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AUTOMOTIVE MECHATRONICS

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LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - October, 2019

NAVTTC

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Introduction

Welcome to your Learner's Guide for the *Automotive Mechatronics Lev 2*. It will help you complete the training and go on with further study or go straight into employment.

The *Automotive Mechatronics Lev 2 training* is to engage young people with a program of development that will provide them with the knowledge, skills and understanding to start this career in Pakistan. This qualification will not only build the capacity of existing workers of this light engineering sector but also support the youth to acquire skills best fit for this sector.

The main elements of your learner's guide are:

- **Introduction:**
  - This includes a brief description of your guide and guidelines for you to use it effectively
- **Modules:**
  - The modules form the sections in your learner's guide
- **Learning Units:**
  - Learning Units are the main sections within each module
- **Learning outcomes**:
  - Learning outcomes of each learning units are taken from the curriculum document
- **Learning Elements:**
  - This is the main content of your learner's guide with detail of the knowledge and skills (practical activities, projects, assignments, practices etc.) you will require to achieve learning outcomes stated in the curriculum
  - This section will include examples, photographs and illustrations relating to each learning outcome
- **Summary of modules**:
  - This contains the summary of the modules that make up your learner's guide
- **Frequently asked questions**:
  - These have been added to provide further explanation and clarity on some of the difficult concepts and areas.
- **Multiple choice questions for self-test**:
  - These are provided as an exercise at the end of your learner's guide to help you in preparing for your assessment.

Frequently Asked Question

1. What is Competency Based Training (CBT) and how is it different from currently offered trainings in institutes?	Competency-based training (CBT) is an approach to vocational education and training that places emphasis on what a person can do in the workplace as a result of completing a program of training. Compared to conventional programs, the competency based training is not primarily content based; it rather focuses on the competence requirement of the envisaged job role. The whole qualification refers to certain industry standard criterion and is modularized in nature rather than being course oriented.
2. What is the passing criterion for CBT certificate?	You shall be required to be declared “Competent” in the summative assessment to attain the certificate.
3. How can I progress in my educational career after attaining this certificate?	You shall be eligible to take admission in the National Vocational Certificate Level-3 in Automotive Mechatronics. You shall be able to progress further to National Vocational Certificate Level-4 in Automotive Mechatronics; and take admission in a level-5, DAE or equivalent course. In certain case, you may be required to attain an equivalence certificate from The Inter Board Committee of Chairmen (IBCC).
4. What is the importance of this certificate in National and International job market?	This certificate is based on the nationally standardized and notified competency standards by National Vocational and Technical Training Commission (NAVTTC). These standards are also recognized worldwide as all the standards are coded using international methodology and are accessible to the employers worldwide through NAVTTC website.
5. Which jobs can I get after attaining this certificate? Are there job for this certificate in public sector as well?	You shall be able to take up jobs as an automotive mechatronics technician, spare parts dealers, supervisors and managers.
6. What are possible career progressions in industry after attaining this certificate?	You shall be able to progress up to the level of supervisor after attaining sufficient experience, knowledge and skills during the job. Attaining additional relevant qualifications may aid your career advancement to even higher levels.
7. Is this certificate recognized by any competent authority	This certificate is based on the nationally standardized and notified

in Pakistan?	competency standards by National Vocational and Technical Training Commission (NAVTTC). The official certificates shall be awarded by the relevant certificate awarding body.
8. Is on-the-job training mandatory for this certificate? If yes, what is the duration of on-the-job training?	On-the-job training is not a requirement for final / summative assessment of this certificate. However, taking up on-the-job training after or during the course work may add your chances to get a job afterwards.
9. What is the examination / assessment system in this program?	Competency based assessments are organized by training institutes during the course which serve the purpose of assessing the progress and preparedness of each student. Final / summative assessments are organized by the relevant qualification awarding bodies at the end of the certificate program. You shall be required to be declared "Competent" in the summative assessment to attain the certificate.
10. Does this certificate enable me to work as freelancer?	You can start your small business as an automotive mechatronics technician. You may need additional skills on entrepreneurship to support your initiative.

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Module-1

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Modules

Module 1: Comply Personal Health and Safety Guidelines

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to comply personal health and safety guidelines.

Duration: 30 Hrs **Theory: Hrs** **Practical: Hrs**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Identify Personal Hazards at Workplace	**The trainee will be able to:** Identify risk to personal health Identify hygiene and safety at work place Identify processes Identify tools, equipment and consumable materials that have the potential to cause harm Report, identified risk to Health, hygiene and safety to concerned		
LU 2: Apply Personal Protective and Safety Equipment (PPE)	**The trainee will be able to:** List the Personal Protective equipment Select personal protective equipment in terms of type and quantity according to work orders. Wear personal protective equipment according to job requirements. Clean personal protective		

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
	equipment Stored Personal Protective equipment in proper place after use.		
LU 3: Comply Occupational Safety and Health (OSH)	**The trainee will be able to:** Maintain cleanliness and hygiene as per organizational policy Comply with Health, hygiene and safety precautions before starting work Comply organizational Health, hygiene and safety guidelines during work Deal with resolvable problems according to prescribed procedures Report un resolvable problems to concerned Place the tools equipment etc at their prescribed place after completion of work		
LU 4: Dispose of hazardous Waste/materials from the designated area.	**The trainee will be able to:** Identify hazardous waste materials which needs to be disposed off Segregate hazardous or non-hazardous waste carefully from the designated area as per approved procedure Use proper disposal		

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
	hazardous containers for dispose-off hazardous waste as per procedure Take necessary precautions like putting masks and gloves while disposing hazardous waste/ materials as per standard operating procedure		

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Module-2

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Module 2: Communicate the Workplace Policy and Procedure

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to communicate the workplace policy and procedure.

Duration: 20 Hrs **Theory: Hrs** **Practical: Hrs**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Identify workplace communication procedures	**The trainee will be able to:** Identify organizational communication requirements and workplace procedures with assistance from relevant authority Identify appropriate lines of communication with supervisors and colleagues. Seek advice on the communication method/equipment most appropriate for the task		
LU 2: Communicate at workplace	**The trainee will be able to:** Use effective questioning, and active listening and speaking skills to gather and convey information Use appropriate non-verbal behavior at all times Encourage, acknowledge and act upon constructive feedback		
LU 3: Draft Written	**The trainee will be able to:** Identify and comply with		

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
Information	required range of written materials in accordance with organizational policy and procedures Draft and present assigned written information for approval, ensuring it is written clearly, concisely and within designated timeframes. Ensure written information meets required standards of style, format and detail. Seek assistance and/or feedback to aid communication skills development		
LU 4: Review Documents	**The trainee will be able to:** Check draft for suitability of tone for audience, purpose, format and communication style Check draft for readability, grammar, spelling, sentence and paragraph construction and correct any inaccuracies or gaps in content. Check draft for sequencing and structure Check draft to ensure it meets organizational requirements Ensure draft is proofread, where appropriate, by		

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
	supervisor or colleague		

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Module-3

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Module 3: Perform Basic Communication (Specific)

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to perform basic communication.

Duration: 30 Hrs **Theory: Hrs** **Practical: Hrs**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU1. Communicate in a team to achieve intended outcomes	**The trainee will be able to:** Treat team members with respect Maintain positive relationships to achieve common organizational goals Get work related information from team Identify interrelated work activities to avoid confusion Adopt communication skills, which are designed in a team. Identify problems in communication with a team Resolve Communication barrier through discussion and mutual agreement		
LU2. Follow Supervisor's instructions as per organizational SOPs	**The trainee will be able to:** Receive the instructions from Supervisor Carry out the instructions of the supervisor Report to the supervisor as per organizational SOPs.		
LU 3. Develop Generic communication skills at workplace	**The trainee will be able to:** Develop basic reading skills Develop Basic writing Skills Develop basic listening skills		

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
	Place the tools equipment etc at their prescribed place after completion of work		

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Module-4

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Module 4: Perform Basic Computer Application

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to perform basic computer application.

Duration: 40 Hrs **Theory: Hrs** **Practical: Hrs**

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Create Word Documents	**The trainee will be able to:** Open word processing application Create a word document Customize page layout with relevant name setting Set up page in a word document Edit word document as required Use simple formatting tools when creating the document Save word document to directory Insert table in a word document Insert appropriate images into document as necessary Insert header/footer in a word document Insert section break in a word document Set style in word document Select basic Print settings Print the document		

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 2: Use internet for Browsing	**The trainee will be able to:** Use search engines to open website Search data on different topics Refine search to increase relevance of information or content Navigate a website to access the information or content required.		

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Module-5

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Module 5: 071400942 Maintain Engine Assembly

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to maintain engine assembly.

Duration: 50 Hrs **Theory:** 16 Hrs **Practical:** 34 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Remove & Refit Engine Head Assembly	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Remove the inlet and exhaust manifold Remove the cylinder head cover Remove cylinder head bolts Remove cam gear by using cam puller Remove the camshaft and cam bearings Remove valve and valve springs using valve lifter Check cylinder head for flatness or warped/twisted Inspect and verify the fault Refit Engine Head assembly as per the workshop manual Ensure housekeeping after completion of task	Identifying and using tools/equipment, required for remove & refit engine head assembly (for example valve lifter, ring compressor, ring expander, plier set, engine hoist, hydraulic jack, combination spanner set, Allen key set) Knowing engine types (i.e. 2 stroke, 4 stoke, Petrol Engine, Diesel Engine etc.) and main parts of engine head assembly (i.e. Cylinder Head, Tappet Cover, Valves, Valve Guides, Cam Shaft, Intake Manifold, Exhaust Manifold) functions of inlet and exhaust manifold Identifying valve timing and valve mechanism of engine Disassembling and assembling of cylinder head including checking of cylinder head for warpage Knowing the variable valve timing with intelligence (VVTI) and variable valve timing & lift electronic control (VTEC) Knowledge of Magnetic Particle Inspection The importance of PPEs when remove and refit engine head assembly Importance of health and safety Importance of housekeeping	Compression Tester Valve Lifter Ring Compressor Ring Expander Plier set Engine Hoist Hydraulic Jack Combination Spanner Set Allen key Set Socket Set Wheel Spanner Oil filter spanner Torque Wrench Tool Trolley Engine mounts. Hammer Mallet Clutch plate alignment tool Engine Oil Kerosene Oil Lock Tight Silicon Tube Engine Gasket Set Emery Paper

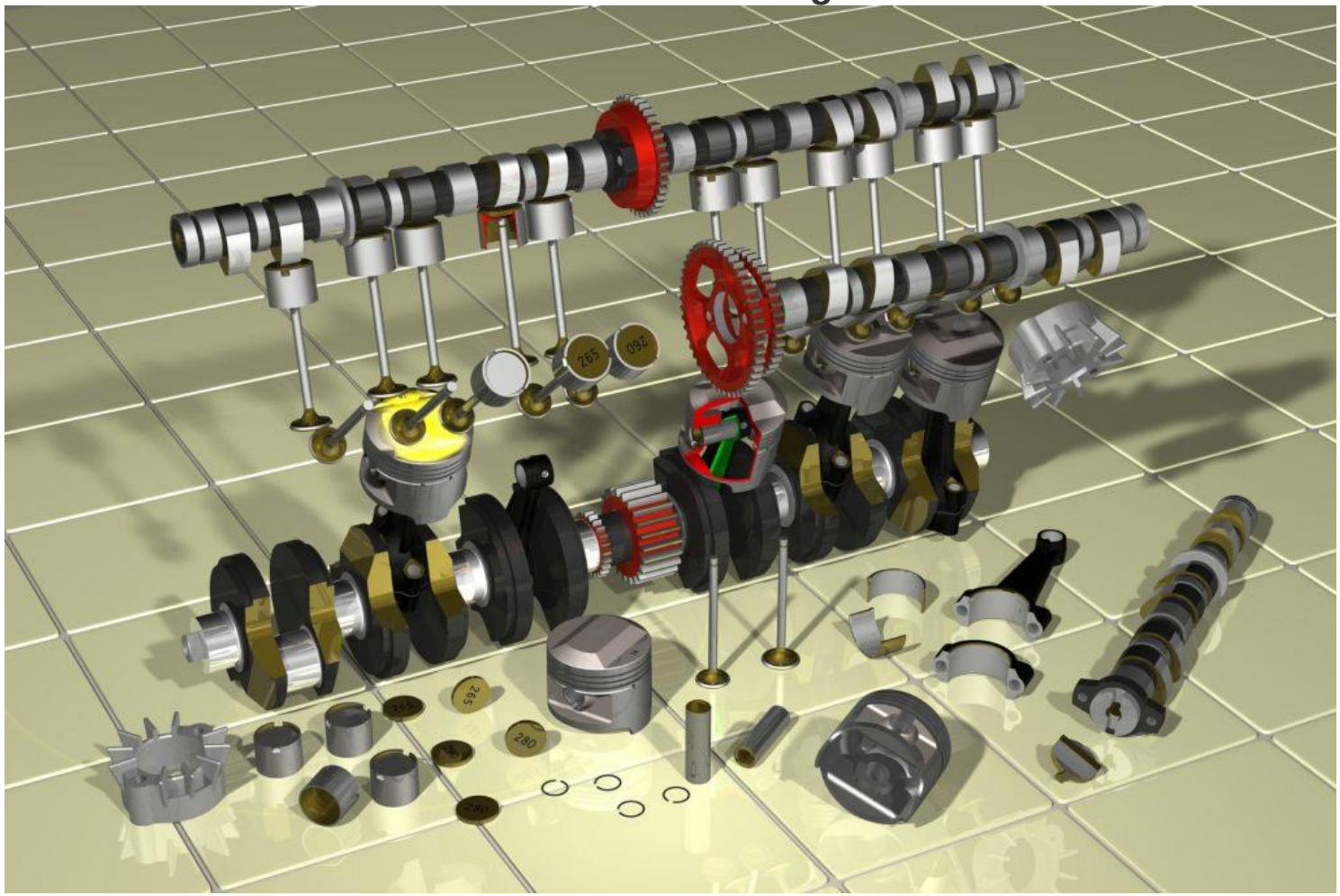
			Cotton Waste Relevant PPEs
LU 2: Remove & Refit Engine Block Assembly	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Remove the cylinder head cover Remove the cylinder head Remove oil sump/pan Remove Crank shaft front and rear Main oil seal Remove main Journal bearing caps. Remove Big end Journal bearing caps Refit Engine Block Assembly as per the workshop manual Ensure housekeeping after completion of task	Identifying and using tools/equipment, required for removal & refit engine block assembly Knowledge about main parts of engine block assembly (i.e. Cylinder Block, Crank Shaft, Piston, Rings, Connecting Rod, Flywheel, Main seal housing) Knowledge of crank and cam shaft function and their location functioning of engine components (i.e. Piston, Piston Rings, Cylinder Liner, Oil Galleries, Thrust Bearings) Types of Engine blocks (i.e. V Engine, Inline Block, Boxer Engines) Demonstrating procedure of disassembly and assembly of engine block as per vehicle's manual The importance of PPEs when remove and refit engine block assembly Importance of health and safety Importance of housekeeping	Compression Tester Valve Lifter Ring Compressor Ring Expander Plier set Engine Hoist Hydraulic Jack Combination Spanner Set Allen key Set Socket Set Wheel Spanner Oil filter spanner Torque Wrench Tool Trolley Engine mounts. Hammer Mallet Clutch plate alignment tool Engine Oil Kerosene Oil Lock Tight Silicon Tube Engine Gasket Set Cotton Waste Emery Paper Relevant PPEs

LU 3: Set Engine Timings	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Set engine timing Start engine for idle running speed as per workshop manual Ensure housekeeping after completion of task	knowledge and understanding of tools/equipment, required to set engine timings The importance of engine timings Procedure to adjusting timing gears Reading and understanding the workshop manual The importance of PPEs when set engine timings Importance of health and safety Importance of housekeeping	Compression Tester Plier set Engine Hoist Hydraulic Jack Combination Spanner Set Allen key Set Socket Set Torque Wrench Tool Trolley Engine mounts Hammer Mallet Clutch plate alignment tool Silicon Tube Cotton Waste Relevant PPEs
LU 4: Couple Engine & Transmission	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Hold the engine assembly and transmission at same level Ensure transmission primary / input shaft centrally aligned with clutch plate drive hub. Insert transmission primary shaft into the clutch plate drive	knowledge and understanding of tools/equipment, required to Couple Engine & Transmission Functioning of clutch assembly Identifying parts (i.e. Clutch plate, Pressure plate, Flywheel, Clutch bearing) of clutch assembly Procedure of disassembly/assembly of coupling engine and transmission The importance of PPEs when Coupling Engine & Transmission Importance of health and safety	Plier set Engine Hoist Hydraulic Jack Combination Spanner Set Allen key Set Socket Set Torque Wrench Tool Trolley Engine mounts. Hammer Mallet

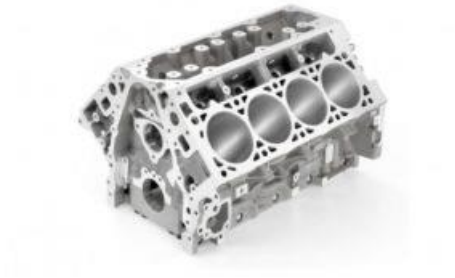
	hub. Ensure Bell housing completely fix with engine rear side Fit engine and transmission bolts Apply torque as per workshop manual and fix the engine and transmission Ensure housekeeping after completion of task	Importance of housekeeping	Clutch plate alignment tool Silicon Tube Cotton Waste Relevant PPEs

Examples and illustrations

Main Parts of an Engine



1. Engine Block



Engine block is an important part of an engine. It is made by pouring the molten iron or aluminum alloy into a mold. The mold is made such that we should have required number of holes in the casted block, which are said to be the number of cylinders of an engine or engine cylinders.

2. Piston

Piston is a cylindrical structure with a flat surface called crown at the top. Piston is the component that moves up and down in an engine cylinder. Now how we go to use this up and down motion of piston, for that we need to know about 2 more things that are connecting rod and wrist pin.

3. Connecting Rod

It is an ‘I’ shape structure whose one end is connected to piston and other one to crankshaft. The piston side end of connecting rod has hole in it. Wrist pin act as a bearing and connecting rod can move like pendulum beneath piston, though piston’s cylindrical structure is gonna limit its

4. Crankshaft

As name suggests it is designed in such a way to convert linear (up and down) motion of piston into rotational motion. It works same as slider-crank mechanism. Material used for making crankshaft is cast iron generally but we also use forged steel in high power engines where load on crankshaft is too high.

5. Crankshaft Casing or Oil Sump

It is also called as oil sump. It is a casing which is bolted to engine block, which covers engine from bottom thus called crankshaft casing. It retains lubricating oil in it which is pumped to different engine parts.

6. Engine Head

Engine head is casted in the same way as engine block. Its mold is made such that the casted piece must have an opening for air to flow into engine cylinder and an exhaust opening from where the burnt gases will go out. This passage of air flowing in and going out of engine cylinder is controlled by inlet and outlet valves.

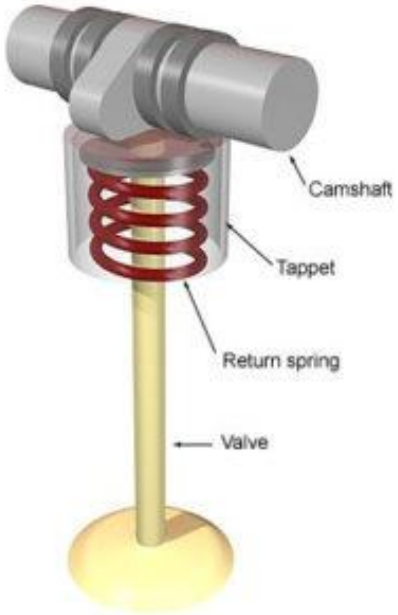
7. Valves

As we have already know that they control the inlet and exhaust air to go into and out of engine cylinder. Material used to make valves is nickel-chromium iron alloy. It can resist high temperature and have great strength**.** Valve could be described in two parts- valve stem and valve head.

8. Camshaft

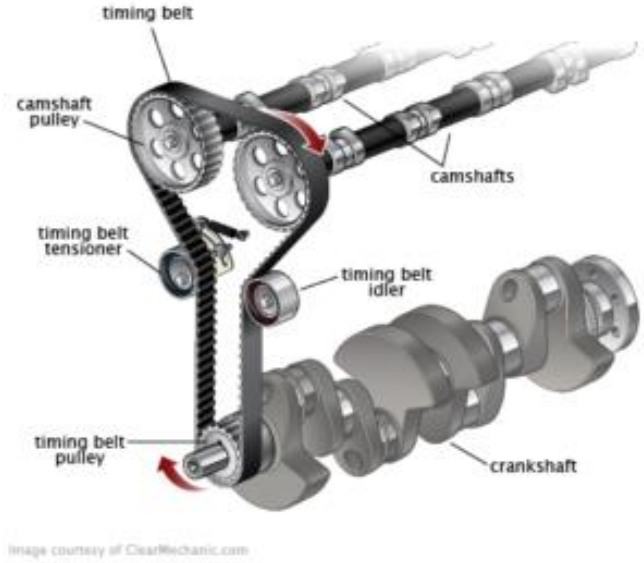
It is a shaft with a number of cam profiles along its length. So it regulates the valves opening and closing time. It does so by pressing the end of valve stem by its cam profile. But we still need a mechanism which would return the valve back to its position once pressed by the cam profile of camshaft. We have valve spring and bucket head tappet assembly for solving this problem.

9. Valve Spring and Tappet



Valve spring provides a self-returning mechanism when valve is not being pressed by camshaft. We further have bucket type tappet covering the valve spring. The purpose of tappet is to provide smooth surface for cam to press the valve spring or inlet and outlet valve.

10. Timing Belt



Wonder how camshaft gets its rotational motion to regulate valves. Yeah it's through timing belt which transmits the motion of gear mounted at crankshaft called crank-gear, to the gear mounted at camshaft. The ration of cam-gear to that of crank-gear is 2:1. So that camshaft would rotate only once in two rotations of crankshaft. Timing belt is made up either from glass-fiber or Kevlar so it does not worn-out easily.

11. Spark Plug

It is the parts of an engine that ignites the air-fuel mixture in the engine cylinder. It produces the spark at right time by using electrical energy of battery. The basic working principle is that when we have high electrical potential at one end and zero or negative potential at other end.

12. Gasket

A wide variety of materials are used in making gaskets like Teflon, glass-fiber, silicon etc. It is generally a paper like sheet which is placed between engine block and engine head.

13. Piston Rings

Piston rings prevent the pressure created by burning of air-fuel mixture from leaking into crankcase. Not only that piston rings scrap down the oil from cylinder walls which is spilled by crankshaft to remove heat from piston. They also transfer heat of the piston to the cylinder walls which are being cooled by water circulation through water vents.

For more detailed information, please visit https://www.mechanicalbooster.com/2014/02/what-are-main-parts-of-automobile-engine.html

And https://www.buyautoparts.com/howto/what_is_a_cylinder_head.html

Timing Chain:

A timing belt is a toothed belt made of high-quality rubber; it runs outside of the engine, covered by a protective cover.

Timing chain.

A timing chain is made of metal, similar to a bicycle chain. A timing chain runs inside the engine, as it needs to be lubricated by the engine oil.

When does the timing chain need to be replaced?

A timing belt in a car engine needs to be replaced at recommended service intervals. If the timing chain is worn, usually it's replaced as a kit with a new tensioner, guides, and other parts of the chain drive mechanism. Many autos have two or even three chains in their motors

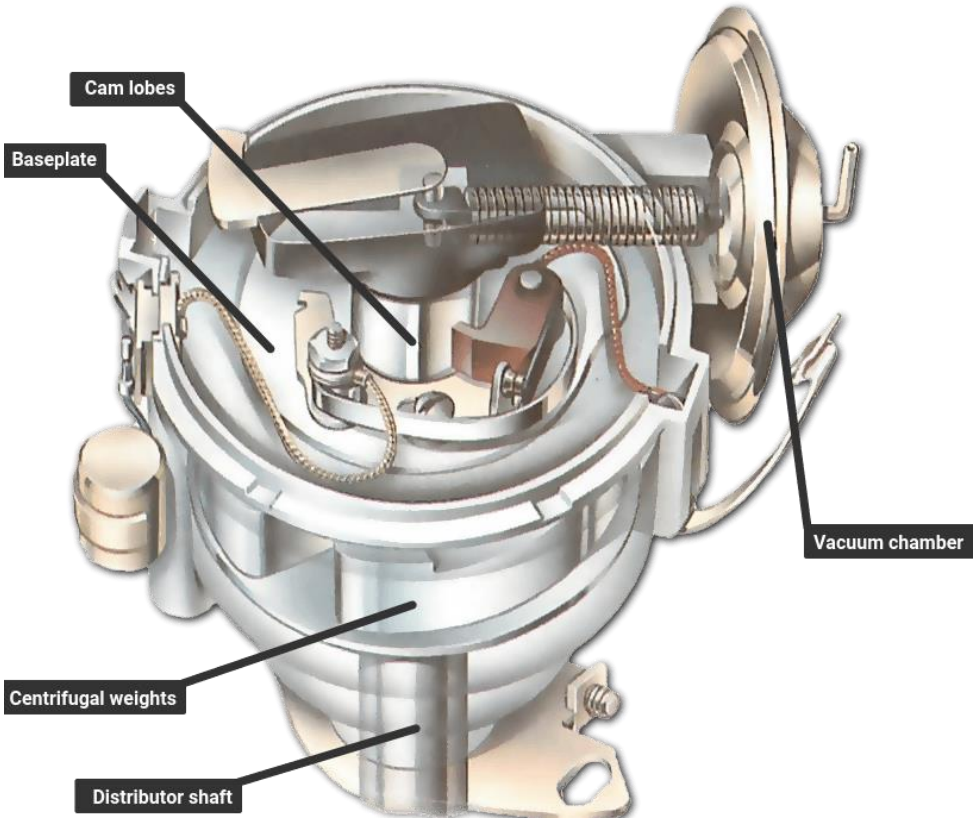
For more detailed information, please visit https://www.testingautos.com/car_care/when-does-the-timing-chain-need-to-be-replaced.html

Engine Timings:

For an engine to work at its best, the fuel /air mixture in each cylinder must fire just as the piston reaches top dead center (TDC).

It takes a certain time for the spark-plug to ignite the mixture and for the combustion to build up. This time stays roughly the same no matter how fast the engine is running.

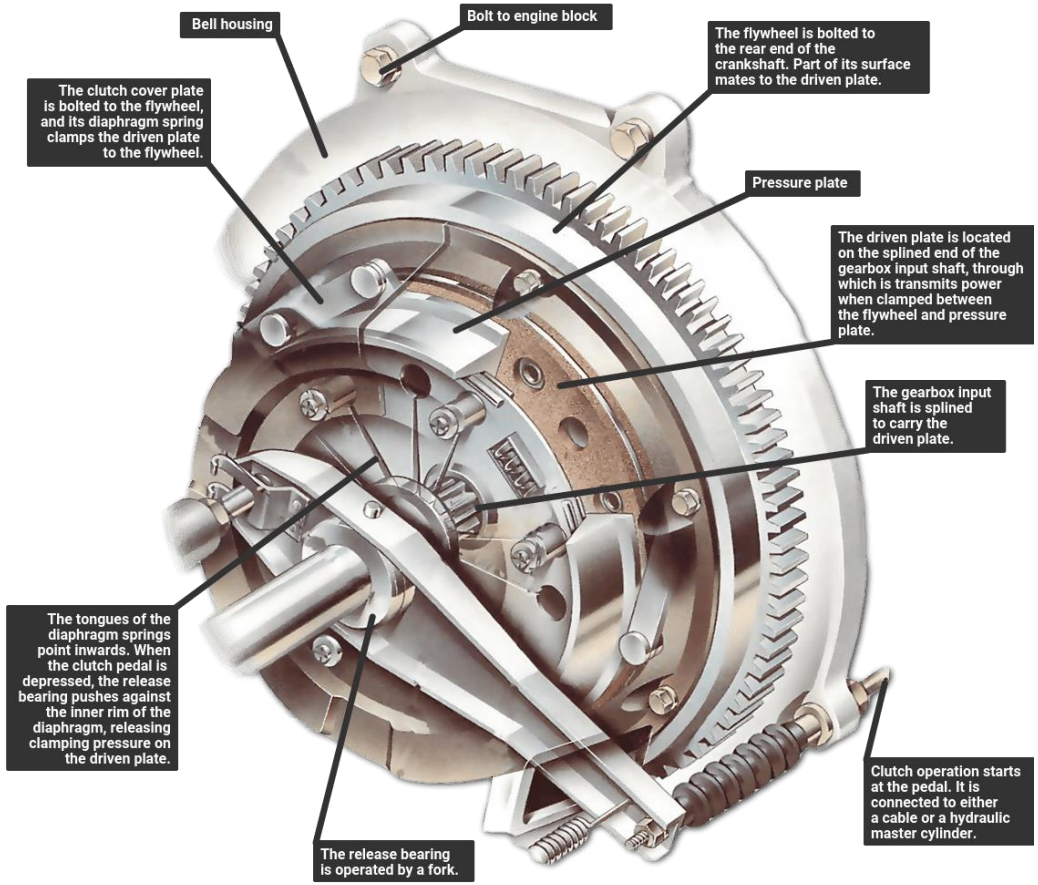
The timing mechanism is set to fire the plug a short time before the TDC. But because the mechanism is worked by the motion of the engine, this time would normally decrease as the engine ran faster, and the plug would fire too late.



