



RQF LEVEL 3



AUTBW 301

**AUTOMOBILE
TECHNOLOGY**

Car body work

TRAINEE'S MANUAL

December 2023



CAR BODY WORK



AUTHOR'S NOTE PAGE (COPYRIGHT)

The competent development body of this manual is [Rwanda TVET Board ©](#), reproduced with permission.

All rights reserved.

- This work has been produced initially with the Rwanda TVET Board, with the support from Swisscontact.
- This work has copyright, but permission is given to all the Administrative and Academic Staff of the RTB and TVET Schools to make copies by photocopying or other duplicating processes for use at their own workplaces.
- This permission does not extend to making copies for use outside the immediate environment for which they are made, nor making copies for hire or resale to third parties.
- The views expressed in this version of the work do not necessarily represent the views of RTB. The competent body does not give a warranty nor accept any liability.
- RTB owns the copyright to the trainee and trainer's manuals. The training providers may reproduce these training manuals in part or in full for training purposes only. Acknowledgement of RTB copyright must be included on any reproductions. Any other use of the manuals must be referred to the RTB.

© **Rwanda TVET Board**

Copies available from:

- *HQs: Rwanda TVET Board-RTB*
- *Web: www.rtb.gov.rw*

KIGALI-RWANDA

Original published version: December, 2023.

ACKNOWLEDGEMENTS

Rwanda TVET Board (RTB) would like to recognize all parties that contributed to the development of the Trainer's and Trainee's manuals for the TVET Certificate III in Automobile Technology for the module **AUTBW 301: Car body work**.

Thanks to Swisscontact for the technical and financial support towards the implementation of this project.

We would also wish to acknowledge all trainers, technicians and practitioners for their contribution to this project.

The Management of Rwanda TVET Board appreciates the efforts of its staff that coordinated this project.

Finally, RTB would like to extend its profound gratitude to the MCT Global team that technically led the entire assignment.



Under Rwanda TVET Board (RTB) guiding policies and directives



Under Swiss contact supervision and involvement

COORDINATION TEAM

Aimable Rwamasirabo

Sosthene Kazima

Production Team

Authoring and Review

Frederic Musabyimana

Timothee Manishimwe

Faradji Gahungu

Conception, Adaptation and Editorial works

Jean Marie Vianney Muhire

Vincent Havugimana

John Paul Kanyike

Josiane Tuyishime

Formatting, Graphics, Illustrations and infographics

Augustin Habimana

Jean Claude Asoka Niyonsaba

Coordination and Technical support

SWISSCONTACT and RTB

Project Implementation

MCT Global Ltd

TABLE OF CONTENTS

_Toc167096236

AUTHOR'S NOTE PAGE (COPYRIGHT)	i
ACKNOWLEDGEMENTS	ii
PRODUCTION TEAM	iii
TABLE OF CONTENTS	iv
LIST OF FIGURES	vi
LIST OF ABBREVIATIONS AND ACRONYMS	vii
INTRODUCTION	1
UNIT 1. PREPARE THE WORKPLACE	2
Topic 1.1: Selection of PPE	5
Topic 1.2: Safety precautions at workplace.	9
Topic 1.3: Cleaning and arrangement of workplace.	13
UNIT 2. REPAIR VEHICLE MINOR PARTS	22
Topic 2.1: Identification of vehicles minor parts.	25
Topic 2.2: Inspection of vehicle damaged panel.	28
Topic 2.3: Selection of tools, materials and equipment.	30
Topic 2.4: Repair vehicles minor parts.	44
UNIT 3. REPAIR VEHICLE MAJOR PARTS	50
Topic 3.1 Identification of vehicles major parts.	53
Topic 3.2 Selection of tools, materials and equipment	56
Topic 3.3 Measurement of damaged panel	69
Topic 3.4 Repair vehicles major parts.	75
UNIT 4. PROTECT VEHICLE PANEL	81
Topic 4.1: Identification of protection materials.	86
Topic 4.2: Selection of tools and equipment.	90
Topic 4.3: Application and sanding of filler.	93
Topic 4.4: Application and sanding of putty.	96
Topic 4.5: Pre-Painting of vehicle panel.	98

UNIT 5. PAINT VEHICLE PANEL-----	105
Topic 5.1. Selection of tools, materials and equipment. -----	109
Topic 5.2 Mixing of paints -----	116
Topic 5.3 Spraying paints -----	121
Topic 5.4 Polishing of paint.-----	125
REFERENCES -----	132

LIST OF FIGURES

Figure 1: Illustration of vehicle minor parts	26
Figure 2: The panel beater is inspecting the vehicle damage	29
Figure 3: The Technicians are repairing rear bumper	44
Figure 4: Technician is observing Vehicle frame	54
Figure 5: The Technician is observing vehicle Uni-body parts	55
Figure 6: Technician is measuring the front damaged major part	75
Figure 7: Sand papers of different sizes	
Figure 8: Technician is Covering unpaintable parts	99
Figure 9: Paint mixing room	116
Figure 11: Different paints to be mixed	117
Figure 12: Technician is spraying paint	121

LIST OF ABBREVIATIONS AND ACRONYMS

RQF:	Rwanda Qualification Framework
RTB:	Rwanda TVET Board
TVET:	Technical and Vocational Education and Training
PPE:	Personal Protective Equipment
VOCs:	Volatile Organic Compounds
SMAW:	Shielded metal arc welding
GTAW:	Gas Tungsten Arc Welding
TIG:	Tungsten Inert Gas
GMAW:	Gas Metal Arc Welding
MIG:	Metal Inert Gas
CMM:	Coordinate Measuring Machine
3D:	Three dimensional
CBET:	Competence Based Education Training

INTRODUCTION

This trainee manual encompasses all necessary skills, knowledge and attitudes required to repair damaged car bodies. Students undertaking this module shall be exposed with practical activities that will develop and nurture their competences. The writing process of this training manual embraced competency-based education and training (CBET) philosophy by providing practical opportunities reflecting real life situations.

The Trainee Manual is subdivided into units, each unit has got various topics, you will start with a self-assessment exercise to help you rate yourself on the level of skills, knowledge and attitudes about the unit.

A discovery activity is followed to help you discover what you already know about the unit.

After these activities you will learn more about the topics by doing different activities by reading the required knowledge, techniques, steps, procedures and other requirements under the key facts section, you may also get assistance from the trainer. The activities in this training manual are prepared such that they give opportunities to students to work individually and in groups.

After going through all activities, you shall undertake progressive assessments known as formative and finally conclude with your own self-reflection to identify your strengths, weaknesses and areas for improvements.

Do not forget to read the point to remember section which provides the overall key points and takeaways of the unit.

UNIT 1. PREPARE THE WORKPLACE



Unit summary:

This learning outcome describes the knowledge, skills and attitude required to prepare for the workplace. It includes selection of PPE, safety precautions at the workplace, cleaning and arrangement of the workplace.

Self-assessment: Unit 1

1. Study the unit illustration above and answer the following questions:
 - a. What do you see in the illustration?
 - b. What is happening in the illustration?
 - c. What topics do you think will be covered under this unit based on the illustration?
2. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this unit.
 - a) There is no right or wrong way to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
Think about yourself: do you think you have the knowledge, skills or attitudes to do this? How well?
 - b) Read the statements across the top. Put a check in the column that best represents your level of knowledge, skills or attitudes.
3. At the end of this unit, you will assess yourself again.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Classify the personal protective equipment.					
Identify the use of that personal protective equipment.					
Identify the safety measures that should be applied at the car body workplace.					
Select tools, materials and equipment that can be used at the workplace.					

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Describe the arrangements of tools, materials and equipment at a workplace.					
Describe the cleaning techniques used before and after work in car body work.					



Key competencies:

Knowledge	Skills	Attitudes
1. Classify the PPE that should be used in car body work.	1. Choose the correct PPE to use in car body work.	1. Hygiene for all PPE.
2. List tools and equipment that shall be used in car body work.	2. Select tools and equipment to be used in car body work.	2. Safe handling of tools and equipment.
3. Describe the arrangements of the workplace.	3. Arranging of personal protective equipment.	3. Care of materials.
4. Identify the safety precautions for tools and equipment.	4. Perform cleaning of the workplace.	4. Time management.
5. Describe cleaning methods.		5. Avoid wastage of materials.
6. Identify different safety equipment.		6. Apply different types of safety on tools, materials and equipment.



Discovery activity



Task 1

John is an engineer in construction technology and has many companies in that domain. Now he also wants to start a company for automobiles painting and he would like first to arrange the workshop.

Help him to.

- a. Identify all kinds of PPE he needs.
- b. Describe all kinds of safety that should be in his workshop.
- c. Discuss the arrangements of safety equipment required in his workshop.
- d. Describe the cleaning of the workplace.
- e. Discuss the safety of material, tools and equipment safety needed in his workshop.

Topic 1.1: Selection of PPE



Activity 1: Problem solving



Task 2

In your respective groups discuss on:

- a. Identify the PPE that should be needed in John's workshop as it is in scenario on the previous activity.
- b. Refer to the answer given on question (a) describe the use and purpose for each.

Key Facts 1.1 Selection of PPE

Classifications	Images	Names and their use.
1. Head protections	 1	Helmet A safety helmet serves as protection from falling debris, electrical shocks or contact with stationary objects and as well as when you are under the vehicle it protects from injuries.
2. Body protection	 2	Overall Is a professional clothing whose primary function is to protect workers; it is a tracksuit to put on over clothes and was originally used to protect against dirt and paint splatters from getting on clothing during work.
3. Foot protection		Safety boots Offer reinforced toes and anti-slip soles to protect feet from falling objects, hazardous materials and provide additional protection against spark and heat.

¹ car body work head protection image - Bing images

² car body work coverall image - Bing images

4. Hearing protection	 3	Earplug Reduce noise exposure during noisy operations.
5. Respiratory protection	 4	Dust masks. Guard against dust and non-toxic particles generated during sanding and grinding.
6. Eye and Face protection	a.  b.  5	a. Safety Goggles. It protects the eye against flying debris, dusts, chemicals and splashes during grinding, sanding and painting. b. Face Shield. This provides additional protection to the face and neck during work.
7. Hands protection	 6 a.	a. Nitrile or Latex Gloves Protect hands from chemicals, paints and solvents. b. Cut-resistant Gloves Protect against sharp edges and cuts when handling sheet metal or using cutting tools. c. Heat-resistant Gloves

³ car body work hearing protection image - Bing images

⁴ car body work respiratory dust mask image - Bing images

⁵ car body work eye protection image - Bing images

⁶ Nitrile or Latex Gloves - Search Images (bing.com)

		Suitable for welding and handling hot materials.
--	---	--



Activity 2: Guided practice



Task 3

Visit your school automobile workshop and perform the following task, under the guidance of the trainer.

- Identify all PPE you found in your workshop.
- Describe each and its uses.



Activity 3: Application



Task 4

Visit a garage near your school and perform the following tasks:

- Analyse the kinds of PPE they use.
- When returning to class, report the task.

⁷ cut-resistant gloves image - Bing images

⁸ Heat-resistant Gloves image - Bing images

Topic 1.2: Safety precautions at workplace.



Activity 1: Problem Solving



Task 5

Read and answer the following questions:

Referring to the scenario in the start of this unit helps John to set the safety measures of the workplace.

- a. Select effective personal safety precautions that should be in his workshop.
- b. Set the safety measures of the workplace.

Key Facts 1.2: Safety precautions at workplace

- **Personal safety precautions**
 - ✓ **Personal protective equipment:**
 - ✚ Ensure PPE fits properly. Too large clothes can cause accidents on running machines.
 - ✚ Wear appropriate PPE all times.
 - ✓ **Safe work.**
 - ✚ Avoid rushing that may compromise safety.
 - ✚ Follow safe work practices and standard operating procedures.
 - ✓ **Safe handling of chemicals.**
 - ✚ Store and handle chemicals in accordance with safety guidelines and local regulations.
 - ✚ Clearly label all containers and keep safety data sheets (SDS) readily available for reference.
- **Use tools and equipment in the proper manner.**
 - ✓ **Personal hygiene.**
 - ✚ Wash hands thoroughly before eating, drinking or touching the face.
 - ✚ Avoid touching eyes, nose or mouth with contaminated hands.

- ✓ **Training.** Provide regular safety training to all employees to keep them informed of potential hazards and best safety practices.
- **Workplace safety precaution:**
 - ✓ **Ventilation and dust control.**
 - ✚ Ensure proper ventilation in the workshop to control fumes and dust.
 - ✚ Use dust extraction systems for tasks generating airborne particles.
 - ✓ **Fire safety.**
 - ✚ Keep work areas free from flammable materials and sources of ignition.
 - ✚ Install and maintain fire extinguishers at strategic locations in the workshop.
 - ✓ **Waste management.**
 - ✚ Properly dispose of hazardous waste materials in accordance with local regulations.
 - ✚ Implement recycling practices for non-hazardous waste where possible.
- **Tools safety precautions.**
 - ✓ **Tool Inspection:** Regularly inspect tools for damage or wear and replace or repair them as needed.
 - ✓ **Proper Use:** Train employees on the correct use of each tool and ensure they use the right tool for the task.
 - ✓ **Sharp Tools Handling:** Handle sharp tools with care and use appropriate guards when not in use.
 - ✓ **Hand Tool Storage:** Store hand tools in designated locations, such as tool cabinets/tool boxes or, to prevent accidents and disorganisation.
 - ✓ **Power Tool Safety:**
 - ✚ Follow manufacturer's guidelines for operating and maintaining power tools.
 - ✚ Disconnect power tools when not in use, during maintenance or when changing accessories.
 - ✚ Ground should be always in place to ensure safety of power tools' users.
- **Equipment safety precautions:**

- ✓ **Regular Inspection:** Regularly inspect all workshop equipment for safe use and proper functionality.
- ✓ **Qualified Operators:** Ensure that only trained and qualified personnel operate specialised equipment.
- ✓ **Machine Guards:** Keep machine guards in place and functional during equipment operation.
- **Materials safety precautions.**
 - ✓ **Chemical Handling:**
 - ✚ Store chemicals in properly sealed labelled containers and in a designated storage area.
 - ✚ Keep a well-organised chemical inventory and maintain safety data sheets (SDS) accessible to all users.
 - ✚ Use chemicals in well-ventilated areas and wear appropriate PPE as required.



Activity 2: Guided Practice



Task 6

In small group, under your trainer guide answer the following questions:

- a. What are personal safety precautions?
- b. What are workplace safety precautions?
- c. What are tools safety precautions?



Activity 3: Application



Task 7

1. Visit your school automobile workshop, observe the following:
 - a. Personal safety precaution.
 - b. Tools safety precaution.
 - c. Workplace safety precautions.
 - d. Materials safety precaution.
2. When you return to the class, report the task and focus on the differences between what you learned and what you observed.

Topic 1.3: Cleaning and arrangement of workplace.



Activity 1: Problem solving



Task 8

Read and discuss on the following:

- a. Identify elements of workplace layout.
- b. Describe the arrangement of personal protective arrangements in the workplace.
- c. What are methods of cleaning?

Key Facts 1.3: Cleaning and arrangement of workplace

- **Workplace layout.**
 - ✓ **Reception:** Set up a reception near the entrance to handle customer inquiries, appointments.
 - ✓ **Staff Office:** The staff office typically consists of administrative personnel who handle various tasks related to managing the workshop and supporting its operations.
 - ✓ **Classroom:** The classroom within a workshop setting acts as an essential hub for learning, training and supporting the overall educational experience. It complements the practical aspects of the workshop, facilitates knowledge transfer and helps participants develop the skills and knowledge required for their specific area of interest or work.
 - ✓ **Locker room:** It serves several important functions related to the convenience, safety and well-being of the workshop's staff or employees. It is a designated area where workshop personnel can store personal belongings and change into appropriate work attire.
 - ✓ **Shop stall:** Shop stalls in a workshop play a crucial role in organising and optimising the workflow, ensuring safety and quality and providing specialised spaces for different tasks and operations.

