TVET CERTIFICATE III IN AUTO ENGINE TECHNOLOGY

EXHAUST SYSTEM REPAIRING

AUTES301

REPAIR EXHAUST SYSTEM

Competence

REQF Level: 3

Learning hours: 70

Credits: 7

Sector: Transport and Logistics

Sub-sector: Automobile

Module Note Issue date: November, 2020

Purpose statement

This particular module describes the performance outcomes, skills and knowledge required to exhaust system repairing. It is very core to every mechanic to perform exhaust system repairing in order to keep the vehicle exhaust system in good condition.

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LU 1. DESCRIBE THE WORKING PRINCIPLE OF EXHAUST SYSTEM

L O 1.1: Select tools, materials and equipment

- **Content/topic 1 Selection of tools used on exhaust system:**

- **Wrenches/ spanners:**

A wrench is a tool for twisting and/or holding bolt heads or nuts

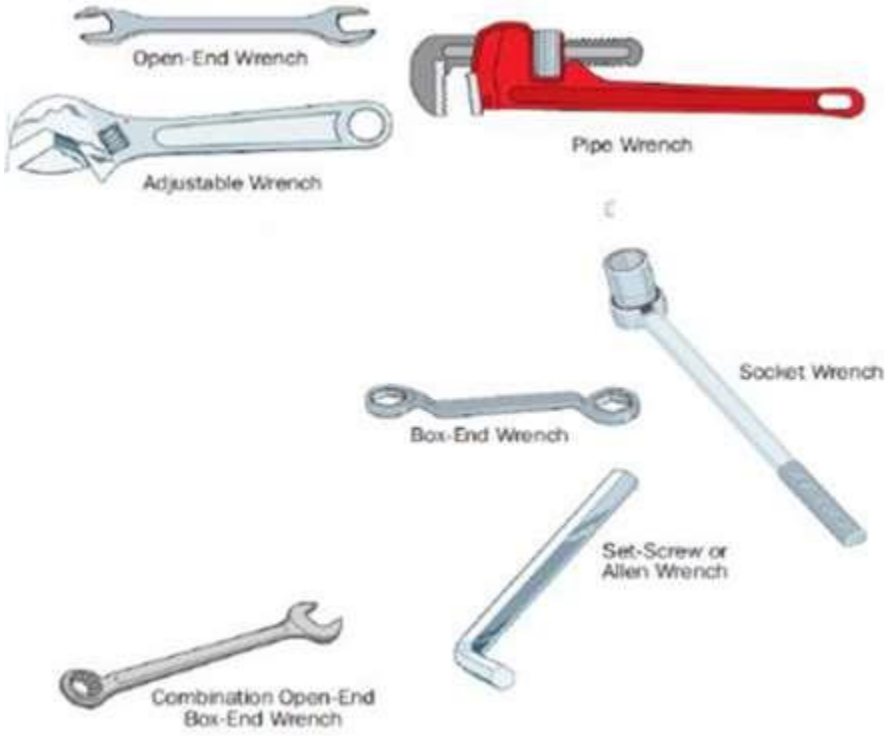

Figure: different type of spanners

- **Screwdrivers**

A screwdriver drives a variety of threaded fasteners used in the automotive industry
Standard Tip Screwdriver: A slotted screw accepts a screwdriver with a standard or blade-type tip
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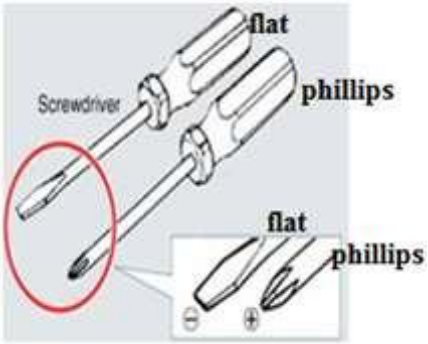

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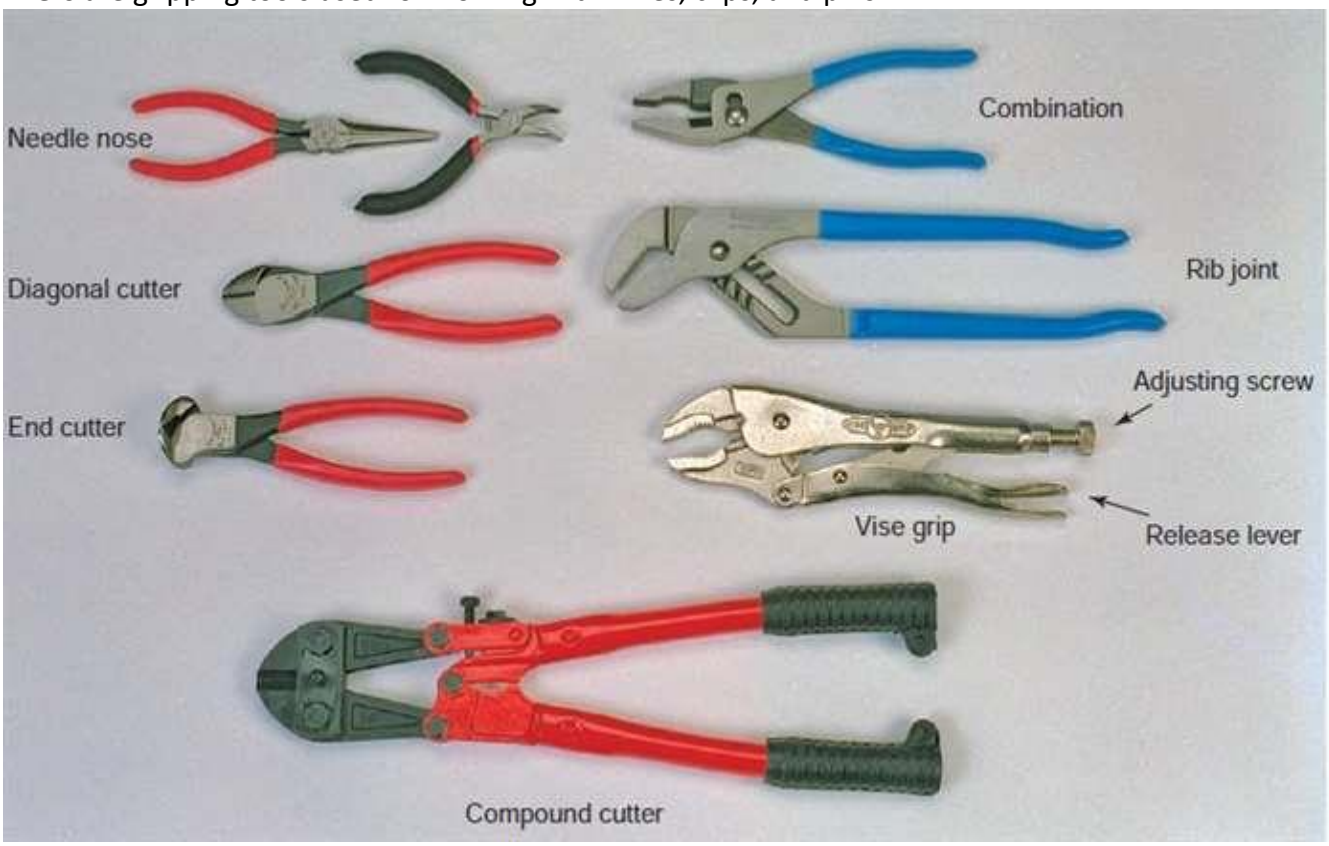

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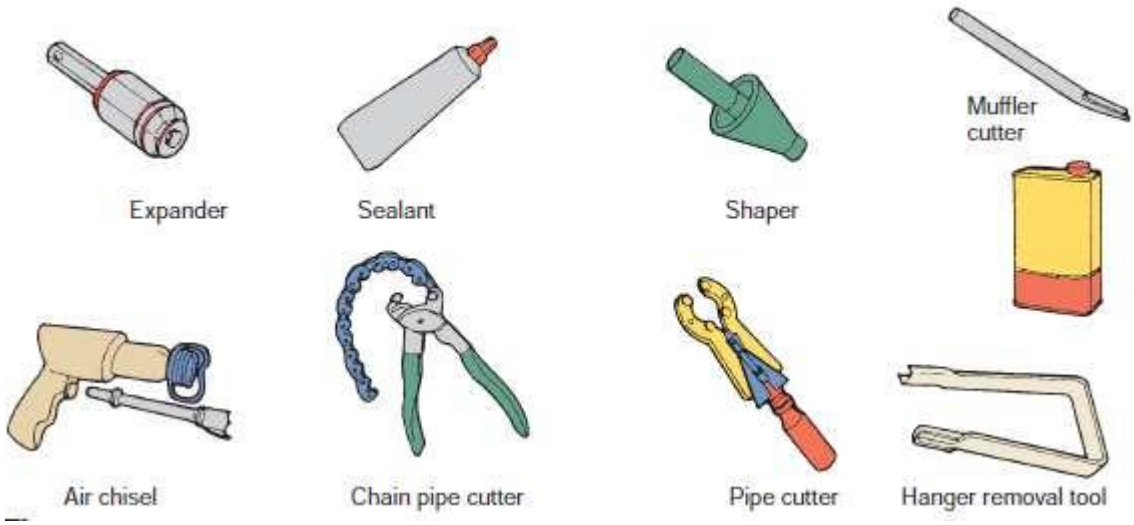
- **Special tool required for exhaust system work**



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- **Content/ topic 2 Selection of materials used on exhaust system**

- **Penetrating oil**

Before attempting to disassemble the exhaust system, spray all nuts and bolts with penetrating oil

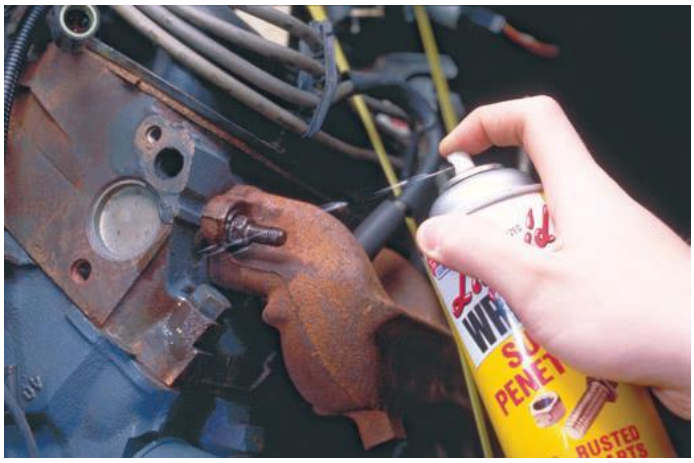

Figure: spraying penetrating oil

- **Exhaust gaskets**

An **exhaust manifold gasket** seals the connection between the **manifold** and cylinder head. This prevents **exhaust** leakage out of the connection and also ensures that all **exhaust** gas will flow through the catalytic converter for treatment

Figure: Exhaust gaskets

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The first function of **overalls** is to protect. However, they do not protect only the body of the wearer. **Overalls** can be used to protect the clothing.

Figure: coverall/ overall

- **Gloves**

Gloves are personal protective equipment (PPE) that protects the hands from the hazards. These **gloves** allow digit articulation while protecting the operator from electrical shock, extreme heat, and ultraviolet and infrared radiation, and also provide abrasion resistance and enhanced grip

Figure: gloves

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Figure: safety boot

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Figure: car lift/ hoist

- **Jack and Jack stands**

Jack stands are tripod- or tower-shaped tools designed to support a vehicle's weight when suspended. They are positioned under the vehicle axle or frame to provide additional support for the elevated vehicle. The **jack stands** are positioned after you **jack** the vehicle up
These stands can be used on hard and level surfaces and for cars that are within the weight capacity of the stands

Figure: jack and jack stand

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Figure: multimeters

- **Exhaust gas aspirator**

They allow sucking the **exhaust gases** directly to the source, unrolling the hose and attaching the nozzle to the **exhaust** pipe, thus avoiding that these **gases** are dispersed in the environment and come into contact with the respiratory tract of the operators

- **Handscaner**

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

- **Exhaust gas-analyzer**

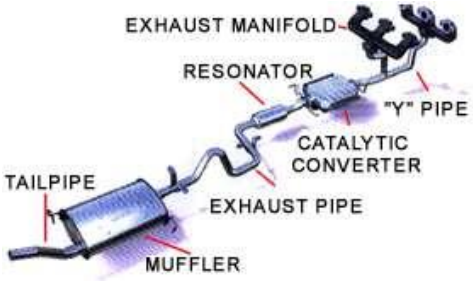
Concentrations of combustion products in the vehicle's exhaust, most of which pollute the air, give important diagnostic clues to the vehicle's engine efficiency. The component gases which contribute the most to air pollution are hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx).

Three of the five gases measured at the tailpipe are regulated pollutants - HC, CO and NOx. The remaining gases, oxygen (O_2) And carbon dioxide (CO_2), while non-regulated, play a significant role as diagnostic aids. Omitec's four gas analyzer measures HC, CO, CO_2 and O_2 concentrations. The five gas analyzer adds the measurement of NOx as well.

L O1.2: Identify exhaust system component

- **Content/ topic 1 Identification of Exhaust system components:**

The diagram illustrated below explains the working of all the main components of an exhaust system used in automobile. The major components used in a typical automobile exhaust system are: exhaust manifold, resonator, catalytic converter, exhaust pipe, muffler, tail pipe, 'Y' pipe, ball flanges. All of these components are especially designed for providing suitable and effective exhaust flow, silencing, and emission levels.



The exhaust system has 3 main functions:

- Directs the exhaust fumes from the engine to the back of the vehicle.
- Reduces the amount of toxic chemicals in the fumes to reduce emissions.
- Reduces the noise from the series of explosions that happen during the fuel combustion process.

