Vehicle body repair
Level-III

Based on November 2016, Version 2 Occupational standard

Module Title: - Repairing/Replacing and Fabricating Fiber Glass/ Composite Material Component

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Table of content

LG #36	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:

- Determining job requirements, including job sheets, quality and quantity of materials.
- Reading and interpreting job specifications
- Observing OHS requirements throughout the work.
- Selecting and inspecting materials quality for repairs and replacements
- Identifying and checking hand, power tools and safety equipment
- Determining procedures to minimize waste material
- Identifying safe procedures for maximizing energy efficiency

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:

- Determine job requirements, including job sheets, quality and quantity of materials.
- Read and interpret job specifications
- Observe OHS requirements throughout the work.
- Select and inspect materials quality for repairs and replacements
- Identify and check hand, power tools and safety equipment
- Determine procedures to minimize waste material
- Identify safe procedures for maximizing energy efficiency

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 Determining job requirements, including job sheets, quality and quantity of materials

1.1 Introduction

In order to define job requirements, the company has to perform several processes. It is not as simple as looking at the job title of the open position, and deciding right there and then the requirements that you expect from the candidates. This may work for some organizations, but it is haphazard at best, and there is a risk that the recruitment and selection process may not go about the way they want it to.

Much of the success of recruitment and selection depends on how properly the company has defined the requirements of the job, as stated in the job description on the posting. And the first thing that must be done is to perform job analysis.

1.2 Job analysis

Job analysis is the process performed to determine and identify the particular tasks, duties and requirements of a given job, and why they are important.

Job analysis is performed to "establish and document the job-relatedness of employment procedures, such as training, selection, compensation, and performance appraisal."

In the recruitment process, job analysis is very useful in determining the duties or tasks that will be included in the crafting of job postings and advertisements. It is also a vital tool that is used in the determination of the salary level or range for that position. During the screening, the selection tests, as well as the questions that will be asked during the interview will be developed by using the results of job analysis.

In the context of this discussion on defining job requirements, job analysis is used in recruitment and selection procedures to identify the minimum and other requirements for the screening and selection of candidates.

In the analysis, the job will be broken down into its component parts, where all the tasks and activities of the person who will perform the job are taken into careful consideration. The next thing that will be considered will be the competencies, behaviors and attributes that the company will be looking for in the person.

That is one thing that must be underlined: job analysis is an analysis of the job, not of the person. After all, it is the job that will be described, and not the person who will do the job.

1.3 Steps in Job analysis for setting job requirement

Step 1. Make a list of the factors that will be used as a guide in gathering information.

The factors that information will be collected on include:

- **Duties and responsibilities of the job.** What are the activities, functions and tasks involved in the job?
- **Skills and knowledge required for performance of the activities.** What are the skills needed to accomplish the identified activities, functions and tasks? What knowledge is needed to accomplish the activities, functions and tasks?
- **Attitudes and behaviors of the jobholder in performing his functions.** What attitudes are expected and required of the person who will carry out the tasks, functions and activities? Should he be flexible, punctual, outgoing, etc.?
- **Context of the job.** Does the job entail constant contact with other employees? With the customers? What are the unique working conditions of the job that are likely to have an impact on the jobholder and his performance of his tasks and activities?
- **Responsibility levels.** Does the job entail supervision of other employees or workers? What supervision will the jobholder require? Who will the employee report and be accountable to?

Step 2. Identify your sources of information

Obviously, your best source of information will be within the organization, where the job is. This will not be much of a problem if we are talking about a small operation, where there are only around five people, because they are likely to be well-informed about the nature of the job and its requirements.

Some of the identified best sources of information include:

- **A former employee who actually held the job.** If the job under analysis is one that already exists, look for someone who performed the actual tasks and functions of the job in the past. Their actual experience will definitely aid the analysis. The risk in using this source is that there may be some bias on the part of the former employee, especially if the circumstances of his being a "former" employee are favorable.
- **The immediate supervisor, or the employee that is directly responsible for supervising the job.** At best, the supervisor will know the basic or fundamentals of the job, although not its details or nitty-gritty. The risk in using this as the sole source of information is that the supervisor may be unaware of the smaller details about the job, since he is mostly tasked to manage.
- **The division, team or work group where the job will belong to, and where it will be performed.** The members of the team may have knowledge and even experience about what the job entails, even if it's not to its full extent. Do not just get information from the team leader or the head of the department. You will find that the better sources are the co-workers, or those who are roughly on the same level as the job under analysis.

Step 3. Collect or gather information.

There are several methods employed by analysts to gather or collect the information needed. The most commonly used methods are:

- **On-site observation:** Information is gathered by observing a person actually performing the tasks, activities or functions of the job. This may be applicable if there is already someone who may be observed. It won't be as reliable if the job being analyzed is new, and there is no one actually performing the tasks yet.
- **One-on-one interviews:** If the job already exists and the plan is to obtain information from former jobholders, the best method to use is an individual interview. This same method is effective when current or incumbent jobholders and supervisors are being tapped as sources of information.
- **Panel or group interviews:** In this setting, members of the group or team where the job is performed may be interviewed collectively at one time.
- **Questionnaires:** Questionnaires and check lists may be distributed to incumbent and former jobholders, supervisors and managers, and team members and co-workers. The questionnaires may be structured, or they may be open-ended.
- **Existing records related to the job:** Review of records that pertain to the job and its performance may also be conducted. Examples of these records are task inventories and work logs.

  Example: Job analysis of an Office Manager position

  Tasks:

  - Delegation of work to the staff with matching skills and knowledge
  - Procurement and distribution of office supplies and materials
  - Bookkeeping
  - Monitoring of costs and expenses
  - Training of staff

Skills required:

- Communication
- Time management
- Computing and numeracy
- Clerical
- Teaching and mentoring

Knowledge required:

- Procurement and reorder procedures
- Inventory management
- Awareness of staff skills and qualifications

Attitudes/behaviors required:

- Pleasant, friendly and approachable
- Strict adherence and commitment to schedule or timetable
- Desire to involve everyone and make them feel that they belong to a unit

1.4 Importance of job requirements

Job requirements are a crucial part of both job descriptions and job postings (job ads). They are equally important for both employers and job seekers.

1.4.1 For employers

Employer use job requirements as a way of preselecting potential candidates. Job requiremnts are used to communicate employer's expectations from job seekers. By laying out clearly defined job requirements, employers can attract the right type of candidates. Over or under qualified candidates will be turned away from applying, thus saving employers a lot of time and money in the long run.

1.4.2 For job seekers

For job seekers, job requirements are the crucial part of job postings (job ads). Job requirements section of the job ads clearly states what an employer is looking for. That way, potential candidates can know what is required of them before applying. If they match all the job requirements criteria, it means they are a good fit for a job.

1.5 Determining job requirement

Determine exactly what the jobrequirements are before looking at any resume—or even placing an ad. It salmost impossible to find qualified candidates if the job requirements areunclear.

Job requirements are “must haves” that an employer is looking for in a candidate for a certain job position. Job requirements aren’t just a list of specific qualifications, education, knowledge and skills needed for a particular position. They are a great opportunity to showcase your Employer Brand and company culture and attract the best candidates!

1.6 Purpose and Importance of Job Requirements

- **To improve the accuracy of the recruitment process**, resulting to the company being able to hire the right person for the job, or the candidate with qualifications that match the requirements of the job.
- **To reduce the number of potential applicants.** Without the job requirements, pretty much anyone and everyone may apply, and would have to be considered, for an open position. By making the jobs requirements as specific as possible, employers are able to reduce the pool of applicants further, resulting in a shortlist of candidates that possess the necessary qualities and qualifications for the job.
- **To assist applicants in making decisions on whether to apply for the job or not.** They may be interested to apply for the open position in the company. However, when they go through the job requirements and realize that they do not meet these requirements, then they can look elsewhere for other job prospects.

1.7 Components of job requirements

It was mentioned earlier that job requirements are specific, so that they target only the candidates who are qualified for the job. But what are the requirements that employers focus on throughout the recruitment process?

- **Skill and knowledge requirements:** There are jobs that require specific and, often, technical skills and knowledge that are unique to the job.
- **Years of work experience:** Employers often pay attention to two aspects of work experience: the quality of work experience, and the amount or duration of the work experience.
- **Quality of work experience:** The relevance of the experience will be taken into account.
- **Amount of work experience:**. This refers to the number of years of work experience of the candidate. It could be in a general capacity, where the employers specify that the candidate must have at least 5 years experience working in the IT industry.
- **Educational requirements***:* There are jobs that require candidates to have obtained a certain level of education, and that fact will be emphasized in the job posting.
- **Equivalent experience***: "*Equivalent experience" is what employers accept in all educational requirements, or even direct and paid work experience. For example, the job posting may require the candidate to "at least have a Bachelor's degree, or a certification from a specific regulatory agency".
- ***Professional certification:*** There are jobs that require the jobholder to be licensed or certified as a professional. For instance, an Accountant position requires the jobholder to be a Certified Public Accountant**.**

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. What is Job analysis?(2pts)
2. List the components of job requirement?(2pts)
3. What is the Purpose of Job Requirements ?(3pts).
4. Explain the components of job requirement. (3pts)

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: _____

Information Sheet - 2 Reading and interpreting job specifications

2.1 List of job qualifications

The job qualifications list is one of the most important parts of the job specification or description. This list may include:

- Education level
- Work experience
- Required licenses or certificates
- Required skills

This list will typically be broken up into preferred and required qualifications. The most important qualifications will often be listed first, so if you meet those qualifications, be sure to emphasize them in your cover letter. If you have a qualification that's similar to one the employer listed, also try to mention it in your resume or cover letter.

Read through the job duties

Employers will also often include a list of duties required for the job. These duties can vary wildly from job-to-job, even if the job titles are the same. Similar to the qualifications, the job duties are often listed in order from most important to least important. As you read through the job duties, make a list of the one you've done in your previous jobs. Then, include some of what you listed in your cover letter.

Check for questions or keywords

Sometimes, employers will ask candidates to answer a question or use a certain keyword in their application to make sure that they thoroughly read through the job description. This question may be something simple, or it might be an important part of the application. Before you move away from the job description and start writing your cover letter, be sure to double check all the requirements in the description.

Use the description in your cover letter

Employers want to know that you carefully read the description and understand what the job entails. One way to show this is to use the description in your cover letter. Put some of the description into your own words, and say how your skills match what's

being described. For example, if one of the job duties is managing meetings, you could discuss a particularly successful meeting you organized at your previous job. Or, if you're just coming out of college and don't have professional experience yet, you could discuss club meetings you've held, or class discussions you've led. When you use the description in your cover letter, you'll show the company that you spent time thinking about their job listing, and that you understand how your unique skillset will fit into the company.

2.2 How to Find the Important Information

As we mentioned above, a job description can be overwhelming and overly detailed. So, when you read a posting, be sure to read it carefully for these key takeaways:

- Check for keywords. You know by now to use keywords on your resume. A job description is the place to find the right keywords to use, as well as give you an idea of what the employer will look for in the right candidate.
- How does the employer want you to respond? Make sure you've found out the company's preferred method of communication. Don't plan to email a resume if the organization wants you to apply through its online job portal.
- Don't get too caught up in jargon. Words and phrases such as passion, commitment, team player, responsibility, dynamic interpersonal skills, ability to work independently, detail oriented, and analytical skills are oftentimes just buzzwords that recruiters and managers use in every job description.

Preparing personal protective equipment is necessary to protecting the person as related to the job performed. Select boot, hats, lotions, goggles, mask and gloves. In similar manner you need to identify the likely risks that might occur on your body or sense organs from specific activities, then once you identify the risks it is necessary to select the necessary personal protective equipment that fit the body or the sense organ involved.

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: choose the correct answer

1. Which one of the following is included in specification or description? (2pts)
   a. Education level
   b. Work experience
   c. Required skills
   d. all
2. ---------- helps the candidates to answer a question or use a certain keyword in their application to make sure that they thoroughly read through the job description. (2pts)
   a. Read through the job duties
   b. Check for questions or keywords
   c. Use the description in your cover letter
   d. none

Note: **Satisfactory rating – greater than 2 points** **Unsatisfactory – less than 2 points**

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

Score = _____

Rating: _____

Information Sheet - 3 Observing OHS requirements throughout the work

3.1 Shop safety practices and health protection

The most important considerations in any body repair and refinishing shop should be accident prevention and safety carelessness and the lack of safety habits cause's accidents. Accidents have a far-reaching effect, not only on the victim, but on the victim's family and society in general. More importantly accident can cause serious injury, temporary or permanent or even death. Therefore it is the obligation at all shop workers, instructors and students to foster and develop a safety habit to protect the health and welfare of those involved.

- **Air Passages and Lungs Protection**

Abrasive dust vapour from caustic solutions and solvents spray mist from undercoats and finishes-all present dangers to the air passages and lungs, especially for workers who are among them day in, day out. The cartridge filter or organic vapour type of respirator, which covers the nose and mouth, is equipped with a replacement cartridge that removes the organic vapours by chemical absorption painting with out this equipment it is harmful to our respiratory organ.

The dust respirator or mask is worn to protect against dust from sanding and grinding. These operations in the body shop create dust can that can cause bronchial irritations and possibly long terms lung damage such as silicosis (well known in mining areas). Keep in mind that these respirators are good for removing solid particles from the air and have little if any ability to remove vapours. They should never be worn when spray painting use cartridge filter.

- **Eye and Face Protection**

Eye protection is required where there is a possibility of an eye injury from flying particles, chips, and so forth clear protective safety goggles, glasses or face shields should be worn when using grinders, disc sanders, power drills, pneumatic chisels,

removing shattered glass, or when working underneath the auto. When they are in the metal working or painting areas of the shop locations there is always the possibility of flying objects, dust particles or splashing liquids entering the eyes. Not only can this be painful it can also cause loss of sight. Remember eyes are irreplaceable. Get in the habit of wearing safety goggles, glasses, or face shields in the working areas.