- ✓ **Lift:** It serves as an essential piece of equipment that has several important functions. It is primarily used to elevate heavy objects, equipment or materials, making it easier to work on or transport them within the workshop.
- ✓ **Storage:**
 - ✚ Create a designated storage area for car parts organised in a systematic manner for easy retrieval.
 - ✚ Consider using shelves or racks to categorise and store parts efficiently.
- ✓ **Wash room:** It serves several essential functions, providing a designated space for employees to maintain personal hygiene and comfort while at work. It plays a crucial role in promoting a clean, healthy and productive work environment.
- ✓ **Outside Repair area:** Serves as an extended workspace outside the main workshop building. This area is typically designed to handle larger or messier repair tasks that require more space, ventilation or involve equipment that may not be suitable for indoor use.
- ✓ **Panel beating room:** Serves as a specialised workspace dedicated to repairing and restoring damaged or dented vehicle panels. It is an essential area where skilled panel beaters carry out their tasks to reshape and restore vehicle body panels to their original form or desired shape.
- ✓ **Mixing room:** This offers a dedicated space for preparing and mixing automotive paints, coatings and other finishing materials used in the repair and refinishing of vehicle body panels. It is an essential area where skilled painters and technicians carry out their tasks to ensure the precise colour matching and application of paints.
- ✓ **Painting room:** Is also known as the paint booth or spray booth, serves as a specialised and controlled environment for applying automotive paints and coatings to vehicle body panels. It is a crucial area where skilled painters carry out their tasks to achieve high-quality and professional paint finishes.
- **Tools and equipment arrangement.**
 - ✓ **Tool Storage.**

-  Utilise tool cabinets, tool shelves or tool boxes to organise and store hand tools efficiently.
-  Group similar tools together and clearly label the storage areas for easy identification and return after use.
-  Store power tools in a separate area, away from workbenches and walkways, when they are not in use.
-  Hang corded power tools on the wall for easy access.
- **Safety equipment arrangement.**
 - ✓ **Personal Protective Equipment (PPE):**
 -  **Safety goggles:** Place them near the entry and exit points for easy access and encourage workers to wear them when using power tools or handling hazardous materials.
 -  **Ear protection:** Keep earplugs or earmuffs at workstations where noisy machinery is operated, such as sanding or grinding areas.
 -  **Respirators:** Store respirators in a designated area, preferably in sealed containers and make sure they are easily accessible to those who need them while working with paints, solvents or other harmful substances.
 -  **Safety gloves:** Provide different types of gloves suitable for various tasks and store them in a visible and reachable location.
 - ✓ **First Aid Kit:**
 -  Keep a well-stocked first aid kit in a designated area, known and accessible to all employees. Regularly check and replenish the supplies as needed.
 -  Clearly mark the location with a recognizable first aid sign.
 - ✓ **Fire Safety Equipment:**
 -  **Fire extinguishers:** Install fire extinguishers at strategic points throughout the workshop, such as near the exits and at high-risk areas like paint booths and welding stations.
 -  **Fire blankets:** Hang fire-resistant blankets near welding stations or any other potential fire-prone areas.

✓ **Eye wash station and safety shower:**

✚ If there are tasks involving the use of chemicals or hazardous materials, install an eye wash station and safety shower within the workshop.

• **Cleaning methods:**

✓ **Abrasive cleaning:** Abrasive cleaning is used to clean disassembled parts, such as engine blocks. The abrasives used include steel shot, ground walnut shells or in the case of cleaning paint from a vehicle body, baking soda can be used.

✓ **Thermal ovens:** Thermal cleaning uses heat to bake off grease and dirt with special high-temperature ovens. This method of cleaning requires the use of expensive equipment but does not use any hazardous chemicals and is environmentally safe.

✓ **Chemical/microbe cleaning:** Chemical cleaning involves one of several cleaning solutions, including detergent, solvents or small, living microorganisms called microbes that eat oil and grease. The microbes live in water and eat the hydrocarbons that are the basis of grease and oil⁹

• **Cleaning the workplace.**

✓ **Before Work:**

✚ **Clearing work areas:** Before starting work, technicians should clear their work areas of any unnecessary clutter or debris. This includes removing any tools or materials from the previous job and disposing of waste properly.

✚ **Tools and equipment cleaning:** Wipe down workbenches, tool cabinets, equipment and other surfaces to remove dust and debris. Clean and organise the tool storage area to ensure easy access to tools during work.

✚ **Ventilation and dust control:** Ensure proper ventilation in the workshop, especially in areas where dust, fumes or harmful particles are generated.

⁹ Automotive Technology 5th edition by Jack Erjavec

Consider using dust extraction systems for sanding and cutting tasks to minimise airborne particles.

✓ **During work:**

 **Containment measures:** When performing tasks that generate a significant amount of dust or debris, use appropriate containment measures.

✓ **After Work:**

 **Waste disposal:** Properly dispose of waste materials, such as used sandpaper, masking materials and empty paint cans, in designated waste disposal containers.

 **Cleaning Paint Booths:** After paint-related work, thoroughly clean the paint booth, including walls, filters and floor, to remove overspray and ensure it is ready for the next job.

 **Final Inspection:** Before leaving for the day, technicians should conduct a final inspection of their work area, ensuring that all tools are properly cleaned, stored and check if the area is clean and tidy.

 **Floor Cleaning:** Sweep or use vacuum pump to clean the workshop floor.

 **Hand Cleaning:** Encourage workers to wash their hands after completing tasks, especially those involving chemicals, paints or solvents.



Activity 2: Guided practice



Task 9

In groups of 5 trainees perform the following tasks:

- Describe the elements of workshop layout?
- Identify the first aid kits arrangements.
- Describe the cleaning of the workshop before work.

Note: Ask the trainer for any clarification.



Activity 3: Application



Task 10

Visit your automobile workshop and perform the following:

- Observe the elements of workplace layout?
- Arrange the workplace.
- Clean the workplace.



Formative Assessment

- Fill in what is missing in the following table.

Image	Name and its use.
a. 	
b. 	

c. 	
d. 	

2. Answer **true** or **false**.

- a. It is acceptable to dispose of hazardous materials and waste in regular trash bins.
 - b. Extinguishers should be readily available and regularly inspected in car body work workshops.
 - c. Is it acceptable to use damaged or malfunctioning tools and equipment as long as it can still perform the required task?
 - d. Keeping the workplace clean and free of debris is not essential for ensuring a safe working environment in the car body workplace.
3. Identify and describe the arrangement of all primary safety equipment that should be in the car body work workplace?
4. What are the criteria of workplace layout?
5. Identify the precaution safety for:
- a. Personal safety
 - b. Workplace safety
 - c. Tools safety
 - d. Equipment safety.
6. List all cleaning should be done before the start of your work.



Points to remember

- Remember that PPE includes Head, Body, Foot, Hearing, Respiratory, Eye and Face protection.
- In workplace precaution safety, remember that we have personal, workplace, tools, equipment and materials safety.
- The arrangement of the workplace layout in a car bodywork workshop is essential for optimising productivity, safety and workflow efficiency.
- Cleaning is divided into abrasive, thermal and chemical cleaning.



Self-reflection

1. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes after covering this unit.
2. There are no right or wrong ways to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process. Think about yourself:
 - a. Do you think you have the knowledge, skills and attitudes to do the task?
 - b. How well?
 - c. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Classify the personal protective equipment.					
Identify the use of that personal protective equipment.					
Identify the safety measures that should be applied at the car body workplace.					
Select tools, materials and equipment that can be used at the workplace.					
Describe the arrangements of tools, materials and equipment at a workplace.					
Describe the cleaning techniques used before and after work in car body work.					

3. Fill in the table below and share results with the trainer for further guidance.

Areas of strength	Areas for improvement	Actions to be taken to improve
1.	1.	1.
2.	2.	2.
3.	3.	3.

UNIT 2. REPAIR VEHICLE MINOR PARTS



Unit summary:

This unit describes knowledge, skills and attitude that allow you to identify and inspect vehicle damaged body, identify vehicle panel materials, select materials tools and equipment and apply different techniques to repair vehicle minor parts.

Self-assessment: Unit 2

1. Study the unit illustration above and answer the following questions:
 - a. What do you see in the illustration?
 - b. What is happening in the illustration?
 - c. What topic do you think will be covered under this unit based on the illustration?
2. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this unit.
 - a. There is no right or wrong way to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
 - b. Think about yourself: do you think you have the knowledge, skills or attitudes to do this? How well?
 - c. Read the statements across the top. Put a check in column that best represents your level of knowledge, skills or attitudes.
3. At the end of this unit, you will assess yourself again.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes.					
Identify vehicle minor parts.					
Inspect vehicle damage.					
Measure vehicle damage.					
Analyse vehicle damage.					
Classify vehicle damage.					
Identify types of vehicle panel materials.					
Select and describe the tools used during vehicle minor parts repair.					

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes.					
Select and describe the materials used during vehicle minor parts repair.					
Select and describe the equipment used during vehicle minor parts repair.					
Realign vehicle damaged Panels.					
Resize and reshape vehicle damaged panels.					
Replace vehicle damaged panels.					



Key competencies:

Knowledge	1. Skills	Attitude
1. Identify vehicle minor parts.	2. Apply identification techniques of vehicle minor parts.	1. Be precise.
2. Explain inspection techniques of vehicle minor damage.	3. Apply visual inspection techniques.	2. Be confident.
3. Explain vehicle minor damage repair techniques.	4. Apply repair techniques. 5. techniques.	3. Time management.



Discovery activity



Task 1

Make four groups of five students, each and each one performs the following task:

- a. Discuss what you can do during inspection of vehicle minor parts damage.
- b. Identify and discuss the materials of which the vehicle panel is made of.
- c. Discuss the techniques used during selection of tools, materials and equipment.
- d. Discuss the techniques used when you are repairing vehicle minor parts.

Note: The chosen secretary of the group will share response and discuss.

Topic 2.1: Identification of vehicles minor parts.



Activity 1: Problem solving



Task 2

ABC Transport company has ten vehicles which are used day-to-day to move people from Gisenyi to Kigali. They call you as technical assistance to identify vehicle minor parts so that they can order them for future use, the vehicles are brand new in Rwanda. Answer the following questions:

- i. Identify vehicle minor parts.
- ii. Describe the purpose of minor parts.
- iii. Identify the location of minor parts.

Key Facts 2.1. Identification of vehicles minor parts.

- **Identification of Vehicle Minor Parts.**



Figure 1: Illustration of vehicle minor parts

- **Description and Location of vehicle minor parts.**

- ✓ **Hood:** The vehicle hood, also known as the bonnet is a cover located at the front of the vehicle, designed to protect and provide access to the engine compartment.
- ✓ **Bumper:** A bumper is a structure attached to the front and rear ends of a vehicle to absorb impact in minor collisions.
- ✓ **Fender:** Fender is a curved sheet metal or plastic of the car's body that seats over and houses wheels.
- ✓ **Lid:** Lid is a removable or hinged cover for closing the opening.
- ✓ **Door:** A vehicle door is an essential component of vehicle designed to provide access to the interior of the vehicle while also ensuring the safety and security of the occupants.
- ✓ **Roof:** The term "vehicle roof" refers to the top part of a vehicle that covers the passenger compartment. The design and construction of vehicle roofs vary depending on the type of vehicle, such as cars, trucks, vans, etc.

- ✓ **Glass:** Vehicle glass refers to the special glass design used in automobiles, including cars, trucks, buses and other vehicles. It serves several important functions, such as providing visibility, protecting occupants from external elements.
- ✓ **Passenger compartment:** The passenger compartment, also known as the cabin or interior of a vehicle, refers to the enclosed space where the passengers sit. It is designed to provide comfort, safety and convenience to the occupants.
- ✓ **Trim:** Vehicle trim refers to the various levels or versions in which a particular vehicle model is available. Trim levels are differentiated by the features, options and equipment included in the vehicle.

Example: Door Trim, Dash Panel, Dashboard.

- ✓ **Side mirrors:** A vehicle side mirror is usually located on the exterior of the vehicle, on both the driver's and passenger's side and provides a view of the side and behind of the vehicle.



Activity 2: Guided practice



Task 3

1. Visit the school automobile workshop where you will find all necessary materials, tools and equipment and identify all vehicle minor parts to be ordered from abroad.
 - a. You will be working in small groups of five each.
 - b. Make rotation until all groups pass in each activity.
 - c. You will be guided by the trainer.
 - d. Present your observation and ask for clarification to your trainer.



Activity 3: Application



Task 4

1. Visit the nearest garage and observe different types of vehicle minor parts and ask a garage mechanic to let you observe vehicle parts to be ordered.
2. All the necessary equipment, tools and materials are available. The work is individual.
3. Present your observation and ask for clarification to your trainer.

Topic 2.2: Inspection of vehicle damaged panel.



Activity 1: Problem solving



Task 5

Read and answer the questions that follow:

- a. Discuss the techniques used to measure the vehicle body damage.
- b. Explain the analysis done on vehicle body damage.
- c. Classify vehicle body damage after doing analysis.

Key Facts 2.2 Inspection of vehicle damaged panel.

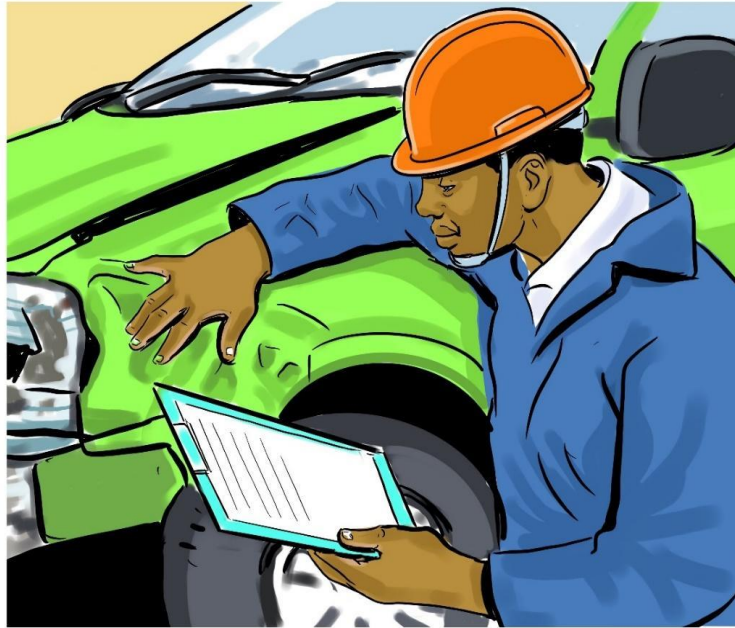


Figure 2: The panel beater is inspecting the vehicle damage

- ✓ **Vehicle inspection requires the following steps:**
 - ✓ **Measure vehicle body damage:** This requires careful observation and assessment to determine the extent of the damage, in some cases, measuring tools are used.
 - ✓ **Analyse vehicle body damage:** The analysis will focus on the severity of the damage.
 - ✓ **Classify vehicle damage:** If the extent of damage is too high, the damage is **major**, if it is too low it is **minor**.
 - ✓ Example of minor damage: Minor cracks, scratches or dents on the front or rear bumper.
 - ✓ Example of major damage: Frame damage.

Notes: Major damage can affect the structural integrity, safety and functionality of the vehicle.



Activity 2: Guided practice



Task 6

1. Visit the school automobile workshop and perform the following tasks the following tasks:
 - a. Measure the vehicle body damage.
 - b. Make analysis then report the type of damage.

Note: For any challenges please ask for help from your trainer.



Activity 3: Application



Task 7

1. In a small group of five trainees each, visit the nearest garage and ask garage manager to let you perform the following tasks:
 - a. Measure the vehicle body damage and report the status.
 - b. Analyse and provide explanation on vehicle body damage.
 - c. Classify vehicle body damage.

Topic 2.3. Selection of tools, materials and equipment.



Activity 1: Problem solving



Task 8

1. Read and answer the question that follows:
 - a. List any ten tools used to repair vehicle minor parts.
 - b. List any ten materials used to repair vehicle minor parts.
 - c. List any five equipment used to repair vehicle minor parts.
 - d. Describe any ten tools used to repair vehicle minor parts.
 - e. Describe any ten materials used to repair vehicle minor parts.
 - f. Describe any five equipment used to repair vehicle minor parts.

Key Facts 2.3 Selection of tools, materials and equipment.

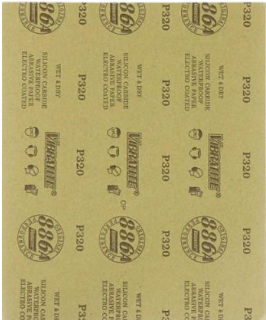
- **Materials**

Vehicle body repair materials are used to repair and restore the vehicle's body, minor parts after damage. These materials can vary depending on the extent and type of repair needed.

Materials	Description
✓ Body Filler  10	✚ Body filler, is a two-part polyester putty, which consists of a resin and a hardener. When these two components are mixed together, a chemical reaction occurs, causing the filler to harden and cure. ✚ Body filler is used in the automotive industry for repairing dents, scratches and other imperfections on a vehicle's body.
✓ Hardener for body filler  11	✚ Used to speed up the drying process, a chemical catalyst is provided by the manufacturer.
✓ Putty	✚ Auto body putty is a two-part product consisting of a plastic filler (like polyester or epoxy) and a hardening agent (catalyst).

¹⁰ Reference: James E. Duffy –Auto body repair Technology 2008 Page 352

¹¹ Reference: James E. Duffy –Auto body repair Technology 2008 Page 352

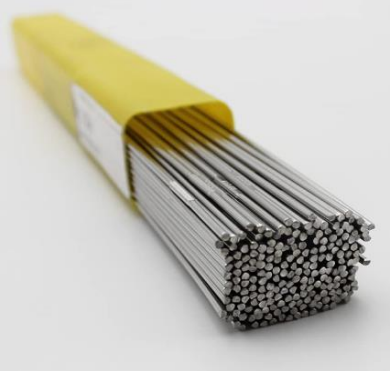
 12	Putty is used in automotive repair to fill in small holes not covered by body filler.
✓ Sandpaper  13  14	- It is a type of abrasive material that consists of a sheet or strip of strong paper or cloth that is coated with abrasive particles. - It is used to remove material from a surface, smooth rough edges and prepare a surface for painting or finishing.
✓ Masking tape  15	Masking tape is an adhesive tape specifically designed for automotive applications. It is commonly used for masking and protecting certain areas of a vehicle's body during paint and refinishing processes. The primary purpose of using masking tape on a car's body is to create clean and precise lines, preventing paint overspray.

