RQF LEVEL 3

AUTWT301

AUTOMOBILE TECHNOLOGY

Wheel and Tire Repairing

TRAINEE'S MANUAL

December 2023

WHEEL AND TIRE REPAIRING

2023

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KIGALI-RWANDA

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TABLE OF CONTENT

AUTHOR'S NOTE PAGE (COPYRIGHT)---------- i
ACKNOWLEDGEMENTS----------ii
TABLE OF CONTENT ----------iv
LIST OF FIGURES----------v
LIST OF ABBREVIATIONS AND ACRONYMS ----------vi
INTRODUCTION---------- 1
UNIT 1: DESCRIBE WHEEL AND TIRE ---------- 3
Topic 1.1: Description of Tires---------- 7
Topic 1.2: Description of wheels----------19
UNIT 2: PREPARE THE WORKPLACE----------27
Topic 2.1: Selection of PPE ----------32
Topic 2.2: Safety Precautions at Working Area ----------40
Topic 2.3: Cleaning and Arrangement of the Workplace----------51
UNIT 3: REPAIR WHEEL AND TIRE ----------59
Topic 3.1: Selection of Tools, Materials and Equipment ----------64
Topic 3.2: Inspection of Wheel and tire----------69
Topic 3.3: Dismounting and Disassembling of Wheel and Tire. ----------74
Topic 3.4: Repairing of Wheel and tire Faults ----------77
Topic 3.5: Re-assembling and Re-mounting of Wheel and tire----------82
UNIT 4: CARRY OUT WHEEL BALANCING ----------92
Topic 4.1: Identification of Wheel Balancer ----------96
Topic 4.2: Description of Wheel Balancing Machine Components ---------- 100
and Accessories---------- 100
Topic 4.3: Perform Wheel Balancing---------- 106
BIBLIOGRAPHY---------- 114

LIST OF FIGURES

Figure 1:Information found on a typical passenger tire sidewall 14
Figure 2: A cutaway of a run-flat tire with an insert to support the tire in case of air loss. 15
Figure 3: Parts of a wheel 21
Figure 4: Safety glasses 33
Figure 5:Ear protection (Ear muffs, Earplugs, Canal caps) 34
Figure 6:Ear protection (ear muffs, Earplugs, Canal caps) 34
Figure 7: Safety shoes 35
Figure 8: Hand gloves 36
Figure 9: Overall/Overcoats 36
Figure 10:Respirator protection 37
Figure 11: Prohibition signs 42
Figure 12: Warning signs 42
Figure 13: Mandatory signs 43
Figure 14: Advisory/ Safe condition sign 43
Figure 15: The fire triangle 44
Figure 16:Use your leg muscles 49
Figure 17: First aid kit 54
Figure 18: 20-Ton jack 66
Figure 19: Puncture Repair Kit 67
Figure 20: Lateral runout measurement 73
Figure 21: 79
Figure 22: Installation of TPMS sensor 80
Figure 23: Wheel re-mounting with torque wrench 84
Figure 24: Tightening pattern 84
Figure 25: Wheel balancing machine in operation 107

LIST OF ABBREVIATIONS AND ACRONYMS

ALUS: Arithmetic Logic Units

BA: Breathing apparatus

DOT: Department of Transportation

DP: Data Processing

GK-AISi: General Knowledge Aluminum Selenium

HR: Heart Rate

LCD: Liquid Crystal Display

LT: Light Truck

M+S: Mountain/Snowflake

OE: Operation and Maintenance

PPE: Personal Protective Equipment

RF: Radio Frequency

RMA: Rubber Manufacturers Association

RPE: Respiratory protective equipment

RTB: Rwanda TVET Board

SAE: Society of Automotive Engineers

TPMS: Tire Pressure Monitoring System

US: United States

USA: United States of America

INTRODUCTION

This trainee manual encompasses all necessary skills, knowledge and attitudes required to Wheel and Tire Repairing. 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 (CBT) philosophy by providing enough practical opportunities reflecting real life situations.

The trainee manual is subdivided into units, each unit has various topics, trainee will start with a self-assessment exercise to help trainee rate him/herself on the level of skills, knowledge and attitudes about the unit.

A discovery activity is followed to help trainee discover what he/she already know about the unit.

After these activities trainee will learn more about the topics by doing different activities, reading the required knowledge, techniques, steps, procedures and other requirements under the key facts section, trainee 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, trainee shall undertake progressive assessments known as formative and finally conclude with his/her own self-reflection to identify his/her 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.

Module Units:

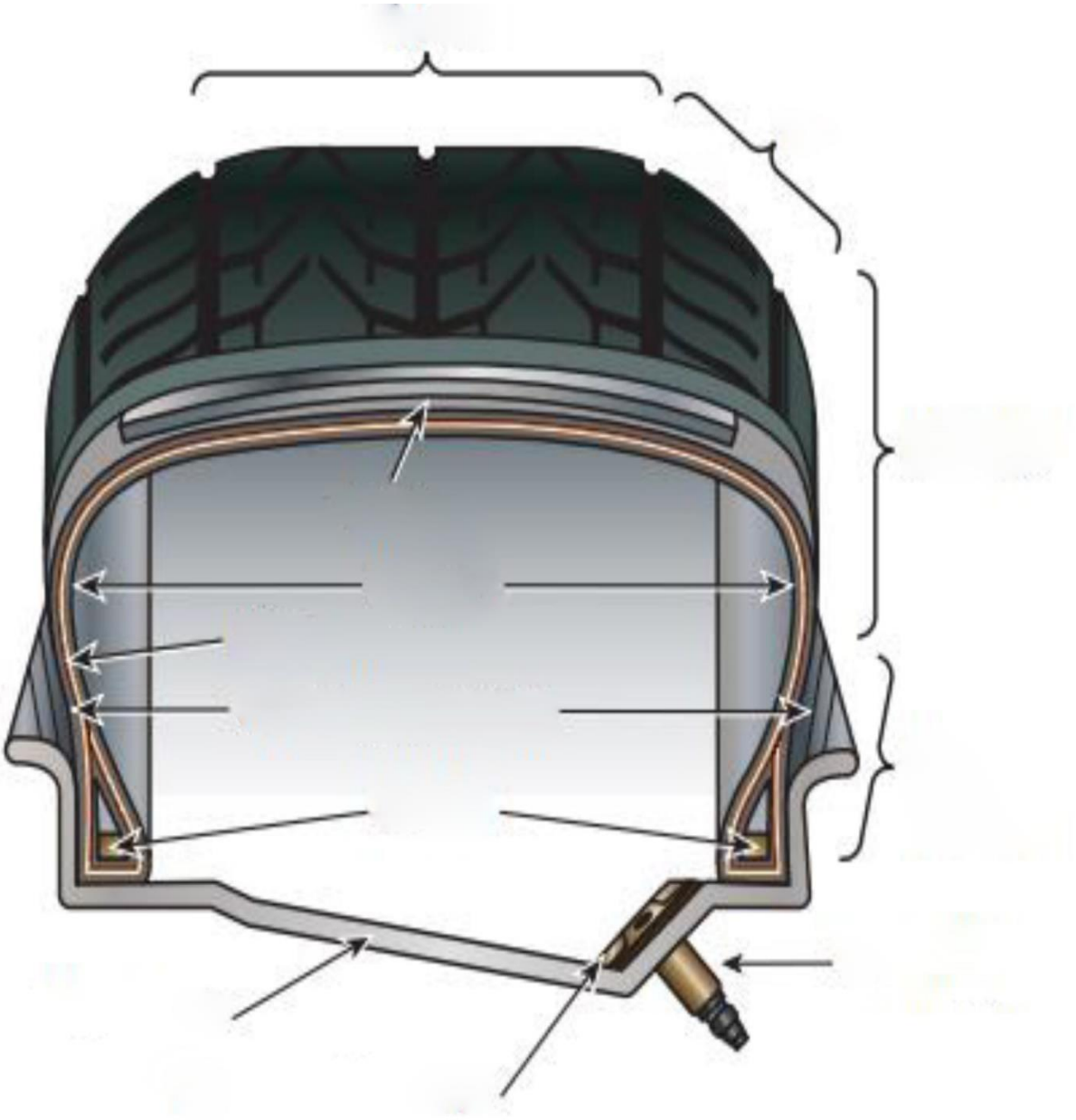
Unit 1: Describe wheel and tire

Unit 2: Prepare the workplace and apply safety

Unit 3: Repair wheel and tire

Unit 4: Carry out wheel balancing

UNIT 1: DESCRIBE WHEEL AND TIRE



Unit summary:

This unit intends to equip trainees with knowledge, skills and attitudes required to describe wheels and tires. It covers the description of wheels and tires.

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 picture?
   c. What topics do you think will be covered under this unit based on the illustration?
2. Complete the self-assessment on the 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 that you have the knowledge, skills and attitudes to do this? How well?
   c. Read the statements across the top. Put a tick in the column that best represents your level of knowledge, skills and attitudes.
3. At the end of this unit, you will take this self-assessment again.

My experience **Knowledge, skills and attitudes**	**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.**
Define wheel and tire					
Describe various size designations of tires					
Describe different wheel and tire components					
Differentiate radial and bias tire					

My experience Knowledge, skills and attitudes	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.
Describe tire inflation and pressure monitoring					

Key Competencies:

Knowledge	Skills	Attitudes
1. Define wheel and tire	**1.** Identify the component of wheel and tire	**1.** Politely listen actively to the ideas
2. List various size designations of tires	**2.** Read various size designations of tires	**2.** Reading carefully various size designation of tires
3. Differentiate tire and wheel	**3.** Identify tire and wheel	**3.** Be careful when touching on the wheel and tire
4. List the difference between wheel and tire	**4.** Demonstrate the difference between wheel and tire	**4.** Be careful during demonstration of the difference between wheel and tire
5. Describe tire inflation and pressure monitoring	**5.** Adjust tire inflation and pressure monitoring	**5.** Adjust and monitor Carefully the tire inflation pressure

6. List types of tire construction	**6.** Identify tire construction	**6.** Politely listen actively to the types of tire construction.

Discovery activity

Task 1:

Read and answer the questions below:

1. What is a wheel
2. What is a tire?
3. Explain the types of wheel.
4. What are the importance and the functionality of automotive wheels and tire?

Topic 1.1: Description of Tires

Activity 1: Problem Solving

Task 2:

Read carefully and discuss about the following questions:

1. The difference between these two terms “Tyre and Tire”.
2. The types of tires.
3. The design of tires.
4. The main components of tires.
5. Types of tire and their various size designations.
6. Tire inflation and pressure monitoring

Key Facts1.1: Description of Tires

- **Introduction to tire**

A service technician will often advise customers about tires, discuss aspects of tire design, and help the customer to make the safest and best choice when buying a new tire or

wheel. Both tires and wheels have an importance in automotive safety and service specialty areas.

- **Definition of tire**

1A Tyre is the standard American English spelling, whereas Tire is the British English spelling. tire is a rubber ring, usually filled with air, that fits around the wheel of a car, bicycle, or other vehicle

- **Requirements on the tire**

✓ Support the weight of the vehicle

✓ To absorb and damping jolts from the road

✓ To transfer drive, braking and lateral forces

✓ Low rolling resistance (low friction and heat development)

✓ Adequate service life

✓ Quiet and low-vibration rolling

- **Structure**

The tires include the inner tube and valve, the tire itself and the rim band.

In these types of tire, the inner tube must always be replaced at the same time as the tire.

The tire consists of:

✓ Carcass

✓ Protector

✓ Bracing layer (on radial-ply tires)

✓ Side wall

✓ Beads with inserted wire-spooked cores

✓ Airtight rubber layer

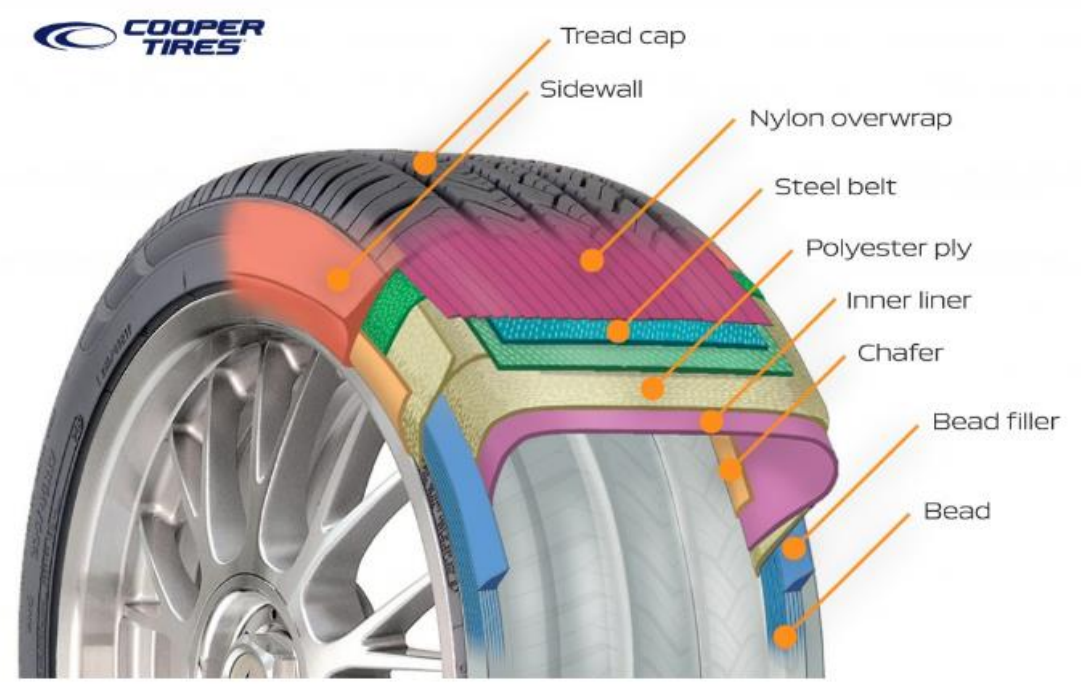
- **Tire components**

Many customers may not get into the technical details of their tires, but it's helpful for them to know that tires are complex and advanced pieces of equipment, with a variety of

[1] https://www.merriam-webster.com/dictionary/tire

components performing unique functions. All of this adds up to deliver the performance, quality and safety that your customers need.