A welding helmet or welding goggles with the proper shade lens must be worn when welding. These will protect the eyes and face from flying molten pieces of steel and from harmful light rays.

- **Ear protection**

Panel beating the piercing noise of sanding, the radio blaring full-blast-it is impossible to hear any thing else. It is enough to deafen a person and that is exactly what it will do if proper precautions are not taken. When in metal working areas, wear are plugs or ear muffs to protect the eardrums from damaging noise levels.

- **Body and Hand Protection**

Loose clothing unbuttoned shirt sleeves, loose Jewellery are very dangerous in body shop. Instead wear approved shop work clothes. Trousers should be long enough to cover the top of the shoes. This will prevent sparks from going down in to the shoes. Especially when using welding equipment. The harmful effects of liquid undercoats and finishes on the hands can be prevented very effectively by wearing proper gloves. When using any body or paint shop chemicals, be sure to wash the hands with soap and water before eating or smoking.

- **Foot Protection**

Wear safety work shoes that have metal toe inserts and no slips. The inserts protect the toes from falling objects, the soles help to prevent falls. In addition, good work shoes provide support and comfort for some one who is standing for a long time.

Never wear plastic (rubber) or sandal none of this shoes provided adequate protection in a body shop.

3.2 Vehicle handling in the shop

When handling a vehicle in the shop, keep the following safety precautions in mind.

- Set the parking brake when working on the vehicle. If the car has an automatic transmission, set it in park unless instructed otherwise for a specific service operation. In the vehicle has a manual transmission, it should be in reverse (Engine off) or neutral (engine on) unless instructed otherwise fort a specific service operation.
- Use safety stands whenever a procedure requires work under the vehicle
- To prevent serious burns avoid contact with hot metal party such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Keep clothing and oneself clear from moving parts when the engine is running. Especially the radiator fan blades and belts.
- When moving a vehicle around the shop. Be sure to look in all directions and make certain noting is in the way.
- Do not smoke while working on vehicles.

3.3 Handling of solvent and other flammable liquids

- Both the body mechanic and refinisher will be working with various solvents to clean surface and equipment and to thin finishes. These solvents are extremely flammable. Fumes in particular can ignite explosively. The following safety practices will help avoid fire and explosion.
- Use only approved explosion proof equipment in hazardous locations.
- Keep all solvent containers closed, except when pouring
- Handle all solvents (or any liquids) with care to avoid spillage. Extra caution should also be used when transferring flammable materials from bulk storage.
- Discard or clean all empty solvent containers. Solvent fumes in the bottom of these containers arte prime ignition sources.

- Do not light matches or smoke in the spraying and paint area, and make sure that the hands and cloth are free from solvent when lighting matches or smoking in other areas of the shop where smoking or an open flame is permitted.
- Paints thinners solvents and other combustible materials used in the body and paint
- shop must be stored in approved and designated storage cabinets or rooms. Storage rooms should have adequate or rooms. Storage rooms should have adequate ventilation never have more than one day's supply of paint outside of approved storage areas.
  - ✓ When spraying paint follow these procedures.
  - ✓ Remove portable lamps before spraying
  - ✓ Ventilation system must be turned on
  - ✓ Spray areas must be free from hot surface such as heat lamps
  - ✓ The spray area must be kept clean of combustible residue.
  - ✓ Ventilation system must be left on while the paint is drying.
- **Fire protection**

Every auto body and paint shop requires fire extinguishers. Since fires are classified as classes there are different types of extinguishers specially designed for a particular class of fire. Fires are classified according to the type of fuel energizing the fire knowledge of the classes of fires is important since the type of fuel involved will determine the method of extinguishing the fire. Each class of fire requires a specialized action.

- ✓ **Class A Fires**

These fires result from the combustions of carbonaceous materials such as wood, textilesand papers for class A Fires extinguishers containing water, which will cool and quench the burning material, are suitable. Dry chemical Extinguishers may also be used since they provide a fire vet ardent blanket to prevent re-flash.

✓ **Class B Fires**

These fires result from materials that become gaseous when heated such as oil, grease and paints. For class B fires, carbon dioxide extinguishers are Excellent. Dry chemical Extinguishers are also useful in these fires.

✓ **Class C Fires**

Live electrical equipment is the cause of class C fires for class C fires use Ethics a carbon dioxide extinguisher (carbon dioxide is non-conductive) or a dry chemical extinguisher. Dry chemical extinguishers are called tri-class extinguishers since they can be used on class A, B and C fires.

✓ **Class D fires**

The specialized classification includes fires from comestible metals, such as magnesium, titanium, Zirconium and potassium. It should be noted that the same fire may involve more than one class as soon as the fire spreads to other materials. Also once electricity is disconnected, a class C fire becomes another class of fire.

3.4 Hazard control and hazardous materials and substances

Effective controls protect workers from workplace hazards; help avoid injuries, illnesses, and incidents; minimize or eliminate safety and health risks; and help employers provide workers with safe and healthful working conditions. The processes described in this section will help employers prevent and control hazards identified in the previous section.

To effectively control and prevent hazards, employers should:

- Involve workers, who often have the best understanding of the conditions that create hazards and insights into how they can be controlled.
- Identify and evaluate options for controlling hazards, using a "hierarchy of controls."

- Use a hazard control plan to guide the selection and implementation of controls, and implement controls according to the plan.
- Develop plans with measures to protect workers during emergencies and nonroutine activities.
- Evaluate the effectiveness of existing controls to determine whether they continue to provide protection, or whether different controls may be more effective. Review new technologies for their potential to be more protective, more reliable, or less costly.

3.5 Hierarchy of Controls

When evaluating the risks associated with specific hazards, the results of this evaluation should guide the researcher in the selection of risk management techniques including elimination, substitution, engineering controls, administrative controls, and personal protective equipment. This is known as the Hierarchy of Controls.

- **Elimination and Substitution**

The most preferred method of controlling risk is to eliminate the hazard altogether. In most cases, elimination is not feasible and when possible, substitution is the best approach to hazard mitigation. When possible, substitute less hazardous agents in place of their more hazardous counterparts. This also applies to conditions and activities.

Examples include substituting toluene(aromatic hydrocarbon) for benzene, non-lead-based paints for lead-based ones for existing traditional table saws.

- **Engineering Controls**

Engineering controls consist of a variety of methods for minimizing hazards, including process control, enclosure and isolation, and ventilation.

- Process controls involve changing the way that a job activity is performed in order to reduce risk. Examples of this include using wet methods when drilling or grinding or using temperature controls to minimize vapor generation.
- Enclosure and isolation are targeted at keeping the chemical in and the researcher out, or visa versa. Glove boxes are a good example of enclosure and isolation. Interlock systems for lasers and machinery are other good examples of isolating processes.
- The most common method for ventilation in research laboratories is localized exhaust systems. Fume hoods, snorkels, and other ventilation systems are discussed at length in the Laboratory Equipment and Engineering Controls section of this site.

- **Administrative Controls**

Administrative controls are controls which alter the way work is performed. They may consists of policies, training, standard operating procedures/guidelines, personal hygiene practices, work scheduling, etc. These controls are meant to minimize the exposure to the hazard and should only be used when the exposure cannot be completely mitigated through elimination/substitution or engineering controls.

- **Personal Protective Equipment (PPE)**

PPE should always be used as a last line of defense and is an acceptable control method when engineering or administrative controls cannot provide sufficient protection. PPE may also be used on a temporary basis while engineering controls are being developed. See the standalone PPE section of this site for more information.

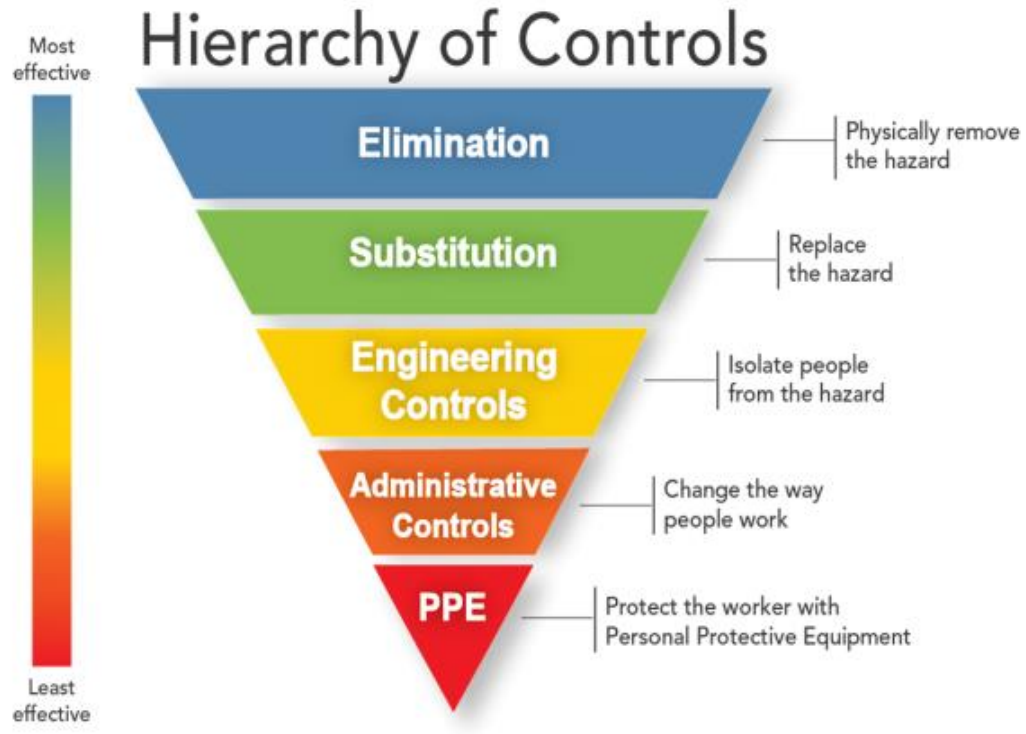


Figure 1 Hierarchy of Controls

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. Which of the following component is worn to protect against dust from sanding and grinding? (2 pts)
   a. Mask
   b. Helmet
   c. welding goggles
   d. work shoes
2. ---------- is required to prevent the possibility of eye injury from flying particles, chips, (2 pts)
   a. Ear protection
   b. Foot protection
   c. Eye protection
   d. all
3. Which of the following safety precautions you are going to keep in your mind when handling a vehicle in the shop? (2 pts)
   a. Use safety stands whenever a procedure requires work under the vehicle
   b. Keep clothing and oneself clear from moving parts when the engine is running
   c. Do not smoke while working on vehicles
   d. Al
4. A fires result from the combustions of carbonaceous materials such as wood, textile sand papers is---------- (2 pts)
   a. Class A
   b. Class B
   c. Class C
   d, Class D

Note: **Satisfactory rating – greater than/equal 4 points** **Unsatisfactory – less than 4**

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

Score = _____

Rating: _____

Information Sheet – 4 Selecting and inspecting materials quality for repairs and replacements

4.1 Material Selection

Materials selection in the automotive industry is governed by the demands emerging from customers expectations and legal requirements. The development of materials application in the near future will be determined by ecological needs like consumption reduction and used vehicle disposal and by the necessity to reduce costs.

Selection of materials is a long-standing, complex decision-making problem with potential impact on entire life cycle of a product including manufacturing, distribution, consumer use, recycling, and disposal.

Such selection is also integral to every product development/fabrication process. How a product should be made relies heavily on the nature of the materials selected. Typically, materials account for as much as 50% of the overall cost of manufactured goods and it is estimated that there are between 40,000 and 80,000 materials available today with at least 1,000 different ways to process them.

Such vast number of materials and processes and variety of requirements in the design process is the root of difficulty of the selection problem.

The problem is further compounded by rapid technological changes, increasing level of sophistication and growing volume of technical

4.2 Material selection criteria

- **Product and material shape**. Materials are available in bulk form and in standard stock geometric shapes (rod, tube, etc.) of various sizes and tolerances.
- **Economic considerations**. The common element is the cost of materials, capital equipment, and overhead (labor, energy, research and development, etc). The impact on overall product cost.
- **Business/management implications**. A decision for material and/or processes selection often influences the upper level business/management decisions and a company's profitability.

- ✓ For instance, market's demand determines the production rate which in turn affects the selection of a manufacturing process.

4.3 New or alternative materials

It is possible to divide possible alternatives to currently used materials into three categories:

- Materials already in use which can be improved and/or made cheaper through further development.
- Materials which have already been developed, but which have however not been used in automobile construction to date.
- Newly developed materials ("high-tech" materials).

Since development is a continuous process, a degree of overlap between categories is inevitable.

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. Write the three material selection criteria. (5 pts)
2. What are the three possible categories to divide alternatives to currently used materials? (5 pts)

Note:

Satisfactory rating greater than/ equal - 5 points **Unsatisfactory – less than 5 points**

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

Score = _____

Rating: _____

Information Sheet – 5 Identifying and checking hand, power tools and safety equipment

5.1 Hand Tools, power Tools, specialist Tools for composite material work

Body working tools include some very familiar general purpose metal working tools as well as specialized tools only used in auto body repair. The following is a description of the most commonly used body working tools. Because of the wide variety of hammers, files and dollies, some of the less common varieties are not discussed but the tool collection of advanced auto body repair technicians will include all the tools necessary for performing every metal shaping technique, no matter how unusual. A typical set of body working tools is shown in

- **Hammer**

A number of different hammers are useful in the body shop. Many are specially shaped for a specific metal shaping operation.

- ✓ **Ball Peen Hammers**

The ball peen hammer is a useful multipurpose tool for all kinds of work with sheet metal heavier than the body hammer, it is used for straightening bent underpinnings, smoothing heavy gauge parts, and roughly shaping body parts before work with a body hammer and dolly begins.