- **Exhaust manifold**

In automotive engineering, an exhaust manifold collects the exhaust gases from multiple cylinders into one pipe.

Figure: exhaust manifold

- **Lambda/ oxygen sensor**

An oxygen sensor (or lambda sensor) is an electronic device that measures the proportion of oxygen (O_2) in the gas.

Figure: oxygen sensor

- **Catalytic converter**

Catalytic Converters are the devices used for converting toxic and harmful hydrocarbons, carbon monoxide, and nitrogen oxides into harmless compounds

Figure: catalytic converter

- **Resonator**

Resonator installed as part of your car or truck's exhaust system serves one main purpose to resonate. It's sort of an echo chamber for your car's exhaust, preparing all of the loud noise

coming from your engine for the muffler to silence it. The resonator doesn't just remove sound, it changes it.

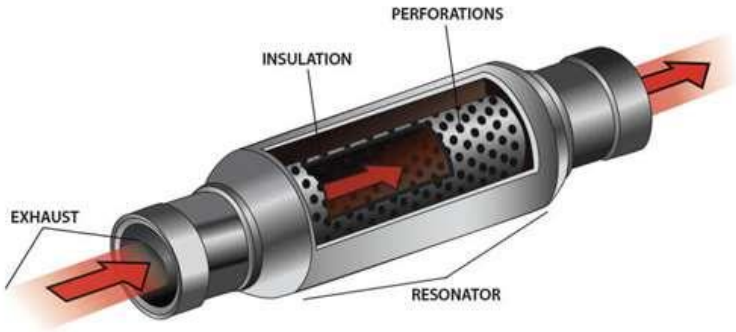


Figure: resonator

- **Silencers / muffler**

A muffler (silencer in many non-US English speaking countries) is a device for decreasing the amount of noise emitted by the exhaust of an internal combustion engine

Figure: muffler

- **Exhaust pipes**

Exhaust Pipes are explicitly engineered to carry or transmit various toxic and noxious gases away from the users of the machine

Figure: exhaust pipe

- **Exhaust tail pipe**

The **tailpipe** is the last pipe in the exhaust system. It releases the exhaust fumes into the atmosphere beyond the back end of the car.

Figure: tail pipe

Exhaust gaskets

The exhaust manifold gasket is usually a multi-layered gasket that contains metal and other materials that are designed to provide the best seal possible. As the exhaust manifold gasket is the first in the exhaust system, it is a very important seal that should be inspected if any problems arise

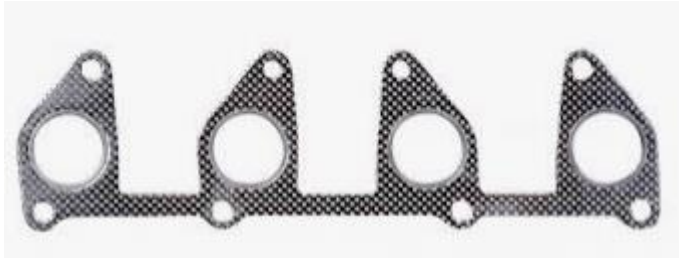


Figure: exhaust manifold gasket

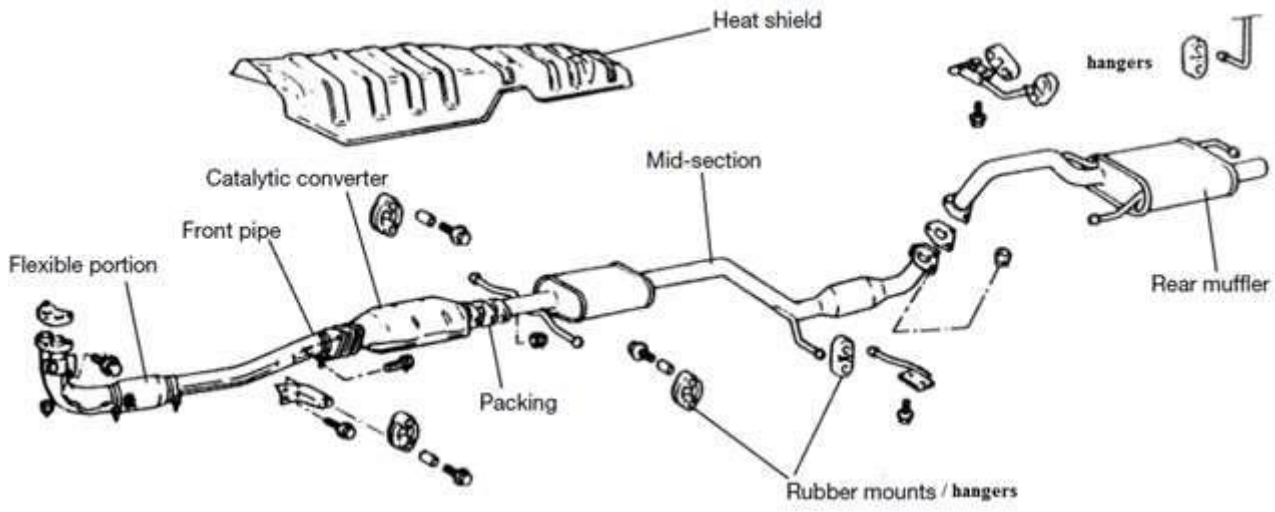
An exhaust flange gasket is a round gasket that is commonly called a donut gasket. This gasket is often used to prevent exhaust leaks between the cast-iron exhaust manifold and the exhaust pipe of an automobile or truck. It is designed with a bevel on both sides of the gasket and a smooth, flat inner surface. The bevelled sides of the gasket help the gasket to seal by allowing the clamps to form an almost circular clamping force on the gasket's surface.

Figure: exhaust flange gasket

L O 1.3: Describe exhaust system components

- Content/ topic 1Definition, purpose and location of exhaust system component:

The various components of the typical exhaust system include the following:



- **Exhaust manifold**

The exhaust manifold collects the burnt gases as they are expelled from the cylinders and directs them to the exhaust pipe. Exhaust manifolds are attached to the engine cylinder head, for most vehicles are made of cast or nodular iron. Many newer vehicles have stamped heavy gauge sheet metal or stainless steel units.
Inline engines have one exhaust manifold. V-type engines have an exhaust manifold on each side of the engine. An exhaust manifold will have three, four, or six passages, depending on the type of engine.

These passages blend into a single passage at the other end, which connects to an exhaust pipe. From that point, the flow of exhaust gases continues to the catalytic converter, muffler, and tail pipe, then exits at the rear of the car.

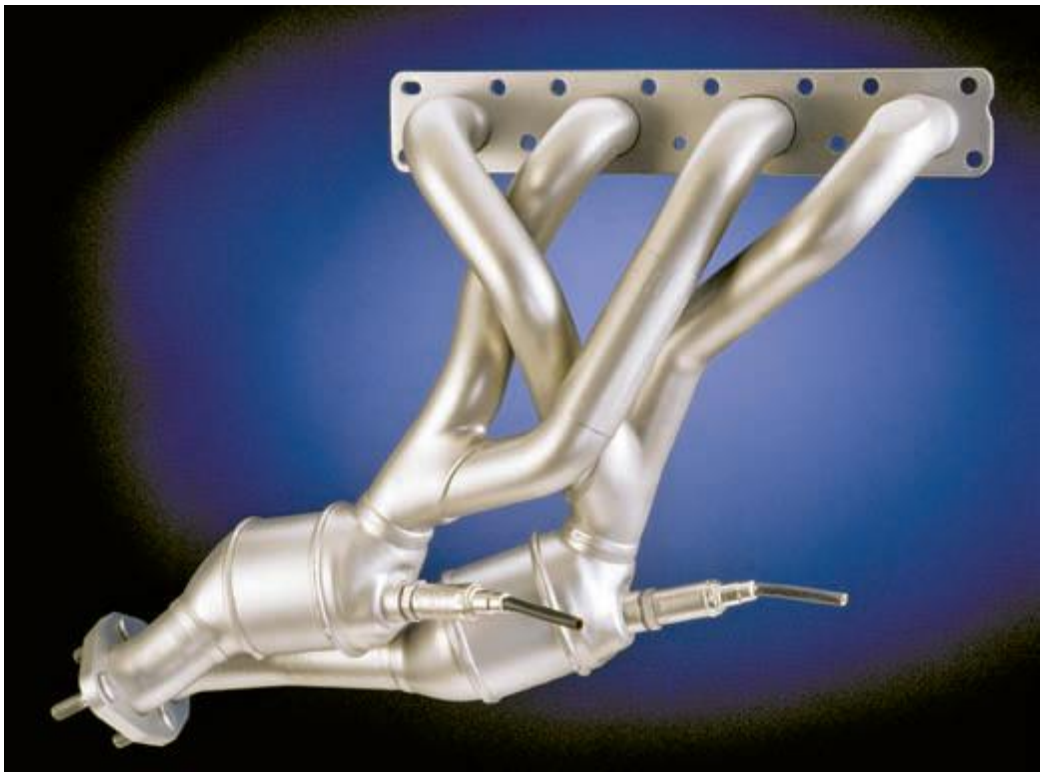


Figure: exhaust manifold has two separate mini- or warm-up catalytic converters.

V-type engines may be equipped with a dual exhaust system that consists of two almost identical, but individual systems in the same vehicle.

The exhaust manifold gasket seals the joint between the head and exhaust manifold. Many new engines are assembled without exhaust manifold gaskets. This is possible because new manifolds are flat and fit tightly against the head without leaks. Exhaust manifolds go through many heating/cooling cycles. This causes stress and some corrosion in the exhaust manifold. Removing the manifold usually distorts the manifold slightly so that it is no longer flat enough to seal without a gasket. Exhaust manifold gaskets are normally used to eliminate leaks when exhaust manifolds are reinstalled.

- **Exhaust pipe and seal**

The exhaust pipe is metal pipe either aluminized steel, stainless steel or zinc-plated heavy gauge
Steel that runs under the vehicle between the exhaust manifold and the catalytic converter

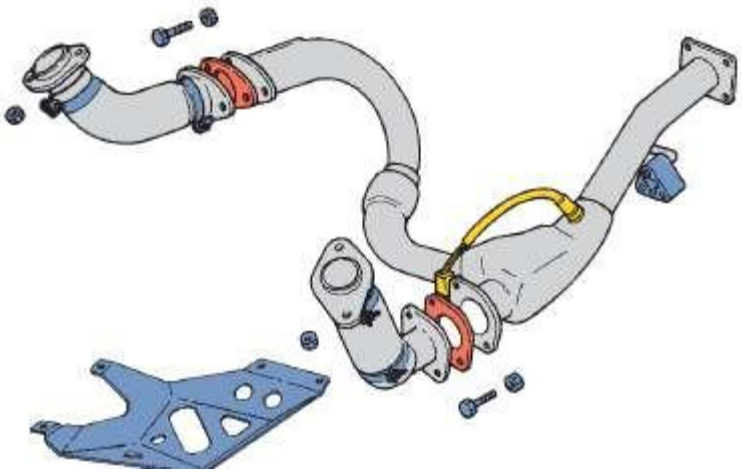


Figure: The front exhaust pipe assembly for a V6 engine.

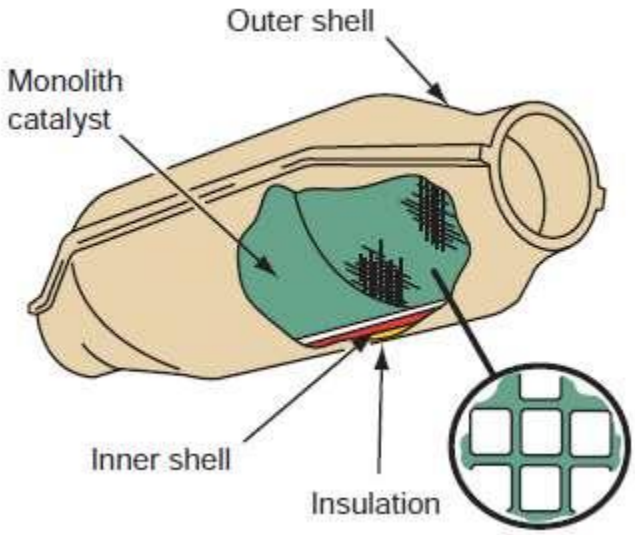
- **Catalytic converter**

A **catalytic converter is** part of the exhaust system and a very important part of the emission control system.

The catalytic converter is located ahead of the muffler in the exhaust system.
The extreme heat in the converter oxidizes the exhaust that flows out of the engine. Because it is part of both systems, it has a role in both.

- As an emission control device, it is responsible for converting undesirable exhaust gases into harmless gases.

- As part of the exhaust system, it helps reduce the noise level of the exhaust



A catalytic converter contains a ceramic element coated with a catalyst.
A catalyst is a substance that causes a chemical reaction in other elements without actually becoming part of the chemical change and without being used up or consumed in the process.

Catalytic converters may be pellet type (used in older systems) or monolithic type. Exhaust gases pass
over this bed of catalyst material. In a monolithic-type converter, the exhaust gases pass through a honeycomb ceramic block.

The converter beads or ceramic block are coated with a thin coating of cerium, platinum, palladium, and/or rhodium and are held in a stainless steel container. These elements are used alone or in combination with each other to change the undesirable emissions into harmless compounds.
Since the late 1980s, vehicles have had a three-way converter (TWC) that treats all three controlled emission gases.