For more detailed information, please visit https://www.howacarworks.com/basics/how-engine-timing-works

Functioning of clutch assembly

The first stage in the transmission of a car with a manual gearbox is the clutch.



How the clutch works

Clutch transmits engine power to the gear box, and allows transmission to be interrupted while a gear is selected to move off from a stationary position, or when gears are changed while the car is moving.

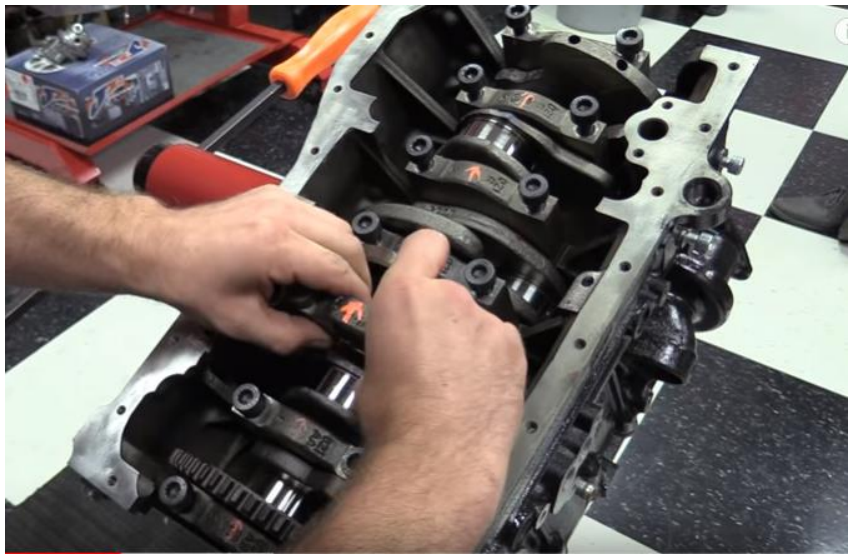
Parts of the clutch

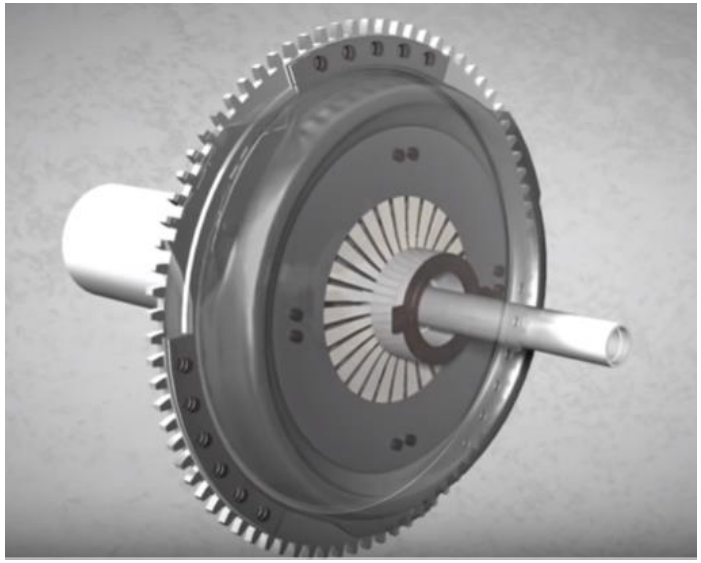
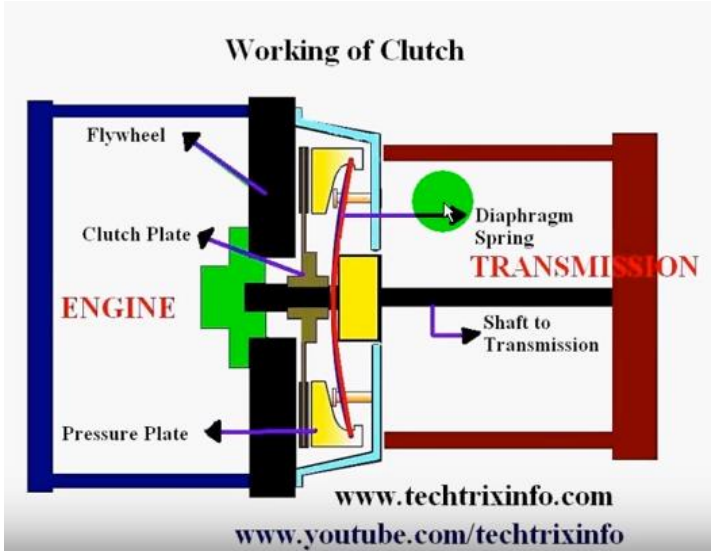
The modern clutch has four main components: the cover plate (which incorporates a diaphragm spring), the pressure plate, the driven plate, and the release bearing.

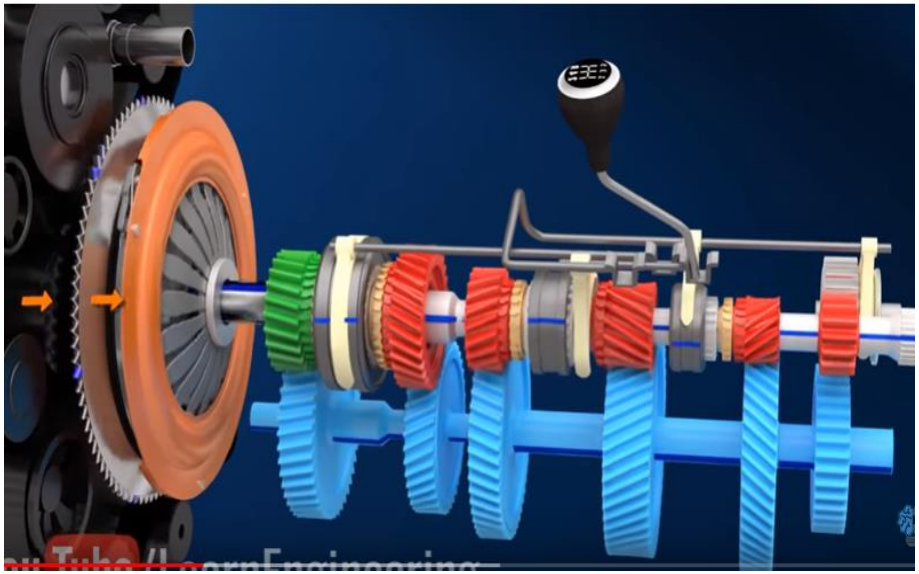
For more detailed information, please visit https://www.howacarworks.com/basics/how-a-car-clutch-works

Also visit http://mechstuff.com/manual-car-clutches-working-principle-parts-types/

VIDEOS:

	**Car engine assembly and operation** **https://youtu.be/P7F68ufzO54**
	**How to Assemble an Engine Block** **https://youtu.be/zPAEIcQH0YY**

	**How a clutch works! (Animation)** **https://youtu.be/pqF-aBtTBnY**
	**Animation - How Clutch Works** **https://youtu.be/H7Iay0Ke_t4**

	**Clutch, how does it work?** https://youtu.be/devo3kdSPQY
	**Specialty Tools Needed For Engine Assembly** https://youtu.be/Xde0NUpMw1Q

AUTOMOTIVE MECHATRONICS

Module-6

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Module 6: 071400943 Maintain Fuel System

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to maintain fuel system.

Duration: 50 Hrs **Theory:** 12 Hrs **Practical:** 38 Hrs

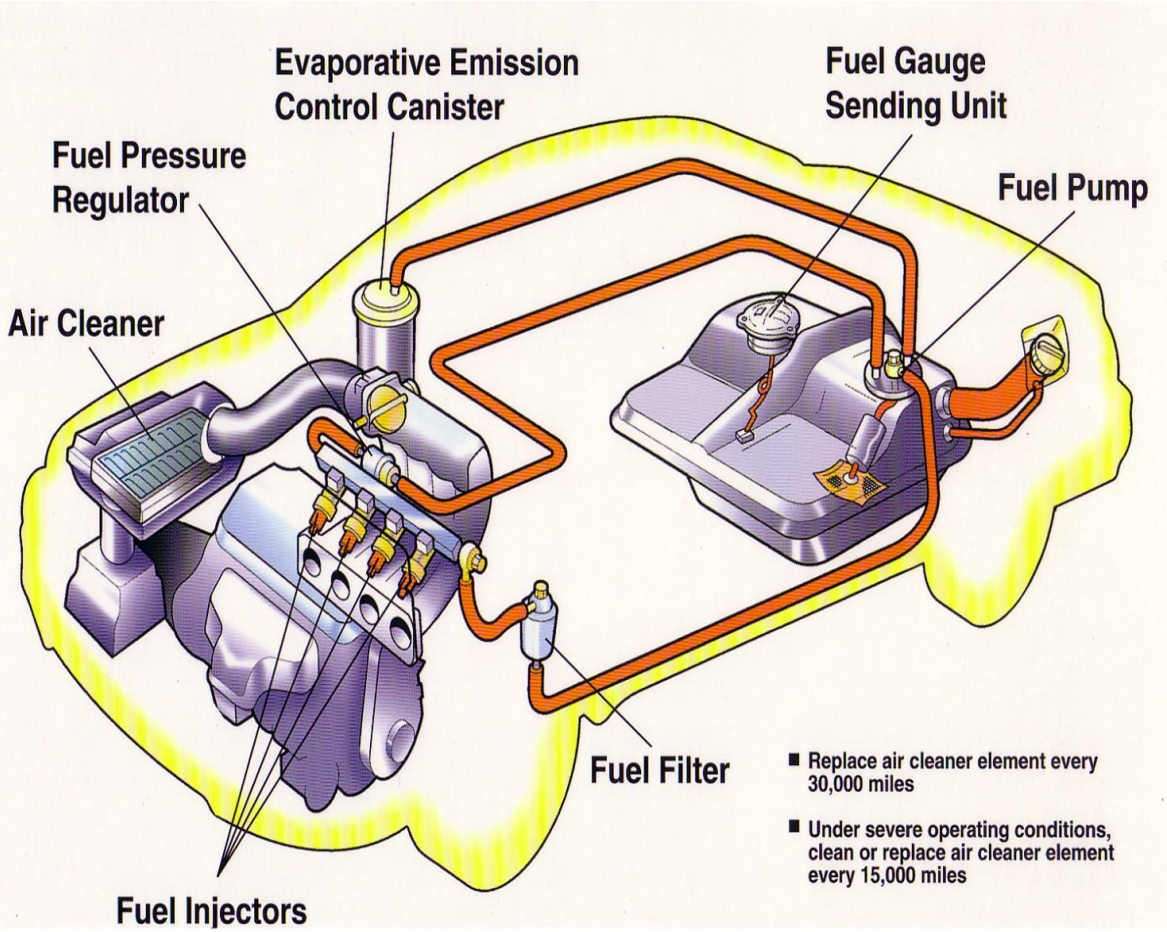
Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Service Fuel Injectors and Rail	**The trainee will be able to:** Select appropriate Tools and equipment. Ensure work safety at all times, complying with health and safety precautions, regulations and other relevant guidelines. Observe Fuel Injector condition through engine operation Check wire harness and connectors Check input supply of fuel injectors. Remove the air cleaner and accessories. Remove and Service of fuel injectors. Assemble the air cleaner and accessories Perform test drive. Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required for service fuel injectors and rail Explaining function and working of fuel system Defining types of fuel used in vehicles gasoline (Petrol), Diesel, LPG (Liquid petroleum gas) and CNG (compressed natural gas) Explaining and identifying parts of fuel system (i.e. Fuel Tanks, Fuel Pipes and rails, Fuel Pump, Fuel filter, Fuel injectors) Describing function of fuel injectors Understanding purpose and method to assemble air cleaner Servicing of injectors as per vehicle's manual The importance of PPEs when service fuel injectors and rail Importance of health and safety Importance of housekeeping	Injector cleaner Petrol Kerosene Oil Cotton waste Emery paper Silicon tube Teflon tape Relevant PPEs
LU 2: Repair Fuel Pump	**The trainee will be able to:** Select appropriate tools and equipment. Ensure work safely at all times, complying with health and safety precautions, regulations and other	Operational knowledge and understanding of tools/equipment, required to repair fuel pump Operational knowledge and understanding of types of fuel pumps (mechanical fuel pump, electrical fuel	Petrol Kerosene Oil Cotton waste Emery paper Silicon tube

	relevant guidelines. Diagnose physical damage or faulty fuel pump in vehicle (Diesel / Petrol) by applying prescribed diagnostic techniques. Check pressure of fuel pump Check vacuum of fuel pump. Repair/replace faulty fuel pump Ensure function of fuel pump after service of vehicle fuel system. Ensure housekeeping after completion of task	pump) Defining function of fuel pump Describing method of servicing fuel pumps including diagnostic techniques (i.e. pressure of fuel, vacuum of fuel) The importance of PPEs to repair fuel pump Importance of health and safety Importance of housekeeping	Relevant PPEs
LU 3: Perform Carburettor Service	**The trainee will be able to:** Select appropriate tools and equipment. Ensure work safely at all times. Remove the engine air filter and accessories. Identify and adjust air fuel mixture adjustment screws. Test the engine carburettor at idle and while revving up. Identify the idle mixture screw; adjust it until the engine is idling smoothly, with no misfires or shakes, and at the proper speed. Assemble the air filter and accessories onto the carburettor Perform test drive. Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to perform carburettor service Describing the types of carburettor and its various circuits. Operational knowledge and understanding of main parts of carburettor Identifying air filter Defining method to remove air filter Explaining procedure of disassembly and assembly of carburettor including its service method as per workshop manual Explaining purpose of mixture screws Defining procedure to adjust mixture screws to get smooth idling of engine The importance of PPEs to perform carburettor service	Petrol Kerosene Oil Cotton waste Emery paper Silicon tube Relevant PPEs

		Importance of health and safety Importance of housekeeping	
LU 4: Perform Throttle Body Service	**The trainee will be able to:** Select appropriate tools and equipment. Ensure work safely at all times. Observe idle speed of vehicle. Disconnect all connectors from throttle body Remove the mounting bolts of throttle body and its accessories Clean the throttle body with non-abrasive cleaner. Assemble the throttle body and accessories Perform test drive Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to perform throttle body service Defining throttle body assembly with accessories (pressure regulator, injector or injectors, TP sensor, idle speed control motor, throttle shaft) Explaining function of throttle body Describing servicing procedure of throttle body The importance of PPEs to perform throttle body service Importance of health and safety Importance of housekeeping	Petrol Kerosene Oil Cotton waste Emery paper Silicon tube Relevant PPEs

Examples and illustrations

Fuel Injection System



http://sparkstireandauto.com/fuel_injection.html

The importance of fuel system maintenance

Fuel system maintenance is something that should be done on the car and can produce some very significant benefits.

- The fuel system of any car has the following primary components:
- Fuel injectors;
- Fuel pump;
- Fuel tank;
- Fuel lines
- Fuel pump and injection pump assembly.

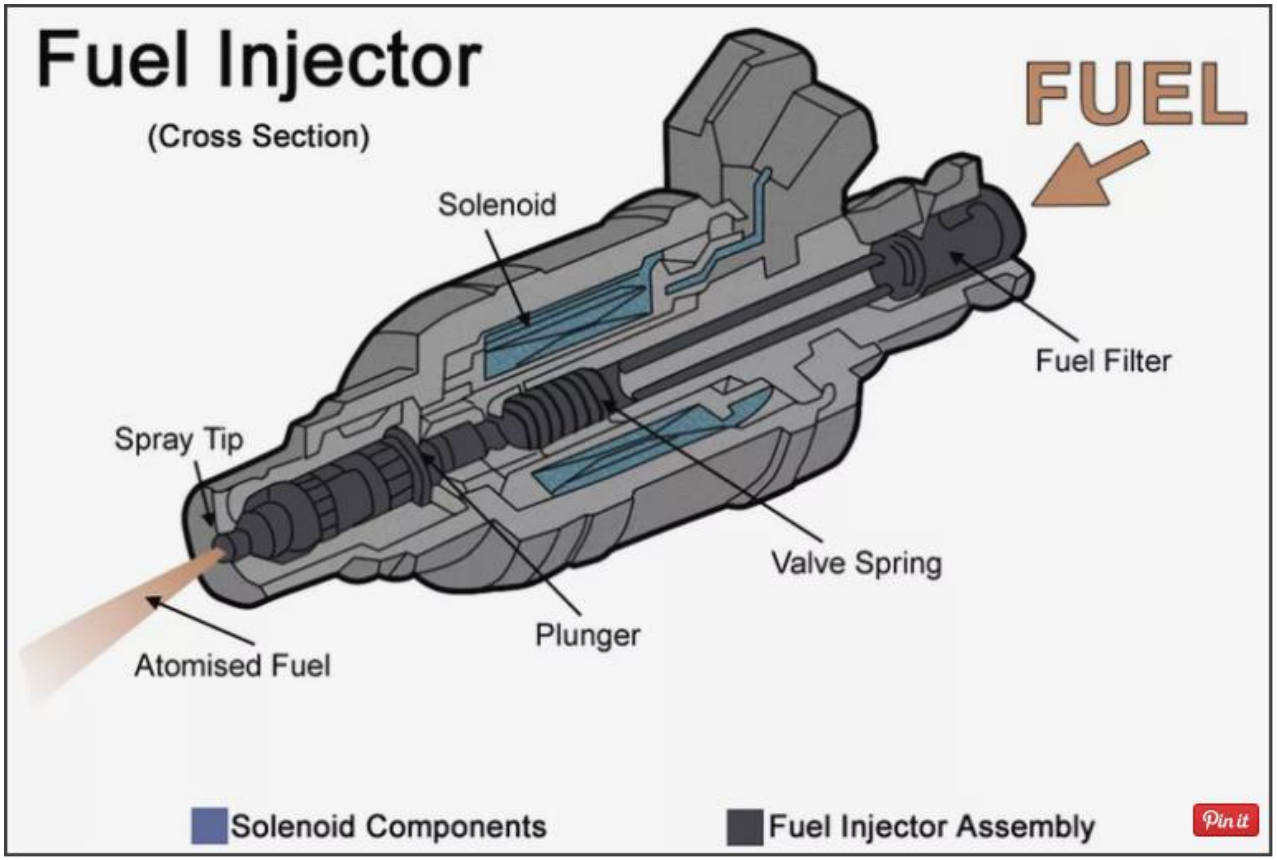
Any time a car is driven it will come in contact with airborne particles and dirt kicked up from the surface of the road. If these get into the fuel system of the car they are going to cause some problems. It does not necessarily mean that the vehicle will break down, but the chances for inefficiency are great and sooner or later there is going to be a major repair required.

For more detailed information, please visit https://procarmechanics.com/the-importance-of-fuel-system-maintenance/

Also visit https://www.howacarworks.com/basics/how-a-fuel-injection-system-works

And http://www.stp.com/the-garage/maintenance/fuel-system

How to Clean Fuel Injectors



Clogged fuel injectors can hinder your vehicle's performance, lowering its power and mileage.

Following are some important points which should be considered at the time of fuel injector cleaning;

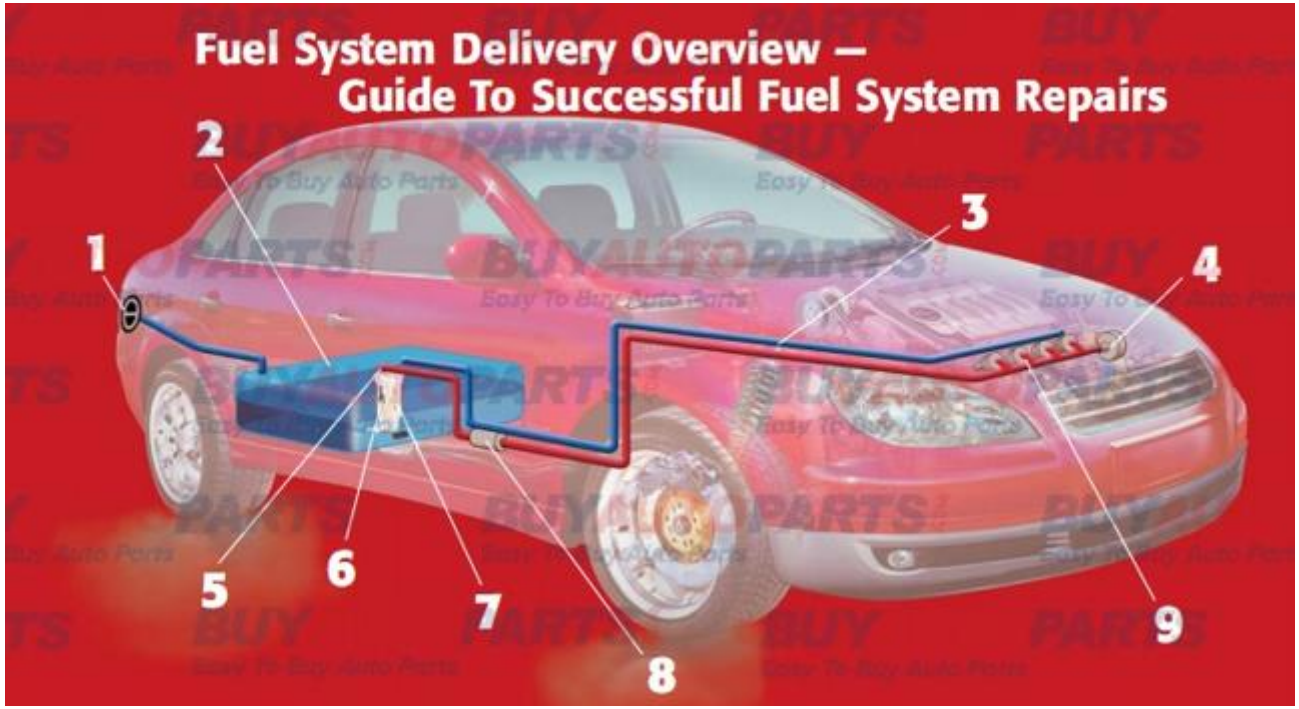
1. Review vehicle's engine layout to locate the fuel injectors.
2. Disconnect the fuel pump from the fuel injectors.

3. Disconnect the pressure regulator vacuum line if available.
4. Connect the cleaning kit to the fuel port
5. Remove the cap from the fuel tank to prevent pressure buildup.
6. Turn the vehicle to let the cleaning fluid into injectors.
7. Remove the cleaning kit and reattach pump and injectors.
8. Turn the vehicle on again to make sure the fuel injectors work.

For more detailed information, please visit https://www.wikihow.com/Clean-Fuel-Injectors also visit https://completeautoloans.com/fuel-injection-service-what-you-should-know/

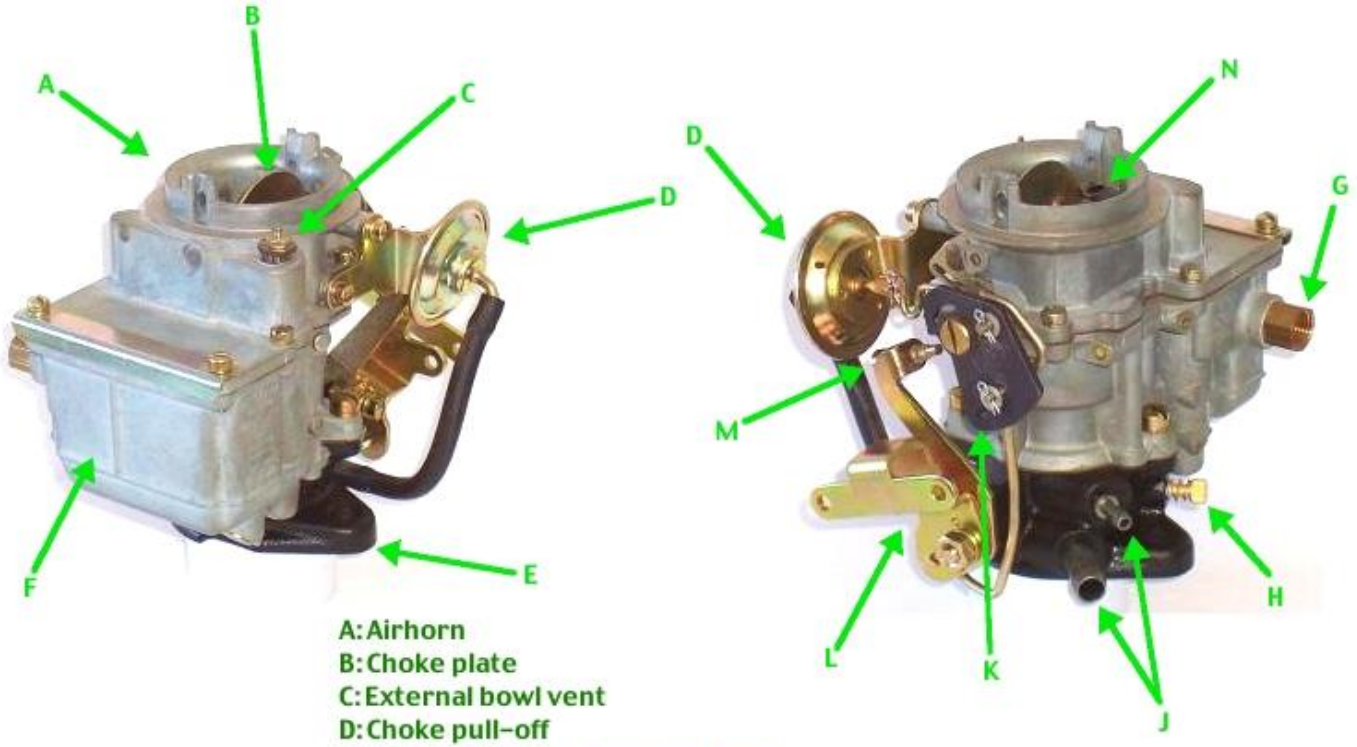
And https://www.liveabout.com/how-to-clean-fuel-injectors-4582625

Factors to Consider in Fuel System Diagnostics



For more detailed information, please visit https://www.buyautoparts.com/howto/repair-fuel-pump.htm
Also visit https://www.buyautoparts.com/howto/repair-fuel-pump-parts.htm

How to Clean a Carburetor



A: Airhorn
B: Choke plate
C: External bowl vent
D: Choke pull-off
E: Throttle body & mounting base
F: Float bowl
G: Fuel inlet
H: Idle mixture adjusting screw
J: Vacuum nipples
K: Fast-idle cam
L: Throttle lever
M: Idle speed adjusting crackscrew
N: Internal bowl vent

The carburetor should be maintained and cleaned on a regular basis to ensure that it is working properly. The process of cleaning it -- inside and and out -- is quite simple;

1. With the engine off, remove your air filter housing so that the carburetor is accessible.
2. Place some rags around the base of the carburetor
3. Put on your safety goggles and spray the "outside" of the carb with your lubricant
4. Before you start the car, spray a small amount of carb cleaner directly into the carb
5. Let the car run for a few minutes at normal idle. Then turn off engine and re install the air filter and housing

For more detailed information, please visit https://itstillruns.com/clean-car-carburetor-2292030.html

Also visit https://www.liveabout.com/how-to-clean-a-carburetor-4573

How to Clean a Throttle Body

A throttle body is an electronic device that operates the throttle valve. The throttle valve controls engine RPMs by regulating the air flow. A small electric motor inside the throttle body opens and closes the throttle valve.

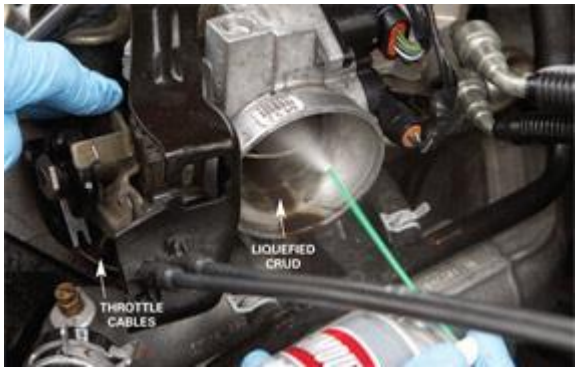
The throttle body service involves cleaning the throttle body with a special cleaning solution and removing carbon deposits from the throttle valve. In some cars, the idle speed must be re-learned after the service was done. The throttle body service is not a part of a scheduled maintenance, but for some problems, it may offer a simple solution.

