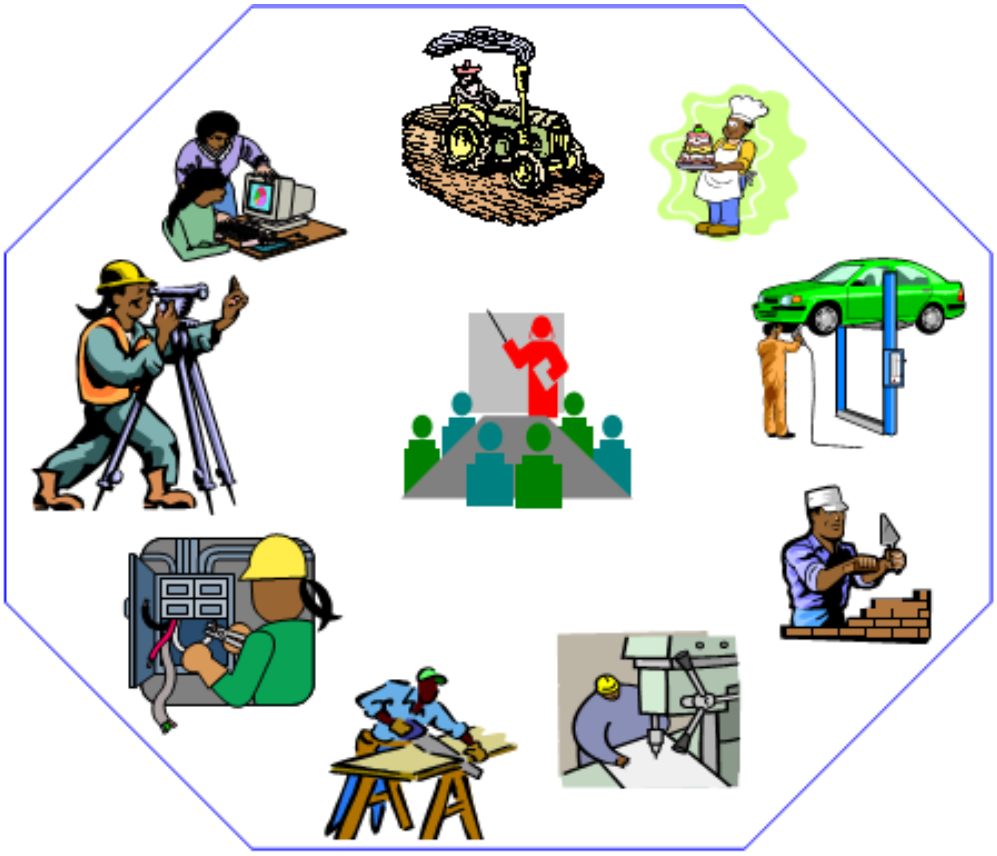
Lapidary

Level-II

Based on Jan 2014, Version 1 OS and April, 2021, V1 Curriculum



Module title: Operating basic machines and equipments

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Table of content

LO #1- Prepare basic machinery and equipment 4

Instruction sheet 4
Information Sheet 1- Identifying and selecting Machinery and equipment with work requirements..... 6
Self-check 1..... 17
Information Sheet 2- Making routine pre-operational checks of machinery 18
Self-Check – 2..... 20
Information Sheet 3- Carrying out equipment to manufacturer's specifications 21
Self-Check – 3..... 24
Information Sheet 4- Identifying Unsafe or faulty machinery and equipment..... 25
Self-Check –4..... 27
Information Sheet 5- Identifying Occupational Health and Safety hazards 28
Self-Check –5..... 31

LO #2- Operate basic machinery and equipment 32

Instruction sheet 32
Information Sheet 1- Selecting suitable personal protective clothing and equipment 34
Self-Check –5..... 38
Information Sheet 2- Operating machinery and equipment 39
self-Check – 2 45
Operation Sheet-1 46
LAP Test 1..... 47
Information Sheet 3- Completing work..... 48
Self-Check – 3..... 49
Information Sheet 4- Identifying and reporting environmental implications..... 50
Self-Check – 4..... 52

LO #3- check, clean and store basic machinery and equipment.....53

Instruction sheet 53

Information Sheet 1- Detailing and recording use of machinery and equipment.....55

1.3.1 Safety Benefits of Pre-Start Checks.. Error! Bookmark not defined.

1.3.2 Financial Benefits of Pre-Start Checklists ..... Error! Bookmark not defined.
Self-Check – 1 56
Information Sheet 2- Cleaning , securing and storing machinery and equipment . 57
Self-Check – 2 59

Information Sheet 3- Identifying malfunctions, faults, wear or damage to machinery 60

Self-Check – 3 62

Information Sheet 4- Cleaning and maintaining workplace areas 63

Self-Check –4 65
Reference Materials 66

LG #08	LO #1- Prepare basic machinery and equipment for use

Instruction sheet

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

- Identifying and selecting machinery and equipment with work requirements
- Making routine pre-operational checks of machinery
- Carrying out equipment to manufacturer's specifications
- Identifying unsafe or faulty machinery and equipment
- Identifying occupational health and safety hazards

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

- Identify and select machinery and equipment with work requirements
- Make routine pre-operational checks of machinery
- Carrying out equipment to manufacturer's specifications
- Identify unsafe or faulty machinery and equipment
- Identify Occupational Health and Safety hazards

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 your performance is satisfactory proceed to the next learning guide,
7. If your performance is unsatisfactory, ask your trainer for further instructions

Information Sheet 1- Identifying and selecting Machinery and equipment with work requirements

1.1 Identifying lapidary machinery and equipment

In the previous level, we know, lapidary is the art of cutting or fashioning gemstones. The cutting/fashioning of gemstones involve different machining operations which are intended to be performed on different machines designed for a specific purpose.Lapidary machines are those which are used to cut, polish and drill gem materials. Gem cutting is a general term which may include slabbing, trimming and cabbing of gem materials. Gem material drilling is pircing of a lapidary product such as pendants, cabochons, beads and others to make them easy to mount as jewellery.