It oxidizes HC and CO by adding oxygen and reduces NOx by removing oxygen from the nitrogen oxides.
The reduction and oxidation catalysts are typically contained in a common housing; however, in some instances, they may be housed separately. A three-way catalytic converter has three simultaneous tasks:

- Reduction of nitrogen oxides to nitrogen (N2): $2\ CO + 2\ NO \rightarrow 2\ CO_2 + N_2$
- hydrocarbon + $NO \rightarrow CO_2 + H_2O + N_2$; $2\ H_2 + 2\ NO \rightarrow 2\ H_2O + N_2$
- Oxidation of carbon monoxide to carbon dioxide: $2\ CO + O_2 \rightarrow 2\ CO_2$
- Oxidation of unburnt hydrocarbons (HC) to carbon dioxide and water, in addition to the above NO reaction hydrocarbon + $O_2 \rightarrow H_2O + CO_2$

These three reactions occur most efficiently when the catalytic converter receives exhaust from an engine running slightly above the stoichiometric point. For gasoline combustion, this ratio is between 14.6 and 14.8 parts air to one part fuel, by weight. The ratio for autogas (or liquefied petroleum gas LPG), natural gas, and ethanol fuels is slightly different for each, requiring modified fuel system settings when using those fuels

- **Muffler**

The **muffler** is a cylindrical or oval-shaped component, generally about 2 feet (0.6 meter) long, mounted in the exhaust system about midway or toward the rear of the-car.

Inside the muffler is a series of baffles, chambers, tubes, and holes to break up, cancel out, or silence the pressure pulsations that occur each time an exhaust valve opens.

Two types of mufflers are frequently used on passenger vehicles

Reverse-flow mufflers change the direction of the exhaust gas flow through the inside of the unit. This is the most common type of automotive muffler.

Straight-through mufflers permit exhaust gases to pass through a single tube. The tube has perforations that tend to break up pressure pulsations. They are not as quiet as the reverse-flow type.

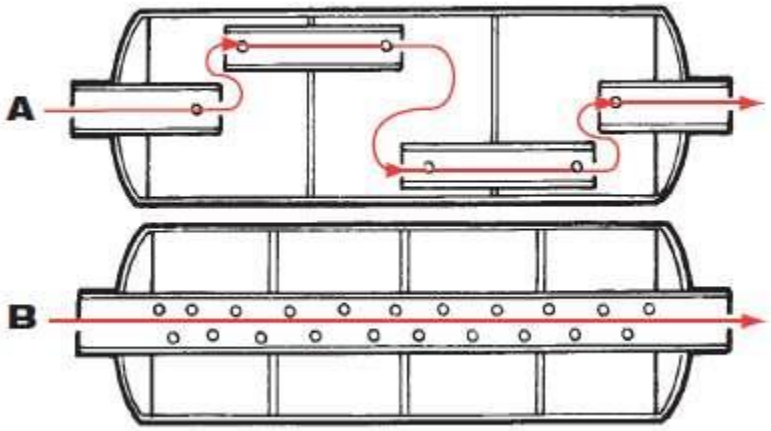


Figure: (A) A reverse-flow muffler; (B) a straight-through muffler.

- **Resonator**

On some older vehicles, there is an additional muffler, known as a **resonator** or silencer. This unit is designed to further reduce or change the sound level of the exhaust. It is located toward the end of the system and generally looks like a smaller, rounder version of a muffler.

- **Tail pipe**

The **tailpipe** is the last pipe in the exhaust system. It releases the exhaust fumes into the atmosphere beyond the back end of the car.

- **Heat Shields**

Heat shields are used to protect other parts from the heat of the exhaust system and the catalytic converter

They are usually made of pressed or perforated sheet metal.

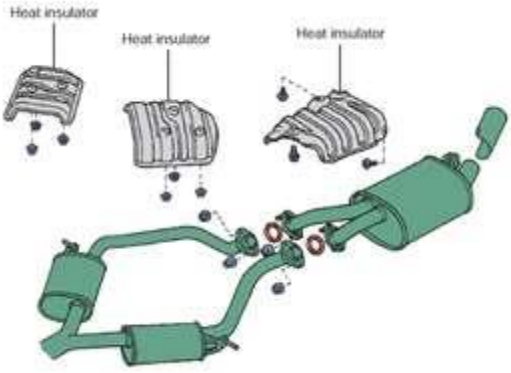


Figure: heat shield

Heat shields on a catalytic converter also prevent the heat from a catalytic converter connected to a misfiring engine from setting grass or other materials on fire while it is parked.

- **Flex Joints**

The exhaust systems on some vehicles have a flex joint somewhere in the front exhaust pipe.

This joint allows the engine to move or roll without moving the exhaust system with it. The joint prevents the exhaust from hitting the vehicle's underbody as well as prevents the pipe from cracking due to the stress put on it.

Figure: exhaust flex joints

- **Clamps, Brackets, and Hangers**

Clamps, brackets, and hangers are used to properly join and support the various parts of the exhaust system.

These parts also help to isolate exhaust noise by preventing its transfer through the frame or body to the passenger compartment.

Clamps help to secure exhaust system parts to one another. The pipes are formed in such a way that one slips inside the other. This design makes a close fit. A U-type clamp usually holds this connection tight
Another important job of clamps and brackets is to hold pipes to the bottom of the vehicle.

Clamps and brackets must be designed to allow the exhaust system to vibrate without transferring the vibrations through the car.

Figure: clamps and brackets

There are many different types of **flexible hangers** available, each designed for a particular application.
Some exhaust systems are supported by doughnut shaped rubber rings between hooks on the exhaust Component and on the frame or car body

L.U.2- CHECK EXHAUST SYSTEM

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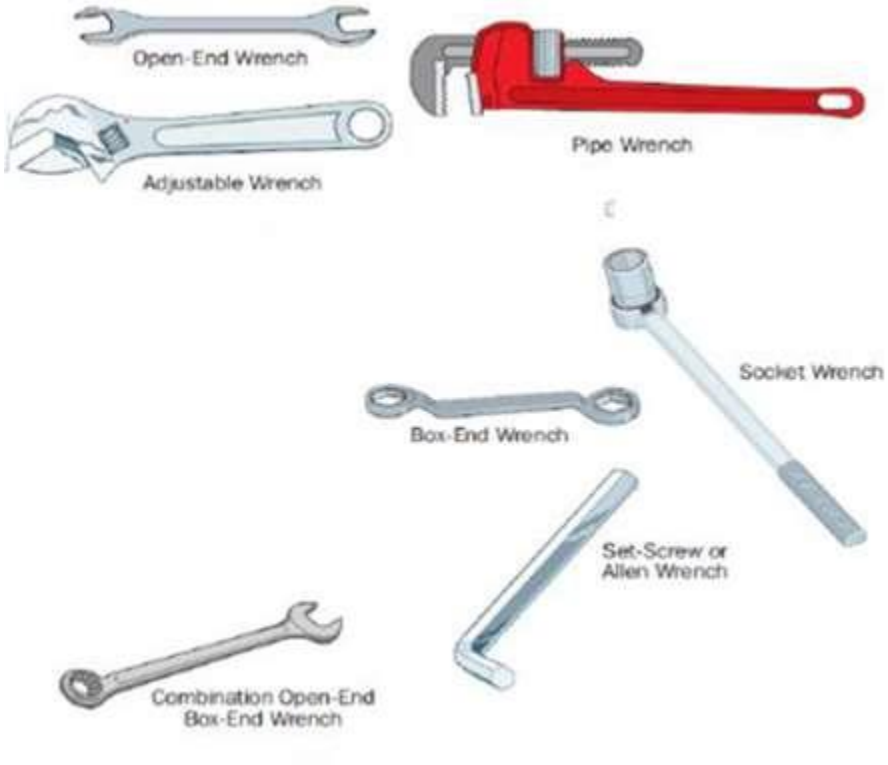

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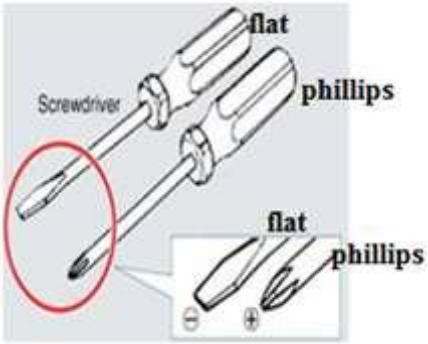

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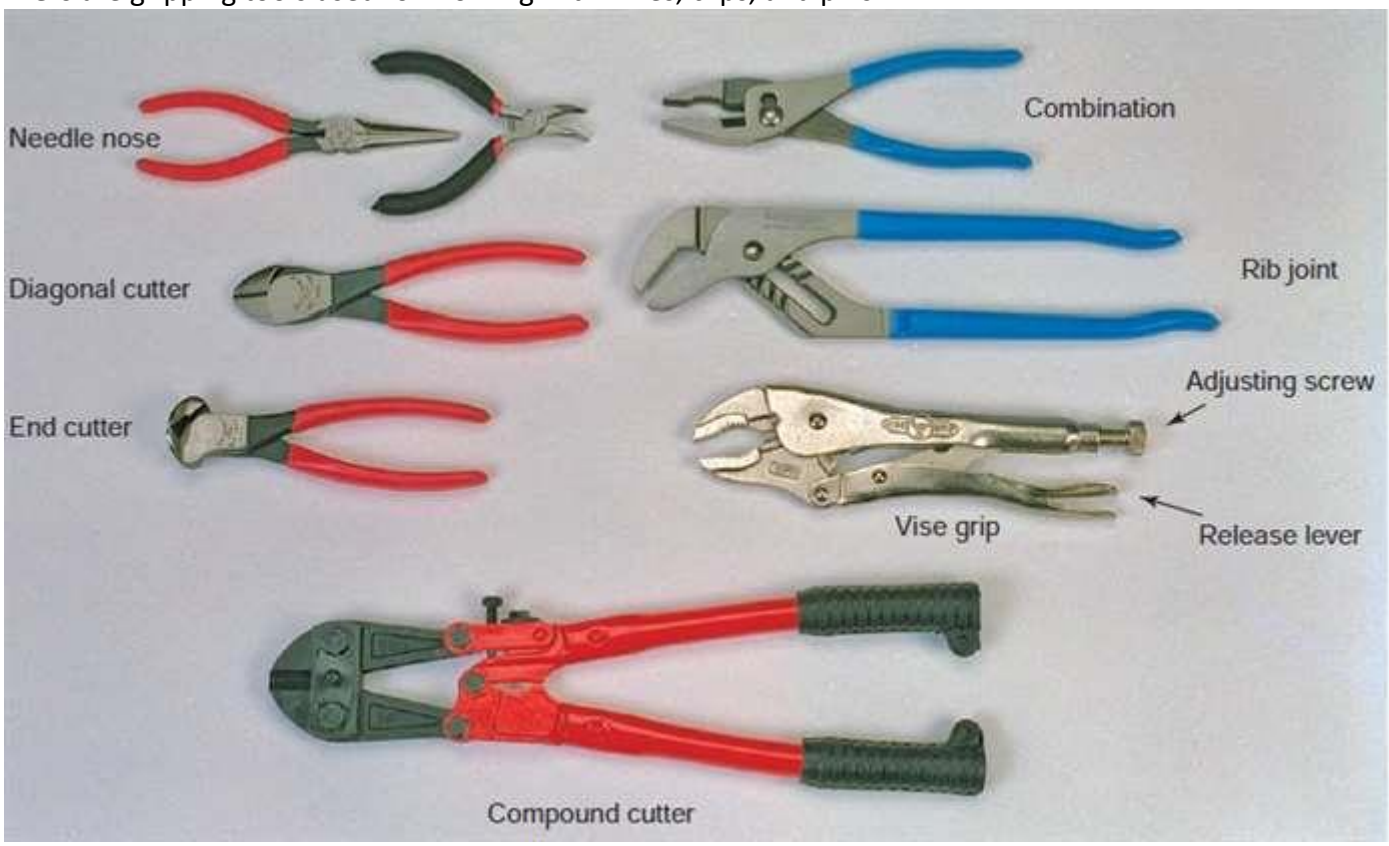

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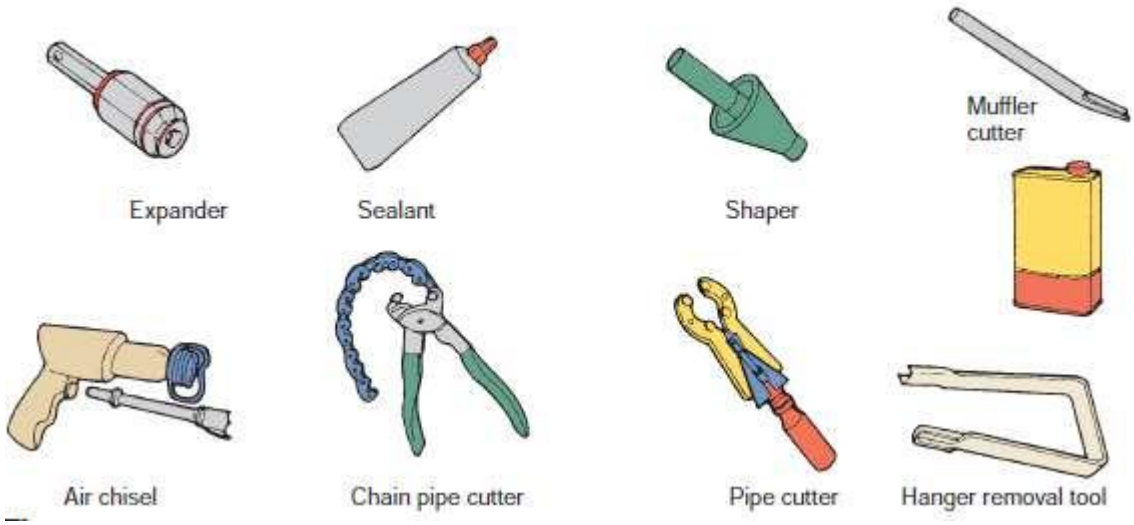

