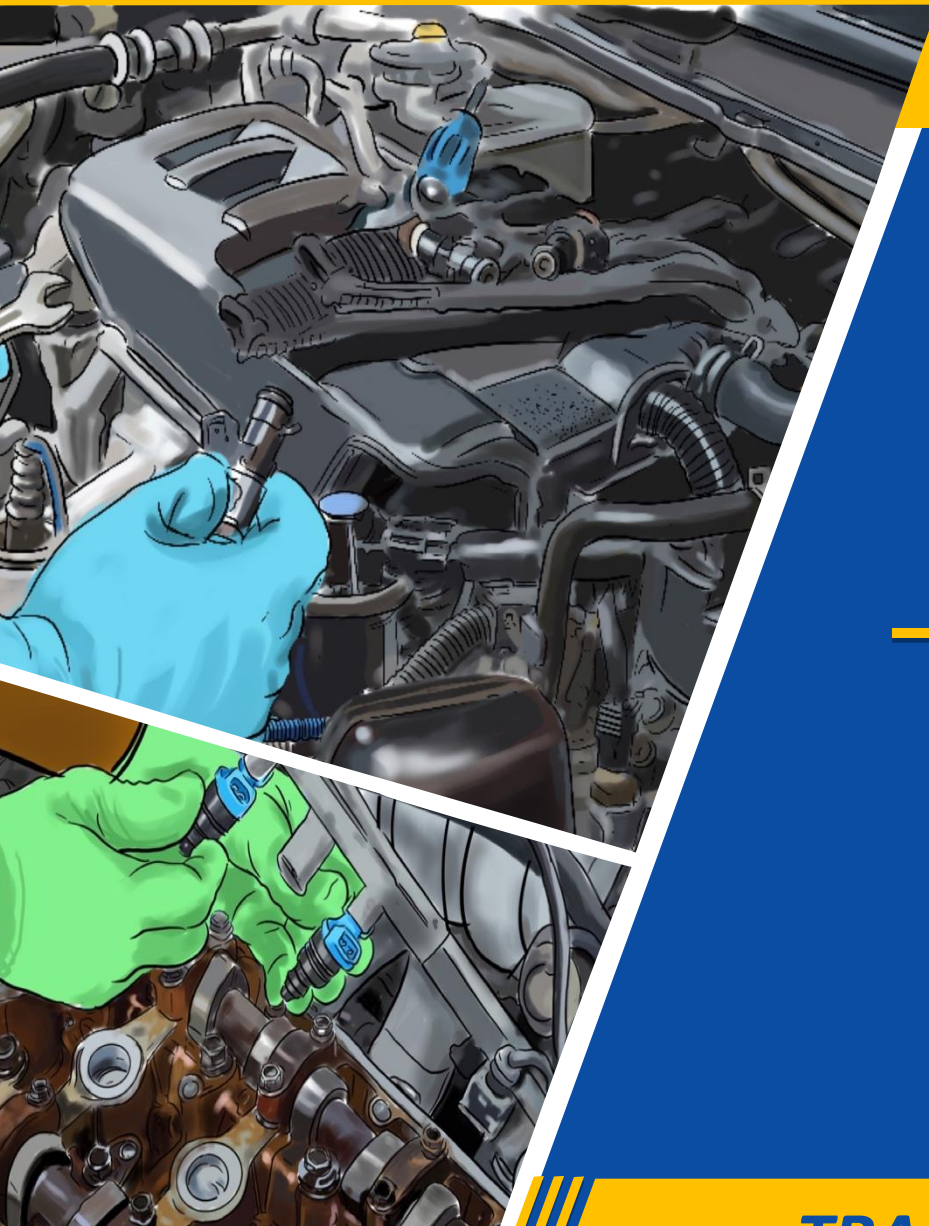




RQF LEVEL 3



AUTFS301 **AUTOMOBILE** **TECHNOLOGY**

Repair Petrol **Engine Fuel** **Supply**

TRAINEE'S MANUAL

December 2023



REPAIR PETROL ENGINE FUEL SUPPLY SYSTEM



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KIGALI-RWANDA

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Rwanda TVET Board (RTB) guiding policies and directives



Under Swisscontact Supervision and Involvement

COORDINATION TEAM

Aimable Rwamasirabo

Sosthene Kazima

Production Team

Authoring and Review

Moise SIBOMANA

Innocent TUYISENGE

Faradji GAHUNGU

Conception, Adaptation and Editorial works

Jean Marie Vianney MUHIRE

Vincent HAVUGIMANA

John Paul KANYIKE

Josiane TUYISHIMIRE

Formatting, Graphics, Illustrations, and infographics

Augustin HABIMANA

Jean Claude Asoka NIYONSABA

UWINEZA Patrick

Coordination and Technical support

Swiss contact and RTB

Project Implementation

MCT Global Ltd

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LIST OF ABBREVIATIONS AND ACRONYMS

%:	Percentages
AC:	Air conditional
CBET:	Competency-based education and training
CKP:	Crankshaft position sensor
CMP:	Camshaft position sensor
DI:	Direct Injection
ECT:	Engine coolant temperature
ECU:	Engine control module
EFI:	Electronic Fuel Injection
GDI:	Gasoline direct injection
ID:	Indirect Injection
Km/h:	Kilometer per hour
MAP:	Manifold absolute pressure
Mph:	Miles per hour
PMFI:	Multi-point fuel Injection
RQF:	Rwanda Qualification Framework
RTB:	Rwanda TVET Board
SFI:	Sequential fuel injection
TVET:	Technical and Vocational Education and Training

INTRODUCTION

This trainer manual encompasses all methodologies necessary to guide you to properly deliver the module titled: Repair Petrol Engine Fuel Supply, 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.

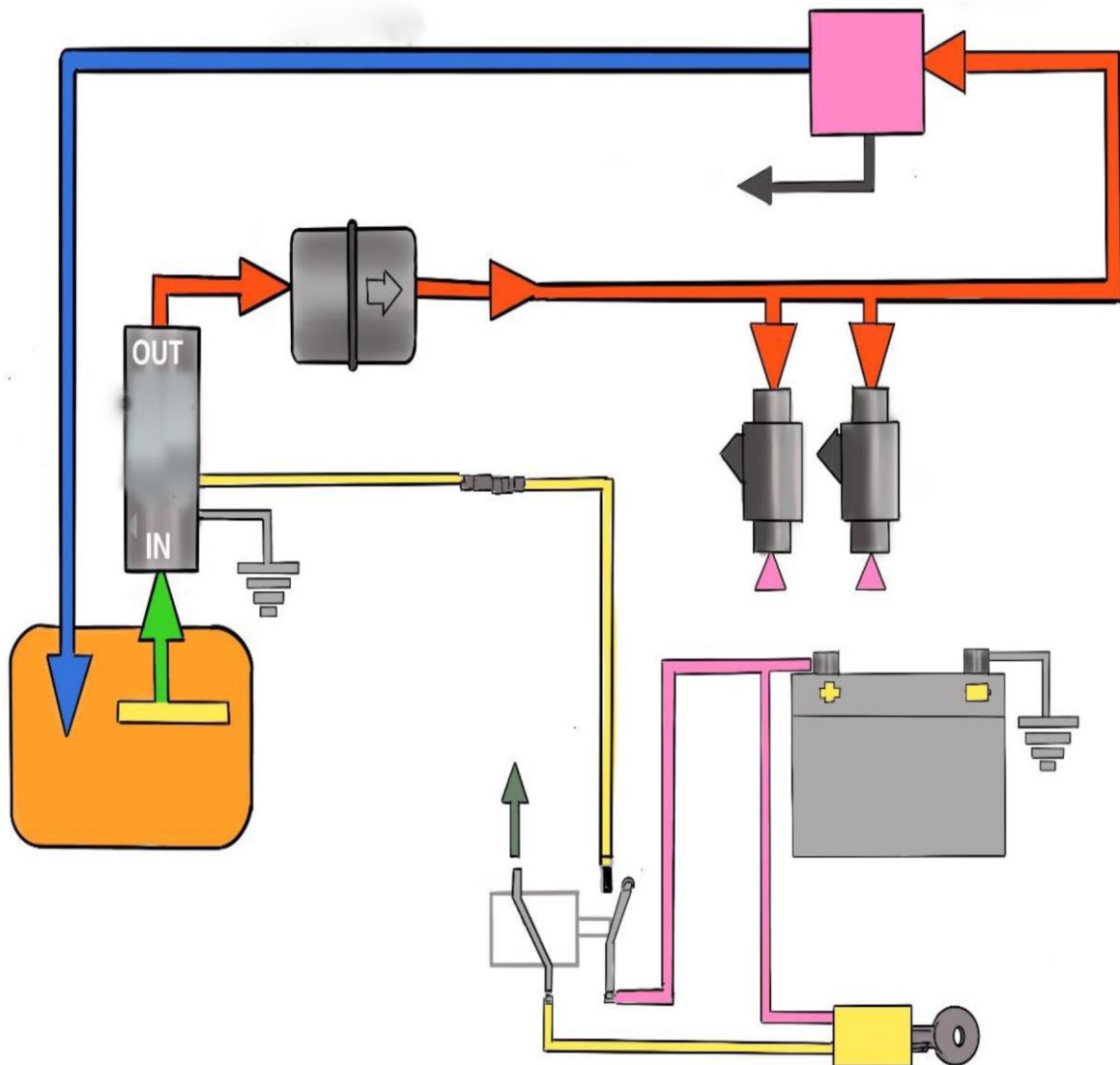
Module Units:

Unit 1: Describe engine fuel supply system

Unit 2: Prepare petrol engine fuel supply system

Unit 3: Repair engine fuel supply system

UNIT 1: DESCRIBE ENGINE FUEL SUPPLY SYSTEM



Unit summary:

This unit describe knowledge , skills and attitude to perform engine petrol fuel supply system , at the end of this the trainees will be able to identify fuel supply systems ,
Identify petrol fuel supply system and Identify petrol fuel supply system components.

Self-Assessment: Unit 1

1. Study the unit illustration above and answer the following questions.
 - a. What do you see in the illustration?
 - b. What is happening in the illustration?
 - c. What topics do you think will be covered under this unit based on the illustration?
2. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this unit.
 - a. There is no right or wrong ways to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.

Think about yourself: do you think you have the knowledge, skills or attitudes to do this? How well?
 - b. Read the statements across the top. Put a check in column that best represents your level of knowledge, skills or attitudes.
3. At the end of this unit, you will assess yourself again.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Explain fuel supply system					
Identify fuel supply system					
Explain all components of petrol fuel system					
Mixture formation in petrol fuel supply system					



Key Competencies:

Knowledge	Skills	Attitudes
1. Explain Petrol fuel supply system	1. Identify petrol fuel supply system	1. Being rapid
2. Describe Types of petrol fuel supply system	2. Identify types of petrol fuel supply system	2. Being precise
3. Explain all components of petrol fuel supply system	3. Identify all components of fuel supply system	3. Being attention to details



Discovery activity



Task 1

Read the statement below and answer the questions that follow

KAYIRANGA has different cars with fuel supply system problem. He calls you for assist and you are requested to answer the following questions:

- Identify fuel supply system type
- Identify all components of petrol fuel supply system

Topic 1.1: Identification of fuel supply systems



Activity 1: Problem Solving



Task 2

Read and answer the following questions:

1. Identify Petrol fuel supply system

Key Facts:1.1: Identification of fuel supply systems

- Identification of fuel supply systems

- ✓ Terminology

- + **Fuel:** Materials such as coal, gas or oil that is burned to produce heat or power
- + **Volatility:** It is a property of gasoline that facilitate measurement of how easily a liquid (fuel) vaporizes
- + **Air-fuel ratio:** It is the right amounts of air and fuel that must be mixed together for proper combustion and engine performance.
- + **Lean mixture:** It is a mixture that contains a large amount of air for the available fuel
- + **Rich mixture:** A rich air-fuel mixture: It contains a little more (too much) fuel mixed with the available air.
- + **Mixture ratio:** The mixture ratio describes the composition of the fuel-air mixture. There are two different types of mixture ratio: the theoretical and the practical.
- + **Theoretical mixture ratio (stoichiometric ratio = theoretical air requirement):** This specifies how many kg of air are required for the complete combustion of 1 kg of fuel. To burn 1 kg of petrol, this figure is roughly 14.8 kg or 10,300 l of air.
- + **Practical mixture ratio:** This deviates from the theoretical mixture ratio, depending on the engine operating state. A mixture with a larger proportion of fuel, e.g. 1:13, is known as a "rich" mixture (air deficiency).

A mixture with a smaller proportion of fuel, e.g., 1:16, is known as a "lean" mixture (excess air).

✓ **Mixture composition**

 **Homogeneous mixture:** The mixture composition is the same in the entire combustion chamber. In order to achieve a homogeneous mixture composition, sufficient time must be made available for a uniform and thorough mixing of the fuel-air mixture. This is achieved by an advanced injection point during induction or by injection of fuel into the intake manifold.

 **Heterogeneous mixture:**
The combustion chamber has areas of differing mixture composition (stratified charge). A retarded injection of fuel into the cylinder during the compression stroke and precisely matched air turbulence facilitate a non-uniform mixture composition. There must be an air ratio of X approximately equal to 1 to ensure safe ignition of the mixture in the spark-plug area in spark-ignition engines. The mixture is lean in the marginal areas of the combustion chamber.

✓ **Description of fuel supply systems**

The combustion chamber has areas of differing mixture composition (stratified charge). A retarded injection of fuel into the cylinder during the compression stroke and precisely matched air turbulence facilitate a non-uniform mixture composition. There must be an air ratio of X approximately equal to 1 to ensure safe ignition of the mixture in the spark-plug area in spark-ignition engines. The mixture is lean in the marginal areas of the combustion chamber

 **Part load:**
The engine does not provide power to the flywheel at idle. Part-load (or part-throttle) operation refers to the range of running conditions between idle and generation of maximum possible torque.

 **Full load:**

When the throttle valve has opened to its maximum, the engine should respond by providing its maximum torque/output.



Idle speed:

It is a rotational speed of an engine at when the accelerator pedal is not depressed and drive train is disconnected from the engine.



Cold start:

An attempt to start an engine when is cold.

- There are two types of fuel supply in spark ignition engine

✓ **Carburetor**

The carburetor is intended to atomize the fuel and mix it with air in the correct proportion. It must adapt the required amount of mixture to the respective engine operating state. Carburetors usually consist of three main components: throttle-valve assembly, carburetor housing and carburetor cover.