All gems are cut and polished by progressive abrasion using finer and finer grits of harder substances. Diamond, the hardest naturally occurring substance, has a Mohs hardness of 10 and is used as an abrasive to cut and polish a wide variety of materials, including diamond itself. Silicon carbide, a manmade compound of silicon and carbon with a Mohs hardness of 9.5, is also widely used for cutting softer gemstones. Other compounds, such as cerium oxide, tin oxide, chromium oxide, and aluminum oxide, are frequently used in polishing gemstones.

. Examples of lapidary machines and equipment may include:

- Trim saws
- Slab saws
- Flat laps
- Grinders
- Tumblers
- Sanders

- Drills and others.

1.2 Selecting machinery and equipment with work requirements

Different lapidary machines are designed and available as per work requirements. The different lapidary machine with their corresponding functions are described as below. Therefore, selection is done depending on their functions.

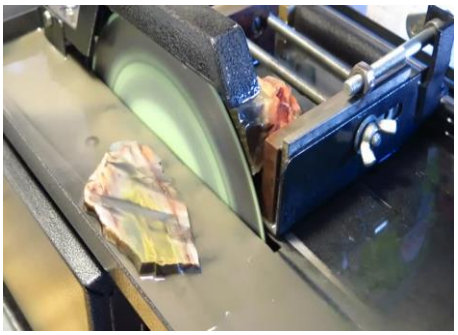
1.2.1 Gem saws

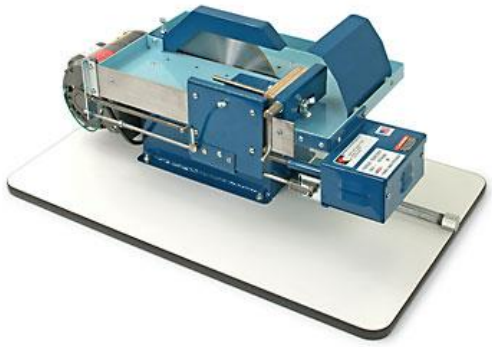
Gem saws are lapidary machines which are used to slice gems of different sizes. These saws can classified depending on the size of the gem material that they able to slice.. A liquid such as oil or water is used to wash away cutting debris and keep the stone and the saw blade from overheating, which could cause damage to both the stone and the saw blade.

Several sizes of circular rock saws are frequently used by most gem cutters :

- A **slab saw**: ussually16 to 36 inches in diameter, is used to cut stones of several inches thickness into relatively thin slabs (often 1/8 to 3/8 inch thick).
- A **trim saw**: usually 6 to 10 inches in diameter, is used to used to cut slabs and other small rock. Most frequently, trim saws are used to cut away the excess rock around a cabochon design as marked on a slab using a template. Trim saws can also be used to manually slab up smaller stones. It uses both mineral oil and water as cutting lubricant.
- A **faceter's trim saw**: usually 4 inches in diameter, is used with a very thin blade, to saw small pieces of expensive rough.

There are also jigsaws that employ either a reciprocating wire or a continuous thin metal band. These are useful for cutting curved lines that are impossible with circular saws. They are also useful in minimizing waste on extremely valuable rough material.

 Fig: slab saw for smaller stones	 Fig: slabs
 Fig: slabbing bigger gems on bigger slab saws	 Fig: slabbed stone on the bed of the machine

 Fig: Gem trim saw	 Fig:Trimming

1.2.2 Gem stone grinders

Grinding, usually with silicon carbide wheels or diamond-impregnated wheels, is used to shape gemstones to a desired rough form, called a **preform**. As with sawing, a coolant, water is used to remove debris and prevent overheating. Very coarse diamond or silicon carbide, such as 60 grit, or mesh, (400 micron particles) or 100 grit (150 micron particles) is used for rapid removal of stone, and finer abrasive (600 grit - 30 micron, or 1200 grit - 15 micron) is used for final shaping and sanding

 FIG: Gem grinder for cabbing	 Fig :Galaxy metal bond wheels for rough grinding	 Fig: Nova wheels for gem polishing

 Fig : gem polishing pads	 Fig: Galaxy wheels for gem carving	
 Fig: cabbing by handling with bare hand	 Fig: cabbing handling with dopstick	 Fig: cabochons

1.2.3 Sanders

sanding is similar to grinding but uses finer abrasives. Its purpose is to remove deep scratches left by coarser abrasives during grinding. Since it removes material less rapidly, it also allows more delicate control over final shaping of the stone prior to polishing. For stones with rounded surfaces, a flexible surface such as a belt sander is often used to avoid creating flat areas and promote smooth curves.

Fig: belt sander

Fig: Expandable drum sander

1.2.4 Laps

Lapping is very similar to grinding and sanding, except that it is performed on one side of a rotating or vibrating flat disk known as a lap, and it is used especially to create flat surfaces. Laps are often made of cast iron, steel, or a copper-bronze alloy, but other materials can also be used. These are used polish wide flat products like bookends and large flats on the same machine, using either Magnetic Novas or the standard process using abrasives on the rotating disc itself. Vibrating laps are similar to tumblers, because they use polishing powders or silicon carbide grit in the same way the tumblers do.

As it has been stated the machine is equipped with a single steel disk which is charged with a special lapping/grinding compound; one moves from the coarsest grinding compound to the finest polishing compound to obtain a high gloss polish. While

grinding/polishing, water and compound are supplied to the disk by hand. Excess water is collected in a small *collector*. Tumbling compounds should not be used on the larg flat lap – lapping compounds are much finer grained than ordinary tumbling compounds and produce a scratch-free finish:

- **Coarse** – to grind a relatively flat surface • medium – to remove the largest scratches and true the flat surface
- **Fine** – to pre-polish out all but the smallest of scratches
- Polish – to provide a shiny, glossy surface

Basic rules while using the lap:

- Ensure an orientation on the large flat lap has been provided by the workshop supervisor before using the machine.
- The large flat lap should only be used to grind and polish stones that have been pre-ground or sawn to a roughly flat surface. The grinding process is quite slow on this machine, even when using the coarsest grit compound. If unsure as to the suitability of a stone, ask a workshop supervisor.
- Ensure sufficient water is being provided to the disk. If the disk becomes too dry the grinding or polishing action will be slowed dramatically.
- Move the stone across the wheel to maximize the grinding surface and speed up the cutting action.
- Wash your hands and stone off with water when moving to a finer compound. This will prevent contamination and the reintroduction of scratches.
- When finished with the flat lap wash off all compound and allow it to dry Lightly oil the steel disk with machine oil to prevent rusting before putting the lid on for storage.