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Figure: exhaust gas analyzer

L O2.2- Check exhaust system leakage

- **Content/ topic 1- Check exhaust leakage**

Exhaust Leaks Exhaust leaks are often identified by sound, although very small leaks can be difficult to locate. One of the most effective ways to identify the source of a leak in the system is the use of a smoke machine. When smoke is introduced to the exhaust system, a trace of smoke will identify the source of the leak

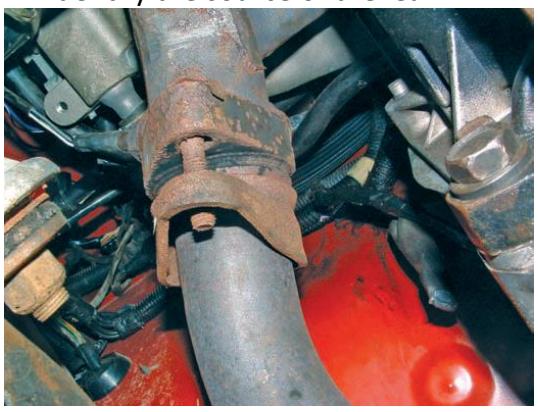


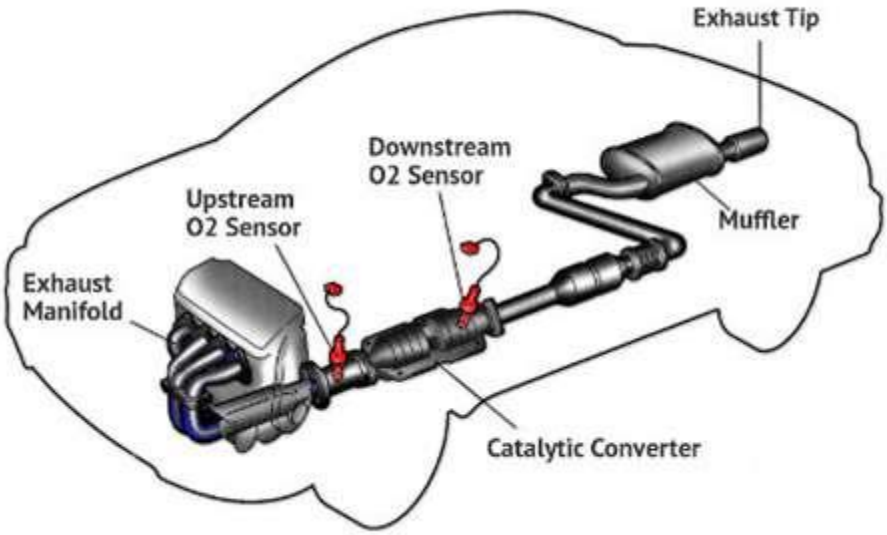
Figure: checking leakage

Leaking gaskets and seals are often found between the exhaust manifold and pipe

- Content/ topic 2- Check Lambda closed loop control

A good O2 sensor should produce an oscillating waveform at idle that makes voltage transitions from near minimum (0.1 v) to near maximum (0.9v). Making the fuel mixture artificially rich by feeding propane into the intake manifold should cause the sensor to respond almost immediately (within 100 milliseconds) and go to maximum (0.9v) output. Creating a lean

mixture by opening a vacuum line should cause the sensor's output to drop to its minimum (0.1v) value. If the sensor doesn't flip-flop back and forth quickly enough, it may indicate a need for replacement.



Step of checking an oxygen sensor

1 *Locate the oxygen sensor in a wiring diagram for the vehicle and identify what part of the sensor each wire is connected to.*

2 *Connect the positive lead of the meter to the power wire for the sensor's heater. Connect the meter's negative lead to a good ground.*

3 *Place the meter where you can see it from the driver's seat.*

4 *Start the engine and observe the voltage reading as the engine initially starts.*

5 *Turn off the engine and move the positive meter lead to the sensor's signal wire. Keep the negative lead grounded.*

6 *Restart the engine and allow it to reach normal operating temperature. Look at the meter to make sure the sensor's signal is toggling from low to high voltage.*

7 *Press the Min/Max button on the meter and observe the voltage. This reading will be the minimum voltage and should be about 0.1 volt.*

8 *Press the Min/Max button again to observe the maximum voltage reading. This should be about 0.9 volt.*

9 *Press the Min/Max button again to read the average voltage. This reading should be about 0.45 volt. Repeat this test at different speeds to get a good look at how well the O_2 sensor responds.*

Figure: photo sequence of testing an oxygen sensor

- **Content/ topic 3 Check exhaust gas color**

- **Excessive exhaust smoke**

Excessive smoke is due to incomplete combustion, normally caused by faulty injection system or other engine troubles. A small amount of exhaust smoke is normal during initial start-up or rapid acceleration. Abnormal Exhaust smoke may be black, white or blue. Each type of smoke indicates engine problems and these are discussed below:

- **Black smoke**

Excessive black smoke is caused by a rich air-fuel mixture. This may result from problems with the injection pump or infection timing, which may in turn be clue to a choked air cleaner, worn fuel injectors, adulterated diesel fuel or the engine itself.

Black exhaust smoke is an indication of a rich fuel condition. These are possible causes:

- Fuel Injectors: A leaking or dripping fuel injector will cause a rich fuel condition.
- Fuel Pressure Regulator: A stuck closed fuel pressure regulator will cause a rich fuel condition.
- Fuel Return: A restricted fuel return line will cause a rich fuel condition

- **White smoke**

White smoke occurs mainly during cold starts, when the fuel tends to condense into liquid and does not burn due to cold engine parts. The most common reason for white smoke are in-operative glow plugs low engine compression, a bad injector spray pattern, late injection timing or injection pump problems.

White exhaust smoke is an indication that coolant is burning in the combustion chamber. These are possible causes:

- Cylinder head: A crack in the cylinder head (around the coolant jacket) will cause coolant to enter the combustion chamber.
- Engine block: A crack in the deck of an engine block near the coolant jacket will cause coolant to enter the combustion chamber.
- Head gasket: A damaged or blown head gasket will cause coolant to enter the combustion chamber resulting in white/gray smoke coming from the tailpipe.

- **Blue smoke**

Excessive blue smoke indicates problems from low engine compression and/or worn piston rings, scored cylinder walls or leaking valve stem seals. The blue smoke is caused by crankcase oil entering the combustion chamber and being emitted after partial combustion through the exhaust.

Blue/gray exhaust smoke is an indication of oil burning in the combustion chamber. These are possible symptoms and causes:

- Valve seals: Leaking valve seals will cause blue/gray exhaust smoke.
- Valve guides: Excessive clearance between the valve stem and the valve guide allows oil to leak past the gap into the cylinder.
- Piston rings: Worn or damaged piston rings will cause blow-by, resulting in blue/gray smoke.
- Worn cylinder walls: Worn cylinder walls cause blow-by, resulting in blue/gray smoke.

- **Content/ topic 4 Check exhaust gas composition:**

The compositions of engine exhaust gas
The toxic gases emitted by the car engine are:

- **Carbon dioxide**

The level of CO2 is a product of combustion and represents the amount of fully burned fuel. Therefore, a higher CO2 level indicates a higher engine efficiency. Many fuel injection engines will show approximately 15% CO2.

- **Carbon monoxide**

Partially burned fuel results in CO. High CO levels indicate a 'rich' fuel mixture. A perfect fuel mixture meters in exactly enough fuel to consume all of the O2 entering the engine. A perfect ratio is not sustainable in real-life operation. A fuel mixture that contains excess fuel is usually referred to as a 'rich' condition. A 'lean' condition refers to an excess of O2.

- **Nitric oxide and nitrogen dioxide NOx**

NO_x generally refers to NO and NO_2 (nitric oxide and nitrogen dioxide). This measurement is in ppm and represents the combustion products of burning nitrogen. This occurs at the higher engine temperatures associated with a lean fuel mixture or being under load. Of the NOx output of a typical engine, the NO component will usually make up the highest proportion. Diesel engines are generally associated with higher NO_x and particulate emissions.

LO 2.3: Check exhausts components.

- Content/ topic 1 Check exhaust components

Exhaust manifold

- Test the car shortly after starting it. You may be able to hear and feel the leak more easily while it is still cold

- Listen to the car. Most exhaust manifold cracks or leaks will cause a ticking noise, especially when your car is running cold. There may even be a noticeable vibration that goes along with the noise

- Use a stethoscope to listen to the manifold closely. You should be able to determine the location of the leak if there is one. If you don't have a stethoscope, use a hose or tube to localize sound

- Check your manifold physically. If you can get it out of your car and manually inspect the part, you may be able to determine warping or cracking. Since this requires removing parts from your engine

- Look for damage around the exhaust ports. Discoloration or burnt paint often signifies a leak

Catalytic converter

One of the first things an experienced mechanic will do to trace a clogged converter is they will temporarily remove the oxygen sensor or unbolt the exhaust downpipe. If engine performance improves with the sensor removed, chances are high that the catalytic converter is the component that’s causing the problem

Silencer/ muffler

Dents on the muffler or the connections can cause issues with airflow. The muffler tends to be more susceptible to rust damage as moisture can build up inside. Surface rust is normal, but if it penetrates through the metal, be sure there is more rust on the inside.

L.U.3- DISMANTLE EXHAUST SYSTEM

L O 3.1- Select tools and equipment

- Content/ topic 1Selection of tools used on exhaust system:

- **Wrenches/ spanners:**

A wrench is a tool for twisting and/or holding bolt heads or nuts

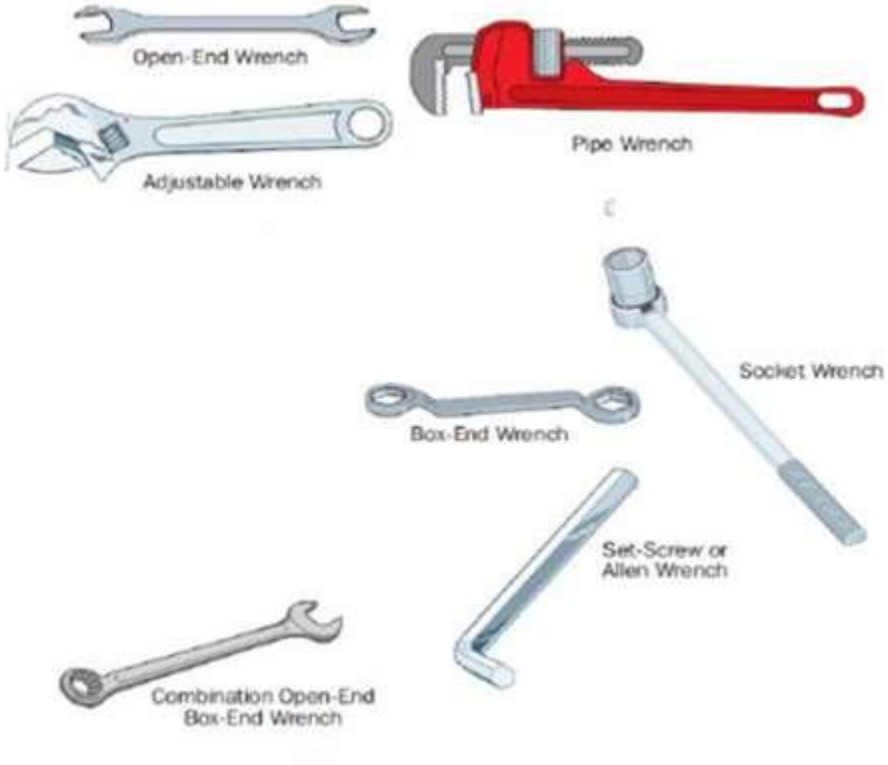


Figure: wrenches

- **Screwdrivers**

A screwdriver drives a variety of threaded fasteners used in the automotive industry

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Phillips Screwdriver: The tip of a **Phillips screwdriver** has four prongs that fit the four slots in a Phillips head screw

