs wire (in case of diesel)
3. Disconnect and insulate the wires from the fuel shutoff- solenoid terminal of the injection pump (Diesel engine). This prevents delivery of fuel during the test.

Disconnect and insulate the wires from +ve terminal of ignition coil primary circuit (gasoline engine). This is to prevent over heating of the ignition coil during the test

4. Depending on the type of tester to be used, remove all **injectors/ glow plugs** (in case of diesel engine) and **spark plugs** (in case of gasoline engine)
5. Crank the engine to remove combustion residues
6. Depending on the engine and tester type, adapt it through glow plugs/ injector/ spark plugs holes.

7. If the engine is throttle valve controlled type, open it fully to allow maximum air to enter the cylinder.
8. Crank the engine through 5 to 10 compression strokes

NB: - All cylinders should be tested with the same number of compression strokes.

9. Check all cylinders the same way and record the result.

1. Dray test result

Cylinders	1	2	3	4	5	6
Measurements in Bar/ PSI						

NB: The lowest compression reading should **not be less than 75% of the highest**

Compare the finding with manufacture's specification. Manufacturer's minimum limit--

To diagnosis further, conduct cylinder wet test. To do this, add 3- 4 droplets of engine oil through glow plus or injectors hole (Diesel engine) and spark plugs hole(Gasoline engine)

Caution: Never perform a wet compression test on a diesel engine. The heat of a compression could ignite the oil and damage the compression tester. Also, since the oil is not compressible, it could fill the combustion chamber and create a hydrostatic lock. This prevents the crankshaft from turning and may damage the engine.

Adding oil helps to seal the piston rings temporarily so that the defective cylinder shows one of the two possible results. These are:-

a) Adding oil increases the compression pressure.

Possible causes: - → Worn cylinder wall or piston.

→ Broken or stuck piston rings.

b) Adding oil does not increases the compression pressure

Possible causes: - → Burned cylinder head gasket.

→ Worn or burned valves and valve seats.

→ Damaged or cracked cylinder head.

→ Incorrect valve clearance adjustment

Repeat step **6-8** for the cylinder with low compression.

2. Wet test

Cylinders	1	2	3	4	5	6
Measurements in Bar/ PSI						

Compare the finding with manufacture's specification.

- Manufacturer's minimum limit----------
- Minimum finding----------

Conclusion----------

Operation Sheet-2	Perform Cylinder leakage test

Testing procedure:

a) Warm-up the engine to normal operating temperature.
b) Remove the spark plugs/glow plug/injector nozzle, radiator cap, oil filter cap, oil dip stick, air cleaner.
c) Open fully the carburetor throttle valve.
d) Connect the leakage tester to the shop air supply and make sure the pressure regulator on the tester is adjusted to “zero “.
e) Select the appropriate adapter and fit into cylinder No.1.
f) Using a whistle, determine the TDC position on Compression stroke.
g) After determination of Compression stroke remove the whistle from the cylinder adapter.
h) Adjusting the pressure regulator to 100%, connect the leakage tester to the cylinder.
i) Lock the crankshaft or engine in the TDC position to avoid crankshaft rotation when pressure is applied to the cylinder.
j) Check the places where excessive air leakage can be heard, felt or seen.
k) Proceed with the other cylinders.

Results and Evaluation of compression test

Cylinder leakage (%)	Condition of cylinder
≤ 10%	Very good
≤ 11 to 25%	Still acceptable
> 25%	Bad

A loss of compressed air (drop of pressure in cylinders) of more than 25% indicates an excessive leakage which might be caused by serious defects inside the cylinder or engine.

ASSIGNMENT	

1. Write **spark-igntion(gasoline**) and **compression igntion**(**diesel) engine** trouble-diagnosis chart separately.

LAP Test-2	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Request necessary tools and materials you are required to perform the following tasks.

Task 1. Perform dry and wet compression test

Task 2. Perform cylinder leakage test

Operation Sheet 3	Check Vacuum at Engine Idle

VACUUM TEST

Checking Vacuum at Engine Idle

NOTE: Refer to your vehicle's service manual to obtain the manufacturer's specifications for vacuum (Most engine specification for idle vacuum is 17 – 21 in. Hg.)

1. MAKE SURE the ignition is off.

2. Locate a vacuum hose which is connected directly to the intake manifold. Disconnect the vacuum hose and connect the gauge in its place.

3. Start engine and idle (Be sure engine is warm-up).

4. Note the value of vacuum and compare this value to the manufacturer's specifications.

- If vacuum indication is LOWER than specified, check for the following:
- Incorrect ignition timing
- Incorrect valve timing or adjustment
- Incorrect idle mixture screw adjustment
- Worn piston rings (cylinder compression)
- Intake manifold vacuum leaks

If vacuum indication OSCILLATES SLOWLY, check for incorrect idle mixture screw adjustment.

- If vacuum indication OSCILLATES RAPIDLY, check for the following:
- Sticky valve guides
- Burned valve seats
- Leak(s) in the head gasket

Checking Vacuum at High Speed

With gauge connected and engine idling as described above, increase engine speed to approximately 2000 RPM. 2. Note the new vacuum value.

- If vacuum value at high speed is LOWER than value at idle, check for restriction(s) in the exhaust system.
- If vacuum indication OSCILLATES, check for weak valve springs.

VACUUM TEST

Job Sheet - 6

Observation:

1. Start the engine and run it at idling speed. Observe the vacuum gauge based on the vacuum test guide. What is the condition?

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2. Accelerate the engine rpm to 2,000 rpm and maintain it for a few seconds. Observe the vacuum gauge based on the vacuum test guide. What is the condition?

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3. Adjust the ignition timing to advance and retard. At idling speed observe the vacuum gauge based on the vacuum test guide. What is the condition?

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4. Cover the exhaust pipe to create a restriction. Accelerate the engine rpm to 2,000 rpm and maintain it for a few seconds. Observe the vacuum gauge based on the vacuum test guide. What is the condition?

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_____

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No	Name	Qualification	Educational background	Region	Phone Number	E-mail
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2						

The trainers who developed this learning guide