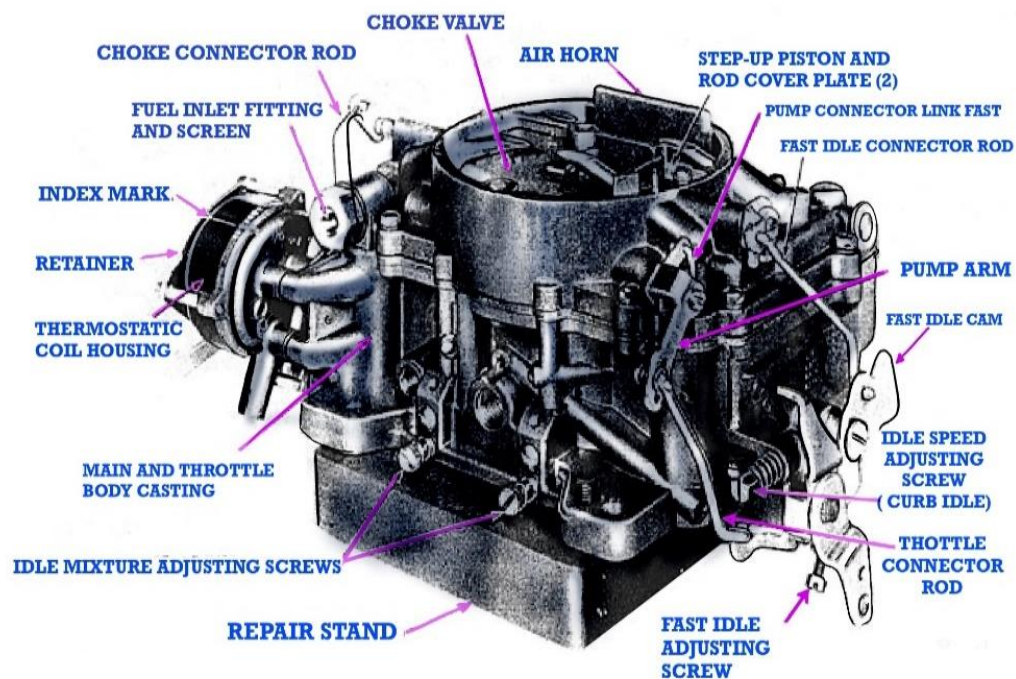


Figure 1:carburetor system parts

✓ **Petrol injection**

Petrol injection system is to spray fuel in finely atomised state into the inducted air. The required mixture quantity in each case and the mixture ratio must be adapted to the respective operating state in the process. Petrol injection can be direct or indirect injection to the combustion chamber.

Direct Injection

The fuel is injected directly into an open combustion chamber formed by the piston and cylinder head.

The main advantage of this type of injection is that it is simple and has high fuel efficiency.

Fuel and air start to be mixed inside of the combustion chamber (interior mixture)

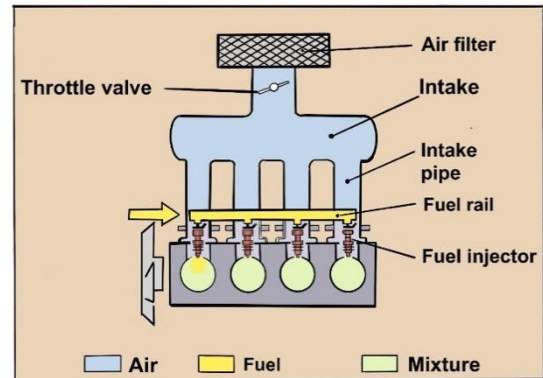


Figure 2:Petrol Direct injection system parts

Indirect Injection

The fuel is injected into the intake manifold or throttle valve housing. Fuel and air already start to be mixed outside the combustion chamber (exterior mixture)

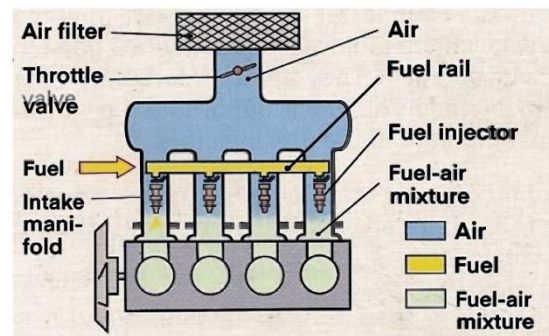


Figure 3:Petrol fuel Indirect injection



Activity 2: Guided Practice



Task 3

1. Visit your school Automobile workshop and perform the following task, under the guidance of the trainer
 - a. Define the following terms
 - ✓ Fuel:
 - ✓ Volatility
 - ✓ Air-fuel ratio
 - ✓ Learn mixture
 - ✓ Rich mixture
 - b. Identify petrol fuel supply.
 - c. What are the functions of carburetor



Activity 3: Application



Task 4

Visit the garage or workshop and perform following task:

Identify petrol fuel supply system and make a report.

Topic 1.2: Identification of petrol fuel supply system



Activity 1: Problem Solving



Task 5

- a. Explain Purpose of petrol fuel supply system

The purpose of a petrol fuel supply system in a car is to deliver fuel from the fuel tank to the engine efficiently and safely. The system consists of various components that work together to ensure the engine receives the right amount of fuel at the correct pressure. The petrol fuel supply system is designed to maintain a steady flow of fuel to the engine, ensuring optimal performance and efficiency while minimizing emissions. It is a critical part of a car's operation, responsible for delivering the fuel needed for combustion to power the vehicle.

- b. Identify Types of petrol fuel supply

Key facts:1.2: Identification of petrol fuel supply system

- **Identification of petrol fuel supply system**

- ✓ The purpose of a petrol (gasoline) fuel supply system in an internal combustion engine is to deliver the appropriate amount of fuel to the engine's combustion chambers, where it can mix with air and ignite to produce the necessary power to propel the vehicle. The fuel supply system plays a crucial role in ensuring the engine operates efficiently and provides the required performance
- ✓ Mixture formation in a petrol (gasoline) fuel supply system is a critical process that ensures the right air-fuel ratio is delivered to the engine's combustion chambers for efficient and optimal combustion. The air-fuel mixture needs to be precisely controlled to achieve good performance, fuel efficiency, and low emissions. There are various methods employed in modern petrol fuel supply systems to achieve proper mixture formation. Let's explore some of the key components and techniques involved

- ✚ **Fuel Tank:** The fuel tank stores the petrol before it is used by the engine. It may have a fuel level sensor to provide information about the fuel quantity to the engine control unit (ECU).
- ✚ **Fuel Pump:** The fuel pump is responsible for pumping petrol from the fuel tank to the engine's fuel injectors. In older carbureted systems, the fuel pump pressurizes the fuel and delivers it to the carburetor.
- ✚ **Fuel Filter:** A fuel filter is often used to remove impurities and debris from the petrol before it reaches the injectors or carburetor. This helps maintain the proper functioning of the fuel system and prevents clogging.
- ✓ Carburetor or Fuel Injectors: These are the two main methods of delivering the petrol to the engine's combustion chambers:
 - ✚ **Carburetor:** In older engines, a carburetor mixes the petrol with air in the correct proportion before it enters the intake manifold. The air-fuel mixture is then drawn into the combustion chambers.
 - ✚ **Fuel Injectors:** Most modern engines use fuel injection systems. The fuel injectors spray a fine mist of petrol directly into the intake manifold or combustion chamber under high pressure.
- ✓ The amount of fuel delivered is controlled by the engine's ECU based on various sensor inputs.
 - ✚ **Intake Manifold:** The intake manifold distributes the air-fuel mixture to each cylinder in a multi-cylinder engine.
 - ✚ **Throttle Body:** In fuel-injected engines, the throttle body regulates the amount of air that enters the engine. This, in turn, affects the air-fuel ratio since the fuel injectors respond to the amount of air entering the engine.
 - ✚ **Mass Airflow Sensor (MAF) or Manifold Absolute Pressure (MAP) Sensor:** These sensors measure the amount of air entering the engine, providing crucial data to the ECU for calculating the appropriate amount of fuel to be injected.
 - ✚ **Oxygen Sensor (O2 Sensor):** The O2 sensor monitors the oxygen content in the exhaust gases and helps the ECU adjust the fuel mixture in real-time for optimal combustion efficiency and emissions reduction.
 - ✚ **Engine Control Unit (ECU):** The ECU is the brain of the engine management system. It processes data from various sensors and controls the fuel injectors' opening time or the carburetor's fuel supply to maintain the desired air-fuel ratio.

Modern fuel injection systems, particularly those with direct injection technology, offer better control over the mixture formation and combustion process, leading to improved performance, fuel efficiency, and lower emissions compared to traditional carbureted systems.

In summary, mixture formation in a petrol fuel supply system involves combining the right amount of petrol with the incoming air to achieve the optimal air-fuel ratio for efficient and clean combustion in the engine. The process is carefully managed by the engine's electronic control system using various sensors and actuators.

There are several types of petrol fuel supply systems used in vehicles, each with its own unique characteristics. Here are some common types

-  **Carbureted System:** In older vehicles, a carbureted system was commonly used to mix air and fuel before delivering it to the engine. The carburetor regulates the fuel flow based on engine demands. However, this system is less efficient and has largely been replaced by more modern fuel injection systems.
- ✓ **Electronic Fuel Injection (EFI):** This is the most common type of petrol fuel supply system in modern vehicles. EFI uses electronic sensors to monitor engine conditions, such as air intake, engine temperature, and throttle position. The fuel injectors then deliver the appropriate amount of fuel directly into the engine cylinders, resulting in better fuel efficiency and performance.
- ✓ **Direct Injection (DI):** In direct injection systems, fuel is injected directly into the engine cylinders rather than into the intake manifold. This allows for more precise fuel delivery, better combustion, and improved fuel efficiency.
- ✓ **Multi-Point Fuel Injection (MPFI):** MPFI is a type of EFI system where each cylinder has its own fuel injector. It offers better fuel distribution and atomization, leading to smoother engine operation and improved performance.
- ✓ **Sequential Fuel Injection:** In this advanced version of EFI, the fuel injectors are activated individually in a precise sequence to match the firing order of the engine. This provides even more accurate fuel delivery and enhances engine performance and emissions control.

- ✓ **Gasoline Direct Injection (GDI):** GDI is a variant of direct injection that sprays fuel directly into the combustion chamber at very high pressures. It allows for better fuel atomization and can improve fuel efficiency and power output.
- ✓ **Flex Fuel System:** Some vehicles are equipped with flex fuel systems, which can run on a mixture of petrol and ethanol. These systems automatically adjust the fuel injection parameters based on the fuel composition, allowing drivers to use different fuel blends.



Activity 2: Guided Practice



Task 6

1. Read and answer the questions below
 - a. What is the purpose of a petrol fuel supply system in an internal combustion engine
 - b. Identify petrol fuel supply system.
 - c. Explain Mixture formation in petrol fuel supply system



Activity 3: Application



Task 7

AB company has cars used petrol fuel supply system and Technical director request you to assist him: Using a diagram explain how petrol fuel supply works

Topic 1.3: Description of Petrol fuel supply system components



Activity 1: Problem Solving



Task 8

Answer the following questions

- List down the component of petrol fuel supply system
- Explain the fuel tank
- Explain the role of delivery pump
- Explain the fuel lines

Key Facts:1.3: Description of Petrol fuel supply system components

- Description of Petrol fuel supply system components**

- ✓ **Fuel tank**

Store fuel for future use, Sheet-steel fuel tanks, on account of their simple structural shape and associated problem-free manufacture, are usually used in commercial vehicles.

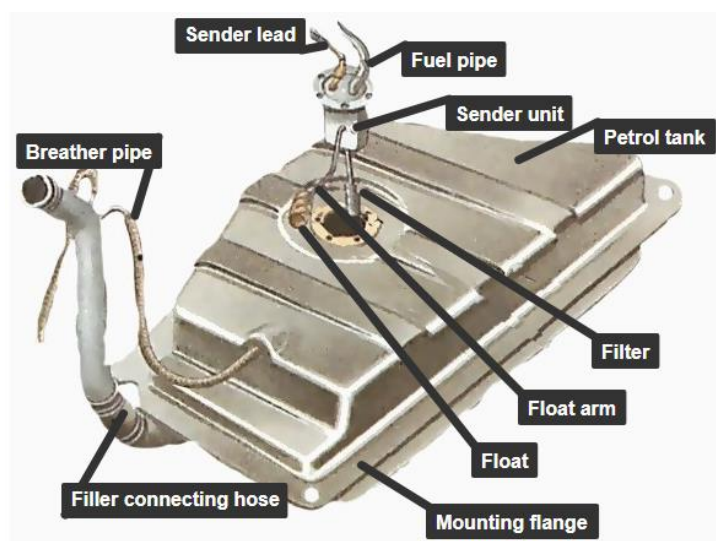


Figure 4:Fuel Tank parts

Tank location and design are always a compromise with available space. Most automobiles have a single tank located in the rear of the vehicle. Fuel tanks today have internal baffles to prevent the fuel from sloshing back and forth. If you hear noises from the rear on acceleration and deceleration the baffles could be broken. All tanks have a fuel filler pipe, a fuel outlet line to the engine and a vent system.

✓ **Delivery pump/ electrical pump**

It draws the fuel from the tank and delivers fuel to the engine's injection system or to the carburetor. Two different types are used, depending on their installation locations: inline pumps and in-tank pumps

✚ Two types of fuel pumps are used in automobiles:

- Mechanical
- Electric fuel pumps.

All fuel injected cars today use electric fuel pumps, while most carbureted cars use mechanical fuel pumps.

▪ **Mechanical**

Mechanical fuel pumps are diaphragm pumps mounted on the engine and operated by an eccentric cam usually on the camshaft. A rocker arm attached to the eccentric moves up and down flexing the diaphragm and pumping the fuel to the engine.

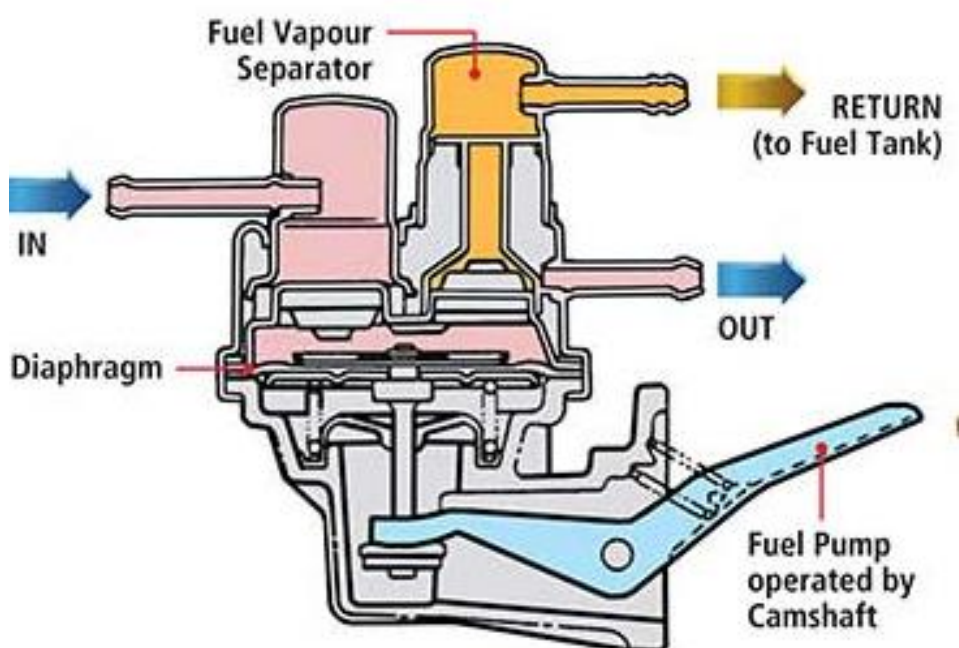


Figure 5: Mechanical Fuel pump parts

- **Electric fuel pumps**

Because electric pumps do not depend on an eccentric for operation, they can be located anywhere on the vehicle. In fact, they work best when located near the fuel tank.