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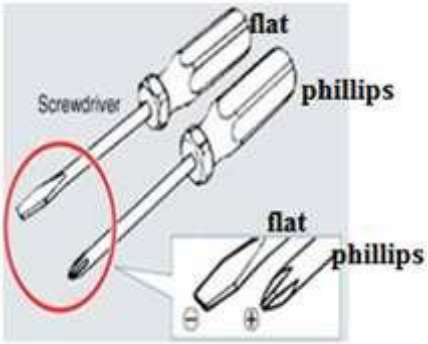
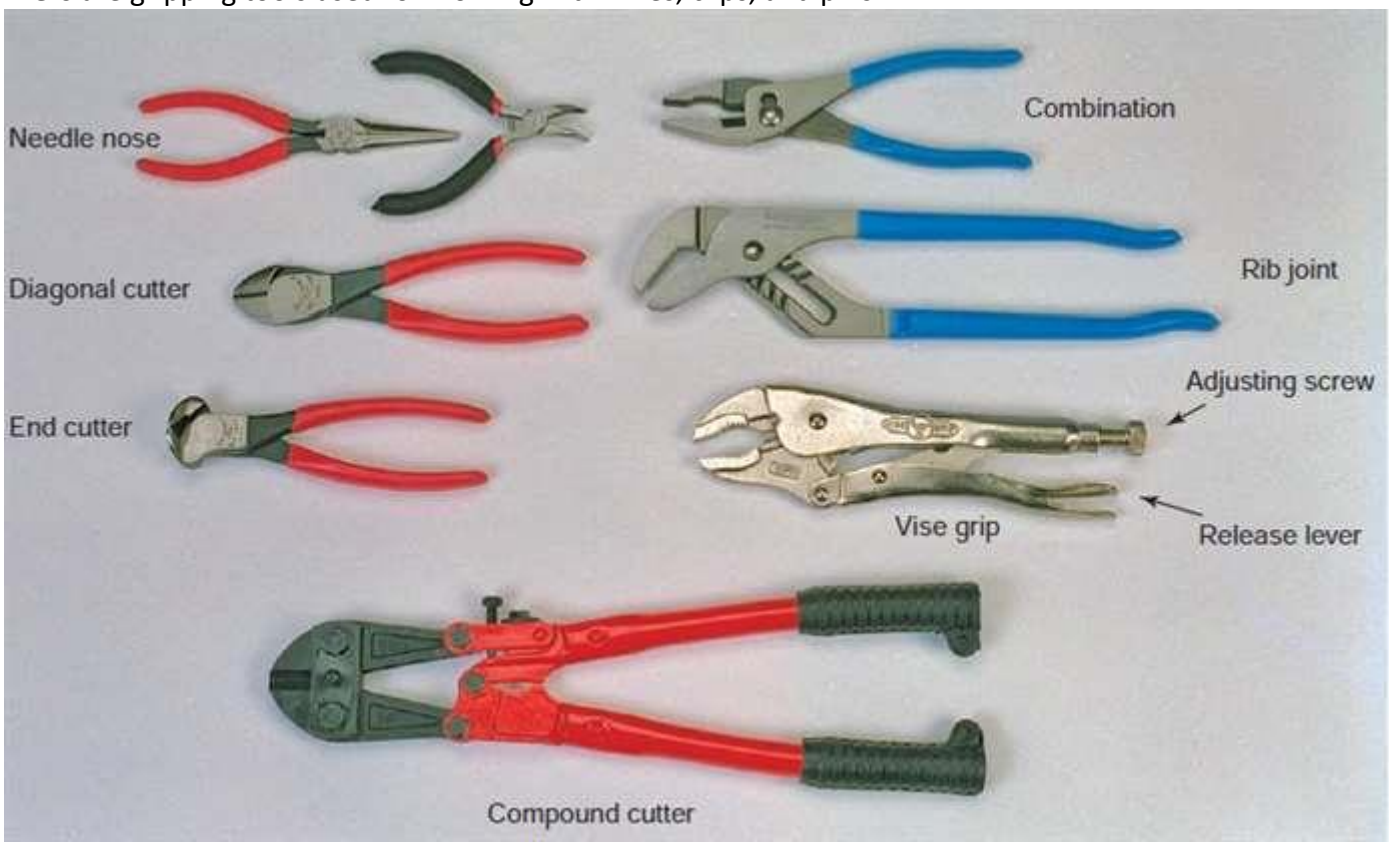


- **Pliers**

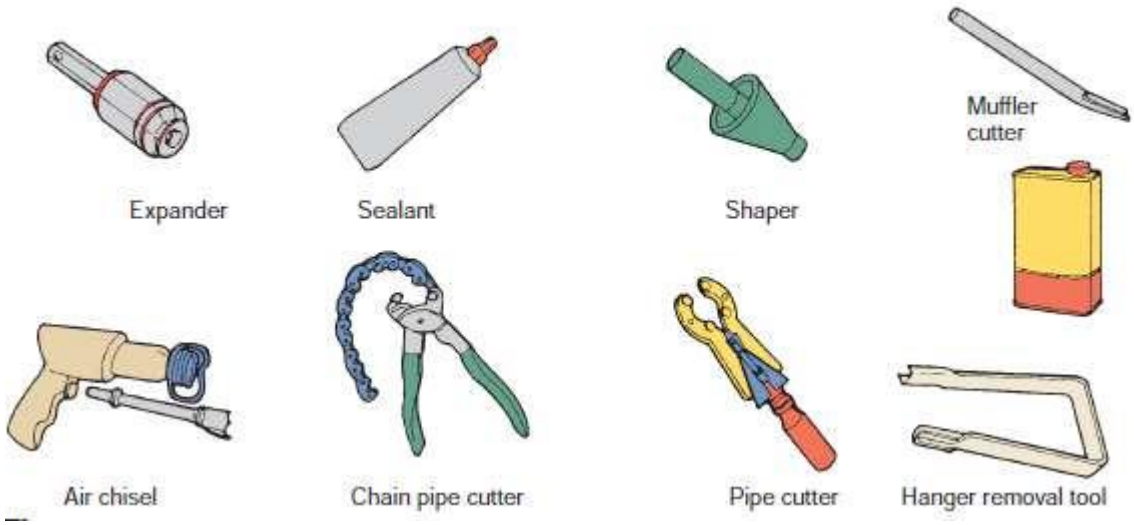
Pliers are gripping tools used for working with wires, clips, and pins.



- **Hammers**

Hammers are identified by the material and weight of the head. There are two groups of hammer heads:
steel and soft faced

- **Special tool required for exhaust system work**



- **Repair manual** and **books**

Factory service manuals (FSM) are the manuals provided by manufacturers which cover the servicing, maintenance, and repair of their products. They were not originally offered to the public as they were developed for the dealerships so that their mechanics were able to fix their own products

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- Content/ topic 2 Selection of materials used on exhaust system:

- **Penetrating oil**

Before attempting to disassemble the exhaust system, spray all nuts and bolts with penetrating oil

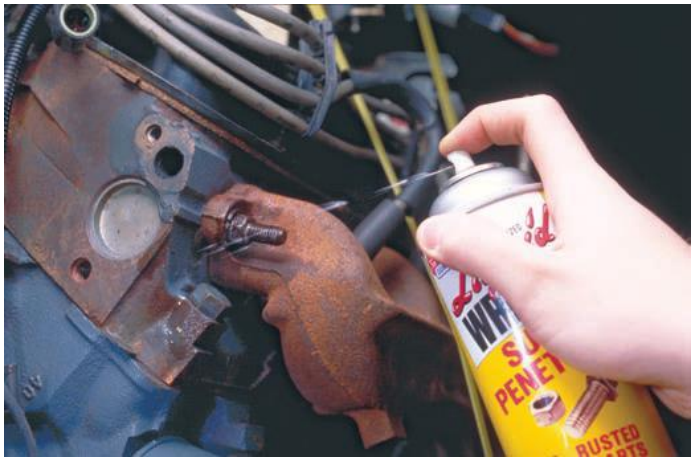

Figure: spaying penetrating oil

- **Exhaust gaskets**

An **exhaust manifold gasket** seals the connection between the **manifold** and cylinder head. This prevents **exhaust** leakage out of the connection and also ensures that all **exhaust** gas will flow through the catalytic converter for treatment

Figure: exhaust gaskets

- **Overall**

The first function of **overalls** is to protect. However, they don't protect only the body of the wearer. **Overalls** can be used to protect the clothing, as well. If your employees work with food, for example, their **overalls** can be used to protect their everyday **wear** from spatters and spill

Figure: coverall/ overall

- **Gloves**

Gloves are personal protective equipment (PPE) that protect the hands from the hazards. These **gloves** allow digit articulation while protecting the operator from electrical shock, extreme heat, and ultraviolet and infrared radiation, and also provide abrasion resistance and enhanced grip

Figure: gloves

- **Safety boots**

Safety boots are **shoes** made with a protective reinforcement at the front making them quite durable. The reinforcement helps to protect the toes from falling objects or any kind of compression. They are normally installed with a sole plate in the main sole to prevent against punctures that may come from below

Figure: safety shoes

- Content/ topic 3 Selection of equipment used on exhaust system:

- **Car lifter / hoist**

Car Hoist, as the name indicates that it is a type of instrument related to or used in vehicles. The purpose of Car Hoist is to lift up a car into the air when someone wants to work on it or examine something on it that is placed beneath the ca

Figure: car lift/ hoist

- **Jack stands**

Jack stands are tripod- or tower-shaped tools designed to support a vehicle's weight when suspended. They are positioned under the vehicle axle or frame to provide additional support for the elevated vehicle. The **jack stands** are positioned after you **jack** the vehicle up
These stands can be used on hard and level surfaces and for cars that are within the weight capacity of the stands


Figure: jack and jack stand

- **Multimeter**

A **multimeter** or a **multitester**, also known as a **VOM** (**volt-ohm-milliammeter**), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. **Analog multimeters** use a microammeter with a moving pointer to display readings. **Digital multimeters** (**DMM**, **DVOM**) have a numeric display, and may also show a graphical bar representing the measured value. Digital multimeters have rendered analog multimeters obsolete, because they are now lower cost, higher precision, and more physically robust


Figure: multimeter

- **Exhaust gas aspirator**

They allow to suck the **exhaust gases** directly to the source, unrolling the hose and attaching the nozzle to the **exhaust** pipe, thus avoiding that these **gases** are dispersed in the environment and come into contact with the respiratory tract of the operators

- **Handscaner**

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

Figure: hand scanner tool

- **Exhaust gas-analyser**

Concentrations of combustion products in the vehicle's exhaust, most of which pollute the air, give important diagnostic clues to the vehicle's engine efficiency. The component gases which contribute the most to air pollution are hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx).

Three of the five gases measured at the tailpipe are regulated pollutants - HC, CO and NOx. The remaining gases, oxygen (O_2) And carbon dioxide (CO_2), while non-regulated, play a significant role as diagnostic aids. Omitec's four gas analyzer measures HC, CO, CO_2 and O_2 concentrations. The five gas analyzer adds the measurement of NOx as well.

Figure: exhaust gas analyzer

L O 3.2: Position vehicle

- Content/ topic 1 Put the vehicle on car lifter

Place the vehicle properly on lift using the following procedure:

- Put the transmission in neutral position, turn off ignition, close all car doors, and check for overhead obstructions such as radio aerials.
- Place adaptors or pads in the proper position under the recommended contact points.
- Check that the automatic chock devices on drive-on or runway lifts are in position before raising a vehicle. Ensure that permanent blocks are sufficient to stop a vehicle. As the lift is raised, watch the automatic chocks at the drive-on end of the lift runners to make sure they operate properly.

- Content/ topic2 Lift up the car

- Raise the lift until the vehicle's wheels are just off the floor (about 30 cm or 1 ft).
- Check again to ensure that contact pads and any adaptors are set accurately and that loads are not being placed on parts of the vehicle which might be damaged.
- Lower the vehicle and reposition the vehicle on the lift before continuing further if the contact with the vehicle is not even or if it looks as if the vehicle may slip.
- Do not bang or move the lift quickly at the top. Raise it slowly for the last 45 cm (about 1.5 feet). Banging the lift will stretch the seal bolts and allow oil to leak.
- Lock the lift with the mechanical locking device or use appropriate jack stands.

Be aware of conditions that could cause the vehicle's centre of gravity to shift and cause the vehicle to fall. For example, before lifting a vehicle, remove a load or cargo if it can shift unexpectedly, or follow the manufacturer's recommendations for removing heavy components

like engines, axles, or universals. In addition, the removal or installation of parts may cause the centre of gravity to shift and the vehicle to become unstable

- Content/ topic3 Support the vehicle with jack stands.

Jack up the vehicle using a solid jacking point, leaving enough room for the jack stand to support the car. If lifting just one wheel, lifting just that corner of the vehicle is a good idea. If lifting the entire front or rear, choose a jack point in the center of the front or rear suspension or frame.

LO 3.3-Dismantle exhaust system

- **Content/ topic 1- remove the exhaust system**

Step 1: prepare the workplace

Park on a flat surface: Ensure the vehicle is located on a flat surface and turned off
Before beginning work on an exhaust system, make sure it is cool to the touch. Some technicians disconnect the battery's negative cable before starting to work to avoid short-circuiting the electrical system.

Soak all rusted bolts, nuts, and other removable parts with good penetrating oil.

Step 2: position the vehicle

Raise the car. Safely raise the vehicle off the ground with the floor jack and safety jack stands. Position all four jack points under the vehicle.

Figure: Vehicle on jack stand

Step3: remove the manifold

- Remove the accessories (EGR, turbocharger, Lambda sensor, Heat shelds)
- Unscrew the exhaust manifold boltS
- Remove the exhaust manifold gasket
- Remove the exhaust manifold mountings from chassis
- Remove the exhaust manifold system

Step 4: remove the muffler

- Remove the muffler. Begin at the rear of the vehicle and remove the muffler

- There should be two bolts to remove from the muffler. Once the hardware is removed, slide the muffler off the rubber hangers and remove it from the car completely.
- set it aside. If your vehicle is equipped with two mufflers, you will repeat the process for the second muffler.

Step 5: remove the catalytic

Detach from the catalytic converter. Remove the bolted, middle part of the exhaust from the catalytic converter.

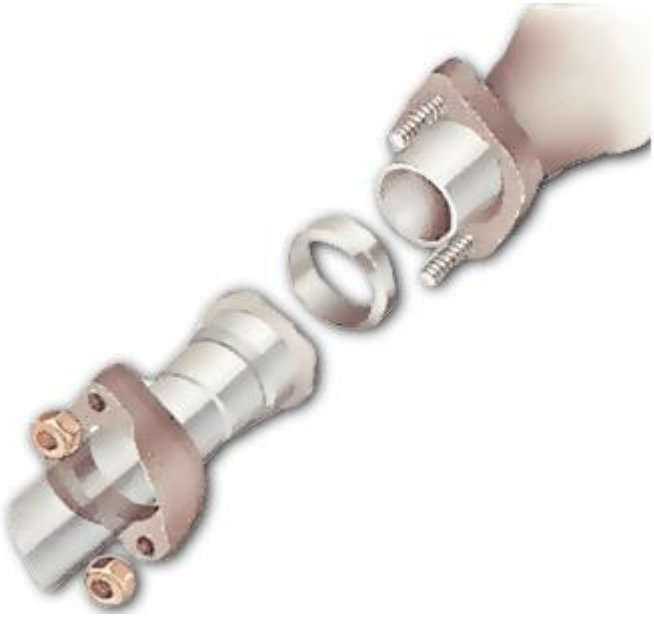

Figure: Detach from the catalytic converter.