- ✓ Tread cap
- ✓ Sidewall
- ✓ Nylon overwrap
- ✓ Steel belt
- ✓ Polyester ply
- ✓ Inner liner
- ✓ Chafer
- ✓ Bead filler
- ✓ Bead



[2]

- **Types of tire**
- ✓ Tubed tire
- ✓ Tubeless tire
- **Tire construction**

[2] https://www.autoinc.org/spotlight-cooper-tire-shares-the-art-science-of-tire-design/

Types of tire based on their construction and design are the following:

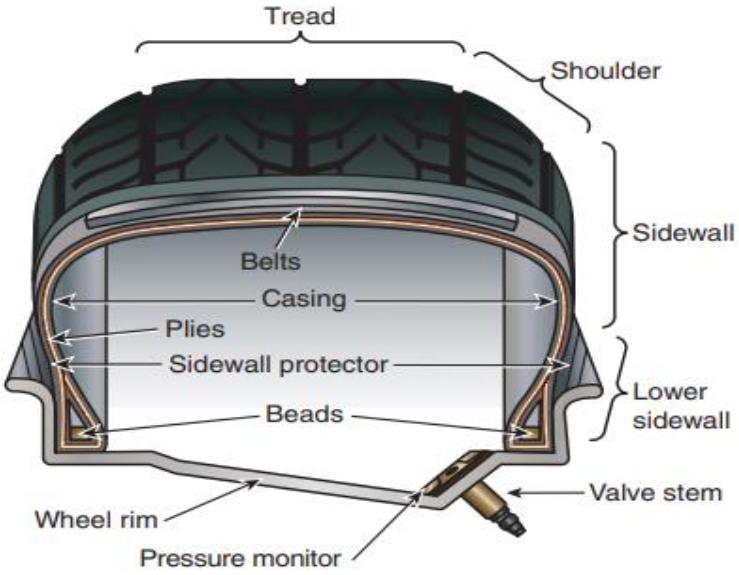
- ✓ Bias ply tires
- ✓ Belted bias ply tires
- ✓ Radial ply tires

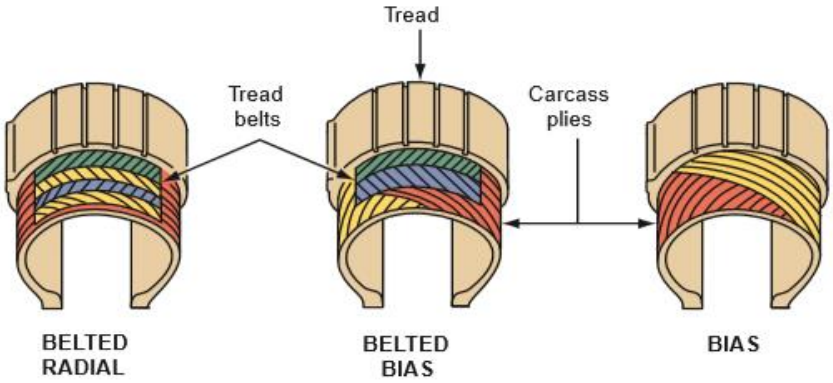
Tires are constructed of several layers of rubber materials, cords, and two rings of wire, called beads. The casing or carcass is the internal structure of the tire.

A ply is metal or fabric cord that is rubberized (covered with a layer of rubber). The plies provide strength to the tire to support the load of the vehicle.

The ends of the plies wrap around the steel bead before being bonded to the side of the tire. The beads are coils of wires at the side edges of the tire.

They give the tire the strength to stay firmly attached to the wheel. Chafing strips are hard strips of rubber that protect the beads from damage that could result from chafing against the wheel rim.





- **Tire Sidewall Markings**

for a mud and snow tire

- **Various size designations of tires**

There is a massive amount of information branded on the sidewall of every tire ... but it's written in code. The tire size is just one small piece of this code. The tire size "P225/45R17 91V". Read on to learn how to crack the tire code with this handy guide dedicated to tire types, sizes, and construction

- **Tire service type ratings**[3]

Most tire sizes begin with one or more letters -- for example, P or LT. The letter tells us what type of vehicle or service the tire was designed for.

- ✓ **P = P-Metric (Example: P215/65R17 98T)**

P-Metric tires are the most common type of tire. The P stands for passenger vehicle, meaning that these tires are designed for use on passenger vehicles like cars, minivans, light-duty pickup trucks.

- ✓ **Metric / Euro-Metric (Example: 185/65R15 88T)**

Metric tires, also known as Euro-Metric tires because the sizing originated in Europe, don't have a letter designation. Euro-Metric sizes are equivalent to P-Metric sizes in dimensions, but Euro-Metric sizes have subtle differences in their load-carrying ratings and capabilities.

[3] https://www.tirebuyer.com/education/understanding-tire-sizes-and-types

- ✓ **LT - Light Truck (suffix) (Example: 9.5-16.5 LT121/117R)**

These tires are made for light-duty, medium-duty, and heavy-duty pickup trucks (typically 1⁄2 ton, 3⁄4 ton or 1-ton load capacity), sport utility vehicles, and vans.

4

- ✓ **T = Temporary Spare (Example: T145/70R17 106M)**

If the tire size begins with a T, it means that the tire is a temporary spare. Also known as mini spares or space savers, temporary spares are designed for short-term use until the regular tire is repaired or replaced.

- ✓ **ST - Special Trailer (Example: ST175/80R13)**

Tires beginning with ST are special trailer tires and should only be used on car, boat, or utility trailers.

C = Commercial (Example : 31x10.50R15/ C109R)

Euro-Metric tire sizes ending with a C are commercial tires, for use on delivery trucks and vans capable of carrying heavy loads. In addition to the C designation, these sizes are also branded with a load range and service description rating (load range B, C, or D).

- **Tire Sizes**

- ✓ **Section width of tire (Example: P 225/45R17 91V)**

In the example above, the tires width, measured from the widest point of the inner sidewall to the widest point of the outer sidewall when properly mounted, is 225

[4] https://www.tirebuyer.com/education/understanding-tire-sizes-and-types

millimeters. The section width can be converted to inches by dividing the width in millimeters by 25.4 like so: (225 millimeters) / (25.4 mm/in) = 8.86 inches.

- ✓ **Aspect ratio of sidewall (Example: P225/ 45R17 91V**

The two-digit number that usually follows the tire's section width tells us the aspect ratio, or tire profile measurement

In this example, the 45 indicates that the sidewall distance, from the wheel rim to the outside of the tread, is 45% of the section width. A lower aspect ratio means a lower-profile tire with a shorter sidewall, while a tire with a higher aspect ratio will have a taller sidewall and look more like a donut. Because we know that the tire size shown in this example has a section width of 8.86 inches and the aspect ratio is 45%, the sidewall height for this tire is 3.98 inches: (8.86 inches) x (.45) = 3.98 inches.

- ✓ **R) Construction**

The “R” stands for radial construction in place of the “R” would indicate that the tire has bias ply construction.

- ✓ **P225/ 45R17 91V**

(17) Rim or Bead Diameter

The “17” represents (in inches) diameter of the beads, which means that this tire is designed to fit on a rim with a 16-inch diameter.

- ✓ **P225/ 45R17 91V (91V) Service Description**

The final component of the size designation is called the Service Description, which indicates the Load Index and the Speed Symbol for the tire. Load Index, or 91 in this example, is a two or three-digit code that represents the maximum load that can be carried at the speed indicated by the speed symbol.

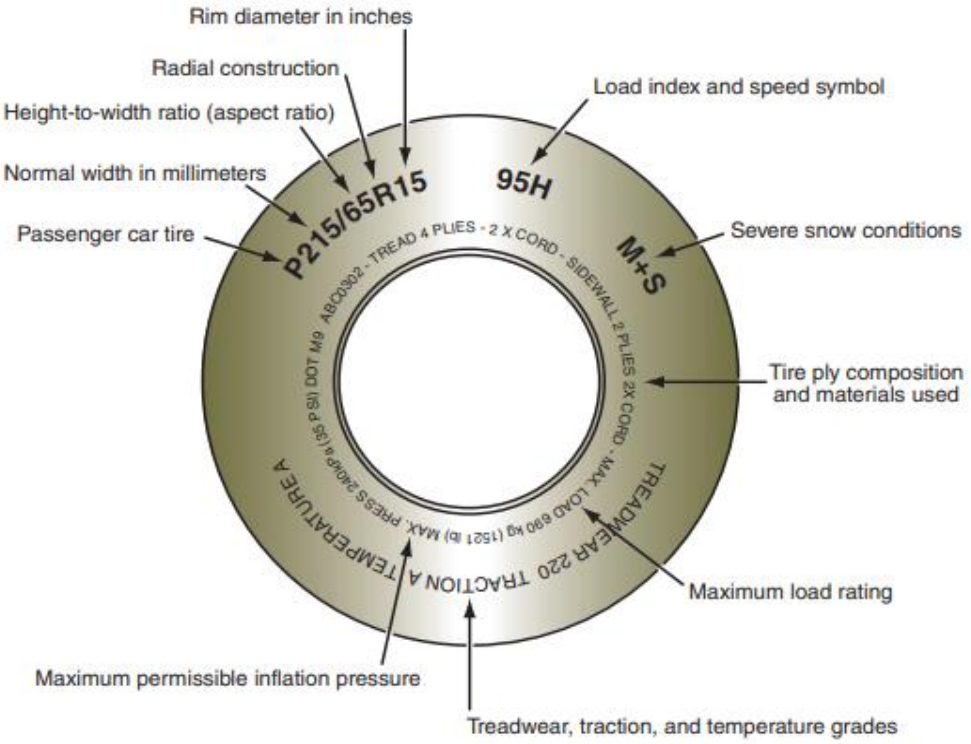


Figure 1:Information found on a typical passenger tire sidewall

- **Tire inflation and pressure monitoring**

There are three mandated safety items on cars: TPMS, air bags, and seat belts. Tire pressure monitoring systems (TPMS) were originally developed for use in run-flat tires during the 1990s. These tires become unsafe if continually driven without air.

Maintaining correct tire inflation improves tire wear. With TPMS, the public has become more aware of the importance of correct tire pressure. The tire pressure monitoring system (TPMS) was phased in until it was required in all vehicles in the United States beginning in the 2008 model year.

Figure 2: A cutaway of a run-flat tire with an insert to support the tire in case of air loss.

- **Tire Pressure Monitoring System(TPMS)**

A tire-pressure monitoring system (TPMS) monitors the air pressure inside the pneumatic tires on vehicles.

A TPMS reports real-time tire-pressure information to the driver, using either a gauge, a pictogram displays, or a simple low-pressure warning light. TPMS can be divided into two different types – direct (dTPMS) and indirect (iTPMS).

TPMS are installed either when the vehicle is made. The goal of a TPMS is avoiding traffic accidents, poor fuel economy, and increased tire wear due to under-inflated tires through early recognition of a hazardous state of the tires.

This functionality first appeared in luxury vehicles in Europe in the 1980s, while mass-market adoption followed the USA passing the 2000 TREAD Act after the Firestone and Ford tire controversy.

Panel illuminates when the tire pressure drops below a predetermined point.[5]

- ✓ **Indirect TPMS**

An indirect tire pressure monitor system uses the antilock brake system to compare the speed of all of the vehicle's wheels, allowing a 10 psi difference in pressure. But if all four tires are low, it does not detect a problem. Consumers might have a false sense of security if they believe their tires are correctly inflated because no instrument panel light is illuminated. The indirect system monitors pairs of wheels located in diagonally opposed

[5] https://www.dreamstime.com/car-dashboard-panel-light-signal-belt-not-fastened-tire-pressure-low-safety-concept-travel-vacation-vehicle-check-image251580762

positions on the vehicle. This is because during a turn, the inside wheels turn more slowly than the outside wheels

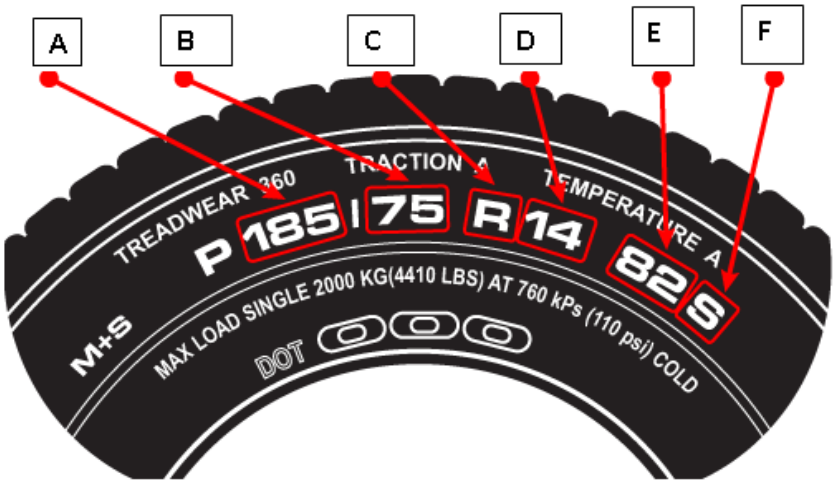
- ✓ **Direct TPMS**

Direct tire pressure monitoring, which uses individual wheel sensors and a computer, is more costly but also more effective. Tire pressure sensors transmit a radio frequency (RF) to transceivers located near the wheel wells.

Activity 2: Guided Practice

Task 3:

Study the figure below and rename the following tire code



Letter	Code name
A	
B	
C	
D	

E	
F	

Technician A says that a tire with a tread wear rating of 200 would be expected to last twice as long under the same conditions as one with a 100 rating. Technician B says that when the diameter of a tire is changed, from-end geometry is altered. Who is right?

Technician A c. Both A and B

Technician B d. Neither A or B

Activity 3: Application

Task 4:

Visit the nearest school Garage, under guidance of the garage manager, to observe the activities at a Garage. Ask questions for more clarification about wheels and tires. Make a report about the visit done on wheel and tire then make a presentation and ask more clarification to your trainer.

By using an arrow, match correctly the tire code from Column A to their corresponding names of Column B.

Column A: FR60-15B	Column B: Names
B	Alphanumeric destination
15	Aspect ratio(Series)
60	Rim diameter in inches
R	Load range

F	Radial construction(Blank is bias)

Topic 1.2: Description of wheels

Activity 1: Problem Solving

Task 5:

1. Study this figure below and answer the following questions:

a) What does the above-illustrated figure represent?

b) What material is a wheel made of?

c) What are its main components?

d) Where is the area of its application?

Key Facts 1.2: Description of wheels

- **Introduction of wheel**

✓ A wheel is a circular component that is intended to rotate on an axle bearing. The wheel is one of the key components of the wheel and axle, which is one of the six simple machines.

✓ Wheels are made of several materials, including steel, aluminum, or an aluminum alloy. OE wheels on lower end (less-expensive) passenger cars are often made of steel.

✓ Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel, and flywheel.

- **Requirements on the wheel**

✓ Low weight

✓ Large diameter for large brake discs

✓ High dimensional stability and elasticity

✓ Good heat dissipation properties (frictional heat)

✓ Easy replacement of tires and wheels in the event of damage

- **Structure of the wheel**

✓ **Rim**

The rim is the "outer edge of a wheel, holding the tire". It makes up the outer circular design of the wheel on which the inside edge of the tire is mounted on vehicles such as automobiles. For example, on a bicycle wheel the rim is a large hoop attached to the outer ends of the spokes of the wheel that holds the tire and tube. Wheels have two parts: the center or flange and the rim

✓ **Hub**

The hub is the center of the wheel, typically houses a bearing, and is where the spokes meet.

A hubless wheel (also known as a rim-rider or centerless wheel) is a type of wheel with no center hub. More specifically, the hub is actually almost as big as the wheel itself. The axle is hollow, following the wheel at very close tolerances.