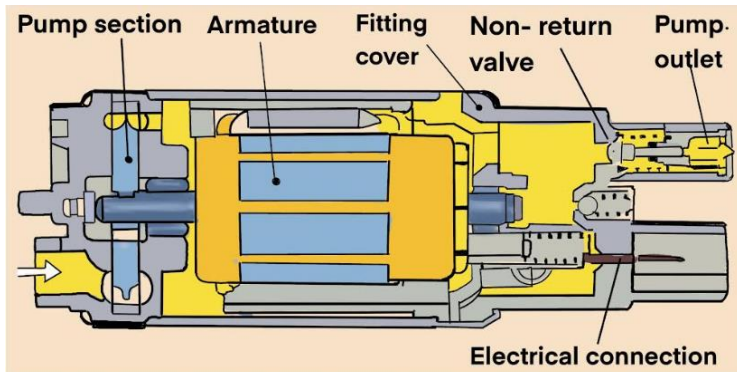


Figure 6: Electrical Fuel Pump Parts

- ✓ **Fuel filter**

These are intended to protect the fuel system against contaminants because, for example, the fuel injectors of a petrol injection system can be destroyed even by tiny dirt particles.

The fuel filter retains particles of impurities which are present in the fuel and which would otherwise have an adverse effect on the functioning of the fuel supply system.

- ✓ **Fuel lines**

Steel pipes or hoses made from flame-retardant, fuel-resistant rubber or plastic are used as fuel lines. Because rubber and plastic hoses change chemically (age) when used for long periods, they become hard and porous. This may result in leaks.

- ✓ **Injector**

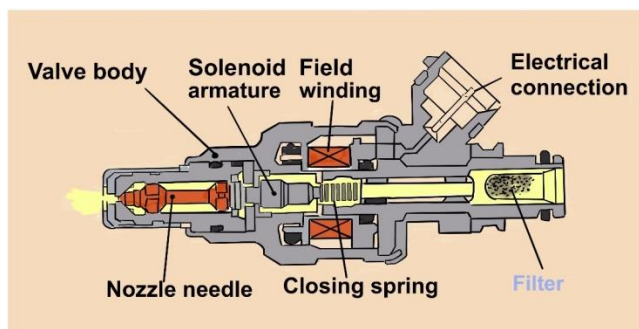


Figure 7: Electronic Injector Parts

¹ <https://www.howacarworks.com/illustrations/petrol-tank>

It has to meter and atomize fuel so that it can be sprayed into the intake manifold (**indirect injection**) or directly in the cylinder (**direct injection**).

✓ **Accumulator**

It maintains the pressure in the fuel system for a certain time after the engine has been switched off in order to facilitate restarting, particularly when the engine is hot.

✓ **Pressure regulator**

The fuel pressure regulator must keep the fuel differential pressure in the two-line system constant under all conditions. It maintains the pressure differential between fuel system and intake manifold at a constant level.

✓ **Rail**

Store fuel under pressure and supply fuel whenever pump does not operate.

✓ **Sensors**

Sensors record and transmit information in the form of electrical voltage signals to the ECU.

Eg: temperature sensor

✓ **Actuators**

The relevant actuators, e.g. the fuel injectors, are supplied with power by the ECU. The desired system operating state is established.

✓ **ECU**

The ECU processes the information contained in the voltage signals and compares the determined actual values with set point values usually stored in program maps. It calculates the actuation of the corresponding actuators.



Activity 2: Guided Practice



Task 9

Read and answer the following questions

1. List down petrol fuel supply components
2. Using a diagram explain the fuel tank
3. What are the parts of electrical fuel pump



Activity 3: Application



Task 10

Visit the garage or workshop and ask the mechanic how you can identify types of fuel pumps



Formative Assessment

1. **Carbureted systems require regular maintenance and tuning to:**
 - a. Improve tire traction
 - b. Enhance the vehicle's appearance
 - c. Optimize fuel efficiency and performance
 - d. Increase vehicle weight capacity
2. **In a cold start, the choke is:**
 - a. Open to allow more air into the engine
 - b. Closed to restrict airflow and enrich the fuel mixture
 - c. Disconnected from the system temporarily
 - d. Adjusted based on the engine temperature
3. **What is a common issue with carbureted systems at high altitudes?**
 - a. Fuel leakage
 - b. Overheating
 - c. Vapor lock
 - d. Rich air-fuel mixture
4. **In a Sequential Fuel Injection (SFI) system, when are the injectors activated to deliver fuel?**
 - a. All injectors are activated simultaneously.
 - b. The injectors are activated in pairs.
 - c. The injectors are activated one after the other in a specific sequence.
 - d. The injectors are activated based on engine temperature



Points to Remember

An engine fuel supply system is a crucial component in internal combustion engines, whether they are used in automobiles, aircraft, generators, or other machinery. Its primary function is to provide the engine with the appropriate amount of fuel in the right mixture with air to ensure efficient combustion and power generation.



Self-Reflection

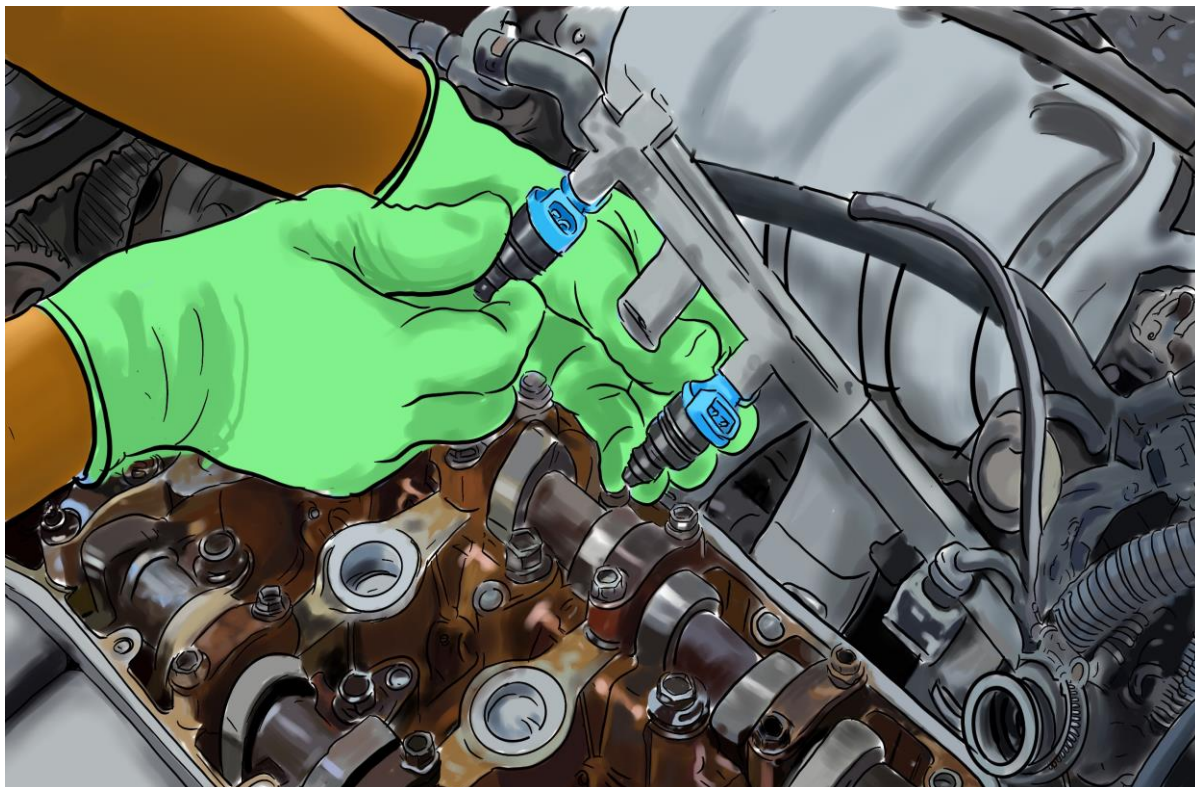
1. Re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee's Manual to identify their areas of strength, areas for improvement and actions to take to improve.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Explain fuel supply system					
Identify fuel supply system					
List all components of petrol fuel system					
Mixture formation in petrol fuel supply system					

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

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

UNIT 2: DIAGNOSE PETROL ENGINE FUEL SUPPLY SYSTEM



Unit summary:

This unit describes the knowledge, skills and attitude required to diagnose petrol engine Fuel Supply System. It includes proper selection of tools, inspection of fuel supply system, dismounting of petrol fuel supply system components, disassembling of Petrol fuel supply components and detection of Petrol fuel supply system faults.

Self-Assessment: Unit 2

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

My experience 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 fuel supply system					
Identify tools, materials and equipment					
Describe fuel supply system					
Describe of petrol fuel supply system component					
Dismounting procedures of Petrol fuel supply system components					

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.
Disassembling procedures of Petrol fuel supply components					
Detection of Petrol fuel supply system faults					



Key Competencies:

Knowledge	Skills	Attitudes
1. List tools and equipment	1. Select tools and equipment	1. Being safe
2. Describe the use of tools and equipment	2. Select materials	2. Avoid wastage of materials
3. Identify maintenance techniques of tools and equipment	3. Maintain tools and equipment	3. Time management
4. Inspect fuel supply system	4. Inspect the fuel supply lines, return lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks, and abrasions	4. Pay attention to details
5. Describe petrol fuel supply system	5. Identify petrol fuel supply system	5. Being careful
6. List dismounting procedure of fuel supply system components	6. Dismounting of fuel supply system components	

Knowledge	Skills	Attitudes
7. Identify who to detect Petrol fuel supply system faults	7. Detect Petrol fuel supply system faults	

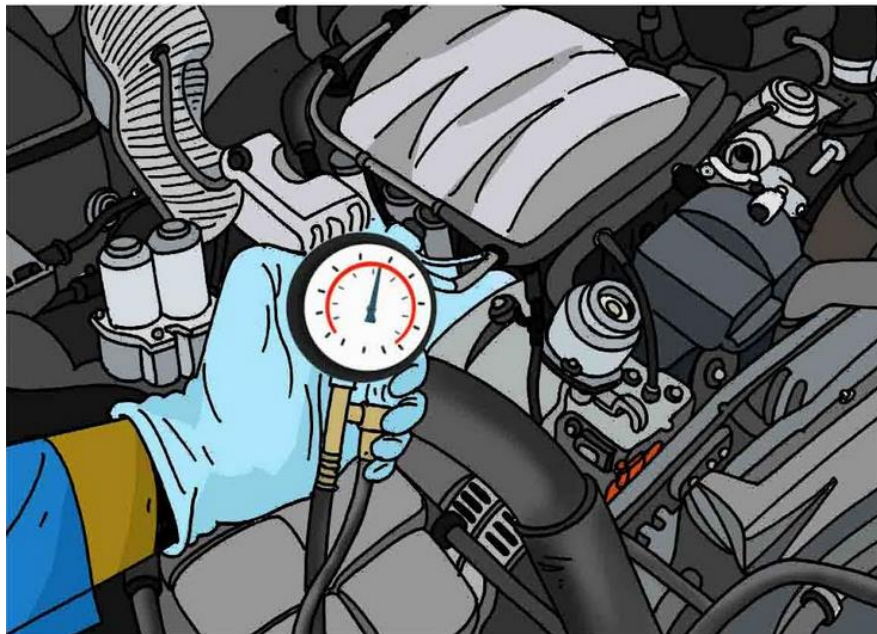


Discovery activity



Task 1

Task: Study carefully the illustration below and answers the following questions:



- What do you see in the illustration?
- What is happening in the illustration?
- What topics do you think will be covered under this unit based on the illustration?
- Do you think the illustration reflects the topic? Briefly explain your response

Topic 2.1: Selection of tools, materials and equipment



Activity 1: Problem Solving



Task 2

Analyse the following illustration

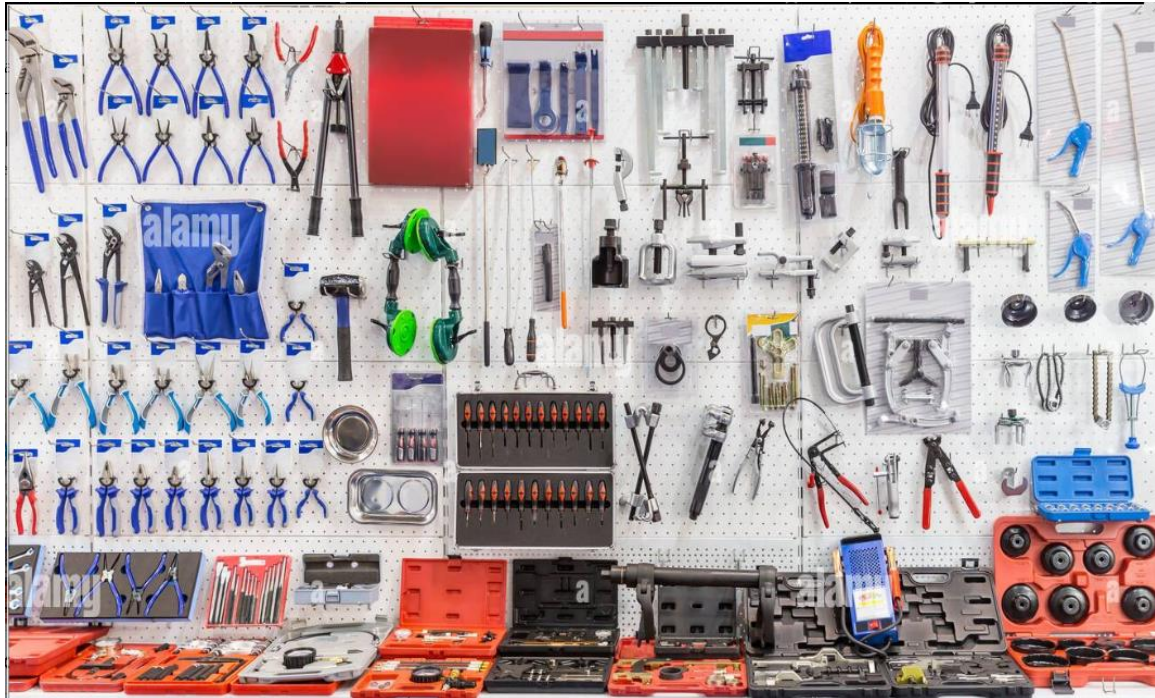


Figure 8 : Tools and Equipment

The illustration above shows the Tools and Equipment used to repair fuel supply system

1. List down at least two tools,
2. List down two equipment and
3. List down two materials used to repair fuel supply system.

Key Facts 2.1: Selection of tools, materials and equipment

- **Selection of tools, materials and equipment**

- ✓ **Tools**

- ✚ **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. He must be aware of the right tool for the job. Otherwise, the quality and efficiency of work will suffer.