¹² Source: Luxor Spot Putty | Buy Online in South Africa | takealot.com

¹³ Source: <https://www.thespruce.com/choose-the-right-sandpaper-grit-1822>

¹⁴ Source: Sandpaper Sheets, 100 Grit Dry Wet Sand Paper, 9 x 11 Inch, Silicon Carbide, for Wood Furniture Finishing, Metal Sanding and Automotive Polishing, 10 -Sheet : Amazon.in: Industrial & Scientific

¹⁵ Source: Buy Paper Tape Local Doctor Tape, Crepe Paper Masking Tape – CopyPencil.pk

✓ Welding rods or welding electrode  16	✚ Used to repair or replace damaged metal parts.
✓ Filler rod  17	✚ A filler rod, also known as a component used in various types of welding processes, such as shielded metal arc welding (SMAW), gas tungsten arc welding (GTAW/TIG) and gas metal arc welding (GMAW/MIG). The filler rod serves the purpose of adding material to the weld joint during the welding process.
✓ Fibreglass  18	✚ Used to fix damage on fibreglass components, such as bumpers and body panels.
✓ Panel bonding adhesive 	✚ Used to bond replacement ✚ Panels to the vehicle's body instead of welding.

¹⁶ Source: Mild Steel 350 mm Welding Rod, Thickness: 1.5 mm at Rs 3500/box in Pune | ID: 23363867188 (indiamart.com)

¹⁷ Source: 0.5Kg 500mm Low Temperature Repair Stainless Steel TIG Welding Rods for Filler Metals DIY Crafts Electrical Engineering Soldered Brazed 1mm 1.2mm 1.6mm 2.0mm 2.5mm 3.2mm: Buy Online at Best Price in UAE - Amazon.ae

¹⁸ Source: fibre decor wall coating wall grace - AliExpress

¹⁹ Reference: 3M 08115 Panel Bonding Adhesive, 200ml - Canada - Toll Free: 1-877-877-0873 — National Hardware Sales Ltd.

²⁰ Reference: Panel Bonding Adhesive Gun FOR SALE! - PicClick

✓ Body Seam Sealer  21	✚ Seam sealer is used to seal gaps and joints in the vehicle's body to prevent water and debris from entering and causing further damage.
✓ Degreaser  22 ✓ Rags  23	✚ Various cleaning agents, degreasers, rags and surface preparation products are used to ensure the body is clean and ready for repair work.
II. Tools	
Tool & Image	Description and Use
✓ Screwdrivers  24	✚ These come in various types and sizes, such as flathead and Phillips or star, Torx and are used to tighten or loosen screws on various components.
✓ Pliers	✚ Pliers are the tools used for gripping, bending and cutting wires, hoses and other small components.

²¹ Reference: Eastwood Seam Sealer Cartridge

²² Reference: Citrus Degreaser - Essential Industries (essind.com)

²³ Reference: Amazon.com : oil rags

²⁴ Source: Amazon.com: Cushion Grip Stubby Screwdriver Set, 2 Piece : Tools & Home Improvement

 25	
✓ Wrenches  26  27  28	✚ Wrenches are essential for tightening and loosen nuts and bolts. Combination wrenches, Open wrenches, adjustable wrenches and socket wrenches are commonly used in vehicle repairs.
✓ Ratchets  29	✚ Ratchets paired with sockets are efficient for quickly removing and installing bolts and nuts.
✓ Torque Wrench  30	✚ A torque wrench is used to apply a specific amount of torque as recommended by the manufacturer.

²⁵ Source: RS PRO Combination Pliers, 150 mm Overall, Straight Tip, 34mm Jaw | RS (rs-online.com)

²⁶ Source: Buy Taparia Combination Spanner Set CSS25 Online in India at Best Prices (industrybuying.com)

²⁷ Source: RIDGID 31025 Heavy-Duty Straight Pipe Wrench, 18" Sturdy Plumbing Wrench with Self Cleaning Threads and Hook Jaws, Red - Ridgid Pipe Wrench - Amazon.com

²⁸ Source: ERGO™ Rubber Handle Central Nut Adjustable Wrenches, with reversible jaw. | BAHCO | Bahco International

²⁹ Source: Kobalt 90-Tooth 3/8-in Drive Quick-release Standard Ratchet in the Ratchets & Ratchet Sets department at Lowes.com

³⁰ Source: <https://boxousa.com/products/1-4-drive-inch-pound-micrometer-type-torque-wrench>

✓ Allen Keys  31	These tools are used to tighten or loosen hexagonal socket screws commonly found in various vehicle parts.
✓ Dollies and Spoons 	- Car bodywork dollies and spoons are solid metal blocks or platforms with various shapes and contours made of hardened steel. - They are fundamental tools in auto body repair and restoring the vehicle's original appearance. - They are used in conjunction with a hammer or mallet to shape and form metal panels precisely without causing further damage. The dolly or spoon is placed on the opposite side of the panel being worked on and the technician strikes the damaged side with the hammer, causing the metal to bend or stretch into the desired shape.
✓ Hammers  32	These are specialised tools designed specifically for shaping and manipulating metal panels in automotive repair and restoration processes. They are used to remove dents, straighten bent panels and create smooth contours in the car's body.

³¹ Source: [Buy Beta Tools 000960374, 96/SC9 Set of Offset Hexagon Key Wrenches, 9 pcs - Mega Depot](#)

³² Source: Bumping Hammer - rough-KING TONY-9CF110

 33 34 35	There are several types of body hammers, each with a specific purpose: ▪ Bumping Hammer: Also known as a "pick" used for general shaping and smoothing of metal surfaces. ▪ Cross Peen Hammer: This hammer has a flat face on one end and a wedge-shaped or "cross peen," on the other end. The cross peen is used for making precise lines in metal panels. ▪ Chisel Hammer: Similar to a bumping hammer, but it has a sharper chisel-like end for more aggressive metal shaping. ▪ Shrinking Hammer: This hammer has a round, ball-like face and is used to shrink stretched metal back to its original shape. ▪ Picking Hammer: This hammer has a sharp, pointed end and is used for working on hard-to-reach areas and for picking out dents.
✓ Soft hammer	It is commonly made in rubber and can be used to tap or gently knock parts into place without causing surface scratch.

³³ Source: Hultafors 3843100 - 1.15kg Blacksmith's Cross Pein Hammer SMH 1000 (Hickory Handle) (hunt gather grow.com.au)

³⁴ Source: CHISEL HAMMER (waymil.com)

³⁵ Source: Light Shrinking Hammer - Bulldog Abrasives

 36	
✓ Pry Bars  37	✚ Pry bars are used to separate components or prying off trim pieces without causing damage.
✓ Chisel  38	✚ It is a tool that has a sharp cutting edge that is typically made of metal and used for cutting or shaping materials.
✓ Vice grip  39 40	✚ A vice grip, also known as a locking plier or Vise-Grip is a hand tool that plays a significant role in various applications. ✚ Its primary function is to securely hold objects, allowing you to perform tasks that require a firm grip or the need to hold materials in place.
✓ Bench Vice	✚ A bench vise (also spelled "vice" in some regions) is a mechanical tool commonly used in workshops, garages and other mechanical settings. It is designed to securely hold work pieces in place,

³⁶ Source: Estwing - DFH-12 Rubber Mallet - 12 oz Double-Face Hammer with Soft/Hard Tips & Hickory Wood Handle - DFH12,Black Red & Yellow - Walmart.com

³⁷ Source: Mayhew | Pry Bars | Pry Bars Sets - Utility Pry Bar Set | 4 PC Utility Pry Bar Set - Mayhew Steel Products

³⁸ Source: Metal Chisel at Best Price in India (indiamart.com)

³⁹ Source: AUTOGEAR VICE GRIP PLIER — RBMidas

⁴⁰ Source: IRWIN VISE-GRIP Locking Pliers, Welding Clamp, 9-Inch (25ZR) - Locking Jaw Pliers - Amazon.com

 41	allowing for various operations like cutting, drilling, filing, grinding and other metalworking or woodworking tasks. .
✓ Jack and Jack Stands  42	✚ These are essential for lifting the vehicle off the ground during repair.
✓ Dent Pullers  43	✚ These tools are used to remove dents from the vehicle body without damaging the paint or finish.
✓ Body filler mixing palette and Spreader	✚ Body filler mixing pallet is a plate on which filler is mixed with hardener using a plastic spreader. ✚ Spreader is a plastic spreader or putty knife that is used to apply body filler smoothly.

⁴¹ Source: Eclipse EMV-5 Mechanics Vice 5 Inch / 125mm | Toolstop

⁴² Source: Daytona DLP1700 + T42001CA 1700 kg Low Profile Hydraulic Trolley Jack & 1.5 Tonne Heavy Duty Jack Stands (sydney tools.com.au)

⁴³ Source: Amazon.com: HiYi Paintless Dent Removal Tools Heavy Duty Vacuum Suction Cup Dent Puller for Refrigerator Glass Tools Hand Puller Lifter Set Body Repair Dent Fix Tools : Automotive

 44	
✓ Auto body file holder  45  46	✚ An auto body file holder for filler is a tool used in the automotive repair industry to hold a file securely while working with body filler or other similar materials.
✓ Sanding pad  47	✚ A sanding pad, also known as a sanding block or sanding sponge, is a tool used in various manual sanding applications. It consists of an abrasive surface mounted on a block or sponge-like material, which provides support and flexibility during sanding.
✓ MAP Gas	✚ It is used to create heat when straightening the bumper or other vehicle minor parts during repair.

⁴⁴ Source: Amazon.com: Custom Shop Automotive 1725 Body Filler Mixing Board with 3-Plastic Spreaders (4", 5" and 6") and Goop Scoop for getting filler out of the can : Automotive

⁴⁵ Source: FBH14 Flexible Body File Holder - Hare & Forbes Machineryhouse

⁴⁶ Source: Amazon.com: Car Body Polisher Files Flexible Body File Adjustable Holder with 350MM Blade (Middle Tooth) : Everything Else

⁴⁷ Source: Hand Sanding Block - Hard Density - For Adhesive Backed Sanding

 48	
III. Equipment Vehicle bodywork equipment refers to the equipment used in the automotive industry to repair, modify and maintain the vehicles. Here's a list of common vehicle body repairs.	
✓ Gas welding set  49	✚ Used to weld a car body which is made in a thin sheet.
✓ Sport welder  51	✚ Specialised in welding and repairing the bodies of vehicles, particularly sports cars or vehicles.
✓ Sanding machine	✚ Used to sand filler and putty.

⁴⁸ Mapp Gas Welding Hand Torch - Buy Mapp (wiceshop.com)

⁴⁹ Source: Big field gas welding kit OX-AC model 40L +AC 40L - Phnom Penh Gas Center (ppgascenter.com)

⁵⁰ Source: ZenStyle Oxygen & Acetylene Gas Cutting Torch and Welding Kit Portable Oxy Brazing Welder Tool Set with Two Hose,Regulator Gauges,Storage Case: Buy Online at Best Price in UAE - Amazon.ae

⁵¹ Source: Amazon.com: VEVOR Stud Welder Dent Repair Kit, 3000W 220V, Spot Welder Dent Puller, 7 Models Spot Welding Machine for Car Body Dent Repair : Automotive

 52	
✓ Angle grinder  53	✚ Used to grind old filler and paint after reshaping the vehicle panel.
✓ Air compressor  54	✚ Provide compressed air for various tools, including paint sprayers and pneumatic hammers.
✓ Bodywork Measurement Systems  55  56	✚ Laser or digital measuring systems to ensure accurate alignment during repairs. ✚ The Mechanical measuring tool allows rapid diagnosis of all types of vehicles by making underbody measurements (length, symmetry and cross check) easier. Its simple operation allows a single person to perform the measurement.



Activity 2: Guided practice



Task 9

1. Make small groups of five for each and go in the automobile workshop, ask garage manager to let you perform the task below:

⁵² Source: Car Palm Orbital Sander Sanding Air Compressor Metal Plastic Composite Filler 722470278436 | eBay

⁵³ Source: Amazon.com: BOSCH 1375A Corded 4-1/2-Inch 6 Amp Angle Grinder : Everything Else

⁵⁴ Source: SE/HE Series | SWAN : An Expert On Air Compressor (swan-aircompressor.com)

⁵⁵ Source: Autorobot EzCalibre - Autorobot

⁵⁶ Source: 052130.pdf (gys.fr)

- i. Select materials, tools and equipment to be used when you will be repairing vehicle minor parts.
 - ii. Describe the selected tools, materials and equipment to be used to repair vehicle minor parts.
 - iii. Discuss the use of each tool, material and equipment that will be needed.
 - iv. Describe the selected tools, materials and equipment to be used to repair vehicle minor parts.
2. After the discussions, let each group present their work and answer questions raised by other group members.
3. Review the assigned task together and provide clarification where necessary.



Activity 3: Application



Task 10

1. Visit the nearest garage and ask garage manager to let you perform the tasks below:
 - a. Select the materials that you will need to repair vehicle minor parts.
 - b. Select the tools that you will need to repair vehicle minor parts.
 - c. Select the equipment that you will need to repair vehicle minor parts.

Topic 2.4: Repair vehicles minor parts.



Activity 1: Problem solving



Task 11

In your respective groups discuss on the task that follow:

- i. What are the techniques used to realign the damaged panels?
- ii. List all steps followed to resize and reshape the damaged panel?
- iii. Explain replacement of the damaged panel.

Key Facts 2.4 Repair vehicle minor parts.

- **Vehicle Minor Parts Repair⁵⁷**



Figure 3: The Technicians are repairing rear bumper

- ✓ **Realignment of damaged panels:** The realignment of damaged panels typically refers to the process of restoring and aligning body panels on a vehicle that have been misaligned or damaged due to accidents, collisions or other incidents.

⁵⁷ Source: James E.Duffy – Auto Body Repair Technology P11(2008, Delmar Cengage Learning) – libgen.lc.

Steps

-  To assess the extent of damage.
-  Disassembly, If necessary, the damaged panels may need to be removed from the vehicle for a more thorough inspection and repair.
-  Refit the panel.
- ✓ **Resize and Reshaping:** This process may vary depending on the type of material the panel is made of (e.g., metal, fibreglass, plastic) and the extent of the damage.

Steps:

-  **Assess the severity of the damage.** Before attempting any repairs, assess the extent of the damage to determine if it can be repaired or if it needs replacement.
-  **Wear appropriate safety gear.** Such as gloves and eye protection, to protect yourself during the repair process.
-  **Remove the Panel.** If the panel is severely damaged, it might need to be removed from the vehicle for better access to the damaged areas.
-  **Straightening the Panel.** If the panel is made of metal and has minor dents, it can be straightened using specialised tools like a dolly and hammer or a dent puller.
-  **Welding and Bonding.** For metal panels with large tears or holes, welding may be necessary to close the gaps. Plastic and fibreglass panels may require bonding with specialised adhesives.
-  **Sanding and Shaping.** After any necessary repairs, sand the panel to create a smooth surface. Use body filler to fill in any remaining imperfections and shape the panel back to its original form.
- ✓ **Replacement of damaged panels:** If the damage is too severe, the panels may need to be replaced entirely. In such cases, new panels will be ordered and installed on the vehicle.

Steps:

- ✓ **Measuring of the damage.** Measure the damaged area and make a record in a notebook.

- ✓ **Analyse the damage.** If the damage is small repair is possible, if it is excessive the panel is replaced.
- ✓ **Replace damaged panel.** Remove the damaged panel from the vehicle using appropriate tools and install a good one.



Activity 2: Guided practice



Task 12

1. Visit your school automobile workshop where you will find all necessary materials, tools and equipment, with the guide of your trainer perform the following task:
 - i. Realign a damaged panel that happened during a vehicle collision.
 - ii. Resize and reshape damaged panels.
 - iii. Replace the panel that has been excessively damaged.
2. For any challenge, ask your trainer for help.



Activity 3: Application



Task 13

1. Visit the nearest garage and ask a garage manager to let you perform the following task:
 - i. Realign a damaged panel that happened during a vehicle collision.
 - ii. Resize and reshape damaged panels.
 - iii. Replace the panel that has been excessively damaged.



Formative assessment

1. Choose items from the following list that are not among the PPE used during vehicle minor part repair.

- a. Overall
- b. Steel toed Safety shoes
- c. Necktie
- d. Hand glove
- e. Masking tape
- f. Sanding pad

2. Mark the following statement as True or False.

The following are vehicle minor parts:

- a. Hood
- b. Bumper
- c. Fender
- d. Frame
- e. Door
- f. Roof
- g. Glass
- h. Passenger compartment
- i. Trim

3. Read the statement and highlight the correct answer.

Vehicle damage are classified into two types:

- a. Linear damage and circular damage.
- b. Minor damage and major damage.
- c. Both **a** and **b** are correct.