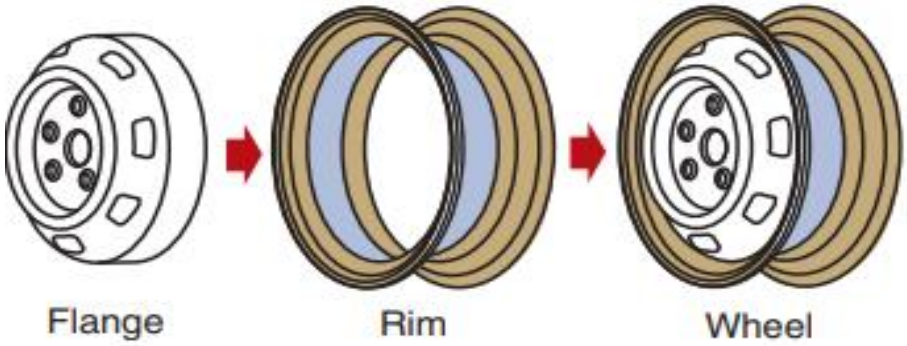


Figure 3: Parts of a wheel

- ✓ **Dimensions and designation of rims**

This data is standardized. The manufacturers stamp the rim designation on each wheel. It consists of two dimensions: the rim width a in inches and the rim diameter D in inches. An "x" on the drop-center shape of the rim flange separates the two dimensions; code letters after the rim diameter indicate the types of rim.

Example: **$6_{1/2}$ JX 15 H RO 35**

$6_{1/2}$: Rim width in inches

J: Code letter for the dimensions of the rim flange

X: Single-Piece rim (drop-center rim)

15: Rim diameter in inches

H: A hump on the outer bead seat

RO 35: Offset 35 mm

- **Classification of wheels.**

- ✓ **The wheels are classified according to:**

- The materials made
- The production process
- The Construction design

✓ Wheel offset is described in various ways. The most common offset classification is as follows

- **Negative wheel offset** increases the track width of the tires.
- **Positive offset** (the opposite of negative offset) is found often on front-wheel-drive cars.

When a wheel is replaced, the new wheel should be of the same offset to maintain the proper scrub radius.

- **Types of wheel**

✓ Disc wheels are pressed out of steel sheet, cast, or forged of light alloy, e.g.GK-AlSi 10Mg.

Benefits of wheels made from light alloy:

- Low weight (small unsprung mass)
- More effective brake ventilation and heat dissipation

✓ Lightweight wheels made from newly developed steels, e.g. DP 600 or HR 60, can have thinner walls and have become up to 40% lighter compared to previous steel wheels made from RSt 37.

Activity 2: Guided Practice

Task 6:

1. Under the guidance by the trainer, discuss and answer the following questions:
   a. What is a wheel?
   b. Design a wheel and name the parts.
   c. What are the requirements followed during selection of the wheel?

Activity 3: Application

Task 7:

1. Go to the nearest school car parking, under the guidance of the car parking owner, observe carefully the following code located on the parked car front right wheel: 61/2 JX 15 H RO 35. Ask questions for more clarification about wheel code. Make a report about the visit done on wheel.

Formative Assessment

1. List the main components of a tire.
2. List three requirements on the wheel.
3. What material is a wheel made of?
4. Select correct answer in two types of tire
    a. Radial
    b. Tubed tire
    c. Bias
    d. Tubeless tire
5. Technician A says that a tire's inflation pressure drops as the car is driven. Technician B says that tire pressure should be checked when the tire is hot. Who is right?
    a. Technician A
    b. Technician B
    c. Both A and B
    d. Neither A nor B

Points to Remember

- Always be careful to read the designation code of wheel and tire.
- If you inflate tires always, respect the indicated maximum pressure on the sidewall.

Self-Reflection

1. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes acquired 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 the task? 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 Knowledge, skills and attitudes	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.
Define wheel and tire					
Describe various size designations of tires					
Describe different wheel and tire components					
Differentiate radial and bias tire					
Describe tire inflation and pressure monitoring					

2. Fill the table below to identify your areas of strength, areas for improvement and actions to be taken to improve.

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

UNIT 2: PREPARE THE WORKPLACE

Unit summary:

This unit describes the knowledge, skills and attitudes required to select and wear PPE, safety precautions at working areas and clean and arrange the workplace.

Self-Assessment Unit 2

1. Study the illustration and answer the following questions:
   a. What is happening?
   b. What do you think this learning unit will be about?
   c. Do you think the illustration reflects the learning unit? Briefly explain your response.
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 the task? 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.
3. At the end of this learning unit, you will take this survey again.

My experience Knowledge, skills and attitudes	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.
Describe PPE					
Use safety precautions at the working area					
Describe the cleaning techniques					
Describe the arrangement of the workplace					
Use first aid tool kit					

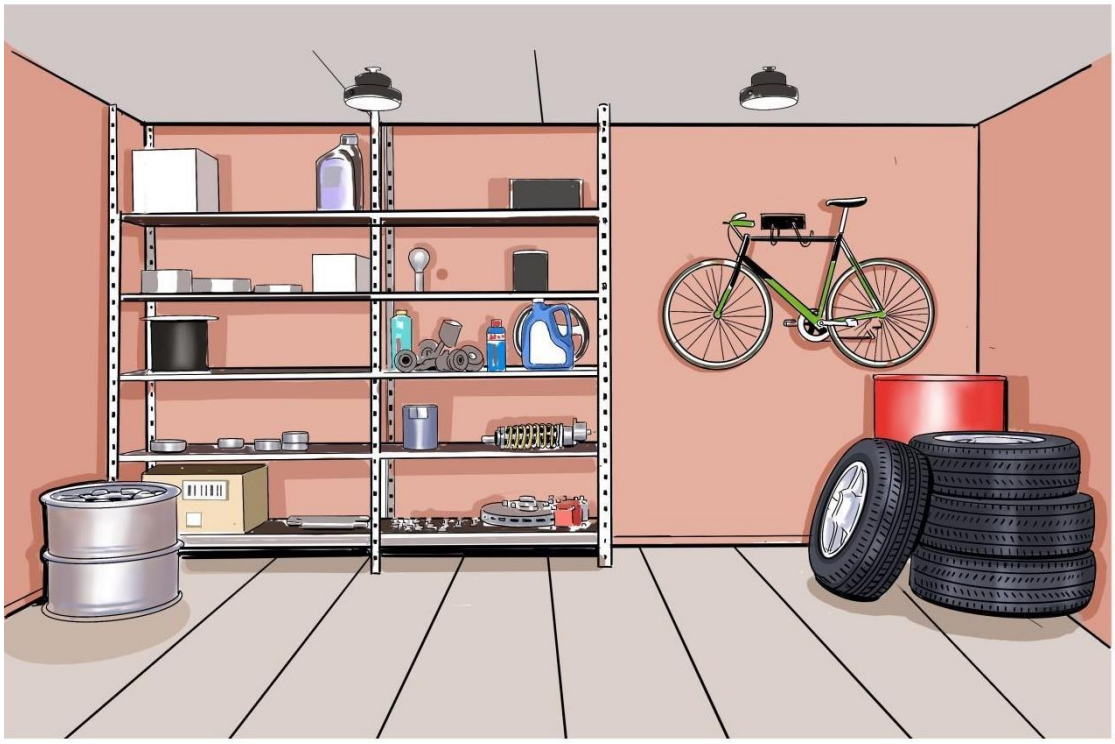
My experience Knowledge, skills and attitudes	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Classify the fire extinguishers					
Use of safety tool and equipment					

Key Competencies:

Knowledge	Skills	Attitude
Describe the tips followed in selecting PPEs	Use of PPEs	Take care of PPEs
List basic principles of personal safety	Apply basic principles of personal safety	Reading careful basic principles of personal safety
Explain the procedures and precautions for safety using tools and equipment	Apply procedures and precautions for safety using tools and equipment	Careful for putting in practice the procedures and precautions for safety using tools and equipment
List the tips for maintaining a safe working	Maintain a safe working area	Encourage other to safe working area
Identify Safety precautions at working area	Apply Safety precautions at working area	Always take measure for safety precautions at working area
List the use of Fire extinguishers	Demonstrate the use of Fire extinguishers	Reading careful the classification code for differentiating fire extinguisher
Describe hazards in workplace	Identify hazards in workplace	Take care for handling hazardous material in workplace
Identify types of accident prevention at workplace	Apply the accident prevention at the workplace	Be careful when you are at workplace

Discovery activity

Task 1:



Study the figure above and answer the following questions.

a. What do you see in the figure?

b. What do you think the figure is all about?

c. Do you think the figure reflects the topic? Briefly explain your response.

d. What do you think will be covered under this topic?

Topic 2.1: Selection of PPE

Activity 1: Problem Solving

Task 2:

Study the above picture and rename the shown PPEs by filling in the following gaps:

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……

Key Facts 2.1: Selection of PPE

- **Definition PPE**

Personal Protective Equipment is defined as all equipment designed to be worn, or held, to protect against a risk to health and safety for workers from hazard. This includes most types of protective clothing, and equipment such as eye, foot and head protection, safety harnesses, life jackets and high visibility clothing, respirators, goggles, facemasks, gloves, footwear and aprons.

Workers must wear the following personal protective equipment (PPE) as it is required at the workplace and when by the supervisor instructed.

- **Classification of PPEs**

Personal Protective Equipment (PPE) is equipment that will protect the user against health or safety risks at work. This can include items such as:

- ✓ Safety helmets
- ✓ Ear protection
- ✓ Overall clothing/Overcoat
- ✓ Safety footwear and safety harnesses
- ✓ Thermal, weather and waterproof clothing
- ✓ Respiratory protective equipment (RPE).

- **Types of PPE**

Figure 4: Safety glasses

✓ **Eye Protection**

Your eyes can become infected or permanently damaged by many things in a garage.
Consider the following:

- Dirt and sharp bits of rust can easily fall into your eyes while you are working under a vehicle.
- Some procedures, such as grinding, release tiny particles of metal and dust, which are thrown off at very high speeds. These particles can easily get into your eyes, scratching or cutting them.
- Pressurized gasses and liquids escaping a ruptured hose or loose hose fitting can spray into your eyes and cause blindness.

✓ **Head protection**

Head protection can protect the head from physical hazards, they can also protect other parts of the upper body, such as the neck, hair, nose and ears.

There are two main types of head protection that are used in the workplace, these are:

- **Industrial safety helmets:** These protect the head from falling objects such as – tree-falling, building and construction and blasting.
- **Bump caps:** These protect the head from being bumped; they are useful for maintenance personnel working under machinery and plumbers working under pipework. However, they do not offer adequate protection from the risk of a falling object.

Figure 5:Ear protection (Ear muffs, Earplugs, Canal caps)

Ear protection

There are three main types of ear protection, these include:

Figure 6:Ear protection (ear muffs, Earplugs, Canal caps)

- **Ear defenders (Ear muffs):** The cups are lined with a sound absorbing material, this helps to reduce the level of noise to the ears.
- **Earplugs:** These fit into the ear canal and form a seal, they also can have a cord on them that you can put behind the back of the neck, to help prevent them from becoming lost.

- **Canal caps:** These are similar to ear plugs, however they offer less protection they are suitable for operations where earplugs would be frequently taken out and put back in.

✓ **Foot protection**

There are two common types of foot protection, they both offer a variety of protection, these are:

- **Safety boots and shoes:** They come with slip-resistant soles, penetration-resistant midsoles, and protective toe caps.
- **Wellington boots:** These are suitable for people who work in wet conditions, they are normally made from rubber, and they come with slip-resistant soles, penetration-resistant midsoles, and protective toe caps.

Figure 7: Safety shoes

✓ **Hand and arm protection**

There are four main types of hand and arm protection, these include:

Gloves: These protect the hands; they can prevent blisters from occurring, people from burning themselves or getting splinters in their hands.

- **Gloves with cuffs:** These protect both the hand and the wrists
- **Elbow protectors**
- **Gauntlets**

Figure 8: Hand gloves

- ✓ **Overall clothing/Overcoat**

This is required to protect the body against certain hazards. The main types are:

- Overall
- Overcoat
- Trousers
- Vests

Figure 9: Overall/Overcoats

- ✓ **Respiratory protective equipment (RPE).**

Respiratory protective equipment (RPE) is a type of personal protective equipment (PPE) designed to protect the wearer: from airborne contaminants: fumes (e.g. welding fumes) asbestos. Hazardous chemicals and dust.

Figure 10:Respirator protection

RPE is divided into the following main types:

- **Respirator (filtering device):** uses filters to remove contaminants in the workplace air, there are two main types:
- **Non-powered respirators:** rely on the wearer's breathing to draw air through the filter
- **Powered respirators:** use a motor to pass air through the filter to give a supply of clean air to the wearer.
- **Breathing apparatus (BA):** Ceeds a supply of breathing-quality air from an independent source (eg: Air cylinder or air compressor).

- **Importance of using PPE in the Workplace**

✓ Proper PPE and laboratory attire help minimize the potential for skin exposure to hazardous chemicals, biological agents, and other hazardous materials.

✓ Make sure your legs are covered and that you wear closed shoes.

✓ Additional PPE such as face masks or respirators may be needed for specialized tasks.

✓ It is important to know that safety equipment provided on the job should meet Personal Protective Equipment Regulation, and that it is most effective when it meets the correct size, fit and height of its user.

PPEs are also important in the workplace because:

✓ It keeps you from being liable for your own injuries.
✓ Long-term conditions may result from a failure to protect yourself.
✓ You only have one pair of eyes.
✓ It increases the quality of your workday.

Activity 2: Guided Practice

Task 3:

1. Under the guidance of your trainer, discuss on the following questions:
   a. When should ear protection be worn?
   b. What are different types of hand and arm protection?
   c. What are the benefits of using PPE at the workplace?
   d. Classify and wear the PPE according to their use.

Activity 3: Application

Task 4:

Use this quiz to self-check your understanding of the topic covered. Match each PPE with their function.

S/N	List of PPE	S/N	Function
1	Overall	a	Help keep your hands clean and lessen your chance of getting germs that can make you sick.
2	Safety helmets	b	They protect the body like a piece personal protective equipment (PPE)
3	Ear protection	c	Tight-fitting eye protection that completely cover the eyes, eye sockets and the facial area around the eyes and provide protection from impact, dust, mists, and splash.
4	Safety shoes	d	Reduce the noise energy reaching and causing damage to the inner ear
5	Goggles	e	Prevent or minimize injuries to the head and brain, protecting against falling objects or debris, impact with other objects, electric shock and rain.
6	Gloves	f	Protect your feet from sharp objects, heavy objects, chemical spills, extreme temperatures, and slippery or wet surfaces

Topic 2.2: Safety Precautions at Working Area

Activity 1: Problem Solving

Task 5:

Analyze the figure below and answer the questions that follow.

a. You see two friends working together at a company. What do you think might have happened to this workmate?
b. What do you think caused that situation?
c. What advice would you give to your workmate regarding their solution?
d. What do you think will be covered under this topic based on that figure?

Key Facts 2.2: Safety Precautions at Working Area

- **Introduction to workplace safety**

Why is workplace safety important? When a company provides a safe work environment, they are protecting themselves, their employees and their customers. It is important to follow guidelines and procedures to remain compliant with local and national occupational safety authorities.

A safe workplace is a happy workplace, as it creates a more comfortable and conducive environment for employees to effectively do their jobs. However, providing a safe workplace is an important part of client relations as well.

- **Work area safety**

Creating a safe work environment is arguably the employer's most important job. A safe place to work means employees have little to no risk of developing an injury or illness while on the job.

✓ **Safety signs**

The rules and regulations of the working environment are communicated to employees by written instructions, signs and symbols. All signs in the working environment are intended to inform. They should give warning of possible dangers and must be obeyed.