- **Classification of hand tools²**

- Laying out tools: measuring tools
 - Striking tools: hammers, and sledges
 - Metal cutting tools: files, drills, reamers, etc.
 - Holding tools: Pliers and clamps
 - Sharpening and grinding tools

Hammer



A hammer is designed to deliver high force in a small area. It is a long wooden stick, attached to a block of metal. Hammer is round on one side, while edgy on the other. Hammer is very versatile, whether you want to nail something or break

something, it will be your best friend. But, make sure that it is of proper weight for the user. When picking hammer, one should choose it carefully among different sizes and weights available.

² <https://www.moglix.com/blog/what-are-the-types-of-hand-tools-and-how-are-they-important/>

Screwdrivers



Screwdrivers are very important and are used to tighten the screws, bolts, and nuts. They come in various shapes and also can be altered as per the size of the bolt

Pliers



Pliers are almost found in every household. They are used to hold objects firmly, bend other materials, and remove unwanted elements. It is also used for bending or straightening wires, cutting wires, removing

nails, or just hold objects firmly in one place. Pliers with needle ends and wire-cutting abilities are one of the best kinds. They are useful in both workshops or homes.

Spanner/Wrench



A spanner is used to grip and turn objects. These tools are generally used in plumbing jobs, Other than this, they can be used in assembling furniture or bike repairs to loosen or tighten nuts and bolts. Spanners are available in many varieties ranging from

close-end to open-end or adjustable ones.

Tape measure



A tape measure is a must-have tool for every craftsman or manufacturer. They are useful in taking a room or wall measurements. If you are in

the construction industry, a tape measure is the first thing that you would need.

Files and Rasps



Files and rasps are used to create smooth edges or create a new shape or profile. In some cases, it is used to remove extra material from plastic, wood or metal.

Allen key



Allen key and a hex key is a simple tool that is used to drive bolts and screws with hexagonal sockets in their heads. These tools are L shaped with unequal arms.

Power tool

A power tool is a tool that is actuated by an additional power source and mechanism other than the solely manual labor used with hand tools.

Power tools can either be classified as electrical power tools or portable. Let's look at a few examples of power tools:

▪ Types Electrical Power Tools

Electrical power tools are the term for stationary power tools used in metalworking. The term electrical power tool is not commonly applied to stationary power tools for woodworking only. In certain circumstances, such as bench grinders and drill presses, the same equipment is used for both woodworking and metalworking.

Some of the most common types of electrical power tools are:

Impact wrench, Lathe, Power drills, Power Ratchet Set, Power sander, Power saw,...

▪ Types of Portable Power Tools

The mobility benefits of portable power tools are undeniable. Whether you enjoy working with machines or require them for a DIY project around the house, you will almost

certainly grab portable power tools and get to work. This will include heat guns, power drills, nail guns, and others.

Some of the most common types of portable power tools are:

Circular Saw, Head guns, Jigsaw, Nail gun, Side grinder, Wall Chaser

✓ **Equipment**

Multimeter



A multimeter and its test leads allow electrical workers to reach into an energized panel, touch live circuit components with the end of the test leads, and capture electrical readings like voltage, current, and resistance.

A multimeter can also be used to determine if a particular circuit is open or has continuity. In some applications, you can measure frequency and even temperature. Yet, if not used effectively, inaccurate readings result in a failed diagnosis.

Hand tool scanner

An automotive scan tool (scanner) is an electronic tool used to interface with, diagnose and, sometimes, reprogram vehicle control modules.

OBD 1 vs OBD 2 the vehicle will also dictate what the scan tool is able to display. If the vehicle is equipped with OBD 1 it will have significantly less available data when compared to a vehicle equipped with OBD 2.

A diagnostic tool, such as an OBD 2 scanner, which is plugged into the vehicle's diagnostic port, reads DTC codes. The tool communicates with the vehicle's onboard computer and retrieves the DTC codes. The mechanic or technician



to determine the specific problem with the vehicle then interprets the codes.

✓ **Materials**



Wires and cables

Automotive wires and cables are the flexible wires with stranded conductors for use on low-voltage automotive systems. Conductor material may be copper or aluminium, although automotive wires sold by Allied Wire & Cable (AWC) are copper because of their better durability and current capacity.



Activity 2: Guided Practice



Task 3

1. The illustration below shows the different example of hand tools. Ender guidance of your trainer Use it to answer the following questions:



a. Give the names of Hand tools shown by number 1 to 5

1.
2.
3.
4.

b. Answer correctly the following questions:

1. List at least five hand tools.
2. What is a power tool?
3. What are the main types of power tools?
4. List at least two equipment used in diagnosis of petrol fuel system?



Activity 3: Application



Task 4

As you are an automobile mechanic, and you are in the store, storekeeper requested you to select the tools to repair the vehicle with petrol fuel supply, including one set of screwdrivers, Set of allen key, five pliers and two adjustable spanners.



Figure 9: Automotive Tools

Topic 2.2: Inspection of fuel supply system

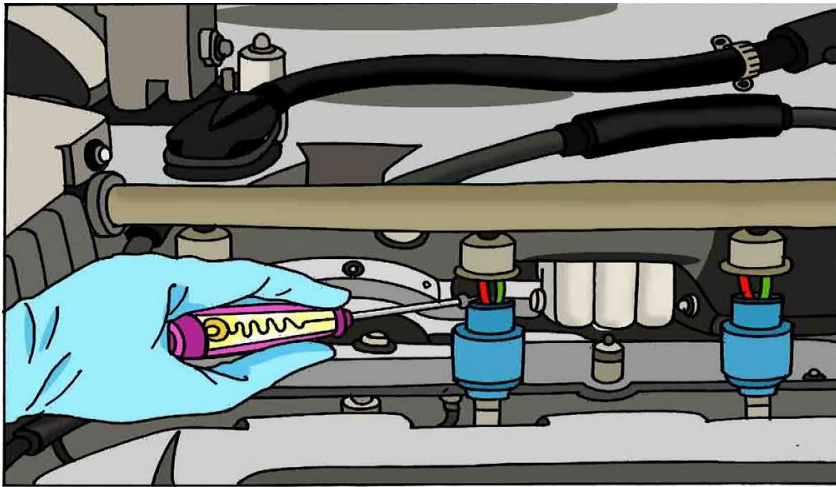


Figure 10: Diagnosis of Electrical Wires for Fuel Supply System



Activity 1: Problem Solving



Task 5

Study the figure above and answer the questions below:

- What are the functions of fuel supply system
- Describe the design of petrol fuel supply
- Explain the checking of petrol fuel supply system components

Key Facts 2.2: Inspection of fuel supply system

- Guidelines for inspection of fuel supply system

- ✓ Check Fuel Level:

- ✚ Ensure there is an adequate amount of fuel in the fuel tank.
- ✚ Inspect the fuel gauge and verify that it is functioning correctly.

- ✓ Inspect Fuel Lines:

- ✚ Look for any visible signs of fuel leaks along the fuel lines.
- ✚ Check the entire length of the fuel lines for cracks, kinks, or other damage.
- ✚ Replace any damaged or worn-out fuel lines.

- ✓ Examine Fuel Filters:

- ✚ Check the fuel filter for any signs of clogging or contamination.

- ✚ Replace the fuel filter if it is dirty or clogged according to the manufacturer's recommendations.
- ✓ Fuel Pump Inspection:
 - ✚ Test the fuel pump for proper operation. This may involve turning the ignition key to the "on" position without starting the engine and listening for the sound of the fuel pump.
 - ✚ Check for any unusual noises or vibrations coming from the fuel pump.
 - ✚ Ensure that the fuel pump is delivering the correct fuel pressure to the engine.
- ✓ Fuel Injectors:
 - ✚ Inspect the fuel injectors for signs of clogging or blockage.
 - ✚ Perform a fuel injector cleaning if necessary.
- ✓ Fuel Pressure Regulator:
 - ✚ Check the fuel pressure regulator for proper operation.
 - ✚ Ensure that the fuel pressure is within the specified range.
- ✓ Fuel Tank Inspection:
 - ✚ Inspect the fuel tank for signs of rust, corrosion, or other damage.
 - ✚ Check the fuel tank for any debris or contaminants.
- ✓ Fuel Cap:
 - ✚ Make sure the fuel cap is in good condition and seals properly.
 - ✚ Inspect the fuel cap for any signs of damage or wear.
- ✓ Check for Diagnostic Trouble Codes (DTCs):
 - ✚ Use a diagnostic tool to check for any fuel system-related trouble codes that may be stored in the engine control module.
- ✓ Functional Tests:
 - ✚ Conduct functional tests by starting the engine and observing its performance.
 - ✚ Monitor for any unusual noises, hesitations, or changes in engine RPM.

- **Checking of petrol fuel supply system components**

A fuel system draws fuel from the tank and forces it into the fuel-metering device (carburetor, gasoline injectors), using a mechanical (engine-driven) or electric fuel pump. The basic parts of a fuel supply system include the following:

- ✓ Fuel tank (stores gasoline)
- ✓ Fuel pump (draws fuel from the tank and forces it to the fuel metering device)
- ✓ Fuel filters (removes contaminants in the fuel)

- **Fuel tank service**

It is sometimes necessary to lower or remove a fuel tank from a car when the tank is corroded or to do the following:

- ✓ Replace fuel or vapor hoses.
- ✓ Replace a fuel tank sending unit.
- ✓ Replace an in-tank electric fuel pump.

Most new vehicles have the fuel pump located in the fuel tank. Sometimes the fuel pump cluster can be removed through an access hole, but often the fuel tank must be removed from the vehicle.

Before removing a fuel tank, fuel should be pumped from the tank using commercial fuel handling equipment. The fuel is pumped out either through the fill opening or through the outlet line to the fuel pump.

- **Bleed Fuel System Pressure**

Fuel injection systems are designed to remain pressurized after the engine is shut off so the engine can start quickly. If one of the fuel line hose clamps is loosened, pressurized fuel can escape. To prevent gasoline from escaping, pinch pliers or long nose vise grips can be installed on the hose on the fuel tank side of the filter (if the fuel hose is flexible).

Another pressure bleeding procedure:

- ✓ Disconnect the battery ground cable.
- ✓ Remove the filler cap from the fuel tank.
- ✓ Some systems have a Schrader valve that can be used to bleed off pressure from the system before disassembly
- ✓ Remove the threaded cap from the fuel pressure test port on the fuel rail to find the Schrader valve
- ✓ Use a special hose that has a pressure-relieving tool on the fuel rail end to drain fuel to a gas can

- **Fuel Filter Service**

Fuel filters have specified intervals for replacement. They can be located in a fuel line, in the tank, in a carburetor, or in any combination of these. Outlet fuel filters can be found on the outlet side of a fuel pump.

- **Pressure Testing**

When fuel system pressure is not within specifications, the fuel injectors will not inject the correct amount of fuel. If the pressure is not too far off, the computer will adjust the air-fuel mixture after the system begins closed-loop operation. The engine can have a cold drivability problem that will disappear when it is warm.

- **Testing a Pressure Regulator**

A pressure regulator can become defective due to foreign material or a ruined diaphragm. The result will be hard starting, poor idle quality, and lack of power. Burned spark plugs can result from operating with a lean air-fuel mixture.

- **Injector Problems**

Fuel injectors occasionally fail. They can be leaking, dirty, shorted, or open. On port fuel-injected cars, individual injectors for each cylinder are located in the intake valve port in the cylinder head. A stethoscope can be used to listen to the opening and closing of the injector as the engine operates. Injector electrical test lights (called node lights) provide an easy way to test to see if there is power to the injector.

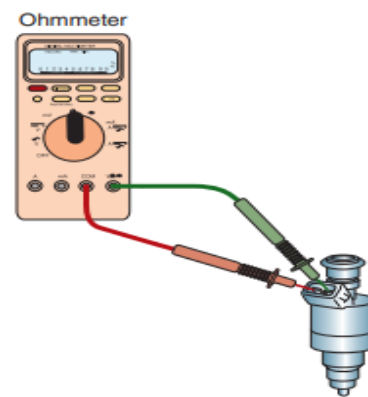


Figure 11: Use an Ohmmeter to Check Injector Resistance

- ✓ Most multiport injection systems use high-resistance injectors with 10–16 ohms of resistance. With 15 volts and 15 ohms (Ω) of resistance, the current draw will be 1 amp.
- ✓ Low-resistance injectors (1–4 ohms), used in TBI and older multiport engines, are peak and hold. A low resistance injector will have a high initial amp draw (peak), followed by about 1 amp of current draw during the “hold” phase

- **Testing Fuel Injector Flow**

When low-quality fuel is used, individual port fuel injectors are prone to plugging up from fuel deposits.

An electronic fuel injector tester is available for testing injector balance. While reading system pressure on a gauge. With the system at the specified pressure, each injector is activated for an equal period. This allows fuel in the loop to escape from the injector. The drop in pressure is recorded. The system is depressurized after each injector is bled, and the next injector is operated with the tester. There should be an equal amount of pressure drop from each injector. If the pressure drop is above or below average by 1.4 psi (10 kPa), the injector is defective

- **Removing and Replacing Injectors**

To replace an injector, bleed pressure from the system first. Be careful that no dirt gets into the system while the fuel rail is removed. Do not soak an injector in cleaning solvent. This can damage or contaminate the injector.

Be sure to replace the rubber O-rings that seal the injectors to the cylinder head.

If they do not seal, this will result in a vacuum leak and, consequently, rough idle.

- **Sensor Service**

Testing procedures vary for the various fuel injection system sensors. Before disconnecting a computer system component, be certain that the ignition key is turned off. Use a scan tool, a digital volt-ohmmeter, or a test light. Always follow the manufacturer's service information procedures. A scan tool is a device that reads computer self-diagnosis signal

- **Oxygen Sensor Service**

The O₂ sensor is tested with the engine running at operating temperature.

- **Replacing the O₂ Sensor**

The O₂ sensor is threaded into the exhaust manifold. Because it can be difficult to remove, use anti-seize compound on its threads. Torque the sensor to 30 foot-pounds using a special socket.

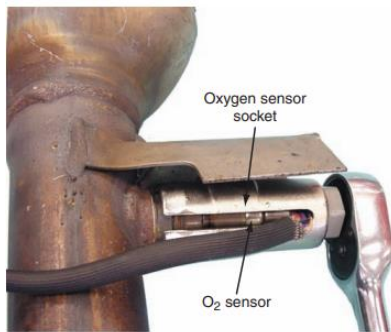


Figure 12: Removing an Oxygen Sensor

- **Inlet Air Temperature Sensor**

The sensor that measures the temperature of incoming air is called an air charge temperature (ACT) sensor. It can be removed and tested in hot water like an ECT sensor.

- **Map Sensor Diagnosis**

A defective manifold absolute pressure (MAP) sensor can cause the engine to run rich or lean. When the engine is off and the key is on, MAP sensors are supposed to tell the computer what the barometric pressure.

- **Mass Airflow (MAF) Sensor Diagnosis**

Testing a mass airflow (MAF) sensor requires a voltmeter with a min/max feature. With the key on, the min/max button is pressed. With a vane-type, MAF sensor, the air vane is moved from closed to wide open and back to close.