4. Mark the following statement as True or False.

- a. Realignment refers to the process of restoring and aligning body panels on a vehicle that have been misaligned or damaged due to accidents.
- b. Replacement of vehicle damaged panels refers to the exchange of vehicle parts.

5. Differentiate resizing and reshaping of the vehicle panel.



Points to remember

- If the panels damage is too severe, then it may need:
to be replaced entirely. In such cases, new panels will be ordered and installed on the vehicle.
- When repairing the damaged panel, care must be taken on the force being applied due to the materials it's made from.
- Remember to use special body panel tools to protect vehicle body.



Self-reflection

1. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes after covering this unit.
2. There are no right or wrong ways to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process. Think about yourself:
 - a. Do you think you have the knowledge, skills and attitudes to do the task?
 - b. How well?
 - c. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.

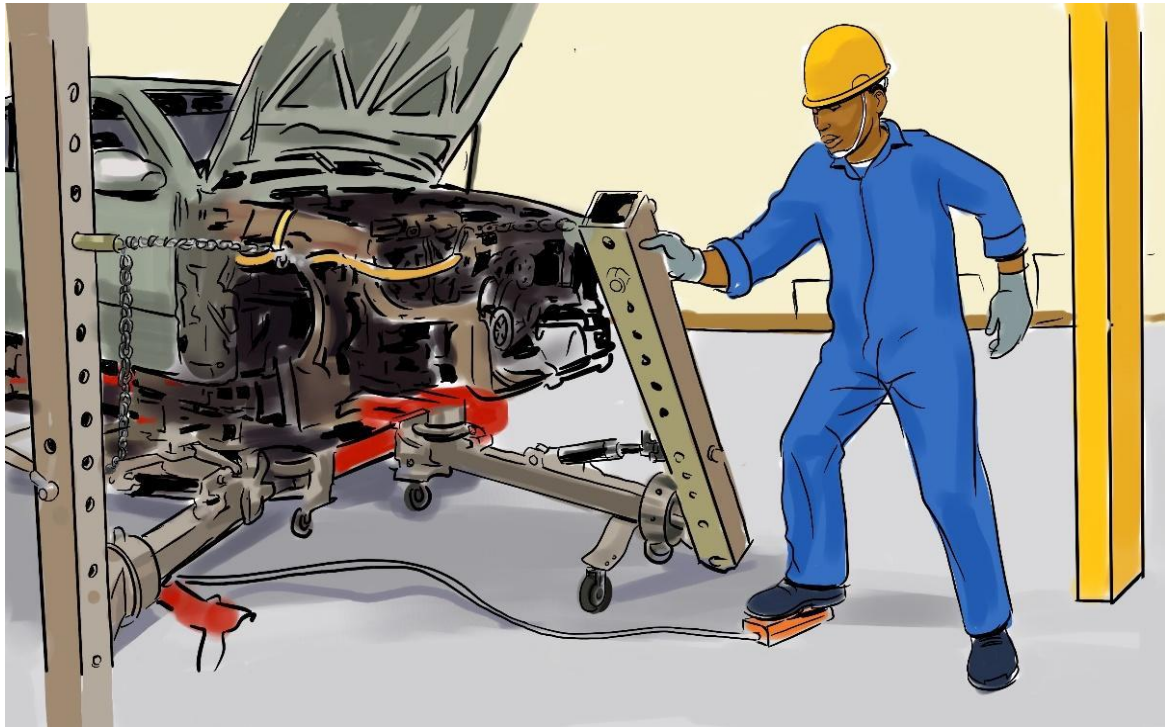
My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Classify the personal protective equipment.					
Identify the use of that personal protective equipment.					

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Identify the safety measures that should be applied at the car body workplace.					
Select tools, materials and equipment that can be used at the workplace.					
Describe the arrangements of tools, materials and equipment at a workplace.					
Describe the cleaning techniques used before and after work in car body work.					

3. Fill in the table below and share results with the trainer for further guidance.

Areas of strength	Areas for improvement	Actions to be taken to improve
1.	1.	1.
2.	2.	2.
3.	3.	3.

UNIT 3. REPAIR VEHICLE MAJOR PARTS



Unit summary:

This Unit describes knowledge, skills and attitude that allow you to identify vehicle major parts; Select materials tools and equipment; Measure damaged panels and repair vehicle major parts.

Self-assessment: Unit 3

1. Study the unit illustration above and answer the questions:
 - a. What do you see in the illustration?
 - b. What is happening in the illustration?
 - c. What topic do you think will be covered under this unit based on the illustration?
2. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this unit.
 - a. There is no right or wrong way to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
 - b. Think about yourself: do you think you have the knowledge, skills or attitudes to do this? How well?
 - c. Read the statements across the top. Put a check in column that best represents your level of knowledge, skills or attitudes.
3. At the end of this unit, you will assess yourself again.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
List major parts.					
Describe major parts.					
List and describe the tools used to repair vehicle major parts.					
List and describe the materials used to repair vehicle major parts.					
List and describe the equipment used to repair vehicle major parts.					
Determine visual extent of impact /damage and its effects.					

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Use measuring tool to determine vehicle collision impact and its effects.					
Realign damaged panels.					
Resize and Reshaping / replacement of damaged panels.					



Key competencies:

Knowledge	Skills	Attitude
1. Identify vehicle major parts.	1. Apply the techniques to identify vehicle major parts.	1. Pay attention to details.
2. Describe and discuss the use of tools, materials and equipment.	2. Use tools, materials and equipment.	2. Be aware of safety.
3. Explain vehicle major damage repair techniques.	3. Apply repair techniques.	3. Time management.
4. Measure vehicle damage.	4. Apply measuring techniques of vehicle damage.	4. Be precise.



Discovery activity



Task 1

Make four groups of five students each and each one performs the following task:

- a. Discuss about what you can do during identification of vehicle major parts.
- b. Describe the materials of which the vehicle panel is made of.
- c. Discuss the techniques used during selection of tools, materials and equipment.
- d. Explain the vehicle major parts damage measuring techniques.
- e. Discuss the vehicle major parts repair techniques.

Note: The chosen secretary of the group will share response and discuss.

Topic 3.1 Identification of vehicles major parts.



Activity 1: Problem Solving



Task 2

Read and answer the following questions:

- i. Identify all vehicle major parts.
- ii. Describe vehicle major parts.

Key Facts 3.1 Vehicle major parts⁵⁸

To avoid confusion, the major parts of a vehicle can be categorised as parts of the body, the chassis or the frame. You must understand each major division.

- **Identification of vehicle major parts**



Figure 4: Technician is observing Vehicle frame

- ✓ **Frame:** The vehicle frame is a high-strength structure used to support all parts of the vehicle. The frame can be separate from the body or integrated into the body shell, as in the case of uni-body design.
- ✓ **Uni-body:** Uni-body construction uses body parts welded or adhesive bonded (glued) together to form an integral (built-in) frame.

⁵⁸ Source: James E.Duffy – Auto Body Repair Technology P11(2008, Delmar Cengage Learning) – libgen.lc.

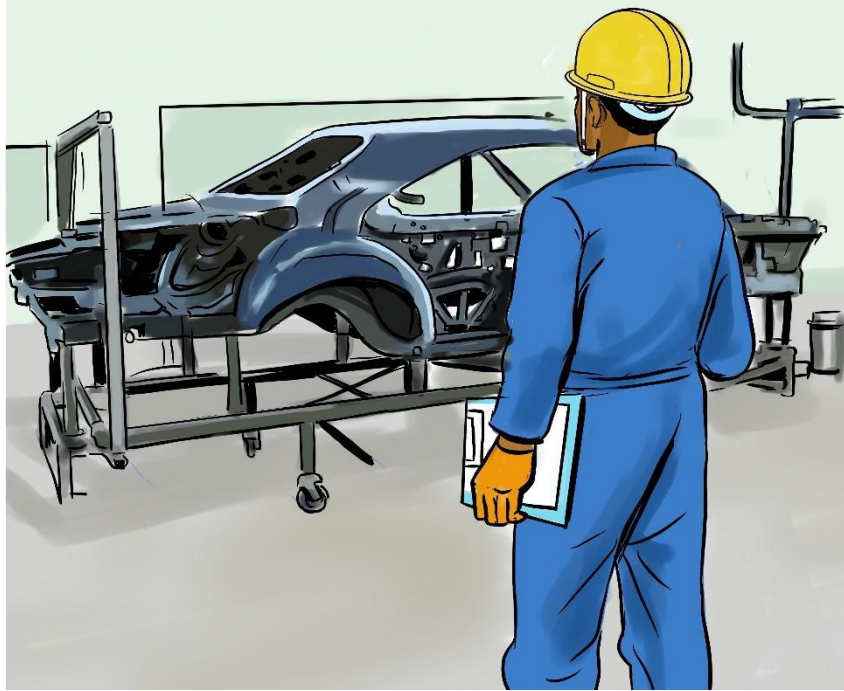


Figure 5: The Technician is observing vehicle Uni-body parts



Activity 2: Guided practice



Task 3

1. Visit the school automobile workshop where you will find vehicle having the two types of major parts and ask garage manager to let you perform the task:
 - a. Identify vehicle major parts.
 - b. Describe the vehicle major parts.
2. You will be working in small groups of five each.
3. Make rotation until all groups pass in each activity.
4. Present your observation and ask for clarification to your trainer.



Activity 3: Application



Task 4

1. Visit the nearest garage and ask a garage mechanic to let you identify and describe the vehicle major parts.
2. Present your observation and ask clarification to your trainer.

Topic 3.2 Selection of tools, materials and equipment



Activity 1: Problem solving



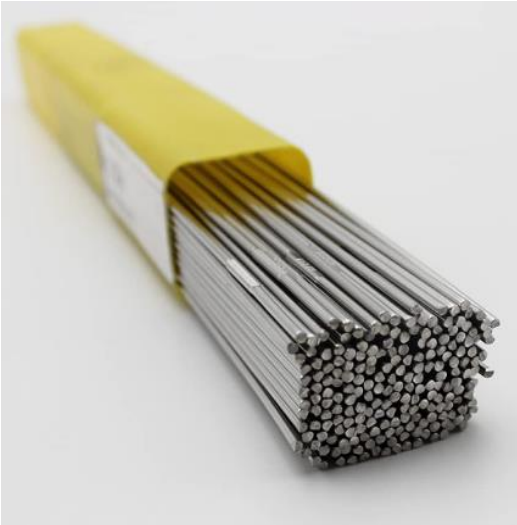
Task 5

1. Answer the question that follows:
 - a. List the tools to be used during vehicle major parts repair.
 - b. List the materials to be used during vehicle major parts repair.
 - c. List the equipment to be used during vehicle major parts repair.
 - d. Describe the tools to be used during vehicle major parts repair.
 - e. Describe the materials to be used during vehicle major parts repair.
 - f. Describe the equipment to be used during vehicle major parts repair.

Key Facts 3.2 SELECTION OF TOOLS, MATERIALS AND EQUIPMENT.

- **Materials**

Vehicle body repair materials are used to repair and restore the vehicle's body, Major Parts after damage. These materials can vary depending on the extent and type of repair needed.

Materials	Description
Welding rods or Welding electrode  59	Used to repair or replace damaged metal parts.
Filler rod  60	A filler rod, also known as opponent used in various types of welding processes, such as shielded metal arc welding (SMAW), gas tungsten arc welding (GTAW/TIG) and gas metal arc welding (GMAW/MIG). The filler rod serves the purpose of adding material to the weld joint during the welding process.
Degreaser	Various cleaning agents, degreasers, rags and surface preparation products are used to ensure the body is clean and ready for repair work.

⁵⁹ Source: Mild Steel 350 mm Welding Rod, Thickness: 1.5 mm at Rs 3500/box in Pune | ID: 23363867188 (indiamart.com)

⁶⁰ Source: 0.5Kg 500mm Low Temperature Repair Stainless Steel TIG Welding Rods for Filler Metals DIY Crafts Electrical Engineering Soldered Brazer 1mm 1.2mm 1.6mm 2.0mm 2.5mm 3.2mm: Buy Online at Best Price in UAE - Amazon.ae



61

Rags



62

Tools

Tool & Image	Description
Wrenches  63	Wrenches are essential for tightening and loosen nuts and bolts. Combination wrenches, Open wrenches, adjustable wrenches and socket wrenches are commonly used in vehicle repairs.

⁶¹ Reference: Citrus Degreaser - Essential Industries (essind.com)

⁶² Reference: Amazon.com : oil rags

⁶³ Source: Buy Taparia Combination Spanner Set CSS25 Online in India at Best Prices (industrybuying.com)

 64 65	
Ratchets  66	Ratchets paired with sockets are efficient for quickly removing and installing bolts and nuts.
Torque Wrench  67	A torque wrench is used to apply a specific amount of torque as recommended by Manufacturer.
Allen Keys  68	These tools are used to tighten or loosen hexagonal socket screws commonly found in various vehicle parts.

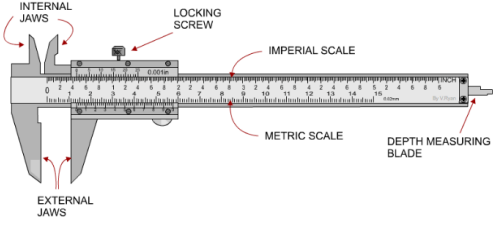
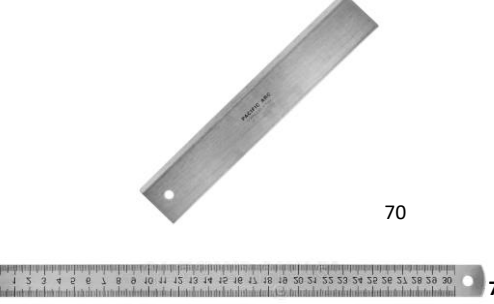
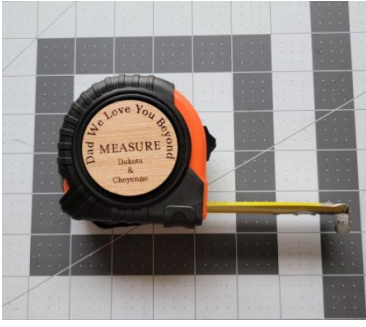
⁶⁴ Source: RIDGID 31025 Heavy-Duty Straight Pipe Wrench, 18" Sturdy Plumbing Wrench with Self Cleaning Threads and Hook Jaws, Red - Ridgid Pipe Wrench - Amazon.com

⁶⁵ Source: ERGO™ Rubber Handle Central Nut Adjustable Wrenches, with reversible jaw. | BAHCO | Bahco International

⁶⁶ Source: Kobalt 90-Tooth 3/8-in Drive Quick-release Standard Ratchet in the Ratchets & Ratchet Sets department at Lowes.com

⁶⁷ Source: <https://boxousa.com/products/1-4-drive-inch-pound-micrometer-type-torque-wrench>

⁶⁸ Source: Buy Beta Tools 000960374, 96/SC9 Set of Offset Hexagon Key Wrenches, 9 pcs - Mega Depot

Vernier Callipers  69	Used to measure the depth and width of dents, as well as the thickness.
Straight Edge/Ruler  70 71	Use a straight edge or ruler to check for deformations of the panel.
Tape Measure  72	Used to measure the length, width and height of the damaged area.
Feeler Gauges:  73	Feeler gauges measure small clearances inside parts. Blade thickness is given on each blade in thousandths of an inch (0.001, 0.010 or 0.020) or in hundredths of a millimetre (0.01, 0.07 or 0.10). Flat feeler gauges are for measuring between parallel surfaces.

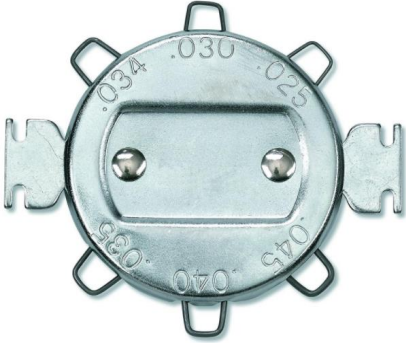
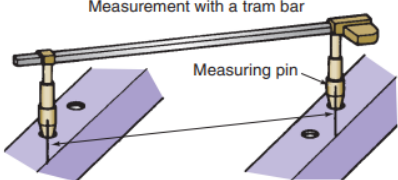
⁶⁹ Source: https://www.researchgate.net/figure/Vernier-calliper-6_fig3_319648634

⁷⁰ Source: Straight Edge Stainless Steel 0.09" Thick Steel, Heavy Duty : Amazon.ca: Office Products

⁷¹ Source: Metal-ruler-30cm-image17369358

⁷² Source: personalised-tape-measure

⁷³ Source: Flat Feeler Gauge | FINE TOOLS (fine-tools.com)

 74	Wire feeler gauges are round for measuring slightly larger distances between nonparallel or curved surfaces, such as spark plug gaps.
Depth Gauge  75	Used to measure the depth of cracks or grooves on the panel.
Dial indicator  76	A dial indicator is sometimes used to measure part movement and out-of-round in thousandths of an inch (or hundredths of a millimetre). For example, the indicator might be used to check for wheel damage by mounting it against the wheel or tire. When the tire is rotated, the dial indicator will show how much the wheel is bent. This would let you know that the wheel should be replaced.
Tram Gauge  77	A tram gauge is a special body dimension measuring tool. It is usually a lightweight frame with pointers. The pointers can be aligned with body dimension reference points to determine the direction and amount of body misalignment damage.