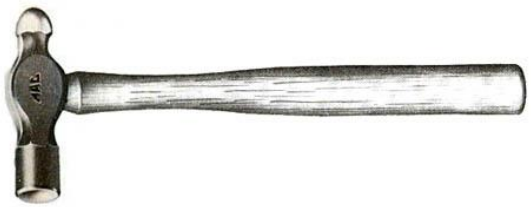


Figure 2: ball peen hammer

- ✓ **Mallets**

The rubber mallet gently bumps sheet metal without damaging the painted finish. Its most frequent use is with the suction cup on soft " cave-in " type dents. While pulling upward on the cup, the mallet is used to top lightly all around the surrounding high spots.

Figure 3: mallet

- ✓ **Sledgehammer**

A light sledgehammer is an essential tool for the first stages of re-forming damaged sheet metal. The sledgehammer can be used to knock damaged metal roughly back in to shape and to clear away damaged metal when replacing a panel.

Figure 4: sledgehammer

✓ **Body Hammers**

Body hammers are the basic tools for pounding sheet metal backs in to shape. They come in many different designs. Some have flat, square heads; some have rounded heads; and some, called picking hammers, have pointed heads. Every style is designed for a special use for which it is ideal.

✓ **Picking Hammers**

The picking hammer will take care of many small dents. The pointed end is used to hammer out small dents from the inside; a gentle tap in the centre usually does it The flat end is for hammer- and-dolly work to remove high spots and ripples. Picking hammers come in a variety of shapes and sizes. Some have long picks for reaching behind body panels. Some have sharp "pencil" points' other have blunted bullet points.

Be careful when using the pick hammer if swung forcefully, the pointed end can pierce the lighter sheet metals used in late model cars. Use the pick only on small dents.

Figure 5: Picking hammer

✓ **Bumping Hammers**

Larger dents require the use of a bumping hammer bumping hammers can have round face or a square face. The surface of the faces are nearly flat. The faces are large area. These hammers are used for initial straightening on dented panels or for working inner panels and rain forced sections that require more force but not a finish appearance.

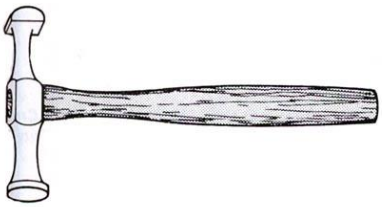
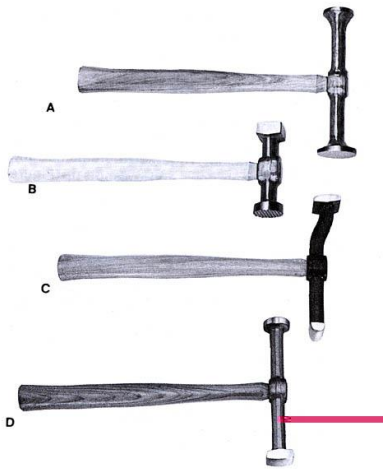


Figure 6: Bumping hammer

✓ **Finishing Hammers**



After the bumping hammer is used to remove the dent, final contour is achieved with the finishing hammer. The faces on a finishing hammer are smaller than those of the heavier bumping hammer. The surface of the face is crowned to concentrate the force on top of the ridge or high spot. A shrinking hammer is a finishing hammer with a serrated or cross- grooved face. This hammer is used to shrink spots that have been stretched by excessive hammering.

Figure 7: Finishing hammer

- **Dollies**

The dolly or dolly block is used like an anvil. It is generally held on the backside of a panel being struck with a hammer. Together the hammer and dolly work high spots down and low spots up

There are many different shapes of dollies each shape is intended for specific types of dents and body panel contours- high crowns low crowns, flanges, and others. It is very important that the dolly fits the contour of the panel. If a flat dolly or one with a low crown is used on a high crown panel, additional dents will be the result.

Figure 8: Dollies

- **Spoon**

  Body spoons are another class of bodyworking tools that are used sometimes like a hammer and sometimes like a dolly. Available in a various of shapes and sizes to match various panel shapes, the flat surface of a spoon distribute the striking over a wide area. They are particularly useful on crease and ridges. A spoon dolly can be used as a dolly where the space behind a panel is limited. A dinging spoon is used with a hammer to work down ridges Inside spoons can used to pry up low places or can be struck with a hammer to drive up dents. Bumping files have serrated surfaces and are used to slap ridges or the underside of creases to bump the metal back to its original shape.

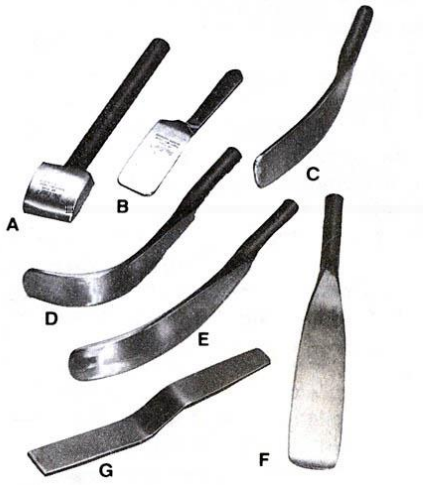
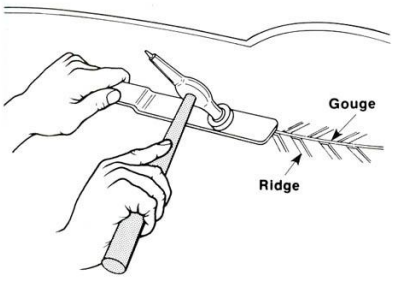


Figure 9: A)spoon dolly B)light dinging spoon C)surfacing spoon D)Inside high crown E)Inside medium crown F)inside heavy-duty spoon G)bumping file

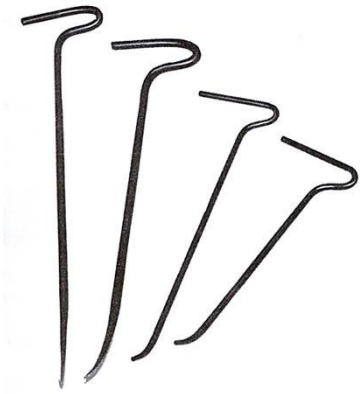
- **Lowering a ridge with a hammer and spoon**



Serrated surface and are used to slap ridges or the underside of creases to hump the metal to its original shape.

Figure 10: Lowering a ridge with a hammer and spoon

- **Picks**



Picks like spoons, are used to reach in to confined spaces. The pick is used only to pry up low spots. They very in length and shape and most have a U- shaped end that serves as a handle picks are commonly used to rise low spots in door, quarter panels, and other sealed body sections Picks are often preferred to slide hammers and pull rods because they do not require drilling holes in the sheet metal.

Figure 11: picks

- **Dent pullers and pull rods**

Creases in sealed body panels or panel sections that can not be reached from backside even with the longest spoon can be pulled out with a dent puller or pull rod. Either tool requires one or more holes drilled or punched in the crease.

A dent puller usually comes with a threaded tip and hook tip Either tip is inserted in the drilled hole and a hammer is slid on a steel shaft and struck against the handle. Tapping the slide hammer against the handle slowly pulls up the low spot

Working with a dent puller is faster when a metal piercing tip is used. When the metal tip is forced through the sheet metal, the angular rings grip the metal as the hammer is tapped against the metal. When the metal has been pulled back to shape, the tip can be backed out of the hole by turning it counter clockwise.

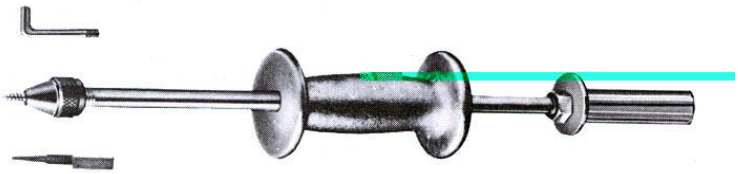


Figure 12: Dent pullers and pull rods

- **Pulling a small dent with a pull rod**

  A pull rod is used in this manner. The curved end of the pull rod is inserted in the drilled hole. A small dent or crease can be pulled up with a single pull rod Three or four pull rods can be used simultaneously to pull up larger dents A body hammer can also be used with a pull rod. The high crown of a dent can also be used with a pull rod. The low spot is pulled up simultaneous bumping and pulling returns the panel to its original shape with less danger of stretching the metal.

  It is important to close the holes created by using dent pullers and pull rods by soldering or welding. Simply patching the holes with body filler will not provided sufficient corrosion protection.

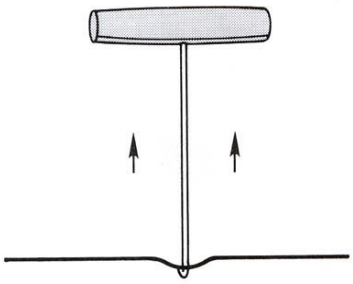


Figure 13: Pulling a small dent with a pull rod

- **Suction cup**

The suction cup is a simple tool that makes short work of shallow dents if they are not locked in by a crease in the metal. Simply attach the suction cup to the centre of the dent and pull. The dent might come right out with no damage to the paint and no refinishing required. It is an easy tool to use and can make a simple repair. However, once a dent is locked in, some hammer and dolly work will be necessary to smooth the metal. Even so, the suction cup method is usually worth a try.

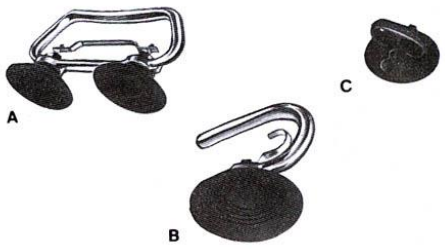


Figure 14: Suction cup

- **Punches and chisels**

A good set punches and chisels is absolutely in every body working tool chest. Centre punches are used to mark the location of parts before they are removed and for marking a spot drilling. (The punch mark keeps the drill bit from wandering.) A drifter or starter punch has a tapered point with a flat end that is used to drive out rivets, pins and bolts. A pin punch is similar to the drifter except its shaft is not tapered; thus it can be used to drive out smaller rivets or bolts. An aligning punch is a long tapered punch used to align body panels for welding or other body parts (such as fender bolt holes and a bumper).

A chisel is a steel bar with a hardened cutting edge for hearing steel. These chisels come in various sizes and a set is necessary for both light and heavy-duty work. The cold chisel is used to split frozen nuts, shear off rusted bolts, cut welds, and separate body and frame parts.

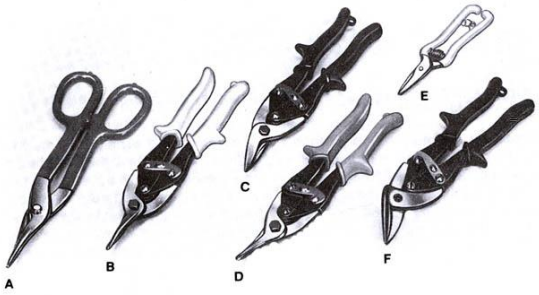
Figure 15: Punches aimd chisels

- **Scratch awl**

A scratch awl. is very similar in appearance to an ice pick, pit the pointed steel shank is heavier. A scratch awl is used to pierce holes in their metal when a specific size hole is not required. It is also used to mark metal for cutting drilling or fastening. A hammer can be used to lightly drive the awl through heavier metal. Keep the awl ground to a sharp point so it can be used effectively and safely in every job.

Figure 16: Scratch awl

- **Metal cuttting shears**



Most body repair technicians have at least one pair of shares or tin snips. Snips are used to trim panels or metal pieces to size. Several types of metal cutters are useful.

Figure 17: A. Tin snips, B. Straight cut, C. Right cut shear D. Left cut shear E. Light duty snips F. Aviation snips

✓ **Tin Snips**

Tin snips are perhaps on most common metal cutting tool. They can be used to cut straight or curved shapes in heavy steel.

✓ **Metal Cutters**

Metal cutters also called aviation snips, are used to cut through hard metals such as stainless steel. The narrow profile of jaws allows the snip to slip between the cut metal. The jaws are serrated to cut through the tough metal.

✓ **Panel Cutters**

Panel cutters are special snips used to cut through body sheet metal. These are used to make straight or curved cut outs in panels that require spot repair for rust or damage. They are designed to leave a clean, straight edge that can be easily welded.

Figure 18: Panel cutters

✓ **Rivet gun**

Pop rivets are one of the handiest inventions for auto body work. They can be inserted in to a blind hole through two pieces of metal and then drawn up with a riveting tool, locking the pieces of metal together There is no need to have access to the back of the rivets, and if enough rivets are used, the joint created is extremely strong. For any kind of sheet metal replacement such as rust hole repair, the pop rivet is by far the easiest and least expensive joining system available.

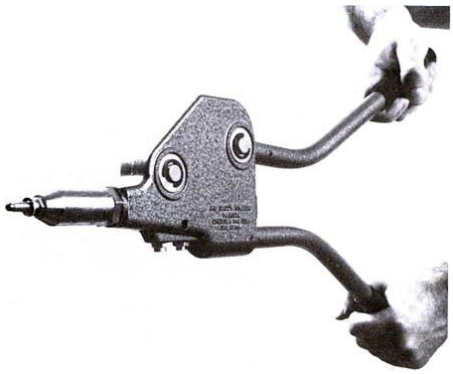


Figure 19: Rivet gun

- **Body Surfacing Tools**

A number of surfacing tools are used to give a repair its final and contour. Some are used to shape the repaired metal. Others are used to apply and shape plastic body filler and putty.

✓ **Metal Files**

After working a damaged panel back to its approximate original contour, a metal file is used to remove any remaining high spots. Two special files are necessary for most bodywork.