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Fig: Rotary lap</td>
<td> 
Fig: Replacing Nova magnetic lap</td>
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Fig : vibratiory lap</td>
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1.2.5 Gem drills

When a gem cutter desires a hole in or through a gemstone (e.g., a bead), a small rotating rod or tube with a diamond tip, or a slurry of silicon carbide and coolant, is used to drill through the stone. The following is a type of gem drill which is commonly used

Fig: gem drilling machine

For different drilling projects ,we have different drilling bits depending on size and duty of operation. The following table figures show some of the gem drill bits.

 Fig: small diamond drill bits	 Fig: small hollow diamond core drill bits
 Fig: Bigger hollow diamond core drills	 Fig: small diamond twist drill bits

1.2.6 Tumbler

Large quantities of roughly shaped stones are often tumbled, i.e., turned at a slow speed in a rotating barrel with abrasives and water for extended periods (days or weeks). By tumbling with progressively finer grades of abrasive (usually silicon carbide)

and washing carefully between grades, the stones are gradually smoothed and polished to serendipitous but often very attractive shapes. Tumbling barrels are often hexagonal in outline in order to enhance the stirring action of barrel rotation. An alternative to rotatory tumblers is a vibratory machine, often called a vibratory tumbler, in which the containing barrel vibrates rather than rotates. The more stationary arrangement of vibratory machines makes it much easier to examine the progress of the stones inside, whereas standard tumblers must be halted in order to check progress. In addition to polishing gemstones, tumbling is often used to polish large quantities of metal jewelry.

Fig:  Rotary tumbler	Fig: Vibratory tumbler
 Fig: tumbled varieties of crystalline quartz	 Fig: tumbled varieties of chalcedony,cryptocrystalline quartz

1.2.7 Bead making machines

Beads or spheres initially sawed into cubes or dodecahedrons and then ground to shape between two pipes or rotating concave cutters, allowing the stone to rotate freely in any direction to form a perfect spherical shape. Bead mills are used to grind and sand large quantities of beads simultaneously. They typically employ a grooved lap and a flat lap between which the beads are rolled and worn to shape. After shaping and sanding, beads are usually polished by tumbling . Beads can also be made by gem grinders after preforming slabs which are deliberately sliced for beads. Thus. Grinders are used to make beads .

Self-check 1	Written test

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

Test I Short Answer Questions

1. List at least 3 machines which are used make beads?(3pts)
2. What are the functions of trim saw?(1pt)
3. What is the advantage polishing stones by flexible belt sanders?(2)
4. What is the difference between Nova and metal bond carbide wheels?(2)

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 2- Making routine pre-operational checks of machinery

2.1 Routine operations

Routine operations are usual activities which are common and should be consistently. These may include:

- Cleaning workshop and machines at the end of the work
- Storing tools after service
- Making power sources off after completion of work
- Taking records of about manufacturing processes
- Conducting preoperational checks beforore operating the machine
- Clothing safety clothes in machine shops
- Stopping the machine during maintenance, etc

2.2 Making Pre-operational checks for machinery

Pre-operational checks are the operations taken by a machinist to check whether the the machines are at the right conditions to operate or missing requirements to be fulfilled. These operations should be routinely performed before starting to operate the machine.

The pre-operational checks that should be performed before starting to operate lapidary machines include:

- Coolant level
- Working condition of pumps
- Position of safety guards
- Power connection

- Use of safety equipment
- Tightness of the stone clamp
- Tightness of grinder wheel
- Illumination of the work area
- Mounting of the right tool for type of gem processing . For instance , type of wheels for grinding polishing processes are different.

2.3 Importance of making pre-operational checks on machines

Routine pre-operational checks on machines have many advantages. The following are some of the common:

- To increase life of the machinery and thus productivity
- To increase safety of workers
- To increase the quality of the product
- To decrease production lead time due to damage of workers and machinery because of accidents etc

Self-Check – 2	Written test

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

Test I: Short Answer Questions

1. Mention at least 4 importance of making pre-operational checks on machines ?(**1pt**)
2. What are the parameters that should be pre-checked before operating a slab saw (**3pt**)
3. What will happen if the clamp of the slab saw is loose?(**1pt**)

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

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

Score = _____

Rating: _____

Information Sheet 3- Carrying out equipment to manufacturer's specifications

3.1 Equipment manufacturer's specifications

Manufacturer's specifications are the written documents of instructions or recommendations provided by the manufacturer of equipment or supplies that describe how the equipment or supplies are to be constructed, erected, installed, assembled, examined, inspected, started, operated, used, handled, stored, ...

The are different manuals that will be provided by manufacturer of the machines and equipments. Among these the two are very common and important.

- Operation manual
- Maintenance manual

3.2 Importance of carrying out equipment to manufacturer's specifications

While carrying out machines and equipment, manufacturer's specifications are used as check points to consider.

Understanding equipment specifications is important to an technicians as knowing the right surgery tools is to a surgeon.

Equipment specifications are written documents or manuals that stipulate the method of production capacity, power requirement, fabrication methods and other finer details of the equipment that makes it apt for use. A technician must have a clear understanding of equipment specifications to avoid equipment breakages. Here are five reasons that assert why an adept understanding of equipment specifications is important for a person or technician carrying out the equipment.

1. **Gives a better understanding of equipment design & operating principles**

Equipment specifications provide a fine understanding of the equipment capabilities based on which the technician can evaluate whether the equipment is appropriate to meet processing objectives. The equipment design, its metrics and capacity can be clearly understood from the equipment specifications.