Signs fall into four categories: **Prohibited activities; Warnings; Mandatory instructions and Safe conditions.**

✓ **Prohibition signs**

These are "must not" do signs. These are circular white signs with a red border and red cross-bar, and are given in Figure below. They indicate an activity, which must not be done.

Figure 11: Prohibition signs

- ✓ **Warning signs**

These give safety information. These are triangular yellow signs with a black border and symbol, and are given in Figure below. They give warning of a hazard or danger.

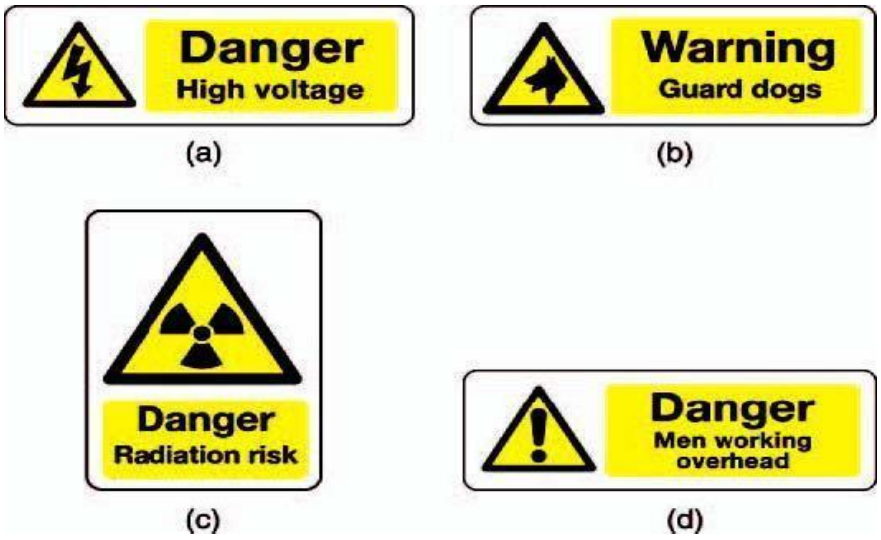


Figure 12: Warning signs

- ✓ **Mandatory signs**

These are circular blue signs with a white symbol, and are given in figure below they give instructions that must be obeyed.

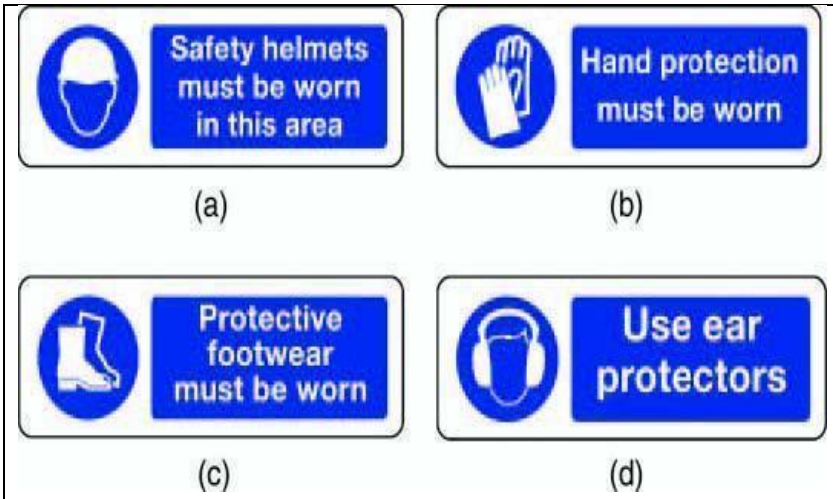


Figure 13: Mandatory signs

- ✓ **Advisory or safe condition signs**

These signs give safety information. These are square or rectangular green signs with a white symbol, and are given in Figure below. They give information about safety provision.

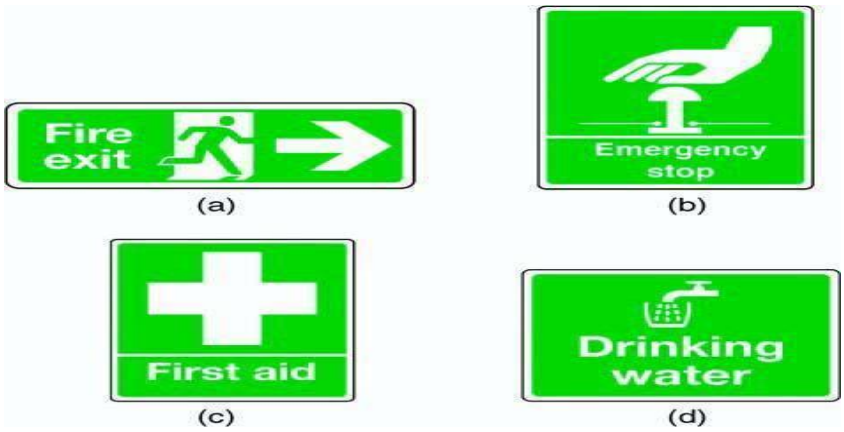


Figure 14: Advisory/ Safe condition sign

- **Firefighting**

- ✓ **Definition**

Fire is a chemical reaction, which will continue if fuel, oxygen and heat are present. To eliminate a fire, one of these components must be removed. This is often expressed by means of the fire triangle.

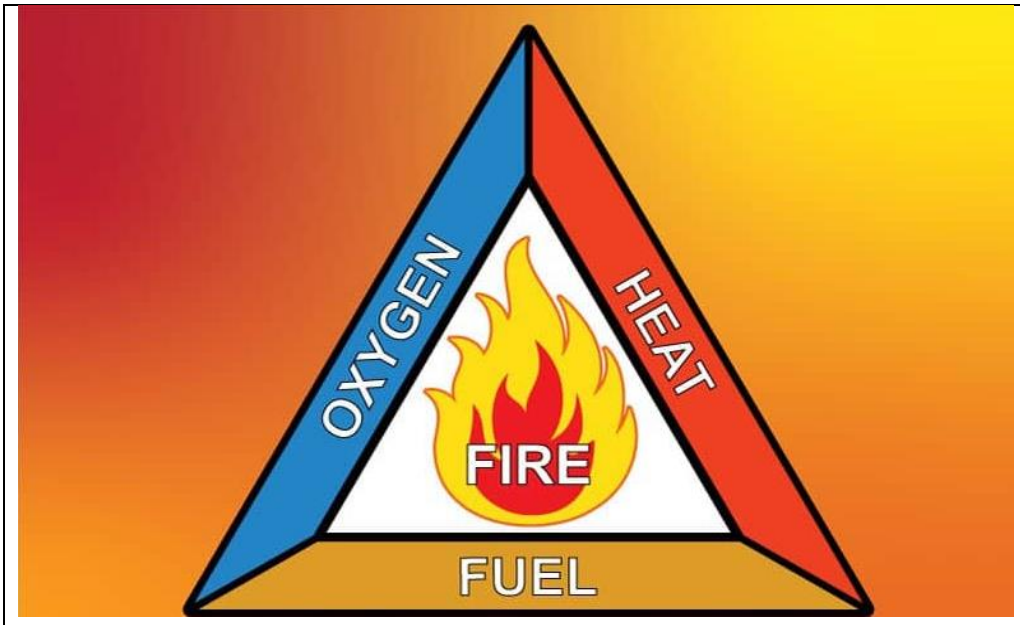


Figure 15: The fire triangle

- **Fuel** is found in the construction industry in many forms: petrol and paraffin for portable generators and heaters; bottled gas for heating and soldering. To eliminate fuel as a source of fire, all flammable liquids and gasses should be stored correctly, usually in an outside locked store.
- **Oxygen** is all around us in the air we breathe, but can be eliminated from a small fire by smothering it with a fire blanket, sand or foam. Closing doors and windows, but not locking them will limit the amount of oxygen available to a fire in a building and help to prevent it spreading.
- **Heat** can be removed from a fire by dousing with water, but water must not be used on burning liquids since the water will spread the liquid and the fire. Some fire extinguishers have a cooling action, which removes heat from the fire.

✓ **Fire classification**

Depending on the cause of fire, it classified into six classes which are:

- **Fire class A:** Is one from ordinary combustible materials such as wood, cloth, paper, rubber and plastic materials.
- **Fire Class B:** Are fires involving flammable liquids such as gasoline, oil-based paints, greases, paints, petrol and oil.

- **Fire Class C:** These are fires involving flammable gasses, e.g. natural gas, hydrogen, propane, butane.
- **Fire Class D:** It involves burning or combustible metals such as magnesium, titanium, sodium, potassium, lithium, and zirconium.
- **Fire Class E:** These are fires involving any of the materials found in Class A and B fires, but including electrical appliances, wiring, or other electrically energized objects in the vicinity of the fire, with a resultant electrical shock risk if a conductive agent is used to control the fire.
- **Fire Class F:** Fires involving commercial cooking appliances with vegetable oils, animal oils, or fats at high temperatures commonly found in commercial kitchens.

✓ **Prevention of fire**

The fire can be prevented by eliminating any of those three factors. Removing anyone of the three will extinguish the fire by:

- Starving the fire of fuel.
- Smothering by sand or blanket to isolate oxygen.
- Cooling using water.

• **Materials which can be used to prevent fire**

✓ **Fire Extinguishers**

The first thing to note regarding fire extinguishers is that they are only designed to fight fire in its early stages or for small fires. There are many types of fire extinguishers that are designed to suit different situations in which a fire may occur and it is important that the correct extinguisher is used for the type of fire being fought.

✓ **Type of Fire Extinguishers**

- Water and Foam
- Carbon Dioxide
- Dry and Wet Chemical
- Powder

- **Tool and equipment safety**

An automotive technician must adhere to the following safety guidelines when using all tools and equipment

✓ **Hand Tool Safety**

Careless use of simple hand tools such as wrenches, screwdrivers, and hammers causes many shop accidents that could be prevented. Keep in mind the following tips when using hand tools:

- Keep all hand tools grease-free. Oily tools can slip out of your hand, causing broken fingers or at least cut or skinned knuckles.
- Inspect your tools for cracks, broken parts, or other dangerous conditions before you use them.
- Hand tools should only be used for the purpose they were designed for. Use the right tool for the job
- Make sure the tool is of professional quality.
- Never use broken or damaged tools
- When using a wrench, always pull it, not push it, toward you.
- Always use the correct size of wrench.
- Use a box-end or socket wrench whenever possible.
- Do not use deep-well sockets when a regular size socket will work. The longer socket develops more twist torque and tends to slip off the fastener.
- Use an adjustable wrench only when it is necessary; pull the wrench so that the force of the pull is on the nonadjustable jaw.
- When using an air impact wrench, always use impact sockets.

- Never use wrenches or sockets that have cracks or breaks.
- Never use a wrench or pliers as a hammer.
- Never use pliers to loosen or tighten a nut; use the correct wrench.
- Always be sure to strike an object with the full face of the hammerhead.
- Always wear safety glasses when using a hammer and/or chisel.
- Never strike two hammer heads together.
- Never use screwdrivers as chisels.
- Be careful when using sharp or pointed tools.
- Do not place sharp tools or other sharp objects into your pockets.
- If a tool is supposed to be sharp, make sure it is Sharp. Dull tools can be more dangerous than sharp tools.
- Use knives, chisels, and scrapers in a motion that will keep the point or blade moving away from your body.
- Always hand a pointed or sharp tool to someone else with the handle toward the person to whom you are handing the tool

✓ **Power Tool Safety**

Power tools are operated by an outside power source, such as electricity, compressed air, or hydraulic pressure. Always respect the tool and its power source. Carelessness can result in serious injury. Also, always wear safety glasses when using power tools. Never try to use a tool beyond its stated capacity.

- **Electrical Tools:** When using an electrically powered tool, make sure it is properly grounded. Check the wiring for insulation cracks, as well as bare wires, before using it. Also, when using electrical power tools, never stand on a wet or damp floor. Before plugging in any electric tool, make sure its switch is in the off position. When you are finished using the tool, turn it off and unplug it. Never leave a running power tool unattended.
- **Compressed Air Tools:** Tools that use compressed air are called pneumatic tools. Compressed air is used to inflate tires, apply paint, and drive tools, such as air ratchets and impact wrenches.

Pneumatic tools must always be operated at the pressure recommended by the manufacturer. Before using a pneumatic tool, check all those connections for leaks. Also, check for airline damage.

- ✓ **Personal safety**
- To protect yourself from injuries, you must take precautions. This includes wearing protective gear, dressing appropriately, working professionally, and correctly handling tools and equipment.
- ✓ **Hair and Jewelry**

Long hair and loose, hanging jewelry can create the same type of hazard as loose-fitting clothing. They can get caught in moving engine parts and machinery.

If you have long hair, tie it back or tuck it under a cap. Rings, necklaces, bracelets, and watches should not be worn while working. A ring can rip your finger off, a watch or bracelet can cut your wrist, and a necklace can choke you. This is especially true when working with or around electrical wires.

- ✓ **Accident**

Accident is something, which happens unexpectedly and unintentionally, and which often damages something or injures someone or it may be defined as an uncontrolled event causing injury or damage to an individual or property.

- **Human error:** Stemming from failure to recognize a hazard, absent-minded conduct, negligence or failure to invest the required effort. Countermeasures to prevent these kinds of accidents.
- **Technical failure:** From material fatigue, unpredictable overloads, action against this type of accident is available in the form of technical safety measures, such as reinforcing a component whose breakage has caused an accident.
- **Acts of God:** From unforeseeable outside sources, such as unusual meteorological phenomena.
- ✓ **Lifting and Carrying**

At least once a week a technician will need to move something that is heavy. Knowing how to lift these heavy things can save your career. When lifting any object, follow these steps:

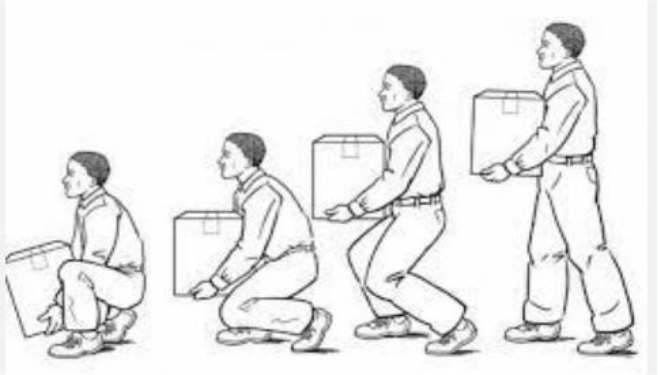


Figure 16:Use your leg muscles

Lifting and handling techniques

- Place your feet close to the object. Position your feet so you will be able to maintain a good balance.
- Keep your back and elbows as straight as possible. Bend your knees until your hands reach the best place to get a strong grip on the object
- If the part is in a cardboard box, make sure the box is in good condition. Old, damp, or poorly sealed boxes will tear and the part will fall out.
- Firmly grasp the object or container. Never try to change your grip as you move the load
- Keep the object close to your body, and lift it up by straightening your legs. Use your leg muscles, not your back muscles.
- If you must change your direction of travel, never twist your body. Turn your whole body, including your feet.
- When placing the object on a shelf or counter, do not bend forward. Place the edge of the load on the shelf and slide it forward. Be careful not to pinch your fingers.
- When setting down a load, bend your knees and keep your back straight. Never bend forward. This strains the back muscles.