Disconnect the air duct

Disconnect the air duct from the throttle body. Disconnect and mark any electrical connectors or vacuum lines you remove.

Spray on a throttle body cleaner

Locate the throttle cables and rotate the throttle plate. Spray throttle body cleaner around the inside of the throttle body.



Dry off the solvent

Shoot compressed air into the throttle body to dry the spray solvent. Reinstall the ductwork and attach the vacuum lines and electrical connectors.

For more detailed information, please visit https://www.familyhandyman.com/automotive/car-maintenance/cleaning-a-throttle-body/

Also visit https://www.testingautos.com/car_care/throttle-body-when-to-service.html

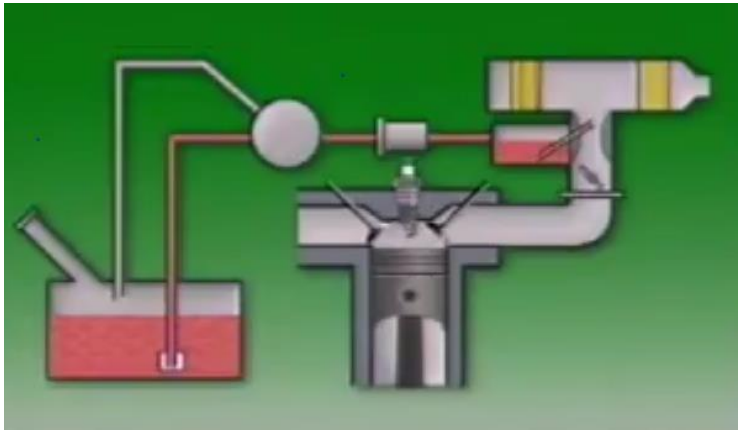
And https://mobiloil.com/en/article/car-maintenance/how-to-do-it-yourself/proper-throttle-body-cleaning-guide

VIDEOS:

	**How to Maintain Fuel Injectors** **https://youtu.be/ImSKopv53jk**
	**How to Help Maintain Your Fuel System** **https://youtu.be/qIJY1MvECpQ**

	**How to Conduct a Fuel Pump Repair and Tank Replacement** **https://youtu.be/zE4vxhbGx00** **The above link is only taken for reference**
	**How to Replace a Fuel Pump in Your Car** **https://youtu.be/jM6jCMH8w8k**

	**How to - Cleaning Throttle Body, Intake Manifold & Piston Crowns // Supercheap Auto** **https://youtu.be/WOGFvju2ZTc**
	**Quick Tip-Throttle Cleaning - EricTheCarGuy** **https://youtu.be/41yFXjibtLY**

	**AUTOMOTIVE ENGINE PERFORMANCE - Carburetor Fuel Systems** **https://www.youtube.com/watch?v=yOKd5Mv52v0**

AUTOMOTIVE MECHATRONICS

Module-7

LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - October, 2019

Module 7: 071400944 Service Engine Cooling System

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to service engine cooling system.

Duration: 50 Hrs **Theory:** 12 Hrs **Practical:** 38 Hrs

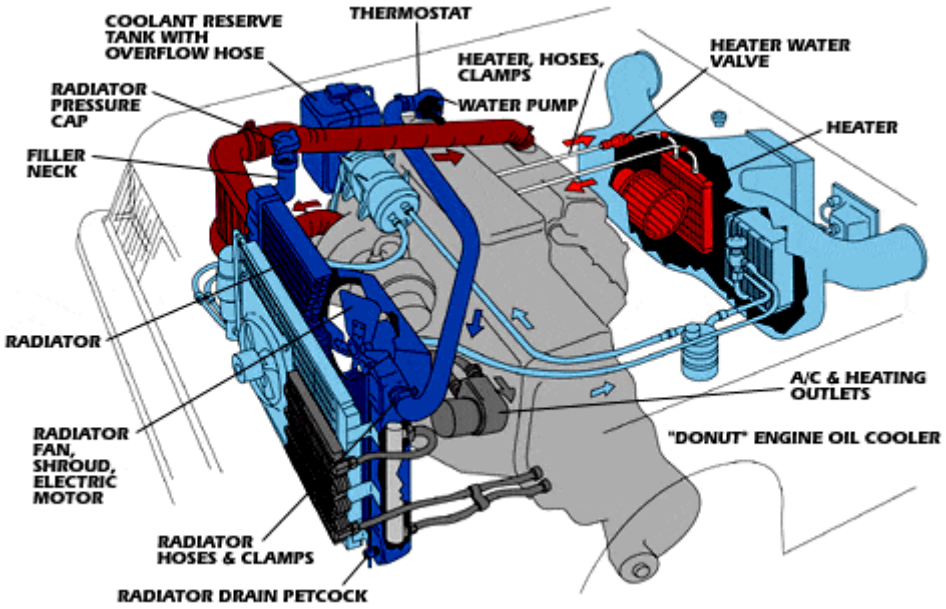
Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Perform Radiator Service	**The trainee will be able to:** Select the tool and equipment according to the job requirement Disconnect all water, automatic transmission fluid (ATF) hoses and electric connections from radiator Remove radiator from vehicle Remove fan with shroud Service/replace the radiator Refit fan and shroud with radiator Refit the radiator in the vehicle Check leakages in cooling system Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to perform radiator service The importance of using the correct tools and equipment (as per job requirement), to perform the competence Operational knowledge and understanding of function and basic parts of cooling system (i.e. Radiator, Hoses, Water Jackets, Thermostat valve, Temperature Switch, Cooling Fan, Water Pump) Explaining purpose and function of coolant in cooling system Defining function of (heat exchanger) Radiator Identifying components of Radiator (i.e. Fins, Upper Tank, Lower Tank, Tubes, Pressure Cap and Drain Plug etc.) function of pressure cap valves (i.e. Pressure relief valve and Vacuum valve) The importance of PPEs when perform radiator service Importance of health and safety Importance of housekeeping	Relevant PPEs Wire Brush Combination Pliers Nose Plier Spanner set Coolant drain tray Fiber brush Phillips Screw Driver Set Flat Screw Driver Set Pressure Cap Tester Thermometer
LU 2: Perform Radiator Fan Service	**The trainee will be able to:** Select the tool and equipment according to the job requirement Disconnect all water, automatic transmission fluid ATF and electric connections	Operational knowledge and understanding of tools/equipment, required to perform radiator fan service Defining types of cooling system (i.e. Air cooling system, Water cooling system) Explaining percentage of direct air cooling (29%) and	Safety Shoes Overall Wire Brush Combination Pliers Nose Plier Spanner set

	from radiator Remove radiator from vehicle Remove fan from shroud Service/replace the fan motor and fan Replace the carbon brushes Refit the fan with shroud. Refit the radiator in the vehicle Ensure housekeeping after completion of task	water cooling (71%) The importance of PPEs when perform radiator fan service Importance of health and safety Importance of housekeeping	Coolant drain tray Fiber brush Phillips Screw Driver Set Flat Screw Driver Set Pressure Cap Tester Thermometer Relevant PPEs
LU 3: Evaluate Thermostat Valve Performance	**The trainee will be able to:** Select the tool and equipment according to the job requirement Disconnect the water connections from thermostat valve hosing. Remove the thermostat valve Check the thermostat valve as per the workshop manual. Replace thermostat if found faulty Refit the valve into the housing Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to evaluate thermostat valve performance Operational knowledge and understanding of function of thermostat valve Defining material used in thermostat valve (i.e. Wax pellet) Knowledge of operating temperature of thermostat valves The importance of PPEs when evaluate thermostat valve performance Importance of health and safety Importance of housekeeping	Combination Pliers Nose Plier Spanner set Phillips Screw Driver Set Flat Screw Driver Set Relevant PPEs
LU 4: Evaluate Water Pump Performance	**The trainee will be able to:** Select the tool and equipment according to the job requirement Disconnect the water and	Operational knowledge and understanding of tools/equipment, required to evaluate water pump performance Explaining parts of water pump (i.e. Propeller, Bearing, Fan pulley)	Combination Pliers Nose Plier Spanner set Coolant drain tray

	electric connections from water pump. Remove Water pump from vehicle. Check water pump pressure, seals and bearings Replace water pump Ensure housekeeping after completion of task	Describing procedure of disassembly and assembly of water pump including its connections (i.e. Water connections) The importance of PPEs when evaluate water pump performance Importance of health and safety Importance of housekeeping	Phillips Screw Driver Set Flat Screw Driver Set Relevant PPEs

Examples and illustrations

How to Service a Radiator



Step 1:

Jack up the car, place jack stands under the frame and lower the car onto them

Step 2:

Remove the thermostat. Follow the upper radiator hose from the radiator to the engine

Step 3:

Remove the upper radiator hose and slowly fill the radiator with tap water.

Step 4:

Start the engine and let it run for three to five minutes to circulate the coolant throughout the cooling system. Let it sit for 20 to 30 minutes.

Step 5:

Drain the radiator. Remove the upper and lower radiator hoses.

Step 6:

Flush the radiator. Insert the garden hose into the upper radiator filler opening

Step 7:

Install the lower radiator hose. Install the thermostat.

Step 8:

Remove the overflow container. Clean and rinse the container.

Step 9:

Start the vehicle and let it idle for 10 minutes, then let the engine completely cool.

For more detailed information, please visit https://itstillruns.com/service-radiator-6922310.html
Also visit https://www.popularmechanics.com/cars/how-to/a78/1272246/
And https://axleaddict.com/auto-repair/How-to-Change-a-Car-Radiator-in-Your-Own-Garage

Radiator Fan:

A radiator fan is very important when it comes to cooling your car. Your car engine must remain cool to avoid overheating and breaking down completely. The radiator fan is responsible for blowing or pulling air around the radiator to keep it cool.

Radiator Fan Service:

Step 1 - Allow Your Car to Cool

If you have just discovered the problem and your engine has been running, it is very important to allow the engine and radiator to fully cool so that you do not burn your hands or cause any additional damage to the engine.

Step 2 - Remove the Fan

Locate your radiator and find the cooling fan. There are usually four bolts on most radiators: two on top of the fan and two below.

Once the bolts are removed, you should be able to pull it out. Make sure to be careful and pull it out slowly because it is connected to a wire at the bottom of the fan.

Step 3 - Clean the Fan

The easiest way to do this is to dip a rag into degreaser and clean off the bad areas.

Use pipe cleaners to clean out the small parts of the fan, gently rubbing it back and forth to remove any unwanted substances or materials.

Step 4 - Check Your Fuses

Find where the fuses are kept in your fan and check them. With some fuses, you can tell if they are broken by holding them up to the light and seeing if a circuit is connected. You can also use a fuse Multimeter to check if there are any bad ones. Replace old fuses with new ones and test your fan again if possible.

Step 5 - Re-attach the Fan

Replace the fan into your radiator, remembering to plug it back into the wire. Bolt it into place with your ratchet and test it by starting your car.

For more detailed information please visit https://www.doityourself.com/stry/how-to-repair-a-radiator-fan

Thermostat:

Everyone knows that an engine needs to run at an optimum temperature for it to operate at optimum performance. One of the most important components that control an engine's peak performance is the thermostat. This is an integral part of a car's cooling system.
The thermostat is a simple valve that opens and closes in relation to engine coolant temperature.

The thermostat in most cars is about 2 inches (5 cm) in diameter. Its job is to block the flow of coolant to the radiator until the engine has warmed up. When the engine is cold, no coolant flows through the engine. Once the engine reaches its operating temperature (generally about 200 degrees F, 95 degrees C), the thermostat opens. By letting the engine warm up as quickly as possible, the thermostat reduces engine wear, deposits and emissions.

The Thermostat Has Two Important Functions:

- To accelerate engine warm-up.
- To regulate the engine's operating temperature.

Having A Properly Working Thermostat Will:

- Help fuel economy
- Reduce engine wear
- Diminishes emissions and blow-by
- Improves cold weather drivability
- Provides adequate heater output
- Helps with overheating

Signs of Thermostat Problems:

- Higher Than Normal Engine Temperature
- Lower Than Normal Engine Temperature
- Fluctuating Engine Temperature (Changing Erratically)
- Poor Engine Performance
- Engine Takes A Long Time To Warm Up
- Engine Overheating
- Popping-Boiling Noises Coming From Your Heater

For more detailed information, please visit https://dannysengineportal.com/thermostat-problems-affect-performance/

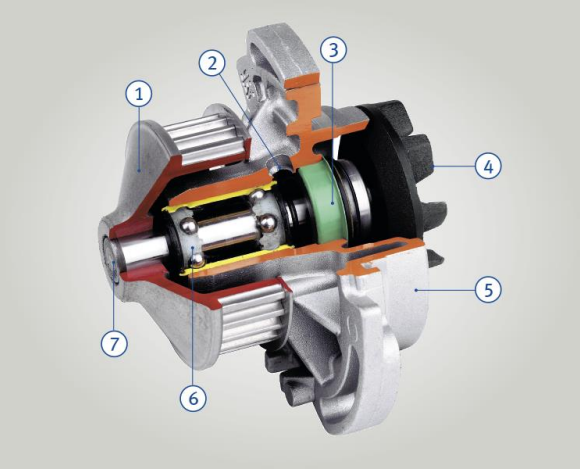
Also visit https://www.carbibles.com/car-thermostat/

And https://auto.howstuffworks.com/how-does-the-thermostat-in-a-cars-cooling-system-work.htm

Water Pump of a Vehicle

One of the reasons an engine can overheat is because of poor design of the water pump and its impeller. If the water-pump is not very efficient, a large improvement in cooling can be had by changing the water-pump to a better design, or even just adjusting its internal tolerances.

A pump is required for transporting the cooling liquid. This water pump – also known as "coolant pump" – circulates the cooling liquid around a closed circuit. Mechanical water pumps are located either externally in their own pump housing or are flanged directly on the crankcase depending on the design. They are usually driven directly by the engine.



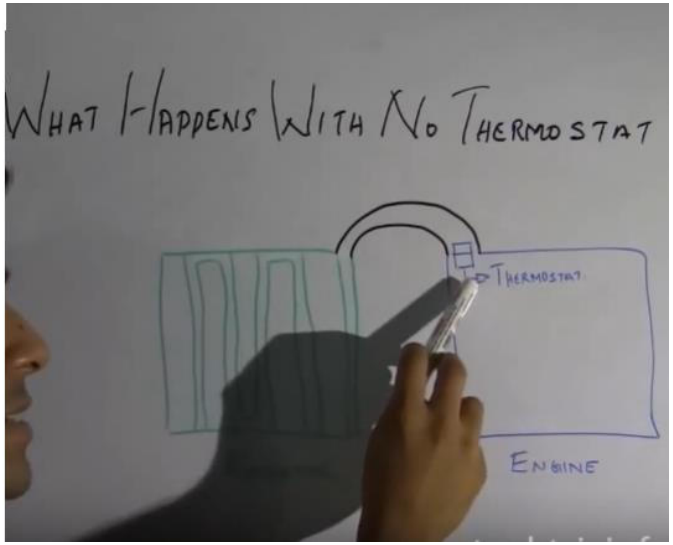
1. Pulley
2. Leakage bore
3. Scraper ring seal
4. Impeller
5. Pump housing
6. Bearing
7. Bearing shaft

For more detailed information, please visit https://www.ms-motorservice.com/en/products-applications/products-in-the-engine/water-pumps-mechanical/

Also visit http://www.autospeed.com/cms/article.html?&title=Water-Pump-Testing&A=110478

Videos:

	**Basic Car Care & Maintenance: Checking Car Radiator Coolant Level** **https://youtu.be/vEdtHZwLKZ8**
	**How to Repair a Cooling Fan in Your Car** **https://youtu.be/iUuK5t-9fiQ**

	**Car radiator cooling fan electrical repair** **https://youtu.be/MoAXL79ThQU**
	**Can engine work without thermostat?** **https://youtu.be/xdFicdS_IX0**

	**Understanding and Testing Thermostats - EricTheCarGuy** **https://youtu.be/PGkSfPbGr3Y**
	**Water Pump Speed: Performance Pulleys and Their Effect on Engine Cooling** **https://youtu.be/7ZXF5n7HGGY**

	**How Do You Test A Water Pump? Testing an Engine Water Pump.** **https://youtu.be/DMYBfrSmQos**

AUTOMOTIVE MECHATRONICS

Module-8

LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - October, 2019

Module 8: 071400945 Maintain Engine Lubrication System

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to maintain engine lubrication system.

Duration: 30 Hrs **Theory:** 06 Hrs **Practical:** 24 Hrs

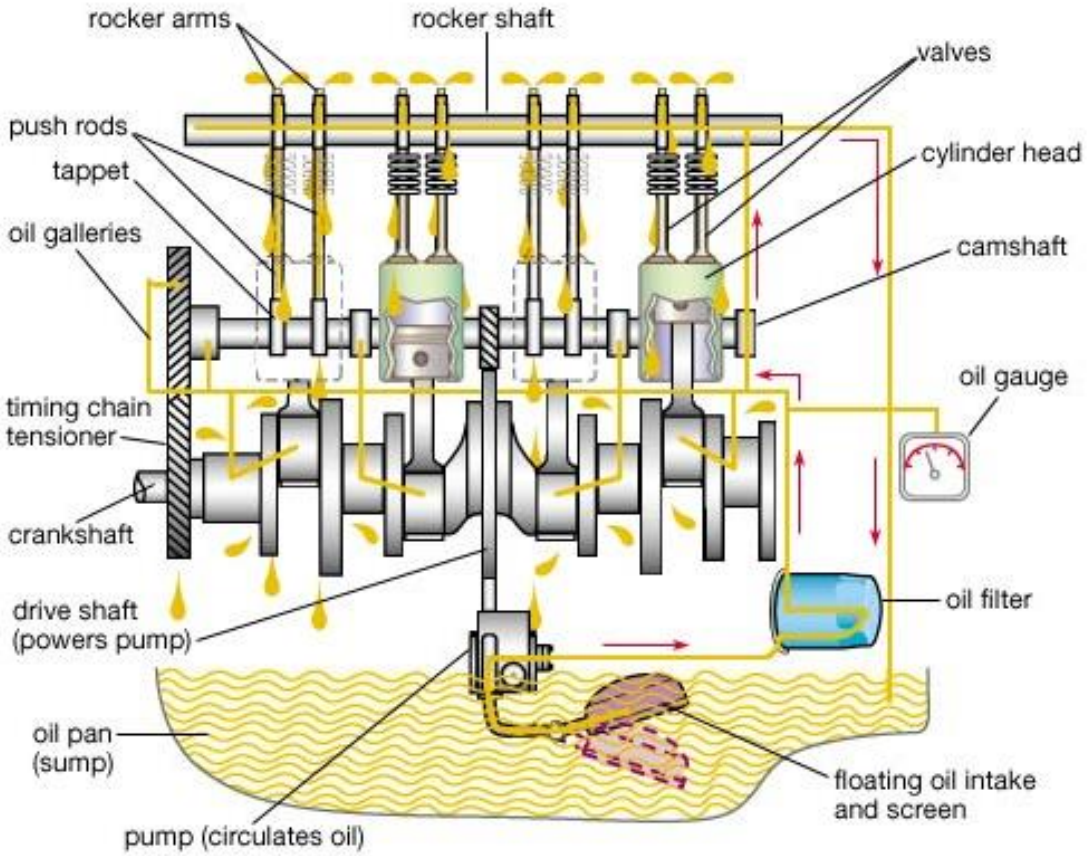
Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Test Performance of Oil Pressure Switch	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Switch on the ignition-switch/key and observe the oil lamp indicator on instrument panel Start the engine and observe the oil lamp indicator Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to test performance of oil pressure switch Explaining types of lubrication system (i.e. splash system, pressure feed system, combined splash and pressure feed system) Describing main functions of engine lubrication system (i.e. reducing frictional effect, cooling effect, sealing effect and cleaning effect) Explaining parts of lubrication system (oil sump, oil pump, oil filter, oil galleries, oil pressure switch and pressure relief valve etc.) Describing main purpose of oil pressure relief valve. Explaining function of oil pressure switch The importance of PPEs when test performance of oil pressure switch Importance of health and safety Importance of housekeeping	Oil filter Kerosene oil Silicon Tube Spanner set Socket set Screw driver set Combination Plier Hammer Seals Relevant PPEs
LU 2: Service Oil Pump	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all	Operational knowledge and understanding of tools/equipment, required for service of oil pump Explaining different types of oil pumps (rotor type, gear type) Operational knowledge and understanding of function of oil	Oil filter Kerosene oil Silicon Tube Spanner set

	times Remove oil sump safely Inspect oil strainer Inspect oil pump Inspect oil pressure relief valve Ensure housekeeping after completion of task	pump Defining structure and parts of oil pump (i.e. oil strainer , oil pump rotor and shaft ,oil seals) Describing about pressure and pressure of oil pump(which ranges from 30-40 PSI) The importance of PPEs when service oil pump Importance of health and safety Importance of housekeeping	Socket set Screw driver set Combination Plier Hammer Seals and gasket Relevant PPEs
LU 3: Investigate & Repair Oil Leakages	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health & safety precautions at all times Locate the oil leakages Replace tappet cover seal Replace oil sump gasket/seal Replace ignition distributor “O” ring (seal)	Operational knowledge and understanding of tools/equipment, required for investigate & repair oil leakages Defining reasons of oil leakage Explaining signs of oil leakage (black spot, wet parts) Explaining function of oil cooler Ensuring repair of oil leakages The importance of PPEs when investigate & repair oil leakages Importance of health and safety Importance of housekeeping	Oil filter Kerosene oil Silicon Tube Spanner set Socket set Screw driver set Combination Plier Hammer Seals Engine oil Relevant PPEs

Examples and illustrations

Engine Lubrication System:

Lubrication is a process that separates the moving parts by supplying a flow of a lubricating substance between them. The lubricant could be liquid, gas or solid. However, engine lubrication system mainly uses liquid lubricants.



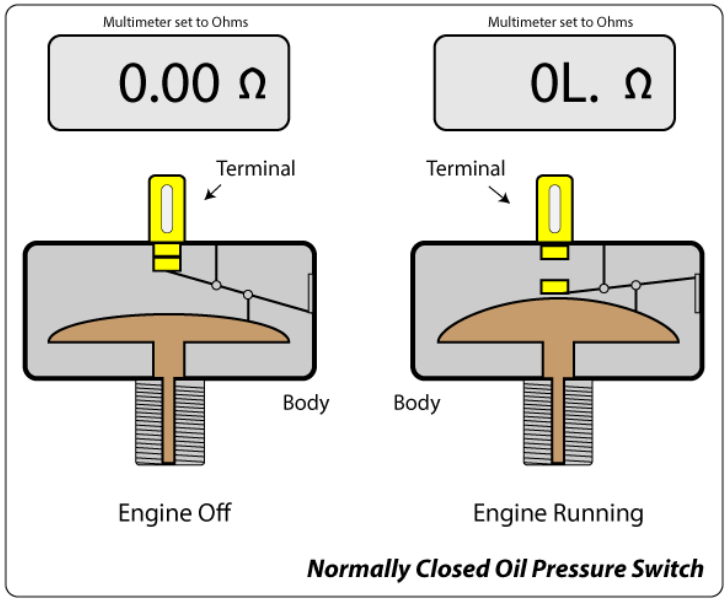
The Engine Lubrication System:

1. Minimizes power loss by reducing the friction between the moving parts.
2. Reduces the wear and tear of the moving parts.
3. Provides cooling effect to the hot engine parts.
4. Provides cushioning effect against vibrations caused by the engine.
5. Carries out the internal cleaning of the engine.
6. Helps piston rings to seal against high-pressure gases in the cylinder.

Oil Pressure Sensor / Switch

The main job of an engine oil pressure sensor is to keep track of the oil pressure in the vehicle and then transmit this information straight to the combination meter or the instrument panel.

If the vehicle has an electronic control module, then the oil pressure switch will send this information to the module where it can be calculated. After it is calculated, the information gets sent to the combination meter or instrument panel so that the engine oil pressure warning light or the oil pressure gauge can be activated.



The switch in the illustration is a typical, normally closed oil pressure switch. Unplug the connector and set the meter to Ohms to check for continuity. Place the positive probe against the terminal and the negative probe against the body. First, test the switch with the engine not running; the switch contacts should be closed. The meter should display zero. Then carefully check the switch with the engine running. When the engine is running, the oil pressure increases beyond the preset value, and the contacts should open; the meter should now display infinity. Depending on the vehicle, it may be easier to remove and bench test the switch with regulated air pressure and a Multimeter set to Ohms.

Symptoms of a Bad Oil Pressure Switch or Sensor

If there is a problem with the oil pressure sensor, then this will usually activate the engine oil pressure light. It could also cause an inaccurate reading to be given from the oil pressure gauge. Below are the three most typical signs of a faulty oil pressure switch or sensor:

#1 – Repeated Blinking from the Oil Pressure Light

Sometimes if the oil pressure sensor is not working properly, there will be blinking from the low oil light on the dashboard. This could cause a driver to panic because they'll believe that their oil levels are low, which would end up damaging the engine if it were true.

#2 – Wrong Reading Shows on the Oil Pressure Gauge

If you are driving an older vehicle, then it likely has a mechanical gauge that calculates the oil pressure. Whenever the oil levels are normal but the gauge is showing zero, this means the oil pressure sensor needs to be replaced because it is faulty or there is some type of connection issue.

#3 – Oil Pressure Light Turns On

The best way to test if your sensor is bad is through the lights on the oil pressure gauge. If the low oil pressure warning light comes on when they engine's oil levels are normal and your engine is running smoothly and quietly, then you likely have a bad oil pressure sensor. Anytime this sensor is defective, it will give you false readings.

For more detailed information, please visit https://cartreatments.com/oil-pressure-sensor-symptoms/

Also visit https://www.freeasestudyguides.com/engine-oil-pressure-switch.html

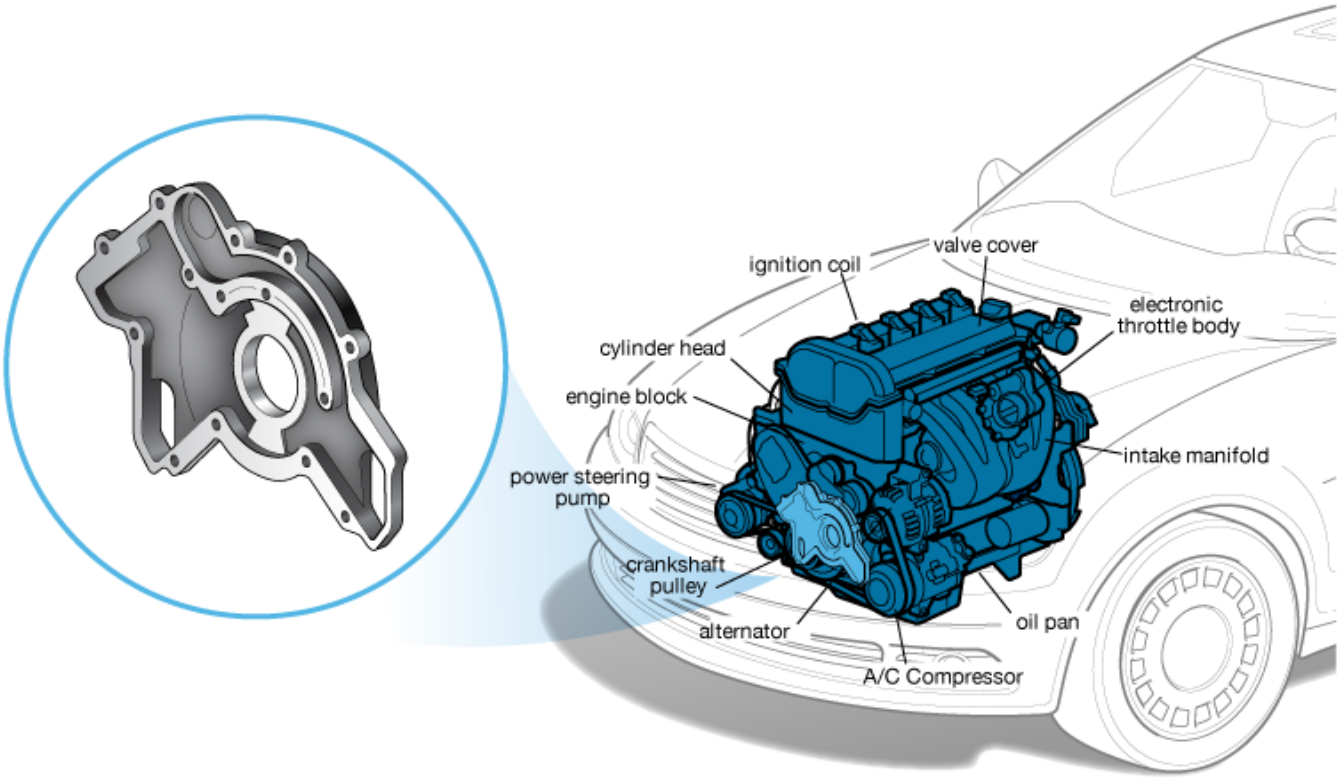
And http://www.masterlineworld.com/index.php/en/knowledge-center/automotive-lubrication/engine-lubrication

And https://carbiketech.com/engine-lubrication-system/

Oil Pump:

The oil pump is the heart of the lubrication system. It sucks oil up from the oil pan and forces it around oilways in the engine, before the oil drops back into the sump and is recirculated. The oil pump is a highly critical part of the engine - if an oil pump stops working it will lead to expensive engine failure 100% of the time. That's one reason why the oil pump is so directly driven from the crankshaft.