PE review electrical engineering courses discuss briefly about how the equipment functions and what their specifications are. It can be rightly called as an owner manual of sorts based on which the technician knows more about how to use the equipment to gain maximum output.

2. **Helps order the right equipment**

Different processes require different equipment with varying processing capabilities. In some cases, the equipment might look identical but might have unique and different features that make them suitable for exclusive functions.

Equipment specifications allows an technician to implement better electrical engineering project construction process. It helps an engineer to make the right choice of an equipment that will serve the purpose without any hassles. Operational delays due to wrong equipment purchase can be avoided if equipment specifications are referred to prior to placing the order. Further the right devise with operational procedures will help achieve desired results.

3. **Enables the electrical technician to forecast power & processing demands**

Each equipment has its power demand and processing capacity. Equipment specifications enable a technician to forecast the power requirements of the equipment for a specific period accurately.

4. **Facilitates selecting the right service conditions**

Equipment specifications provide a detailed overview of the service conditions and processes to be followed for equipment maintenance. It helps the engineer in establishing routine equipment conditions like power supply, use of materials, usage frequency, etc. to keep the equipment in prime condition. Equipment specifications also provide insights on the indoor and outdoor conditions in which the equipment may or may not be used.

5. **Enables adherence to accurate specification standards**

Misinterpretation of equipment specifications can cause severe fluctuations in the testing results. Before writing off the equipment as defective, it is necessary to check whether the right specification standards are used to determine its efficiency. The use of applicable testing standards as laid down in the equipment specifications will help in an accurate evaluation of the equipment functioning without any deviation. It is the engineer's responsibility to ensure that the right testing standards as per the equipment specifications are used to derive an actual appraisal of the equipment's efficiency.

To generalize, equipment specifications enable an technicians to make the right logical decisions in circumstances where huge investments are involved. It helps to avoid costly mistakes that can disrupt production or cause material and human loss. An technician will be able to sustain a steady level of activity with the help of equipment specifications used in day to day routine process.

Self-Check – 3	Written test

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

Test I: Short Answer Questions

1. What do we mean by equipment specification?(3
2. What are the contents of equipment specification ?(3)
3. What are the importance of knowing equipment specifications while carryingout it?(4)

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

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

Score = _____

Rating: _____

Information Sheet 4- Identifying Unsafe or faulty machinery and equipment

4.1 Unsafe or faulty machinery and equipment

Unsafe or faulty equipment is any type of mechanical or electronic equipment that is dangerous or unsafe to use. This usually refers to equipment used in the workforce for producing or manufacturing products. Faulty equipment is responsible for several types of on the job injuries each any time

4.2. Indicators of unsafe or faulty machinery and equipment

The following are the signs that indicate conditions of unsafe or faulty machinery or equipments and contribute to the breakdown of parts in any machinery.

- Vibration
- Shock
- Malfunction of the coolant delivery system
- Reduction of rotational speed of spindle
- Stacking of saw carriage system
- Increase of friction in saw carriage system
- High temperature
- High or low voltage or current and electric shock

The effects of the above mentioned conditions and their causes are described as below:

- ✓ Vibration can come from gears and belts that are out of alignment
- ✓ Shock can come from accidents and from poor operator techniques
- ✓ High temperatures can come from extended use, friction, poor lubrication and worn parts, among other reasons
- ✓ High or low voltage or current and electric shock may damage the machinery

- ✓ Age affects many key components. Over time, belts will warp. Seals will dry and crack. Bolts will loosen and stretch out of shape. Age is a factor to monitor in equipment.

4.3 Approaches to identify unsafe or equipment and machinery

There are different techniques of fault identification. The following are the common approaches to identify faulty equipment and machines.

- Visual inspection
- Pre-operational checks
- Using touch sensors to check whether parts' temperature is raising or not
- Auditory system to evaluate sound and noise
- By measuring parameters
- etc

The purpose of an inspection is to identify whether work equipment can be operated, adjusted and maintained safely – with any deterioration detected and remedied before it results in a health and safety risk. ... The need for inspection and inspection frequencies should be determined through risk assessment.

Self-Check –4	Written test

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

Test I: Short Answer Questions

1. What do we mean by unsafe equipment(2pts).
2. Mention at 5 indicators for faulty machinery(5)
3. What does vibration of a machine shaft indicate(1).
4. What are the approaches used to identify unsafe or faulty equipments ?(2pts)

Note: **Satisfactory rating - 10 points** **Unsatisfactory – below10 points**

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

Score = _____

Rating: _____

Information Sheet 5- Identifying Occupational Health and Safety hazards

5.1. Occupational health and safety hazards

Accidents or safety hazards are usually the result of unsafe acts or conditions, or both. In the workplace, unsafe acts can include:

- Horseplay
- Not using personal protective equipment
- Running
- Using damaged tools
- Not lifting properly
- Violating safety rules

5.2. Hazard identification methods

Here are a few examples of methods you could adopt to identify **health and safety hazards** *before* an incident occurs:

- Conducting pre-start discussions on the work to be carried out;
- Encouraging workers to recognise and highlight hazards while performing work;
- Carrying out safety inspections and audits of the workplace and work procedures;
- Conducting job safety analyses (or similar task evaluation processes);
- Monitoring , measuring and testing the working environment, such as noise monitoring, electrical testing and atmospheric testing;
- Analyzing proposed new or modified plant, material, process or structure;
- Conducting hazard (or risk) surveys;
- Reviewing product information, e.g. safety data sheets, operating manuals;

- Researching publicly available data on hazards, e.g. media articles, industry or safety regulator alerts; and
- Looking at past incident and near-miss reports.