⁷⁴ Source: Wire Gauge : Automotive

⁷⁵ Source: YURI Digital Depth Gauge 8", Stainless Steel, 0-200 mm Range : Amazon.in: Industrial & Scientific

⁷⁶ Source: Measure brake disc run out using our Moore and Wright indicator and magnetic base set - Machine DRO UK (machine-dro.co.uk)

⁷⁷ Source: James E.Duffy – Auto body Repair Technology (2008- P503)

Bodywork Measurement Systems  78	Laser or digital measuring systems to ensure accurate alignment during repairs. The Mechanical measuring tool allows rapid diagnosis of all types of vehicles by making underbody measurements (length, symmetry and cross check) easier. Its simple operation allows a single person to perform the measurement.
Dollies and Spoons 	Car bodywork dollies and spoons are solid metal blocks or platforms with various shapes and contours made of hardened steel. They are fundamental tools in auto body repair and restoring the vehicle's original appearance. They are used in conjunction with a hammer or mallet to shape and form metal panels precisely without causing further damage. The dolly or spoon is placed on the opposite side of the panel being worked on and the technician strikes the damaged side with the hammer, causing the metal to bend or stretch into the desired shape.
Hammers  79	

⁷⁸ Source: [Autorobot EzCalibre - Autorobot](#)

⁷⁹ Source: Sledge Hammer | General Site Tools | Building & Site (psm hire.co.uk)

Pry Bars  80	Pry bars are used to separate components or prying off trim pieces without causing damage.
Chisel  81	It is a tool that has a sharp cutting edge that is typically made of metal and used for cutting or shaping materials.
Bench Vice  82	A bench vise (also spelled "vice" in some regions) is a mechanical tool commonly used in workshops, garages and other mechanical settings. It is designed to securely hold work pieces in place, allowing for various operations like cutting, drilling, filing, grinding and other metalworking or woodworking tasks. .
Jack and Jack Stands  83	These are essential for lifting the vehicle off the ground during repair.

⁸⁰ Source: Mayhew | Pry Bars | Pry Bars Sets - Utility Pry Bar Set | 4 PC Utility Pry Bar Set - Mayhew Steel Products

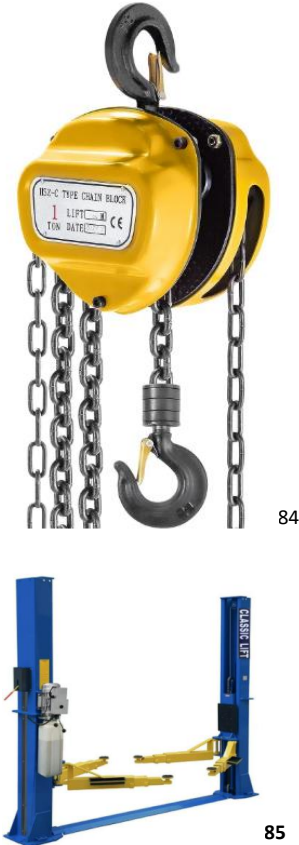
⁸¹ Source: Metal Chisel at Best Price in India (indiamart.com)

⁸² Source: Eclipse EMV-5 Mechanics Vice 5 Inch / 125mm | Toolstop

⁸³ Source: Daytona DLP1700 + T42001CA 1700 kg Low Profile Hydraulic Trolley Jack & 1.5 Tonne Heavy Duty Jack Stands (sydney tools.com.au)

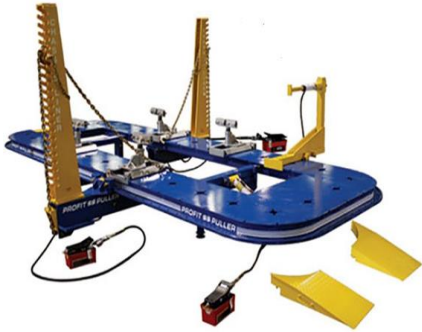
- **Equipment**

Vehicle bodywork equipment refers to the equipment used in the automotive industry to repair, modify and maintain the vehicles. Here's a list of common vehicle body repairs.

Equipment & Image	Description
Hydraulic Lifts and Hoists  84 85	Used to raise the vehicle off the ground, making it easier to access the undercarriage and body components. It is a specialised equipment used in the automotive industry to repair and align the damaged structural frame and body of a vehicle.
Frame Rack	

⁸⁴ Source: Lifting-Pulling-Equipment

⁸⁵ Source: (Car lift.com.au)

 86	
Welding Machines with accessories  87  88	Used for joining and repairing metal parts of the vehicle body. Common types include MIG (Metal Inert Gas) welders, TIG (Tungsten Inert Gas) welders and spot welders.
Gas welding set	Used to weld a car body which is made in a thin sheet.

⁸⁶ Source: Chassis Liner Profit Puller 18' 2-Tower 360-Degree Frame Rack 832165 (collisionsservices.com)

⁸⁷ Source: techno tronics Arc 218 DC Inverter Arc Welder Inverter Welding Machine Price in India - Buy techno tronics Arc 218 DC Inverter Arc Welder Inverter Welding Machine online at Flipkart.com

⁸⁸ Source: Powerweld Welders Essentials Kit WEBKIT | Zoro

 89  90	
Sport welder  91	Specialised in welding and repairing the bodies of vehicles by making sports.

⁸⁹ Source: Big field gas welding kit OX-AC model 40L +AC 40L - Phnom Penh Gas Center (ppgascenter.com)

⁹⁰ Source: ZenStyle Oxygen & Acetylene Gas Cutting Torch and Welding Kit Portable Oxy Brazing Welder Tool Set with Two Hose,Regulator Gauges,Storage Case: Buy Online at Best Price in UAE - Amazon.ae

⁹¹ Source: Amazon.com: VEVOR Stud Welder Dent Repair Kit, 3000W 220V, Spot Welder Dent Puller, 7 Models Spot Welding Machine for Car Body Dent Repair : Automotive

Angle grinder  92	Used in cutting or grinding process.
Air compressor  93	Provide compressed air for various tools like pneumatic hammers.



Activity 2: Guided practice



Task 6

Mr Karim got an accident when he was driving from Rwamagana to Kigali, his vehicle got a collision with another car in opposite direction due to the tire puncture and the front cross member of the frame got excessive damage and lose its shape and fitting position, Mr Karim decided to bring the car in the school workshop for repair.

You are requested to form groups of five trainees each, visit the workshop and perform the given tasks.

- Select materials, tools and equipment to be used when you will be repairing that car.
- Describe the selected above tools, materials and equipment.
- Discuss the use of each tool material and equipment that will be needed to repair that car.

⁹² Source: Amazon.com: BOSCH 1375A Corded 4-1/2-Inch 6 Amp Angle Grinder : Everything Else

⁹³ Source: SE/HE Series | SWAN : An Expert On Air Compressor (swan-aircompressor.com)

Note: For any challenges please ask for help from your trainer.



Activity 3: Application



Task 7

1. The task is individual.
2. Read the statement and act accordingly:

Visit the nearest garage where you will find a vehicle with a damaged.

Uni-body, observe the damage and ask garage manager to let you perform the following tasks:

- i. Select the materials that you will need to repair major parts of the vehicle.
 - ii. Select the tools that you will need to repair major parts of the vehicle.
 - iii. Select the equipment that you will need to repair major parts of the vehicle.
3. Present your observation and ask for clarification to your trainer.

Topic 3.3 Measurement of damaged panel



Activity 1: Problem solving



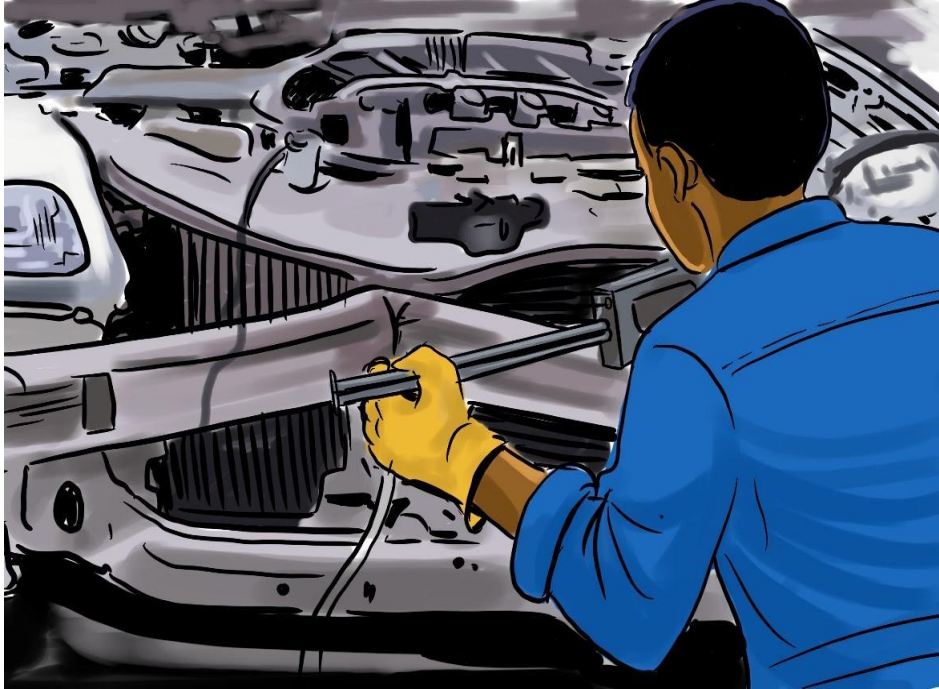
Task 8

In group of five, answer the following questions:

- i. Explain visual inspection technique used to determine the extent of impact / damage and its effects.
- ii. Discuss the use of measuring tools technique to determine vehicle collision impact and its effects.

Key Facts 3.3 Measurement of damaged panel

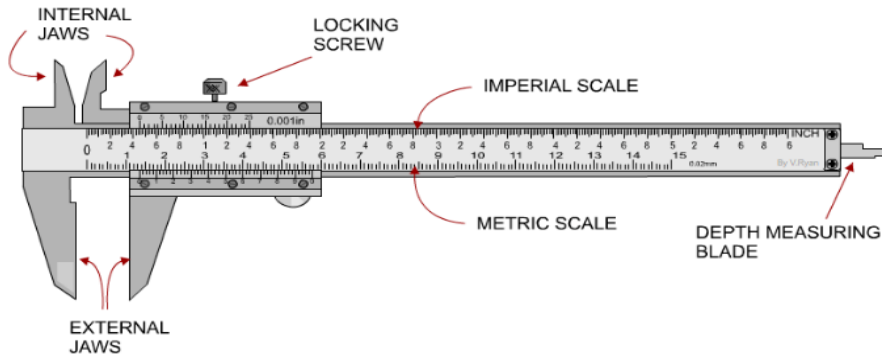
Measuring a damaged panel involves assessment of its dimensions and condition compared to the original ones.



- **Measuring techniques of damaged panel**

Measuring techniques for damaged panels can vary depending on the type of panel, the extent of the damage and the desired level of precision. The following are general steps and techniques you can use to measure damaged panels:

- ✓ **Visual Inspection:** Used to identify the type and extent of damage, such as dents, cracks or deformations.
- ✓ **Use of Measuring tool:** You may need various measuring tools depending on the type of damage such as:
 - ✚ **Vernier Callipers:** Used to measure the depth and width of dents, as well as the thickness.

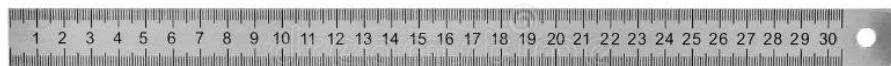


94

- ✚ **Straight edge/Ruler:** Use a straight edge or ruler to check for deformations of the panel.

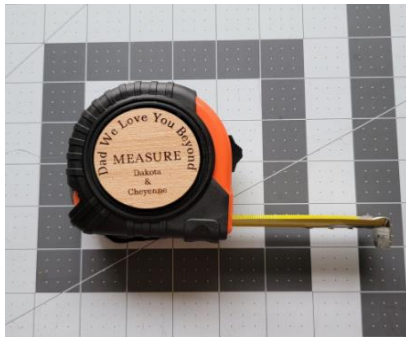


95



96

- ✚ **Tape Measure:** Used to measure the length, width and height of the damaged area.



97

- ✚ **Feeler Gauges:** Feeler gauges measure small clearances inside parts. Blade thickness is given on each blade in thousandths of an inch (0.001, 0.010 or 0.020) or in hundredths of a millimetre (0.01, 0.07 or 0.10). Flat feeler gauges are for measuring between parallel surfaces. Wire feeler gauges are round for measuring slightly larger distances between nonparallel or curved surfaces, such as spark plug gaps.

⁹⁴ Source: https://www.researchgate.net/figure/Vernier-calliper-6_fig3_319648634

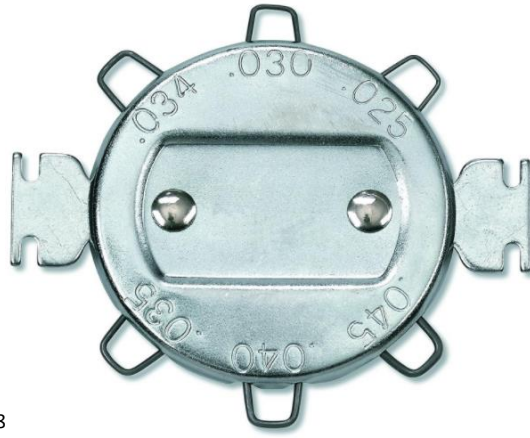
⁹⁵ Source: Straight Edge Stainless Steel 0.09" Thick Steel, Heavy Duty : Amazon.ca: Office Products

⁹⁶ Source: Metal-ruler-30cm-image17369358

⁹⁷ Source: personalised-tape-measure



98



99

Depth gauge: Used to measure the depth of cracks or grooves on the panel.



100

Dial indicator: A dial indicator is sometimes used to measure part movement and out-of-round in thousandths of an inch (or hundredths of a millimetre). For example, the indicator might be used to check for wheel damage by mounting it against the wheel or tire. When the tire is rotated, the dial indicator will show how much the wheel is bent. This would let you know that the wheel should be replaced¹⁰¹.

⁹⁸ Source: Flat Feeler Gauge | FINE TOOLS (fine-tools.com)

⁹⁹ Source: Wire Gauge : Automotive

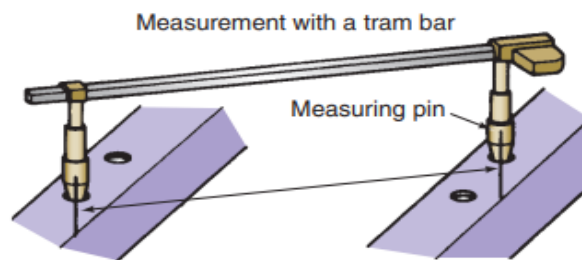
¹⁰⁰ Source: YURI Digital Depth Gauge 8", Stainless Steel, 0-200 mm Range : Amazon.in: Industrial & Scientific

¹⁰¹ Source: James E.Duffy – Auto body Repair Technology (2008- P76)



102

 **Tram Gauge:** A tram gauge is a special body dimension measuring tool. It is usually a lightweight frame with pointers. The pointers can be aligned with body dimension reference points to determine the direction and amount of body misalignment damage.



103

¹⁰² Source: Measure brake disc run out using our Moore and Wright indicator and magnetic base set - Machine DRO UK (machine-dro.co.uk)

¹⁰³ Source: James E.Duffy – Auto body Repair Technology (2008- P503)



Activity 2: Guided Practice



Task 9

1. Make groups of five each and visit the school automobile workshop where you will find Vehicle with major damaged frame. With the guide of your trainer, perform the task:
 - a. Use visual technique to determine the extent of damage and its effects.
 - b. Use tram gauge to measure the vehicle frame damage.
2. Make rotation until all groups pass in each activity.
3. Present your observation and ask for clarification to your trainer.



Activity 3: Application



Task 10

1. The task is individual.
2. Visit the nearest garage and ask a garage mechanic to let you measure the extent of major damage using tram gauge.

Topic 3.4 Repair vehicles major parts.



Activity 1: Problem solving



Task 11

1. In your respective groups discuss on the tasks that follow:
 - i. Discuss the steps used to realign the damaged frame/Uni-body.
 - ii. Describe all procedures followed to resize and reshape damaged frame / Uni-body.
 - iii. Explain replacement techniques of the damaged frame / Uni-body.

Key Facts 3.4. Vehicle major parts repair



Figure 6: Technician is measuring the front damaged major part

- **Realignment of damaged Frame / Unibody:** The realignment of damaged Frame / Unibody typically refers to the process of restoring and aligning Vehicle frame / unibody that have been misaligned or damaged due to accidents, collisions or other incidents.