- When lowering something heavy to the floor, set the object on blocks of wood to protect your fingers

Activity 2: Guided Practice

Task 6

1. Under your trainer's guidance, read and discuss in group on the following:
   a. Correct process for lifting a heavy object.
   b. Two things you should remember when using hand tools.
   c. Types of fire extinguishers according to their classes.

Activity 3: Application

Task 7

1. Technician A says that it is recommended that you wear shoes with nonslip soles in the garage. Technician B says that steel-toed shoes offer the best foot protection. Who is correct?

   a. Technician A c. Both A and B

   b. Technician B d. Neither A nor B

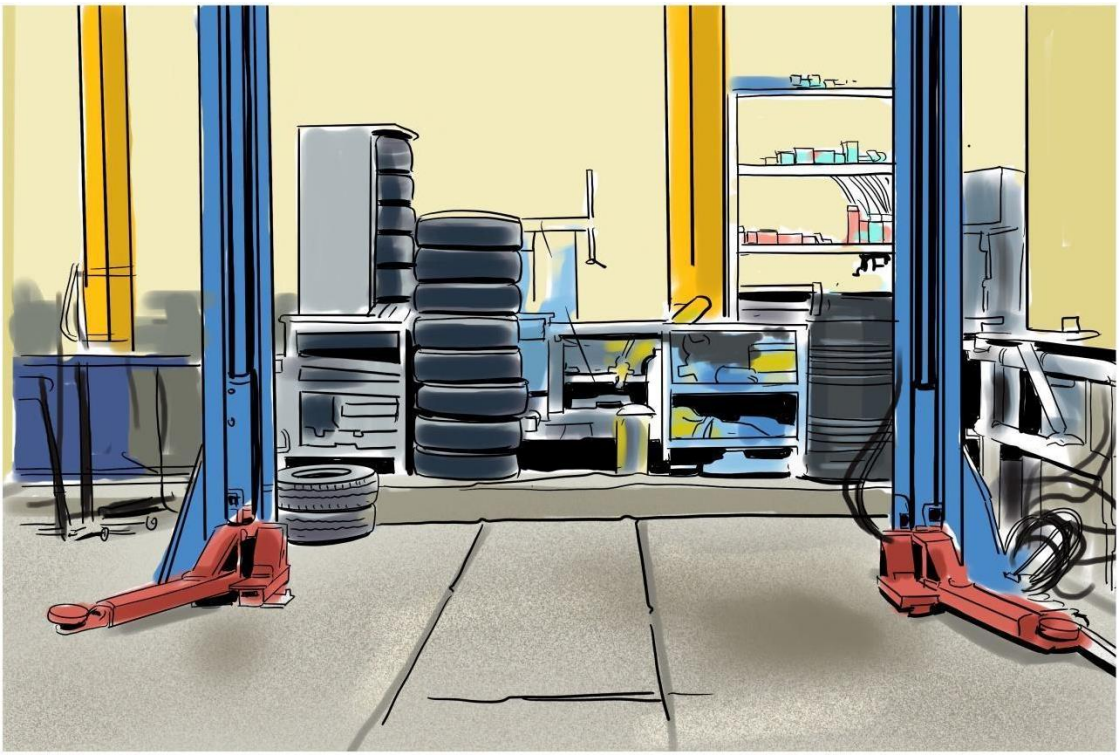
2. Which of the following is/are important when working in an automotive shop?
   a. Using the proper tool for the job
   b. Avoiding loose-fitting clothes
   c. Wearing steel-toed shoes
   d. All of the above
3. Which of the following is not recommended for use when trying to extinguish flammable liquid fires?
   a. Foam c. water
   b. Carbon dioxide d. dry chemical
4. What is an accident and what are the sources?

Topic 2.3: Cleaning and Arrangement of the Workplace

Activity 1: Problem Solving

Task 8

1. Analyze the figure below and answer the following questions:



a. How do you clean and organize a garage?

b. Give two tools and chemicals used for cleaning a garage.

c. What measures can be taken to ensure cleaning the workplace?

d. What techniques do you use when you carry a wheel with your hand?

Key Facts 2.3: Cleaning and Arrangement of the Workplace

- **Cleaning**

By safely and effectively removing soils, germs and other contaminants, they help us to stay healthy, care for our workplace and possessions, and make our surroundings more pleasant.

✓ **Main types of cleaning agents**

Although there are a huge variety of cleaning products available, they all eventually fall into one of four main categories: abrasives, acids, degreasers and detergents.

Hazardous Materials and Environmental Safety Some materials routinely used in the shop may be dangerous to your health. In addition, many chemicals irritate skin. Cautions about skin and eye protection A material is considered hazardous if it causes illness, injury, or death or pollutes water, air, or land.

✓ **Cleaning Methods**

Several categories of automotive materials call for different cleaning methods, including water-soluble deposits (dirt), organic soils, scale, and rust. Cleaning methods include:

Wet cleaning with petroleum solvents or water-based chemical solutions

Abrasive cleaning

Thermal cleaning

✓ **Cleaning workplace, tools, materials, and equipment**

Cleaning tools	Mechanical equipment	Chemicals/Materials
Microfiber Cloth	Vacuum cleaner	Chlorine dioxide
Abrasives	Polishing machine	Alcohols
Different types of brushes	Floor Scrubber	Iodophor disinfectant
Brooms	Steam vapor Machine	Quaternary Ammonium

✓ **Cleaning Solvent Safety Precautions**

There are several precautions to be aware of regarding cleaning solvents.

- **Cleaning solvent cautions**

Cleaning solvents are used extensively in auto repair. Their use is generally safe provided the user has knowledge of hazards associated with them. A flammable liquid's flash point is the temperature at which it will catch fire. Stoddard solvent has a relatively high flash point, but fires can still result.

✓ **Arrangement workplace layout**

A workshop layout refers to the placement of storage, machines, and workbenches in a confined space relative to each other. A poor workshop layout requires excessive traveling and handling between areas or may have too much disruption or clutter.

Tools should be categorized in a workshop and each tool can be organized further by having a designated and outlined location.

✓ **Hazardous materials and environmental safety**

Safe handling of hazardous material, when not handled correctly, hazardous materials in the workplace can cause substantial damage to personal and property.

Hazardous materials that automotive technicians commonly come into contact with include:

- Cleaning chemicals (Caustics, Acid, Solvents)
- Battery acid
- Fuels
- Paints and thinners
- Used oil and fluids
- Heavy metals
- Antifreeze/coolant
- Refrigerants

✓ **Arrangement first aid tool kit**

The first aid supplies should be located in an easily accessible area, and the first aid provider generally should not have to travel through several doorways, hallways and/or stairways to access first aid supplies.

- Basic first aid kit contains:
- Plasters in a variety of different sizes and shapes
- Small, medium and large sterile gauze dressing
- Triangular bandages
- Crepe rolled bandages
- Safety pin
- Disposable sterile gloves
- Tweezers
- Scissors
- Alcohol-free cleansing wipes
- Sticky tape
- Thermometer (preferably digital)
- Skin rash cream, such as hydrocortisone or calendula
- Cream or spray to relieve insect bites and stings
- Antiseptic cream
- Painkillers
- Antihistamine cream or tablets
- Distilled water for cleaning wounds
- Eyes wash and eyes bath

Figure 17: First aid kit

✓ **Arrangement of fire extinguishers**

Portable fire extinguishers can be an effective early response to a developing fire, if they are installed and used properly. In this section, we are going to review general information about the placement and spacing of portable fire extinguishers.

To avoid putting workers in danger, fire extinguishers should be located throughout the workplace and readily accessible in the event of a fire.

Activity 2: Guided Practice

Task 9

1. Study the figure below and answer the following questions:

a. Based on the given photo, which workplace is it representing? What does it show?

b. What is the importance of workplace arrangement?

c. What do you think will be covered under this topic based on that figure?

Cleaning tools	Mechanical equipment	Chemicals/Materials

Activity 3: Application

Task 10

1. The following is the mixed list of equipment, tools and materials used to clean the workplace. Select the appropriate cleaning tools, products/materials and equipment:
   a. Microfiber cloth
   b. Polishing machine
   c. Brooms
   d. Vacuum cleaner
   e. Alcohols
   f. Chlorine dioxide
2. Clean the workplace by using the above selected cleaning tools, products/materials and equipment.
3. Go to the nearest school garage, under the guidance of the garage owner, observe carefully the cleaning techniques used in the garage. Ask questions to the garage owner for more clarification about cleaning techniques. Make a report about the visit done.

Formative Assessment

1. Under the guidance of your trainer, discuss on the following questions:
   a. When should ear protection be worn?
   b. What are different types of hand and arm protection?
   c. What are the benefits of using PPE at the workplace?
   d. Classify and wear the PPE according to their use.
2. Read and discuss in group on the following questions:
   a. What are the correct Techniques for lifting a heavy object?
   b. State two things you should remember when using hand tools.
   c. Give the types of fire extinguishers according to their classes.

Points to Remember

- Carelessness or mishandling of power tools can cause serious injury. Make sure you know how to operate a tool before using it.
- Never use a lift or jack to move something heavier than it is designed for. Always check the rating before using a lift or jack.

Self-Reflection

1. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes acquired 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 the task? 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.

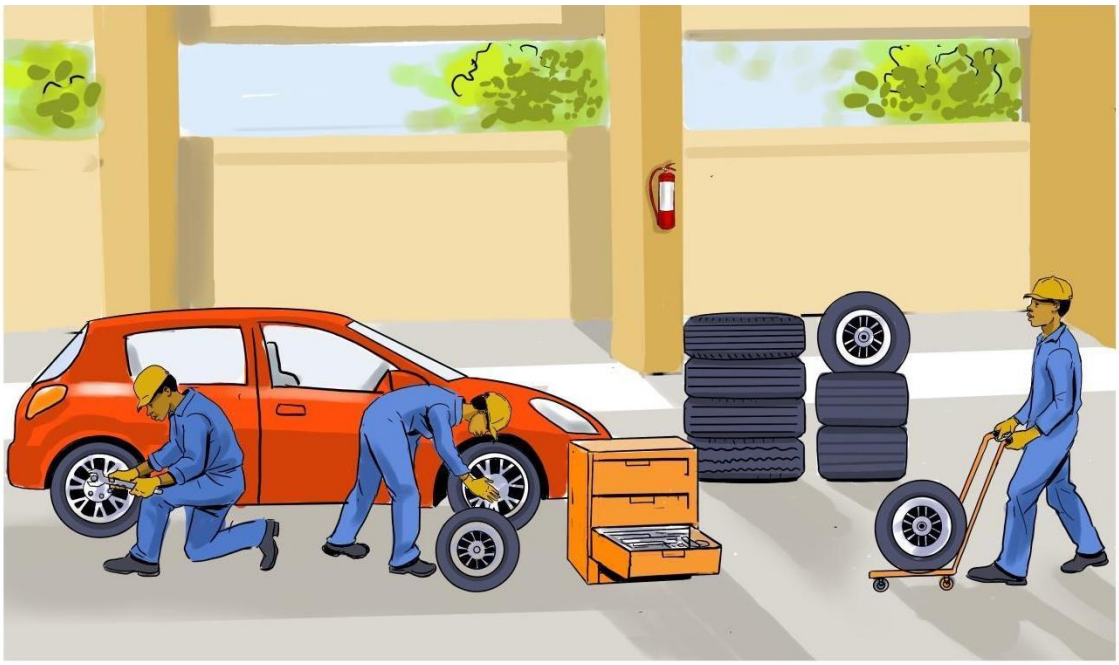
My experience Knowledge, skills and attitudes	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe PPE					
Use safety precautions at the working area					
Describe the cleaning techniques					

My experience Knowledge, skills and attitudes	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.
Describe the arrangement of the workplace					
Use first aid tool kit					
Classify the fire extinguishers					
Use of safety tool and equipment					

2. 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 WHEEL AND TIRE



Unit summary:

This unit provides you with the skills, knowledge, and attitudes required performing wheel and tiring repair. It involves selection of tools, materials and equipment; inspection of wheel and tire; dismounting and disassembling of wheel and tire; repairing of wheel and tire faults and remounts wheel and tire.

Self-Assessment Unit 3

1. Study the unit illustration above and answer the following questions:
    a. What do you see in the illustration?
    b. What is the man illustrated in the above figure doing?
    c. What topic do you think will be covered under this unit based on the illustration?
    d. Based on his work, what is the name of the man illustrated on the above picture?
2. Complete the self-assessment on the 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 that you have the knowledge, skills and attitudes to do this? How well?
    c. Read the statements across the top. Put a tick in the column that best represents your level of knowledge, skills and attitudes.
3. At the end of this unit, you will be assessing yourself again.

My experience **Knowledge, skills and attitudes**	**I do not 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.**
Inspect wheel and tire					
Dismantle procedures of wheel and tire					
Disassembling wheel and tire					
Reassemble wheel and tire					
Repair wheel and tire					

My experience Knowledge, skills and attitudes	I do not 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.
Remount wheel and tire					

Key Competencies:

Knowledge	Skills	Attitudes
1. Describe on how to inspect wheel and tire	1. Inspect wheel and tire	1. Reading carefully different types of wheel and tires
2. Describe dismounting procedures of wheel and tire	2. Dismounting wheel and tire	2. Take care when you are dismounting wheel and tire
3. Describe disassembling procedures of wheel and tire	3. Disassembling wheel and tire	3. Being careful when you are disassembling wheel and tire
4. Repairing method of wheel and tire	4. Repair wheel and tire	4. Demonstrate carefully the different methods of repairing wheel and tire

5. Describe reassembling wheel and tire	5. Reassembling wheel and tire	5. Apply safety measures when you are reassembling wheel and tire
6. Describe remounting procedures of wheel and tire	6. Remount wheel and tire	6. Apply safety measures when you are remounting wheel and tire

Discovery activity

Task 1

Study carefully the photo below and answer the questions that follow.

a. What do you see in the above illustration?

b. What topic do you think will be covered under this topic based on the illustration?

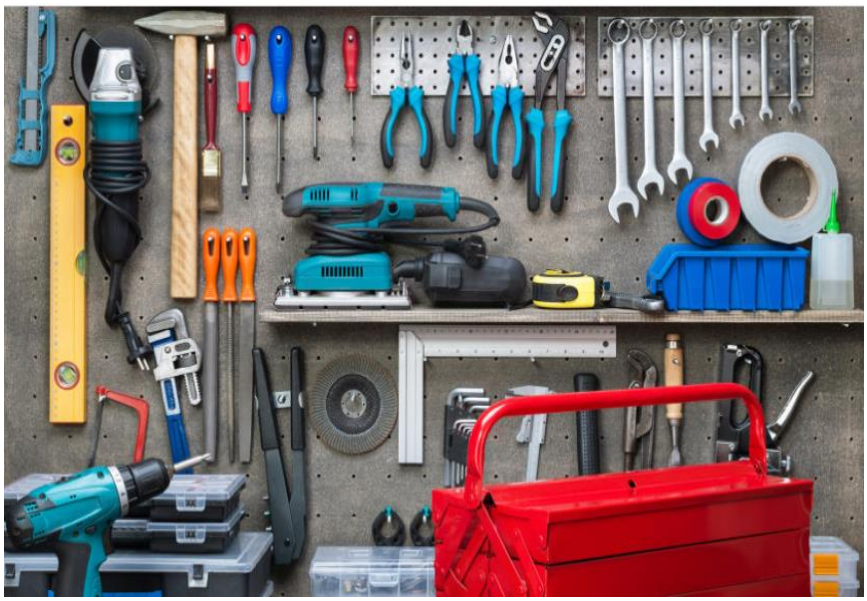
c. Do you think the illustration reflects the topic? Briefly explain your response.