Oil pumps are situated in the oil pan, or more usually at the front of the engine.



The oil pump is responsible for conveying the oil for engine lubrication and building up the oil pressure in the lubrication system.

All oil pumps are called **positive displacement pumps** - the amount of oil that leaves is the same as that enters. In other words, the pump moves oil from one side, to the other. This can be contrasted with a coolant pump, for example, which tries to move water but will not do so if the pressure is too great on one side.

As engine RPM increases, the pump turns faster and more oil is pumped. This is convenient because at higher engine speeds lubrication and cooling requires a greater flow of oil.

Function

Oil pumps are usually operated by the crankshaft by way of auxiliary drives. The delivery of the oil pump is governed by its size, speed and design.

Oil pump mechanisms

There are two main types of oil pump in use. Both use metal gears for longevity and the ability to pump against high pressures.

Rotor-type pumps

Rotor type pumps are the most common. Sometimes called **gerotors**, or **trochoidal pumps** . The pump has two gears - one inner gear, which is driven and one outer gear which rotates around the inner gear. The inner gear has one less tooth than the outer gear, leaving a space into which expands and sucks oil in to fill it. As the rotation continues, that space is slowly closed as the gear teeth mesh together once again, and the oil is forced out of the gap and out of the pump.

Gear-type pumps

A gear-type oil pump has two gears of the same size, which mesh against each other. One gear is driven, and interlocks with the undriven gear to mean that they both rotate at the same time. As the teeth move around, they carry oil in the gap, until meeting in the middle and meshing together once more - forcing the oil out.

Checking or replacing an oil pump is not part of routine service or maintenance, but because it's critical to an engine any warning signs should be addressed immediately. An illuminated oil system warning light (usually red with the outline of a vintage oil can) or low-pressure indication on an oil pressure gauge are signs that the oil level is extremely low, the pump is not operating at normal speed or there's a related problem that needs prompt attention.
When a warning light comes on, the best approach is to shut the engine off, wait several minutes and check the oil level. If the oil level is normal and the warning light comes on again when the engine is restarted, continuing to run the engine increases the risk of major damage.

Removing, checking and refitting the pump

Put a tray or rag under the engine to collect any drips of oil, and unscrew the bolts securing the pump to the engine block.

As you withdraw the pump, mark the position of the pump drive shaft so it can be put back in exactly the same way.

The drive shaft sometimes drives the distributors as well (check in the service manual). On such engines, remove the distributor cap and mark the position of the rotor arm.

If the rotor arm is moved at any time — if the engine is turned, for example the ignition timing will have to be reset.

On externally mounted pumps with a skew gear, the gear can usually be put back in any position.

Use a rag dipped in petrol and, if necessary, a scraper tool to carefully remove dirt and any gasket remains from the pump mounting flange.

Be careful not to damage the mounting faces on the pump or engine. Usually only externally mounted pumps have a gasket.

Make sure the working parts of the pump are thoroughly cleaned.

On externally mounted pumps, fit a new gasket to the pump flange, and keep it in position with a smear of gasket sealant while you locate the drive shaft.

Make sure the drive shaft is correctly aligned before you push the pump back into position. If it fails to locate properly, withdraw the pump and move the drive shaft very slightly, then try again.

Refit and tighten the pump securing nuts or bolts to the torque-wrench setting recommended in the service manual for your car.

On an internally mounted pump, refit the sump pan and replace the engine oil.

For more detailed information, please visit https://www.howacarworks.com/engine/engine-oil-pump-replacement

Also visit https://www.howacarworks.com/engine/checking-the-oil-pump

And https://www.cars.com/auto-repair/glossary/oil-pump/ and https://www.howacarworks.com/oil-pump

And https://www.my-cardictionary.com/cardictionary/products/produkt/Produkt/show/oil-pump.html

Oil Leak

Oil leaks and losses are one of the most common reasons that drivers bring their cars in for inspection. An oil leak should never go ignored.

A leak of any kind should be addressed immediately, but an engine oil leak even more so. Leaking oil can cause ugly stains and are an environmental hazard. And worst of all, engine oil leaks are a fire risk in engine compartment and can result in catastrophic engine failure at the worst possible time, not that there is a good time for catastrophic engine failure. So fixing oil leaks should be number one priority.

Causes of an Oil Leak

There are many different things that lead to an oil leak and can sometimes be difficult to identify. To take out some of the guesswork, here are common causes of oil leaks:

Valve Gasket - Over time and lots of miles on a car, gaskets can become damaged which does not allow for a proper seal causing a leak.

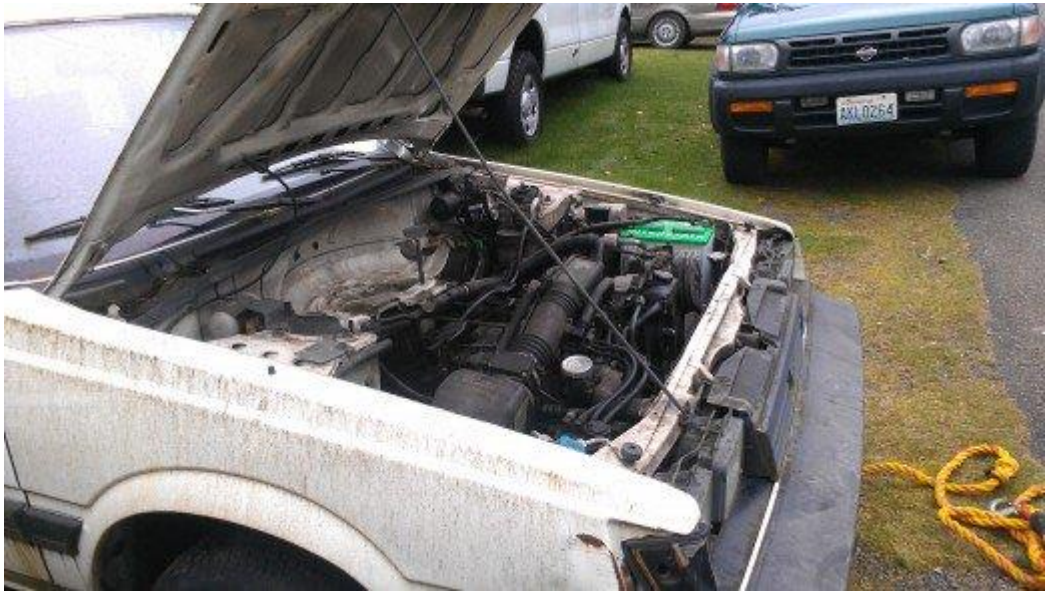
Oil Drain Plug - Each oil pan has a drain plug. A worn out, misaligned, or loose plug can cause an oil leak.

Oil Pan - An oil pan can become damaged by road debris and rocks and cause leaks.

Oil Filler Cap - A missing, loose, or broken cap can lead to a leak because oil can easily spill.

Oil Filter - Filters can be installed improperly, loose, or wear out causing a leak. Be sure your filter is changed and checked for correct fitting each time your oil is changed to avoid future leaks.

How to Spot an Oil Leak



Spotting an oil leak can be extremely obvious or not at all. Here are a few ways to spot an oil leak, big or small:

Stains or Puddles - The most obvious indicator of an oil leak is a brown puddle or stain under the engine compartment of your car.

Low Engine Oil Level - Check your vehicle's engine oil often. If you notice the level on your dipstick drops over time, you're losing oil.

Blue Smoke - Blue smoke from your tailpipe is often an indicator that oil is leaking into the engine.

Burnt Oil Scent - If you smell burning oil after you've driven your vehicle, oil could be leaking onto hot parts of your engine.

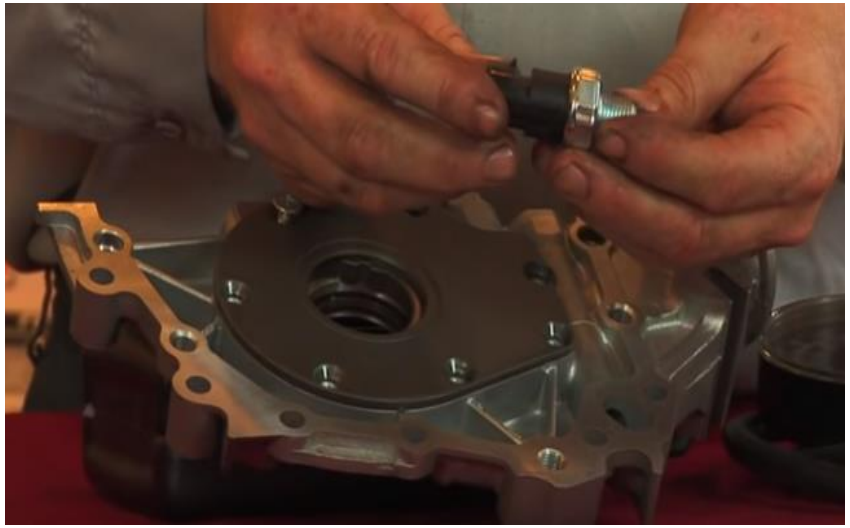
For more detailed information, please visit https://axleaddict.com/auto-repair/5-Reasons-Your-Car-is-Leaking-Oil

Also visit https://www.goldeagle.com/tips-tools/oil-leak-causes-and-how-fix-them/

And https://boostperformanceproducts.com/blogs/boost-engine-performance/how-to-spot-an-oil-leak

Videos:

	**HOW TO TEST AN OIL PRESSURE SWITCH. Everything You Need To Know.** https://youtu.be/4x_-uZOOrMk
	**Engine Oil Pump Service** https://youtu.be/8qbryKb9LmU

	**Auto Repair & Maintenance: How to Check if an Oil Pump Is Bad** **https://youtu.be/lbXsjLMJkjk**
	**How to Fix Engine Oil Leaks in Your Car** **https://youtu.be/yn2CTZ1MA_Q**

AUTOMOTIVE MECHATRONICS

Module-9

LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - October, 2019

Module 9: 071400946 Maintain Brake System

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to maintain brake system.

Duration: 50 Hrs **Theory:** 16 Hrs **Practical:** 34 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Perform Maintenance of Mechanical Brake System	**The trainee will be able to:** Select appropriate tools and equipment. Remove, clean, inspect and measure drum/disc diameter Repair brake drum/disc Inspect wheel cylinders for leakage and proper operation Adjust brake shoes and parking brake Install brake drums or hub assembly Install wheel bearing as per workshop manual Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to perform maintenance of mechanical brake system Identifying brake system Describing function of brake system Defining types of brake system (i.e. Mechanical, Pneumatic, Hydraulic, Power Brake, ABS) Identifying components of mechanical brake system (i.e. Hand lever, cable, Brake assembly) Explaining types of brake assembly (i.e. Shoe/Drum type, Disc/Pad type) Inspecting and servicing of mechanical brake systems Defining method of installing wheel bearing The importance of PPEs when perform maintenance of mechanical brake system Importance of health and safety Importance of housekeeping	Cotton waste Brake Shoes Brake Pads Petrol Emery paper Relevant PPEs
LU 2: Perform Maintenance of Hydraulic Brake System	**The trainee will be able to:** Select appropriate tools and equipment. Measure brake pedal height Adjust brake pedal travel and free play	Operational knowledge and understanding of tools/equipment, required to perform maintenance of hydraulic brake system Describing types of hydraulic brake system (i.e. Calliper assembly, Wheel cylinder) Explaining procedure of maintaining hydraulic brake	Brake fluid Cotton waste Brake Shoes Brake Pads Master cylinder kit

	Check master cylinder for external leakages and proper operation. Inspect brake lines, hose pipes and fittings Select and fill brake fluids to proper level. Perform brake bleeding Perform road test Ensure housekeeping after completion of task	system including disassembly and assembly of related components Describing importance and procedure of brake bleeding Explaining purpose of brake master cylinder, Wheel cylinder and brake booster Defining purpose, characteristics and importance of brake fluid The importance of PPEs when perform maintenance of hydraulic brake system Importance of health and safety Importance of housekeeping	Wheel cylinder seal Petrol Emery paper 0 No. Relevant PPEs
LU 3: Perform Maintenance of Pneumatic Brake System	**The trainee will be able to:** Select appropriate Tools and equipment. Measure brake pedal height Adjust brake pedal travel and free play Check master cylinder for external leakages and proper operation. Inspect brake lines, hose pipes and fittings Inspect air reservoir, safety valve, water drain plugs Start vehicle and check the air leakage. Perform road test Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to perform maintenance of pneumatic brake system Explaining types of pressure (i.e. Atmospheric pressure, Negative pressure) Explaining parts of pneumatic brake system (i.e. Compressor, Storage tanks, Brake booster, Valves, Diaphragm etc.) Explaining procedure of maintaining pneumatic brake system including disassembly and assembly of related components The importance of PPEs when perform maintenance of pneumatic brake system Importance of health and safety Importance of housekeeping	Cotton waste Brake Shoes Brake Pads Petrol Emery paper 0 No. Relevant PPEs

Examples and illustrations

Braking System

The braking system is one of the main safety elements active in any vehicle. Of its various components, the materials that cause friction - brake discs and brake pads - need to be periodically maintained and replaced, as they are subject to wear.

To ensure that the braking system is always in perfect working order, both brake pads and brake discs must be maintained in the best possible condition. Indeed, each time the vehicle brakes, the friction generated causes the material used in both the brake pads and the brake discs to become worn.

In order to maintain your brakes, it helps to know exactly which parts & components to check. No matter what car you drive, you have to pay attention to these primary players:

Master brake cylinder – this device is responsible for taking the signal from your brake pedal and transferring pressure to each wheel. There, calipers or drum assemblies move to help slow & stop your vehicle.

Brake fluid reservoir – this is where you'll need to add brake fluid following brake changes, or if you need to cap off the fluid level.

Brake lines – basically, this is the conduit for the brake fluid. Brake lines travel to each wheel and originate near the master cylinder.

Brake rotor – a spinning disc behind your wheel, this is compressed by brake pads for the necessary stopping power.

Brake pads – there are 2 pads per rotor, and each presses against the rotor when the brake pedal is pressed.

Calipers – located around the rotor, they're responsible for moving the brake pads, thanks to an interior piston.

Drum brake assembly – usually located on the rear wheels, the drum assembly uses brake shoes that move outward toward the inner surface of the drum. This friction enables the wheels to slow & stop.

BrakeMaintenanceBasics

Now that we've identified which parts to look out for, it's time to talk brake maintenance 101. There are some things you can do to make your brakes work better.

- **Keep the brake fluid cylinder full.** Whenever the level is low, you're putting excess strain on the master brake cylinder and other components. And this ripple effect goes all the way down to your pads, rotors and drums.

- **Perform regular inspections.** Many cars nowadays have steel or alloy wheels, which enables you to look at the calipers, pads and rotors without much hassle (it's harder with plastic wheel covers, but you can simply pop those off to check).

- **Pay attention to dashboard lights.** Newer cars have a built-in "system status" check for brakes. If your brakes aren't functioning properly, you may see a "BRAKE" light on your dashboard (for other cars, this may indicated your emergency brake is on). The light's on for a reason (or many reasons), so perform a brake check soon afterwards.

- **Check the underbelly.** Your car's underside takes the brunt of everything – ice, tar, pebbles, salt and other materials. And your brakes lines take a beating in the process.
- **Get on a schedule.** The good news: your auto owner's manual already has the blueprint in place for proper brake maintenance.

When to replace brake discs and brake pads

We recommend checking your brakes every 15,000/20,000 kilometers, but a check-up should be performed immediately if the vehicle presents signs of vibration.

The main signals that indicate that the brake disc or brake pads are worn or deteriorated are:

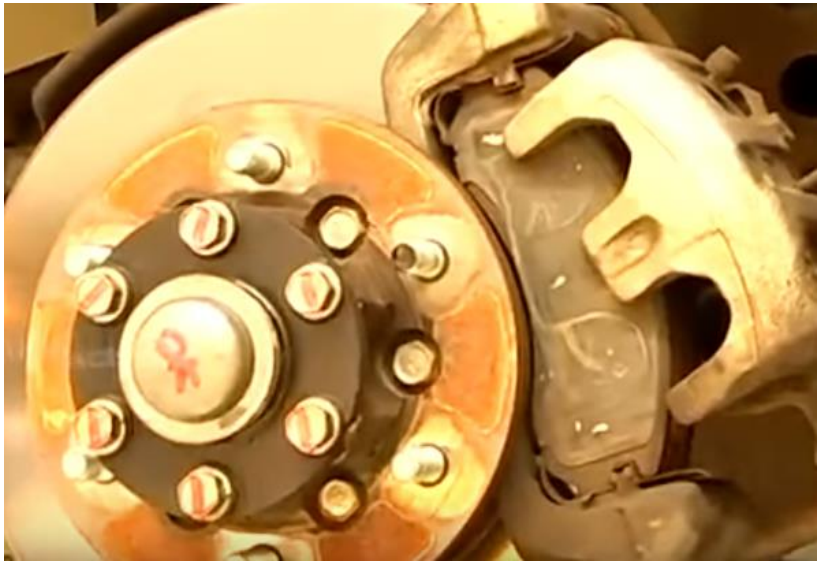
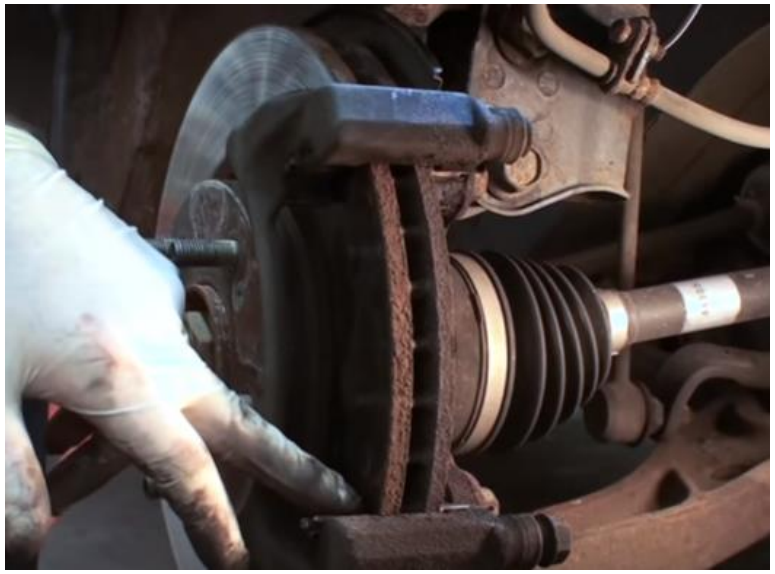
1. The warning light comes on (when one is present, and only for the brake pads)
2. Noise occurs during braking
3. Presence of vibrations
4. Presence of deep circular lines or radial cracks on the braking band
5. Signs of overheating

in some cases, the level of the brake fluid may also provide useful information about the rate of wear of the brake discs and brake pads. When the brake pads and discs become worn, the small piston of the brake caliper is forced to travel further in order to compensate for the loss of

brake disc and/or pad thickness, in turn absorbing a larger quantity of brake fluid that causes the appropriate warning light on the dashboard to light up.

For more detailed information, please visit https://www.brembo.com/en/car/aftermarket/drivers/maintenance-of-the-braking-system
Also visit https://www.actiongatortire.com/5-keys-brake-maintenance/
And http://www.totalmarketingmiddleeast.com/en/total-car-maintenance-tips/brake/how-to-maintain-your-braking-system.html
And https://www.buyautoparts.com/howto/Brake-Maintenance.html

Videos:

	**Checking and Maintenance of Car Brake System** **https://youtu.be/ZnZpkqqiT3I**
	**The Basics of Disc Brake Service -EricTheCarGuy** **https://youtu.be/cKpmBvfVYZg**

	**Servicing Disc Brakes** **https://www.wikihow.com/Service-Brakes**

AUTOMOTIVE MECHATRONICS

Module-10

LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - October, 2019

Module 10: 071400947 Maintain Suspension System

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to maintain various types of suspensions and their component parts.

Duration: 60 Hrs **Theory:** 20 Hrs **Practical:** 40 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Check Performance of McPherson Strut	**The trainee will be able to:** Select the tool and equipment according to the job requirement. Ensure safety precaution. Check for damaged or sagging springs. Check the steering mounts and linkages. Remove McPherson strut. Check the McPherson strut pivot bearing Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to check performance of McPherson strut Defining suspension system and its types Describing sprung and un-sprung weight Describing coil spring and its damages Identifying steering linkages and their location Explaining procedure of disassembling and assembling of steering and linkages Explaining about McPherson pivot bearing and purpose of its placement. Procedure of removal of McPherson strut from car, including assessment of its performance. The importance of PPEs when check performance of McPherson strut Importance of health and safety	Rubber seal Rubber boots Hydraulic oil Cotton clothes Relevant PPEs

		Importance of housekeeping	
LU 2: Check Tie Rod Performance	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Check play in ball joint Replace ball joint Inspect tie rod end, tie rod/rack-end and ball joints at the end Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to check tie rod performance Identifying ball joint, Tie rod, tie rod end, rack end inspection Describing purpose of ball joint Explaining function of ball joint and their types. Defining performance of ball joint including free play Describing procedure to replace ball joint The importance of PPEs when check tie rod performance Importance of health and safety Importance of housekeeping	Rubber bushes Staring oil Oil seal Cotton cloths Relevant PPEs
LU 3: Check Performance of Coil Spring Sagging	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution	Operational knowledge and understanding of tools/equipment, required to check performance of coil spring sagging Explaining Types of coil spring Defining coil spring and explaining coil spring height,	Rubber bush Relevant PPEs

	Inspect coil spring height Replace cracked/ damaged rubber cushion Replace cracked/ damaged coil spring Ensure housekeeping after completion of task	diameter, wire diameter and number of turns. Explaining coil spring rubber cushion including replacement of cracked/damaged rubber cushion Explaining spring rate and calculating loading capacity of the coil spring. Explaining of Coil spring replacement as per manufacture's specification. The importance of PPEs to check performance of coil spring sagging Importance of health and safety Importance of housekeeping	
LU 4: Test Performance of Stabilizer Bar	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Inspect/replace the stabilizer bar mounting bush Inspect/replace stabilizer bar links Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to test performance of stabilizer bar Defining components of stabilizer bar including linkage. Explaining inspection procedure for stabilizer bar and linkage Describing replacement sequence of Stabilizer bar including Stabilizer bar linkages. Explaining Stabilizer bar adjustment Defining operation of Stabilizer bar Defining procedure of transverse (or side-to-side) wheel supporting. Defining procedure of longitudinal (front-to-back) wheel supporting. The importance of PPEs when test performance of stabilizer bar	Grease and oil Stabilizer bush kit Cotton cloth Relevant PPEs

		Importance of health and safety Importance of housekeeping	
LU 5: Test Knuckle Assembly Operations	**The trainee will be able to:** Select the tool and Select the tool and equipment according to the job requirement Ensure safety precaution Check performance of knuckle assembly Replace wheel bearing Replace wheel hub Replace knuckle assembly Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to test Knuckle assembly operations Describing inspection procedure for knuckle assembly Explaining the reasons and rectification of excessive play in knuckle assembly. Defining replacement procedure of wheel bearing. Determining wheel hub replacement procedure including safety precautions taken. Explaining types of wheel hub bearings and oil seals. Explaining function of Tapper roller bearing including ball bearing. The importance of PPEs when test Knuckle assembly operations Importance of health and safety Importance of housekeeping	Grease and kerosene oil Cotton cloth Relevant PPEs
LU 6: Check Performance of Upper & Lower	**The trainee will be able to:** Select the tool and equipment according to the job requirement	Operational knowledge and understanding of tools/equipment, required to check performance of upper & lower suspension arms	Grease and oil Rubber bushes Relevant PPEs

Suspension Arms	Ensure safety precaution Replace mounting bush Replace ball joint Inspect upper & lower arms bush Replace suspension arms Ensure housekeeping after completion of task	Describing inspection procedure of suspension, upper and lower arms ball joints. Defining replacement procedure of suspension arm rubber bushes. Explaining of suspension, upper and lower arms ball joint replacement. Explaining replacement procedure of upper and lower Suspension arm. Procedure of shock absorber rubber bush replacement including their types (single acting, double acting, Oil filled/Gas filled) The importance of PPEs when check performance of upper & lower suspension arms Importance of health and safety Importance of housekeeping	
LU 7: Test Differential System	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Check oil level Replace differential oil with specified grade oil Clean/ replace axle case breather	Operational knowledge and understanding of tools/equipment, required to test differential system Describing differential axle types and their purpose (Hypoid gear & Spiral Bevel) Explaining differential oil level inspecting/ checking procedures Importance of oil grade Explaining of differential oil level replenishment. Explaining of differential air breather service/working	Oil and grease Rubber bushes Relevant PPEs

	Replace axle seals Ensure housekeeping after completion of task	procedure. Explaining of differential axle oil seals replacement procedure. The importance of PPEs when test differential system Importance of health and safety Importance of housekeeping	
LU 8: Test Axle Assembly	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Replace inner/outer CV (constant velocity) joint Replace inner/outer axle boots Inspect/ replace axle nut and lock Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to test axle assembly Explaining procedure of inner/outer CV Joint replacement including CV Joint excessive play and noisy determine. Defining procedure of inner/outer CV Joint rubber boot replacement Explaining procedure of assembling Wheel hub lock & nut for proper securing wheel. The importance of PPEs when test axle assembly Importance of health and safety Importance of housekeeping	Axle oil Grease Cotton cloth Relevant PPEs
LU 9: Maintain Wheel Alignment	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Perform pre-alignment inspection Inspect wheel alignment	Operational knowledge and understanding of tools/equipment, required to maintain wheel alignment Describing types of tires and rims (Radial & Bias tyre, tubeless tyres, RFT, Alloy rims) Explaining procedure to inspect and replace tires and rims	Wheel balancing weight Cotton cloth Relevant PPEs

	Adjust camber, caster and toe in/toe out Perform road test Ensure housekeeping after completion of task	Explaining wheel alignment and steering geometry Wheel alignment procedure for proper wheel alignment. Explaining inspection procedure for camber, caster, toe-in/ toe-out Demonstrating adjusting/measuring procedure for camber, caster, toe-in/ toe-out on wheel alignment machine. Importance of road testing after the wheel alignment procedure. The importance of PPEs when maintain wheel alignment Importance of health and safety Importance of housekeeping	
LU 10: Maintain Wheel Balancing	**The trainee will be able to:** Select the tool and equipment according to the job requirement Ensure safety precaution Inspect tyre conditions and specifications Balance wheel assembly on wheel balancing machine	Operational knowledge and understanding of tools/equipment, required to maintain wheel balancing Checking of vehicle tires conditions including specification. Explaining alloy wheel balancing procedure on wheel balancing machine. Describing procedure of wheel assembling & disassembling on wheel balancing machine. The importance of PPEs when maintain wheel balancing Importance of health and safety Importance of housekeeping	Wheel balancing Machine Balancing weight (different weight set) Cotton cloth Relevant PPEs

	Ensure housekeeping after completion of task		

Examples & illustrations:

MacPherson Strut

A MacPherson strut consists of a piston connected to a rod in a tube of oil. A series of valves control the oil flow to control the pitching and rebound in the suspension system.

How Does a MacPherson Strut Suspension Work?