Steps:

✓ **Frame**

- ✚ To assess the extent of damage.
- ✚ Disassembly if necessary, the damaged frame may need to be removed from the vehicle for a more inspection and repair.
- ✚ Refit the frame.

✓ **Uni-body**

- ✚ To assess the extent of damage.
- ✚ The damaged Uni-body is realigned by pulling machinery in the same cases by heating damaged areas.

- **Resize and Reshaping:** This process may vary depending on the type of material the panel is made of (e.g. metal, fibreglass) and the extent of the damage.

Steps:

- ✓ **Assess the severity of the damage.** Before attempting any repairs, assess the extent of the damage to determine if it can be repaired or if it needs replacement.
- ✓ **Wear appropriate safety gear.** Such as gloves and eye protection, to protect yourself during the repair process.
- ✓ **Remove the Frame.** If the Frame is severely damaged, it might need to be removed from the vehicle for better access to the damaged areas.
- ✓ **Straightening the Frame /Uni-body.** If the Frame is made of metal and has Major damage, it can be straightened using specialised equipment like Straightening Rack.
- ✓ **Welding.** For metal frames/uni-bodies with large tears or holes, welding may be necessary to close the gaps.
- ✓ **Sanding and Shaping.** After any necessary repairs, sand the Frame/Uni-body to create a smooth surface. Use body filler to fill in any remaining imperfections and shape the panel back to its original form.
- ✓ **Replacement of damaged Frame/Uni-body:** If the damage is too severe, the Frame/Uni-body may need to be replaced in partial or entirely. In such cases, new Frame / Uni-body will be ordered and installed on the vehicle.



Activity 2: Guided practice



Task 12

1. Form groups of five each and go in your school automobile workshop where you will find all necessary materials, tools and equipment, with the guide of your trainer realign a damaged frame that happened during a vehicle collision.



Activity 3: Application



Task 13

1. Visit the nearest garage and ask a garage manager to let you size and reshape vehicle damaged uni-body.



Formative assessment

1. Choose items from the following list that are not among the PPE used during vehicle

Major part repair.

- a. Overall
- b. Safety shoes
- c. Ear muffler
- d. Puller
- e. Hand glove
- f. Tram gauge

2. Mark the following statement as True or False.

The following are vehicle major parts:

- a. Hood
- b. Frame
- c. Bumper
- d. Fender
- e. Uni-body

3. Mark the following statement as True or False.

- a. Straightedge is used to measure the depth of the dent.
- b. Dial indicator can be used to measure the run out of brake disc.
- c. Tram gauge determines the direction and amount of body misalignment damage.
- d. Wire feeler gauges are used to measure spark plug gaps.
- e. Frame rack is used to measure the frame damage.

4. Read the following statements and choose the correct answer.

- a) Partial replacement of uni-body refers to cutting off the damaged Uni-body part and replacing it by a normal one of the same size and shape.
- b) Partial replacement of uni-body refers to ordering a new complete uni-body and replacing the damaged one.
 - i. a. only
 - ii. b. only
 - iii. Both **a** and **b** are correct.
 - iv. None is correct

5. Differentiate Resizing and Reshaping of the vehicle frame /unibody.



Points to remember

- Major parts of the vehicle.
- PPE to be worn when you are repairing vehicle major parts.
- Techniques used to measure major damage.
- Tools, material and equipment used to repair vehicle major parts.
- Steps followed to realign damaged frame / Unibody.
- Steps followed to Resize / Reshape / Replace damaged Frame / Unibody.



Self-reflection

1. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes after covering this unit.
2. There are no right or wrong ways to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process. Think about yourself:
 - a. Do you think you have the knowledge, skills and attitudes to do the task?
 - b. How well?
 - c. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.

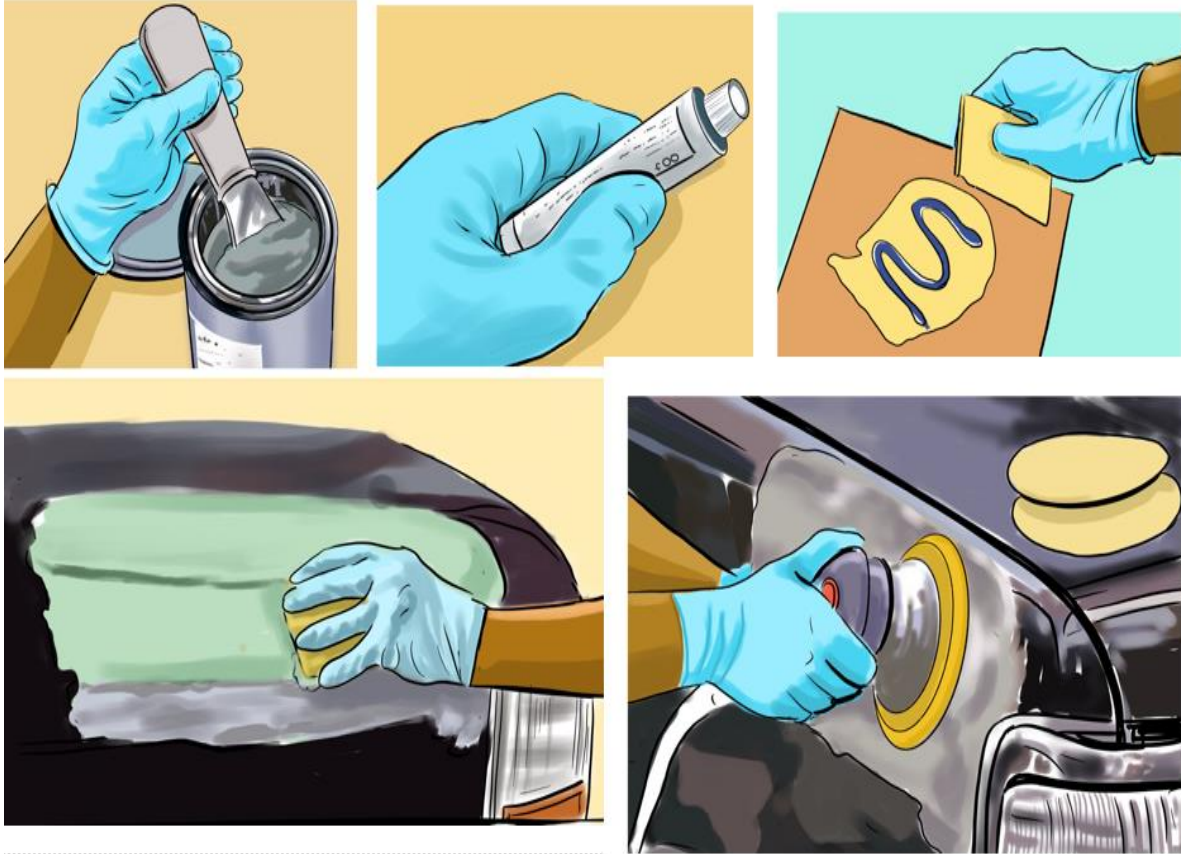
My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Classify the personal protective equipment.					
Identify the use of that personal protective equipment.					
Identify the safety measures that should be applied at the car body workplace.					
Select tools, materials and equipment that can be used at the workplace.					
Describe the arrangements of tools, materials and equipment at a workplace.					

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Describe the cleaning techniques used before and after work in car body work.					

3. Fill in the table below and share results with the trainer for further guidance.

Areas of strength	Areas for improvement	Actions to be taken to improve
1.	1.	1.
2.	2.	2.
3.	3.	3.

UNIT 4. PROTECT VEHICLE PANEL



Unit summary:

This learning outcome describes the knowledge, skills and attitude required to protect vehicle panels. It includes identification of protection materials, selection of tools and equipment, application and sanding of filler, application and sanding of putty and pre-painting of vehicle body protection.

Self-assessment: Unit 4

1. Study the unit illustration above and answer the following questions.
 - a. What do you see in the illustration?
 - b. What is happening in the illustration?
 - c. What topics do you think will be covered under this unit based on the illustration?
2. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this unit.
 - a) There is no right or wrong way to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
 Think about yourself: do you think you have the knowledge, skills or attitudes to do this? How well?
 - b) Read the statements across the top. Put a check in the column that best represents your level of knowledge, skills or attitudes.
3. At the end of this unit, you will assess yourself again.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Classify materials to be used in protection of vehicle bodies.					
Select tools and materials used in protection of vehicle panels.					
Describe tools and equipment used in					

My experience	I don't have	I know a	I have some	I have a lot of	I am
Knowledge, skills and attitudes	any experience doing this.	little about this.	experience doing this.	experience with this.	confident in my ability to do this.
vehicle panel protection.					
Identify the steps for mixing filler.					
Identify the steps for mixing putty.					
Describe the techniques for application and sanding filler.					
Describe application and sanding of putty.					
Identify all steps for pre-painting.					
Identify all safety measures that are taken during vehicle panel protection.					



Key Competencies:

Knowledge	Skills	Attitudes
1. List vehicle body panel protection materials.	1. Select materials for vehicle panel protection.	1. Avoid wastage of materials.
2. Describe the use of tools and equipment.	2. Select tools.	2. Safe handling of tools and equipment.
3. Identify the techniques of mixing filler.	3. Mix filler.	3. Time management.
4. Describe the techniques for application of filler.	4. Apply filler.	4. Health care.
5. Identify the procedures for putty mixing.	5. Mix putty.	5. Team work.
6. Identify the procedures for application of putty.	6. Apply putty.	6. Take necessary safety precautions during the application of putty.
7. Describe the sanding procedures.	7. Sand filler and putty.	7. Be attentive to details while sanding both filler and putty.
8. Identify the composition of primer and control paint.	8. Apply primer and control paint.	8. Comply with national and international standards during work execution.



Discovery activity



Task 1

Study the picture below with your partner and answer the asked question.



- Name that image above?
- Write all details for the above image?
- Identify the work being performed on the above image?
- According to the answer given to the question (c), describe the purpose of this work.

Topic 4.1: Identification of protection materials.



Activity 1: Problem solving



Task 2

Read the scenario below and discuss the asked question.

Peter's car had an accident. After an accident he took his car to the panel beating workshop to reshape it again. Even though they reshaped it, his car remained with small holes and dent. You are requested to identify the materials required to repair Peter's car.

Key Facts 4.1. Identification of protection materials.

- **Introduction**

Materials are consumable products used to fill remaining gaps after vehicle body panels have been reshaped and other related activities like covering.

The materials in vehicle panel protection can be classified as follow:

- ✓ Body protection materials.
- ✓ Sanding materials.
- ✓ Cleaning materials.
- ✓ Covering materials.

- **Protection materials**

Protection materials are materials used to fill or level damaged areas. There are different types like body fillers, hardener, putty and paint.

- ✓ **Body filler**



Body filler or plastic filler is a heavy-bodied plastic material that cures very hard for filling small dents in metal.

✓ **Hardener**



Used to speed up the drying process, a chemical catalyst is provided by the manufacturer.

✓ **Grazing putty**



Is a material made for filling small holes not covered by body filler?

✓ **Primer**



Automotive primers are applied to the repaired areas to create a smooth and even surface for the paint to adhere to.

✓

✓ **Thinner**

Used for cleaning equipment, adjusting the viscosity of paint and removing paint overspray.



- **Sanding materials includes** Sandpaper which is a heavy paper coated with an abrasive grit. It is the most commonly used abrasive in auto body repair. There are several kinds, shapes and grits of sandpaper. Sanding discs are round and are normally used on air powered orbital sanders. They might have self-stick coating or require the use of disc adhesive to hold the sandpaper onto the tool pad. Sanding sheets are rectangular and can be cut to fit sanding blocks. Long sheets are also available for use on air files.

- **Covering materials:** Are used to cover and protect body parts from paint overspray. Overspray is unwanted paint spray mist floating around from a spray gun. Those include:
 - ✓ Covering paper
 - ✓ News papers
 - ✓ Tape
 - ✓ Plastic sheets
- **Cleaning materials:** Those are different materials needed to get a car clear, like:
 - ✓ Car wash soap,
 - ✓ Glass cleaner,
 - ✓ Car wax,
 - ✓ Cleaning rags.



Activity 2: Guided practice



Task 3

Visit your automobile workshop and perform the following tasks:

- Categorise the car panel protection materials you found in the workshop.
- Describe their use.



Activity 3: Application



Task 4

Tom wants to start a new spare parts shop including car panel protection materials. Visit your neighbour's garage and give him a list of needed protection materials in Rwanda.

Topic 4.2: Selection of tools and equipment.



Activity 1: Problem solving



Task 5

In small groups discuss on identification of:

- Tools to be used in car panel protection.
- Equipment used in car panel protection.

Key Facts 4.2. Tools and equipment used in car panel protection.

- Hand tools

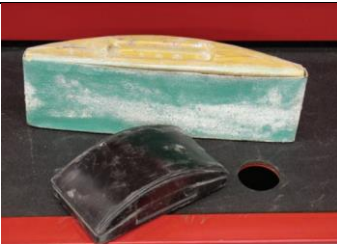
Names	Image	Function
✓ Mixing board	 104	✚ To mix both body fillers a hardener to become one colour.
✓ Spreaders	 105	✚ Used to apply body filler and are made of rigid plastic and available in various 106sizes.
✓ Scratchers	 107	✚ Used to remove old body filler, paint and adhesive as well as to apply body filler and glazing putty when a plastic spreader or

¹⁰⁴ James E. Duffy –Auto body repair Technology 2008

¹⁰⁵ car body filler spreaders image - Bing images

¹⁰⁶

¹⁰⁷ James E. Duffy –Auto body repair Technology 2008

		squeegee is not appropriate.
✓ Body files	 108	✚ To level rough contour.
✓ Sanding block	 109	✚ Used to support sandpaper when you are levelling and smoothing a repaired body panel.
✓ Sanding board	 110	✚ Once the body filler has hardened, the repair can be shaped and levelled. This eliminates waves and uneven areas.
• Power tools and equipment.		
✓ Spray gun	 111	✚ Used to apply sealer, primer, paint and other liquid finishing materials to a vehicle. Spray guns must atomize the liquid, often paint, so that it flows onto the body surface smoothly and evenly.
✓ Air compressor	 112	✚ Used in the generation of compressed air.

¹⁰⁸ James E. Duffy –Auto body repair Technology 2008

¹⁰⁹ James E. Duffy –Auto body repair Technology 2008

¹¹⁰ James E. Duffy –Auto body repair Technology 2008

¹¹¹ James E. Duffy –Auto body repair Technology 2008

¹¹² Source: SE/HE Series | SWAN : An Expert On Air Compressor (swan-aircompressor.com)

✓ Air sander		✚ Uses an abrasive action to smooth and shape body surfaces.
• Handling of tools and equipment: hygiene of tools and equipment listed above should be maintained. ✓ Carry every tool and equipment with full attention. ✓ Clean every tool after using it. ✚ Mixing board and spreader: After work use the scribe to remove the filler which can be dried on it, then wash it to become clear as it was before. ✚ Spray gun: After performing your work please clean your spray gun with thinner as well as compressed air to maintain your spray gun nozzle. ✓ Wipe all of your tools and equipment. ✓ Keep it in a well-arranged order.		



Activity 2: Guided practice



Task 6

Visit your automobile workshop and perform the following tasks:

- Select tools used for car body protection.
- Select equipment used for car body protection.
- Describe the use of all tools and equipment you found in the workshop.

¹¹³ James E. Duffy –Auto body repair Technology 2008



Activity 3: Application



Task 7

Peter has a garage for car body work but most of his tools and equipment are old and most of them have broken. As a technician visit a garage around you and help Peter to order new tools and equipment by giving him a list of all needed:

- a. Hand tools.
- b. Power tools.
- c. Equipment.

Topic 4.3: Application and sanding of filler.



Activity 1: Problem solving



Task 8

In small groups do the following:

- a. Write Steps of applying body filler.
- b. Write Steps of sanding body filler.

Key Facts 4.3. Application and sanding of Filler

- **Introduction**

Body fillers are designed to cover up minor depressions that cannot be removed by metal straightening alone.

Body filler is used to fill dents, scratches and other surface imperfections on metal or fibreglass body panels.

It is applied over the damaged area and once cured, it can be sanded to achieve a smooth and even surface.

Steps followed in application of filler:

- ✓ **Surface preparation**

- ✚ Grind area to remove old paint.
- ✚ Washing vehicles to remove all dirt.
- ✚ Clean the area to be applied by the filler with wax and grease remover to eliminate wax, silicone and grease that can contaminate the area.

- **Mixing filler:** the filler comes in cans and plastic bags.



- ✚ Using a mixing board mix both filler and hardener.
- ✚ Mix filler with a collect amount of hardener to become one colour.

114

Body filler is a two-part material. Squeeze the tube to dispense a little hardener into the body filler. Add a good ratio to avoid drying problems.

- **Spreading of filler:**



- ✚ After mixing, use a clear spreader to centre mixed filler out the mixing board check the image below.

115

- ✚ Stand near the panel and start to apply the body filler. Make sure that the surface is cleaned before checking the image below.