The flange (external lip) connected to the catalytic converter end may have two or three bolts that are attached and will need to be removed. Once the hardware is removed, slide the piping off the rubber hangers and set it aside.

Step 6: detach the rubber hanger

Remove the rubber hangers. Remove the old rubber hangers from the vehicle and replace them with the new ones.

Figure: Remove all the rubber hangers

Step 7: Put down the exhaust system

L.U.4- REPAIR EXHAUST SYSTEM

LO4.1- Select tools and equipment

- Content/ topic 1Selection of tools used on exhaust system:

- **Wrenches/ spanners:**

A wrench is a tool for twisting and/or holding bolt heads or nuts

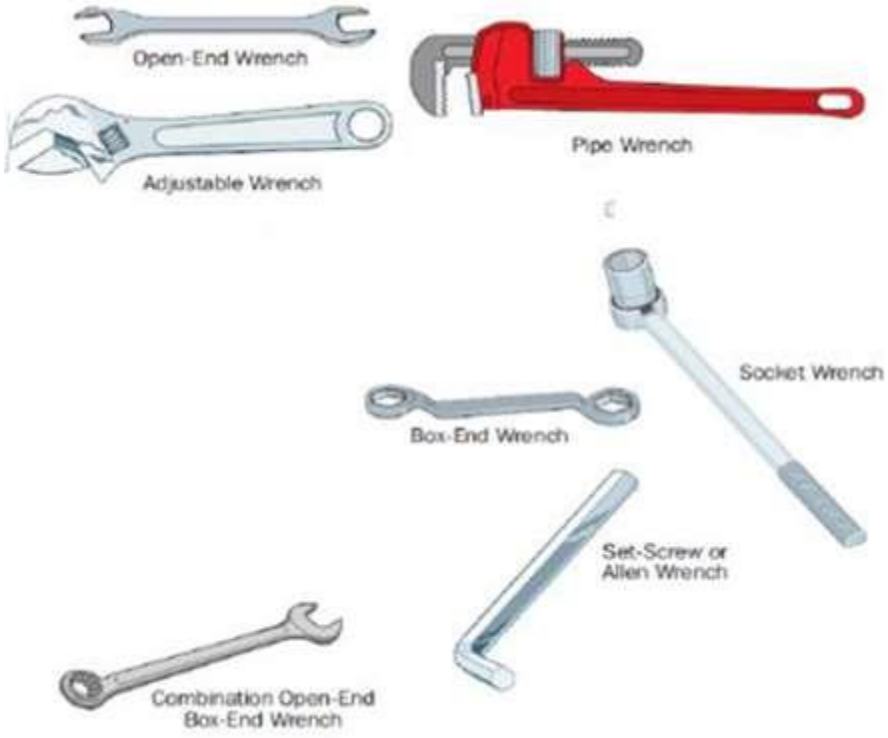

Figure: different type of spanners

- **Screwdrivers**

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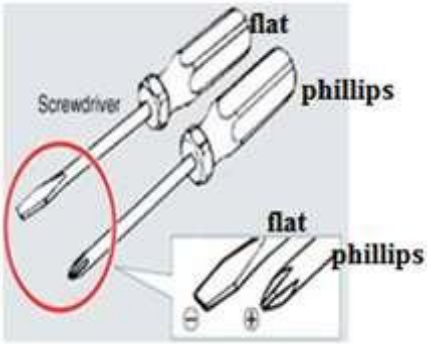

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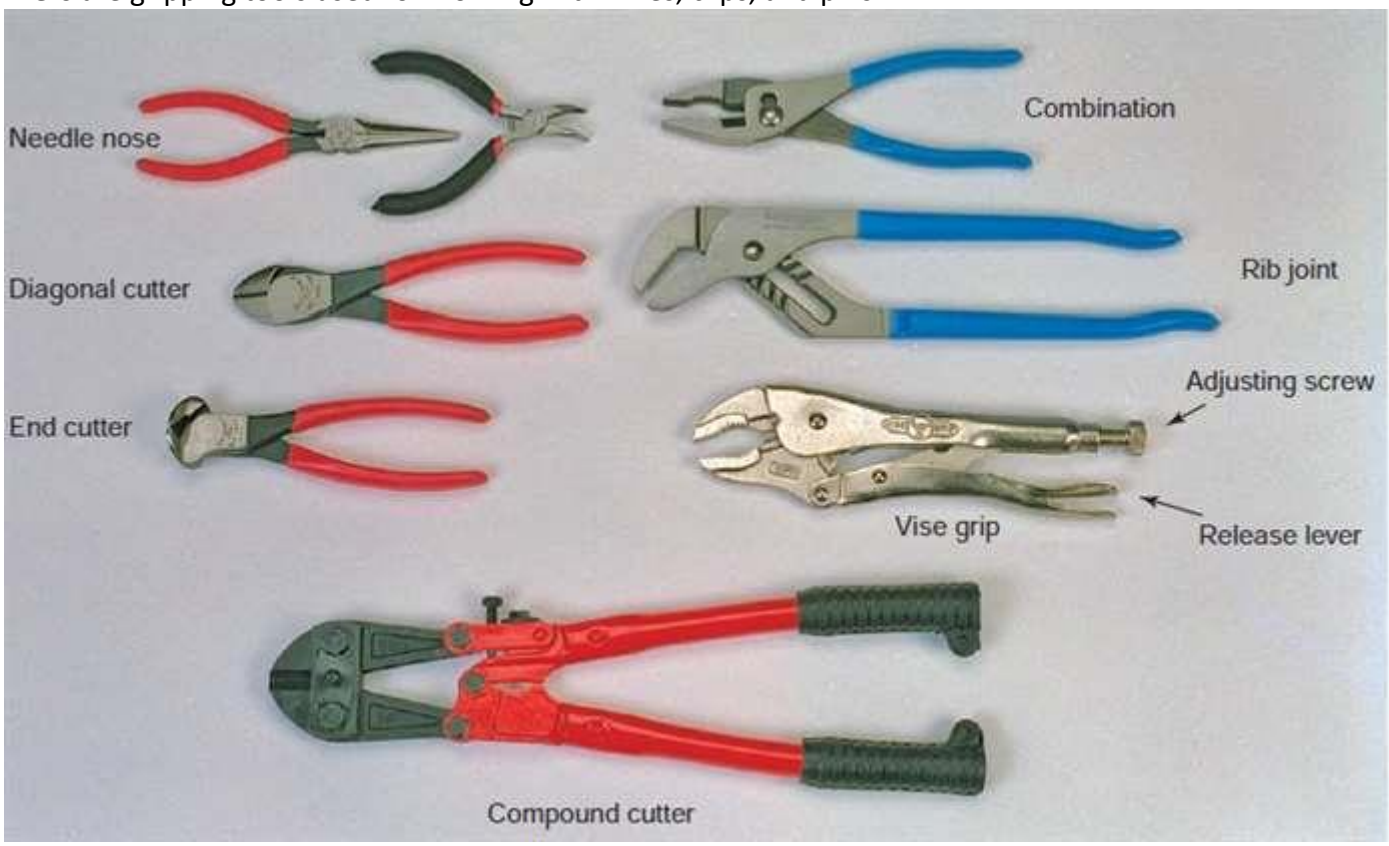

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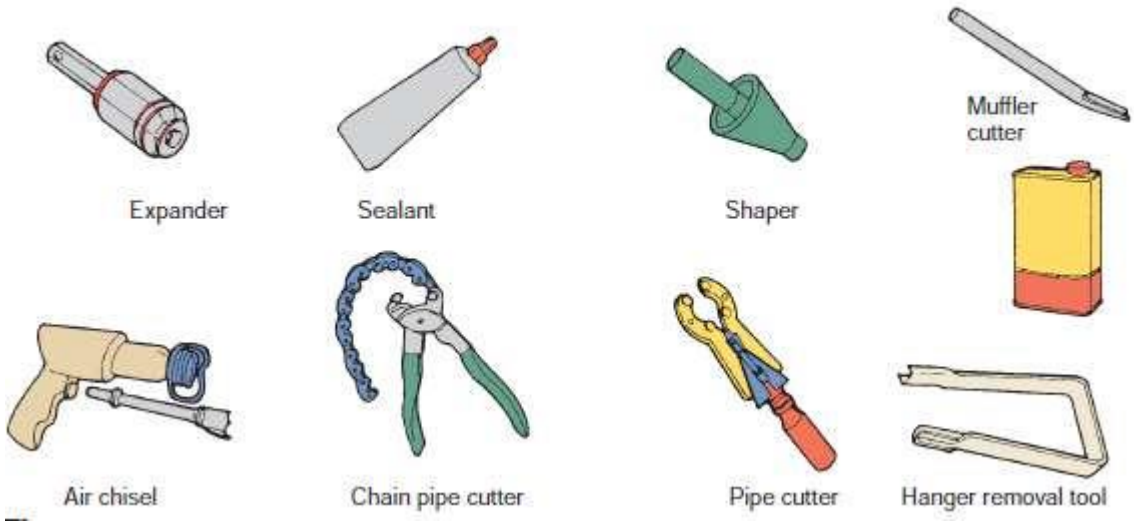

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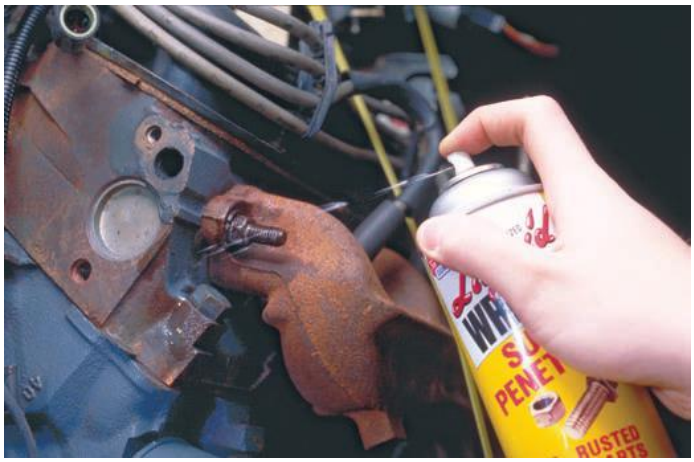

Figure: spraying penetrating oil

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Figure: Exhaust gaskets

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Figure: multimeters

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L O 4.3- Replace damaged parts

- Content/ topic1 Replace exhaust manifold gasket

Exhaust Manifold Servicing As mentioned, the manifold itself rarely causes any problems. On occasion, an exhaust manifold will warp because of excess heat. A straightedge and feeler gauge can be used to check the machined surface of the manifold. Another problem also the result of high temperatures generated by the engine—is a cracked manifold.
This usually occurs after the car passes through a large puddle and cold water splashes on the manifold's hot surface. If the manifold is warped beyond manufacturer's specifications or is cracked, it must be replaced.

Step 1: Let Engine Cool Off
Before you do anything to the exhaust manifold, let your engine cool down

Step 2: Remove Manifold Bolts
Spray down the manifold bolts with some penetrating oil. Because they are subjected to high heat, they will essentially weld themselves to the manifold. The oil will help you break that bond with your wrench. Use socket wrench, with an extension if you have it, to take off the bolts. Be careful not to break off the bolts as you remove them

Step 3: Scrape Old Gasket Off
The old gasket will be sealed onto the metal parts of the manifold and the cover itself. A small putty knife will help to scrape off the old gasket. Make sure you get all of it as anything left behind will cause the manifold to leak

Step 4: Set New Gasket
Place the new gasket in place on the manifold and replace the cover. Use a set of new bolts to tighten the manifold cover down. A torque wrench will keep you from overtightening the bolts and causing it to warp or crack

- Content/ topic2 Adjust exhaust pipe shape

Exhaust Restriction Test Often leaks and rattles are the only things looked for in an exhaust system.
The exhaust system should also be tested for blockage and restrictions. Collapsed pipes or clogged converters and/or mufflers can cause these blockages.

There are many ways to check for a restricted exhaust. The sound of the exhaust can indicate a restriction. With a restriction, the exhaust will wheeze as it struggles to exit the exhaust system

- Content/ topic3 Replace leaking gasket and Seal

The most likely spot to find leaking gaskets and seals is between the exhaust manifold and the exhaust pipe. To replace an exhaust manifold gasket, follow the torque sequence in reverse to loosen each bolt. Repeat the process to remove the bolts. Doing this minimizes the chance that components will warp.

Replace exhaust flange gasket procedures

Step 1 - Locate the Bolts. Jack up your car, secure with jack-stands, and roll under it.

Step 2 - Loosen the Bolts. Once you have located the bolts, you will need to loosen all of them.

Step 3 - Loosen the Exhaust Flange Gasket.

Step 4 - Remove the Exhaust Flange Gasket.

Place the gasket between the flanges. On most flange connections, there's a small piece of pipe protruding on the inside of the flange to place the gasket on, depending on the type of application. Some front pipe gaskets are called "donut" gaskets and fit into a ball-flared exhaust pipe.

L O4.4- Clean exhaust components

- Content/ topic1 Cleaning of exhaust components:

- **Exhaust manifold**

Using a lacquer thinner, soak the interior of the manifold. Using steel wool and a wire brush, **scrub** the manifold exterior, paying special attention to coated spots. Wipe the entire manifold with the lacquer, let it sit for a while. After the manifold has been cleaned, you simply need to reattach it to the engine

- **Lambda sensor**

A faulty oxygen sensor leads to engine to stutter and consequently fuel consumption to increase. This information is misleading as oxygen sensors are designed for replacement, not cleaning. No car manufacturer supports cleaning.