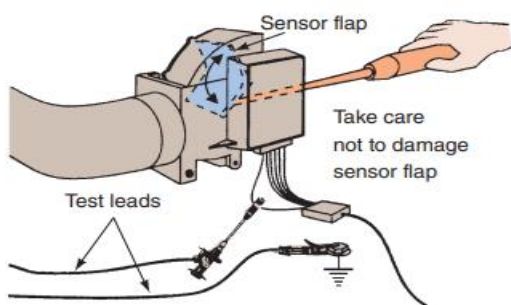


Figure 13: Move the sensor air vane from open closed to test it

- **Testing fuel pump**

- ✓ **Static pressure test** If the fuel pressure is acceptable, then check the system for leak down. Observe the pressure gauge after five minutes. The pressure should be the same as the initial reading. If not, then the pressure regulator, fuel-pump check valve, or the injectors are leaking.

- ✓ **Dynamic pressure test** to test the pressure dynamically, start the engine. If the pressure is vacuum referenced, then the pressure should change when the throttle is cycled. If it does not, then check the vacuum supply circuit. Remove the vacuum line from the regulator and inspect for any presence of fuel.

There should never be any fuel present on the vacuum side of the regulator diaphragm. When the engine speed is increased, the pressure reading should remain within the specifications.



Activity 2: Guided Practice



Task 6

1. Under your guidance ask trainees to answer the following questions
 - a. List down six components of fuel system
 - b. List down five parts of fuel filter
 - c. What are the procedures to check fuel tank service
 - d. Explain the fuel testing injector flow
 - e. Differentiate static pressure test versus dynamic pressure test



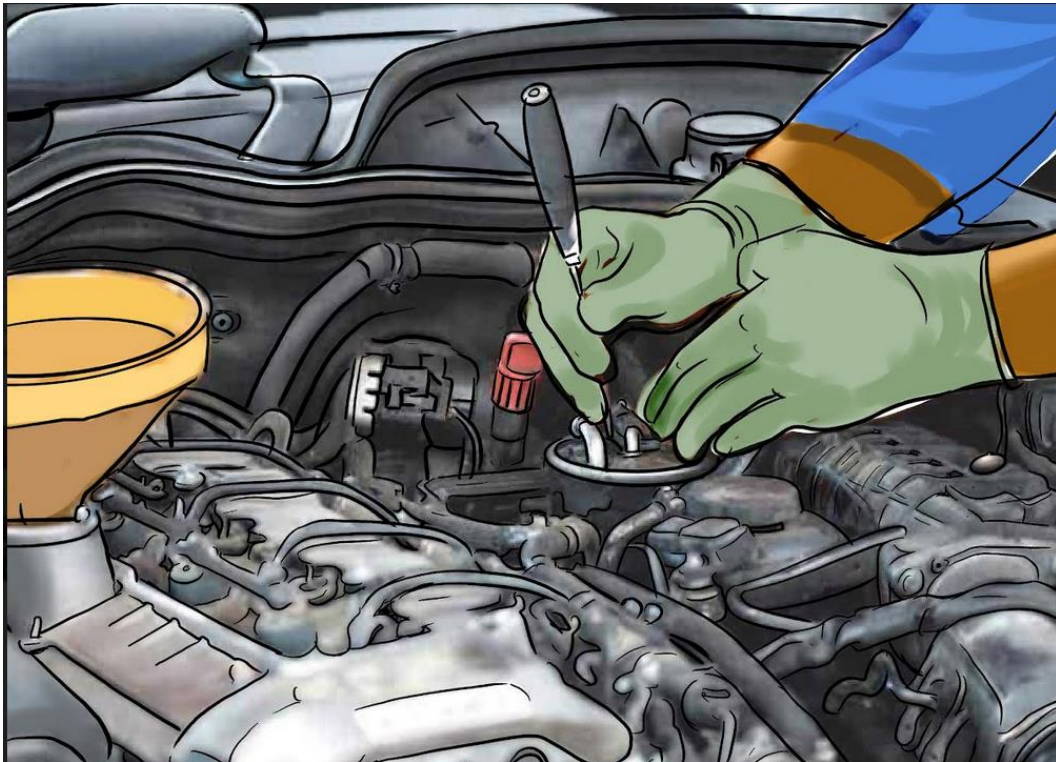
Activity 3: Application



Task 7

Go to the nearest school garage, under guidance of garage owner, observe and perform the activity of vehicle fuel supply pressure bleeding, Once again they back to school, Each one will share his/her experience gained from Garage with the rest of the class.

Topic 2.3: Dismounting of Petrol fuel supply components.



Activity 1: Problem Solving



Task 8

Answer the following question:

1. Explain the process to dismount the petrol fuel supply
2. Explain the process to disconnected of petrol fuel lines
3. What techniques use when you dismount and disassemble Petrol fuel supply components?

Key Facts 2.3: Dismounting of Petrol fuel supply components.

- **Dismounting of petrol fuel supply system components.**

- ✓ **Dismounting of petrol fuel tank**

A fuel tank is used for one of the most obvious purposes in your vehicle for holding the fuel. However, if your car runs on petrol the problem could be explosive.

- ✚ **Drain the old fuel tank**

Before you can install your new tank, you will need to remove the old tank. The first step in this process is draining the fuel out of the old tank. Many tanks have a small stop valve on the body of the part that allows you to neatly drain all of the fuel. If this is the case, simply loosen the valve and let the fuel run out into the fuel can.

- ✚ **Remove the Fuel Lines**

There should be two fuel lines going into the tank. The smaller line at the bottom of the tank directs the fuel into the engine, whilst the larger line at the top of the tank is used for filling the tank. The third line is an air-line that allows for the decrease in pressure as the petrol travels through the tank. Detach all lines from the old tank.

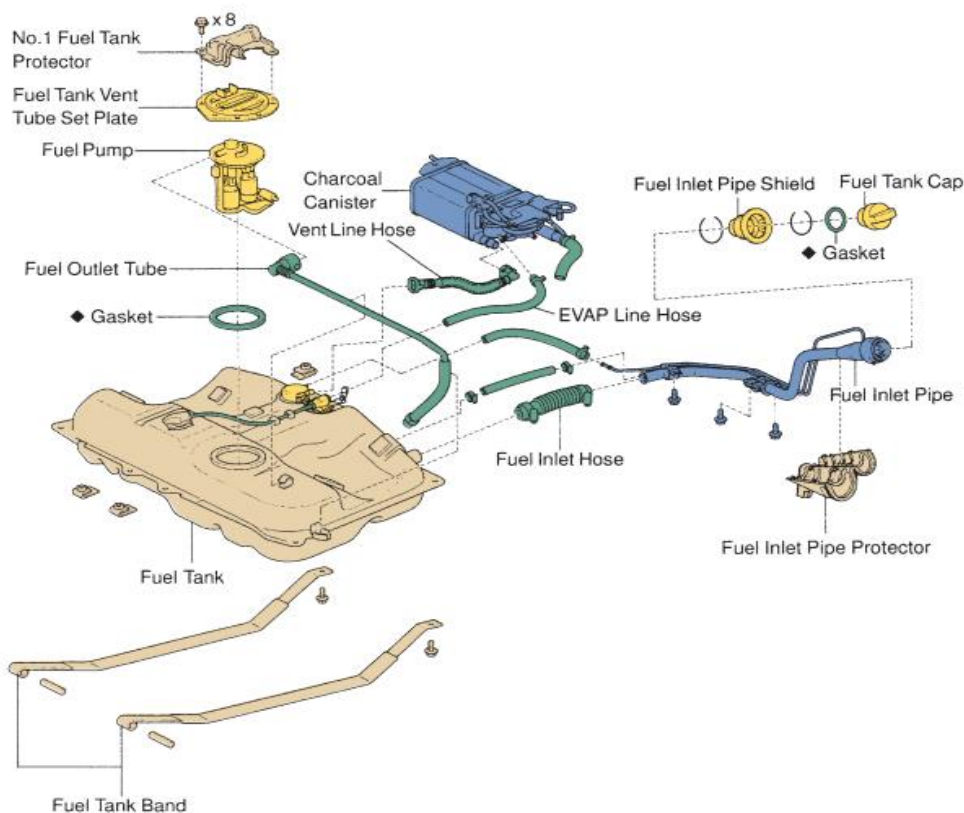


Figure 14: The hose, wires, and tubes normally connected to a fuel tank

- ✚ **Disconnecting of petrol fuel lines**

- When working on a fuel system in the engine compartment, disconnect the negative cable of the battery. An electrical spark may cause a fire or explosion
- Remove the fuel filler cap slowly. Wait until the hissing or vapor venting ceases before removing the cap entirely if it is occurring.
- If a fuel line or hose is damaged in any way, replace it.
- When disconnecting or reconnecting a fuel line or hose, make sure that the mating parts are totally clean.
- When disconnecting and reconnecting a fuel line or hose, only use the tools designed for that connection. Using the wrong tool can cause a poor connection that can result in a fuel leak.
- After disconnecting a fuel line or hose, plug both ends to prevent dirt from entering.
- Use fuel line pinch-off tools or rubber fuel lines to minimize fuel spillage when changing fuel filters and pumps.

Dismounting of petrol fuel injectors

Depending on the type of engine and injector you have, removal and assembly methods vary. Here is a typical change process:

- When disconnecting the battery, always disconnect the negative cable first
- Remove the injector cover and remove the high-pressure fuel lines.
- Disconnect the tube assemblies for the fuel filter base for the fuel inlet and outlet.
- Remove the fuel hoses from the injector and remove the setscrew and holding clamp.
- Remove the injectors from the cylinder head.
- Remove and discard the O-ring seal and seat washer from the injector.

Disconnecting of petrol fuel filter

- Locate fuel filter
- Remove static pressure from fuel system
- Obtain correct replacement

- Carburetted fuel system
- Using correct equipment, remove fuel filter
- Install carburetted system filter
- Remove old EFI system filter
- Install EFI system filter
- Replace damaged fuse

- **Disassembling of petrol fuel injector.**

The disassembling procedures for a petrol fuel injector may vary depending on the make and model of the injector. However, here is a general outline of the steps involved in disassembling a fuel injector:

- ✓ Ensure you have all the necessary tools and equipment, including safety glasses, gloves, and any specific tools required for your injector model.
- ✓ Disconnect the electrical connector or harness from the fuel injector. Carefully remove it, taking care not to damage the connectors or wires.
- ✓ Using a suitable tool, unbolt or unclip any attachments or accessories that may be present on the injector, such as a fuel rail or mounting bracket. Keep track of all the fasteners and hardware you remove.
- ✓ Remove the fuel injector from its mounting location on the engine. This may require removing other components or parts to gain access to the injector.
- ✓ Once the fuel injector is accessible, inspect it for any signs of damage or wear. Pay particular attention to the O-rings or seals, as these should be replaced during reassembly.
- ✓ To disassemble the fuel injector further, carefully remove the nozzle and pintle assembly from the injector body. This may require using specific tools or techniques recommended by the manufacturer.
- ✓ Inspect and clean all the individual components of the fuel injector thoroughly. Use an appropriate cleaning solution and ensure that all dirt, debris, or contaminants are removed.
- ✓ Inspect the nozzle and pintle assembly for any signs of damage or wear. Replace any faulty or worn-out components to ensure optimal performance.
- ✓ Carefully remove the filter basket or filter screen from the injector body. Inspect it for any signs of clogs or debris and clean or replace as necessary.
- ✓ Continue disassembling any remaining components of the fuel injector, following the specific recommendations and guidelines provided by the manufacturer.

It's important to note that these procedures are general guidelines and may not cover all the specific steps required for your particular fuel injector model. Always refer to the

manufacturer's instructions and follow any specific guidelines or recommendations provided.



Activity 2: Guided Practice



Task 9

Go to the school workshop, under the guidance of trainer, perform the following tasks:

- a. Dismount petrol fuel tank from the vehicle
- b. Disconnect petrol fuel lines from the vehicle.



Activity 3: Application



Task 10

1. Go to the nearest school garage, in groups, perform the following tasks:
 - a. Dismount petrol fuel tank from the vehicle.
 - b. Disconnect petrol fuel lines from the vehicle.
 - c. Disassemble fuel injectors.

Topic 2.4: Disassembling of Petrol fuel supply components



Activity 1: Problem Solving



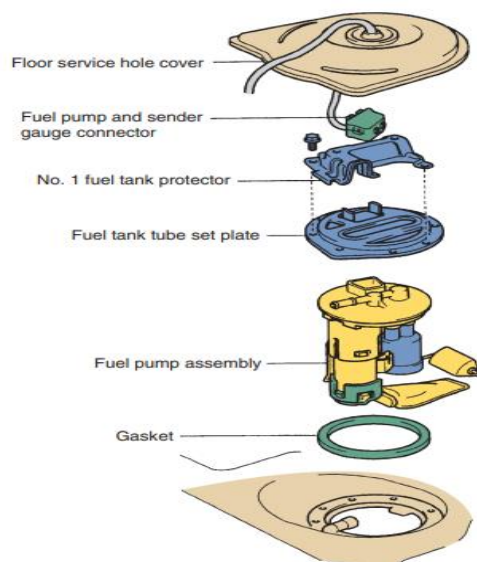
Task 11

Read and answer the following question:

What techniques to use when you disassemble Petrol fuel supply components?

Key Facts 2.4: Disassembling of Petrol fuel supply components

• Disassembling of combination of electric fuel pump and sending unit



- ✓ Connect the wire connectors and fuel lines.
- ✓ Lift the vehicle so you can remove the tank
- ✓ Drain it into an approved container first
- ✓ Remove the fuel tank clamps from the fill lines
- ✓ Remove the fill lines as you prepare to drop the fuel tank
- ✓ Remove the straps and carefully lower the fuel tank
- ✓ Remove the pump assembly so that you can replace it with a brand-new part

Figure 15: Some fuel pump can be serviced

• Disconnecting of fuel pressure regulator

- ✓ Disconnect the battery
- ✓ Raise the vehicle
- ✓ Locate fuel pressure regulator vacuum hose
- ✓ Disconnect the vacuum hose
- ✓ Install new hose
- ✓ Test new installation



Figure 16: Fuel pressure regulator vacuum



Activity 2: Guided Practice



Task 12

Go to the school workshop, under the guidance of trainer, perform the following tasks:
Disassembling combination of electric fuel pump and sending unit



Activity 3: Application



Task 13

- 1 With your trainees go to the nearest garage, under guidance of the garage owner; perform disassembling of Petrol fuel supply system components. Once again, they back to school; they will present their observation and ask more clarification to their trainer on disassembling of Petrol fuel supply components.
2. Visit the nearest school garage, in groups, perform the following tasks: Disconnecting fuel pressure regulator.

Topic 2.5: Detection of Petrol fuel supply system faults.



Figure 17: Detections of petrol fuel systems faults



Activity 1: Problem Solving



Task 14

Read and answer the questions bellow:

1. Enumerate preliminary check before test the fuel system
2. What is the common problems recorder in the fuel system?
3. What is the process to troubleshoot petrol fuel supply components?