✓ **Reveal File**

The reveal file is a small file that is available in numerous shapes. Generally it is curved to fit tightly crowned areas such as around wind shields, wheel openings, and other panel edges. The reveal file is pulled, not pushed, when used. Pushing causes the file to chatter, resulting in nicks and an uneven surface.

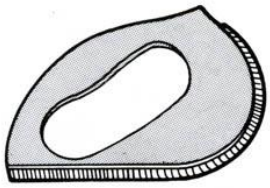


Figure 20: Reveal File

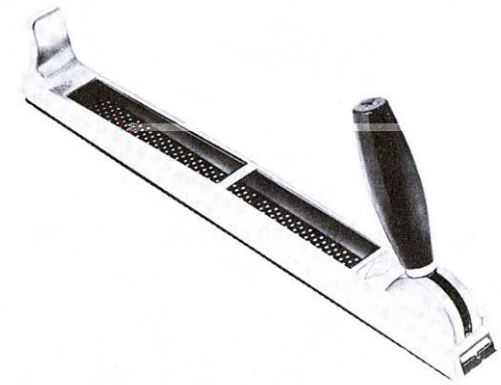
- ✓ **Body Files**

Body files are used to level large surfaces. After a dent has been bumped or pulled back in to shape, the body file will hone down high spots and reveal any low spots that might require additional bumping. Keep in mind that it is possible to file through thin metal used in some vehicles.

The blade of the body file is held in a flexible holder with a turn buckle. The turnbuckle can be adjusted to flex the file. The flexible holder allows the shape of the file to fit the contour of the panel.

Figure 21: Body Files

- ✓ **Surform File**



Body filler can be made level to the adjacent panel with a surform file Commonly refereed to as a "cheese grater," the surform file is used to shape body filler while it is semi hard. Shaping the filler before it hardness shortens the waiting period while the filler cures and reduces the sanding effort later in the repair process.

Figure 22: Surform File

Self-Check – 5	Written test

Name…… ID…… Date…….

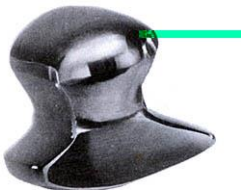
Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: choose the correct answer

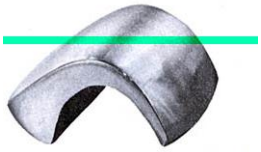
1. Which one of the following is a type of hammer that is useful for all kinds of work with sheet metal? (2 pts)
   a. Ballpeen hammer c. Picking hammer
   b. Mallet d. all
2. ---------- is used to bumps the sheet metal gently without damaging the painted finish. (2 pts)
   a. Ballpeen hammer c. Picking hammer
   b. Mallet d. all

Test II: <u>Identify the following component</u> (8pts)

1.



2.



3. 

4. 

Note: **Satisfactory rating greater than/equal - 6 points Unsatisfactory – less than 6 points**

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

Score = _____

Rating: _____

Information Sheet – 6 Determining procedures to minimize waste material

6.1 Determining waste minimizing procedure

Waste minimization is a set of processes and practices intended to reduce the amount of waste produced. By reducing or eliminating the generation of harmful and persistent wastes, waste minimization supports efforts to promote a more sustainable society.

Waste minimization involves redesigning products and processes and/or changing societal patterns of consumption and production. Waste minimization entails limiting the amount of waste that is generated thereby helping to

eliminate the production of persistent and harmful wastes effectively supporting efforts that promote a society that is sustainable. Thus, waste minimization involves a change of societal patterns that relate to production and consumption as well as redesigning products to eliminate the generation of waste.

Waste Minimization is reduction in the quantity of hazardous wastes achieved through a conscientious application of innovative or alternative procedures. Simple adjustments to a process producing wastes (e.g. a teaching lab experiment, a vehicle cleaning operation, etc.) may be the only requirement to achieve some results.

6.2 Benefits of Waste Minimization

While it is obvious that waste minimization supports sound business and economic practices

in addition to protecting the environment, other benefits include the following:

- Improved product quality New technological practices and innovation will not only reduce generation of waste but also contribute to improved input quality that translates to improved products.
- Economic benefits Efficiency in product use translates to reduced costs when purchasing materials thus significantly affecting financial performance.
- Efficiency of production practices – Waste minimization will attain more output of the product for every part of raw material.

- Environmental responsibility eliminating or minimizing generation of waste will make it easy for you to achieve environmental policies, standards and regulations.
- Public image Embracing waste minimization will boost the reputation of your company, as it is a reflection of proactive movement in the quest to protect the environment.

6.3 R's of Waste Minimization

Waste minimization revolves around three R's as follows:

- **Reduce**

This calls for using resources that are just enough to cater to your needs for instance building a smaller house. This is an effective way of conserving resources as it also lowers the costs. This can be achieved through attaining accuracy when ordering to ensure that there is no waste or no material is sitting on the site for long periods that it is damaged.

- **Reuse**

Here, you will do well to reuse existing materials and buildings effectively reducing the need for resources while lowering waste volumes and saving money. A huge percentage of resources are incorporated in the construction of homes owing to the mixed materials that are used yet the end destination for most of them are landfills. Thus, renovating a house is a much better option than bringing it down to put up another one because a negligible fraction of the old house may be reused/recycled.

- **Recycle**

Using left over resources or those resources that have reached the end of their life minimizes the need for new materials as well as lowers the volume that ends up in landfills. Thus, it is advisable to use materials that are recyclable as this creates a market for the resources that are recycled while also raising the price that recyclers pay for resources that are recovered even as the recycling viability increases.

6.4 Waste Minimization Techniques

1. Optimization of resources

In order to reduce the quantity of waste that is produced by individuals or organizations calls for the optimization of raw materials used in production. For instance, a dressmaker will do well to arrange the pieces of pattern in a certain way along the length of the fabric to use a small portion of the fabric.

2. Scrap metal reuse

Incorporating scraps into the initial stages of manufacturing is a surefire way of ensuring that they do not end up in landfills as waste products. A majority of industries embrace this process effectively returning rolls that are damaged to the initial production line and in the manufacturing of off cuts, plastic items so that scrap is re-incorporated in the new commodities.

3. Quality control improvement and process monitoring

Measures can be put in place to control the number of rejects and ensure it is at a minimum. This may be achieved through increased frequency of inspection as well as increasing the number of inspection points. For instance, installation of continuous monitoring device that is automated will help in identifying production problems before they get to an advanced stage.

4. Exchange of Waste

Here, the waste products from one process are used as raw materials for other processes. Exchange of waste is another means of minimizing waste disposal volumes especially for waste that may not be eliminated.

5. Shipping to the point of use

Here, raw materials as well as other components are directly delivered at the point of assembly or manufacturing plant ostensibly to minimize handling and use of enclosures and protective wrappings.

6. Zero waste

This systems approach is designed to eliminate waste from the source as well as at every point of the supply chain to ensure that no waste is produced. This design

philosophy places emphasis on waste prevention and not waste management at the end of production line.

6.5 Waste Minimization for Households

Households can practice waste minimization by employing various techniques. One of the ways to achieve this is through purchasing adequate sizes and amounts of food. Purchasing large containers of paint when taking small decorating jobs or purchasing large volumes of food than you need will result in wastage. In instances where cans or packs may be thrown the remains of the containers should be removed to allow for recycling of the container.

Home composting, thoughtful use of electricity as well as reducing the number of car journeys is also a great way of waste minimization. G enerally, buying fewer products or products that last longer, mending worn or broken equipment or clothing can also minimize household waste. Additionally, households can also minimize wastage of water and cycle or walk to various destinations as opposed to using cars thereby saving on fuel. Overall, personal waste reduction will have an effect on the general waste volumes. Consumers may also shun products without eco-labeling.

Self-Check – 6	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. What is Waste minimization? (2 pts)
2. Explain the benefits of Waste Minimization. (2 pts)
3. What are R's of Waste Minimization? (2 pts)
4. List at least four Waste Minimization Techniques(4 pts)

Note: **Satisfactory rating greater than/equal - 5 points Unsatisfactory – less than 5 points**

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

Score = _____

Rating: _____

Information Sheet – 7 Identifying procedures to maximizing energy efficiency

7.1 Energy Efficiency

Energy efficiency is a resource that can be acquired to help utilities meet current and future energy demand. To realize this potential requires leadership at multiple levels, organizational alignment, and an understanding of the nature and extent of the energy efficiency resource.

- Leadership at multiple levels is needed to establish the business case for energy efficiency, educate key stake- holders, and enact policy changes that increase investment in energy efficiency as a resource. Sustained leadership is needed from:
  - ✓ Key individuals in upper management at the utility who understand that energy efficiency is a resource alternative that can help manage risk, minimize longterm costs, and satisfy customers.
  - ✓ State agencies, regulatory commissions, local governments and associated legislative bodies, and/or consumer advocates that expect to see energy efficiency considered as part of comprehensive utility management.
  - ✓ Strong support from upper management and one or more internal champions.
  - ✓ A framework appropriate to the organization that supports large-scale implementation of energy efficiency programs.
  - ✓ Clear, well-communicated program goals that are tied to organizational goals and possibly compensation.
  - ✓ Adequate staff resources to get the job done.
  - ✓ A commitment to continually improve business processes.
- Understanding of the efficiency resource is necessary to create a credible business case for energy efficiency.

7.2 Best practices on Energy Efficiency

- ✓ Conduct a “potential study” prior to starting programs to inform and shape program and portfolio design.
- ✓ Outline what can be accomplished at what costs.
- ✓ Review measures for all customer classes including those appropriate for hard-to-reach customers, such as low income and very small business customers.

Self-Check – 7	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 Energy efficiency? (5 pts)
2. Write the Best practices on Energy Efficiency. (5 pts)

Note: **Satisfactory rating greater than/equal - 5 points** **Unsatisfactory – less than 5 points**

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

Score = _____

Rating: _____

Operation Sheet 1– preparing tools and equipment for work

Objectives of conducting pre-start check of tools, equipment and machinery;

- To know all the tools, equipment and machine functional and sufficient enough
- To know tools, equipment and machine which needs maintenance

Procedures to undertak a pre check on your tools and equipments before you *start* work.

Step 1: Select, fit and use personal protective clothing and/or equipment

Step 2: Inspecting equipment condition for wear;

Step 3 - Visual inspections of important features prior to starting the work.

Step 4: Visual & function tests while the machine is turned on but stationary

Step 5: Maintain work area to meet housekeeping standards

Step 6: Clean tools equipment and machinery

Step 7: Turn tools equipment and machinery in to their storing area

Step 8: Make record and report to your supervisors

LAP TEST	Performance Test

Name…… ID……Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** hour. The project is expected from each student to do it.

Task 1: prepare tools and equipment for work

LG #37	LO #2- Carry out repair procedures

Instruction sheet

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

- Accessing and interpreting information from manufacturer specifications
- Identifying terms to be repair
- Identifying methods of repair
- Preparing equipment, tools and materials for use
- Carrying out repair procedures in accordance with enterprise procedures
- Completing repair procedures without causing damage to equipment or machinery
- Carrying out all activities according to industry regulations/guidelines, ohs legislation, and enterprise procedures/policies
- Checking repairs based on specification and completing records

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**:

- Access and interpret information from manufacturer specifications
- Identify terms to be repair
- Identify methods of repair
- Prepar equipment, tools and materials for use
- Carry out repair procedures in accordance with enterprise procedures
- Complete repair procedures without causing damage to equipment or machinery
- Carry out all activities according to industry regulations/guidelines, ohs legislation, and enterprise procedures/policies
- Check repairs based on specification and completing records

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 Accessing and interpreting information from manufacturer specifications

1.1 Introduction to Composite materials

A composite material is a combination of two materials, with its own distinctive properties. Its strength or other desirable quality is better or very different from either of its components working alone. The principal attraction of composite materials is that they are lighter, stiffer and stronger than most other structural materials. They were deve loped to meet the severe demands of supersonic flight, space exploration and deep water applications, but are now used in general engineering including automotive applications.

The automotive composite materials, reinforced plastics and polymers are among widely preferred alternatives for light weighting of the automobile as they offer enhanced properties such as impact strength, easy mold–ability, improved aesthetics, and reduced weight as compared to conventional automotive components. The main advantages, which offer opportunities in the automotive industry, are their potential for maximum mass reduction of automobile and carbon emission reduction potential by light weighting of the vehicle. The factors restraining the market are high material costs and huge investments in material research activities by companies.

The automotive industry is under increasing pressure to meet higher fuel efficiency, environmental and performance demands at competitive costs. All material industries plastics and polymer composites, as well as steel, aluminum, and magnesium, are operating to respond to the automotive industry changing needs. For decades, advanced plastics and polymer composites have helped the improvement of appearance, functionality, and safety of automobiles while reducing vehicle weight and delivering superior value to customers at the same time.

The automotive sector is under constant pressure to reduce carbon emissions and bring down fuel consumption by reducing the weight of vehicles, with an increase in safety requirements. The underlying reason for this is the need for lower weight,

different types of materials, as well a stricter environmental legislation and related traffic regulations.

1.2Types of composite materials

Composite materials are commonly classified at following two distinct levels:

- The first level of classification is usually made with respect to the matrix constituent. The major composite classes include Organic Matrix Composites (OMCs), Metal Matrix Composites (MMCs) and Ceramic Matrix Composites (CMCs). The term organic matrix composite is generally assumed to include two classes of composites, namely Polymer Matrix Composites (PMCs) and carbon matrixcomposites commonly referred to as carboncarbon composites.
- The second level of classification refers to the reinforcement form - fibre reinforced composites, laminar composites and particulate composites. Fibre Reinforced composites (FRP) can be further divided into those containing discontinuous or continuous fibres.
- Fibre Reinforced Composites are composed of fibres embedded in matrix material. Such a composite is considered to be a discontinuous fibre or short fibre composite if its properties ary with fibre length. On the other hand, when the length of the fibre is such that any further increase in length does not further increase, the elastic modulus of the composite, the composite is considered to be continuous fibre reinforced. Fibres are small in diameter and when pushed axially, they bend easily although they have very good tensile properties. These fibres must be supported to keep individual fibres from bending and buckling.
- Laminar Composites are composed of layers of materials held together by matrix. Sandwich structures fall under this category.
- Particulate Compositesare composed of particles distributed or embedded in a matrix body. The particles may be flakes or in powder form. Concrete and wood particle boards are examples of this category.