- **Catalytic converter**

1. **Get Oxicat Catalytic converter cleaner**

The product that you can use is the OXICAT – Oxygen Sensor & Catalytic Converter Cleaner. You tap it into your fuel tank, and it does not matter if you have a petrol, diesel or hybrid car

2. **Pour the Catalytic converter cleaner into the fuel tank.**

Tap this into the tank with the required amount from the manual. Make sure that you are using the required amount for your car type and engine so you are not using too much of the product this can cause even more damages to your catalytic converter

3**. Take your car for a drive**

Drive your car a couple of miles to see if your car runs better than before. You can also try to drive your car at high RPM's over 3000 for a long distance to get the catalytic converter really hot to burn out the clog inside it. Remember to check that there is no oil or other fluids in your catalytic converter that could ignite it

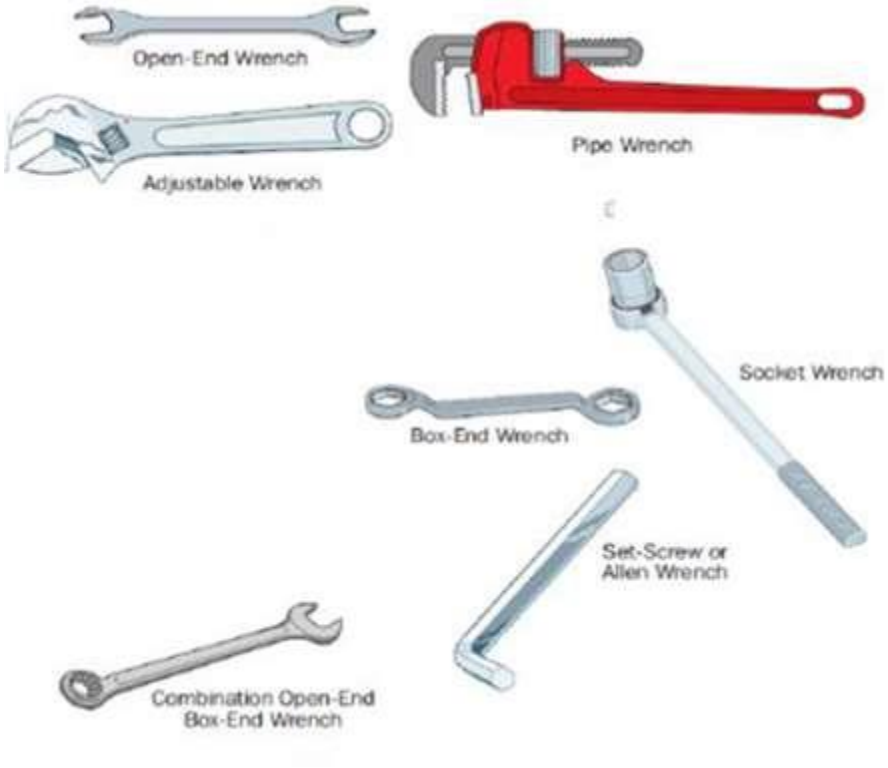
LU5- MOUNTS EXHAUST SYSTEM

L O 5.1- Select tools and equipment

- Content/ topic 1Selection of tools used on exhaust system:

- **Wrenches/ spanners:**

A wrench is a tool for twisting and/or holding bolt heads or nuts



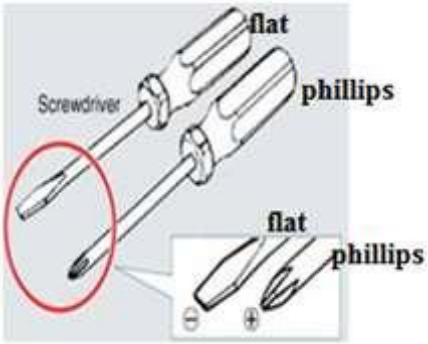
- **Screwdrivers**

A screwdriver drives a variety of threaded fasteners used in the automotive industry

Standard Tip Screwdriver: A slotted screw accepts a screwdriver with a standard or blade-type tip

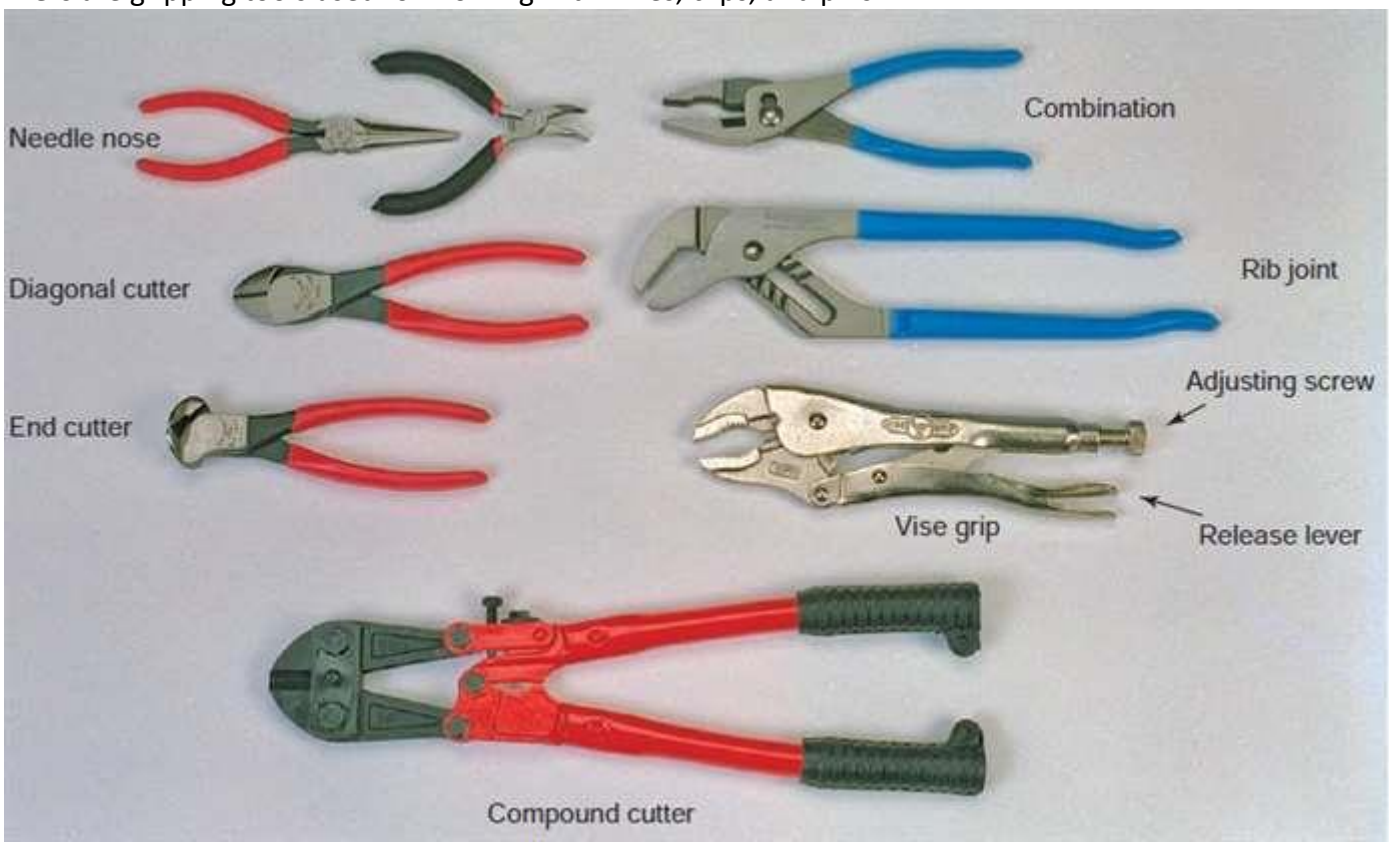
Phillips Screwdriver: The tip of a **Phillips screwdriver** has four prongs that fit the four slots in a Phillips head screw

Pozidriv® Screwdriver: The **Pozidriv screwdriver** is like a Phillips but its tip is flatter and blunter.



- **Pliers**

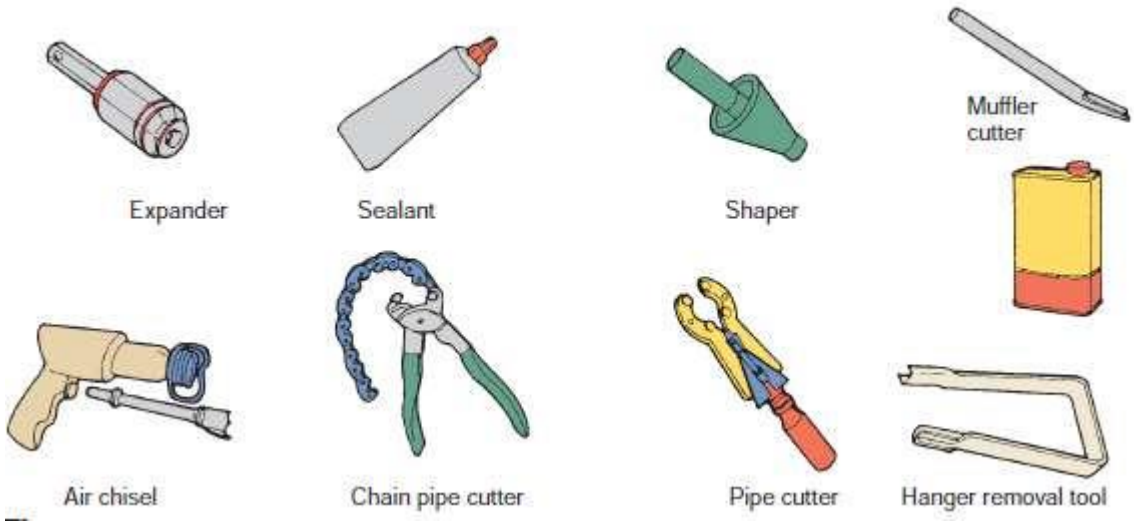
Pliers are gripping tools used for working with wires, clips, and pins.



- **Hammers**

Hammers are identified by the material and weight of the head. There are two groups of hammer heads:
steel and soft faced

- **Special tool required for exhaust system work**



- **Repair manual** and **books**

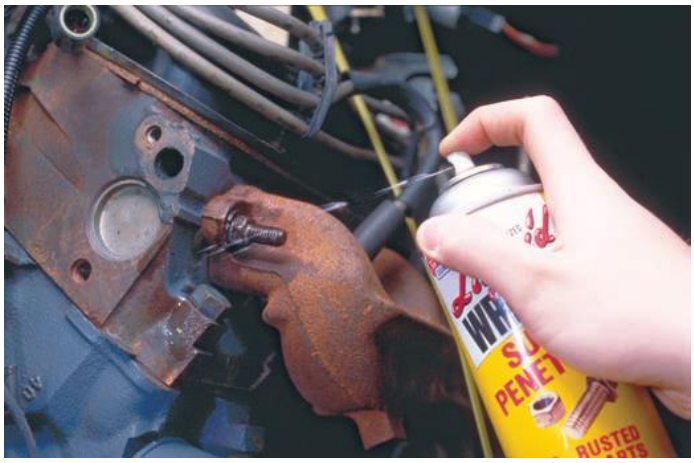
Factory service manuals (FSM) are the manuals provided by manufacturers which cover the servicing, maintenance, and repair of their products. They were not originally offered to the public as they were developed for the dealerships so that their mechanics were able to fix their own products

For vehicles, the following content are usually covered: body, frame & mounting, engine, suspension, driveline, brake systems, transmission/transaxle, clutch, chains, exhaust, fuel, steering, shocks, climate control, instrumentation & Warnings Systems, battery & charging systems, audio, lighting, electrical distribution, and wiring.

- Content/ topic 2 Selection of materials used on exhaust system:

- **Penetrating oil**

Before attempting to disassemble the exhaust system, spray all nuts and bolts with penetrating oil



- **Exhaust gaskets**

An **exhaust manifold gasket** seals the connection between the **manifold** and cylinder head. This prevents **exhaust** leakage out of the connection and also ensures that all **exhaust** gas will flow through the catalytic converter for treatment

- **Overall**

The first function of **overalls** is to protect. However, they don't protect only the body of the wearer. **Overalls** can be used to protect the clothing, as well. If your employees work with food, for example, their **overalls** can be used to protect their everyday **wear** from spatters and spill

- **Gloves**

Gloves are personal protective equipment (PPE) that protect the hands from the hazards. These **gloves** allow digit articulation while protecting the operator from electrical shock, extreme heat, and ultraviolet and infrared radiation, and also provide abrasion resistance and enhanced grip

- **Safety boots**

Safety boots are **shoes** made with a protective reinforcement at the front making them quite durable. The reinforcement helps to protect the toes from falling objects or any kind of compression. They are normally installed with a sole plate in the main sole to prevent against punctures that may come from below

- Content/ topic 3 Selection of equipment used on exhaust system:

- **Car lifter / hoist**

Car Hoist, as the name indicates that it is a type of instrument related to or used in vehicles. The purpose of Car Hoist is to lift up a car into the air when someone wants to work on it or examine something on it that is placed beneath the ca

- **Jack stands**

Jack stands are tripod- or tower-shaped tools designed to support a vehicle's weight when suspended. They are positioned under the vehicle axle or frame to provide additional support for the elevated vehicle. The **jack stands** are positioned after you **jack** the vehicle up
These stands can be used on hard and level surfaces and for cars that are within the weight capacity of the stands

- **Multimeter**

A **multimeter** or a **multitester**, also known as a **VOM** (**volt-ohm-milliammeter**), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. **Analog multimeters** use

a microammeter with a moving pointer to display readings. **Digital multimeters** (**DMM**, **DVOM**) have a numeric display, and may also show a graphical bar representing the measured value. Digital multimeters have rendered analog multimeters obsolete, because they are now lower cost, higher precision, and more physically robust

- **Exaust gas aspirator**

They allow to suck the **exhaust gases** directly to the source, unrolling the hose and attaching the nozzle to the **exhaust** pipe, thus avoiding that these **gases** are dispersed in the environment and come into contact with the respiratory tract of the operators

- **Handscaner**

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

- **Exhaust gas-analyzer**

Concentrations of combustion products in the vehicle's exhaust, most of which pollute the air, give important diagnostic clues to the vehicle's engine efficiency. The component gases which contribute the most to air pollution are hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx).