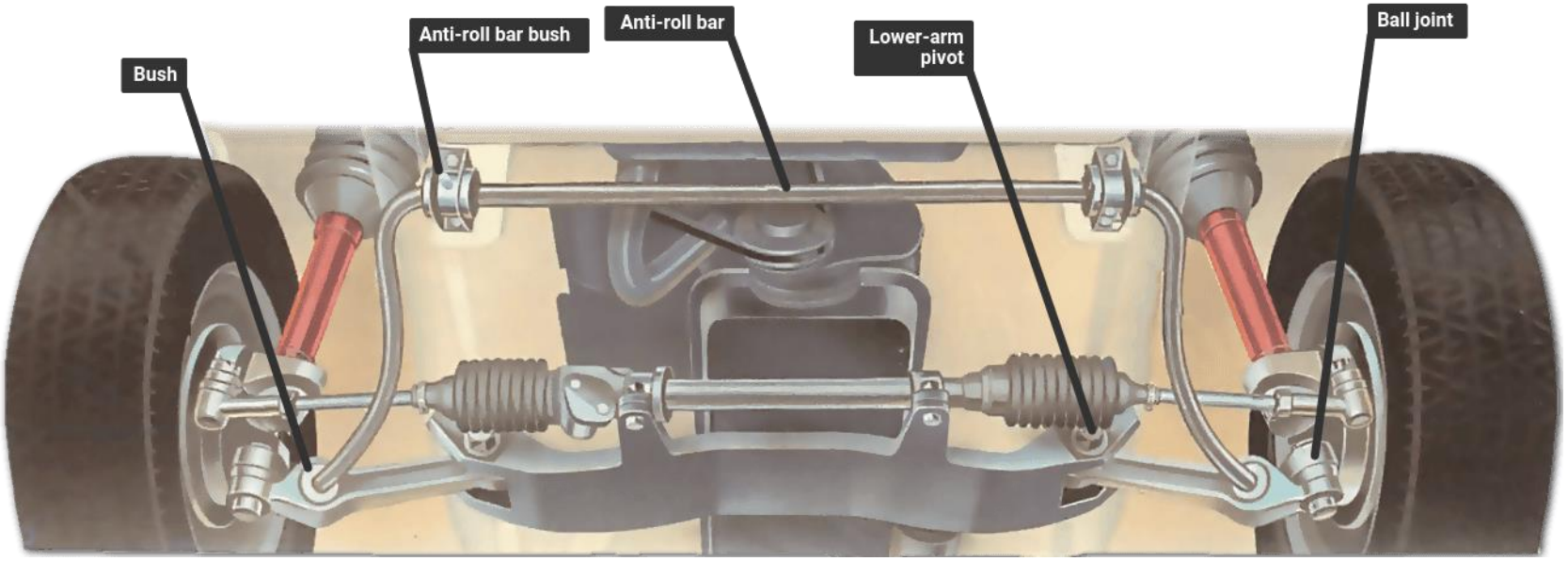
MacPherson strut suspension systems typically utilize either a steering knuckle or a hub carrier that has two mounting points that attach it to the body of the vehicle. The lower mounting point attaches to a track control arm or lower control arm, and it is this connection that dictates both the longitudinal and lateral orientation of the wheel assembly.

In turn, the upper mounting point of the knuckle or hub is attached in some way to an assembly that contains a coil spring and a shock absorber. It is this combination of housing, spring, and dampener that is referred to as a strut or, more properly, as a MacPherson Strut.

Checking suspension joints and pivots:

Almost all joints and pivots in a modern suspension system have rubber or plastic bushes, with the possible exception of steering swivel joints.

Because of the constant movement of the suspension parts, the bushes gradually wear out, soften and perish.



Checking the front suspension
A MacPherson-strut-type front suspension. The strut incorporates a damper and coil spring.

Oil contamination also causes them to deteriorate, and if they are allowed to deteriorate too much, they become loose and the steering and road holding suffers.

It is essential to make a regular check on the condition of all joints in the suspension system.

If you find any joints or pivots to be worn or damaged, replace them or have them replaced at a garage as soon as possible.

If any are found to be contaminated with oil, find the source of the leak and repair it, otherwise any new bushes fitted will be affected.

MacPherson Strut Failure

Since the strut in a MacPherson strut system is an integral part of both the steering and suspension systems, a failure can be catastrophic. If a failure occurs at the tie rod end mounting point, or at the control arm mounting point, the tire may pivot at an angle and cause the driver to lose control. In some cases, the vehicle may even roll. Failures like these are typically the result of manufacturing defects or impact damage rather than worn out or poorly maintained parts.

For more detailed information, please visit http://www.crankshift.com/macpherson-strut/ and https://www.howacarworks.com/suspension/checking-suspension-joints-and-pivots

Also visit https://auto.howstuffworks.com/car-suspension4.htm

And https://www.seat.com/car-terms/m/mac-pherson-strut.html

And https://www.carthrottle.com/post/what-is-macpherson-strut-suspension-and-why-is-it-so-popular/

Tie Rod:

As an important part of your vehicle's steering and suspension system, tie rods act as the link between your vehicle's steering system and the steering arm, which is attached to the steering wheel. When you turn the steering wheel, the steering arm moves the front wheels through the steering system. The inner and outer tie rods connect to the steering arm in order to move the wheels of your vehicle.

How to know when to replace outer tie rods

Tie rod ends connect the steering knuckle of the wheel to the steering rack, and largely responsible for turning the wheels. When you turn the steering wheel, the steering system reacts through the rack and pinion, ultimately telling the outer tie rod ends to push or to pull the wheel to turn. A failed tie rod could lead to loss of control or the wheel breaking completely free of the vehicle, both extremely dangerous situations that can be avoided by proactive maintenance. Symptoms of worn outer tie rods include:

- Loose vehicle steering, or play in the steering wheel
- Uneven tire wear
- Vehicle pulling
- Noises like clicks/rattling/chuckling

Test the outer tie rod for excess wear

If your vehicle experiences the above symptoms, there is a test that will pinpoint if the issue is with the outer tie rod. First, raise the vehicle just enough so that the wheel is not touching the ground. Second, place your hands at nine and three on the wheel, and move the wheel left and right. If the parts are in good shape, the wheel would just simply turn. If there is excess wear, the wheel will shake as if the lug nuts were loose. This is the most common sign to replace the tie rod.

How to replace an outer tie rod end

Remove the lock nut

After soaking the inner tie rod jam nut and thread with penetrant, hold the inner tie rod steady with a wrench and bust the jam nut loose. To avoid damage or warping, do not use a hammer. Moving to the other end, remove the lock nut.

Completely remove from the steering knuckle

Using a specialized tool for removing tie rod ends and ball joints, lift the outer tie rod from the steering knuckle. Once the end is free, count the number of turns, or mark the position before turning, when removing the old tie rod end from the inner tie rod. When the outer tie rod is completely removed from the car or truck, compare the length, taper and thread length of the new and old parts to ensure the replacement part is compatible with the steering system.

Installing the new outer tie rod

Connect the new tie rod end to the inner tie rod, counting the turns or stopping at the mark you recorded earlier. Place the free end of the outer tie rod into the steering knuckle, making sure the taper goes in all the way. Using your fingers or light wrench work, tighten the new lock nut until the whole stud starts to spin.

Get an alignment immediately

Once the new part is installed, do one last check of the other suspension parts before putting the wheel back on. Torque the wheel on the ground and go on a short road test, then immediately take the vehicle in for an alignment. Anytime there is a front end alignment done on a vehicle, make sure to reset the steering angle sensor.

For more detailed information, please visit https://www.delphiautoparts.com/usa/en-US/resource-center/how-replace-outer-tie-rod-end

Also visit https://www.bigjohnsperformance.com/Auto-Repairs/steering-and-suspension-system/inner-tie-rod-outer-tie-rod-replacement

Coil Spring:

The coil spring suspension exists in the suspension system of a vehicle. A better name for a coil spring is a compression spring because they are meant to help absorb the shock inflicted upon the vehicle. Basically, the coil spring suspension will absorb the bumpiness and shakiness as you're driving on the road.

It's uncommon to hear about a car having coil spring failure because these springs are generally very durable and last for years. However, damage and breakage can and do happen to coil springs as well as the components that support them.

How Coil Springs Help You Handle Your Car

Coil springs have long been used to stabilize vehicles around corners and over bumps and dips. These springs basically keep the vehicle stable and all four wheels on the road. Previously, most vehicles used leaf springs, which work great on heavier vehicles but made the suspension stiffer. Coil springs allow for more range of movement.

How Coil Springs Can Break

because springs are situated near the wheels and close to the road, they are susceptible to corrosion and damage. While many springs are coated, this coating can break down and rust can form causing cracks and breakage.

Also, a severe bump can even break an already old and weakened spring. Overloading your vehicle can cause severe strain on your springs, especially if it's repeated over and over again.

Signs Your Coil Springs May Be Worn or Broken

the biggest sign that your coil springs are damaged is if your vehicle droops or sags on one side or corner. The drooping or sagging could be caused by one side of the vehicle being repeatedly overloaded. Your car may also sway more around turns or bounce higher than normal.

In some cases, you will hear a squeak or clunk, especially over bumps. All of these signs could indicate other suspension problems since the whole system has many components that affect each other, so a visual check is necessary.

How to Check for Broken or Damaged Coil Springs

the easiest way to check for broken springs is by doing a visual check. Springs are located near the wheel just above the axle. It is usually helpful to lift your vehicle as it will make a broken spring more visible. Be sure to safely secure the body against any dropping or another sudden movement.
If you're lucky, the broken spring will be easy to spot near the wheel. However, it may be more difficult to spot if it's broken in the middle or in a less visible area.

How to Repair Broken Coil Springs

the only way to safely repair a broken spring is by replacing it. While this option may seem simple, most springs are highly compressed and can be dangerous if removed without the right tools and experience. For best results, have the spring on the opposite side of the car changed as well. It is also generally recommended that new shocks be installed along with the spring.

How to Prevent Coil Spring Damage

though metal can bend and weaken over time, in most cases, coil springs are very durable, so they require little maintenance. However, you can do a few things to help your coil springs last longer. Be careful while driving on rough roads, especially those with deep holes or bumps. Do not overload your car, especially over long time periods. And if you live in an area where they salt or use chemicals on the roads, have your undercarriage cleaned at regular intervals.

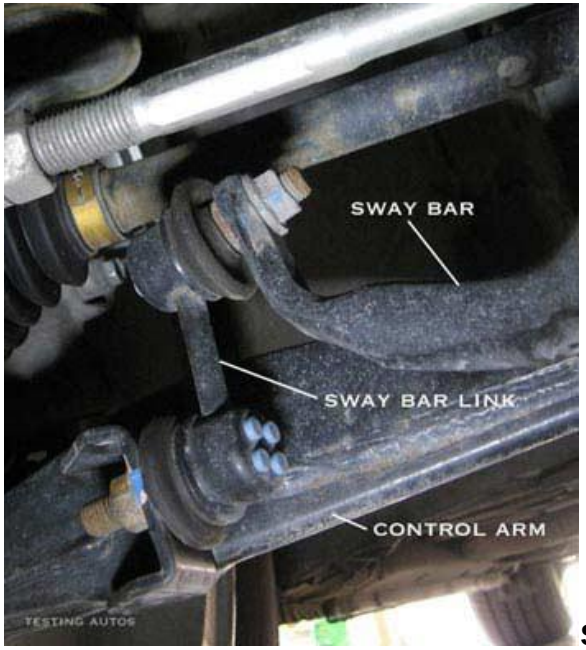
For more detailed information, please visit https://www.whitesautomotive.com/blog/how-to-diagnose-coil-spring-problems

Also visit https://shop.advanceautoparts.com/r/car-projects/how-to-change-coil-springs and https://oards.com/symptoms-of-a-bad-coil-spring-suspension/

Stabilizer or Sway bar link:

A sway or stabilizer bar prevents the car body from leaning too much and keeps the vehicle stable when driving in turns. Most of the cars have one sway bar in the front and another separate sway bar in the rear suspension. Some cars have only one sway bar in the front suspension.

The responsibility of keeping your car stable and handling smoothly under diverse driving conditions falls on the stabilizer, or sway bar as it's often referred to as. This mechanical unit is attached to the body of the vehicle by way of a body mount with stabilizer bar bushings and the stabilizer bar links, which attach to the lower control arm of the front suspension and have bushings along the link for protection and to ensure a smooth ride.



Sway (stabilizer) bar link.

A sway bar is connected via rubber bushings to the car body or frame in the middle. Outer ends of the sway bar are connected to the parts of the vehicle suspension that holds the wheel (struts or control arms). The part that connects the outer ends of the sway bar to the suspension component is called a sway bar link.

Over time, the sway bar link ball joints wear out. The first sign of a worn-out sway bar link is a knocking noise from the suspension when driving slowly over road bumps. In rare cases, if the grease inside the sway bar link joints dries up, it may also make a creaking noise when the suspension is moving up and down.

A worn-out sway bar link will show a free play when pushed up or down. An extremely worn out sway bar link can separate. This will cause your car to lean excessively in turns and feel less stable and secure on the road. A worn-out sway bar link must be replaced to keep your vehicle safe.

Since the stabilizer bar links are attached to the lower control arm, steering and handling are also negatively impacted when they begin to wear out.

When the stabilizer bar links are starting to wear out, the symptoms can range from barely noticeable to significant, and if you don't have your stabilizer bar links replaced, can result in catastrophic damage to the front end of your vehicle and potentially an accident.

Knuckle Assembly:

The steering knuckle provides an attachment point for the tie rod to the wheel. The steering knuckle also provides an attachment point for the upper and lower ball joints in conventional A frame suspension system. With Macpherson strut systems, the steering knuckle anchors the lower end of the strut and the lower ball joint. The spindle of a rear wheel drive vehicle is supported and attached by the steering knuckle. With a front wheel drive vehicle, the front hub and bearing assembly is attached to the steering knuckle. Disc brake systems also use the steering knuckle as a mount for the brake caliper. The components attached to the steering knuckle will usually wear out before the steering knuckle itself. In fact, most of the damage to a steering knuckle will occur from collision damage.

Steering knuckle & Spindle repair guide:

Removal & installation

1. Raise and support the front of the vehicle frame using jack stands.
2. Remove the tire and wheel assembly.
3. Remove the brake caliper from the steering knuckle and hang it from the vehicle using wire or a coat hanger. Make sure the brake line is not stretched or otherwise damaged.
4. Remove the grease cup, the cotter pin, the castle nut and the hub-and-rotor assembly. For details, please refer to the brake rotor (disc) procedure located in **Brakes** of this repair guide.
5. Remove the splash shield-to-steering knuckle bolts and separate the shield from the knuckle.
6. At the tie rod end-to-steering knuckle stud, remove the cotter pin and the nut. Using suitable jawed tie rod end puller tools such as J-6627, J-24319-01 or their equivalent, separate the tie rod end from the steering knuckle.
7. Position a floor jack under the spring seat of the lower control arm in order to retain the spring seat. Raise the floor jack until it just contacts the arm. Keep the jack in position during removal and installation to ensure the spring and control arm remain in position.
8. Remove the cotter pins from the upper and lower ball joint studs, then loosen the retaining nuts.
9. Use a ball joint separator such as J-23742 or equivalent to separate the upper ball joint from the steering knuckle. Remove the nut and pivot the upper control arm free of the knuckle.
10. Use the ball joint tool to separate the lower ball joint from the steering knuckle, then remove the nuts and lift the steering knuckle from the lower control arm.

11. Clean and inspect the steering knuckle and spindle for signs of wear or damage; if necessary, replace the steering knuckle. If any out-of-roundness is found in the tapered knuckle hole it must be replaced.

To install:

12. Position the steering knuckle onto the lower ball joint stud, then using the jack, lift the upper control arm to insert the upper ball joint stud into the steering knuckle. Loosely install both ball joint stud nuts to hold the components in position.
13. Properly tighten the upper and lower ball joint stud nuts, then install new cotter pins. For details, please refer to the procedures located earlier in this section.

When installing a cotter pin, never loosen the castle nut to expose the cotter pin hole.

14. If equipped, position a new steering knuckle gasket.
15. Install the splash shield to the knuckle and secure the retaining bolts.
16. Install the tie rod end to the steering knuckle, then tighten the stud nut to specification and install a new cotter pin.
17. Install the hub and rotor assembly and castle nut. Properly adjust the wheel bearings, then install a new cotter pin followed by the grease cup.
18. Remove the support, then reposition and secure the brake caliper.
19. Install the tire and wheel assembly.
20. Remove the jack stands and carefully lower the vehicle.

For more detailed information, please visit https://www.autozone.com/repairguides/GM-S-Series-Pick-ups-and-SUV-s-1994-1999-Repair-Guide/FRONT-SUSPENSION/Steering-Knuckle-and-Spindle/_/P-0996b43f80cb0bcf

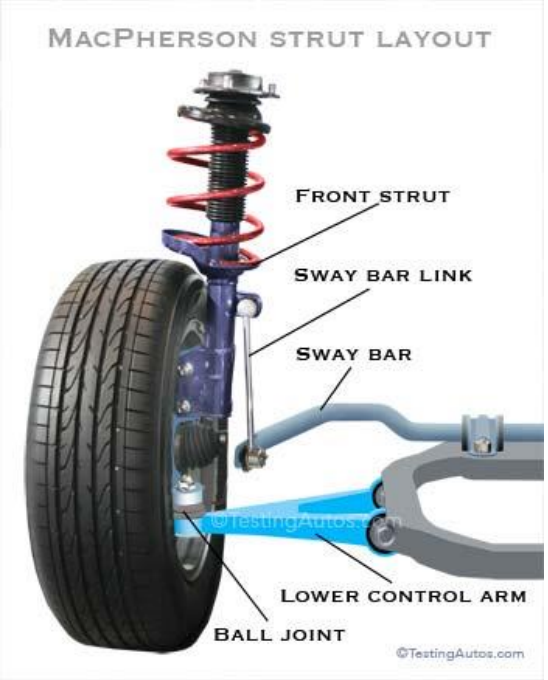
Also visit http://www.auto-repair-help.com/automotive_maintenance/steering_knuckle.php

Control Arm:

Most cars have two control arms in the front suspension. Often they are called *lower control arms*. It connects the frame or body of a car to the assembly that holds a front wheel. This assembly is called a steering knuckle.
Control arms are connected to the frame or body of a car through flexible rubber bushings, called *control arm bushings*. This allows a control arm to swing up and down as front wheels roll over bumps and potholes. The outer end of a control arm has a *ball joint*. In some cars, a ball joint is bolted to or pressed into the control arm and can be replaced separately. In others, a ball joint comes with a control arm as one piece.
Control arms have a very important role holding both front wheels on the road. If a control arm is excessively worn, damaged or bent, the vehicle is NOT SAFE to drive.

How a control arm works:

In the front suspension design with *MacPherson struts* common in modern cars, there is one "lower" control arm on each side, see the illustration. The inner side of the arm is attached to the sub frame or body via rubber bushings to dampen a road noise and vibration. The bushings provide pivot points, allowing the control arm to swing up and down when the vehicle drives over bumps.



Lower control arm in a MacPherson strut layout

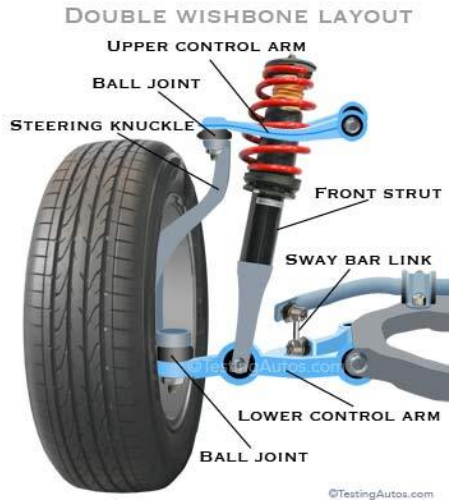
In the front suspension design with *MacPherson struts* common in modern cars, there is one "lower" control arm on each side, see the illustration. The inner side of the arm is attached to the sub frame or body via rubber bushings to dampen a road noise and vibration. The bushings provide pivot points, allowing the control arm to swing up and down when the vehicle drives over bumps.

The outer end of the control arm connects through a ball joint to the steering knuckle, the part that carries the front wheel. A stabilizer (sway) bar connected to both lower control arms and struts keeps the car stable in turns..

In a *double-wishbone* ("double A-arms") layout (in the image), the steering knuckle is held by two, lower and upper control arms. A double wishbone layout is used in many pickup trucks, large SUVs, many high-end vehicles and race cars. The upper control arm is smaller. The larger lower control arm carries most of the load. Both lower and upper control arms have a ball joint, although the upper ball joint is often smaller. When the wheel drives over a bump, both arms swing up and down on rubber bushings following the wheel.

In either layout, control arms are very important components. If a control arm fails, the safety of the vehicle is compromised.

If a control arm needs to be replaced, especially if it happens soon after the warranty expired, check with a local dealership, search online. In recent years, a number of car manufacturers issued service campaigns, warranty extensions or recalls to cover failed or rusted control arms. Even if it's not covered, and you have to pay for the repairs, keep the receipt. If there is a recall in the future, there is a chance that a manufacturer might offer a reimbursement.



Lower and upper control arms in a double wishbone front suspension

Control arm problems

There are a few reasons why a control arm may need to be replaced. A worn-out ball joint that cannot be replaced separately is one of the most common reasons. A ball joint is an extremely important component. If it wears out, the car is unsafe to drive: the front wheel can separate from the lower suspension causing the vehicle to lose control.

This ball joint has separated while driving

Worn out or torn control arm bushings is another reason a control arm may need to be replaced. In some cars, control arm bushings can be replaced separately, but it involves more labor and could cost more. For this reason, the whole control arm is usually replaced if the bushings are worn out. The control arm is also the most common part that bends in a collision involving one of the front wheels or after hitting the curb. A bent control arm must be replaced.

For more detailed information, please visit https://www.samarins.com/glossary/control_arm.html

Also visit https://www.testingautos.com/car_care/when-to-replace-control-arms.html

What is a Differential?

As part of the front and/or rear axle assembly, the differential plays an integral role in how your car makes turns. The differential is designed to drive a pair of wheels while allowing them to rotate at different speeds. This function provides proportional RPMs between the left and right wheels. If the inside tire rotates 15 RPM less in a turn than going straight, then, the outside tire will rotate 15 RPM more than going straight.

For example, when your vehicle goes around a corner, the wheel on the outside must travel faster than the wheel on the inside. The differential distributes equal amounts of torque to both wheels.

The 3 Types of Differentials

Open Differential is the oldest and most common design that is suitable for various makes and models of vehicles. It's the most simple, reliable, and widely-used type of differential. The powered pinion gear, located at the end of the driveshaft, engages with the ring gear, which then transmits power to both axles through another set of gears. The only flaw in its design is that when one wheel begins to slip, all power is in essence sent to the wheel with the least traction, making this setup unfit for rock climbing or high-speed racing.

Limited-Slip is similar to an Open Differential but utilizes an integrated clutch system. The clutch mechanism locks the left and right sides of the axle together when a wheel loses traction. This is the preferred system for high-performance vehicles such as drag racers and those towing heavy loads.

Torque-Vectoring is the latest and greatest in differential technology. Torque vectoring encompasses a complicated collection of sensors and electronics to obtain data from the steering system, throttle position, road surface, and more, giving it the ability to distribute power to each wheel, according to the data. This option provides maximum traction while cornering, increasing performance significantly.

Caring for the Differential

Regular maintenance on any vehicle is a necessity from oil changes, belts, hoses, and other fluids. The differential fluid is no exception. Differential oil is used to lubricate manual transmissions and differentials. It's similar to the importance of engine oil for the engine. It plays a vital role in protecting the differential and transmission, allowing them to function safely and smoothly.

The spent differential fluid becomes dirty and contaminated after time. Continuing to drive with contaminated fluid is risky as it can put unnecessary wear on components, leading to permanent damage. Signs your differential needs service:

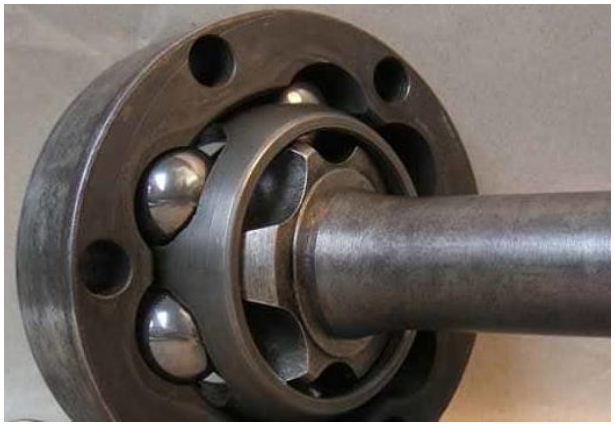
- Whirring noise only when decelerating.
- A howl or whine during acceleration over small or large speeds.
- Rumbling or whirring at speeds over 20 MPH but changes while turning.
- Regular clunking sound every few feet or when starting to move.

- Steady vibration that increases with vehicle speed.

For more detailed information, please visit https://www.sunautoservice.com/what-is-a-differential-on-a-car/

CV Joint

The function of constant-velocity joints, or CV joints, in a vehicle is to help transfer power to the wheels from your transmission. Power is transmitted at a consistent speed of rotation when there isn't much friction. In other words, power from the engine is transferred smoothly to the wheels of the vehicle, no matter the angle of the steering wheel.



Top 5 Symptoms of a Bad CV Joint

There are certain warning signs to look out for when it comes to CV joint failure. Below are the 5 most common symptoms of a bad CV joint:

#1 – Tire Edge Grease

When you spot grease along the edge of your tire, particular from a tear or tiny crack, it could be a sign you could have a bad CV joint. A significantly damaged CV joint means darker colored grease might be visible on the rim and wheel's interior.

#2 – Turning Causes Loud Noises

When you turn the steering wheel and hear noises such as a clicking sound or popping sound, it's very likely you have a broken or worn CV joint. You can test this by doing the following:

1. Shift the gear into reverse

2. Turn the wheel all the way to one side,
3. Step on the gas pedal.

You will be going in a circle, so make sure the area around you is clear. As you move backward in a circle, the popping sounds should get louder if you have a bad CV joint. You'll either have to replace the joint or the entire shaft assembly.

#3 – Bouncy Driving

You likely have a faulty CV joint if you're driving on a flat paved road and your vehicle is still bouncing around. You can verify this by going to an auto shop that repairs transmissions.

#4 – Vibrations

A worn or damaged CV joint will vibrate while you're driving. CV joints in this condition will not be able to balance properly during rotation. The more you accelerate, the more intense the vibrations will become.

When vibrations become too excessive, the vehicle will become more difficult to control and your overall riding experience will be impacted. This means the drive will become less comfortable and less safe for everyone in the car. The only solution here is to replace the CV joint.

#5 – Movement Causes Knocking Sounds

A CV joint that has become worn out from being used too much will cause a knocking sound. This noise can come from the inner joint on a front-wheel drive car. For rear-wheel drive, it can come from either the outer or inner joints. Knocking sounds can also come from the differential gears.

To perform a self-diagnosis of the joint problem, put the vehicle in reverse and accelerate, then decelerate. Alternate back and forth between acceleration and deceleration and listen for louder knocking sounds. This is proof of a bad CV joint.

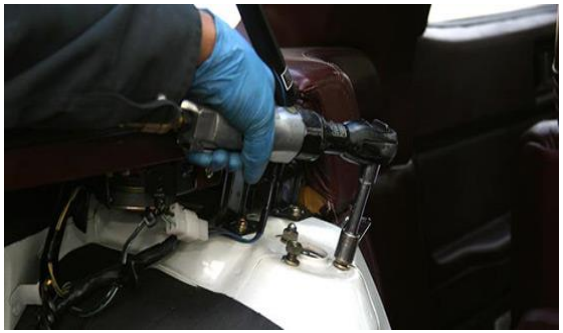
Replacing CV joint axles

While the basic concept of a CV joint axle is the same from vehicle to vehicle, there are a number of different peculiarities that make access to a service manual an important first step before disassembly. Axle pullers and impact wrenches may be required. Pry bars, c-clips and snap rings inside differentials may also be part of the bargain. This knowledge is best gained before getting started, not while 90-weight gear oil is dripping down your sleeve.

Step 1: This is a rear drive vehicle with two CV joint axles. Start by disconnecting the battery, jacking up the vehicle and allowing some penetrating oil to soak into any retaining bolts.

Step 2: In this case, suspension disassembly was not required. Moving brake lines and other obstacles out of the way of wrenches is a good bet before beginning.

Step 3: Loosening but not removing the strut top mounts and sway bar end link bushings can provide a bit more suspension travel for easier axle removal.



Step 4: Loosen and remove the wheel side axle mounting bolts.

Step 5: Separate the axle from the wheel. Do not allow the axle to hang from the transmission or differential. Oil seals could be damaged.

Step 6: Gently pull, pry or otherwise liberate the axle from the transmission or differential. Do not bend axle seals. Be careful not to tear the transmission or differential oil seals.

Step 7: The axle splines on the left show damage. Note the c-clip on both axles.

Step 8: Don't forget to transfer any axle seals, ABS rings or other parts to the replacement axles.

Step 9: Guide the replacement CV joint axle into place. Depending on the type of retainer, the axle should click firmly in place.

Step 10: Always use the proper torque on the axle bolts. Check axle rotation. Reassemble dismantled components.