1.3Advantages and Limitations of Composites Materials

1.3.1 Advantages of Composites

Summary of the advantages exhibited by composite materials, which are of significant use in aerospace industry are as follows:

- High resistance to fatigue and corrosion degradation.
- High ‘strength or stiffness to weight’ ratio. Weight savings are significant ranging from 25-45% of the weight of conventional metallic designs.
- Due to greaterreliability, there are fewer inspections and structural repairs.
- Fibre to fibre redundant load path.
- Improved dent resistance is normally achieved. Composite panels do not sustain damage as easily as thin gage sheet metals.
- It is easier to achieve smooth aerodynamic profilesfor drag reduction. Complex double-curvature parts with a smooth surface finish can be made in one manufacturing operation.
- Composites offer improved torsional stiffness.
- High resistance to impact damage.
- Thermoplastics have rapid process cycles, making them attractive for high volume commercial applications that traditionally have been the domain of sheet metals. Moreover, thermoplastics can also be reformed.
- Composites are dimensionally stable i.e. they have low thermal conductivity and low coefficient of thermal expansion.
- Manufacture and assembly are simplified because of part integration (joint/fastener reduction) thereby reducing cost.
- Close tolerances can be achieved without machining.
- Material is reduced because composite parts and structures are frequently built to shape rather than machined to the required configuration, as is common with metals.
- Excellent heat sink properties of composites, especially Carbon-Carbon, combined with their lightweight have extended their use for aircraft brakes.

- Improved friction and wear properties.
- The ability to tailor the basic material properties of a Laminate has allowed new approaches to the design of aeroelastic flight structures.

1.3.2 Limitations of Composites

Some of the associated disadvantages of advanced composites are as follows:

- High cost of raw materials and fabrication.
- Composites are more brittle than wrought metals and thus are more easily damaged.
- Transverse properties may be weak.
- Matrix is weak, therefore, low toughness.
- Reuse and disposal may be difficult.
- Difficult to attach.
- Repair introduces new problems, for the following reasons:
  - ✓ Materials require refrigerated transport and storage and have limited shelf life.
  - ✓ Hot curing is necessary in many cases requiring special tooling.
  - ✓ Hot or cold curing takes time.
  - ✓ Analysis is difficult.
  - ✓ Matrix is subject to environmental degradation.

1.4Materials in the Automotive Industry an Overview

Since materials play a decisive role with regard to both the quality and cost of a car, selection of the correct materials at the earliest possible stage of the development process is of vital importance.

The materials used in vehicles nowadays are selected so as to optimally fulfill the specific requirements. It is the job of the materials engineer in a car-manufacturing company to ensure that this optimum will be reached. However, the corporation, itself, must decide what "optimal" actually means in practice. As well as considering the general economic framework, external influences such as the customers selected as the target group, and legal requirements and regulations are particularly relevant here.

Various materials are used to make cars. The main materials used for making cars, parts and components, along with future trends, are steel, aluminum, magnesium, copper, plastics and carbon fiber. The main factors for selecting the material, especially for the automobile body, are numerous and include thermal, chemical or mechanical resistance, easy manufacturing and durability. Affordability is an important issue in vehicle manufacturing, which includes factoring in the costs associated with a car's complete life–cycle, including manufacturing, operating and disposal costs. Composite materials may have big advantages over steel in automobile manufacturing in the future. Composites are considered to make lighter, safer and more fuel efficient vehicles. A composite is composed of high–performance fiber (such as carbon or glass) in a matrix material (epoxy polymer) that, when combined, provides enhanced properties compared with the individual.

Titanium has been mainly used in high temperatures zones, and high strength requirement areas, such as exhaust systems, suspension springs, valve springs, valves and connecting rods. Fiber reinforced composites offer a wide range of advantages to the automotive industry. It is because the composite structures are the high strength/low weight ratio. Carbon fiber–reinforced or fiber glass reinforced composites offer numerous new design possibilities for structural components in cars. These advanced materials are not only light in weight, but also stiff, strong and durable. The future lightweight materials will be used in the automobile industry.

Now, carbon fiber is very expensive, but the automobile industry has been developing affordable carbon fiber, so the future cars will be lighter. Fiber reinforced composites are now being used to make structural and nonstructural components such as seat structures, bumpers, hoods, and fuel tanks.

1.5 The Development of New Automotive Materials and Components

The producers in the automotive industry are expressing more and more interest in the industrial applications of light, strong and thus energy efficient and cleaner solutions, such as composites. This requires innovations in materials, design, production, processing and process automation and, above all, cost effectiveness. The traditional production processes for cars are still focused mainly on the processing of metal chassis and other components. Although plastics are extensively used, the deployment of fiber reinforced composites for high volumes of cars is still in the pioneering phase.

To develop new automotive materials, components, and systems in the most effective way, the completely automotive supply chain needs to work together. Composite materials, reinforced plastics and polymers come up with improved material qualities that make them suitable for use in interior, exterior, and under bonnet components of automobiles. The automotive composite materials are used in various automotive components such as bumpers, seating, dashboards, internal and external trims. The careful selection of these automotive materials enables designers to improve durability meet load–bearing requirements, and achieve reduction in vehicle weight.

1.6 Materials for new applications in automobile manufacture

The potential for applying light-weight materials in automobile manufacture has increased, partly due to the demand for reduced consumption and therefore for light-weight construction, and partly thanks to improved and consequently more economical production techniques. Al- and Mg-alloys have already been considered above. The mechanical properties of titanium are excellent in relation to its weight but its high price restricts its use to special applications such as connecting rods for racing engines.

Plastics are widely used in vehicles and still have a high potential for application in automotive engineering. Apart from the major reason, i.e. weight saving, one essential advantage is the opportunity to design highly complex component shapes. This allows optimum utilization of the increasingly restricted space for components in modem cars.

Further use of plastics is currently hindered by open questions regarding used vehicle disposal and recycling.

Fibre-reinforced plastics can also be used in components subjected to high stresses. an FRP leaf spring, which replaces steel leaf springs, reducing the weight of the spring by 60% and which has passed the required tests for commercial vehicles.

Even carbon fibre-reinforced plastics with strengths higher than steels, which are by far too expensive for mass-production components, can be used economically in special parts with a limited production.

The expected trends for the further application of polymer materials in automotive engineering are as follows:

- use of recycled polymers
- reduction in the number of types of plastics
- replacing composite materials by
  - ✓ single-material systems
  - ✓ compatible material systems
- plastics with minimum quality loss during recycling
- multifunctional components

1.7 Safety precautions

- You are likely to get a localised rash up your arms and hands if you handle the mat with no precautions.
- If you are allergic, do not continue. Get someone else to do the job as the allergy can cause severe swelling, rashes and can be extremely painful.
- Coverup your arms when cutting or handling mat and use washing-up gloves of necessary.
- Resins normally give people no problems, apart from the smell which may upset you. Always give yourself good ventilation when doing a job since the heavy vapour given off (styrene) can cause headaches and even unconsciousness if you are exposed to it for too long. If you ever feel drowsiness coming on get out immediately into the fresh air.

- The warning signs for resins are an itchy nose and running eyes. When you reach this stage stop and recover.
- When grinding, cutting or sawing a laminate you must always wear a mask and goggles and always grind outside, never in a garage etc., as very fine pure glass particles are thrown everywhere and once they are inhaled the body doesn't get rid of them.

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: choose the correct Answer Questions

1. One of the following is the advantages of composite materials (2pts)
   a. High resistance to fatigue and corrosion degradation
   b. Composites offer improved torsional stiffness
   c. High resistance to impact damage
   d. All
2. Which of the following is the disadvantages of composites material (2pts)
   a. High cost of raw materials and fabrication c. Matrix is weak
   b. more brittle than wrought metals d. all

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

1. A composite material is a combination of two materials, with its own distinctive properties (2 pts)
2. composite materials are used as an alternatives for light weighting of the automobile as they offer enhanced properties. (2 pts)

Note: **Satisfactory rating greater than/equal - 4 points Unsatisfactory – less than 4 points**

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

Score = _____

Rating: _____

Information Sheet - 2 Identifying terms to be repair

2.1 Monitoring variation of equipment

Damage to composite components is not always visible to the naked eye and the extent of damage is best determined for structural components by suitable NonDestructive Test (NDT) methods.

Alternatively the damaged areas can be located by simply tapping the composite surface and listening to the sound. Thedamaged areas give a dull response to the tapping, and theboundary between the good and damaged composite can easily be mapped to identify the area for repair.

Awareness of and inspection for composite damage should be included in the regular maintenance schedules for composite structures. Particular attention would be made to areas which are more prone to damage.

2.2 Stages of composite repair

- **Damage assessment**

Some damage to composites is obvious and easily assessed but in some cases the damage may first appear quite small, although the real damage is very much greater. Impact damage to a fibre can appear as a small dent on the reinforced composite surface but the underlying damage can be much more extensive.

The decision to repair or scrap is determined by considering the extent of repair needed to replace the original structural performance of the composite. Other considerations are the repair costs, the position and accessibility of the damage and the availability of suitable repair materials.

- **Repair type**
  - ✓ **Easy repairs** are usually small or do not effect the structural integrity of the component. These repairs are made by following the simple guidelines indicated for laminate or sandwich panels (see repair sections).
  - ✓ **Complex repairs** are needed when the damage is extensive and needs to replace the structural performance of the component. The best choice of

materials would be to use the original fibres, fabrics and matrix resin. Any alternative would need careful consideration of the service environment of the repaired composite, i.e. hot, wet and mechanical performance. The proposed repair scheme should meet all the original design requirements for the structure.

- **Temporary repair**

When a composite repair is needed for components in use. Some repairs need the specialist equipment of the workshop and some form of improvised repair is needed to return the component to a suitable repair workshop. A temporary repair, usually in the form of a patch, can be fixed to the component. Usually a 'belt and braces' approach is taken to ensure safety until the component can be repaired at a later date.

- **Permanent repair**

The approved general guidelines for laminate and sandwich repairs should be followed. These repair operations should be carried out in controlled workshop areas to ensure high quality repairs. Good housekeeping and attention to repair detail will ensure success.

- **Quality Check**

For comprehensive inspection of repaired parts a number of Non Destructive Tests (NDT) can be used. The inspector should examine the quality of the repaired area and particular attention should be given to the interface between the original part and the repaired area. Usual inspection methods use some form of ultrasonic test equipment where the reflection of the ultrasonic sound waves detect and identify any damaged areas or faults.

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. Damage to composite components is not always visible to the naked eye. (2pts)
2. Easy repairs are needed when the damage is extensive and needs to replace the structural performance of the component (2pts)
3. Complex repairs are usually small or do not effect the structural integrity of the component. (2pts)

Note: **Satisfactory rating greater than/equal - 3 points** **Unsatisfactory – less than 3 points**

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

Score = _____

Rating: _____

Information Sheet - 3 Identifying methods of repair

3.1 methods of composite repair

When a composite structure sustains damage in service one of three levels of repair must be employed.

3.1.1 Cosmetic repair

In this case inspection has determined that the damage has not affected the structural integrity of the component. A cosmetic repair is carried out to protect and decorate the surface. This will not involve the use of reinforcing materials.

3.1.2 Temporary or interim repairs

It is often the case in service, that small areas of damage are detected which in themselves do not threaten the integrity or mechanical properties of the component as a whole. However if left unrepaired they may lead to further rapid propagation of the damage through moisture ingress and fatigue.

Simple patch type repairs can be carried out, with the minimum of preparation, to protect the component until it can be taken out of service for a proper structural repair.

Temporary repairs should be subject to regular inspection.

3.1.3 Structural repair

If the damage has weakened the structure through fibre fracture, delamination or disbonding the repair will involve replacement of the damaged fibre reinforcement, and core in sandwich structures, to restore the original mechanical properties. Since a bonded-on repair constitutes a discontinuity of the original plies, and therefore a stress raiser, structural repair schemes normally require extra plies to be provided in the repair area.

If the damaged area is very small it can be questionable whether a structural repair, requiring removal of a substantial amount of the structure in damage removal and preparation, is preferable to a cosmetic repair.

3.2 Role and Selection of fibers

The points to be noted in selecting the reinforcements include compatibility with matrix material, thermal stability, density, melting temperature etc. The efficiency of discontinuously reinforced composites is dependent on tensile strength and density of reinforcing phases.

The compatibility, density, chemical and thermal stability of the reinforcement with matrix material is important for material fabrication as well as end application. The thermal discord strain between the matrix and reinforcement is an important parameter for composites used in thermal cycling application. It is a function of difference between the coefficients of thermal expansionof the matrix and reinforcement. The manufacturing process selected and the reinforcement affects the crystal structure.

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: choose the correct answer

1. One of composite repair is not employed in damage service. (2pts)

   a. Cosmetics repair
   b. Structural repair
   c. Temporary or interim repairs
   d. all

2. There are some points to be noted in selecting the reinforcements include, (2pts)

   a. thermal stability
   b. melting temperature
   c. density
   d. all

3. a type of composite repair carried out to protect and decorate the surface. (2pts)

   a. Structural repair
   b. Cosmetics repair
   c. Temporary or interim repairs
   d. all

Note: **Satisfactory rating greater than/equal - 3 points** **Unsatisfactory – less than 3 points**

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

Score = _____

Rating: _____

Information Sheet - 4 Preparing equipment, tools and materials for use

4.1 Equipment, tools and materials used for body repair

Technicians carry out complex repair and refinishing jobs, removing dents and repainting delicate surfaces. Professional standard tools can be the difference between a straightforward job and one that causes constant headaches.