Unsafe conditions are physical hazards and can include:

- Hazardous chemicals
- Over loading
- Missing machine guards
- Exposed electrical circuits
- Damaged equipment
- Slippery floors
- Improper storage of materials
- Lack of proper supervision

The good news is that there are steps you can take to eliminate the unsafe conditions and acts that often lead to accidents. Consider these simple practices to reinforce with your employees to help make the workplace safer:

- Follow all specific safety rules
- Report all unsafe acts or unsafe conditions to your supervisor
- Encourage fellow employees to work safely
- Check the condition of personal protective equipment and use the correct PPE for the specific hazard you are dealing with
- Ask for help if you need it
- Ask questions if you are not sure of the proper way to do something
- Lock out and tag all equipment before adjusting it or performing maintenance on it
- Inspect the condition of ladders before using them
- Don't use chemicals unless you have been specifically trained on the hazards and protective steps you need to follow to use them safely
- Keep your work area neat and clean to avoid trip hazards

- Use three-point contact when entering and exiting the cab of a truck
- Push, don't pull whenever possible

This list could go on, but you get the idea. Working in a safe manner is often just a matter of following some common sense guidelines and adhering to specific safety work rules.

Self-Check –5	Written test

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

Test I: Short Answer Questions

1 Mention at least 5 hazard identification methods (5 pts).
2 List at least 5 unsafe acts of operators that can cause accidents(5).
3 How can slippery workshop floors cause accidents?(2pts)
4 What do we mean by horseplay ?(3)

Note: **Satisfactory rating - 15 points** **Unsatisfactory – below15 points**

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

Score = _____

Rating: _____

LG #04	LO #2- Operate basic machinery and equipment

Instruction sheet

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

- Selecting suitable personal protective clothing and equipment
- Operating machinery and equipment
- Completing work
- Identifying and reporting environmental implications

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

- Select suitable personal protective clothing and equipment
- Operate machinery and equipment
- Complete work
- Identify and report environmental implications

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, ask your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Selecting suitable personal protective clothing and equipment

1.1 Types of personal protective equipment and clothing

PPE can be classified in the following categories, based on the type of protection afforded by the equipment:

Respiratory protection - for example, disposable, cartridge, air line, half or full face

Eye protection – for example, spectacles/goggles, shields, visors

Hearing protection – for example, ear muffs and plugs

Hand protection – for example, gloves and barrier creams

Foot protection – for example, shoes/boots

Head protection – for example, helmets, caps, hoods, hats

Working from heights - for example, harness and fall arrest devices

Skin protection – for example, hats, sunburn cream, long sleeved clothes

Other personal protective equipment: This may include PPE(personal protective equipment) for specific tasks such disposable clothing for working with chemicals, radiation hazards,. Examples include: lead aprons for x-ray protection; sleeve protectors, aprons, coveralls when using chemicals; leather jackets, trousers and spats for welding; thermal and cold protective clothing for work near furnaces and cool rooms.

1.2 Selection of Protective clothing and equipment for lapidary

While selecting , there are factors to be considered for each type of PPE. The following table shows types of PPEs and the factors that should be considered during selection.

Types of PPE	Selection factors
Respiratory protection -	• adequacy of warning available • type of hazard • concentration of contaminant • acuteness of hazard, that is, the effect of short exposure. • time spent in contaminated atmosphere • nature of the working environment • activity of the wearer • mobility of the wearer • whether for routine or emergency use.
Eye protection	♦ nature of risk to eyes. For example, radiation, impact, dust / abrasive particles, liquid / chemical splash or spray ♦ conditions under which the person is working ♦ visual requirements of the task ♦ personal preference/comfort of wearer. This may include appearance, weight, ventilation and unrestricted vision. ♦ condition of person's eyesight.
Hearing protection	❖ requirement for the device to attenuate noise to a level not greater than 85 dB(A) ❖ weight ❖ clamping force of earmuffs, and ear canal caps ❖ suitability for use with other personal protection

	equipment such as helmets or goggles ❖ acceptability to the wearer.
Hand protection	• Sufficient stocks should be held to ensure that there is an adequate supply, particularly in the event that gloves become damaged. • Consideration should be given to the need for a glove lining or inner glove or moisturizer/barrier cream where prolonged use of waterproof gloves is envisaged. • A range of sizes should be available to accommodate individual requirements.
Foot protection	♦ a firm heel counter and deep heel seat that holds the heel well and doesn't slip when walking ♦ sufficient depth and width at the toes to prevent pressure on toes and nails ♦ a sole that does not bend at the ball of the foot. The shoe should not bend in the middle of the shoe under the arch. ♦ firm, well padded synthetic or rubber sole with non-slip tread ♦ soft upper with minimal stitching ♦ laces ♦ a heel less than 2.5 cm high ♦ little distortion on attempting to twist the shoe ♦ a shape that matches your feet.
Head protection	• nature and location of the work • extent of adjustment for comfort • accessories must be compatible with the make of

	helmet used • sweat bands • white helmets will provide better heat reflection and are easily seen in poor lighting cond
Skin protection	♦ form of the product suitable for environmental conditions ♦ user acceptance of product (odour, consistency, colour) ♦ existence of product literature on health effects (for example, allergic reactions, dermatitis, long term effects) ♦ suitability and durability of packaging ♦ adequacy and permanence of labeling

Self-Check –1	Written test

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

Test I: Short Answer Questions

1. what are the factors that should be considered while selecting eye protection equipment (2 pts).
2. List at least 3 safety equipments for eye protection(3).
3. what do we mean by PPE?(1pt)
4. mention at least 2 ear protection equipments ?(2)

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 2- Operating machinery and equipment

2.1 Lapidary machine operation

After preparing the machinery and equipment and having fulfilling safety equipments , then comes operating the machinery. Different machines have their different operating procedures.

2.1.1 Operating slab saw

The detailed steps that should be followed while slabbing /sawing operation are indicated as below:

1. Detect the part of the stone to be sliced
2. Draw a sawing line;
3. Mount the gemstone rough on the machine
4. Now that the coolant oil has been added and the rock is firmly gripped in the vise jaws and positioned for the first cut, you are ready to start slabbing.
5. The vise and carriage are slid forward until the rock is almost touching the blade.
6. The brass half nuts are engaged (due to equipment wear a short brass wire is placed between the half nuts.
7. Check that the saw blade guard will clear the stone and vice while cutting.
8. Put the Plexiglas hood in place.
9. Make pre-operational checks before turning on the machine.
10. Turn on the machine
11. The cut will start shortly, and you can watch the progress through the transparent hood. Listen to the machine, is it turning smoothly? If not notify a target Officer. You should hear the “ching” of the rock being cut.