Key Facts: 2.5: Detection of Petrol fuel supply system faults.

- **Detection of Petrol fuel supply system faults.**

- ✓ **Preliminary checks**

Before conducting a test on the fuel system, be certain of the following:

- ✚ The battery is fully charged, with clean terminals and connections.
- ✚ The charging and starting systems are operating properly
- ✚ All fuses and fusible links are intact.
- ✚ All electrical harnesses are routed properly and their connectors and terminals are free of corrosion and tight
- ✚ The gasoline in the tank is of good quality and has not been substantially cut with alcohol or contaminated with water.
- ✚ Check on the instrumentation panel level of the fuel

- ✓ **Visual check**

A vision check can often locate an obvious problem, such as a disconnected or damaged hose or wire. Electrical connections apart and look for corroded. Take the connections apart and putting them back together is sometimes enough to improve the electrical connection and solve the problem.

- ✓ **Pressure testing**

When fuel system pressure is not within specifications, the fuel injectors will not inject the correct amount of fuel. If the pressure is not too far off, the computer will adjust the air-fuel mixture after the system begins closed-loop operation. The engine can have a cold driveability problem that will disappear when it is warm.

To test fuel pressure, the pump must be operating. If it is not, check the fuel pump fuse. To hear if a fuel pump is running, put a long funnel in the fuel tank opening and listen. Check vehicle-specific service information. For instance, on Fords an inertia switch in the circuit that powers the fuel pump is located in the trunk. Push the reset button on it first to see if the problem goes away.

- ✓ **Common problems**

Overtime, the fuel system can experience various problems. Here are some common ones:

✚ **Fuel filter is blocked:** The fuel filter becoming blocked is one fuel system problem. It may simply need to be changed.

✚ **Fuel injectors are not working correctly:** One or multiple fuel injectors may need to be cleaned or replaced. Some indicators include rough idle, difficulty starting the vehicle, and an increase in the amount of fuel being used.

✚ **Fuel pump is going bad:** If the fuel pump is failing, the fuel is unable to move from the tank. Misfires, loss in power, and clicking or whining sounds when idle are symptoms you may notice when the fuel pump is going bad.

✓ **Signals of fuel system problems**

A few symptoms can pop up when there is a fuel system problem³.

If there is smell of fuel, there could have a leak. However, when it comes to smelling the fuel, sometimes you only smell it when you first start the car or turn the heat or air conditioning on.

Sometimes, it may not be a big leak like a fuel line but the injectors could be seeping or a seal might be going bad, causing a little bit of fuel to leak. Trying to find those can be tricky and may mean that the vehicle needs to stay at a repair shop overnight.

Figure 18: A combination electric fuel pump and sending unit

Other symptoms of fuel system problems include rough running issues. If the fuel pump or fuel pressure regulator is failing, the fuel pressure may be too high. Generally, the pressure is too low if you have a bad fuel pump, and it will feel like the vehicle does not have enough power. Computer controlled cars lack a fuel volume and pressure as drivers travel uphill, making it seem like the transmission is bad.

Bad fuel or gas that contains water can create some weird misfires. The water will collect in the tank, so when you turn corner water may be sucked up and result in the engine running rough.

Fuel injectors not working correctly is another potential problem. They can become clogged or not be able to distribute the fuel right, leading to misfires and running issues.

✓ **Fuel lines and fittings**

³ <https://stevesautorepairva.com/blog/fuel-system-problems-maintenance/>

The fuel lines carry fuel from the tank to the fuel filter and fuel injection assembly. Fuel lines can be made of either metal tubing or flexible nylon or synthetic rubber hose. The latter must be able to resist gasoline. The hoses must also be non-permeable, so fuel and gas vapors cannot evaporate through the hose. Ordinary rubber hose, such as that used for vacuum lines, deteriorates when exposed to gasoline. Only hoses made for fuel systems should be used. Similarly, vapor vent lines must be made of material that resists attack by fuel vapors.

✓ **Troubleshooting of petrol fuel supply system components**

A visual check can often locate an obvious problem, such as a disconnected or damaged hose or wire. Electrical connections sometimes become corroded. Take the connections apart and look for corrosion. Taking the connections apart and putting them back together is sometimes enough to improve the electrical connection and solve the problem.

-  Check fuel tank status
-  Bleed fuel system pressure
-  Vapour recovery
-  Checking the hoses
-  Checking of fuel gauge sending unit
-  Checking of fuel filter
-  Engine running by listening for hissing
-  Diagnosis fuel injectors
-  Checking of pressure regulator

✓ **Troubleshooting of petrol fuel supply system electronic control**

 Fuel pumps.

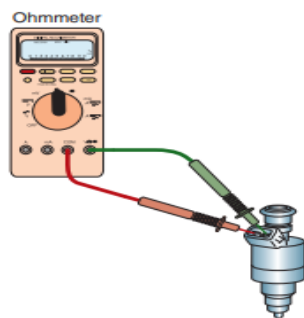
A fuel pump draws fuel from the fuel tank and pushes it through fuel lines to the engine's injection system. All current vehicles use an electric fuel pump.

 Checking fuel injectors resistance

To ohm out a fuel injector with a multimeter, you will need to first locate the two electrical connectors for the injector.

- Disconnect the connectors and then
- Set your multimeter to resistance (ohms) mode.
- Connect the meter's probes to each of the terminals on the connector.

- The reading that is displayed should reflect an open circuit (infinite resistance).



If there is no reading or if it reads 0 ohms, replace the injector. A good fuel injector should have a resistance level between 10-15 Ω . If you wish to test further, you can reset your multimeter to amperage (amps) mode and check for a current.

Figure 19: Use an ohmmeter to check injector resistance

Sensors and actuators

In an EFI system, the computer must know the amount of air entering the engine so it can supply the correct amount of fuel for that amount of air. In systems with a MAP sensor, the computer calculates the amount of intake air based on MAP and rpm input signals. This type of EFI system is referred to as a speed density system, because the computer calculates the air intake flow according to engine speed and intake manifold vacuum. Because air density changes with air temperature, an intake air temperature sensor is also used. Today the most commonly used EFI system is the mass airflow (MAF) system. This system relies on a MAF sensor that directly measures the amount of intake air.

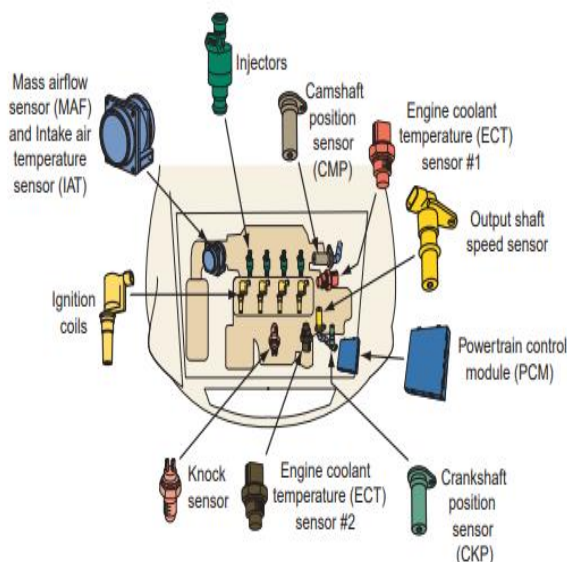


Figure 20: A typical electronic fuel injection system

✓ **Diagnosis of the electronic control system**

-  Remove wire connector test plug cap

 Install malfunction indicator lamp

 Check diagnosis codes



Activity 2: Guided Practice



Task 15

Under the guidance of trainer, Visit your school workshop and perform the following task:

- a) Troubleshoot electronically the petrol fuel supply system electrical components.
- b) Before conducting test, perform the preliminary checks done on the car petrol fuel system.



Activity 3: Application



Task 16

Go to the nearest school garage, in groups, under guidance of the garage owner; troubleshoot electronically the petrol fuel supply system electrical components.



Formative Assessment

1. What are components make up the fuel-supply system of a petrol engine?
2. What is the common problem in fuel system supply
3. Below is the process to troubleshoot the fuel supply components rearrange it

- ✓ Bleed fuel system pressure
- ✓ Diagnosis fuel injectors
- ✓ Checking of pressure regulator
- ✓ Vapour recovery
- ✓ Check fuel tank status
- ✓ Checking the hoses
- ✓ Engine running by listening for hissing
- ✓ Checking of fuel gauge sending unit
- ✓ Checking of fuel filter

4. Explain the process to diagnose of the electronic control system



Points to Remember

- There should never be any fuel present on the vacuum side of the regulator diaphragm. When the engine speed is increased, the pressure reading should remain within the specifications.
- Gasoline is very volatile and flammable. Never expose it to open flame or extreme heat.
- Disconnect the negative battery cable before doing anything that may release gas vapours.
- Use containers to catch gasoline and rags vapours. Use a flashlight or an enclosed fluorescent tube or LED lamp designed for safe use around fuels. When working with a fuel system, always have a Class B fire extinguisher nearby.



Self-Reflection

1. Re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee's Manual to identify their areas of strength, areas for improvement and actions to take to improve.

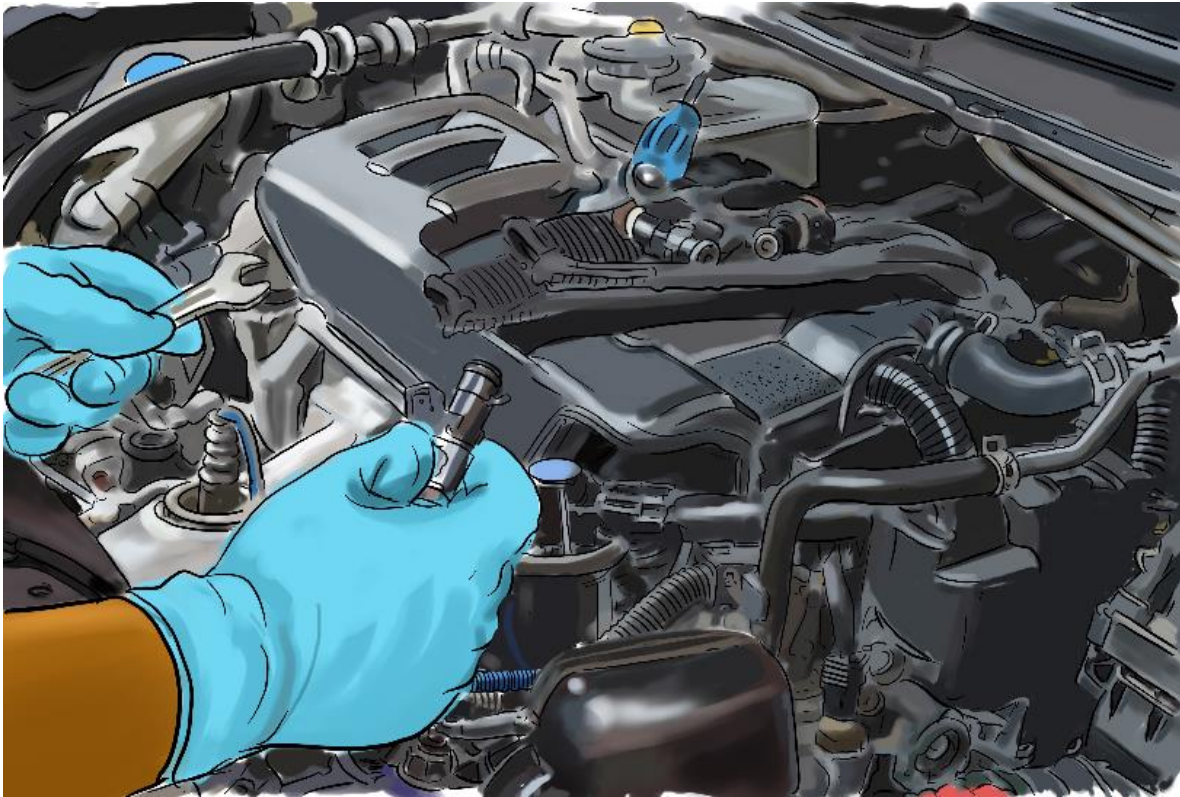
My experience Knowledge, skills and attitudes	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe fuel supply system					
Identify tools, materials and equipment					
Describe fuel supply system					

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 of petrol fuel supply system component					
Identify tools, materials and equipment					
Dismounting procedures of Petrol fuel supply system components					
Disassembling procedures of Petrol fuel supply components					
Detection of Petrol fuel supply system faults					

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

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

UNIT 3: REPAIR ENGINE FUEL SUPPLY SYSTEM



Unit summary:

This unit describes the knowledge, skills and attitudes required to repair petrol engine fuel supply system. It includes properly correction of petrol fuel supply system damaged components, re-assembling of petrol fuel supply system components, re-installing of petrol fuel supply system and testing of petrol fuel supply system.

Self-Assessment: Unit 2

1. Look at the illustrations. What is happening? What do you think these learning outcomes will be about?
2. Fill in the self-assessment below.