A good auto body shop needs to be equipped with a number of important hand tools, power tools, and automated equipment to make sure repair experts can handle any job. Some such tools can include air compressors, caulking irons, and files. However, there are a few that are more crucial than others. What should students pursuing auto body careers make sure to have in their toolboxes? These are just some of the most invaluable tools you'll use during your career.

The auto repair world boasts a plethora of gadgets and tools that are essential for varying jobs. While you don't need to be an expert with each one, it does help to know the basics like the back of your hand. Whether you are considering going to school to start a new career or you are just tinkering around in your own garage, you'll certainly find a use for these 8 auto body repair tools.

1. Dual Action Air Sander– This quick-hitting tool drastically cuts down your time spent on sanding and body fill.

2. Grinder– If you're exploring body kit fabrication or custom work, you will need a grinder along with some attachments. Depending on how you outfit it, this could be a method to remove rust or an entire mirror.

3. Block Sander– Every good auto tech will have a block sander on hand even if he also has a fast-acting air sander. They are needed for color sanding and buffing, shaping body filler, cutting high spots and finding low spots.

4. Body Hammer and Dolly– You will need this collaborative set of auto body repair tools to fix the body work of a car. While the hammer does the heavy lifting and physical

shaping, the dolly holds the shape and directs the metal where to go when it is being manipulated by the hammer.

5. Air Paint Spray Gun– Like most tools, these vary in quality. For an even coat, look for one that atomizes correctly.

6. Putty knives– Putty knives or body fill spreaders are used to mix body filler, which is also known as Bondo. They come in both metal and plastic, but metal is more durable and easier to clean.

7. Suction Cup Dent Pullers– A handy tool for a quick fix, the suction cup removes surface dents with a suction force that pulls the metal to a convex position.

8. Stud Welder Dent Pullers – Similar to a screw-in dent puller, but won't leave holes that need to be filled. This tool spot-welds a stud in place to pull the dent; after the dent is pulled, the stud is snapped off and the area is ground down.

Figure 23: Essential vehicle body repair tools

4.2How to Make Repairs Using Fiberglass

Although many car parts are created using fiberglass, it will crack over time and need repairs. If you want to do body work on small areas using a patch method for cosmetic reasons, start off by sanding the surface with a heavy grit sandpaper to create a mechanical bond. Next, remove any dirt and grease by wiping the surface with acetone or a similar solvent. Lay your fiberglass piece a top of the area that needs repairing, allowing for overlap. After this, apply the necessary amount of resin with a brush, removing any excess resin and air bubbles with a squeegee. Once the resin has dried, repeat the previous steps as necessary or simply sand and polish the fiberglass to make it smooth. Finally re-wipe using acetone or a similar solvent. Once this has been completed, paint the surface as necessary.

However, if you would like to do fiberglass body work yourself, start off by prepping the surface where the fiberglass will be bonded, similar to the prep method above. To make a repair using filler, mix the filler with hardener and apply it to the area that needs to be repaired. Fill in the area until it is as smooth as possible. Once it has dried, sand the surface with a coarser grits, minimizing the grit as the surface becomes smoother. Use spot putty on blemishes and allow it to cure before continuing to sand. Lastly, wipe down the surface with solvent and paint as necessary.

Making repairs using fiberglass isn't complicated, however it does take a lot of time and patience. Set aside enough time to make the proper improvements and with enough practice you'll be working with fiberglass with ease.

4.3 Inspect and Measure, Identify, and Determine:

4.3.1 How to inspect damaged composites

There are four main categories for composite damage, your repair may involve one or all of these categories depending upon the severity of the impact or failure. The categories are as follows:

- **Tear** — This damage results when the tensile strength of the composite part has been exceeded and the laminate has failed. This typically results in a fracture which extends completely through the substrate.
- **Hole or Puncture** — This damage is typically a result of an impact or cutting. Holes and punctures are sometimes limited to surfacing layers or skins.
- **Crushed Core** — This damage applies only to composite parts containing sandwich core materials. It is typically the result of an impact which forces the composite skin of the laminate to deflect—but not fail—causing the sandwich core material to collapse.
- **Delamination** — This damage results in layers of the material separating from each other. It is typically caused by impact or stress between or across the layers.

4.3.2 How to measure the scope of your composite repair

Once you understand what type of damage you have, we recommend that you use a contrasting marker to outline the boundary of the damage. This will help you to understand the scope and magnitude of the damage, as well as offer you the chance to fully inspect your part. Take note, however, that you should inspect the damage carefully as the problem area often extends farther than can be easily detected visually. One inspection tip we can offer is the coin tap test. By tapping a coin around the surrounding area, you can quickly and easily generate an audible difference between a solid laminate, a crushed material, and a potentially delaminated area.

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: Choose the correct answer (10 pts)

1. Grinder is a quick-hitting tool drastically cuts down your time spent on sanding and body fill.
2. Dolly holds the shape and directs the metal where to go when it is being manipulated by the hammer.
3. Putty knives or body fill spreaders are used to mix body filler
4. Tear is a damage results when the tensile strength of the composite part has been exceeded and the laminate has failed.
5. Hole or Puncture is a damage typically a result of an impact or cutting

Note: **Satisfactory rating greater than/equal - 5 points Unsatisfactory – less than 5 points**

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

Score = _____

Rating: _____

Information Sheet - 5 Carrying out repair procedures in accordance with enterprise procedures

5.1 Carryout Fibreglass repair

Fibre glass repair is used across several sectors and vehicles, from train carriages to cars and everything in between.

- Remove damaged components
- Repair and rebuild components
- Plate and fasten in position
- Shape and profile fibreglass
- Prime and paint surfaces

Each and every operation is treated with the utmost care to ensure the structural integrity of your vehicle. This work ethic combined with our highly trained teams makes us the premier supplier of fibre glass repair.

To keep up with this demand we are only as good as our suppliers and we maintain these relationships to ensure we have the part or paint for every job.

5.2 Deciding Repair or Replace

Some automakers using carbon fiber have decided that if body panels are damaged beyond the point of a “cosmetic” repair, they should be replaced rather than repaired. The difference is whether the body panel is painted or not.

While it’s possible to repair a painted carbon fiber body panel and get a “Class A” finish once repainted, that’s not possible on an unpainted carbon fiber panel – the repair will always be visible. However, the same can be said for repaired aluminum body panels that are left unpainted.

5.3 Working With Fiberglass for Car Repair

Auto-body repair shops often use fiberglass for repairs because it will bond to metal and offer a long-lasting, durable repair. Fiberglass is applied in layers of reinforced fiberglass material that's saturated with a catalyzed resin mixture. Fiberglass is easy to work with and very inexpensive to use as a repair material.

Step 1- Put on your safety glasses and grind the damaged area smooth using a dye grinder. For any cracks or fractures, grind directly on the crack, removing any rough or damaged material. Scuff the entire surface that will get fiberglass applied to it.

Step 2- Clean the surface of the affected area using a rag and acetone to remove any dirt or grease. This is crucial for a solid bond.

Step 3 - Tear the fiberglass mat to size so it covers the damaged area. Tear the number of layers needed to bring the damaged area level with the surrounding surface. Tearing instead of cutting fiberglass mat eliminates visible edge lines on repair patches.

Step 4 - Add catalyst to a small bucket of resin following the recommendations on the container. Thoroughly stir the catalyst into the resin using a stir stick.

Step 5 - Wet the surface of the repair with the resin using a 4-inch felt roller. Apply the first layer of mat and saturate it with resin using the felt roller. When the entire layer is full of resin, roll out any air bubbles using an air roller. Repeat this process for each layer of mat until the repair is complete. Let the fiberglass harden.

Sand the fiberglass repair using 100-grit sandpaper on a sanding block until it's smooth and level with the surrounding surface.

Self-Check – 5	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. Explain why auto-body repair shops use fiberglass for repairs? (10 pts)

Note: **Satisfactory rating greater than/equal - 5 points** **Unsatisfactory – less than 5 points**

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

Score = _____

Rating: _____

Information Sheet - 6 Repair procedures without causing damage to equipment or machinery

6.1 Carbon fiber Repair Step by Step procedures

Repairs to carbon fiber structures follow a predictable set of steps, although the complexity of the damage can change the number of individual steps needed. The following example assumes a simple repair to a set of delaminated outer plies on a structural surface with no actual puncture or through-hole damage, and no damage to underlying honey comb or foam core.

Step 1 – Remove body panels and other items to gain access to the repair area, for at least one extra foot all around the visible damage if possible. It will be helpful if backside access to the damaged area is available.

Step 2 – Inspect the damage to determine its actual size. Carbon fiber is a brittle material. While it may be crushed in, it will not bend and stay bent like metals. The actual damaged area – including cracks in the resin, delaminations between layers, etc. The extent of the “hidden damage” is very important to know and will determine the size of the eventual repair.

Determining the size of the hidden damage is usually performed by “tap testing” using a simple small lightweight tap hammer or even a quarter. An undamaged area, when lightly tapped, should have a sharp, almost metallic ring tone. A damaged area will have a duller “thud” sound.

Tap in an organized pattern around the visible damage, every inch or so, marking the area where the tone just begins to change from a sharp rap to a dull thud. A silver Sharpie felt tip pen works well for marking out the area of damage, which may be significantly larger than the visible damage.

Note: Other methods of non-destructive inspection utilizing ultrasonic phased array, thermography or other techniques may be required for determining damage in thicker laminates or for larger, more complex damage repairs not covered in this article.

Step 3 – Thoroughly clean the area to be repaired using clean rags and isopropyl alcohol or acetone, removing any dirt, grease, oil, road grime, etc. Remove the damaged cloth layers (plies) using a die grinder with 80 grit or finer sanding discs. All damaged, crushed fibers or delaminated plies of cloth, etc., must be removed down to the original undamaged materials.

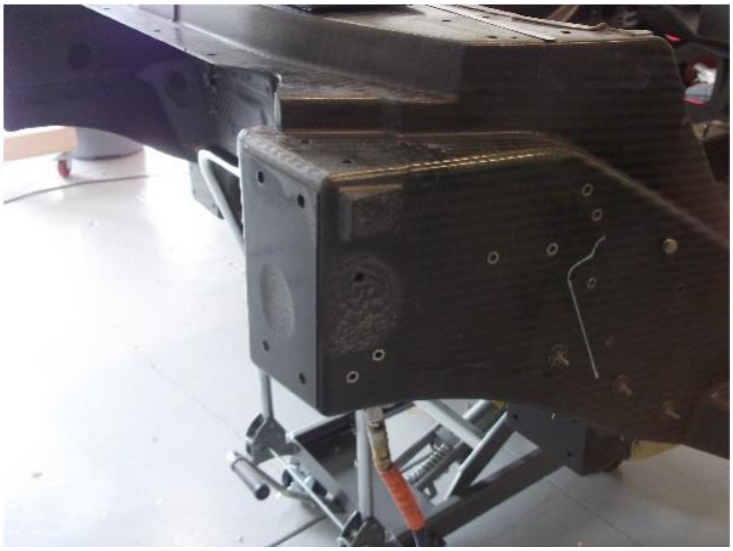


Figure 24: An example of a scarfed repair that involves taper sanding.

Step 4 – Taper sand (often called scarfing) back from the middle of the damage removal area. Scarfing technique, like much bodywork, is a muscle “motor skill” that needs practice, but it’s not really difficult, and practicing on scrap panels is pretty easy to do. One hour or so of practice is all that’s needed for most people. Appropriate personal protective equipment such as a good quality N95-rated dust mask and eye protection are needed for taper sanding.

Step 5 – Clean the scarfed surface as before, removing all dust and grit. Trace the outlines of the visible edges of each ply in the scarfed area, ply by ply, on a thin sheet of clear plastic with a Sharpie pen. You will use these tracing templates for the layout of the repair plies.

Important: Mark the ply orientation (direction) of the fibers on each template.

Step 6 – Obtain a piece of carbon fiber cloth large enough to cut all of the required repair plies. Place the fabric between two sheets of thin clear plastic film, taking care so

as not to distort the fiber. If the scarfed area is not a perfect circle, then each repair ply will need to match the ply shape and orientation of the original structural plies.

important! If possible, these repair plies should be made from the same type of carbon fiber cloth as used in the original structure, as specified by the manufacturer of the vehicle.

Step 7 – Mix an appropriate amount of epoxy repair resin, typically about the same weight of mixed resin as the weight of the cut-out cloth, plus a little extra for waste. Always use epoxy resin (not polyester resin or vinyl ester resin) for structural, load-carrying carbon fiber repairs. As with the cloth, the exact type of epoxy to be used should be specified or approved by the vehicle manufacturer.

Important: <u>The right Mixing Ratio</u>

Each product has a different mixing ratio. Typically, this is 1 : 1 or 2 : 1 between resin and hardener, but there are also much more complicated ones such as 100 : 45. You can usually find the details on the packaging or containers. The mixing ratio has to be very precise, otherwise the epoxy resin will not harden or it will not work optimally.

Carefully mix the resin in clean plastic cups, not waxed paper cups, and mix at the exact ratio of resin and hardener as specified by the resin vendor. Mix ratio with epoxies is critical; if you're off by more than 2%, the resin will never gain full strength. You cannot mix by "eye"; you must mix accurately.