For more detailed information, please visit https://mobiloil.com/en/article/car-maintenance/car-maintenance-archive/ten-steps-to-replacing-cv-axles and https://cartreatments.com/cv-joint-symptoms-and-cost/

Wheel Alignment

In its most basic form, a wheel alignment consists of adjusting the angles of the wheels so that they are perpendicular to the ground and parallel to each other. The purpose of these adjustments is maximum tire life and a vehicle that tracks straight and true when driving along a straight and level road.

What is Wheel Alignment?

Wheel Alignment is a process that helps bring the car suspension in an optimal position which can significantly reduce uneven tyre wear. The car is attached to a wheel alignment machine and lifted up. The machine with the help of a computer makes precise calculations, this way the car wheels are made truly perpendicular to the ground while keeping them parallel to each other. During the process, the wheels and axle of the car are moved in one direction while the mechanic gets busy adjusting different angles of the suspension. The mechanic also makes sure that the steering wheel is also centered to avoid miss-alignment.

Wheel Alignment is often confused with Wheel Balancing. The two really have nothing to do with each other except for the fact that they affect ride and handling.

When You Need Alignment?

You may be wondering that why and when you need a wheel alignment. First of all, wheels can get miss-aligned due to many reasons such as:

- Road accident
- Hitting pot holes
- Height Modifications
- Worn-out Suspension Components

Here are some symptoms:

- Uneven or rapid Tyre wear
- Steering wheel not returning back easily
- Screeching Noises coming from tyres
- Car drifting towards one side

These are clear indications that your car wheels need an alignment.

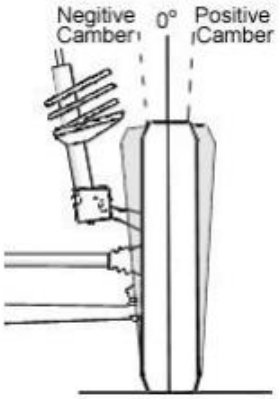
If a wheel is out of balance, it will cause a vibration at highway speeds that can be felt in the steering wheel and/or the seat. If the alignment is out, it can cause excessive tire wear and steering or tracking problemsIf you know anything about wheel alignment, you've probably heard the terms Camber, Caster and Toe-in.

Camber

Camber is the angle of the wheel, measured in degrees, when viewed from the front of the vehicle. If the top of the wheel is leaning out from the center of the car, then the camber is positive,if it's leaning in, then the camber is negative. If the camber is out of adjustment, it will cause tire wear on one side of the tire's tread. If the camber is too far negative, for instance, then the tire will wear on the inside of the tread.

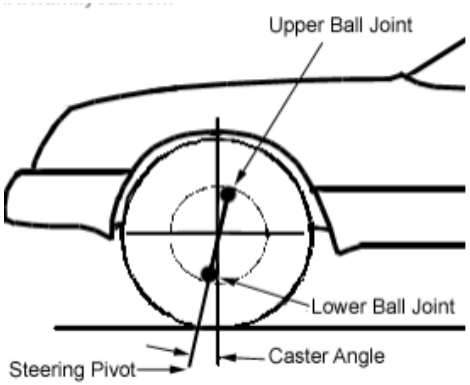
Camber wear pattern

If the camber is different from side to side it can cause a pulling problem. The vehicle will pull to the side with the more positive camber. On many front-wheel-drive vehicles, camber is not adjustable. If the camber is out on these cars, it indicates that something is worn or bent, possibly from an accident and must be repaired or replaced.



Caster

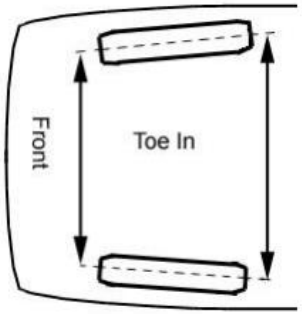
When you turn the steering wheel, the front wheels respond by turning on a pivot attached to the suspension system. Caster is the angle of this steering pivot, measured in degrees, when viewed from the side of the vehicle. If the top of the pivot is leaning toward the rear of the car, then the caster is positive, if it is leaning toward the front, it is negative.



If the caster is out of adjustment, it can cause problems in straight line tracking. If the caster is different from side to side, the vehicle will pull to the side with the less positive caster. If the caster is equal but too negative, the steering will be light and the vehicle will wander and be difficult to keep in a straight line. If the caster is equal but too positive, the steering will be heavy and the steering wheel may kick when you hit a bump. Caster has little effect on tire wear.

Toe-in

The toe measurement is the difference in the distance between the front of the tires and the back of the tires. It is measured in fractions of an inch in the US and is usually set close to zero which means that the wheels are parallel with each other.



Toe-in means that the fronts of the tires are closer to each other than the rears. Toe-out is just the opposite. An incorrect toein will cause rapid tire wear to both tires equally. This type of tire wear is called a saw-tooth wear pattern as shown in this illustration.

If the sharp edges of the tread sections are pointing to the center of the car, then there is too much toe-in. If they are pointed to the outside of the car then there is too much toe-out. Toe is always adjustable on the front wheels and on some cars, is also adjustable for the rear wheels.

Four-Wheel Alignments

There are two main types of 4-wheel alignments. In each case, the technician will place an instrument on all four wheels. In the first type the rear toe and tracking is checked, but all adjustments are made at the front wheels. This is done on vehicles that do not have adjustments on the rear. The second type is a full 4-wheel alignment where the adjustments are first made to true up the rear alignment, then the front is adjusted. A full 4-wheel alignment will cost more than the other type because there is more work involved.

Other facts every driver should know about wheel alignments.

- A proper wheel alignment should always start and end with a test drive.
- The front end and steering linkage should be checked for wear before performing an alignment.
- The tires should all be in good shape with even wear patterns.
- Pulling problems are not always related to wheel alignment. Problems with tires (especially unequal air pressure), brakes and power steering can also be responsible. It is up to a good wheel alignment technician to determine the cause.

  For more detailed information, please visit http://www.valleyofhastings.com/WheelAlignment2.pdf and https://www.tirerack.com/tires/tiretech/techpage.jsp?techid=4

Wheel Balancing

Wheel balancing—also known as tire balancing—is the process of equalizing the weight of the combined tire and wheel assembly so that it spins smoothly at high speed. Balancing involves putting the wheel/tire assembly on a balancer, which centers the wheel and spins it to determine where the weights should go.

At high speeds, a tiny imbalance in weight can easily become a large imbalance in centrifugal force, causing the wheel/tire assembly to spin with a kind of “galumphing” motion. This usually translates into a vibration in the car as well as some very irregular and damaging wear on the tires.

Wheel balancing and Wheel Alignment are two different but very vital part for any car. On the basic level, wheel balancing ensures that the car is driven smooth on the road.

When You Need Balancing?

In most cases, you can detect wheel imbalance while driving a car. Mostly at high speeds you can feel the steering wheel vibrating or the other tyres bouncing. This is enough to remind you to visit the wheel balancing center as soon as possible.

There is no fixed time to get the wheels balanced. Depending on the driving conditions you may need to get the wheel balancing as often as once a month. Avoid hitting pot holes and respect your car’s load capacity. These are two basic things you can do to minimize your visits to wheel balancing center.

Keep in mind that wheel imbalance can cause uneven wear to the tyres, shaky and a bouncy ride will eventually hurt the suspension and cost you money.

Traditional Spin Balancing

To balance a wheel and tire assembly, we place it on a balancing machine. There are several ways to manually balance tires, but they frankly do not compare to machine-balancing in terms of either ease or precision.

The most important things to know about balancing are:

- **Balancing Is Necessary:** A weight imbalance in every wheel/tire assembly is pretty much inevitable. Only once in a very blue moon do we see an assembly come out naturally, perfectly balanced.
- **Balance Changes Over Time:** As the tire wears, the balance will slowly and dynamically change over time. Most good tire places will want to rebalance when tires are rotated, or when swapping in winter/summer tires for a second season, for example. Rebalancing at least once over the life of the tires will almost certainly extend their lifetime.
- **Balancing Only Fixes Balance:** Balancing will not prevent vibrations from a bent wheel, out of round tire, or irregular wear. Balancing weights can't compensate for a problem that is actually physical in nature, only for weight differences.

Road Force Balancing

Because there are those other reasons than just balance for vibrations and strange tire wear, the “Road Force” balancer was born. This style of balancer, in addition to performing a traditional spin balance, also measures both the wheel and tire to determine if there are conditions that would tend to cause a vibration on the road.

For more detailed information, please visit https://www.pakwheels.com/blog/car-needs-wheel-balancing/ and https://www.liveabout.com/the-what-why-and-how-of-wheel-balancing-3234378

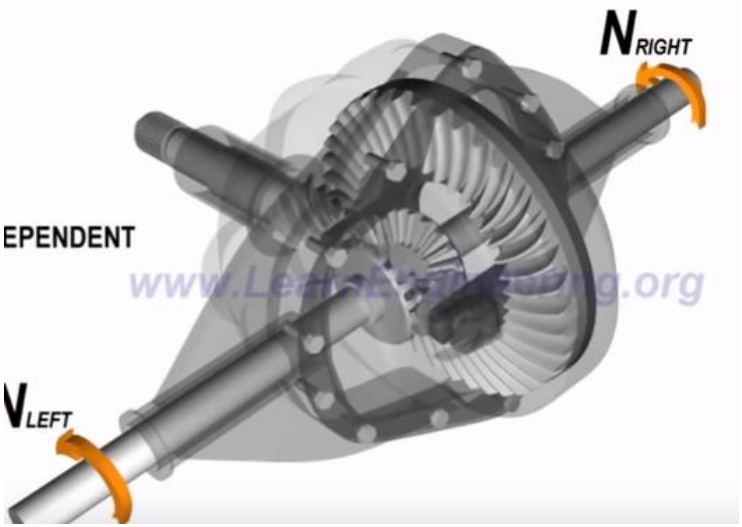
Videos:

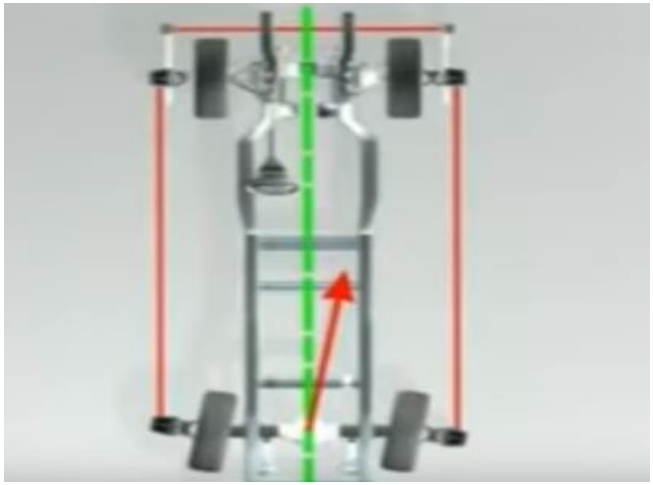
	**Strut bearing failure. How to tell if yours is gone.** **https://youtu.be/UWh3JxRJ5L8**
	**How to Inspect and Replace Strut Mounts on Your Car** **https://youtu.be/gAU3zS7mJS0**

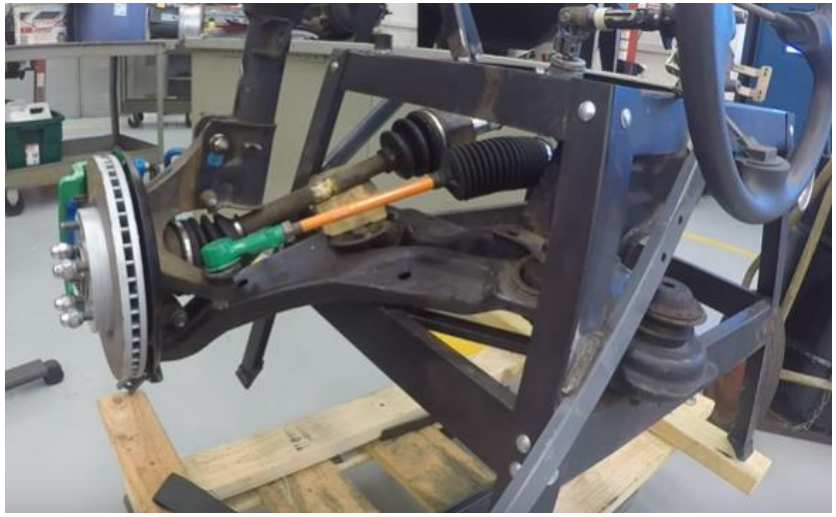
	**How to Test and Inspect the Inner and Outer Tie Rod Ends on Your Car** **https://youtu.be/ZTn7EUmm6zY**
	**How-To Replace Coil Springs** **https://youtu.be/zKxw5ZMAlts**

	**How to Replace Sway Bar Bushings and Stabilizer Links** **https://youtu.be/xIPNmd-jA3A**
	**Hub steering knuckle assembly remove step by step** **https://youtu.be/eArtSCN0ciM**

	**How to Replace a Control Arm (upper or lower)** **https://youtu.be/v7bOxQe_WhU**
	**How to replace your upper and lower control arm bushings** **https://youtu.be/91wdKd9-Wh8**

	**How a Differential works?** **https://youtu.be/SOgoejxzF8c**
	**How to Replace a CV Joint: How to Install a Drive Shaft** **https://youtu.be/LwKIp9rITVs**

	**How to Replace a CV Axle in Your Car** **https://youtu.be/bH98nX8fb6M**
	**Wheel Alignment - WHAT IS CAMBER, TOE, CASTER, AND OFFSET?** **https://youtu.be/w5qQw9F4HNE**

	**Adjusting Toe When Performing an Alignment** **https://youtu.be/amfuLqY-w7k**
	**Wheel balancing** **https://youtu.be/v5sXEuf8pBM**

AUTOMOTIVE MECHATRONICS

Module-11

LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - October, 2019

Module 11: 071400948 Check Vehicle Transmission System

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to Check Vehicle Transmission System.

Duration: 50 Hrs **Theory:** 10 Hrs **Practical:** 40 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Check Performance of Manual Transmission	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Check and replace gear oil Check performance of manual transmission Replace Transmission seals Replace synchronizer ring gears Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to check performance of manual transmission Explaining Gear types and their usage in different transmissions. Defining transmission types (for example manual, automatic, semi-automatic, CVT) Explaining transmission oil replacement procedure (including oil seals). Explaining transmission gear shifting methods/procedure. Identifying transmission noises during driving operation. Describing inspection and replacement procedure of synchronizer ring gears Importance of gear ratios for torque or speed in gearbox	Cotton cloth for cleaning. Gear oil. Relevant PPEs

		The importance of PPEs when check performance of manual transmission Importance of health and safety Importance of housekeeping	
LU 2: Check Performance of Mechanical Clutch System	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Inspect clutch system components Adjust clutch cable Remove components from clutch system of vehicle Remove gearbox assembly Diagnose faulty/damaged/broken part related with clutch system Replace faulty components Refit gearbox assembly	Operational knowledge and understanding of tools/equipment, required to check performance of mechanical clutch system Identifying components of mechanical clutch system (clutch cable, release bearing). Explaining disassembling/assembling process of clutch components Describing procedure of clutch cable adjustment Explaining gearbox assembly removal /installation procedure. The importance of PPEs when check performance of mechanical clutch system Importance of health and safety Importance of housekeeping	Oil can for lubricating joints. Gear oil as recommended by OEM. Cotton cloth for cleaning Relevant PPEs

	Ensure housekeeping after completion of task		
LU 3: Check Performance of Hydraulic Clutch System	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Replace clutch master cylinder seal Replace slave cylinder seal Perform clutch bleeding Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to check performance of hydraulic clutch system Explaining of Hydraulic clutch components Describing hhydraulic clutch operating method/procedure. Explaining clutch master cylinder oil seal replacement. Defining clutch slave cylinder oil seal replacement Describing hydraulic clutch bleeding procedure. The importance of PPEs when check performance of hydraulic clutch system Importance of health and safety Importance of housekeeping	Cotton waste Brake Shoes Brake Pads Petrol Emery paper 0 No. Relevant PPEs

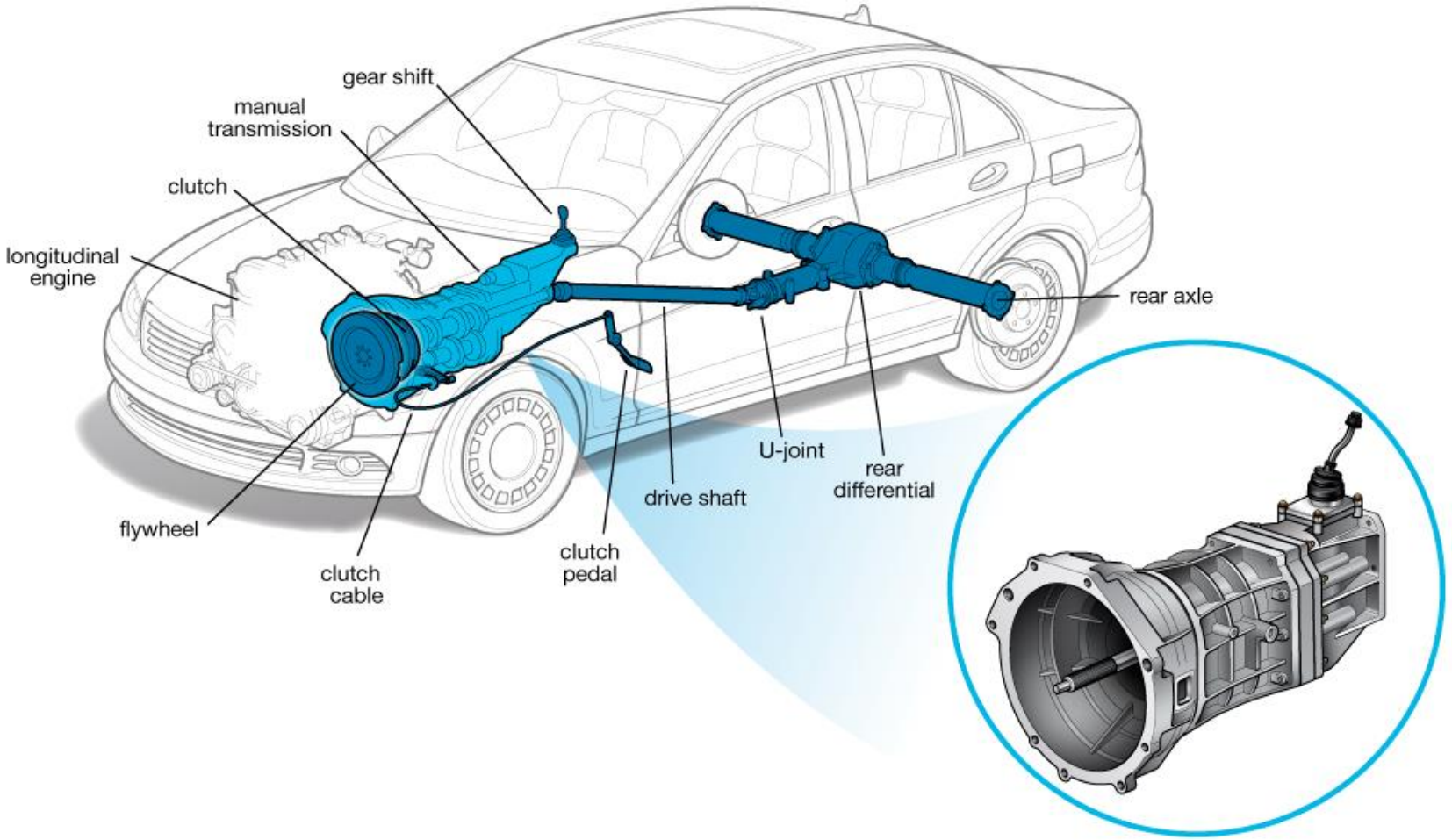
Examples & illustration:

Transmission

A car transmission is that part of the vehicle that transfers or transmits the rotational power generated by the engine to the car's wheels.

Types of Car's Transmission

1. **Manual Transmission:** A manual transmission is also known as a stick-shift, the driver literally uses a stick to change gears. To change gears, a clutch disc sandwiched between the engine and the transmission needs to be released via a third pedal located on the left side of the brake. Release the clutch, select the desired gear, and engage the clutch again. Depending on driving style, manual transmission tend to require clutch replacements with time and use.

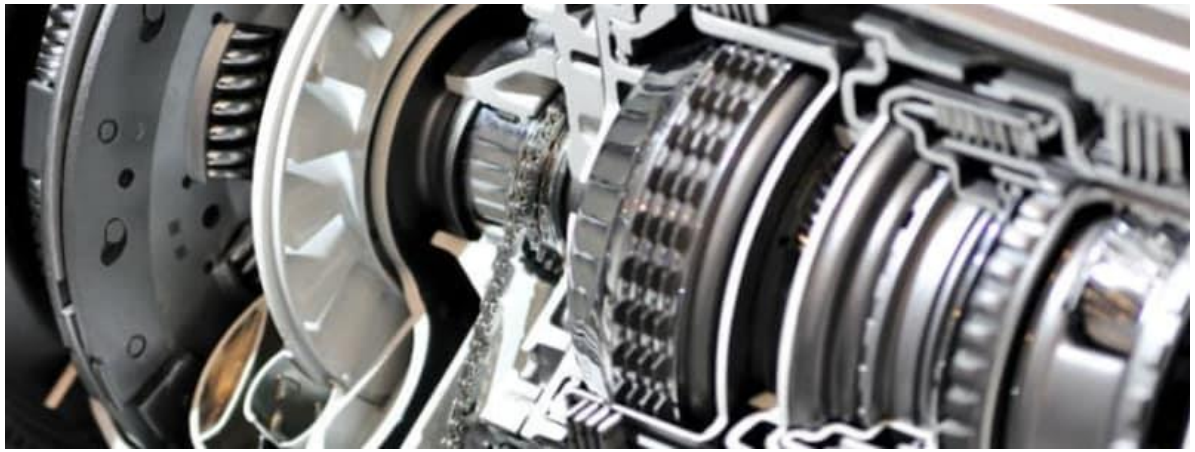

gear shift
manual transmission
clutch
longitudinal engine
rear axle
U-joint
rear differential
drive shaft
flywheel
clutch cable
clutch pedal

2. **Automatic Transmission:** The principle of power transmission is essentially the same as manual. The only difference is that instead of a clutch you have a torque converter and instead of a fixed set of drive gears arranged in a linear fashion. Because there really no clutch to worry about, the automatic is the preferred choice for beginners as well as those who prefer a more relaxed ride.

3. **Continuously variable transmission (CVT):** It has a nearly infinite range of gear ratios. In the past, CVTs could not compete with four-speed and five-speed transmissions in terms of cost, size and reliability, so you didn't see them in production automobiles. These days, improvements in design have made CVTs more common. In lieu of gears, a CVT relies on belt and pulley system that provides an infinite number of ratios. In other words, the transmission never shifts. A car equipped with a CVT is smoother to drive than an equivalent model fitted with a regular automatic transmission.

For detailed information, please visit https://www.carbibles.com/transmission-guide/ and https://www.cars.com/auto-repair/glossary/manual-transmission/ also visit https://www.digitaltrends.com/cars/manual-vs-automatic-transmission/ and https://auto.howstuffworks.com/transmission2.htm

Clutch:



The **clutch** is the part of the car which connects two or more rotating shafts. In a manual transmission car, the clutch controls the connection between the shaft coming from the **engine** and the shafts which turn the wheels. It is a vital part of the car´s working machinery as the engine generates power all the time, and has parts which are constantly rotating, but the wheels are not constantly spinning.

The clutch is the main component that makes the car drive smooth. Clutch is basically used in shifting the gears soothingly while driving the vehicle. It resides in the gearbox for proper transmission between the engine and paddle.

There are two main parts to your **clutch**: the clutch plate and the flywheel. If your foot is not pressing down on the clutch pedal, there are a set of springs which keep a pressure plate pushed up against the clutch plate.

There are two types of clutches discovered until now, hydraulic clutch and the mechanical clutch. Both these clutches have a similar procedure of working in disengaging the gears while driving. In traditional clutches, there is a cable wire attached with the engine, flywheel, and the gearbox. Whereas, the cable wire is replaced with small bore pipes in the hydraulic clutches.

Hydraulic Clutch vs Mechanical Clutch- the Comparison

One can come across a lot of pros and cons of both these clutches. Most of the car companies have started to go with the hydraulic clutches because of its durability and efficiency. The mechanical clutches consists of steel wires that might tear apart after a certain age. But, there is a huge risk of master cylinder leakage in hydraulic cylinders. Therefore, this state that both of these clutches have advantages and disadvantages of their own.

Let’s find out some differences between the hydraulic and mechanical clutch

1. Price

While going for any type of clutch in the car, one must look around the price as well. The cable clutch costs low than that of hydraulics. This is because the mechanical clutch is made up of cable wire, which is easy to maintain and set up. Whereas, the hydraulic clutches comprise bore pipes, master cylinder, small cylinders, and fluid.

2. Maintenance

The cables require a lot of maintenance than hydraulics. For instance, if the cable wire gets loose after a certain period, one might not get the complete disengagement like before. One might damage the clutch plates if not noticed on time. In hydraulic plates, the things are a little different. The hydraulic clutches never ask for maintenance very easily. This is because of the fluid that self-adjusts the clutch plates when required.

3. Eminence

The hydraulic clutch combats mechanical clutch in terms of quality as well. The cable wire clutches are vulnerable to corrosion and can break easily after **aging**. The mechanical clutch requires lubrication periodically. And, these might get struck if the wires get bent too piercingly. You do not have to worry about all this stuff in the hydraulic clutches. These are easy to modulate and consists fluid to work. One might have to replace the fluid after a number of years for better performance. The hydraulic setup is a little expensive if the seals of cylinders leak in any case. But, hydraulics are much better in terms of quality.

How to Repair the Clutch

Before you start to **replace the clutch**, make sure that it is definitely the source of the problem and that it hasn't been caused by something smaller such as the pedal-arm bushings or the slave-master cylinder.

1. Park your car on a surface which is both solid and level.
2. Disconnect the cable from the negative battery terminal.
3. Use a jack to raise the front end of your car off the ground. Use jack stands or a sturdy ramp to secure the car in its raised position. Stabilize the engine either by using a hoist from above or supports from below

4. If your car is rear wheel drive then you should take off the transmission shifter lever next.
5. Take off the driveshaft.
6. Disengage the clutch linkage so that the cables are no longer connected.
7. Locate the speedometer cable and disconnect it from the transmission.
8. Locate the starter motor and unfasten it from the engine housing. Disconnect the electrical wires taking care to make a note of exactly where the wires ran to. (When it comes to putting these wires back in place, if you connect them to the wrong terminals you could short circuit the entire car's electrical system and have to replace all of the wiring).
9. Locate all of the other electrical connections on the engine housing and disconnect these too. Again, make sure that you know exactly how to reconnect these wires once you have replaced the clutch.
10. Position a jack or some kind of structural support underneath the transmission putting slight pressure underneath it.
11. Loosen all of the bolts on the transmission and disconnect it from its mount.
12. Carefully slide the transmission out of place (you may need to loosen the jack slightly to be able to do this).