There are no right or wrong ways to answer this survey. It is for your own use during this course. Think about yourself: do you think you can do this? How well? Read the statements across the top. Put a check in column that best represents your situation. At the end of this learning outcome, we'll 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.
Repair of leakage of fuel supply system					
Replace of damaged fuel supply system component					
Re-assemble combination of electric fuel pump and sending unit					
Disconnect fuel pressure regulator					
Re-mount petrol fuel tank					
Connect petrol fuel lines					
Remount petrol fuel injectors					
Connect petrol fuel filter					
Test fuel supply system performance					



Key Competencies:

Knowledge	Skills	Attitudes
1. Describe repairing procedures of leakage of fuel supply system	1. Repair of leakage of fuel supply system	1. Being responsible
2. Describe replacement procedures of damaged of fuel supply system component	2. Replace of damaged fuel supply system component	2. Being attentive
3. Explain reassembling combination of electric fuel pump and sending unit	3. Re-assemble combination of electric fuel pump and sending unit	3. Being accountable
4. Describe disconnecting of fuel pressure regulator	4. Disconnect fuel pressure regulator	4. Be carefully
5. Re-mount petrol fuel tank	5. Apply re-mounting of petrol fuel tank	5. Being communicative
6. Describe connecting of petrol fuel lines	6. Connect petrol fuel lines	6. Being positive critically
7. Describe remounting of petrol fuel injectors	7. Remount petrol fuel injectors	7. Being patient

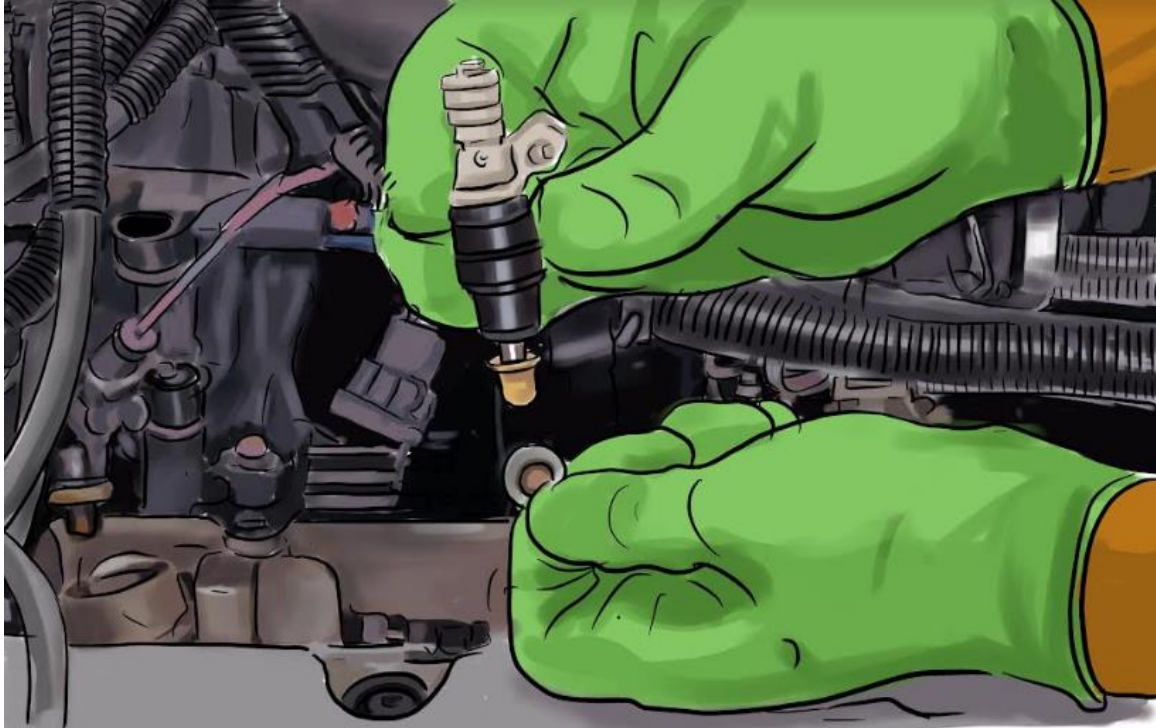


Discovery activity



Task 1

Read and answer following questions



- What do you see in the figure?
- What is happening in the figure?
- What topics do you think will be covered under this unit based on the figure?
- Do you think the figure reflects the topic? Briefly explain your response.

Topic 3.1. Correction of petrol fuel supply damaged components.



Activity 1: Problem Solving



Task 2

Read and answer the following questions:

- a. List down the typical procedures followed during removing a fuel tank from the vehicle.
- b. List down the procedures followed during removing and replacing a fuel injector
- c. List down the procedures for fuel tank services

Key Facts 3.1: Correction of petrol fuel supply damaged components.

- **Correction of petrol fuel supply damaged components.**

- ✓ **Service Precautions**

These precautions must be observed when servicing electronic fuel injection systems:

-  Always relieve the fuel pressure before disconnecting any component in the fuel system.
-  Never turn the ignition switch on while any component of the fuel system is disconnected.
-  Use only the test equipment recommended by the vehicle manufacturer.
-  In order to reduce the electrical risk to the vehicle's modules, disconnect both battery cables before beginning any arc welding. The welder should also position their ground as close as possible to the welding electrode or wire.
-  When disconnecting the battery, always disconnect the negative cable first.
-  Use a grounding strap to prevent static electric discharges when handling computers, modules, and computer chips.
-  Isolate or disable all high-voltage systems before testing or servicing the fuel system.

✓ **Replacement of damaged fuel supply system component**

 Fuel Filter Service

Fuel filters have specified intervals for replacement. They can be located in a fuel line, in the tank. Outlet fuel filters can be found on the outlet side of a fuel pump.

 Check fuel tank status.

- Replace fuel or vapor hoses
- Replace a fuel tank sending unit
- Replace an in-tank electric fuel pump

 Fuel tank service procedures.

The procedure for removing a fuel tank varies depending on the vehicle make and year. Always follow the procedure in the vehicle manufacturer's service manual. What follows is a typical procedure:

-  Disconnect the negative terminal from the battery.
-  Relieve the fuel system pressure and drain the fuel tank.
-  Raise the vehicle on a hoist or lift the vehicle with a floor jack and lower the chassis onto jack stands.
-  Use compressed air to blow dirt from the fuel line fittings and wiring connectors.
-  Remove the fuel tank wiring harness connector from the body harness connector.
-  Remove the ground wire retaining screw from the chassis if used.
-  Disconnect the fuel lines from the fuel tank. If these lines have quick-disconnect fittings, follow the manufacturer's recommended removal procedure in the service manual. Some quick-disconnect fittings are hand releasable, and others require the use of a special tool.
-  Wipe the filler pipe and vent pipe hose connections with a shop towel, and then disconnect the hoses from the filler pipe and vent pipe to the fuel tank.
-  Unfasten the filler from the tank. If it is a rigid one-piece tube, remove the screws around the outside of the filler neck near the filler cap. If it is a three-piece unit, remove the neoprene hoses after the clamp has been loosened.

- ✚ Loosen the bolts holding the fuel tank straps to the vehicle until they are about two threads from the end.
- ✚ Take out the strap bolts and drop the tank to the ground while maintaining a firm grip on it with one hand against the undercarriage. Make sure all of the tubes and connections are disconnected before lowering the tank. Small amounts of petrol may still remain in the tank, so proceed with caution.
- ✓ **Removing and replacing a fuel injector**
 - ✚ Select appropriate tools
 - ✚ The injectors are held to the fuel rail by a clip that fits over the top of the injector.
 - ✚ Pull up on the fuel rail assembly. The bottoms of the injectors will pull out of the manifold while the tops are secured to the rail by clips
 - ✚ Remove the clip from the top of the injector and remove the injector unit.
 - ✚ Install the injector into the fuel rail and set the rail assembly into place
 - ✚ Tighten the fuel rail hold down bolts according to manufacturer's specifications
 - ✚ Reconnect all parts that were disconnected. Install the fuel pump fuse and reconnect the battery.
- ✓ **Service of fuel pump**

When replacing an electric pump be sure that the new or rebuilt replacement unit meets



Figure 21: Fuel pump repair

the minimum requirements of pressure and volume for that particular vehicle. This information can be found in the service manual. If the fuel pump is mounted in the fuel tank, the procedure for replacement is different than if the unit is external to the tank.

If the pump is not running, check the wiring and current flow before going through the process of dropping the fuel tank to remove the pump.

- ✓ **Replacement of fuel pump**

The following recommendations should be followed whenever replacing an electric fuel pump:

-  Clean around the fuel pump retainer area before removing the fuel pump assembly.
-  The fuel-pump strainer (sock) should be replaced with the new pump.
-  If the original pump had a deflector shield, it should always be
-  Used to prevent fuel return bubbles from blocking the inlet to the pump.
-  Always check the interior of the fuel tank for evidence of contamination or dirt.
-  Double-check that the replacement pump is correct for the application.
-  Check that the wiring and electrical connectors are clean and tight

✓ **Fuel Supply-Related Symptom Guide**

Problem	Possible Causes
Pressure too high after engine start-up.	• Defective fuel-pressure regulator • Restricted fuel return line • Excessive system voltage • Wrong fuel pump
Pressure too low after engine start-up.	• Stuck-open pressure • Low voltage 3 • Poor ground • Plugged fuel filter • Faulty inline fuel pump • Faulty in-tank fuel pump • Partially clogged filter sock • Faulty hose coupling • Leaking fuel line • Wrong fuel pump • Leaking pulsator regulator • Restricted accumulator • Faulty pump check valves

	Faulty pump installation
Pressure drops off with key on/engine off. With key off, the pressure does not hold	- Leaky pulsator - Leaking fuel-pump coupling hose - Faulty fuel pump (check valves) - Faulty pressure regulator - Leaking fuel injector - Faulty installation - Lines leaking



Activity 2: Guided Practice



Task 3

Read and answer the following questions

- Explain the fuel tank services procedures
- Replace a fuel injection system



Activity 3: Application



Task 4

Go to the nearest school garage, in groups, under guidance of the garage owner; perform the following tasks:

- Remove the fuel tank from the vehicle.
- Remove and replace a fuel injector

Topic 3.2. Re-assembling of petrol fuel supply system components

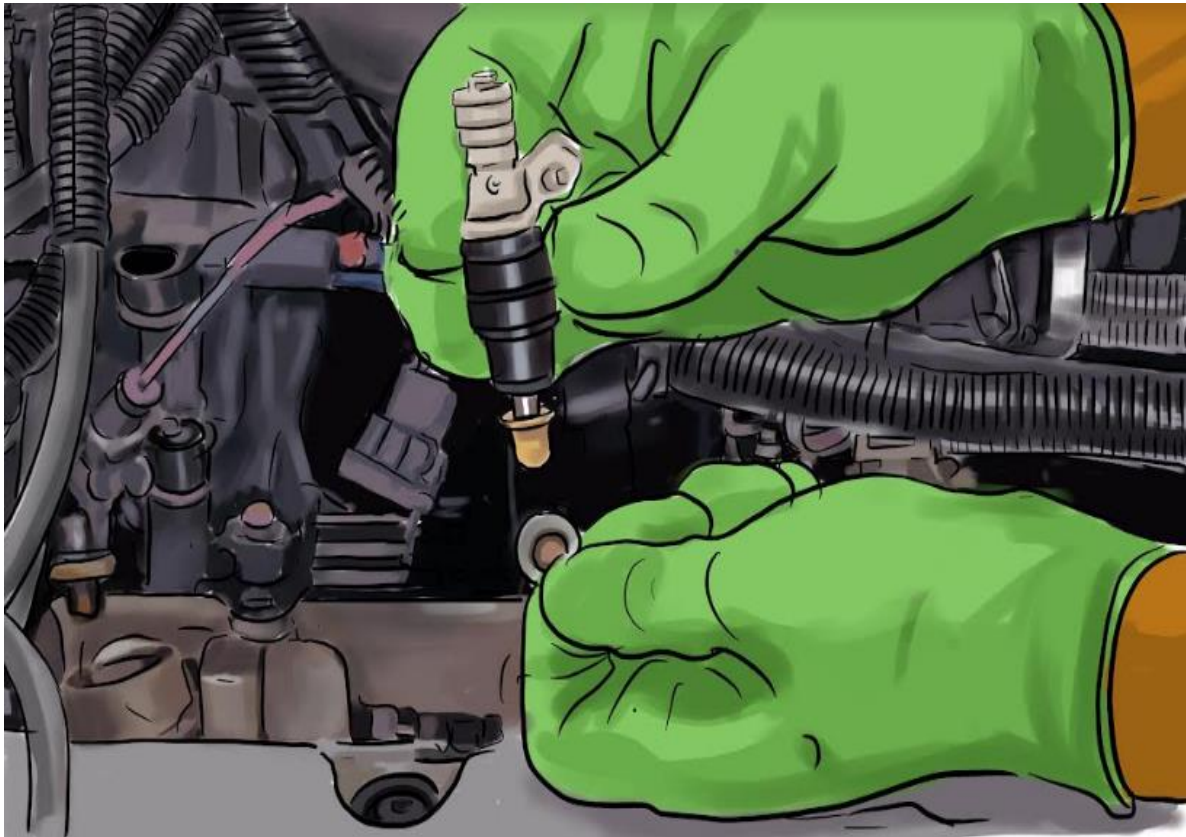


Figure 22: Re-assembling of fuel injector



Activity 1: Problem Solving



Task 5

Read and answer the following questions:

- a. List down the procedures followed during replacement of an electric fuel pump.
- b. List down the procedures followed during disconnection of fuel pressure regulator.

Key Facts:3.2: Re-assembling of petrol fuel supply system components

- **Re-assembling of petrol fuel supply system components**

- ✓ **Re-assembling combination of electric fuel pump and sending unit**

To replace an electric fuel pump, proceed as follows:

- ✚ Disconnect the ground terminal at the battery.
- ✚ Disconnect the electrical connector(s) on the fuel pump. Label the wire(s) to aid in reassembly
- ✚ Remove the fuel and vapor lines from the pump. Label the lines to aid in connecting them to the new pump.
- ✚ The fuel sending unit retaining ring must typically be removed before removing an inside tank type pump. Nonetheless, in order to reach the retaining ring, it is frequently required to remove the fuel tank.
- ✚ When working on a fuel pump outside the tank, remove the bolts holding it in place. On intake models, loosen the retaining ring by rotating it counterclockwise with a brass drift and hammer. Pull the pump and sending unit out of the tank (if they are combined in one unit) and discard the tank O-ring seal. Then push the pump up until the bottom is clear of the bracket. Swing the pump out to the side and pull it down to free it from the rubber fuel line coupler
- ✚ In most cases, the rubber sound insulator between the bottom of the pump and bracket and the rubber coupler on the fuel line can be discarded because new ones are included with the replacement pump. Some pumps have a rubber jacket around them for quieter operation; if so, slip off the jacket and put it on the new pump.
- ✚ Compare the new or rebuilt pump with the old one. If necessary, transfer any fuel line fittings from the old pump to the new one. Note the position of the filter sock so you can install the new one in the same relative position.
- ✚ When inserting the new pump back into the sending unit bracket, be careful not to bend the bracket. Also, make sure the rubber sound insulator under the bottom of the pump is in place.

- ✚ Install a new filter sock on the pump inlet and reconnect the pump wires. Be certain you have correct polarity.
- ✚ Replace the O-ring seal on the fuel tank opening, and then put the pump and sender assembly back in the tank. Tighten the locking ring by rotating it clockwise with a brass drift and hammer. Note that bolts secure some pump/sender assembly units.
- ✚ If the fuel was removed from the vehicle, replace it.
- ✚ Reconnect the electrical connector(s), then re-connect the ground terminal at the battery
- ✚ Start the engine and check all connections for fuel leaks

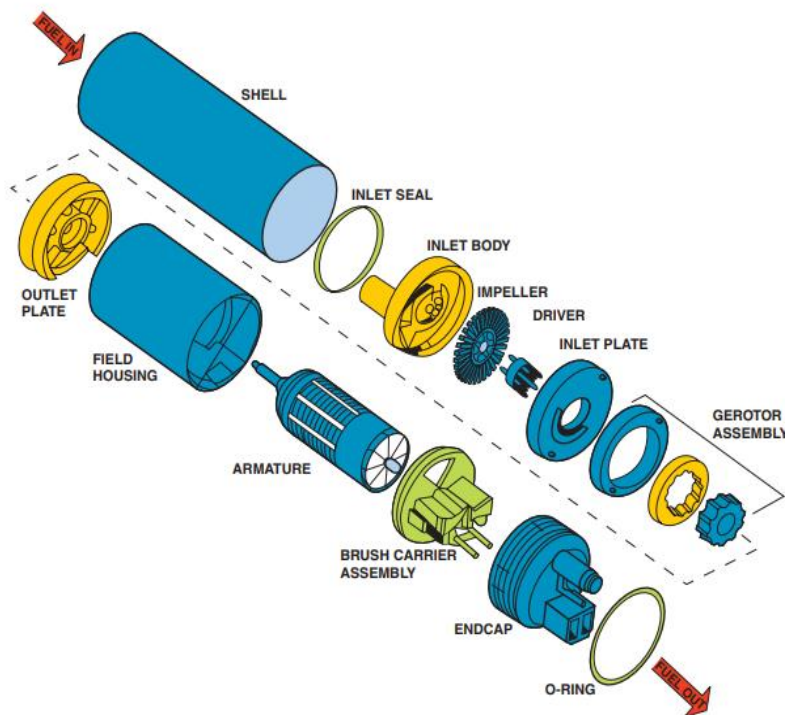


Figure 23: An exploded view of an electric fuel pump

✓ **Disconnection of fuel pressure regulator**

✚ **Disconnect the Battery**

Begin by disconnecting the negative terminal from your vehicle's battery. This will prevent any accidental sparks that could otherwise ignite gasoline fumes during the repair process

✚ **Raise the Vehicle**

Raise up one side of the vehicle, so components can be accessible. Make sure to use jack stands for extra support once the vehicle is raised off ground.