Step 8 – Saturate the carbon fabric with the freshly mixed resin by placing half of the mixed resin and the dry cloth on the first sheet of plastic film, and pour the remaining resin on top of the cloth, placing the (ply-traced) piece of clear film over the top. Use a plastic or rubber squeegee to work the resin through the cloth, saturating all the way through. Squeeze out any air bubbles and excess resin, and then flip the plastic over to look at the backside. Squeeze out any air bubbles on the back until the cloth is evenly saturated on both sides and there are no remaining dry spots or air bubbles.

Cut each repair ply as marked from the film-covered fabric. Leave the plastic film in place until just prior to application in the repair.

Step 9 – Using a small paint brush or acid brush, paint on an “interface coat” of freshly mixed resin over the entire scarfed area. Then, remove the bottom layer of film and apply the first repair ply to the repair area (Note: The small ply goes down first). Carefully remove the film from the first repair ply before proceeding with the next repair ply.

Carefully orient the fibers in this ply to match the fiber orientation of the original structure, which you marked on the tracing templates in Step 5.

Step 10 – Apply the remaining plies (in this example, there will be three remaining at this time) over the repair area as before, taking care to orient each ply to match the original structural plies. You will work from smaller to bigger repair plies, with the biggest ply on top. Carefully and gently squeegee each ply into place, squeezing out any air bubbles or wrinkles. Be sure to remove all plastic film from each layer in the process and save to verify that all film was removed from the repair.

Step 11 – Cure the repair area. There are some epoxy resins that will cure at room temperature, although this can take days if the temperature is cool. Most of the strong structural wet lay-up repair resins require an elevated-temperature cure. This is typically done somewhere between 140°F and 200°F for a few hours. The heat can be applied by a hot air blower into a temporary aluminum foil tent built over the repair, or with a heat blanket or other controlled heat source. However, these resins systems will give their best strength if they’re vacuum-bagged prior to cure, as in Step 12.

Figure 25: Vacuum-bagging the repair patch pulls out air bubbles from the uncured resin and also helps ensure a good bond.

Step 12 – Vacuum-bagging the repair patch (see photo above) is the preferred method used for obtaining the best results. The purpose of the vacuum bag is to pull out the thousands of tiny air bubbles from the uncured resin, which can be trapped in the weave of the cloth and between plies. Every place there is a tiny air bubble means there is not a bond between the resin and the cloth, which weakens the entire structure. The vacuum bag also squeezes the plies together and presses the repair against the original structure, helping to ensure a good bond.

By pulling all the air out of the vacuum bag with a vacuum pump, atmospheric pressure pushes on the repair area. At sea level with a good vacuum pump, more than 14 pounds per square inch can be achieved.

There are thin layers which need to go inside the vacuum bag, over the repair to “bleed” excess resin out of the repair plies, “breathe” the air out, and serve as “release” layers to keep the bleeder and breather layers from sticking to the patch. The vacuum bag itself is a nylon film which goes on top of the other layers and is typically attached to the structure with a sticky, thick vacuum-bag sealant tape. Full vacuum is applied to the bag until the repair is cured.

Step 13 – The last step! All that's left is de-bagging the cured repair, tap-testing the surface to make sure there are no bonding problems, light surface smoothing with a fine abrasive pad, admiring your handiwork, and then cleaning and painting.

Self-Check – 6	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. Determining the size of the hidden damage is usually performed by “tap testing” (2 pts)
2. Removing body panels before going to repair helps to gain access to the repair area (2 pts)
3. Mixing an appropriate amount of epoxy repair resin is not important (2 pts)

Note: **Satisfactory rating greater than/equal - 3 points** **Unsatisfactory – less than 3 points**

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

Score = _____

Rating: _____

Information Sheet - 7 Carrying out all activities according to industry regulations/guidelines, OHS legislation, and enterprise procedures/policies

7.1 Finishing

Finishing the repairs are just like any other fiberglass body work project. Sanding the repair smooth and then using a body filler and high-build primer to finish it. One extra step should be taken, which is to use a sprayable polyester primer. This seals the fiberglass much like a gel coat for a factory-perfect finish.

The last step after the bodywork is the polyester primer. This stuff goes on thick and is then sanded off smooth. 3-4 medium wet coats get the job done. This is over the filler work we did on the hood, but before the main body work to the rest of the car. The polyester primer has to be block sanded.

Figure 26: polyester primer

Figure 27: After paint, the hood is perfect, you would never know that there used to be a giant hole in the center.

The process shown here can be used for any type of fiberglass structure, including boats, RVs and campers, even shelters. The key to a good fiberglass repair is clean preparation, patience, and good quality components such as 3M resins and matting.

Self-Check – 7	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 the basic steps of finishing composite repair in auto body work (10 pts)

Note: **Satisfactory rating greater than/equal - 3 points Unsatisfactory – less than 3 points**

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

Score = _____

Rating: _____

Information Sheet - 8 Checking repairs based on specification and completing records

8.1 Maintaining workplace record

There are a few fundamental principles that, once understood, allow most composite repairs to be completed successfully. Successful repairs allow you to extend the life of a part or mold and save you the cost of replacing your composite part. When you perform fiberglass auto body repair, make sure you are considering these three main principles of composite repair:

- **Repairs differ from the original part** — The first principle you must understand is that structural repairs are made by a different process than the original piece. When a composite part is initially manufactured, its resin cures bonding both chemically and physically with the reinforcement fabric resulting in a single unit, regardless of the number or orientation of the plies of fabric. This is referred to as the primary structure or bond, and it is the strongest type of bond that can exist within a composite part.

  Once a part is damaged, all repairs become secondary bonds attached to the original primary structure. This means all repairs are dependent upon physical bonding to the surface of the original primary structure (more on this later). For this reason, fiberglass repairs rely upon the adhesive quality of their resin for their strength—the strength of physical bond to the primary structure. Because of this, the resin used for the repair should be just as strong as the resin used to fabricate the part. In fact, resins with strong adhesive properties are sometimes used for repairs.

- **Increased surface area will increase the strength of composite repairs** — Since fiberglass repairs depend upon surface adhesion (physical bonding) of the repair to the primary structure, increasing the surface area of the bond line will

increase the strength and durability of the bond—and by extension the part or repair.

- **You should match your repair to the original part when possible** — While your composite repair is different than your original part, it is recommended that you duplicate the thickness, density, and ply orientation of the original laminate when making your repair. This will help to maintain the functionality of the part. More is not always better—in this case, if your repair is thicker than the original part, it will almost certainly be stiffer, regardless of the material in use. Introducing various strengths within a part can cause unintended stress points, eventually leading to material fatigue or failure. It is better to carefully replace every ply that has been removed in the damaged area with an identical material, placed in the same orientation when possible. This ply—for—ply replacement approach guarantees the repaired structure can withstand the same loads as the original, and that it will disperse loads as intended.

With these three fundamental principles in place: Repairs Differ from the Original Part, Increased Surface Area Increases Strength, and Repairs Should Match your Original Part; you have the foundation for understanding the sequences for repairs. As stated earlier, we are going to provide detailed steps for both structural fiberglass repairs and general cosmetic composite repairs. Keep in mind that these are general steps, and certain applications may call for additional steps or slight variances in approach.

Self-Check – 8	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. Explain the three main principles of composite repair (10 pts)

Note: **Satisfactory rating greater than/equal - 3 points** **Unsatisfactory – less than 3 points**

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

Score = _____

Rating: _____

Operation Sheet – 1 Mixing and Applying the Fiberglass

Objectives of Carrying out repair procedures in accordance with enterprise procedures;

- To provide the trainees with the knowledge, skills and right attitudes to repair components on vehicle bodies using composite materials.

Mixing epoxy resins safety

Making sure you have the proper tools and safety equipment for using and handling epoxy resins, including the following:

- Eye Protection
- Disposable Latex or Reusable Rubber Gloves
- Clean Mixing Cups (If you're using recycled materials avoid anything that held fats/oils, like butter or margarine containers.)
- Clean Mixing Sticks

Step by step procedure

Step 1 Measure an appropriate amount of resin in a metal container.

Step 2 Add the hardener, according to package instructions.

Step 3: Mixing this material thoroughly, being careful to stir the bottom and sides, and not just the middle of the container, using a paint stick

Step 4: Lay mat on or in your form, and spread the resin mixture over it with a disposable paint brush.

- As you spread the resin over the fiberglass mat, make sure to apply it over corners and weak spots with the same coverage that you would over flat, easy-to-reach surfaces. If you fail to get good coverage in corners, for example, your fiberglass will eventually develop weaknesses in those corners.

Step 5: Work the mat and resin completely over your form until it is covered uniformly. Continue working until you have used all of your material.

Operation Sheet – 2 Carrying out repair procedures in accordance with enterprise procedures

Objectives of Carrying out repair procedures in accordance with enterprise procedures;

- To provide the trainees with the knowledge, skills and right attitudes to repair components on vehicle bodies using composite materials.

Materials in a Fiberglass Repair Kit

- Fiberglass resin
- Hardener
- Plastic spreader
- Fiberglass cloth
- Mixing stick
- Mixing tray

Step 1: Remove Paint and Rust

Use an angle grinder with flapper wheel to remove the old rust and paint from the surface to be repaired. It is possible to accomplish the same thing by hand with coarse 80 grit sandpaper and a wire brush, but it is much harder to do a thorough job.

Step 2: Cleaning the damaged area

Use acetone to clean the damaged area. If you don't have it, soapy water will also be useful for removing the dirt, oil, grease, and other ingredients. Let it air-dry completely or use a piece of dry cloth to wipe the area.

Step 3: Sanding the damaged area

Use the Sandpaper 80 grit to sand the damaged area. It will remove all the rust, paint, primer, and gel-coat. Sand the other side of the damaged spot too because repairing both sides will strengthen the surface. Clean the area again with acetone or soapy water.

Step 4: Making resin and hardener mixture

Cut several pieces of fiberglass cloth to one-inch larger than the cracked or holed area. Then **mix the resin** with the hardener in the mixing tray. Blend in small amounts and remember that the working life of the mixture will be nearly 8 to 12 minutes at 75°F. You have to use ten drops of hardener for one ounce of resin.

Step 5: Applying a coat of mixture

Use the paintbrush to apply a coat of mixed resin on the damaged area. The resin should cover the area that extends 2 to 3 inches beyond repair. Then, place a piece of **fiberglass cloth** onto the damaged spot and saturate it with the mixed resin. Keep applying layers of cloth pieces and resin until the area is repaired completely. Follow the same procedure for the both sides.

Step 6: Drying then sanding the damaged area

Let the area dry properly. The curing will be better if the temperature of the place remains at 75°F. After that, sand the area with Sandpaper 80 grit. You can **use a body filler** at this stage to smoothen the small curves.

Step 7: Sanding the contour of the repaired area

Use the Sandpaper 180 grit on the contour of the repaired area so that it blends with the rest of the surface.

LAP TEST	Performance Test

Name…… ID……Date……

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **10** hour. The project is expected from each student to do it.

Task 1: Mix and Apply the Fiberglass

Task 2: Carry out repair procedures in accordance with enterprise procedures

LG #38	LO #3- Clean up work area and maintain equipment

Instruction sheet

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

- Collecting and storing materials that can be reused
- Removing waste and scrap by following workplace procedures.
- Cleaning and inspecting equipment and work area for serviceable conditions
- Identifying and tagging unserviceable equipment
- Completing operating maintenance
- Maintaining tool in accordance with workplace procedures and repair methods

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**:

- Collect and store materials that can be reused
- Remove waste and scrap by following workplace procedures.
- Clean and inspect equipment and work area for serviceable conditions
- Identify and tag unserviceable equipment
- Complete operating maintenance
- Maintain tool in accordance with workplace procedures and repair methods

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- Collecting and storing materials that can be reused

1.1 Collecting and storing material that can be reused

Storage and Preservation are an important part of the storekeeping function. When materials remain idle in the store these materials should be taken care of and looked after properly. Otherwise these materials may get perished due to natural chemical reaction like rusting by moisture, melting by heat etc and also may get affected by insets, rats etc.

In order to protect the materials from various adverse effects the following actions should be taken: -

1. Materials should be stocked free from ground. No material should be stocked on the floor as it may be affected by dampness, white ants etc.
2. Materials should be stocked in the appropriate place according to the nature of the materials

The proper care and storage of materials, tools and equipments are not only the concern of the management but of the workers who use the equipment.

A major responsibility of the technician is to ensure that materials, tools and equipment are maintained in a good condition and are readily available when required for the various work activities. Faulty tools and equipments are a common reason for delays on technical activities.

Good organization of stored materials is essential for overcoming material storage problems whether on a temporary or permanent basis. There will also be fewer strain injuries if the amount of handling is reduced, especially if less manual materials handling is required. The location of the stockpiles should not interfere with work but they should still be readily available when required. Stored materials should allow at least one meter (or about three feet) of clear space under sprinkler heads.

1.2 Housekeeping Signs

The workplace or office is a place where productivity is expected and having a pleasant work area certainly adds to a positive environment. Employees can do their part in addition to regular cleaning staff housekeeping and caretaker maintenance to keep it clean, safe, and healthy for all

Figure 28: proper storage of tools, materials and equipments

- **Importance of proper storage of tools and equipments**
  - ✓ It is important factor for safety and health as well as good business.
  - ✓ Improves appearance of general-shop and construction areas.
  - ✓ Reduce overall tool cost through maintenance.
  - ✓ This also ensures that tools are in good repair at hand.
  - ✓ Teaches workers principles of tool accountability.

- **Pointers to follow in storing tools and equipments**
  - ✓ Have a designated place for each kind of tools.
  - ✓ Label the storage cabinet or place correctly.
  - ✓ Store them near the point of use.
  - ✓ Wash and dry properly before storing.
  - ✓ store sharp edge materials properly when not in use with sharp edge down.
  - ✓ Put frequently used items in conveniently accessible conditions.
  - ✓ Gather and secure electrical chord to prevent entanglement or snagging.