116

¹¹⁴ James E. Duffy –Auto body repair Technology 2008

¹¹⁵ James E. Duffy –Auto body repair Technology 2008

¹¹⁶ James E. Duffy –Auto body repair Technology 2008



images

- **Sanding of body filler:** After body filler is applied and dry (at least 10 minutes at ambient temperature), you can proceed to sanding using Sanding paper of higher grade like 60 or using mild file in case of thicker filler, proceed to visual and hand checking, if the panel surface is well levelled, clean it. Check the

117



Activity 2: Guided practice



Task 9

Obtain a damaged panel (fender, hood, door or lid) from a salvage yard. Use a hammer to place a small dent in a flat area of the panel as we have learned in previous units. Use the information in this chapter to grind, fill and smooth the dent using filler. Write all steps to be followed.



Activity 3: Application



Task 10

Take one of the damaged vehicle body panels in your workshop and perform the task that follows:

- Use hand tools or power tools straight to gain its original shape.
- Mix both filler and hardener with a mixing board.
- Spread it and sand it to gain the original shape of your panel.

¹¹⁷ Source: Skim Coat Tips and Tricks (inthegaragemedia.com)

Topic 4.4: Application and sanding of putty.



Activity 1: Problem solving



Task 11

Discuss:

- a. Steps of applying putty.
- b. Sanding of putty procedures.

Key Facts 4.4. Application and sanding of putty

• Introduction

Putty is a material made for filling small holes or sand scratches.

Once it is dry, the primer will often show tiny pits that were not visible in the body filler. Small pinholes and scratches can be filled with glazing putty.

Step 1. Clean the panel.

Step 2. With modern polyester putty, mix the putty and hardener according to the manufacturer's instructions.

Step 3. Place a small amount of putty onto a clean rubber squeegee. Apply a thin covering of putty over any pits or other imperfections in the filler.

Step 4. Use single strokes and a fast scraping motion. Use a minimum number of strokes when applying putties. They skim over or surface dry very fast. Repeated passes of the spreader might pull the putty away from the filler. Look at the figure below.



¹¹⁸a.



¹¹⁹b.

(a) A tiny spreader is being used to apply a two-part spot putty to a tiny chip in the paint. (b) When spot putty cures, block sand putty down flush with existing paint.

¹¹⁸ James E. Duffy –Auto body repair Technology 2008

¹¹⁹ James E. Duffy –Auto body repair Technology 2008

Step 5. Allow the putty to dry completely before sanding smooth with 240 or finer grit sandpaper.

Step 6. Sanding the putty before the solvents in it have completely evaporated results in subsequent sand scratches in the finish.

Step 7. Clean and apply the primer.



Activity 2: Guided practice



Task 12

Referring to the guided task in the previous topic (application of filler) and check for all scratches found after sanding of filler and other small holes then perform the following tasks:

- a. Apply putty in scratches and small dents found.
- b. Sand that applied putty.



Activity 3: Application



Task 13

In your automobile workshop take a panel you have used to apply filler in previous topics. Individually mix putty, apply it on your panel then after sand it.

Topic 4.5: Pre-Painting of vehicle panel.



Activity 1: Problem solving



Task 14

Discuss:

- a. Steps for application of primer.
- b. Steps for control paint application.

Key Facts 4.5 Pre-painting of vehicle panel

- **Introduction**

Pre-painting a vehicle panel involves applying a primer and a control coat before the final colour coat and clear coat are applied. This process is crucial in ensuring the adhesion, colour accuracy and durability of the paint job.

Steps for application of primer.

- **Surface Preparation:**

-  Before applying any paint, the vehicle panel must be thoroughly cleaned to remove dirt, grease, wax and other contaminants.
-  If there are any imperfections or damage on the panel, they should be repaired using appropriate body filler and the area should be sanded to achieve a smooth surface.

- **Mask any parts of the vehicle you don't want to get primer on.** Cover the areas surrounding your painting surface with newspaper or plastic sheeting and use strips of low-adhesive masking tape to secure the edges. Strategic taping will keep you from having to deal with messes as a result of drift and over spraying.



Figure 7: Technician is Covering unpaintable parts

- **Mixing Primer**

- ✚ Read Manufacturer's Instructions.
- ✚ Follow the manufacturer's guidelines and instructions for mixing the primer paint.
- ✚ Some primers may require thinning with a specific solvent or reducer, while others may come ready-to-spray.

- **Measure the Components:**

- ✚ If required, measure the correct proportions of the primer paint and any additives or thinners.
- ✚ Use graduated mixing cups or a digital scale to ensure accurate measurements.

- **Mix Thoroughly:**

- ✚ Pour the primer paint and any additives into a clean mixing container.
- ✚ Stir the components thoroughly using a stir stick or a paint mixing machine to achieve a consistent mixture.

- **Spraying of primer.**

- ✚ **Prepare the Spray Gun:**

- Clean and set up the spray gun according to the manufacturer's instructions.

- Adjust the air pressure and paint flow to the recommended settings for the primer.

Spray technique:

- Hold the spray gun approximately 6-8 inches away from the car body surface.
- Begin spraying with a side-to-side motion, overlapping each pass slightly to ensure even coverage.
- Maintain a consistent distance and speed to avoid runs or uneven application.

Apply Multiple Coats:

- Apply the primer in light, even coats, allowing each coat to flash off (partially dry) before applying the next.
- The number of coats will depend on the manufacturer's recommendations and the condition of the car's surface.

• **Application of control coat.**

✓ **Prepare the surface**

-  Sanding primer to have a smooth surface.
-  Clean and cover unwanted panels.

✓ **Prepare the Control Coat Paint:**

-  Just like with the primer, follow the manufacturer's instructions for mixing the control coat paint.

• **Spraying Control Coat:**

-  Apply the control coat in the same manner as the primer, using the appropriate spray gun settings and techniques.
-  The control coat will typically be a contrasting colour that makes it easier to identify surface imperfections.

• **Inspection:**

-  After spraying the control coat, carefully inspect the surface for any imperfections or defects.
-  Address any identified issues by sanding or filing as needed before proceeding with the basecoat.



Activity 2: Guided Practice



Task 15

Referring to the guided task in the previous topic (application of putty). Take the panel you have applied putty and perform the following tasks:

- a. Apply primer.
- b. Apply control paint.



Activity 3: Application



Task 16

Read and answer the following questions

1. The task is individual.
2. Go to the automobile workshop.
3. Take a panel which has been filled and sanded.
4. Follow all steps and apply both primer and control paint.
5. Write your remarks, introduce them and discuss them with other groups.
6. Present your observation and ask more clarification to your trainer.



Formative assessment

1. Describe the function of the following materials:
 - a. Body filler
 - b. Putty
 - c. Hardener
2. List and describe all steps for application of body filler.
3. Observe the table below and match the tools and equipment in column **A** with their function in column **B**.

A	B
1. Air compressor	a. Used to remove old body filler, paint and adhesive as well as to apply body filler and glazing putty.
2. Air sander	b. Is a material made for filling small holes or sand scratches not covered by body filler.
3. Putty	c. Used for cleaning equipment, adjusting the viscosity of paint and removing paint overspray.
4. Scratcher	d. Used to cover unwanted vehicle panels during painting.
5. Thinner	e. Used to apply body filler and are made of rigid plastic and available in various ¹²⁰ sizes.
5. Body file	f. Used in the generation of compressed air.
6. News paper	g. Uses an abrasive action to smooth and shape body surfaces.
7. Spreader	h. To level and to rough contour.

4. Identify all steps for application of primer paint.
5. Identify primer paint spray techniques.
6. Answer **true** or **false**.
 - a. Before applying any paint, the vehicle panel must be cleaned to remove dirt.
 - b. Putty is a material made for filling big holes.
 - c. Surface preparation is among the steps of body filler application.
 - d. Body filler is used to fill dents, scratches.

¹²⁰James E. Duffy –Auto body repair Technology 2008



Points to Remember

- In protection of car body panels, materials are consumable products used to fill remaining gaps after vehicle body panels have been reshaped and other related activities.
- Body fillers are designed to cover up minor depressions that cannot be removed by metal straightening alone.
- Putty is a material made for filling small holes or sand scratches.
- Before applying the primer, prepare the surface, mask the part of the vehicle you don't want to primer on, mix the primer paint and spray the paint.



Self-reflection

1. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes after covering this unit.
2. There are no right or wrong ways to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process. Think about yourself:
 - a. Do you think you have the knowledge, skills and attitudes to do the task?
 - b. How well?
 - c. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Classify the personal protective equipment.					
Identify the use of that personal protective equipment.					
Identify the safety measures that should be applied at the car body workplace.					
Select tools, materials and equipment that can be used at the workplace.					
Describe the arrangements of tools, materials and equipment at a workplace.					
Describe the cleaning techniques used before and after work in car body work.					

3. Fill in the table below and share results with the trainer for further guidance.

Areas of strength	Areas for improvement	Actions to be taken to improve
1.	1.	1.
2.	2.	2.
3.	3.	3.

UNIT 5. PAINT VEHICLE PANEL



Unit summary:

This learning outcome describes the knowledge, skills and attitude required to paint vehicle panels. It includes, identification of selection of tools, materials and equipment, mixing paint, spraying paint and polishing paint.

Self-assessment: Unit 4

1. Study the unit illustration above and answer the following questions.
 - a. What do you see in the illustration?
 - b. What is happening in the illustration?
 - c. What topics do you think will be covered under this unit based on the illustration?
2. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this unit.
 - a) There is no right or wrong way to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
 - b) Think about yourself: do you think you have the knowledge, skills or attitudes to do this? How well?
 - c) Read the statements across the top. Put a check in the column that best represents your level of knowledge, skills or attitudes.
3. At the end of this unit, you will assess yourself again.

My experience	I don't	I	I have	I have a	I am
Knowledge, skills and attitudes	have any experience doing this.	know a little about this.	some experience doing this.	lot of experience with this.	confident in my ability to do this.
Classify materials to be used in paint vehicle panels.					
Select tools and equipment to be used in painting vehicle panels.					
Describe the techniques for paint mixing.					

My experience	I don't	I	I have	I have a	I am
Knowledge, skills and attitudes	have any experience doing this.	know a little about this.	some experience doing this.	lot of experience with this.	confident in my ability to do this.
Identify the steps for adjusting paint viscosity.					
Identify the steps for covering the vehicle body before painting.					
Describe the techniques for spraying paint.					
Describe steps for vehicle panel polishing.					
Identify safety measures during car panel painting.					



Key competencies:

Knowledge	Skills	Attitudes
1. List vehicle body panel painting materials.	1. Select materials for vehicle panel painting.	1. Health care.
2. Describe the tools and equipment for car panel painting.	2. Select tools.	2. Time management.
3. Identify the techniques of mixing paint.	3. Mix paint.	3. Avoid wastage of materials.
4. Describe the techniques for	4. Adjust paint viscosity.	4. Safe handling of tools and equipment.

Knowledge	Skills	Attitudes
adjusting viscosity of paint.		
5. Identify the procedures for vehicle body covering.	5. Cover vehicle panel.	5. Team work.
6. Identify the procedures for spraying paint.	6. Spray paint.	6. Take necessary safety precautions during the application of putty.
7. Describe the paint polishing procedures.	7. Polish vehicle panel paint.	7. Be attentive to details while sanding both filler and putty.



Discovery activity



Task 1

Study the picture below with your partner and answer the asked question.



- Write all details for the above image?
- Identify the work being performed on the above image?
- According to the answer given to the question (b), describe the purpose of this work.

Topic 5.1. Selection of tools, materials and equipment.



Activity 1: Problem solving



Task 2

In small groups discuss on the following:

- Describe tools used for car panel painting.
- Select materials and name their functions.
- Describe the equipment required in car panel painting.

Key Facts 5.1. Selection of tools, materials and equipment.

- Tools

Names	Image	Functions.
✓ Mixing cup	 121	✚ Is used in car painting to accurately measure and mix the different components of automotive paint.
✓ Mixing paint sticks	 122	✚ It helps to achieve uniformity by ensuring that pigments, binders and other additives are evenly distributed.

¹²¹ automotive paint mixing cup image - Bing images

¹²² automotive paint mixing stick image - Bing images

✓ Sanding blocks	 123	+ Is a tool used in various manual sanding applications as it provides support and flexibility during sanding?
✓ Paint brush	 124	+ This allows the painter to apply paint to specific areas, edges and contours that may be challenging to reach with spray equipment.
✓ Paint depth gauge	 125	+ It is an essential tool for achieving accurate repair, maintaining paint quality and ensuring the safety and longevity of the vehicle's exterior.
✓ Paint ruler	 126	+ This tool helps to achieve consistent colour matching, proper paint viscosity and help to desire final paint quality.
• Power tools and equipment		

¹²³ Hand Sanding Block - Hard Density - For Adhesive Backed Sanding

¹²⁴ automotive paint brush image - Bing images

¹²⁵ automotive paint depth gouge image - Bing images

¹²⁶ automotive paint ruler image - Bing images

✓ Spray gun	 127	+ It must atomize the liquid, often paint, so that it flows onto the body surface smoothly and evenly.
✓ Air sander	 128	+ Uses an abrasive action to smooth and shape body surfaces.
✓ Polisher machine	 129	+ It holds and drives sanding pads to remove fine scratches, swirl marks, oxidation and other imperfections from the car's paint surface.
✓ Air compressor	 130	+ Used in the generation of compressed air.

¹²⁷ James E. Duffy –Auto body repair Technology 2008

¹²⁸ James E. Duffy –Auto body repair Technology 2008

¹²⁹ James E. Duffy –Auto body repair Technology 2008

¹³⁰ Source: SE/HE Series | SWAN : An Expert On Air Compressor (swan-aircompressor.com)

✓ Paint mixing machine	 131	 It accurately and consistently mixes automotive paint colours to ensure that the exact proportion of different pigments are blended together to achieve the desired colour.
✓ Computerised Scale	 132	 Used to measure different amounts of paint bases are mixed to form the final coat.
✓ Computer with Mixing software	 133	 It is used to calculate the amount of paint base to be mixed to give the final coat.
✓ Paint curing lamp or infrared heater	 134	 It accelerates the drying process of automotive paint, which enhances adhesion, reduces the risks of debris sticking to the wet surface and improves the overall quality of paint.
• Materials		

¹³¹ automotive paint mixing machine image - Bing images

¹³² Source: Steel Electronic Digital Paint Mixing Scale at Best Price in Howrah | Pioneer Scales Industries (tradeindia.com)

¹³³ Source: Retail Paint Software - Paint Color Match Software | Datacolor

¹³⁴ paint curing lamp - Bing images

✓ Sand papers	 135	✚ Is used to smooth out rough or uneven surfaces such as body filler, primer and old paint. It levels the surface and creates a uniform and smooth foundation for the new paint layer.
✓ Polishing pads	 136	✚ They work in conjunction with a polishing compound to remove fine scratches, swirl marks, oxidation and other imperfections from the car's paint surface.
✓ Thinner	 137	✚ Is used to adjust the viscosity of automotive paint and make it easier to apply to ensure a smooth and even coat.
✓ Polishing compound	 138	✚ It contains abrasive particles that help to remove imperfections such as swirl marks, light scratches and other surface defects from the car's paint.

¹³⁵ Sandpaper Sheets,100 Grit Dry Wet Sand Paper, 9 x 11 Inch, Silicon Carbide, for Wood Furniture Finishing,Metal Sanding and Automotive Polishing,10 -Sheet : Amazon.in: Industrial & Scientific

¹³⁶ car paint polishing pads image - Bing images

¹³⁷ automotive paint thinner image - Bing images

¹³⁸ automotive car polishing compound image - Bing images

✓ Masking papers	 139	✚ Are used to isolate areas of the car that shouldn't be painted.
✓ Masking tapes	 140	✚ Used to create clean lines and precise edges between different sections or colours of the car's surface and it holds the masking papers.
✓ Strainer	 141	✚ Are designed to remove particles, debris and other impurities from paint.
✓ Paint Hardener	 142	✚ Helps the paint to dry more quickly and allows the painted surface to become tough and durable in a shorter amount of time.

¹³⁹ : Source: Pre-Taped Masking Paper for Painting - 24 inch x 50 feet Tape and Drape Painters Paper, Paint Adhesive Protective Paper Roll for Covering Skirting, Frames, Cars and Auto Body (1 Roll): Amazon.com: Tools & Home Improvement

¹⁴⁰ Buy Paper Tape Local Doctor Tape, Crepe Paper Masking Tape – CopyPencil.pk

¹⁴¹ automotive paint strainer - Bing images

¹⁴² automotive paint hardener image - Bing images

✓ Paint	 143	✚ Primary function of paint is to enhance the appearance of the vehicle body by adding colour and providing a visually pleasing finish. It also protects the vehicle body from corrosion.
-----------------------	--	--



Activity 2: Guided practice



Task 3

Marry has a blue-coloured paint car but due to her more transportation now her paint is too old. She brought her car to the School garage for paint renewal. As a technician perform the following tasks:

- Select all needed tools.
- Select all equipment to be used.
- Choose needed materials to renew Mary's car paint.



Activity 3: Application



Task 4

Andrew is a car repair parts shop owner but now he also wants to sell the materials needed in car painting and polishing. Visit the car body work garage around your school and help Andrew by giving him a list of all daily needed painting materials.