12. Once started, the cut should progress smoothly until completed. The carriage will advance at approximately 10” per hour. Stay in the room with the saw and listen for any sound of problems with the saw or cut.
13. If the cut is started on a steeply sloping surface of a hard-to-saw material, the blade may be deflected sideways slightly and start a crooked cut. If this is suspected, the cut should be restarted after the blade has cut a slight notch. Restarting is very seldom necessary with this saw.

2.1.2 Operating gem stone grinders

The basic procedures that should be followed while operating gem grinder include the following:

The detailed steps that should be followed while slabbing /sawing operation are indicated as below:

1. Mount the right grinding or polishing wheels on the machine and firmly tighten them
2. Position the safety hoods on the right place of the machine and check whether it is touching the moving part including wheels by moving the parts by hand to prevent crush with it and adjust if there any tiching points
3. Fill the tray with water
4. Position the gyser/coolant delivery system in the water
5. Once again, conduct pre-operational checks before starting the machine
6. Switch on the light for illumination
7. Turn on the machine and inspect all the conditions are ok
8. Select the trimmed rough for cabbing
9. Make cab/grind

Note: Operation procedures for the rest of the lapidary machines will be done depending on the the type of project they are intended to make.

2.1.3 Sanders

sanding is similar to grinding but uses finer abrasives. Its purpose is to remove deep scratches left by coarser abrasives during grinding. Since it removes material less rapidly, it also allows more delicate control over final shaping of the stone prior to polishing. For stones with rounded surfaces, a flexible surface such as a belt sander is often used to avoid creating flat areas and promote smooth curves.

	
Fig: belt sander	Fig: Expandable drum sander

2.1.4 Laps

Lapping is very similar to grinding and sanding, except that it is performed on one side of a rotating or vibrating flat disk known as a **lap**, and it is used especially to create flat surfaces. Laps are often made of cast iron, steel, or a copper-bronze alloy, but other materials can also be used. These are used polish wide flat products like bookends and large flats on the same machine, using either Magnetic Novas or the standard process using abrasives on the rotating disc itself.

.

 **Fig: Rotary lap**	 Fig: Replacing Nova magnetic lap

2.1.5 Operation of Gem drills

The necessary inputs to drill gems include:

- Small Diamond Drill bits
- Rotary drill with Flex shaft or drill press.
- Safety goggles
- Water dish

Drilling operation involves the following basic procedures:

Step 1

Mark your gemstone with your entrance and exit hole (personal preference). Set up your water dish, either an ice cream tub, sandwich box or some form of solid tray with a piece of wood or blu-tac to hold the stone on whilst drilling. It will need to be deep enough to immerse your stone in. Select your drill bit, say 1mm and attach to your flex shaft/drill press.

Step 2

Whilst keeping your gemstone immersed in water and holding your stone, start your drilling. Go slow to begin with to prevent the drill bit skittering across the surface. Once your initial starter hole has been created begin to move the drill bit up and down to allow water to flush in and out of the hole to remove the drilling debris and to keep the area

and the drill bit cool. Overheating can cause the diamonds to come off the drill bit and the material you are drilling to shatter.

Step 3

Once you have drilled about halfway you may like to flip the gemstone over and begin drilling again from the other side where you have marked. If you were to drill straight through there may be a possibility of chipping your exit hole.

Step 4

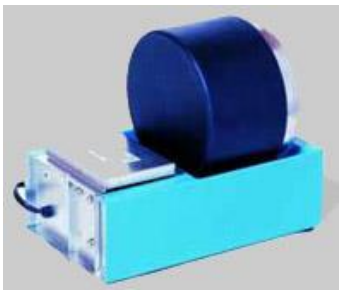
If you discover the hole needs opening up further use one of our twist drills to do so. Or if you find you would like a smooth, professional beveled hole trying using one of our small diamond files. Scratches on gemstones can be removed by using a small amount of diamond polishing paste on a felt bob, working through the grades of the paste until the desired finish is achieved. We would recommend trying a 3 micron then a 1 micron.

2.1.6 Operation of gemstone tumbler

The most popular tumblers have a barrel that is loaded with rocks, water, and abrasive grit. The abrasive grit is a granular material similar to the grains glued onto sandpaper. The grit is often labeled "coarse," "medium," and "fine," similar to the different grades of sandpaper.

The barrel containing rocks, grit, and water is placed on a motorized machine that rotates the barrel to tumble the rocks that are inside. As the rocks tumble, they grind against one another with particles of the abrasive grit caught between them. This action wears sharp edges off of the rocks and smoothens their surfaces. Tumblers that operate this way are known as "rotary tumblers."

The rocks are typically tumbled for one or two weeks in coarse grit, one week in medium grit, and one week in fine grit, with a thorough cleaning of the rocks and the barrel between each grit size. Then the rocks are tumbled for one final week with water and a rock polish. After following this procedure, the rocks are usually transformed into brightly polished stones.

 Fig: Rotary tumbler	 Fig: Vibratory tumbler

2.1.7 Bead/sphere making machines

Spheres are initially sawed into cubes or dodecahedrons and then ground to shape between two pipes or rotating concave cutters, allowing the stone to rotate freely in any direction to form a perfect spherical shape. As with other lapidary processes, gradually finer grades of abrasive are used to grind, sand, and polish the stone. While beads may be faceted, they are more commonly cut and polished as small spheres and then drilled to allow stringing.