Locate Fuel Pressure Regulator Vacuum Hose.

Using a flashlight, look around the underside of the engine bay to locate the fuel pressure regulator vacuum hose. Depending on your make and model, this hose may be located in various places so make sure to consult an automotive repair manual.

Disconnect the Vacuum Hose.

Once you've located the fuel pressure regulator vacuum hose, use pliers or a wrench to disconnect it from its fitting at both ends. If there is any worn and break on the rubber hose itself, then you'll need to replace that as well.

Reassembling of petrol fuel injector.

Assembling procedures for a petrol fuel injector may vary depending on the make and model of the injector. However, here is a general outline of the steps involved:

-  Gather all the necessary tools and equipment for the assembly process, including safety glasses, gloves, and the specific tools needed for your injector model.
-  Clean the fuel injection components thoroughly using an appropriate cleaning solution. This ensures that no dirt or contaminants are present during assembly.
-  Inspect all parts of the fuel injector for any signs of damage or worn.
-  Install the filter basket or filter screen in the injector body. This helps prevent debris from entering the injector and causing clogs.
-  Apply a small amount of lubricant or fuel injector assembly grease to the O-rings or seals. This helps provide a good seal and facilitates ease of assembly.
-  Insert the nozzle and pintle assembly into the injector body. Make sure it is properly aligned and seated. Use any specific tools or techniques recommended by the manufacturer to ensure proper alignment.
-  Attach the electrical connector or harness to the fuel injector. Make sure it is securely connected and properly seated.
-  Install any additional components or attachments specific to your injector model, such as a fuel rail or mounting brackets.
-  Double-check all connections and ensure that all components are securely in place.

-  Test the fuel injector for proper functionality before installation. This may require using a specialized testing device or equipment.
-  Once the fuel injector has been tested and deemed functional, it can be installed in the appropriate location in the engine.

It's important to note that these procedures are general guidelines and may not cover all the specific steps required for your particular fuel injector model. Always refer to the manufacturer's instructions and follow any specific guidelines or recommendations provided.



Activity 2: Guided Practice



Task 6

Under the guidance of trainer, visit the school workshop and perform the following task:

- a. Replace an electric fuel pump.
- b. Disconnect fuel pressure regulator.
- c. Reassemble petrol fuel injector.



Activity 3: Application



Task 7

Go to the nearest school garage and perform the following tasks:

- a. Replace the electric fuel pump.
- b. Disconnect the fuel pressure regulator
- c. Reassemble petrol fuel injector.

Topic 3.3: Re-installing of petrol fuel supply system



Activity 1: Problem Solving



Task 8

Read and answer the following questions

1. What is the process to remount Petrol fuel tank?
2. Enumerate the activities to check after remounting petrol fuel tank.
3. How we test the fuel injection?
4. List the process to test the fuel supply performances.

Key Facts: 3.3: Re-installing of petrol fuel supply system

- **Re-installing of petrol fuel supply system**

Remounting a petrol (gasoline) fuel tank typically involves the process of reinstalling or attaching the fuel tank back to its original position in a vehicle after it has been removed for maintenance, repair, or replacement. This process can vary depending on the make and model of the vehicle, but the general steps are as follows:

Note: Working with fuel can be dangerous. Always follow safety guidelines and take proper precautions when handling fuel. If you're not confident in doing this task yourself, it's best to seek the help of a professional mechanic.

- ✓ **Preparation:**

- ✚ Ensure that the vehicle is parked on a flat, stable surface in a well-ventilated area.

- ✚ Disconnect the vehicle's battery to prevent accidental sparks.

- ✓ **Drain the Fuel Tank (If Necessary):** If the fuel tank still contains fuel and it needs to be removed, you'll first need to drain the gasoline safely. You can use a hand pump or siphon to remove the fuel into a suitable container.

- ✓ **Remove Obstacles:** If there are any components or parts obstructing the fuel tank's access, such as exhaust system components or protective shields, they need to be temporarily removed to gain access to the tank.
- ✓ **Disconnect Fuel Lines and Wiring:** Carefully disconnect any fuel lines, hoses, and electrical connections that are attached to the fuel tank. There may be fuel supply and return lines, as well as electrical connectors for the fuel pump and fuel level sensor.
- ✓ **Support the Tank:** Before fully removing the fuel tank, support it with a jack or another appropriate tool to prevent it from falling or causing damage.
- ✓ **Unbolt and Remove the Tank:**
 -  Locate and remove the bolts or straps securing the fuel tank to the vehicle's undercarriage.
 -  Slowly and carefully lower the fuel tank from its mounting position using the jack or support mechanism.
- ✓ **Inspect and Clean:** Inspect the fuel tank and surrounding areas for any damage, leaks, or corrosion. Clean the mounting area to ensure proper contact.
- ✓ **Mounting the Fuel Tank:**
 -  Carefully lift the fuel tank back into its original mounting position.
 -  Reattach the mounting straps or bolts to secure the fuel tank in place.
- ✓ **Reconnect Fuel Lines and Wiring:** Reconnect all fuel lines, hoses, and electrical connections to their respective fittings on the fuel tank.
- ✓ **Replace Obstacles:** Reinstall any components or parts that were removed to access the fuel tank, such as exhaust components or shields
- ✓ **Refill the Fuel Tank:** If the fuel tank was drained, now is the time to refill it with the appropriate type of gasoline.
- ✓ **Check for Leaks:** Before starting the engine, carefully inspect the fuel tank and connections for any signs of leaks.
- ✓ **Reconnect the Battery:** Reconnect the vehicle's battery.
- ✓ **Test the System:** Start the engine and allow it to run for a few minutes to ensure everything is functioning correctly.

- ✓ **Final Check:** Double-check all connections and fittings to ensure everything is secure and in its proper place.

- **General steps to properly connect petrol fuel lines:**

- ✓ **Identify the Fuel Lines:** Identify the fuel lines by tracing them from the fuel tank to the engine or fuel system components. In most vehicles, the fuel lines are made of rubber or metal and are typically black, gray, or metallic in color.
- ✓ **Gather Necessary Tools:** You'll need the appropriate tools for the job, which may include screwdrivers, wrenches, pliers, and hose clamps.
- ✓ **Inspect the Fuel Lines:** Check the condition of the fuel lines for any signs of damage, wear, or deterioration. If you find any cracks or leaks, it's essential to replace the damaged sections before connecting them.
- ✓ **Purchase the Correct Replacement Fuel Lines (if necessary):** If any fuel lines are damaged beyond repair, acquire suitable replacements. Ensure they match the correct make, model, and year of your vehicle or equipment.
- ✓ **Prepare the Fuel Lines:** If you are working with existing fuel lines, clean the ends of the hoses to remove any debris, dirt, or old gaskets.
Make sure the hose ends are smooth and free from damage.
- ✓ **Use Proper Fittings:** When connecting fuel lines, use appropriate fittings, connectors, or clamps designed for fuel systems. The fittings should provide a secure and leak-proof connection.
- ✓ **Connect the Fuel Lines:** Carefully insert the fuel line onto the fuel inlet or outlet pipe of the fuel tank or fuel system component. If applicable, use hose clamps to secure the connections. Tighten the clamps appropriately, but be careful not to overtighten, as it may damage the hoses or cause leaks.
- ✓ **Check for Leaks:** After connecting the fuel lines, turn the ignition to the "ON" position (do not start the engine) to pressurize the fuel system. Check for any leaks around the connections. If you notice any leaks, immediately turn off the ignition and address the issue before attempting to start the engine.

- ✓ **Test the Fuel System:** Once you are confident that there are no leaks, start the engine and let it run for a few minutes to verify that everything is functioning correctly.
 - ✓ **Recheck Connections Periodically:** It's good practice to inspect the fuel lines and connections periodically for signs of wear or leaks. Replace any damaged or worn-out components promptly.
 - ✓ **Check for Leaks:** Turn the ignition to the "ON" position (do not start the engine) to allow the fuel pump to pressurize the system. Check for any fuel leaks around the fuel filter and fittings. If you detect any leaks, turn off the ignition and double-check your connections.
-  **Start the Engine:** Once you've verified there are no leaks, start the engine and let it run for a few minutes. Monitor for any unusual behavior or signs of fuel leakage.
 -  **Test Drive:** Take the vehicle for a short test drive to ensure everything is functioning correctly. Keep an eye out for any issues and recheck for leaks after the test drive.
 -  **If you're not confident in performing this task yourself, it's best to seek assistance from a qualified mechanic or technician to ensure the fuel system is correctly connected and functioning safely**



Activity 2: Guided Practice



Task 9

Visit the workshop and perform the following task, under the guidance of the trainer

Develop all the procedures that you can follow in order to re-mount the petrol fuel tank.



Activity 3: Application



Task 10

Visit the garage or workshop and ask mechanical to let you connect petrol fuel filter. Perform task and observe if the outcome is similar to what you learnt at school. Note that you will prepare a report once you return to school.

Topic 3.4: Testing of fuel supply system performance



Activity 1: Problem Solving



Task 11

Read and answer the questions below

1. What is static testing in the context of petrol fuel supply?
2. List all steps to test pipe leakage.

Key Facts: Testing of fuel supply system performance

Test fuel injector

✓ Voltage testing

- ✚ Turn the ignition key to the on position. You do not need to start the engine for this test
- ✚ Disconnect the electronics plug wire from the fuel injector
- ✚ Set the multimeter to volts. Place the red and black leads on either side of the electrical plug for the fuel injector. It is not required to have a specific lead on a specific side of the plug because you are measuring the voltage.
- ✚ Read the multimeter the voltmeter should read approximately 12 volts, replace the wiring for any single wire set which fails the 12 volts test. Be sure to test all

the wire before replacing any single set, mass failure may indicate a failure in electronic fuel injection relay or control module.

✓ **Fuel injector resistance testing**

- ✚ Turn the multimeter to Ohm (Ω)
- ✚ Place the multimeter leads into the fuel injector plug terminal, it is not necessary to have black or red lead on a specific side of the plug terminal
- ✚ Read ohm resistance produced by fuel injector note the value down
- ✚ Test all fuel injector Ohm (Ω) reading, compare the value of each injector to the other one's value, operational of fuel Injector will have the same, or very similar ohm values.

A failed injector will have too little or too much resistance and ohm value will be widely different than the other readings. Replace the injector if the ohm value is significantly different than another injector. Failed injector may still fire leading you to believe problem is wiring.



Activity 2: Guided Practice



Task 12

Take a car chosen in the workshop that needs to be repaired and develop all the procedures that you can follow to testing petrol fuel pressure of that car.



Activity 3: Application



Task 13

Request permission from trainer to visit nearby garage, ask for guidance from mechanic on how to test petrol fuel injector. And make a report based on the information during the garage visit



Formative Assessment

- a. Explain the tank service procedures
- b. That is the process to remove and replace a fuel injector, put it in the ideal order
 - i. The injectors are held to the fuel rail by a clip that fits over the top of the injector.
 - ii. Reconnect all parts that were disconnected. Install the fuel pump fuse and reconnect the battery.
 - iii. Pull up on the fuel rail assembly. The bottoms of the injectors will pull out of the manifold while the tops are secured to the rail by clips
 - iv. Install the injector into the fuel rail and set the rail assembly into place
 - v. Remove the clip from the top of the injector and remove the injector unit.
 - vi. Select appropriate tools
 - vii. Tighten the fuel rail hold down bolts according to manufacturer's specifications
- c. List down the procedures followed during replacement of an electric fuel pump.
- d. List down the procedures followed during disconnection of fuel pressure regulator.
- e. List down the procedures followed during reassemble of petrol fuel injector
- f. This causes correspond to what problem

1. Defective fuel-pressure regulator
2. Restricted fuel return line
c) Excessive system voltage
1. Wrong fuel pump



Points to Remember

- Remember to consult the vehicle's service manual or seek professional advice if you encounter any difficulties during the process.
- Connecting petrol fuel lines properly is crucial for the safe and efficient operation of any vehicle or petrol-powered equipment. Incorrectly connected fuel lines can lead to leaks, fuel system malfunctions, and potential hazards.
- Important Safety Note: Working with petrol and fuel systems can be dangerous, and if you are unsure about any step or do not have experience with automotive repairs, it is best to seek help from a professional mechanic or technician.
- Remember that fuel system safety is the most importance, and any doubts about proper fuel line connections should be addressed immediately to prevent accidents or damage to the vehicle
- After reinstalling fuel pump, always check all fuel line connections for leaks, with engine running.
- Reversing polarity on most electric fuel pumps will destroy the unit.
- Avoid the temptation to test the new pump before replacing it in the fuel tank by energizing it with a couple of jumper wires. Running the pump dry can damage it.
- Before working on the fuel lines, ensure that the engine is off, and there are no open flames or sparks nearby.

1. Re-take the self-assessment they did at the beginning of the unit.

My experience	I don't have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Knowledge, skills and attitudes					
Repair of leakage of fuel supply system					
Replace of damaged fuel supply system component					
Re-assemble combination of electric fuel pump and sending unit					
Disconnect fuel pressure regulator					
Re-mount petrol fuel tank					
Connect petrol fuel lines					
Remount petrol fuel injectors					
Connect petrol fuel filter					
Test fuel supply system performance					

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

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



Summative assessment

Integrated situation

RUKUMBI CAR Co Ltd located at Gisozi sector in Gasabo sector has a new model Toyota Rav4; which has a problem in Petrol fuel supply system. Where it has hard started, unstable idle, loss of power and vibration when is running. The hired company for repair is Akagera motors located at JALI sector in Gasabo district; the mechanic is requested to repair it within 5 hours.

As an engine repair mechanic; you are requested to:

Tasks:

1. Perform Engine Petrol Injection fuel system Supply
2. Diagnose the engine fuel supply system
3. Repair the engine fuel supply system
4. Replace damaged parts of engine fuel supply system
5. Test fuel supply system performance
6. All needed tools, materials and equipment are available
7. The task above must be done within 4 hours

Tools	Set of screw drivers, Set of pliers, spanners, Allen keys, hammers,
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Equipment	Multimeter, Hand scanner machine, auto-data, repair manual, internet, PPE, oxyacetylene cylinder gas,
Materials/ Consumables	Wires, Cables, fuel, fuel supply system spare parts, clamps, welding electrode

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