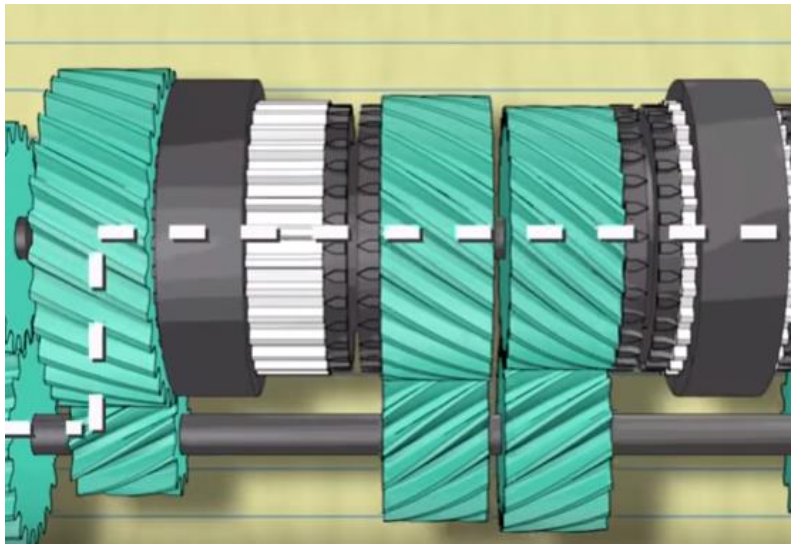
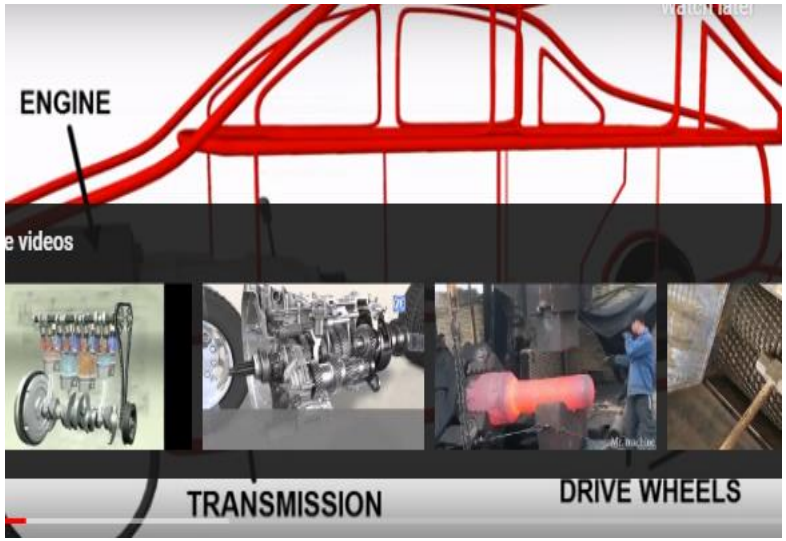
13. You should now have access to the clutch itself.
14. Inspect the flywheel and the pressure plate for identifying marks to help you know exactly what position to put them back in when you come to it.
15. Loosen all of the bolts which fix the pressure plate in place and remove it, along with the clutch disc, from the car.
16. Inspect the flywheel closely to see if it has been damaged in any way. Remove it and clean it or replace it if necessary.
17. Look out for oil leaks around the whole of the clutch area.
18. Check the pilot bearing in the center of the flywheel to make sure that all of the needle bearings are lubricated properly.
19. Be sure to clean the crankshaft flange well before you replace the flywheel. With the flywheel back in place, tighten the bolts securing it in position in a star formation. Secure them according to the specified torque for your particular vehicle. (You should be able to find this outlined in your owner's manual).
20. Put in the new clutch and pressure plate. Don't forget to connect the new release bearing to the release fork before you replace any other parts you have disconnected.
21. Replace all of the parts of the car which you took apart to access the clutch in reverse order to the way in which you removed them. Be extremely careful when it comes to rewiring the electrical parts.
22. Once you have put all of the parts back where they should be, lower your car from the jacks slowly and carefully.
23. Drive your car in a safe, quiet area to make sure that it is all working properly.

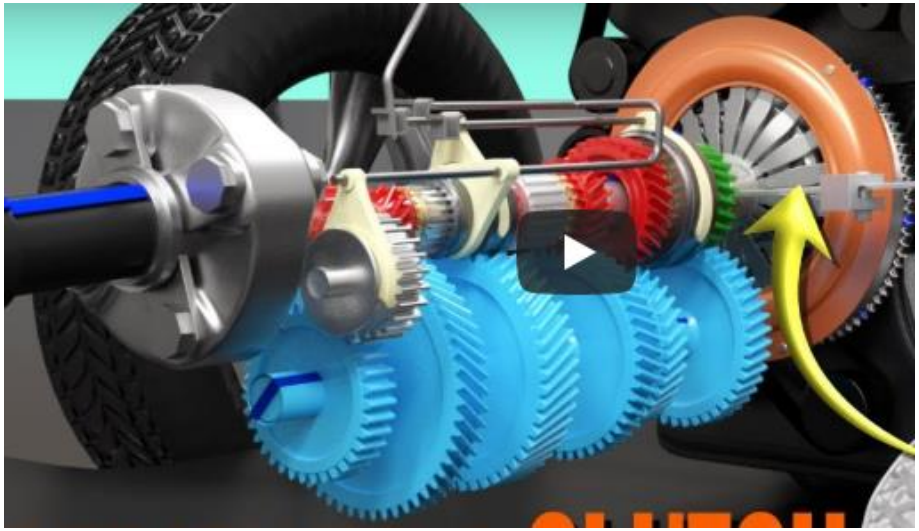
For more detailed information, please visit https://www.autobutler.co.uk/how-to/clutch-repair also visit https://carfromjapan.com/article/industry-knowledge/hydraulic-clutch-vs-mechanical-clutch/ and https://carfromjapan.com/article/industry-knowledge/hydraulic-clutch-vs-mechanical-clutch/

https://www.cars.com/auto-repair/diy/transmission-fluid-change/

https://www.cars.com/auto-repair/diy/

Videos:

	**MANUAL TRANSMISSION | How it Works** **https://youtu.be/h50ylRZzPGU**
	**Manual Transmission** **https://www.carbibles.com/transmission-guide/**

	**Clutch, how does it work** **https://www.carbibles.com/how-do-clutches-work/**
	**How to Diagnose a Bad Clutch - EricTheCarGuy** **https://youtu.be/h7JJ_g2UuBI**

AUTOMOTIVE MECHATRONICS

Module-12

LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - October, 2019

Module 12: 071400949 Service Electrical System

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to service electrical system.

Duration: 70 Hrs **Theory:** 20 Hrs **Practical:** 50 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Check Performance of Ignition System	**The trainee will be able to:** Select appropriate tools and equipment. Ensure work safely at all times. Check performance of battery and Indication light. Check operation of ignition switch Check wire harness and connectors Check spark plug and rectify faulty parts. Check distributor and distributor cap Check performance of CB (contact breaker) point Check ignition system sensor	Operational knowledge and understanding of tools/equipment, required to check performance of ignition system Reading and interpreting manufacturer's repair manual Identifying and explaining different types of ignition system (i.e. direct ignition system, IDS ignition system, distributor system, distributor less system, mechanical ignition system, electronic ignition system) Explaining operation of ignition switch Defining the spark plug types (i.e. cold type plug, hot type plug) Describing function of plugs (i.e. troubleshooting and rectify faulty parts) Explaining distributor and distributor caps with its operation, function and location of components (i.e. rooter, point, condenser and mechanical weight) Defining function of contact breaker (CB) point and its location Identifying sensors of ignition system Describing types of sensors The importance of PPEs when check performance of ignition system Importance of health and safety Importance of housekeeping	Service Creeper Digital Multimeter Flat / Philips Screwdriver Set Combination Spanner Set Repair Manual Combination Plier Needle Nose Plier Test Lamp Bearing puller OBD – II scanner Relevant PPEs

	Ensure housekeeping after completion of task		
LU 2: Test Performance of Fuses & Relays	**The trainee will be able to:** Select appropriate tools and equipment Check performance of battery Check fuses of Instrument panel Check relays of Instrument panel Check wire harness and connectors Ensure work safely at all times. Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to test performance of fuses & relays Identifying fuses and relays and their purpose Checking fuses and relays (i.e. under dash fuse box, under hood fuse box) Defining wiring harness and wiring circuit diagram Checking all wiring harness and connectors of an electrical system of cars Describe use of Scanners Diagnosing fault with the help of OBD – II scanner (i.e. troubleshooting, repair and maintenance) The importance of PPEs when test performance of fuses & relays Importance of health and safety Importance of housekeeping	Service Creeper Digital Multimeter Flat / Philips Screwdriver Set Combination Spanner Set Repair Manual Combination Plier Needle Nose Plier Test Lamp Bearing puller OBD – II scanner Relevant PPEs
LU 3: Service Lighting System	**The trainee will be able to:** Select appropriate Tools and equipment. Ensure work safely at all times. Check the headlights and tail lights and replace faulty parts Check reverse lights and reverse gear switch and replace	Operational knowledge and understanding of tools/equipment, required for service lighting system Checking method of the condition of head lights, tail lights/bulbs and replacing Checking and replacing method of the reverse light and the reverse gear switch Checking and replacing method of fog lights and their bulbs Checking and replacing method of roof light, reading lights and their bulbs Checking and replacing method of break switch and its	Service Creeper Digital Multimeter Flat / Philips Screwdriver Set Combination Spanner Set Repair Manual Combination Plier Needle Nose Plier Test Lamp Bearing puller

	Check fog lights and replace faulty parts Check roof and reading lights and replace in case of any fault Check brake switch and replace faulty parts Check turn signals (indicators) and replace faulty parts	function Checking signals with their bulbs and replace their faulty parts Checking and replacing method of parking lights with their bulbs Explaining about instrument panel light with their bulbs Explaining combination switch with its function and its parts Explaining how to check wiring harness of lighting system The importance of PPEs when service lighting system Importance of health and safety Importance of housekeeping	OBD – II scanner Relevant PPEs
LU 4: Test Performance of Alternator	**The trainee will be able to:** Select appropriate tools and equipment. Ensure work safely at all times. Check charging warning light Check alternator output voltage and ampere Check wire harness and electrical connection Check tension of belt.	Operational knowledge and understanding of tools/equipment, required for test performance of alternator Describing method to check charging warning light on odometer Describing uses of DMM (digital multi-meter) Defining method to check the alternator output voltage and ampere with the help of DMM Explaining the function of alternator with voltage regulator Checking the wiring harness and electrical connectors Defining the tension belt of alternator Method to replace the faulty components of the alternator according to standard procedure Explaining how to check the wiring harness of alternators with the help of DMM	Service Creeper Digital Multimeter Flat / Philips Screwdriver Set Combination Spanner Set Repair Manual Combination Plier Needle Nose Plier Test Lamp Bearing puller OBD – II scanner Relevant PPEs

	Replace faulty components according to procedure. Ensure housekeeping after completion of task	The importance of PPEs when test performance of alternator Importance of health and safety Importance of housekeeping	
LU 5: Service Self-Starting System	**The trainee will be able to:** Select appropriate tools and equipment. Select appropriate tools and equipment. Ensure work safely at all times, complying with health and safety precautions, regulations and other relevant guidelines. Check performance of battery. Check electrical wire harness, relays and connection of starter motor. Check alignment of starter motor pinion with fly wheel. Ensure the fault is removed and starter motor is functioning properly. Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required for service self- starting system Explaining how to check the self-starting components (i.e. self-starter, self-solenoid, wiring harness, self-relay and fuse) Defining the function of solenoid in self-starter Knowledge of different types of batteries (including Hybrid Batteries) Operational knowledge and understanding of the function of relay in self-starter and starter motor Defining the function of starter motor Explaining the wiring harness of self-starting system Explaining how to troubleshoot the fault of self-starter system with OBD – II scanner The importance of PPEs when service self- starting system Importance of health and safety Importance of housekeeping	Service Creeper Digital Multimeter Flat / Philips Screwdriver Set Combination Spanner Set Repair Manual Combination Plier Needle Nose Plier Test Lamp Bearing puller OBD – II scanner Relevant PPEs

Examples & illustration:

Ignition System:

An ignition system is an array of components that are all involved in the process of igniting the air/fuel mixture in an internal combustion engine.

The purpose of the ignition system is to generate a very high voltage from the car's 12 volt battery, and to send this to each sparkplug in turn, igniting the fuel-air mixture in the engine's combustion chambers. The ignition system consists of an ignition coil, distributor, distributor cap, rotor, plug wires and spark plugs.

The Ignition Coil

The ignition coil is the unit that takes your relatively weak battery power and turns it into a spark powerful enough to ignite fuel vapor.

The Distributor, Distributor Cap, and Rotor

The distributor is basically a very precise spinner. As it spins, it distributes the sparks to the individual spark plugs at exactly the right time. It distributes the sparks by taking the powerful spark that came in via the coil wire and sending it through a spinning electrical contact known as the rotor. The rotor spins because it's connected directly to the shaft of the distributor. As the rotor spins, it makes contact with a number of points (4, 6, 8 or 12 depending on how many cylinders your engine has) and sends the spark through that point to the plug wire on the other end.

Spark Plugs and Wires

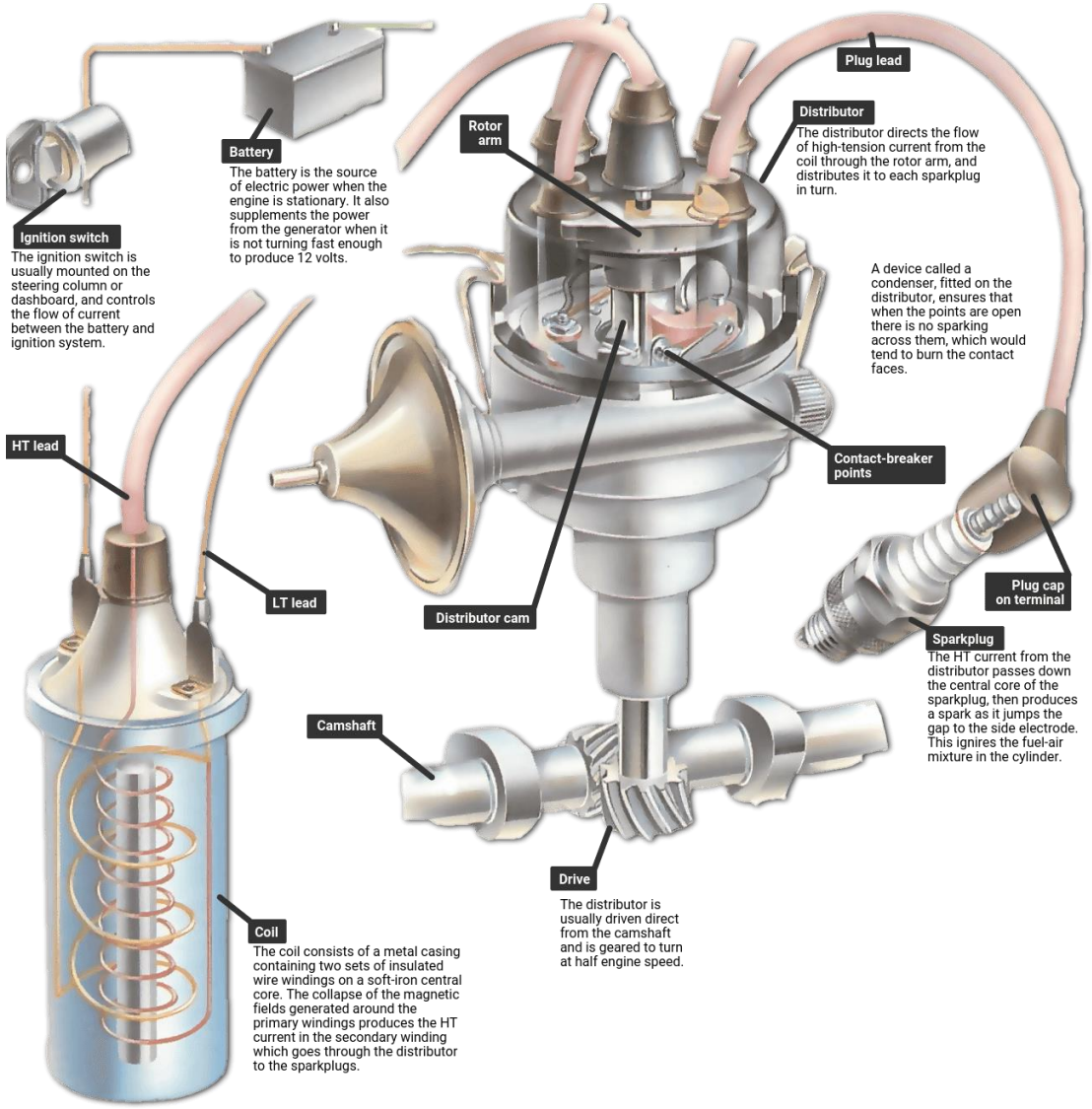
The spark plugs are screwed into the cylinder head, which means that the end of the plug is sitting at the top of the cylinder where the action happens. At just the right time (thanks to the distributor), when the intake valves have let the right amount of fuel vapor and air into the cylinder, the spark plug makes a nice, blue, hot spark that ignites the mixture and creates combustion.

At this point, the ignition system has done its job, a job it can do thousands of times per minute.

The coil is the component that produces this high voltage. It is an electromagnetic device that converts the low-tension (LT) current from the battery to high-tension (HT) current each time the distributor contact-breaker points open.

The distributor unit consists of a metal bowl containing a central shaft, which is usually driven directly by the camshaft or, sometimes, by the crankshaft.

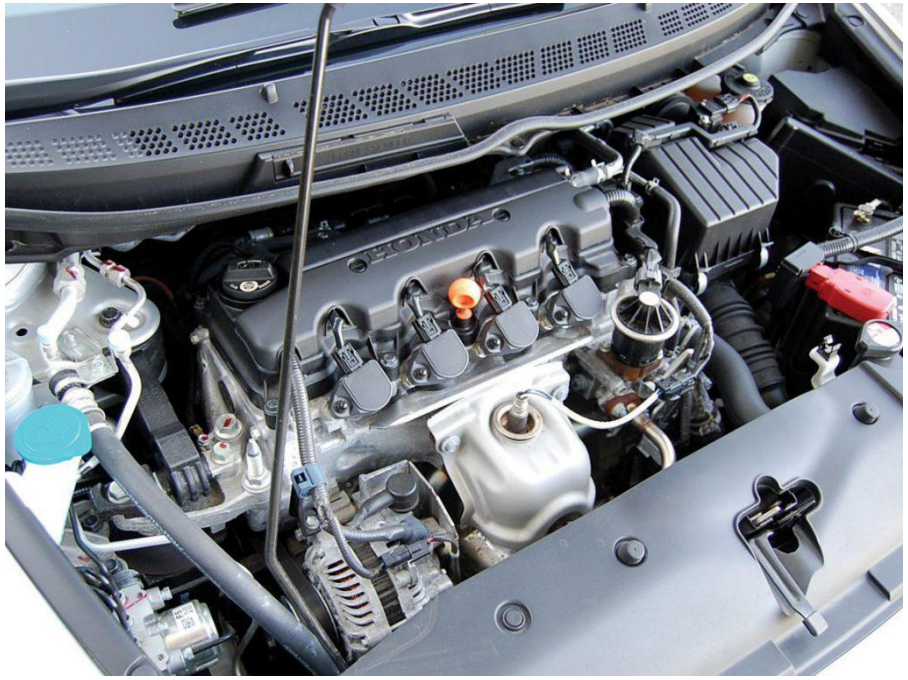
The bowl houses the contact-breaker points, rotor arm, and a device for altering the ignition timing. It also carries the distributor cap.



Types of Ignition System

1. **Electronic Ignition Systems**

The electronic ignition systems are similar to the mechanical ignition systems. It utilizes electronic timing devices in place of ignition points. The electronic control module separates from the distributor and guides the flow of current in the ignition coil primary circuit.



2. **Coil-On-Plug Ignition System**

The Coil-On-Plug (COP), also known as **direct ignition systems**, which includes all electronic controls found inside a car with DIS (Distributor less Ignition System). However, instead of two cylinders sharing a single coil, each coil in the Coil-On-Plug ignition system utilizes a single cylinder. It has twice the time to develop the maximum magnetic field. Some cars with the COP can generate 40,000 to 50,000 volts and stronger sparks.

3. Distributor less Automotive Ignition System

The Distributor less Ignition System determines the spark timing depending on two shaft position sensors and a computer. It has crankshaft with the Crankshaft Position Sensor (CKP) or near the flywheel in some vehicles. The sensors monitor the shaft position and send this information to the computer. The DIS utilizes multiple ignition coils known as coil packs with each generating spark for two cylinders. It is another popular **type of ignition systems**, which automotive manufacturers prefer. The Distributor less Ignition System is also known for being less expensive when you are looking for an ignition system offering high voltage at a low price. In short, it is a better alternative for those looking to get an ignition system without spending too much.

Contact breaker point:

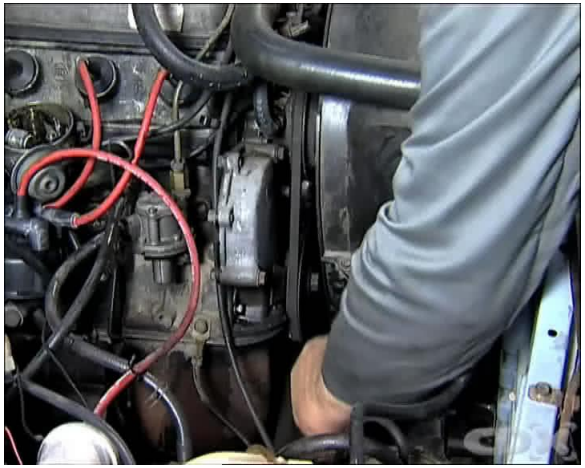
It is a switching device used in the distributor of an internal-combustion engine which controls the timing of the spark that ignites the spark plug.

Replacing Contact breaker points:

Changing your contacts will keep your car running and ensure correct ignition function.

Step 1 - Locate the Distributor And Remove The Cap

Step 2 - Rotate the Engine



Step 3 - Remove Brake Pads and Caliper

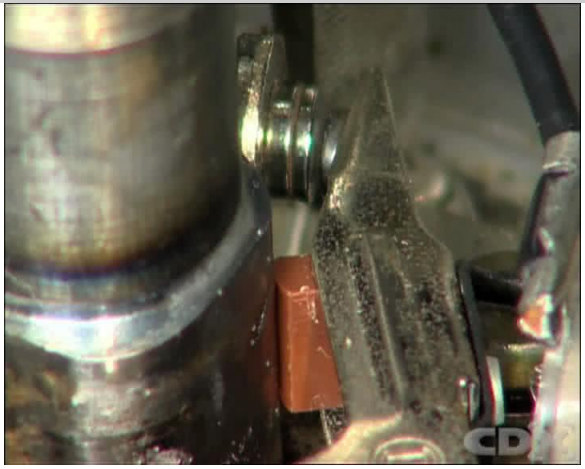
Step 4 - Inspect the Points

Step 5 - Check Mechanical Advance and Retard Weights

Step 6 - Check the Vacuum Advance Unit

Step 7 - Fit the Contact Breaker Points

Adjust the Contact Breaker Points



Step 9 - Check the Dwell

For more detailed information, please visit http://www.crankshift.com/ignition-system/ and also visit https://www.howacarworks.com/basics/how-the-ignition-system-works and https://auto.howstuffworks.com/ignition-system.htm and https://www.liveabout.com/your-ignition-system-how-does-it-work-281578 and https://carfromjapan.com/article/car-maintenance/the-three-types-of-ignition-system-and-how-they-work/

Ignition Relay:

The ignition relay is normally found in the fuse box situated underneath the hood and it transfers electricity from the battery to the ignition components, which allows you to start the car in the blink of an eye.

The ignition relay is basically an electrical device that works as a switch for the power to the ignition system and the fuel system of your vehicle. The ignition relay is activated as soon as your turn on the ignition of your vehicle with the key.

The ignition relay then switches the power on and lets it reach to the systems that are required to be powered up so that your vehicle can function. As a result, the battery transmits the power to the ignition coil, which is then transmitted to the spark plugs of your vehicle to start the engine.

Signs of a bad ignition relay

An ignition relay does normally sit with a few other relays and fuses in the fuse box found in the engine bay. The area under the hood is open to contaminants and pollutants like dirt and debris – the common reason behind ignition relay failure. Even the car's battery can destroy the relay by sending inconsistent electricity flow through to the system.

1. **Ignition is Unresponsive**

The ignition relay's primary job is to help you start the car. Therefore, it is natural that if you are unable to feel anything when you turn the key in the ignition, the ignition relay is having troubles.

2. **Engine Stalls**

The ignition relay not only gives life to the engine but it works as an influencer that maintains the delivery of power to the fuel pump. The fuel pump, in turn, keeps the engine running, so if the engine stalls suddenly while working, you could be looking at ignition relay failure.

3. **Dead Battery**

If you are looking at a battery that has died even when it was working perfectly the day before, the ignition relay could have been the cause

4. **Fried Relay**

If the ignition relay is of low-quality it can get short-circuited pretty easily. A fried relay will affect ignition and it might even blow up due to overheating, which might also destroy the other relays and fuses in the fuse box. In which case you will be required to change the entire fuse box.

For more detailed information, please visit https://mechanicbase.com/electric/ignition-relay-symptoms/

Automotive Fuses:

Almost everything in a car is wired through a fuse. Fuses are designed to fail when too much current is drawn through the device. This prevents heating of the wires and subsequent melting of the insulation, followed usually by fire!

Fuses are simple in design. Inside a fuse is a soft wire with a specific cross-sectional thickness. This dimension dictates how many amps can be carried before the wire melts.

Most of any car's fuses are located in the fuse panel, but some are in-line. In-line fuses are found under the dash and in the engine compartment.

For more detailed information, please visit http://www.secondchancegarage.com/public/133.cfm and https://www.captoyota.com/service/information/easy-tips-for-replacing-blown-fuses-relays-salem-or.htm

Vehicle Lighting Systems
Vehicle lighting systems are extremely important specifically from road safety considerations. If headlights suddenly fail at night and at high speed the result would be catastrophic. Many techniques have been incorporated, ranging from automatic changeover circuits, to thermal circuit breakers, which pulse the lights rather than putting them out as a blown fuse would. Most modern wiring systems fuse each bulb filament separately and if the main supply to the headlights were to fail, it is likely that the dim dip would still work.
The vehicle lights must perform two functions, they must allow the driver to see in the dark and allow the vehicle to be seen in the dark (or in conditions of poor visibility). Side lights, tail lights, brake lights and others are relatively straightforward.

Car lights include:

- **Headlights.** There are two types of headlights—low beam and high beam.
- **Tail lights.** Tail lights are required to produce only red light at the rear of the vehicle and are wired such that they are lit whenever the headlights are on.
- **Daytime running lights.** These lights are located in both the front and rear of the car and generally turn on automatically.

- **Fog lights.** Located near the headlights, these lights and are generally mounted low in order to prevent the light from refracting on the fog and glaring back toward you (the driver).
- **Signal lights.** Also known as turn signals or “blinkers” these are located in the front and back of the car, beside the head and tail lights.
- **Brake lights.** Located to the side of your rear lights.
- **Hazard lights.** Also known as flashers, they are located in the front and back of the vehicle.
- **Driving lamps.** These are located inside the cab of your vehicle.

Broken Headlight

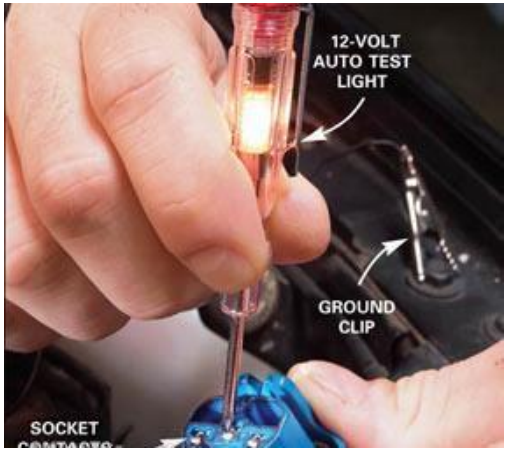
Step 1: Replace the bulb

Remove the old bulb and insert the new bulb. Don’t touch the glass of the bulb with your bare hands because the oils on your skin can cause the bulb to fail. Reinsert the socket into the headlamp housing and turn on your lights.

Step 2: Clean the socket

Turn off the light switch and remove the bulb again. Clean the socket with electrical contact cleaner or scrape it off with a small screwdriver or wire brush.

Step 3: Test the socket



Test for power at the socket. Turn on the light switch, then ground the tester to a clean screw on the body of the car. Probe the contacts to see if the tester lights. If the contacts look corroded, scratch the surface, but be careful not to bend or distort them.

Step 4: Test for power at the wires

Push the point of the tester through the wire insulation behind the socket to make contact with the wire. The tester should light for two of the three wires (the ground wire won't light). If it lights for two wires, the wiring is good. Simply replace the socket. If not, you may have a bad wire or connector somewhere, so check for any visible problems.

For more detailed information, please visit https://www.familyhandyman.com/automotive/how-to-diagnose-and-repair-a-broken-auto-light-socket/ and https://www.dulaneylauerthomas.com/faqs/types-of-car-lights-and-when-you-should-use-them.cfm and https://what-when-how.com/automobile/vehicle-lighting-systems-automobile/ also visit https://www.gofar.co/car-warning-lights/car-warning-light-symbols-and-indicators/

Alternator:

An automotive charging system is made up of three major components: the **battery**, the **voltage regulator** and an **alternator**. The alternator works with the battery to generate power for the electrical components of a vehicle, like the interior and exterior lights, and the instrument panel. An alternator gets its name from the term **alternating current (AC)**.

How to diagnose a failing alternator

If you suspect a failing alternator but don't have a warning light, pop the hood and check the condition of the belt. If it is glazed and slightly burned looking, that is an indication that it is slipping. The belt is too loose, so it slips on the pulleys instead of traveling along them. The metal-

on-rubber friction heats up the belt, quickly wearing it out. Adjust the tensioner to get the belt just right (too tight can also damage an alternator's bearings), or just replace the serpentine belt since it is among the most affordable car parts you can buy, and it's a quick and easy repair.