Three of the five gases measured at the tailpipe are regulated pollutants - HC, CO and NOx. The remaining gases, oxygen (O_2) And carbon dioxide (CO_2), while non-regulated, play a significant role as diagnostic aids. Omitec's four gas analyzer measures HC, CO, CO_2 and O_2 concentrations. The five gas analyzer adds the measurement of NOx as well.

L O 5.2: Position vehicle

- **Content/ topic 1 Put the vehicle on car lifter**

Place the vehicle properly on lift using the following procedure:

- Put the transmission in neutral position, turn off ignition, close all car doors, and check for overhead obstructions such as radio aerials.
- Place adaptors or pads in the proper position under the recommended contact points.
- Check that the automatic chock devices on drive-on or runway lifts are in position before raising a vehicle. Ensure that permanent blocks are sufficient to stop a vehicle. As the lift is raised, watch the automatic chocks at the drive-on end of the lift runners to make sure they operate properly.

- **Content/ topic 2 Lift up the car**

- ✓ Raise the lift until the vehicle's wheels are just off the floor (about 30 cm or 1 ft).
- ✓ Check again to ensure that contact pads and any adaptors are set accurately and that loads are not being placed on parts of the vehicle which might be damaged.
- ✓ Lower the vehicle and reposition the vehicle on the lift before continuing further if the contact with the vehicle is not even or if it looks as if the vehicle may slip.
- ✓ Do not bang or move the lift quickly at the top. Raise it slowly for the last 45 cm (about 1.5 feet). Banging the lift will stretch the seal bolts and allow oil to leak.
- ✓ Lock the lift with the mechanical locking device or use appropriate jack stands.

Be aware of conditions that could cause the vehicle's centre of gravity to shift and cause the vehicle to fall. For example, before lifting a vehicle, remove a load or cargo if it can shift unexpectedly, or follow the manufacturer's recommendations for removing heavy components like engines, axles, or universals. In addition, the removal or installation of parts may cause the centre of gravity to shift and the vehicle to become unstable

- Content/ topic3 Support the vehicle with jack stands.

Jack up the vehicle using a solid jacking point, leaving enough room for the jack stand to support the car. If lifting just one wheel, lifting just that corner of the vehicle is a good idea. If lifting the entire front or rear, choose a jack point in the center of the front or rear suspension or frame.

L O 5.3- Mount exhaust system

- Content/ topic1 Mount the exhaust manifold system

Step 1: Attach the new exhaust manifold gasket onto the studs on the cylinder head.

Step 2: Install a new gasket between the bottom of the exhaust manifold and the exhaust pipes.

Step 3: Attach the exhaust manifold to the exhaust pipes below the vehicle.

Step 4: Slide the exhaust manifold onto the cylinder head studs.

Step 5: Hand-tighten each nut onto the cylinder head studs. Tighten nuts in the precise order as instructed by the vehicle manufacturer until each nut is hand-tight and the exhaust manifold is flush against the cylinder head equally.

Step 6: Tighten exhaust manifold nuts. Tighten to the require torque pressure and in the exact pattern as recommended by the vehicle manufacturer.

Step 7: Reinstall heat shield onto exhaust manifold.

Step 8: Reattach parts. Reattach engine covers, coolant lines, air filters and other parts that were removed to gain access to the exhaust manifold.

Step 9: Refill radiator with recommended coolant. Refill the coolant (if you had to remove coolant lines).

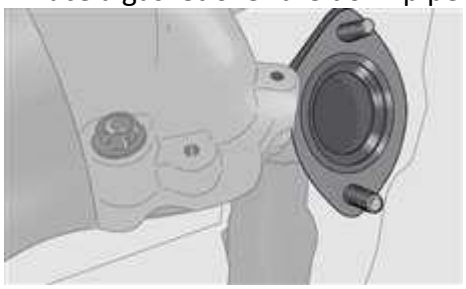
Step 10: Remove any tools, parts, or materials used for the job.

Step 11: Reattach battery terminals

- Content/ topic2 Mount the exhaust system

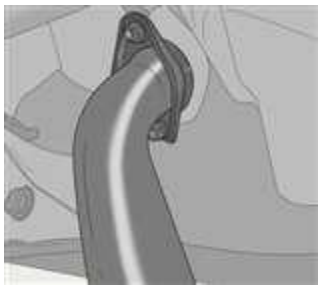
1 Clean the rust off of the bolt threads with a wire cleaning brush

2 Place a gasket over the downpipe with one of the bolts



A gasket is a thin piece that fits between pipes to prevent any leaks from escaping the connection

3 Attach the front of the exhaust system loosely to the downpipe with the bolts

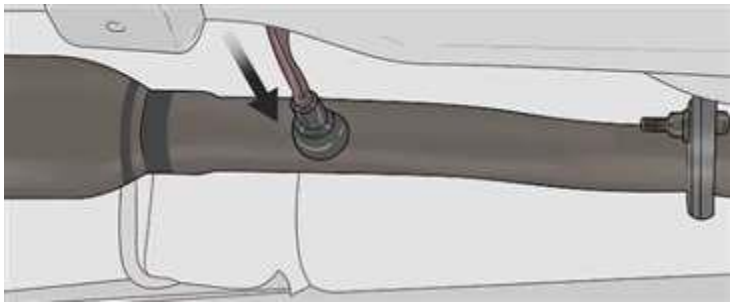


Position the end of the new exhaust pipe with the port on the downpipe so the bolt holes line

Exhaust systems that come in multiple pieces will fit together easily, but they may be prone to leaking if they are not tightened

- Content/ topic 5 Mount the accessories

Plug the oxygen sensors back into the ports on your vehicle.



Locate the small holes in the sides of the exhaust pipe near the front axle of your vehicle. Slide the old oxygen sensors back into the holes and tighten them by hand by turning the bolts clockwise. Use your ratchet or wrench to fully secure the sensors so they're tight

- ✓ Mount the exhaust gas recirculation component, if necessary
- ✓ Mount turbocharger component , if necessary
- ✓ Mount engine retarders, if necessary

L O 5.4 Correct testing of exhaust system

- **Content/topic 1.Test Exhaust gas by gas analyzer equipment**

Exhaust Gas Analyzers is widely appreciated by its accurate measurements, optimum functionality and long service life. Gas analyzer test visualizes measurement data graphically. This technologically advanced Exhaust Gas Analyzers are highly sought after for significant parameters including adequate heat provision, low energy consumption and reduced pollutant emissions. The highly efficient arrays of Analyzers are provided by us at cost effective prices

We break down our analyzers into 5 categories:

- ✓ Oxygen or O_2 Analyzers with a range from 0-100% O_2 Handheld, Panel Mount, Visual and Audible Alarms, Optional Relay Switch on Alarm model
- ✓ Carbon Monoxide or CO Analyzers with a range from 0-100 ppm CO Handheld, Panel Mount, Visual and Audible Alarms, Optional Relay Switch on Alarm model
- ✓ Carbon Dioxide or CO_2 Analyzers with a switchable range from 0-2000ppm CO_2 Handheld, Panel Mount, Visual and Audible Alarms, Optional Relay Switch on Alarm model
- ✓ Helium or He Analyzers with a range of 0-100% He Concentration Handheld, Panel Mount, Visual and Audible Alarms, Optional Relay Switch on Alarm model
- ✓ Trimix Analyzers capable of monitoring the composition of:

  Helium in Nitrogen (N_2) and/or Oxygen (O_2)
  Oxygen in Nitrogen (N_2) and/or Helium (He)

This technique can therefore reveal cyclical variation, as well as cylinder to cylinder variation. Such a capability may also be useful when verifying the effects of variable valve timing.

Figure: Exhaust gas analyzer

- **Content/ topic 2. Test Lambda closed loop control**

The O2 or Oxygen sensor works like a tiny voltage generator. It actually produces a voltage in the theoretical range of 0.01 to 0.98 volts. It does this depending on the Oxygen content of the exhaust. This signal is a major input to the ECM, which it uses to control the air-fuel mixture and emissions.

Theorxy of Operation

The O2 sensor measures the oxygen content of the exhaust. The O2 sensor's sensing ability comes about by producing a small voltage proportionate to the exhaust oxygen content. In other words, if the oxygen content is low it produces a high voltage (0.90 Volts - Rich mixture) and if the oxygen content is high it produces a low voltage (0.10 Volts - Lean mixture). Although theoretically the O2 sensor should cycle between 0.00 volts and 1.00 volts, in reality it cycles between 0.10 volts and 0.90 volts.

- ✓ In many modern cars the O2 sensor has been replaced by the AFR or Wide-Band sensor. But, the rear or after-cat O2 sensor is still the same old fashioned O2 sensor.

A few key issues are very important in the analysis of O2 sensor signals.

- ✓ An O2 sensor will cycle between 0.10 to 0.90 or almost 1 volt.
- ✓ An O2 sensor has to reach the 0.8x Volts amplitude mark while at full operation.
- ✓ An O2 sensor also has to reach the 0.1x Volts amplitude mark while at full operation.

(Full operation means the engine is fully warmed up, O2 sensor above the 600 deg. F. operating temperature, and no fuel or mechanical problems present. Also most rear O2 sensor will not cycle as wide, but during testing you have to goose the throttle and do a few WOT events to prove your O2 sensor voltage swing.)

- ✓ The front O2 sensor must cycle at least once per second, which would show 3 cross counts on the scan tool PID.
- ✓ Silicone is the leading cause of O2 contamination.
- ✓ It is easier for an O2 sensor to go from rich to lean than vise-versa.
- ✓ O2 sensors tend to fail on rich bias. In other words, they tend to shift their cycling to the upper side or rich side of the voltage scale.
- ✓ There is a small hole at the body of the O2 sensor, which allows it sample the outside reference Oxygen.

✓ Contrary to what many people think, an O2 sensor WILL NOT cycle by itself. The O2 sensor cycle is a direct result of the ECM response to the changes in the mixture.

✓ When the O2 cycles and crosses the 0.450 volts mark every second, the system is in CLOSE-LOOP.

✓ Even though an O2 sensor is cycling and crossing 0.450 volts (ECM in close loop) it DOES NOT mean that it is working properly.

✓ O2 sensor operation is extremely important not only to keep HC & CO emissions low but also to reduce NOx as well.

✓ Proper O2 sensor cycling will determine the catalytic converter's efficiency. The catalytic converter needs the O2 sensor cycling at its proper amplitude and frequency for it to function at its maximum efficiency.

✓ An O2 sensor with a high voltage reading does not necessarily mean that the mixture is rich or high in fuel content. An EGR valve problem will send the O2 signal high as well.

✓ The O2 sensor signal stuck at 450 mV is an indication of an open O2 sensor circuit (signal wire) or faulty O2 signal ground. The 450 mV value is called a bias voltage and it is not the same for all manufacturers. Some manufacturers employ a dedicated O2 sensor ground. Such a ground lead is attached to the engine block or chassis and feeds an ECM O2 ground pin only. The O2 circuit is then grounded through the inside of the ECM electronic board by this ground wire. A loss of this ground would also put the O2 sensor signal at around 450 mV, which makes it look like an open circuit. The same holds true for Chrysler, but these use a different O2 bias voltage, which is usually 2.00 to 4.00 volts. Remember, this bias voltage circuit is very low current.

- **Content/topic 3. Take the car for a test drive**

Whether you replaced your exhaust due to damage or decided to upgrade it for performance, remember to always take caution when driving through driveways, speed bumps, and dips. The exhaust is exposed underneath the car and can be damaged if pulling into a driveway too quickly.

If you live in areas that experience snow, be sure to have your undercarriage washed weekly during those winter months to prevent your exhaust and other components under the vehicle exposed to the elements from turning to rust.

If you aren't comfortable replacing your car's exhaust system yourself, ask a professional mechanic, such as one from your mechanic, to help you replace your hangers, manifold gasket, or catalytic converter. Our mobile mechanics come to your home or office to inspect or repair your car at your convenience.

References

1. R. Gscheidle, (1997). Modern automotive technology: fundamentals, service, diagnostics. VERLAG Europa – LehrmittelNorneyVolmer GmbH & Co.KG; Germany
2. Halderman J.D., (2012). Automotive Technology: Principles, diagnosis and service, 4th ed. Pearson education, 1 Lake Street, Upper Saddle River, New Jersey 07458. USA ISBN-13: 978-0-13-254261-6
3. Erjavec J., Delmar, (2009). Automotive Technology: A systems approach, 5th ed. 5 Maxwel Drive, Clifton Park, NY12065-2919, USA. ISBN-13:978-1428311497
4. Gerschler H., (1989). Technology for Automotive Trade, 20th ed. VERLAG Europa – LehrmittelNorneyVolmer GmbH & Co., Wuppertal; Germany