- ✓ Cutting boards should be stored vertically to avoid moisture collection
- ✓ Metal equipments can be stacked on one another after drying.
- ✓ Make sure the areas where you are storing the equipment are clean, dry and not overcrowded.

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 are the actions that should be taken in order to protect the materials from various adverse effects?(10 pts)

Note: **Satisfactory rating greater than/equal - 5 points** **Unsatisfactory – less than 5 points**

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

Score = _____

Rating: _____

Information Sheet 2- Removing waste and scrap by following workplace procedures

2.1 Waste Disposal Practices

Waste management is the precise name for the collection, transportation, disposal or recycling and monitoring of waste. This term is assigned to the material, waste material that is produced through human being activity. This material is managed to avoid its adverse effect over human health and environment. Most of the time, waste is managed to get resources from it. The waste to be managed includes all forms of matter i.e. gaseous, liquid, solid and radioactive matter.

There are eight major groups of waste management methods, each of them divided into numerous categories. Those groups include source reduction and reuse, animal feeding, recycling, composting, fermentation, landfills, incineration and land application. You can start using many techniques right at home, like reduction and reuse, which works to reduce the amount of disposable material used.

2.2 Methods of Waste Disposal

1. **Landfill**:- which is the most popularly used method of waste disposal used today. This process of waste disposal focuses attention on burying the waste in the land

2. **Incineration/Combustion**:- which is a type disposal method in which municipal solid wastes are burned at high temperatures so as to convert them into residue and gaseous products. .

3. **Recovery and Recycling:- It** is the process of taking useful discarded items for a specific next use. These discarded items are then processed to extract or recover materials and resources or convert them to energy in the form of useable heat, electricity or fuel.

4. **Recycling** is the process of converting waste products into new products to prevent energy usage and consumption of fresh raw materials. Recycling is the third component

of Reduce, Reuse and Recycle waste hierarchy. The idea behind recycling is to reduce energy usage, reduce volume of landfills, reduce air and water pollution, reduce greenhouse gas emissions and preserve natural resources for future use.

5. Plasma gasification:- It is another form of waste management. Plasma is a primarily an electrically charged or a highly ionized gas. Lighting is one type of plasma which produces temperatures that exceed 12,600 °F . With this method of waste disposal, a vessel uses characteristic plasma torches operating at +10,000 °F which is creating a gasification zone till 3,000 °F for the conversion of solid or liquid wastes into a gas.

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

1. What are the methods of Waste Disposal? (8 pts)

Note: **Satisfactory rating greater than/equal - 4 points** **Unsatisfactory – less than 4 points**

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

Score = _____

Rating: _____

Information Sheet - 3 Cleaning and inspecting equipment and work area for serviceable conditions

3.1 Identifying and reporting maintenance requirement

Cleaning up is not just a measure of respect for the workspace, it also removes hazards. Cleaning is so important because when we clean an area, we are also doing some inspection or checking of machinery, equipment, and work conditions. An operator cleaning a machine can find many mal-functions. When a machine is covered with oil, soot, and dust, it is difficult to identify any problems that may be developing. While cleaning the machine, however, one can easily spot oil leakage, a crack developing on the cover, or loose nuts and bolts. Once these problems are recognized, they are easily fixed. It is said that most machines breakdowns begin with vibration (due to lose nuts and bolts), with introduction of foreign particles such as dust (due to the crack on the cover, for instance), or with inadequate oiling and greasing. For this reason cleaning is useful to make discoveries while cleaning machines.

3.2 Kinds of Cleaning Solvents

Solutions are homogeneous mixture of two or more components. They can be gaseous, liquid or solid. When we speak of a solution, we usually think of a solid dissolved in water. While water is the most common solvent, other liquids are frequently employed as solvents for certain substances for example wax maybe dissolved in gasoline. The dissolved material in a solution is termed as solute (e.g. wax) while the dissolving medium is called solvent (e.g. gasoline). Solvent is a component of a solution that dissolves solute and is usually present in large proportion or amount. It can be classified as polar or non polar.

- **Polar solvents**: are solvents which dissolve/are soluble in water;
- **Non polar solvents**: are solvents which do not dissolve/are insoluble in water.

Solvents usually used for cleaning in automotive shops are: water, gasoline, kerosene, thinner and detergent soap.

3.3 Properties of Cleaning Solvents

A useful generalization much quoted is that “Like dissolves like”. More specifically, high solubility occurs when the molecules of the solute are similar in structure and electrical properties to the molecules of the solvent.

When there is a similarity of electrical properties; e.g. high dipole element between solute and solvent, the solute-solvent attractions are particularly strong. When there is dissimilarity, solute-solvent attractions are weak. For this reason, a polar substance such as H2O usually is a good solvent for a polar substance such as detergent soap but a poor solvent for a non polar substance such as gasoline.

3.4 Uses of Cleaning Solvents

Cleaning Solvents	Uses
1. Gasoline	- It is used to wash oil/greasy tools/equipment.
2. Diesoline	- It is used to wash oil engine, transmission and other parts of the vehicle.
3. Kerosene	- It is used to remove dust, grease oil, paint, etc.
4. Thinner	-It is used to remove spilled paint on the floor, walls and tools.
5. Soap and water	- It is used to wash/clean upholstered furniture such as seats, tables, cabinets, etc.

3.5 Occupational Health and Safety Practices in Handling Cleaning Solvents

A great percentage of eye injury and cuts results from a disregard for the simplest of rules in handling cleaning solvents. You should never use compressed air to clean your clothes, hands or body. The pressure could cause the cleaning solvents and dirt particles to penetrate your skin, resulting in infection and /or blood poisoning. Do not use compressed air to clean an object immediately after it has been removed from a hot

cleaning tank. First, rinse the cleaning solvents away with water. Do not use carbon tetrachloride as a cleaning solution. The fumes, when inhaled can cause serious internal injury and possibly result in death. When steam-cleaning, place the object to be cleaned on a pallet and wear a face shield and rubber gloves for protection against loose debris.

If a job or cleaning task requires the use of gloves, use the appropriate gloves. Do not for instance use welding gloves when removing an object from a hot tank, or rubber gloves when welding. If you have cut, nicked, or burned yourself, or something has got into your eyes, report immediately to the first-aid person. Keep all inflammable cleaning solvents in closed tin containers and whenever possible, store them in a separate area.

3.6 Inspection of work tools/equipment

The purpose of inspection is to identify whether work tool/equipments and working area can be operated, adjusted and maintained safely. Not all work area, tools/equipments needs formal inspection to ensure safety and in many cases a quick visual check before use will be sufficient. However inspection is necessary for any work area, tools/ equipments where significant risks to health and safety may arise from incorrect installation, reinstallation, deterioration or any other circumstances. The need for inspection and inspection frequencies should be determined through risk assessment.

3.7 Importance of inspection

As an essential part of a health and safety program, workplaces should be inspected. Inspections are important as they allow you to:

- listen to the concerns of workers and supervisors
- gain further understanding of jobs and tasks
- identify existing and potential hazards
- determine underlying causes of hazards
- monitor hazard controls (personal protective equipment, engineering controls, policies, procedures)
- recommend corrective action

Self-Check – 3	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. Solvent is a component of a solution that dissolves solute and is usually present in large proportion or amount. (2pts)
2. Non polar solvents are solvents which dissolve/are soluble in water (2pts)
3. Polar solvents are solvents which do not dissolve/are insoluble in water (2pts)

Note: **Satisfactory rating greater than/equal - 3 points** **Unsatisfactory – less than 3 points**

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

Score = _____

Rating: _____

Information Sheet - 4 Identifying and tagging unserviceable equipment

4.1 Tags

The use of tags is considered an administrative control and as such only provides limited protection to people and plant; therefore in all cases a physical isolation must be used in conjunction with a tag to prevent the accidental activation of an isolation point.

4.2 Attaching the Tag

The person attaching the tag must completely fill the tag with the following information:

- Name & company of person placing tag
- The classification/department the person works for
- The date that the tag was placed
- The equipment / plant the tag was placed on
- Contact number
- Work order / job number if applicable
- Signature

It is important to clearly identify the exact piece of equipment that the tag and lock was placed on to allow identification of those personnel working on the plant.

Depends on what you need it for. You can include a stub to give to your customers, or feature numbering so you can easily track each defective part. Choose materials with a bit more durability if you'll be working outside, replace old tags, or fasten your tags to something new.

- We specialize in Repair Tags and we stock several different options for whatever suits your space. Check out our repair tag material guide to compare.
- All tags feature smudge-proof surface. Write your information with a pen, pencil, or marker.
- Bright colored repair and inspection tags with bold, legible prints display and highlight vital information.

- Order tags with our handy Tag-in-a-Box® for convenient storage and dispensing of tags. Just pull and tear!
- Looking for the right fit? Get a custom design. Our customer service staff is happy to help you find what you need.

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. What are the information that the person attaching the tag must completely fill in the tag. (10pts)

Note: **Satisfactory rating greater than/equal - 5 points** **Unsatisfactory – less than 5 points**

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

Score = _____

Rating: _____

Information Sheet - 5 Completing operating maintenance

5.1 Tools and Equipment Maintenance

All tools, equipment and vehicles must be properly maintained so that workers are not endangered. Construction regulations require inspections of vehicles, tools, machines and equipment before use.

5.2 Components of maintenance program

A maintenance strategy includes procedures as well as corrective and preventive maintenance

- Inspections ensure that tools and equipments are operating correctly. Safety inspections ensure the tools/equipments are safe for both patients and operators.
- Corrective maintenance (cm) restores the function of a failed device and allows it to be put back in to service.
- Preventive maintenance (pm) aims to extend the life of the tools/equipment and reduce failure rates.
- Preventive maintenance is the systematic care and protection of tools, equipment, machines and vehicles in order to keep them in a safe, usable condition, limit downtime and extend productivity. We must always be aware that maintenance tasks themselves are potentially hazardous and can result in injury. The successful maintenance program is:

  - ✓ well organized and scheduled,
  - ✓ controls hazards,
  - ✓ defines operational procedures, and
  - ✓ trains key personnel.

Self-Check – 5	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. Any activities which require maintenance should be identified properly and reported immediately as soon as possible. (2pts)

2. Corrective maintenance is work carried out following the failure of the plant and equipment.(2pts)

3. Emergency maintenance is that work which is required to be performed without delay due to a failure of a component which. (2pts)

Note: **Satisfactory rating greater than/equal - 5 points** **Unsatisfactory – less than 5 points**

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

Score = _____

Rating: _____

Information Sheet - 6 Maintaining tool in accordance with workplace procedures and repair methods

6.1 Equipment maintenance

Equipment maintenance is any process used to keep a business's equipment in reliable working order. It may include routine upkeep as well as corrective repair work. Equipment may include mechanical assets, tools, heavy off-road vehicles, and computer systems. The resources needed to keep it all in good repair will vary by type. For instance, repairs made on heavy construction equipment won't look the same as those performed on automated food processing machines.

Maintenance extend the life of tools and equipment, here are the major maintenance components you should be aware of.

Keep Them Dry: In terms of preventative care, it's crucial that you keep your machine tools dry. By storing them out of the elements where they can be exposed to rust and other environmental pollutants, you can keep your equipment in better working order for a longer period of time.

Keep Them Lubricated: While it's crucial to keep the body of the machine dry, it's equally important to keep moving parts lubricated properly. If you use your machine tool on a daily basis, be sure to check lubrication levels of joints, moving parts, and internal components. Without proper lubrication, friction on these moving parts can cause your machine tool to break down. For questions about what kind of lubrication you should use between maintenance visits, contact your local Phoenix machine shop.

Keep Them Sharpened: If your machine tool has components designed for cutting, slicing, or sharpening, it's crucial that you check your equipment regularly for sharpness. Not only can wear and tear on these sharpening elements force your machine to work harder, causing unnecessary wear and tear, but it can also put

production at risk by producing substandard products. This is especially true if the materials you're producing are designed with precision in mind, where accuracy is of the utmost importance.

Keep Them Clean: If your machine tool isn't clean, then problems can start to crop up in both the short and long term. Machines clogged with potentially flammable or hazardous materials can pose a threat to both your workers and your machinery in the short term. Over time, grime can keep your machinery from running at optimal levels, leading to a shorten lifespan or more costly repairs. The technicians at a Phoenix machine shop should be able to advise you on what an ideal cleaning schedule should look like based on your machine, your production output, and other factors that are unique to you.

Self-Check – 6	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 Equipment maintenance. (2pts)

2. Write the major maintenance components you should be aware of.(2pts)

Note: **Satisfactory rating greater than/equal - 5 points** **Unsatisfactory – less than 5 points**

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

Score = _____

Rating: _____

Operation Sheet 1– Cleaning workplace step by step procedures

Objectives; to know successful shut down procedure of spice and herbs primary processing equipment / machine.

The procedure to successful shut down equipment/machine

Following the steps outlined below will help to cleanup the workplace

Cleaning workplace step by step procedures

Stape 1: Clean up every time whenever you leave an area, including sweeping the floor.

Stape 2: Clean and return all tools to where you got them.

Stape 3: Remove Everything & Prepare your Supplies.

Stape 4: Give the garage floor a good sweep to get the debris and bugs out.

Stape 5: Mop up spills immediately and put a chair or cone over them if they are wet enough to cause someone to slip.

Stape 6: Hang some pictures, signs, or posters

LAP test	Performance test

Name…… ID…… Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2** hour. The project is expected from each student to do it.

Task: Clean workplace

Reference

1. https://www.wikihow.com/Fiberglass
2. http://www.gogaragedoorguru.com/blog/tips-for-cleaning-up-and-organizing-your-garage-this-spring-.shtml
3. https://swellcomposites.com/blogs/news/step-by-step-guide-measuring-and-mixing-epoxy-resins
4. https://www.onupkeep.com/learning/maintenance-applications/equipment-maintenance

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