Topic 3.1: Selection of Tools, Materials and Equipment

Activity 1: Problem Solving

Task 2

1. Study the illustration below and select the tools, materials and equipment.



Key Facts 3.1: Selection of Tools, Materials and Equipment

- **Materials, tools and equipment selection**

✓ **Hand tool**

- A tool held in the hand and operated without electricity or other power. Hand tools are of different types and can be used for any kind of work.
- Proper use and precision are more important than speed of work while using hand tools. Based on the type of work that needs to be done, a craftsman must choose the right kind of tools.
- One must be aware of the right tool for the job. Otherwise, the quality and efficiency of work will suffer.

✓ **Air tools**

- Impact wrenches
- Cordless impact wrenches
- Impact wrench safety
- Air ratchet
- Air drill

✓ **Tire repair tools and accessories**

- Contour wheel
- Buff out wheel
- Tire related hand tools
- Scrapers, rasps and inserting tools
- Tire probes
- Miscellaneous tire repair tools
- Tire repair knives
- Flexible tire repair knife
- Skiving knife
- Trimmer blade
- Rubber knife

- Flared contour wheels
- Low- profile patch prep wheel
- Economy flared contour wheel
- Polyp lugs for flared counter wheels
- Buzz out wheels
- 1/8” shaft repair kit
- 1/4” & 1/8” rotor saws
- Disc/dish sidewall wheels
- Rotary knife blades
- Nail hole reamers
- Retreading sidewall wheels

- Vacuum cleaners
- Carbide cutting tools
- Buffing stones for steel belted tires
- Tire probe awl
- Black handled tire denailer
- Tire repair tool pouch
- Leak detection spray

✓ **Equipment**

- Hydraulic jacks

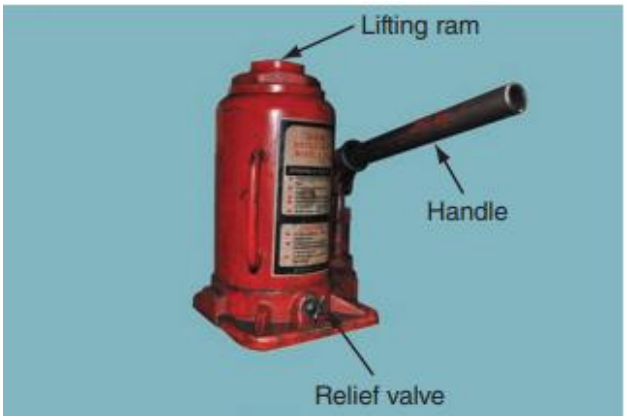


Figure 18: 20-Ton jack

- Bottle jack
- Tire changer
- Air compressor
- Air buffers and drills

✓ **Materials**

- Tire cement
- Sealants
- Patches
- Vulcanizing fluid
- Pre-buff cleaner
- Tire talc

Figure 19: Puncture Repair Kit

Activity 2: Guided Practice

Task 3

1. Make three groups and go to the School store to perform the following tasks under guidance of trainer:
    a. The first group is tasked to select the 5 tools used on wheel and tire repairing.
    b. The second group is tasked to select the 5 materials used on wheel and tire repairing.
    c. The third group is tasked to select the 5 equipment used on wheel and tire repairing.

Activity 3: Application

Task 4

1. The following is the mixed list of tire repair tools/accessories, equipment and materials used to repair wheel and tire. Select the right tire repairing tools/ accessories, equipment and materials.
    a. Patches
    b. Air compressor
    c. Skiving knife
    d. Vulcanizing fluid
    e. Tire probes
    f. Hydraulic jacks.
    g. Air ratchet.
    h. Impact wrenches.
2. After selection, discuss and make a report on the status of the selected tools, materials and equipment.

Topic 3.2: Inspection of Wheel and tire

Activity 1: Problem Solving

Task 5

Study the following figure and answer the following questions:

1. What do you see in the above illustration?
2. What are these people on the figure doing?
3. What topic do you think will be covered under this topic based on the illustration?
4. Do you think the illustration reflects the topic? Briefly explain your response.

Key Facts 3.2: Inspection of Wheel and tire

- **Inspection of wheel and tire**

✓ A proper visual inspection can help prevent tire failure at an early stage.

✓ Do check the tire surface and sidewall for any irregularities like bulges, cuts and cracks.

✓ Remember to check the inner surface too. Cracks due to stones, glass or other debris on the road can get wider over time and result in tire failure.

✓ Check your rims, too a damaged rim can also lead to tire failure over a period, hence should be replaced as soon as possible. If you notice a nail but your

tubeless-tire pressure is normal do not pull it out, as this will cause the air to escape.

- ✓ Proper tire service is extremely important for the safe operation of any vehicle.
- ✓ Premature wear can often be avoided by checking and performing routine service, such as frequent rotation and monthly inflation checks.
- ✓ Avoid overloading the vehicle and have any leaks repaired as soon as possible.
- ✓ All tires should be carefully inspected for faults in the tire itself or for signs that something may be wrong with the steering or suspension systems of the vehicle. For examples of common problems.

- **Checking done on wheels and tire:**

- ✓ Tire pressure
- ✓ State of rim/Run out
- ✓ Leakage
- ✓ Tire treads worn
- ✓ Valve steam faults

- **Inflation of tire**

- ✓ Tires should always be inflated to the pressure indicated on the driver's door or pillar sticker.
- ✓ Tires should be checked when cold, before the vehicle has been driven because driving on tires increases the temperature and therefore the pressure of the tires.
- ✓ **Proper tire inflation is important for the following reasons.**
- ✓ Inflation pressure carries the load of the vehicle. If the pressure is low, the load capacity of the tire is decreased.
- ✓ **Inflation pressure varies with temperature.** Tires lose 1 PSI for every 10-degree drop in temperature. This means that as the sensors change and the temperature changes, so does the inflation pressure inside the tires.
- ✓ **Tire inflation affects fuel economy.** A drop in inflation pressure from 30 PSI to 23 PSI can result in a drop of fuel economy from 20 miles per gallon to 18 miles per gallon.

- ✓ **Tire inflation affects tire life.** Even a slight drop in air pressure can have a major effect on the life of a tire. If, for example, the inflation pressure dropped 10 PSI, the life of the tire would be reduced by 40%.

- ✓ **The tread Act specifies that the driver be notified if the inflation of a tire drops by 25%.** However, 25% represents a loss of air pressure of about 8 PSI. A drop of 8 PSI means an approximate 2-mpg decrease in fuel economy as well as about a 25% reduction in tread wear.
- ✓ **Wheel run out**

Lateral wheel runout refers to how much a wheel or tire "wobbles" as it rotates. This unbalanced distribution of weight can cause vibrations or premature wear on your tires. Several different factors can cause excessive wheel run out, including rim, wheel and tire mounting. There are two types of wheel run out:

- ✓ **Radial run out**

To check radial run out (checking for out-of-round) and lateral run out (checking for side-to-side movement), follow these steps:

- Raise the vehicle so that the tires are off the ground approximately 2 in(5 cm).
- Place the run-out gauge against the tread of the tire in the center of the tread and, while rotating the tire, observe the gauge reading.
- Note that maximum radial run out should be less than 0.060 in. (1.5 mm). Little, if any, tramp will be noticed with less than 0.030 in. (0.8 mm) run out. If the reading is over 0.125 in. (3.2 mm), replacement of the tire is required
- Check all four tires.

Correcting Radial Run out: Excessive radial run out may be corrected by one of several methods:

- Try relocating the wheel on the mounting studs. Mark one stud and remount the wheel two studs away from its original position. Excessive wheel hole and/or stud

tolerance may be the cause. If the radial runout is now satisfactory, re-mark the stud and wheel to prevent a future occurrence of the problem.

- Remount the tire on the wheel 180 degrees from its original location. This can solve a run out problem, especially if the tire was not match mounted to the wheel originally.

- If run out is still excessive, remove the tire from the wheel and check the run out of the wheel. If the wheel is within 0.035 in. (0.9 mm), yet the run out of the tire/wheel assembly is excessive, the problem has to be a defective tire and it should be replaced.

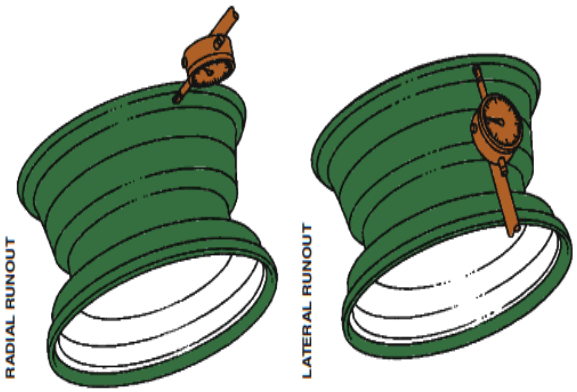
✓ **Lateral run out**

- Another possible problem that tires can cause is a type of vibration called shimmy. This rapid back-and-forth motion can be transmitted through the steering linkage to the steering wheel.
- Excessive runout is usually noticeable by the driver of the vehicle as a side-to-side vibration, especially at low speeds between 5 and 45 mph (8 and 72 km/h). Shimmy can be caused by an internal defect of the tire or a bent wheel. This can be checked using a run out gauge on the side of the tire or wheel to check for lateral run out.
- Place the run-out gauge against the side of the tire and rotate the wheel. Observe the readings. The maximum allowable reading is 0.045 in. (1.1 mm). If close to or above 0.045 in. (1.1 mm), check on the edge of the wheel to see if the cause of the lateral run out is due to a bent wheel.
- Most manufacturers specify a maximum lateral run out of 0.035 in. (0.9 mm) for alloy wheels and 0.045 in. (1.1 mm) for steel wheels.

✓ **Correcting Lateral Run out**: Excessive lateral run out may be corrected by one of several methods:

- Re-torque the wheel in the proper star pattern to the specified torque. Unequal or uneven wheel torque can cause excessive lateral runout.

- Remove the wheel and inspect the wheel-mounting flange for corrosion or any other reason that could prevent the wheel from sitting flat against the brake rotor or drum surface.
- Check the condition of the wheel or axle bearings. Looseness in the bearings can cause the wheel to wobble.



The most accurate method of measuring wheel run out is to dismantle the tire and take dial indicator readings on the inside of the wheel rim as shown above.

Figure 20: Lateral runout measurement

✓ **Check tire pressure**

- Start with cold tires
- Check the manufacturer's recommended PSI
- Write down the PSI for each tires
- Check tire pressure with your gauge
- Fill to recommended PSI
- Repeat every monthly

Activity 2: Guided Practice

Task 6

1. Guided by trainer, form groups and answer the following questions:
   a. Perform the checkup is made on wheels and tires.
   b. What is the importance of checking tire inflation?
   c. What are the types of wheels run out?

Activity 3: Application

Task 7

1. In groups or individual practical, check tire pressure by using a tire pressure gauge and after presenting your observation and ask more clarification to your trainer.

Topic 3.3: Dismounting and Disassembling of Wheel and Tire.

Activity 1: Problem Solving

Task 8

1. Study carefully the figure below and answer following questions:
    a. What do you see in the above illustration?
    b. Name of the tools used to dismount the wheel and tire from the vehicle.

Key Facts 3.3: Dismounting and Disassembling of Wheel and Tire.

- **Dismounting tires**

Never dismount tires while inflated and avoid tools that will damage the sidewalls or tire beads. Lubricate the rim flange and tire beads to assist the removal process. Tires can be dismounted following the steps below:

1. Identify the types of wheel and if there are any special handling issues
2. Positioning wheel assembly on tire changer remove valve core
3. Remove any wheel weights, again being careful not to damage wheel
4. Use breaking shovel to unseat the top bead
5. Turn tire/ wheel assembly around and repeat using the shovel
6. Secure assembly on tire changer
7. Mounted on a center post style changer.
8. Lubricate top bead
9. Break top bead by pushing down using the changer's unique tool
10. Use the changer's lever to slip the top bead over the rim flange
11. Lift bottom bead over rim flange

- **Lubricate tire and wheel components**

There are plenty of moving parts during mounting and dismounting, and all that motion can take a toll on your tire and wheel components. Lubricating facilitates mounting, dismounting, and adjustments, so it will not have to worry about punctures or tears.

Before fitting a new or existing tire back onto the wheel, lubricate:

- ✓ The inside and outside of the tire beads
- ✓ Rim seats
- ✓ Rim flanges
- ✓ The wheel's drop center
- ✓ **Process of disassembling wheel and tire**
- ✓ Remove Air Pressure. Start by removing the valve stem cap and using the valve stem tool to depress the valve core.
- ✓ Loosen Lug Nuts.
- ✓ Position the Vehicle Correctly.
- ✓ Dislodge the Tire.
- ✓ Remove the Tire from the Rim.

Activity 2: Guided Practice

Task 9

1. The illustration below shows how to dismount a tire from a wheel. After observing this illustration under your trainer's guidance, answer the questions below:

Under the guidance of trainer in the school workshop, perform the wheel and tire disassembling, respecting the process of disassembling

Activity 3: Application

Task 10

1. Read and act on the following questions:
    a. Based on the unit learnt, visit your nearest garage, and apply procedures of dismounting and disassembling wheel and tire.
    b. Enumerate tools and equipment that an automobile mechanic needs during dismounting and disassembling wheel and tire.
    c. Give advice to other automobile mechanics on the procedures of dismounting and disassembling wheel and tire quickly and safely.

Topic 3.4: Repairing of Wheel and tire Faults

Activity 1: Problem Solving

Task 11

Study this figure and answer the following questions:

1. What does the illustrated figure represent?
2. What are the two person shown in the followed figure doing?
3. Describe the process followed to repair a punctured vehicle tire.

Key Facts 3.4: Repairing of Wheel and tire Faults

Repairing of Tire

- ✓ Tread punctures, nail holes, or cuts up to 1/4 in. (2.6 mm) can be repaired.
- ✓ Repairs should be done from the inside of the tire using plugs or patches.
- ✓ The tire should be removed from the rim to make the repair.
- ✓ With the tire off the wheel, inspect the wheel and the tire for hidden damage.
- ✓ When properly repaired, the tire can be put back in service without the fear of an air leak recurring.
- ✓ Punctures in the tread area are the only ones that should be repaired or even attempted to be repaired.
- ✓ Never attempt to service punctures in the shoulders or sidewalls. In addition, do not service any tire that has sustained the following damage:

- Bulges or blisters
- Ply separation
- Broken or cracked beads
- Fabric cracks or cuts
- Wear to the fabric or visible wear indicators

- Punctures larger than 1⁄4-inch (6 mm) diameter
- ✓ To locate a puncture in a tire, inflate it to the maximum inflation pressure indicated on its sidewall.
- ✓ Then submerge the tire/wheel assembly in a tank of water or sponge it with a soapy water solution.
- ✓ Bubbles will identify the location of any air leakage.
- ✓ Mark the location of the leak with a tire crayon so it can be easily found once the tire is removed from the wheel.
- ✓ Also use the crayon to mark the location of the valve stem so that original tire and wheel balance can be maintained after the tire is put back on the wheel.
- ✓ **Repair Methods**

Once the tire is off the wheel and the cause of the puncture is removed and the location marked, the tire can be repaired from the inside using a service plug and a vulcanized patch. Although the repair kit's instructions should always be followed, there are some general guidelines that help make a good, permanent patch of the puncture.