Bead mills are used to grind and sand large quantities of beads simultaneously. They typically employ a grooved lap and a flat lap between which the beads are rolled and worn to shape. After shaping and sanding, beads are usually polished by tumbling

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 the machine which is used to polish wide slabs which used for bookend?(2)
2. What are the procedures that shuld be followed to operate a cabbing machine?(4)
3. How can a tumbling machie be used in bead making ?(1)

Note: Satisfactory rating - 7 points Unsatisfactory – below7 points

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

Score = _____

Rating: _____

Operation Sheet-1	Machine operation to slab gem material

Operation steps to slab gem material in to10mm thick

steps	operations
1	Detect the part of the stone to be sliced
2	Draw a sawing line; measuring a 10mm thickness beyond thaw blade
3	Mount the gemstone rough on the machine
4	Now that the coolant oil has been added and the rock is firmly gripped in the vise jaws and positioned for the first cut, you are ready to start slabbing.
5	The vise and carriage are slid forward until the rock is almost touching the blade.
6	The brass half nuts are engaged (due to equipment wear a short brass wire is placed between the half nuts.
7	Check that the saw blade guard will clear the stone and vice while cutting.
8	Put the Plexiglas hood in place.
9	Make pre-operational checks before turning on the machine.
10	Turn on the machine
11	The cut will start shortly, and you can watch the progress through the transparent hood. Listen to the machine, is it turning smoothly? If not notify a target technician. You should hear the “ching” of the rock being cut.
12	Turn of the machine after the slabbing is complete
13	Open the hood and remove the slab

LAP Test 1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Use all necessary tools, equipment and materials that you require to perform the following tasks within **1hour**

Task 1: Operate and slab gem material with a thickness of **10mm**

Information Sheet 3- Completing work

3.1 Completion of the work

After having done the required operations on lapidary machines, the the machine has to be stopped as per standared procedures.

After finishing the project work which have been on the process, the machine should be turned off and the following common activites must be performed before finalizing the work.

- The machine should be turned off
- The product should be removed from the machine
- The product should be cleaned and stored
- The machine should be cleaned and made ready for further use
- Cleaning the workshop
- Turning off power breakers
- Keep personal hygiene
- Note the events that occurred
- Keep documentation of all the information of the working period
- Close the workshop
- Complete the work

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 I: Short Answer Questions

1. Mention at least 5 tasks that should be performed before completing the work/project. (4pts)
2. Why we clean machines after completing the work?(1)
3. What will be the consequence when the information of working period is not recorded and documented ?(2)

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

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

Score = _____

Rating: _____

Information Sheet 4- Identifying and reporting environmental implications

4.1 Environmental implications of the work

Many of the technologies we use every day consume a lot more resources and power than they need to, and using and manufacturing them can create a mess. Here are a few of the ways that a lapidary, as a technology can harm the environment:

1. **Pollution** - Air, water, heat and noise pollution can all be caused by producing and using technology

    - ✓ Air pollution can be caused by diffusion of gase and oil from the coolant tank
    - ✓ Water pollution can be caused by disposal of slurry of used coolant and lubricant
    - ✓ Heat/temperature can be raised because of friction of the cutting process.
    - ✓ Noise can be created while sawing and grinding gem material and so on.

2. **Consuming resources** - Non-renewable resources, including precious metals like gold, are used to make technology. Many others, such as coal, are consumed to generate the electricity to use technology. Even some renewable resources, like trees and water, are becoming contaminated or are used up faster than they can renew themselves because of technology.
3. **Waste** - Manufacturing technology creates large amounts of waste, and used lubricants and coolants, grits, blades, wheels, etc thrown out when they break or become outdated. These contain all sorts of hazardous materials that are very unsafe for the environment. They need to be disposed of using special methods.
4. **Health hazards** - Using toxic materials that can harm our health can cause cancer

Thus, the lapidary has his/her own part to reduce environmental impact by not being wasteful and proper disposing waste of the process.

4.2 Reporting environmental implications of the lapidary work

The diverse environmental negative effects that can be enhanced by act of lapidary should be identified and finally reported to the concerned body.

The environmental implications which are caused by lapidary are mentioned above. The importance of reporting the issue is to react on it and to solve the problem of it by doing the following activates :

- By venting and reducing concentration of polluted air in the shop and if possible reducing diffusion of coolant by making researches on its properties
- By properly disposing waste as per standard procedures of waste disposal
  - ✓ By properly burying
  - ✓ Burning it in a confined space to prvent its entrance to drinking water lines systems
- By properly applying sound absorbers to make silence of sound and noise
- Reuse of metallic discs for other purposes
- Use of proper personal equipments and safety guards to prevent expansion of cancer causing compounds etc

Self-Check – 4	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 are the environmental impacts of lapidary as a manufacturing technology?(3pt)
2. What is the method of disposing slurry of used coolant?(1pt)
3. What is the importance of reporting environmental implications of lapidary work ?(1pt)

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

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

Score = _____

Rating: _____

LG #05	LO #3- check, clean and store basic machinery and equipment

Instruction sheet

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

- Detailing and recording use of machinery and equipment
- Cleaning , securing and storing machinery and equipment
- Identifying malfunctions, faults, wear or damage to machinery
- Cleaning workplace areas

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

- Detail and record machinery and equipment
- Clean , secure and store machinery and equipment
- Identify malfunctions, faults, wear or damage to machinery
- Clean workplace areas

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 your performance is satisfactory proceed to the next learning guide,
7. If your performance is unsatisfactory, ask your trainer for further instructions

Information Sheet 1- Detailing and recording use of machinery and equipment

1.1 Detailing and Recording the use of machinery

Recording is the having a note of the use and working principles of machinery and equipment in a detailed format for proper handling of information necessary used as a guide to operate the equipment.

- The information that should be recorded about the use of the machinery and equipment may include:
- Function of the equipment
- Operating conditions of the equipment
- Operating procedures
- Capacity of machinery

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 1: short Answer Questions

1. What is the safety benefit of pre-start up checks?(2 pts)
2. What is the economic benefit of pre-start up checks?(2pts)
3. How can we check the level of coolant in the reservoir of the slab saw machine?(1pt)

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

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

Score = _____

Rating:

Information Sheet 2- Cleaning, securing and storing machinery and equipment

2.1 Cleaning of the machinery and equipment

Cleaning is a routine activity that should be always performed after completion of work. Cleaning is usually being termed as part of a preventive maintenance. To clean machines, proper detergents should be selected as per their application requirements.