¹⁴³ Source: Kapci Base B150 Metallic base medium-fine grain 3.7LT - WagaPaint

Topic 5.2 Mixing of paints



Activity 1: Problem solving



Task 5

1. Read and perform the given task.
 - a. Identify composition of vehicle paint.
 - b. Identify colour code.
 - c. Describe colours using colour wheel.
 - d. Describe the techniques used to mix paint.
 - e. Explain the techniques used to adjust paint.
 - f. Explain the techniques used to adjust clear coats.
 - g. Explain safety measures to be applied when you are mixing paint.

Key Facts 5.2: Mixing of Paints



Figure 8: Paint mixing room



Figure 9: Technician is mixing paint

- **Introduction to colour mixing**

Mixing vehicle paint refers to the process of combining different paint colours, often in a specific ratio, to create a custom colour for painting vehicles.



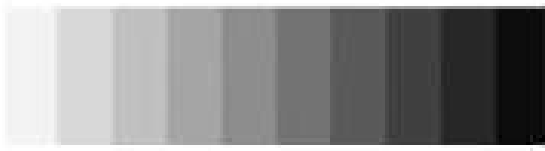
Figure 10: Different paints to be mixed¹⁴⁴

- **Composition of paint**

- ✓ **Pigments:** These are finely ground particles that provide colour and opacity to the paint.
- ✓ **Binders:** Binders are resins that hold the pigments together and adhere them to the vehicle's surface. They also contribute to the paint's durability and glossiness.
- ✓ **Solvents:** Solvents control the paint's viscosity, allowing for proper application. They evaporate as the paint dries, leaving behind the pigments and binders.
- ✓ **Additives:** Those are substances which are added to carry out special jobs like Wax in varnish creates a matt finish and silicones in metallic paint give a hammer finish.
- ✓ **Color Code Identification:** The first step is to identify the desired colour shade. This is done using a colour code provided by the vehicle manufacturer.

Colour codes are standardised references that help ensure accurate colour matching.

- **Description of colours using colour wheel**

✓ Primary colours:  Red Yellow Blue	✓ Secondary Colours  Red+Yellow = Orange Yellow+Blue = Green Blue + Red = Purple
✓ Intermediate / Tertiary Color:  • Red - Orange • Yellow – Orange • Yellow - Green • Blue - Green • Blue - Purple • Red – Purple ✓ Neutral colours: Neutral colours can be defined as those colours to which you can't give a definite colour name, these colours can be light, medium or dark or a contrasting combination of light and dark. Those are black, grey, brown, white etc... 	

¹⁴⁴ Source: mixing vehicle paint photo - Google Search

- **Techniques of Mixing Paint:** Paint components are carefully measured and mixed according to the calculated ratios. The following are two common Techniques:
 - ✓ **Manual Mixing:** Manual mixing refers to the process of combining different colours and components of automotive paint by hand to create a custom colour shade that matches a specific requirement.
 - ✓ **Automated Mixing:** Mixing is done automatically by specialised mixing equipment.
- **Adjustment of paint viscosity:** Adjusting paint viscosity refers to changing the thickness or consistency of paint to make it more suitable for a particular application method on the surface.
- **Adjustment of clear coat viscosity:** Adjusting the viscosity of clear coat is an important process in automotive refinishing, this helps the clear coat flow more smoothly and evenly. However, it's important to use the recommended thinners or reducers from the same manufacturer to maintain the quality of the clear coat and its performance.
- **Hardening paint:** Paint hardener facilitates a chemical reaction that bonds the paint molecules together, forming a more resilient and robust coating. This accelerates the drying and curing process, reducing the time it takes for the paint to reach its full hardness.
- **Safety measures when mixing vehicle paint:** Mixing vehicle paint requires careful attention to safety measures to protect both yourself and the environment. Here are some important safety measures to consider:
 - **Always wear the appropriate PPE:** Including safety goggles, a respirator or mask, gloves and Overall. This will protect you from inhaling harmful fumes and chemicals, as well as skin contact with the paint.
 - **Ventilation:** Mixing paint releases volatile organic compounds (VOCs) that can be harmful if inhaled. Ensure you're working in a well-ventilated area, such as a paint booth with exhaust ventilation or outdoors if weather permits.



Activity 2: Guided Practice



Task 6

1. All the necessary equipment, tools and materials are available.
2. You will be working in small groups of five each.
3. Using an appropriate methodology, read and perform the task:
 - i. Identify and wear appropriate PPE and apply other required safety measures
 - ii. Apply mixing paint techniques.
 - iii. Apply the appropriate techniques to adjust paint.
 - iv. Apply the appropriate techniques used to adjust the clear coat.
4. Make rotation until all groups pass in each activity.
5. Present your observation and ask for clarification to your trainer.



Activity 3: Application



Task 7

1. The task is individual.
2. Read the statement that follows and act accordingly:

Visit the nearest garage where you will find a vehicle with a body that has been repaired to the level of painting, observe the car body and ask garage manager to let you perform the following tasks:

 - i. Identify and wear appropriate PPE and apply other required safety measures.
 - ii. Mix paint using an automated method.
 - iii. Adjust paint using appropriate techniques.
 - iv. Apply vehicle painting techniques.
 - v. Adjust clear coat using appropriate techniques.
3. Present your observation and ask clarification to your trainer.

Topic 5.3 Spraying paints



Activity 1: Problem Solving



Task 8

Read and answer the following questions:

- i. Discuss the techniques used to cover the vehicle parts that are not paintable.
- ii. Explain the techniques of spraying paint.

Key Facts 5.3 : Spraying paints

• Introduction

Spraying vehicle paint is the process of applying a coat of paint onto the surface of a vehicle using specialised equipment such as paint sprayers or spray guns.



Figure 11: Technician is spraying paint

• Techniques of Covering the vehicle parts that are not paintable:

✓ Avail Supplies:

-  **Masking tape:** This is a low-adhesive tape that won't damage surfaces when removed.
-  **Masking paper or plastic sheeting:** These protect larger areas from overspray.

- ✚ **Plastic or cloth /drop cloths:** To cover the ground and surroundings.
- ✚ **Cutting tools:** Scissors or a utility knife to cut tape and masking materials.
- ✓ **Clean the vehicle:** Ensure the surfaces to be painted are clean and free from debris, dirt and grease. A clean surface will ensure proper adhesion of the masking materials.
- ✓ **Identify areas to mask:** Determine the parts of the vehicle that you want to protect from paint. This could include windows, rubber trim, headlights, mirrors, tires, etc.
- ✓ **Apply masking tape:** Apply Masking tape to the edges of the areas you want to mask. Make sure the tape adheres firmly and is straight. Press down on the edges to ensure a good sealing.
- ✓ **Use masking paper or Plastic sheeting:** For larger areas like windows or panels, use masking paper or plastic sheeting. Tape these materials in place using masking tape. Ensure they're securely attached to prevent overspray from reaching these areas.
- ✓ **Cover surrounding areas:** Cover the surrounding areas of the vehicle using plastic or cloth drop cloths to protect them from accidental overspray.
- ✓ **Cutting and Shaping:** Use cutting tools to carefully shape the masking materials as needed. This is particularly important for complex curves and edges.
- ✓ **Checking:** Before starting painting, check if all masked areas are properly covered.
- **Techniques of spraying paint:** Spraying paint on a vehicle requires precision and skill to achieve a smooth and professional finish.
 - ✓ **Surface preparation:** Before you start spraying paint, ensure the vehicle's surface is properly prepared. This involves priming, sanding and cleaning the surface to remove dirt, rust and imperfections. A well-prepared surface ensures better paint adhesion and a smoother finish.

- ✓ **Choose the right spray gun:** Select a high-quality spray gun suitable for automotive painting.
- ✓ **Adjust air pressure:** Adjust the air pressure on your spray gun to ensures even atomization of the paint and prevents overspray.
- ✓ **Spray paint:** The proper spraying technique is crucial for achieving an even and consistent coat of paint.
- ✓ **Distance and position:** Hold the spray gun at a 90-degree angle to the surface and maintain a consistent distance of about 6-8 inches (15-20 cm) from the surface.
- ✓ **Overlap:** Maintain a consistent overlap between each pass of the spray gun. Overlapping each pass by 50% helps avoid streaks and ensures an even coat. To further ensure an even distribution of paint, use a crosshatch pattern (spray horizontally and vertically) while applying paint.
- ✓ **Speed control:** Control the speed at which you move the spray gun across the surface and maintain a consistent distance from the vehicle. A slower movement may result in a thicker coat, while a faster movement may lead to uneven coverage.
- ✓ **Apply multiple thin coats:** It's better to apply multiple thin coats of paint rather than one thick coat. Thin coats minimise the risk of drips and sags. Allow each coat to dry before applying the next.
- ✓ **Check for drips and runs:** Be vigilant for drips or runs in the paint. If you notice any, address them immediately by wiping them off and lightly sanding the area before reapplying paint.
- ✓ **Maintain a clean environment:** Paint in a clean and controlled environment to avoid contaminants like dust and debris from landing on the wet paint. A paint booth with proper ventilation and filtration is ideal.
- ✓ **Spray clear coat:** After applying the base coat, it's common to spray a clear coat for added protection and a glossy finish. Follow similar techniques for applying the clear coat.

- **Safety measures:** Always wear appropriate safety gear, including a respirator, goggles, gloves and protective clothing. Paint fumes and overspray can be hazardous to your health.



Activity 2: Guided practice



Task 9

Visit the School Automobile workshop, with the guide of your Trainer, perform the following task:

- i. Apply the required techniques to cover the vehicle parts that are not paintable.
- ii. Demonstrate the techniques of spraying paint.



Activity 3: Application



Task 10

1. The task is individual.
2. Visit the nearest garage and ask a garage mechanic to let you observe the vehicle that is ready for painting and ask him to let you perform the tasks that follow:
 - i. Cover the vehicle parts that are not paintable.
 - ii. Spray paint and clear coat.

Topic 5.4 Polishing of paint.



Activity 1: Problem Solving



Task 11

Discuss:

- a. Steps of polishing paint.
- b. Safety measures while polishing paint.

Key Facts 5.4. Polishing of paint.

• Introduction

Polishing paint refers to the process of refining the appearance of painted vehicle body surfaces. This process involves using specialised tools, materials and techniques to remove imperfections, scratches from the paint surface. The goal of polishing paint is to achieve a smooth, glossy and reflective finish that enhances the overall aesthetic appearance of the object. The steps of polishing are:

Step 1. Select the best tools, material and equipment:

- ✓ **Tools:** Polishing pad, Bucket.
- ✓ **Materials:** Polishing compounds (First compound and final compound) Cleaning rags, Water, soap, fine sand papers.
- ✓ **Equipment:** Polishing machine.

Step 2. Surface Preparation: Before polishing, the painted surface needs to be cleaned and washed to remove any dirt or contaminants. The paint surface is carefully inspected to identify imperfections, scratches, Oxidation **and** other defects that need to be addressed during the polishing process.

Sanding the painted clear coat by using fine wet-sandpaper to remove scratches, the dirty and small particles. If you are satisfied with the appearance, go to the next step.

Step 3: Polish paint:



145

Figure 19. Technician is Polishing paint

- ✓ **Apply the first compound** to perform polishing of the whole car, excessive buffing and rubbing can damage the clear coat, so make sure to use a non-abrasive formula and polish carefully.
- ✓ **Apply final compound:** Once the major imperfections are addressed, a finer polishing compound is used with a softer pad to further refine the paint's finish to have a high quality paint shining and finally check it for best appearance.

Step 4. Protection: After polishing, it's important to apply a protective layer such as wax, sealant or ceramic coating to maintain the polished finish and protect the paint from environmental factors.

- **Safety measures while polishing a car paint.**
 - ✓ Always wear PPE.
 - ✓ Work in a well-ventilated area to avoid inhaling fumes or particles from the polishing compounds.
 - ✓ Keep any flammable materials away from your work area and avoid working near open flames or heat sources.
 - ✓ Ensure you have adequate lighting to see the surface clearly and avoid accidents.

¹⁴⁵ Source: <https://www.motor1.com/products-services/auto-products/best-buffing-pads/>

- ✓ Read and follow the instructions on the polishing compounds carefully and use chemicals in a well-controlled manner to avoid spills or splashes.
- ✓ Check that polishing equipment is in good working condition and follow manufacturer guidelines for usage.



Activity 2: Guided Practice



Task 12

1. In your respectively groups visit your car body work workshop, find your panel and then perform the following tasks:
 - a. Select tools and equipment.
 - b. Select materials.
 - c. Polish paint.
2. For any challenge ask for a trainer.



Activity 3: Application



Task 13

Read and answer the following questions

1. Task is individual.
2. Go to the car body work garage near the school.
3. Work with a mechanic while he/she performs the polishing process.
4. Write your observations and remarks then present them to your trainer.



Formative Assessment

1. Choose the required two safety measures applied during vehicle mixing of paint from the list that follows:
 - a. Wear the overall.
 - b. Check the ceiling clearance.
 - c. Use ear muffler.
 - d. Ventilation of working area is required.
 - e. Lock the vehicle before you start the work.
2. Mark the following statement as True or False.

The following are composition of colours:

- a. Pigment
 - b. Putty
 - c. Binder
 - d. Fender
 - e. Solvents
 - f. Brake oil
 - g. Additives
3. Mark the following statement as True or False.
 - a. Primary colours are Red, Yellow and White
 - b. Red + Yellow= Orange
 - c. Blue colour + Red colour = Purple
 - d. Yellow + Blue = Green
 - e. Neutral colour is a colour that you can give a definite colour name.
4. Read the following statement and choose the correct one.
 - a. Adjusting paint viscosity refers to changing the thickness or consistency of paint to make it more suitable for a particular application method on the surface.
 - b. Adjusting paint viscosity refers to changing the viscosity of paint to be sprayed on vehicle body surface by adding required amount of thinner.
 - c. Both **a** and **b** are correct.

5. Differentiate manual paint mixing and automated paint mixing.
6. List four materials used in covering of non-paintable parts.
7. List the techniques of covering the vehicle parts that are not paintable.
8. List the techniques of spraying paint.
9. Describe briefly the techniques of spraying paint.
10. With a table, give five examples of tools, equipment and materials used in car panel painting.
11. Identify the steps for paint polishing.



Points to Remember

- Work in a well-ventilated area to avoid inhaling fumes or particles from the polishing compounds.
- Keep any flammable materials away from your work area and avoid working near open flames or heat sources.



Self-Reflection

1. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes after covering this unit.
2. There are no right or wrong ways to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process. Think about yourself:
 - a. Do you think you have the knowledge, skills and attitudes to do the task?
 - b. How well?
 - c. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Classify the personal protective equipment.					
Identify the use of that personal protective equipment.					
Identify the safety measures that should be applied at the car body workplace.					
Select tools, materials and equipment that can be used at the workplace.					
Describe the arrangements of tools, materials and equipment at a workplace.					
Describe the cleaning techniques used before and after work in car body work.					

3. Fill in the table below and share results with the trainer for further guidance.

Areas of strength	Areas for improvement	Actions to be taken to improve
1.	1.	1.
2.	2.	2.
3.	3.	3.



Summative Assessment

Read the integrated situation below and perform the tasks that follow:

NDORI is a driver from KIVU-AUTO- SPARES Company Ltd, which delivers car spare parts across the country, he was driving, BMW X5 from Rubavu to Musanze, arriving at MUKAMIRA center, he had an accident against AUDI Q5, the right-side door of the vehicle was highly damaged. He spoke to EJO HEZA Garage for intervention. The head of the garage requested him to bring the vehicle to the garage located in NYABIHU District, MUKAMIRA sector a side of MUKAMIRA guest house for repair, after several test by the Head of the garage, he requested you as car body work mechanic to use the required materials, tools and equipment to carry out the repairing of the damaged door within 8 hours.

Resources	
Materials	Equipment and Tools
Rivet, bolts and nuts, electrodes and filler metals, rags, masking paper, masking tape, soap, water, sheet metals, body filler, putty, sandpapers, thinner, control paint, final paint, clear coat, polishing compound, Wax.	Pliers, Spanners, creeper, Goggles, Helmet, Screwdrivers, Hammers, Scratcher, bench vise, scraping and sharp cutting tools, rim wrench, trim repair tool kit, dollies, spoons, picks, dent pullers and pull rods, suction cups, wire brushes, metal brushes, punches and chisels, metal-cutting shears, rivet rim and upholstery tools, door handle tool, body surfacing tools, metal files, spreaders and squeegees, hand tool safety, jack and stand, file for filler, tape measure. Gas welding set, Air compressor, PPE, air drills, air file, air polisher, air ratchet, air sander, grinders, heat guns, drilling machine, hydraulic press, angle grinder, straightening ram.

REFERENCES

1. Auto Body Repair Technology, James E. Duffy (2008, Delmar Cengage Learning) - libgen.lc
2. Modern Automotive Technology 7th Edition, James Duffy, The Good heart-Wilcox Company, Inc., 2009. (ISBN: 978-1-59070-956 -6)
3. The Repair of Vehicle Bodies 7th Edition andrew Livesey 2019
4. Automotive body Work and Rust Repair – Matt joseph 2009



December, 2023