Figure 21:

The following methods are the most common methods used to repair a tire:

- ✓ An external repair using tire string
- ✓ An internal repair using a repair patch
- ✓ An internal repair using a combination repair patch and plug.

The proper steps to follow for a tire repair are:

- ✓ Mark the location of the tire on the wheel

- ✓ Dismount the tire; inspect and clean the punctured area with a pre-buff cleaner. Do not use gasoline!

- ✓ Buff the cleaned area with sandpaper or a tire-buffing tool until the rubber surface has a smooth, velvet finish.
- ✓ Ream the puncture with a fine reamer from the inside. Cut and remove any loose wire material from the steel belts.
- ✓ Fill the puncture with contour filling material, and cut or buff the material flush with the inner liner of the tire.
- ✓ Vacuum and clean the area. Then apply chemical vulcanizing cement and allow to dry
- ✓ Apply the patch and use a stitching tool from the center toward the outside of the patch to work any air out from between the patch and the tire. Another excellent tire repair procedure uses a rubber plug. Pull the stem through the hole in the tire.
- ✓ Remount the tire on the rim, aligning the marks made in step 1. Inflate to the recommended pressure and check for air leaks.
- ✓ Installation of TPMS sensor flat side down. When installing a tire-pressure monitoring system sensor, be sure that the flat part of the sensor is parallel to the center section of the rim.

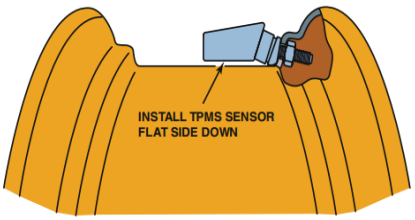


Figure 22: Installation of TPMS sensor

Activity 2: Guided Practice

Task 12:

Under the guidance of trainer go in groups and perform the following task:

Visit the Garage, under guidance of the garage owner, observe well the activities in the Garage about the steps followed for a tire repair and ask questions for more clarification about wheel and tire repair. Make a report about the visit done on wheel and tire repair then make a presentation and ask more clarification to your trainer.

Activity 3: Application

Task 13

Go to the garage near the school, under guidance of the garage owner, practically perform tire puncture repair. Once returned to your school, present the constraints met and ask more clarification to your trainer.

Topic 3.5: Re-assembling and Re-mounting of Wheel and tire

Activity 1: Problem Solving

Task 14

Based on the information on the following figure, answer the following questions:

a. What are the steps followed to assemble and re-mount the wheel and tire?
b. What are the steps to re- assemble and re-mount the wheel and tire?
c. List down the recommendations followed during tire service and mounting.

Key Facts 3.5: Re-assembling and Re-mounting of Wheel and tire

- ✓ **Re-assembling and re-mounting procedures**
- ✓ Dismounting the tire from the wheel begins with releasing the air, removing the valve stem core, and unseating the tire from its rim. The machine does the unseating. The technician merely guides the operating lever
- ✓ Once both sides of the tire are unseated, place the tire and wheel onto the machine. Then depress the pedal that clamps the wheel to the tire machine
- ✓ Lower the machine's arm into position on the tire and wheel assembly
- ✓ Insert the tire iron between the upper bead of the tire and the wheel. Depress the pedal that causes the wheel to rotate. Do the same with the lower bead.
- ✓ After the tire is totally free from the rim, remove the tire.
- ✓ Prepare the wheel for the mounting of the tire by using a wire brush to remove all dirt and rust from the sealing surface. Apply rubber compound to the bead area of the tire.
- ✓ Place the tire onto the wheel and lower the arm into place. As the machine rotates the wheel, the arm will force the tire over the rim. After the tire is completely over the rim, install the air ring over the tire. Activate it to seat the tire against the wheel
- ✓ Reinstall the valve stem core and inflate the tire to the recommended inflation
- ✓ **Wheel mounting torque**

For wheel mounting torque, make certain that the wheel studs are clean and dry, and torqued to the manufacturer s specifications.

Figure 23: Wheel re-mounting with torque wrench

CAUTION: Most manufacturers warn that the wheel studs should not be oiled or lubricated with grease; this can cause the wheel lug nuts to loosen while driving. Always follow the vehicle manufacturers recommended service procedures.

- ✓ **Torque Sequence**
- ✓ Always tighten wheel lug nuts (or studs) in a star pattern to ensure even pressure on the axle flange, brake rotors or drums, and the wheel itself.

Figure 24: Tightening pattern

Always tighten lug nuts gradually in the proper sequence star pattern (tighten one nut, skip one, and tighten the next nut). This helps prevent warping the brake drums or rotors, or bending a wheel.

Tire lug nuts should always be torqued to factory specifications. If the exact torque value is not available, use the following chart as a guide for the usual value based on the size (diameter) of the lug studs.

Lug Nut Thread	Torque in Ft/Lbs

½ in.	85-95
9/16 in.	130-140
5/8 in.	130-140
12mm	70-89
14mm	85-90

- ✓ **Recommendations during tire service/ mounting.**
- ✓ When removing a wheel from a vehicle for service, mark the location of the wheel and lug stud to ensure that the wheel can be replaced in exactly the same location. This ensures that tire balance will be maintained if the tire/wheel assembly was balanced on the vehicle.
- ✓ Make certain that the wheel has a good, clean metal-to-metal contact with the brake drum or rotor. Rust, grease, oil, or dirt between these two surfaces could cause the wheel lug nuts to loosen while driving.
- ✓ Always check the rim size. For example, simply by looking it is hard to distinguish a 16-in. wheel from a 16.5-in. wheel used on some trucks. The rim size is marked on the sidewall of the tire, and the rim's diameter and width are stamped somewhere on the wheel.
- ✓ Remove the tire from the rim following the instructions of the tire change machine adhering to all safety precautions.
- ✓ Install a new tire valve or the tire-pressure monitoring system
- ✓ Many tires have been marked with a paint dot or sticker. This mark represents the largest diameter (high point) and/or stiffest portion of the tire. This variation is due to the overlapping of carcass and belt fabric layers, as well as tread and sidewall rubber splices.
- ✓ The tire should be mounted to the rim with this mark lined up with the valve stem. The valve stem hole is typically drilled at the smallest diameter (low point) of the wheel.

- ✓ Mount the tires on the rim with the valve stem matched to (lined up next to) the mark on the tire. This is called match mounting.
- ✓ Never use more than 40 PSI (275 kPa) to seat a tire bead.
- ✓ Rim flanges must be free of rust, dirt, scale, or loose or flaked rubber build-up prior to mounting the tire.
- ✓ When mounting new tires, do not use silicone lubricant on the tire bead. Use special lubricant such as rendered (odorless) animal fat or rubber lubricant to help prevent tire rotation on the rim.

- ✓ This rubber lube is a water-based soap product that is slippery when wet (coefficient of friction when less than 0.3) and acts almost as an adhesive when dry (coefficient of friction when dry of over 0.5 for natural products and over 1.0 for synthetic products).
- ✓ If the wrong lubricant is used, the rubber in the bead area of the tire can be softened or weakened. In addition, most other lubricants do not increase in friction when they dry like rubber lubricant does. The result can be the rotation of the tire on the rim (wheel), especially during rapid acceleration or braking.

NOTE: Many experts recommend that when a new tire is installed the vehicle should be driven at less than 50 mph (80 km/h) for the first 50 miles (80 km) to allow the tires to adhere to the rim. During this break-in period, the rubber lube used to mount the tire is drying and the tire is becoming fully seated on the rim. By avoiding high speeds, rapid acceleration, and fast braking, the driver is helping to prevent the tire from rotating on the rim.

- ✓ **Rotation of tire**
- ✓ To ensure long life and even tire wear, tire rotation is essential. It is important to rotate each tire to another location. Some rear wheel-drive vehicles, for example, may show premature tire wear on the front tires.
- ✓ The wear usually starts on the outer tread row. This wear usually appears as a front-to-back (high and low) wear pattern on individual tread blocks.

- ✓ These blocks of tread rubber are deformed during cornering, stopping, and turning. This type of tread block wear can cause tire noise and/or tire roughness.
- ✓ While some shoulder wear on front tires is normal, it can be reduced by proper inflation, alignment, and tire rotation.
- ✓ For best results, tires should be rotated every 6,000 miles or every six months.
- ✓ Due to their construction. If wheel alignment is correct, attempt to correct a pull by rotating the tires front to rear or, if necessary, side to side.
- ✓ Some tire manufacturers do not recommend rotating the tires on front-wheel-drive vehicles because the front tires often wear three times as fast as the rear.
- ✓ They recommend replacing just front tires, because the rear tires often last over 90,000 miles (145,000 km).
- ✓ The method most often recommended is the modified X method. Using this method, each tire eventually is used at each of the four-wheel locations. An easy way to remember the sequence, whether front wheel drive or rear wheel drive, is to say to yourself, Drive wheels straight, cross the non-drive wheels.

Activity 2: Guided Practice

Task 15

Under the guidance of your trainer, perform wheel and tire re-assembling and re-mounting to the vehicle, by respecting re-assembling, and re-mounting procedures.

Activity 3: Application

Task 16

Individually, perform wheel and tire re-assembling and re-mounting to the vehicle, by respecting re-assembling, and re-mounting procedures.

Formative Assessment

1. List three tools, three equipment et three materials used in wheel and tire repairing.
2. Explain the steps of performing tire puncture repair.
3. Explain the procedures to perform wheel and tire re-assembling and re-mounting to the vehicle.

Points to Remember

Tires cannot be buried because they tend to come to the surface.

They also trap and hold water, which can be a breeding ground for mosquitoes.

Used tires should be sent to a local or regional recycling center where the tires will be ground up and used in asphalt paving or other industrial uses.

Because there is often a charge to dispose of old tires, it is best to warn the customer of the disposal fee.

Open-end wrenches make it easier tire repair is made easier if two open-end wrenches are used to hold the beads of the tire apart.

Self-Reflection

1. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes acquired 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 the task? 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 Knowledge, skills and attitudes	I do not 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.
Check leakages on wheel and tire					
Check tire pressure					
Check state of rim					
Check tire treads					
Check valve steam fault					
Dismantle procedures of wheel and tire					
Disassembling wheel and tire					
Reassemble wheel and tire					
Repair wheel and tire					
Remount wheel and tire					

2. 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. **2.**	**1.** **2.**	**1.** **2.**

3.	**3.**	**3.**

UNIT 4: CARRY OUT WHEEL BALANCING

Unit summary:

This unit provides you with the skills, knowledge, and attitudes required to carry out wheel balancing. It involves identification of wheel balancer, description of Wheel Balancing Machine Components and Accessories and performs wheel balancing.

Self-Assessment:

1. Study the unit illustration above and answer the following questions:
    a. What do you see in the illustration?
    b. What is the man illustrated in the above figure doing?
    c. What topic do you think will be covered under this unit based on the illustration?
    d. Based on his work, what is the name of the man illustrated on the above picture?
2. Complete the self-assessment on the 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 that you have the knowledge, skills and attitudes to do this? How well?
    c. Read the statements across the top. Put a tick in the column that best represents your level of knowledge, skills and attitudes.
3. At the end of this unit, you will be assessing yourself again.

My experience **Knowledge, skills and attitudes**	**I do not 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.**
Identify wheel balancer					
Describe wheel balancing machine components and accessories					
Differentiate wheel balancing machine					

My experience Knowledge, skills and attitudes	I do not 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.
Carry out wheel balancing					
Test of wheel and tire					

Key Competencies:

Knowledge	Skills	Attitudes
1. Identify types of wheel balancer machine	1. Identify wheel balancer	1. Take care when identifying wheel balancer
2. Describe the operating principle of wheel balancing machine	2. Operate wheel balancing machine to check the working condition	2. Carefully operate wheel balancing machine to check the working condition
3. List all procedures followed to mount the wheel on wheel balancer	3. Mount wheel on wheel balancer machine	3. Carefully Mount wheel on wheel balancer machine
4. List steps followed to set data into balancing machine	4. Set the data into the machine	4. Accurately set data into balancing machine
5. Describe wheel balancing procedures	5. Perform wheel balancing	5. Carefully perform the wheel balancing
6. Describe testing method of wheel on the wheel balancer	6. Test wheel on the machine	6. Take care when testing wheel using wheel balancer

Discovery activity

Task 1

1. Probably you have covered wheel and tire repairing as unit.
    a. Have you ever seen where they are using a tire wheel balancer? If yes, explain the process.
    b. What is tire wheel balancing?
    c. What do you call the machine/equipment used to perform tire wheel balancing?
    d. What is the importance of performing tire wheel balancing?

Topic 4.1: Identification of Wheel Balancer

Activity 1: Problem Solving

Task 2

Read this scenario and answer the question below:

1. Technician A says that a tire with a tread wear rating of 200 would be expected to last twice as long under the same conditions as one with a 100 rating. Technician B says that when the diameter of a tire is changed, from-end geometry is altered. Who is right?
   a. Technician A
   b. Technician B
   c. Both A and B
   d. Neither A or B
2. Have you ever seen a tire wheel balancer mechanic?

Key Facts 4.1: Identification of Wheel Balancer

- **Identification of wheel balancing machine types**

✓ **Wheel Balance**

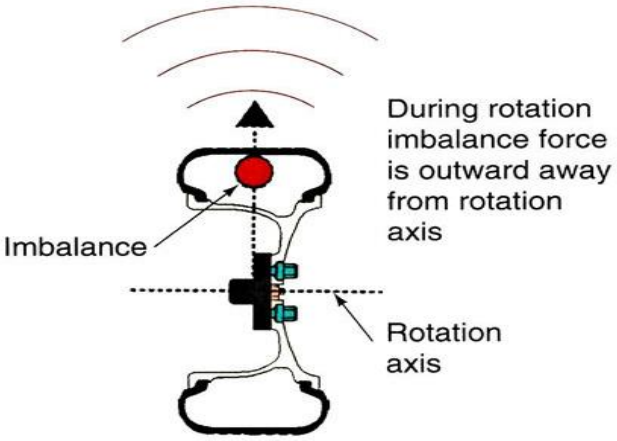
- Wheel balancing is the process of balancing the weight of a tire and wheel assembly so that it travels evenly at high speeds.
- Balancing requires putting a mounted wheel and tire on a balancer, which centers the wheel and spins it to determine where the weights should be added.
- Every time a wheel is first mounted onto a vehicle with a new tire, it has to be balanced.
- The goal is to make sure the weight is evenly distributed throughout each of the wheels and tires on a vehicle.
- This process evens out heavy and light spots in a wheel, so that it rotates smoothly. If there is even a slight difference in weight in the wheels, it will cause enough momentum to create a vibration in the car.

- But when things get unbalanced, it's a completely different experience and you certainly wouldn't want that to happen to your tires!