Basic Cleaning Supplies include:

- Sponges and scourers.
- Yellow dusters/microfiber cloths.
- Glass polishing cloths.
- Cleaning **brushes**.
- A mop and bucket.
- A **dustpan** and brush.
- Protective gloves.

2.2 Importance of cleaning

Cleaning of machine and equipments after work and routine work of it provides importance to the machine and the facilitation of work. The following are some of the benefits:

- It is used to clearly inspect the machinery and equipment
- It increases more of the worker
- Increase useful life machines as it discards contaminations and stains of the dirt that can cause decrease in strengths of parts
- It is considered as analogous to bathing for equipments and enhances relaxation of the body of machines etc

2.3 Securing and storing of machinery and equipment

Security of machines is the basic issues to be considered if we are willing to extend their useful life. After properly cleaning and oiling them, machines and equipment should be kept at places where designed for their safe placement. That is, their position should be secured from reach of factors that may cause any negative side effect. They may be wore safeguarding cover clothes, unplugged to safeguard from power damages, etc . The term storing is to mean that machines should be put at a common standard place so that that can be accessed easily. Storing is done at predesigned machine and equipment stores.

As modern approaches of workshop management, Kaizen should be applied to make work of cleaning and storing effective.

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 1: short Answer Questions

1. What are the advantages of cleaning machinery and equipment.(4pts)
2. Why should machines be secured after completion of work(1pt)
3. Mention at least 5 consumable in cleaning machines?(5pts)

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

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

Score = _____

Rating: _____

Information Sheet 3- Identifying malfunctions, faults, wear or damage to machinery

3.1 Malfunctions ,faults and damage of machinery

Malfunctions: a state a machine that indicates the improper functioning of machinery because of different causes.

Equipment malfunction can be caused by a number of factors. It may involve improper handling or use by operator. It could also involve equipment that is poorly maintained or worn out. Sometimes, the equipment is defective as designed.

Faults: are imperfections of machines in their functions due to may be improper calibrations, installation, programming etc

Wear: is damage that naturally and inevitably occurs as a result of normal wear or aging. Wear or damage is a form of depreciation which is assumed to occur even when an item is used competently and with care and proper maintenance.

Generally, the common causes of equipment failure include:

- Improper operation.
- Failure to perform preventive maintenance.
- Too much preventive maintenance.
- Failure to continuously monitor equipment.

3.2 Procedures to identify malfunctions, faults and damage of machinery

The following are the procedures to identify the failures of the machinery**.**

Top 5 Signs of Machine Failure:

- Listen for abnormal sounds. Manufacturing floors are loud places, but the people who work on them quickly grow accustomed to the sound of the machines they use
- Take notice of unexplained heat
- Check for cleanliness

- Monitor production speed.
- Feel for unnecessary vibration.

Three steps to prevent equipment failure:

- Establish a maintenance schedule. When repairs and upkeep take place on machines at regular intervals, these efforts can significantly improve the equipment reliability of these systems
- Eliminate potential defects
- Utilize equipment monitoring.

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 1: short Answer Questions

1. What are the causes for failure of machines?(4)
2. What do we mean by malfunctioning of the machinery?(2)
3. Mention the top 5 signs of machine failure?(5pts)

Note: Satisfactory rating -10 points Unsatisfactory – below12 points

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

Score = _____

Rating:

Information Sheet 4- Cleaning and maintaining workplace areas

4.3 Cleaning and maintaining of work area

As have been stated in previous sections, cleaning of workshop should be a routine work like cleaning of machines and equipments after completion of work. Everybody working in the work shop is responsible to carry out the cleaning work as per schedule of hygiene rule and regulation of the workshop. The consumables used to clean work area include:

- Different detergents
- Brush
- Water
- Chemicals (Some examples of alkaline cleaning agents include (but may not be limited to): Potassium hydroxide. Sodium hydroxide. Bleach)
- Bucket
- Picker
- Cotton clothes etc

4.4 Benefits of a clean and tidy workplace

The following are the general benefits that a clean and tidy workshop provides

- Give a good impression to clients. The appearance of your premises sends a message to your clients about who you are and what your business represents. ..
- Increase the productivity of your employees
- Make your employees happy
- Safeguard your employees' health.

- Reduce hazards
- Keep your office running smoothly
- Keeps workshop machines clean

Self-Check –4	Written test

Name…… ID…… Date…….

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

Test 1: short Answer Questions

1. List at least 5 benefits that a clean work area provides?(5pts)
2. How often should work area be cleaned?(2)
3. Who is responsible to clean workshop?(1pt)
4. List the inputs used to clean workshop.(2pts)

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

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

Score = _____

Rating:

Reference Materials

- Lapidary machinery manufacturer manual (Lapidary Equipment and Supply Catalogue)
- Basic machine operation and maintenance manual www.portmoodyrockclub.com (Workshop Rules & Guidelines)
- maintaining Health and Safety at Workplace: Employee - ERIC https://files.eric.ed.gov › fulltext
- Gemstone technical training manual - Levin Sources http://www.levinsources.com › assets › pages ›
- GEMSTONE TECHNICAL TRAINING MANUAL - Levin Sources http://www.levinsources.com › assets › pages › W...
- Managing Maintenance Resources-A.Kelly, Butterworth-Heinemann.
- Handbook of Maintenance Management-Levitt Joe
- https://www.globalsecurity.org/military/library/policy/navy/nrtc/14310_ch1.pdf
- Machine safetySafety and health in the use of machinery - ILO httpswww.ilo.org › documents › wcms_164653
- Diamonnd_Pacific_Complete_2018_catalog
- safety httpsosha.oregon.goveduDocumentsworkshop-materials1-120i.pdf

No	Name	Qualification	Educational background	Institution	Region	Phone Number	E-mail
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3							
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The trainers who developed this learning guide