✓ **Types of wheel balancing method**

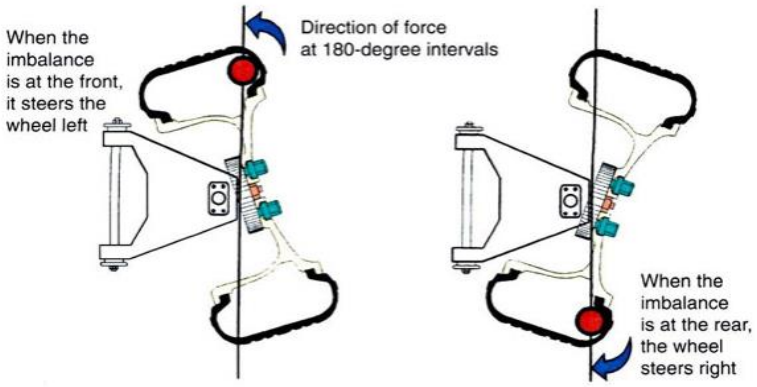
- **Static balancing**

Static balancing is accomplished while the wheel is at rest.



- **Dynamic balancing**

Dynamic balancing is accomplished while the wheel is in motion. Dynamic balancing is a much more accurate measurement due to the simulation of operating speeds.



- **How does balancing work?**

✓ **Spin balancing**

- Your installer uses special equipment to analyze the tires and wheels and find any heavy spots that could cause them to vibrate when spinning.

- One at a time, the tire and wheel assemblies are placed on the balancing machine and run through a series of diagnostic tests.
- The machine identifies where the tire and wheel assembly is out of balance, and then the technician corrects any imbalances by applying small weights to the rim at specific locations, in order to even out the distribution of weight.

✓ **Road Force Balancing**

- While spin balancing spins the tire assembly in the air to find imbalances, a Road Force balancer simulates the force of the road on a tire by pressing a large roller against the tire as it spins.
- Then the machine measures the deviation from perfect roundness so the technician can balance the tire.

✓ Road Force balancing may be able to detect tire issues not found by spin balancing.

✓ **Selection criterion of wheel balancer**
✓ Technical data
✓ Features
✓ Working environment
✓ **Wheel imbalance**
✓ Static imbalance
✓ Dynamic imbalance

Activity 2: Guided Practice

Task 3

Go to the school workshop, under guidance of a trainer; identify the two different types of wheel balancing machine. Present what you have observed and ask more clarification to the trainer.

Activity 3: Application

Task 4

Go to the nearest school garage, under guidance of garage owner; identify the two different types of wheel balancing machine. Present what you have observed and ask more clarification to the trainer.

Topic 4.2: Description of Wheel Balancing Machine Components and Accessories

Activity 1: Problem Solving

Task 5

Study the figure below and answer following questions:

a. Identify the wheel balancer parts.

b. Describe the wheel-balancing machine outside parts.

c. Describe safe operating of a wheel balancing machine.

Key Facts 4.2: Description of Wheel Balancing Machine Components and Accessories

- **Wheel balancing machine outside parts description**

✓ A balancing machine is a measuring tool used for balancing rotating machine parts such as wheels, rotors for electric motors, fans, turbines, disc brakes, disc drives, propellers and pumps.

✓ The machine usually consists of two rigid pedestals, with suspension and bearings on top supporting a mounting platform.

✓ Wheels are balanced on a wheel-balancing machine. The machine rotates the tire and wheel assembly and automatically calculates the weight and location of the balance counter weight. And a required amount of weights are added to the rim of the wheel.

✓ It is observed that by balancing the life of the tire will increase, hence there will not be any vibrations in steering or car and the drive will be smooth and comfortable.

✓ **Parts of wheel balancer**

✓ Adapters.

✓ Backing Plate

✓ LCD Display

✓ Food pedal braking

✓ Multi pocket storage tray

✓ Bowl mounting

✓ Saf**e operating of wheel balancing machine**

✓ Before starting to use the balancing machine, carefully read the operating instruction manual.

✓ Keep the manual in a safe place for future reference.

✓ Forbid removing or modifying machine parts as this would impair correct operation.

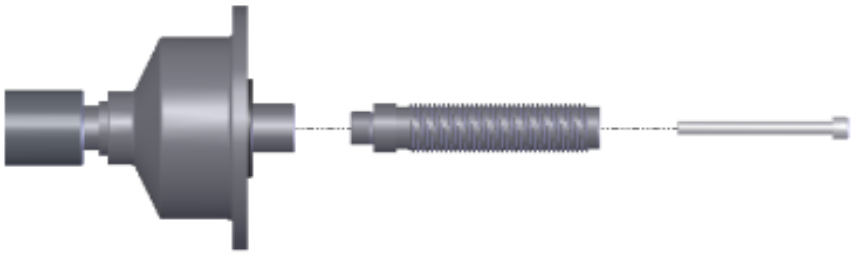
✓ Do not use strong jets of compressed air for cleaning.

- ✓ Use alcohol to clean plastic panels or shelves (AVOID LIQUIDS CONTAINING SOLVENTS).
- ✓ Before starting the wheel balancing cycle, make sure that the wheel is securely locked on the adapter.
- ✓ The machine operator should not wear clothes with flapping edges. Make sure that unauthorized personnel do not approach the balancing machine during the work cycle.
- ✓ Avoid placing counterweights or other objects in the base which could impair the correct operation of the balancing machine
- ✓ **Machine assembly**
- ✓ **Unpack: Unpack the carton; check if it is missing any spare parts.**
- ✓ **Install:**

- The machine can only work on a flat floor, otherwise it is not accurate.
- Leave 5 m^2 around the balancer for easy operation
- Fix the balancer to the floor with screws on the bottom.

- ✓ **Adaptor mounting**

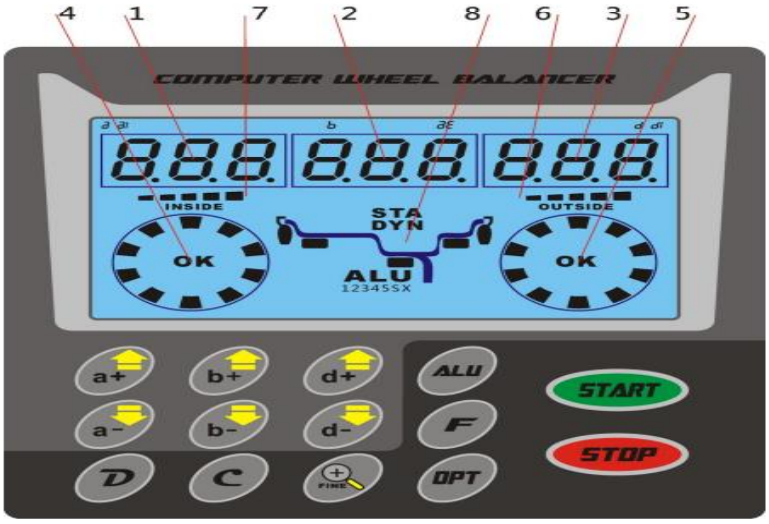
- The wheel balancer is supplied complete with cone type adaptor for fastening wheel with central bore.



- ✓ **Install wheel**

- Clean the wheel, take off counterweights, and check the pressure of the wheel. Choose the way of installation according to the type of wheel.

✓ **Controls and component**



1. Digital readout of “a” , distance dimension, inside amount of unbalance
2. Digital readout of “b”, width dimension
3. Digital readout of “d”, diameter dimension, outside amount of unbalance
4. Digital readout, inside position of unbalance
5. Digital readout, outside position of unbalance
6. Indicator bar for ruler when pull out ruler for outside position
7. Indicator bar for ruler when pull out ruler for inside position

- **Self-calibration of wheel balance**

Attention: Do the self-calibration before the first use or whenever you think the balancer is not accurate. The 100g counterweights must be very accurate.

✓ Calibration of automatic gauges

- Rim distance gauge calibration
- Rim diameter gauge calibration
- ✓ Self-diagnosis
- ✓ Computer board replacement
- ✓ ALUS mode
- ✓ ALUS split function
- ✓ Errors
- ✓ Wheel balancing machine accessories
- Calibration weight for weaver
- Weight hammer for weaver
- Quick nut 36mm for weaver
- Ring for weaver
- Spacer ring for weaver
- Motorcycle wheel balancer large shaft
- Truck cone kit

Activity 2: Guided Practice

Task 6

Under guidance of a trainer, rename the following parts identified by letters.

Activity 3: Application

Task 7

Go to the nearest school garage, under guidance of garage owner, describe wheel balancing machine components and accessories. Present what you have observed and ask more clarification to the trainer.

Topic 4.3: Perform Wheel Balancing

Activity 1: Problem Solving

Task 8

1. Read and answer the questions below:
    a. How do you mount and balance tires?
    b. List down the steps for balancing a tire.
    c. How do you test a tire after balancing?

Key Facts 4.3: Perform Wheel Balancing

- **Wheel balancing machine outside parts description**

There are a number of reasons why you should be checking the balance of the tires/wheels on your customers' vehicles. The three basic times when balancing should be done include:

- ✓ When a tire is replaced or repaired
- ✓ When a balance weight is moved or falls off
- ✓ When new tires are purchased
- Tire technicians know that balancing tire/wheel assemblies can eliminate vibration and wobbling. This will improve tire wear, increase fuel mileage and remove stress from a vehicle. Vibration caused by out-of-balance tires usually occurs at speeds of 50 mph to 70 mph.

- **Mounting and balancing tires safely**

Figure 25: Wheel balancing machine in operation

Inspect your machines

- ✓ Use protective equipment
- ✓ Match tires to rims correctly
- ✓ Examine the wheel closely
- ✓ Body positioning
- ✓ Don't loosen beads before the tire has been fully deflated.

- ✓ Don't force the issue when mounting.
- ✓ Never remove the hood on a wheel balancer.
- ✓ Use the right weights and apply them correctly.
- ✓ Slow down.

✓ **Pre-balance checks.**

Before attempting to balance any tire, the following should be checked and corrected to ensure good tire balance:

- ✓ Check the wheel bearing adjustment for looseness or wear.
- ✓ Check the radial run out.
- ✓ Check the lateral run out.
- ✓ Remove stones from the tread.
- ✓ Remove grease or dirt buildup on the inside of the wheel.
- ✓ Check for dragging or misadjusted brakes.
- ✓ Check for loose or backward lug nuts.
- ✓ Check for proper tire pressures.
- ✓ Remove all of the old weights.
- ✓ Check for bent or damaged wheel covers.

✓ **Steps for Balancing a Tire/Wheel Assembly**

After ensuring that the beads have reseated properly, the tire should be inflated to the recommended pressure.

The balancing steps outlined in this article are typical but will vary somewhat depending on the type of equipment used.

- ✓ Turn on the balancer
- ✓ Clean the tire, rim flange and wheel
- ✓ Mount the tire/wheel assembly on a balancer
- ✓ Enter the A & D wheel dimensions
- ✓ Enter width wheel dimensions
- ✓ Lower the hood to spin the wheel and check dimensions
- ✓ Raise the hood after the tire stops rotating
- ✓ Note when the inboard center bar blinks
- ✓ Attach inboard corrective weight
- ✓ Press NEXT, which rotates the wheel
- ✓ Note when the outboard center bar blinks
- ✓ Attach outboard corrective weights
- ✓ Lower the hood to re-spin and check balance
    - ✓ **Benefits of wheel balancing**
        - ✓ It will save you from the risky drive
        - ✓ Smooth driving experience
        - ✓ It will protect your tires from uneven wearing
        - ✓ It will control vibrations on the steering wheel
        - ✓ You will have more control of your vehicle
    - ✓ **Indications of unbalanced tires:**
        - ✓ When you are driving at a certain speed and you feel some vibrations in your steering wheel, then it must be due to tire unbalancing.
        - ✓ You must immediately get your tire balanced to avoid any mishap.
        - ✓ An important tip here is to get your tires rotated after every 5000 km to keep your tires and vehicle safe.
        - ✓ Testing of wheel and tire
        - ✓ Drivability
        - ✓ Wheel stability

Activity 2: Guided Practice

Task 9

Go to the school workshop, under guidance of the trainer, observe and perform the basic precautions observed when mounting and balancing tires, checking and correction made on the tire to ensure good tire balance, tire wheel balancing and test made on wheel and tire after balancing.

Activity 3: Application

Task 10

Go to the nearest school garage, under guidance of the garage owner, observe and perform the basic precautions observed when mounting and balancing tires, checking and correction made on the tire to ensure good tire balance, tire wheel balancing and test made on wheel and tire after balancing. Once again they go back to school. Each one will share his/her experience gained from garage with the rest of the class.

Formative Assessment

a. Describe wheel balancing machine components and accessories.
b. How do you mount and balance tires?
c. List down the steps for balancing a tire.
d. How do you test a tire after balancing?

Points to Remember

Never remove the weights that are welded to the surface of the brake drum facing the wheel. If replacement wheels do not fit without removing these weights, either replace the brake drum (one without a weight) or select another brand or style of wheel.

Removing the weights from a brake drum can cause severe vibration at highway speeds.

Whenever balancing a tire, it is wise to use as little amount of weight as possible. For most standard-size passenger vehicle tires, most experts recommend that no more than 5.5 oz of weight be added to correct an imbalance condition.

If more than 5.5 oz total weight is needed, remove the tire from the wheel (rim) and carefully inspect for damage to the tire or the wheel.

If the tire still requires more than 5.5 oz and the wheel is not bent or damaged, replace the tire.

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 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:
    a. Do you think you have the knowledge, skills and attitudes to do the task?
    b. How well?
3. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.

My experience Knowledge, skills and attitudes	I do not 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.
Identify wheel balancer					
Describe wheel balancing machine components and accessories					
Differentiate wheel balancing machine					
Carry out wheel balancing					
Test of wheel and tire					

4. 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. **3**	**2.** **3**	**2.** **3**

Summative assessment (Integrated Assessment)

Integrated/Summative assessment
Integrated situation Mr KANANGA who works in Rwanda standard Board was driving his car RAV4 from the job to NIYO tire service station to change his car's front left tire that was worn and had a dynamic imbalance. When reaching the Garage, he found a flat tire on his car's rear right. The head of NIYO Service station requested you as wheel and tire maintainer to solve the above mentioned problem within 2 hours.

Tools	Set of screwdrivers, Set of pliers, jacks, jack stand, tire inflation gauge, valve remover, tire repair tool kit
Equipment	PPE, tire changer, wheel balancer, air compressor, car
Materials/ Consumables	Internet, repair manual, valve steam, tube, tires, solvent, lubrication oil, tire seals, solution, water, metallic brush

BIBLIOGRAPHY

1. Jam D.Haldman, Automotive technology volume principles diagnosis and services fourth edition
2. Jack Erjavec Automotive technology volume a systems approach 5th edition
3. Lehmetel, Modern automotive technology Europa 2nd edition
4. 2002 Automobile Task List, National Automotive Technicians Education Foundation (NATEF), www.natef.org
5. John C. Huntington, Dina Bangdel, The Circle of Bliss: Buddhist Meditational Art, p. 524
6. Kingston Heritage (February 19, 2016). "What to do if your car gets the shakes after a snow storm". Metroland Media Group Ltd. Archived from the original on 2019-12-14.
7. Gilles, Tim (2012). Automotive Service: Inspection, Maintenance, Repair. Cengage Learning. p. 1167. ISBN 9781133420682.

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