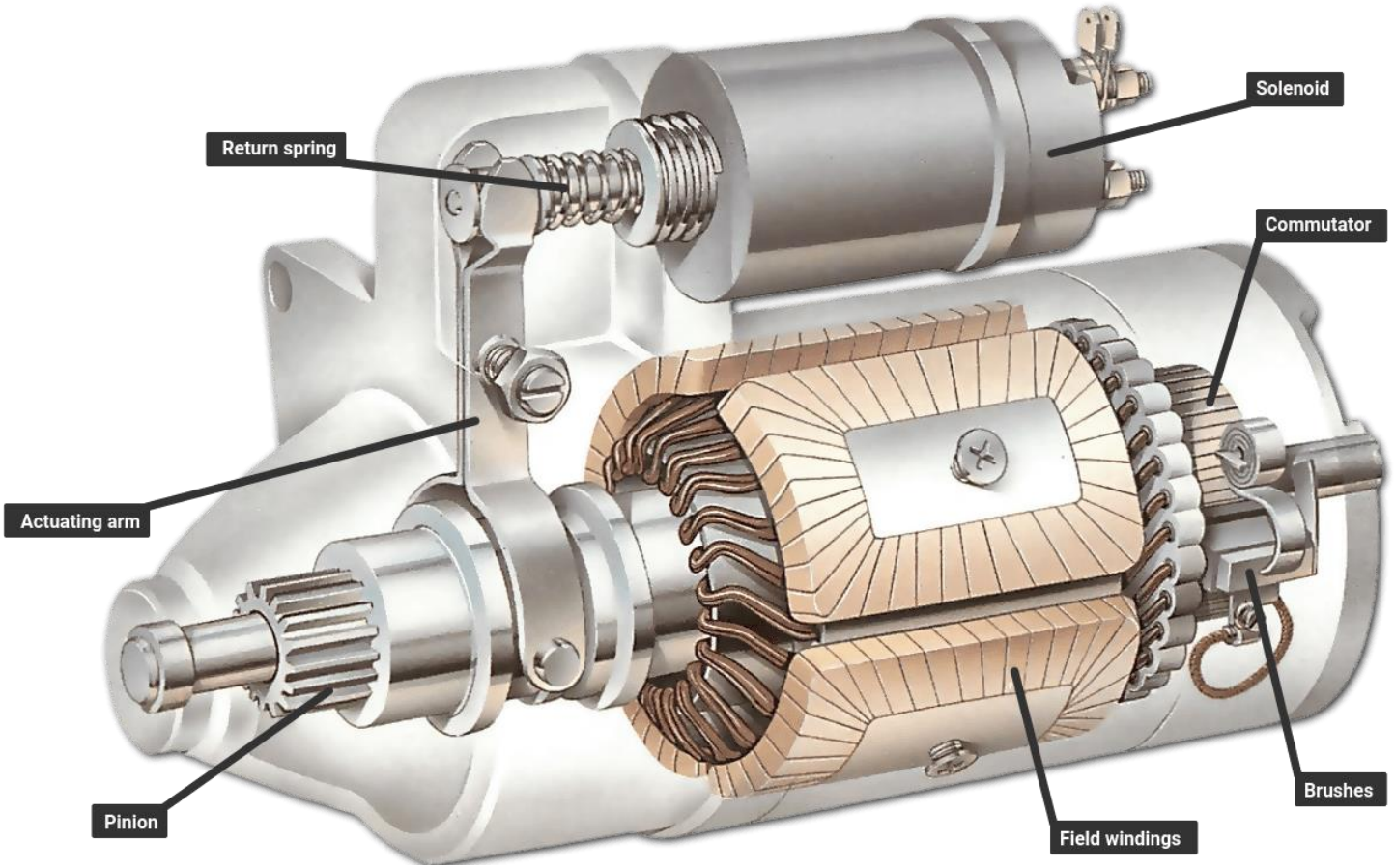
If everything looks good under the hood, grab your Multimeter. Make sure the vehicle is parked on level ground with the parking brake on and wear your safety glasses. Set the meter to 20 V DC and connect the leads to the battery—positive lead to positive battery terminal and negative lead to negative terminal. It should read around 12.6 volts.

Start the engine and carefully check voltage again. This time it should be at least 14.2 volts if the alternator is healthy and charging the battery. If voltage is good, turn on the headlights, interior lights, radio, heater, and any other electrical load. The meter should still display above 13 volts. If any of the voltages are below spec, it's a strong case for a new alternator. Check all your cables for corrosion or a loose connection.

For more detailed information, please visit https://shop.advanceautoparts.com/r/advice/car-maintenance/symptoms-of-a-bad-alternator and https://auto.howstuffworks.com/alternator1.htm also visit https://www.samarins.com/glossary/alternator.html

Starter motor

A starter is an electric motor that turns over or "cranks" the engine to start it. It consists of a powerful DC (Direct Current) electric motor and the starter solenoid that is attached to the motor.



What are the symptoms of a bad starter motor?

When starting a car with the fully charged battery, there is a single click or nothing happens at all. The starter motor doesn't run, even though there is a 12-Volt power at the starter control terminal.

Another symptom is when the starter motor runs, but fails to turn over the engine. Often, this might cause a loud screeching noise when starting the car. Of course, this could also be caused by damaged teeth on the ring gear of the flex plate or flywheel.

For more detailed information, please visit https://www.samarins.com/glossary/starter.html and https://www.howacarworks.com/basics/how-the-starting-system-works

Videos:

	**How to test spark plugs and ignition system work** **https://youtu.be/mQp8qYInv2U**
	**How to Check Car Fuses With a Multimeter-Tutorial to Check If A Fuse Is Good** **https://youtu.be/FQGjt2c6ADU**

	**How to fix a brake light** **https://youtu.be/KQhri34HVrw**
	**How to Test an Alternator** **https://youtu.be/LGB6ZEjGm7Q**

	**Starter motor pinion/ Bendix gear not engaging with flywheel** **https://youtu.be/RhdSq4WOaDM**

AUTOMOTIVE MECHATRONICS

Module-13

LEARNER GUIDE

National Vocational Certificate Level 2

Version 1 - October, 2019

Module 13: 071400950 Perform On-Board Diagnostic (OBD-II) Scanner Operations

Objective of the module: The aim of this module is to develop knowledge, skills and understanding needed to perform On-Board Diagnostic (OBD-II) scanner operations.

Duration: 50 Hrs **Theory:** 11 Hrs **Practical:** 39 Hrs

Learning Unit	Learning Outcomes	Learning Elements	Materials Required
LU 1: Perform Scanning & Diagnoses	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Connect the required connector with car of OBD-II Switch on the ignition switch Enter the Car's detail in OBD-II scanner Diagnose Engine and Electronically Controlled Transmission Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to perform scanning & diagnoses Introducing OBD-II scanner Explaining function of OBD-II scanner Identifying main parts of OBD-II scanner Explaining procedure of connecting OBD-II scanner Defining complete procedure of scanning by OBD-II Identifying different types of sensor and their location (i.e. engine coolant temperature sensor, O2 sensor, TP sensor, crank shaft position sensor, cam shaft position sensor, MAF sensor, MAP sensor, Knock sensor, vehicle speed sensor etc.) Defining ECT (Electronically Controlled Transmission) The importance of PPEs when perform scanning & diagnoses Importance of health and safety Importance of housekeeping	Relevant PPEs
LU 2: Investigate OBD-II for Fault Analysis	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times	Operational knowledge and understanding of tools/equipment, required to remove & refit various sensors and actuators. Explaining DTC (Diagnostic trouble code) Describing different DTC codes (for example P 1120	Relevant PPEs

	Check the DTC (Diagnostic trouble code) with OBD-II scanner Remove faults and ensure with OBD-II scanner Ensure housekeeping after completion of task	and P 1125 for air fuel control) Describing to remove faults and ensure with OBD-II scanner The importance of PPEs to remove and refit various sensors and actuators. Importance of health and safety Importance of housekeeping	
LU 3: Check Vehicle's Mechanical Parameters of OBD-II Operations	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times Set idle speed through adjustment screw on throttle body Diagnose the adjusted RPM with OBD-II Diagnose engine coolant temperature with OBD-II scanner Check the mass air flow with OBD-II scanner at different engine speed Ensure housekeeping after completion of task	Operational knowledge and understanding of tools/equipment, required to remove & refit various sensors and actuators. Explaining complete procedure for scanning faults with OBD-II Defining Actuators Explaining different Type of Actuator (IAC Valve, solenoid, stepper motors etc.) The importance of PPEs to remove and refit various sensors and actuators. Importance of health and safety Importance of housekeeping	Relevant PPEs
LU 4: Maintain OBD-II Scanner	**The trainee will be able to:** Select tools and equipment according to job requirement Observe occupational health and safety precautions at all times	Operational knowledge and understanding of tools/equipment, required for remove & refit engine head assembly Handling and cleaning techniques of OBD-II scanner Ensuring the good working condition of OBD-II	Relevant PPEs

	Ensure availability of required connectors of OBD-II scanner Clean OBD-II scanner on regular basis Replace battery of OBD-II scanner when required Store OBD-II scanner safely Ensure housekeeping after completion of task	Storing OBD-II scanner safely at allocated place The importance of PPEs when remove and refit engine head assembly Importance of health and safety Importance of housekeeping	

Examples & illustrations:

What is an OBD II scanner?

On-board diagnostic II or OBD II is a standardized system in trucks and cars. It's mainly used for self-diagnostics. The OBDII software regulates and monitors your car's main functions. It can send commands to different systems to maintain your car's overall health. It can also self-correct any anomalies in fuel mixture and vehicle ignition.

To understand OBD II's gathered data, car owners and technicians use an OBD II scanner. This device can present data about a vehicle's engine RPM, coolant, and air temperature, camshaft and crankshaft position, throttle, and road speed.

Types of OBD II scanners

There are two types of OBD II scanner that you can find in the market.

1. **Code readers**

OBD II code readers are no-frills and inexpensive gadgets that can clear and read codes from your vehicle.

2. **Scan tools**

Scan tools are more expensive than code readers, but this device has various features that are not incorporated in the readers.

How does OBD II scanner work?

The way an OBD II scanner function depends on its type. If your scanner is a code reader, then it can only clear and read codes. If you bought a scan tool, then it can view live and stored data and do lots of other functions.

How to use an OBD II scanner?

This device is easy to use. It's true that different models offer various functions; however, the general process for utilizing an OBD II scanner is simple. All you have to do is to follow the procedure below.

1. First, you have to turn off the power of your vehicle and plug the scanner into the OBD II's data link connector located under your car's control panel. The scanner functions after you insert the plug into the OBD II system of your vehicle. Some scan tools include modules or key that will amplify the universal connector to interact or access OEM-specific controls and data.
2. Second, switch your car on and wait for the OBD II scanner to boot up. If it doesn't automatically initialize, press its power button.

3. When the scanner is ready, input all required data. This includes information about your car's model, type, engine, Vehicle Information Number (VIN), etc.
4. After that, you have to allow the device to scan or read your vehicle's diagnostic system. If you don't know how to do this, then check the scanner's manual, and look for the button that can initiate this process.
5. After scanning all of your car's systems, the OBD II scanner will provide several codes or single trouble code. You can either write these codes down or transfer all the data to your laptop or mobile phone using Bluetooth.
6. Check these trouble-codes in the scanner's manual to know what each means. Most manuals only provide basic codes. If you can't find the given DTC code, then check it on the internet. There are lots of supplemental codes for various vehicle models online.
7. When you're done recording the codes, switch off your vehicle, and unplug your OBD II scanner carefully.

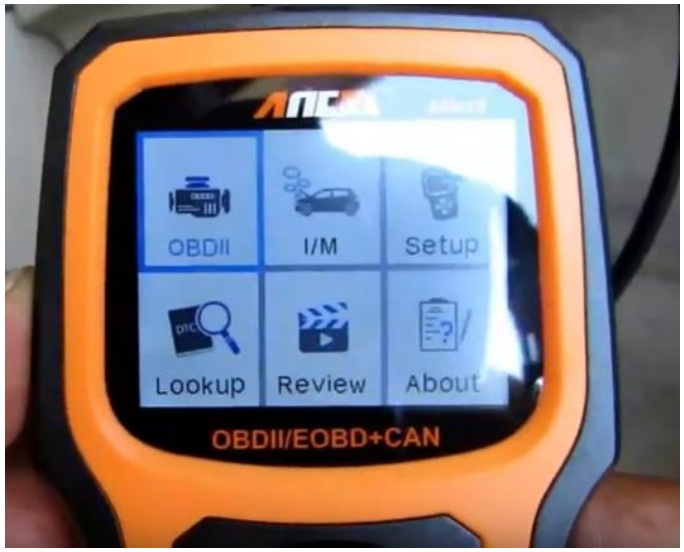
Rules to follow

OBD II scanners are not fragile, and some models are extremely durable. But, if you don't take caution in using it, your OBD II system or OBD II scanner can malfunction. Here are some do's and don'ts when using this device.

- The procedure above is a comprehensive guide for using any OBD II scanner. However, it's recommended to read the manual that comes with your scan tool.
- When connecting the universal connector to the OBD II system, always be gentle. The 16-pinned plug is extremely delicate. The pins may bend if you plug carelessly.
- Always turn your car on when you're using the scanner so that you can avoid corrupting the OBD II software.

For more detailed information, please visit https://curateview.com/everything-about-obd2-scanners/ and https://www.lifewire.com/what-is-obd-ii-scanner-534868 also visit https://www.1aauto.com/content/articles/what-is-obd2 and https://www.wikihow.com/Read-and-Understand-OBD-Codes

Videos:

	**Learn How to Do A Car Diagnostic Using an OBD II Scanner - Turn Engine Light Off** **https://youtu.be/EXYcPuB_quY**
	**How to Use an OBD-II Scan Tool** **https://youtu.be/h9-6dkjMmQ4**

Module summary

Module Title and Aim	Learning Units	Timeframe of modules
Module 1: Comply Personal Health and Safety Guidelines **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to comply personal health and safety guidelines	**LU 1:** Identify Personal Hazards at Workplace **LU 2:** Apply Personal Protective and Safety Equipment (PPE) **LU 3:** Comply Occupational Safety and Health (OSH) **LU 4:** Dispose of hazardous Waste/materials from the designated area	30 Hrs
Module 2: Communicate the Workplace Policy and Procedure **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to communicate the workplace policy and procedure	**LU 1:** Identify workplace communication procedures **LU 2:** Communicate at workplace **LU 3:** Draft Written Information **LU 4:** Review Documents	20 Hrs
Module 3: Perform Basic Communication (Specific) **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to perform basic communication (specific)	**LU 1:** Communicate in a team to achieve intended outcomes **LU 2:** Follow Supervisor's instructions as per organizational SOPs **LU 3:** Develop Generic communication skills at workplace	30 Hrs
Module 4: Perform Basic Computer Application (Specific) **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to perform basic computer application (specific)	**LU 1:** Create Word Documents **LU 2:** Use internet for Browsing	40 Hrs

Module Title and Aim	Learning Units	Timeframe of modules
Module 5: Maintain Engine Assembly **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain engine assembly	**LU 1:** Remove & Refit Engine Head Assembly **LU 2:** Remove & Refit Engine Block Assembly **LU 3:** Set Engine Timings **LU 4:** Couple Engine & Transmission	50 HRS
Module 6: Maintain Fuel System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain fuel system	**LU 1:** Service Fuel Injectors and Rail **LU 2:** Repair Fuel Pump **LU 3:** Perform Carburettor Service **LU 4:** Perform Throttle Body Service	50 HRS
Module 7: Service Engine Cooling System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to service engine cooling system	**LU 1:** Perform Radiator Service **LU 2:** Perform Radiator Fan Service **LU 3:** Evaluate Thermos tat Valve Performance **LU 4:** Evaluate Water Pump Performance	50 HRS
Module 8: Maintain Engine Lubrication System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain engine lubrication system	**LU 1:** Test Performance of Oil Pressure Switch **LU 2:** Service Oil Pump **LU 3:** Investigate & Repair Oil Leakages	30 HRS
Module 9: Maintain Brake System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain brake system	**LU 1:** Perform Maintenance of Mechanical Brake System **LU 2:** Perform Maintenance of Hydraulic Brake System **LU 3:** Perform Maintenance of Pneumatic Brake System	50 HRS

Module Title and Aim	Learning Units	Timeframe of modules
Module 10: Maintain Suspension System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to maintain suspension system	**LU 1:** Check Performance of McPherson Strut **LU 2:** Check Tie Rod Performance **LU 3:** Check Performance of Coil Spring Sagging **LU 4:** Test Performance of Stabilizer Bar **LU 5:** Test Knuckle Assembly Operations **LU 6:** Check Performance of Upper & Lower Suspension Arms **LU 7:** Test Differential System **LU 8:** Test Axle Assembly **LU 9:** Maintain Wheel Alignment **LU 10:** Maintain Wheel Balancing	60 HRS
Module 11: Check Vehicle Transmission System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to check vehicle transmission system	**LU 1:** Check Performance of Manual Transmission **LU 2:** Check Performance of Mechanical Clutch System **LU 3:** Check Performance of Hydraulic Clutch System	50 HRS
Module 12: Service Electrical System **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to service electrical system	**LU 1:** Check Performance of Ignition System **LU 2:** Test Performance of Fuses & Relays **LU 3:** Service Lighting System **LU 4:** Test Performance of Alternator **LU 5:** Service Self-Starting System	70 HRS
Module 13: Perform On-Board Diagnostic (OBD-II) Scanner Operations **Aim:** The aim of this module is to develop advanced knowledge, skills and understanding to perform On-Board diagnostic scanner operation	**LU 1:** Perform Scanning & Diagnoses **LU 2:** Investigate OBD-II for Fault Analysis **LU 3:** Check Vehicle's Mechanical Parameters of OBD-II Operations **LU 4:** Maintain OBD-II Scanner	50 HRS

Short Questions/Answers

1. What is index mark?	It is a fix mark located near crank shaft and cam shaft.
2. Where the timing mark is located?	It is located on the crank shaft and cam shaft.
3. Give name of main parts of an engine	Main parts of an engine are head cylinder, cylinder block and oil pan.
4. Define function of carburettor system	It provides accurate mixture of air and gasoline to engine combustion chamber.
5. What's a throttle body? https://mechanicbase.com/engine/fuel-induction-service/	It is responsible for taking in the air and fuel to mix it according to the right proportion and as per the computer's input. The throttle body consists of a body and a plate which determines how much air inlet in, similar to how the butterfly valve works in carburetors.
6. Why do I need to clean my fuel injectors? https://www.precisiontune.com/services/fuel-system-service/	Cleaning the fuel injectors on a regular scheduled maintenance program removes carbon deposits which forms on piston valves and fuel injector nozzles due to burning of the fuel. It interferes with the spray pattern and flow of fuel.
7. Is the following statement True or False? Pressure valve and vacuum valve are parts of radiator pressure cap	True
8. When should the thermostat valve replace?	It should be replaced if not completely closed at normal atmosphere temperature.
9. Are pressure valve and vacuum valve parts of radiator pressure cap?	Yes they are.
10. What are the Purposes of engine lubrication? https://scholarexpress.com/multiple-choice-questions-mcq-with-answers-on-engine-lubrication-system/	Minimizes wear in moving parts Helps in keeping the parts cool Washes away and carries away dirt
11. What parts of the engine of a car can oil leak from?	Valve Cover Gaskets, Head Gasket, Rear Main Seal, Front Main Seal, Timing Cover, Oil Pan Gasket, Oil Drain Plug, Oil Filter, Dip Stick Inlet,

https://axleaddict.com/auto-repair/5-Reasons-Your-Car-is-Leaking-Oil	Crack in the Block, Oil Cap, and anywhere that water can leak from if the block or head gasket has ruptured and allowed oil and water to mix.
12. What is Viscosity index (VI)? https://scholarexpress.com/multiple-choice-questions-mcq-with-answers-on-engine-lubrication-system/	Viscosity index (VI) is a measure for the change of viscosity with change in temperature
13. How many types of of Oil pumps are used in Engine Lubrication system? https://scholarexpress.com/multiple-choice-questions-mcq-with-answers-on-engine-lubrication-system/	There are 3 types of oil pumps are used in Engine Lubrication System; Gear type Rotor type Plunger type
14. Which parts are lubricated by splash system? https://scholarexpress.com/multiple-choice-questions-mcq-with-answers-on-engine-lubrication-system/l	Piston and piston rings Tappets Cams on camshaft
15. To stop a vehicle, the force required is dependent on? https://scholarexpress.com/multiple-choice-questions-mcq-on-braking-system/	the weight of vehicle the deceleration rate
16. An automobile brake is only used to reduce the speed or bring the vehicle to hault https://www.sanfoundry.com/machine-design-questions-answers-brakes/	No. It can also be used to hold the car stationary.
17. Are pneumatic brake same as electrical brakes? https://www.sanfoundry.com/machine-design-questions-answers-brakes/	No, one deals with pressure and other with electricity.

18. How mechanical brakes are operated? https://scholarexpress.com/multiple-choice-questions-mcq-on-braking-system/	mechanical brakes are operated by means of a) levers b) bell cranks c) cams
19. Internal shoe brakes are radial while external shoe brakes are axial brakes. https://www.sanfoundry.com/machine-design-questions-answers-brakes/	False. Both internal and external shoe brakes are radial brakes.

20. What is the function of master cylinder in hydraulic brakes? https://scholarexpress.com/multiple-choice-questions-mcq-on-braking-system/	The function of master cylinder in hydraulic brakes is to (A) builds up hydraulic pressure to operate the brakes (B) maintains constant volume of fluid in the system (C) serves as a pump to force air out of the hydraulic system
21. What is the main purpose of a car suspension? https://play.howstuffworks.com/quiz/car-suspension-quiz	The job of a car suspension is to maximize the friction between the tires and the road surface, to provide steering stability with good handling and to ensure the comfort of the passengers.
22. Why the stabilizers (sway bars) are used? https://scholarexpress.com/multiple-choice-questions-mcq-with-answers-on-suspension-system/2/	The stabilizers (sway bars) are used to connect shock absorber operating arm
23. What is called a combination of roll and pitch? https://scholarexpress.com/multiple-choice-questions-mcq-with-answers-on-suspension-system/2/	Diagonal pitch.
24. What term describes the ability of a vehicle to travel a curved path? https://play.howstuffworks.com/quiz/car-suspension-quiz	Cornering is the ability of a vehicle to travel a curved path.
25. What are the two different cycles of shock absorbers? https://play.howstuffworks.com/quiz/car-suspension-quiz	Shock absorbers work in two cycles -- the compression cycle and the extension cycle.
26. What are the types of leaf springs? https://scholarexpress.com/multiple-choice-questions-mcq-with-answers-on-suspension-system/	three Quarter elliptic semi elliptic quarter elliptic
27. What are the dead axles? https://scholarexpress.com/multiple-choice-questions-mcq-with-answers-on-suspension-system/	These are simply beams which supports the vehicle weight

28. What is loosely defined as the mass between the road and the suspension springs? https://play.howstuffworks.com/quiz/car-suspension-quiz	The sprung mass is the mass of the vehicle supported on the springs, while the unsprang mass is loosely defined as the mass between the road and the suspension springs.
29. What is CVT stands for?	Continuous variable transmission
30. What are the classes of Mechanical transmission? https://scholarexpress.com/multiple-choice-questions-mcq-on-transmission-system/	Mechanical transmission can be of following classes (A) Clutch, gearbox and live axle transmission (B) Clutch, gearbox and dead axle transmission (C) Clutch, gearbox and axle less transmission
31. How Increase of torque in a vehicle is obtained? https://www.sanfoundry.com/automobile-engineering-questions-answers-transmission-system-gearbox/	Increase of torque in a vehicle is obtained by decreasing speed.
32. What is the purpose of bleeding in hydraulic system?	To remove air from wheel cylinder/ hydraulic system
33. How manual transmission is connected to the engine? https://play.howstuffworks.com/quiz/transmission-quiz	The clutch connects the transmission to the engine.
34. What connects the gears to the drive shaft in a manual transmission? https://play.howstuffworks.com/quiz/transmission-quiz	The collar can slide left or right along the shaft to engage one of the gears.
35. What two things do automatic transmissions lack that manual transmissions have? https://play.howstuffworks.com/quiz/transmission-quiz	An automatic transmission lacks a clutch pedal and gear shift.
36. What provides a smooth means of disengagement and engagement between the engine and the remainder of transmission system? https://scholarexpress.com/multiple-choice-questions-mcq-on-transmission-system/	Clutch
37. What type of modern transmission is generally best for fuel economy? https://play.howstuffworks.com/quiz/transmission-quiz	CVT type

38. Which type of transmission uses chain and sprocket to transmit power? https://scholarexpress.com/multiple-choice-questions-mcq-on-transmission-system/	Clutch, gearbox and dead axle transmission
39. How the cover is separated, in coil spring type of clutch? http://iitportal.com/Paper/Multiple-Choice-Questions-Exam-Paper-For-Engineering-Automobile-4	By removing three screws or nuts
40. What type of a continuously variable transmission is? https://play.howstuffworks.com/quiz/transmission-quiz	The continuously variable transmission is based on the automatic transmission.
41. What is the torque tube? https://scholarexpress.com/multiple-choice-questions-mcq-on-transmission-system/	The torque tube is a tubular member which encloses the propeller shaft
42. What does a tachometer do? https://play.howstuffworks.com/quiz/transmission-quiz	The tachometer tells the driver how fast the engine is moving, measured in rpms.
43. The function of a torque converter or fluid converter is similar to? http://iitportal.com/Paper/Multiple-Choice-Questions-Exam-Paper-For-Engineering-Automobile-4	Gear box
44. Why synchronizing devices are designed? http://iitportal.com/Paper/Multiple-Choice-Questions-Exam-Paper-For-Engineering-Automobile-4	To prevent gear clash when shifting into Second and high
45. Why is the CVT so common in hybrid cars? https://play.howstuffworks.com/quiz/transmission-quiz	For better fuel economy
46. What are the purposes of the distributor in the ignition system? https://scholarexpress.com/multiple-choice-questions-mcq-on-ignition-system-of-automobile/	It operates break and make mechanism It distributes high tension current to spark plug at correct time
47. What are the two types of distributor system?	The two types of distributor system are CB point distributor and CB point less distributor

48. What is it called when the spark timing is moved closer to the top of the compression stroke? https://play.howstuffworks.com/quiz/ignition-system-quiz	Retarding the spark
49. What is the difference between a "hot" spark plug and a "cold" spark plug? https://play.howstuffworks.com/quiz/ignition-system-quiz	The shape of the ceramic tip
50. In a distributor less ignition system, what component has total control over spark timing? https://play.howstuffworks.com/quiz/ignition-system-quiz	The engine control unit (ECU)
51. What DTC code from P000 to P0299 represent?	Air fuel mixture control
52. Is the following statement True or False? Map sensor located on intake manifold	True
53. Is the following statement True or False? Oxygen (O2) located on transmission unit	False
54. Is the following statement True or False? OBD-II scanner connector is located behind rear seats	False

Test Yourself (Multiple Choice Questions)

MODULE 5

Question 1 Which type of engine is used in most of the cars?

A Rotatory engine

B Opposed engine

C V type engine

D In-line engine

Question 2 From which of the following system, a thermostat belongs?

A Liquid cooling system

B Lubrication system

C Transmission system

D Cabin system

Question 3 Into which energy, an engine converts the chemical energy?

A Heat

B Kinetic

C Mechanical

D Light

Question 4 Into which of the following, Crank shaft converts reciprocating motion?

A Harmonic motion

B Rotatory motion

C Liner motion

D Up & down motion

Question 5 Is the following statement True or False?
Intake and exhaust valves are same in design and material

A False

B True

MODULE	6		
Question	**6**	Where the fuel pump of a vehicle is located?	A In Engine room B Under Driving seat C With transmission system D In Fuel tank
Question	**7**	What is the full form of EFI?	A Electronic fuel injection. B Elementary fuel injection C Periodically fuel injection D Electric fuel ignition
Question	**8**	Due to which of the following reason, Pre ignition can occur?	A Missing B Detonation

C Over lapping

D Dieseling

Question 9 What FIP Stands for?

A Fuel injection pump.

B Fuel ignition plug

C Fuel integrator pump

D Fuel inhale pump

MODULE 7

Question 10 At which pressure, the radiator cap opens?

A 10 bar

B 0.9 bar

C 0.8 bar

D 0.83 bar

Question 11 In which part of the vehicle, ATF (automatic transmission fluid) is filled?

A Radiator

B Oil cooler

C Water cooler

D Reservoir

Question 12 In which part, the water jacket is built-in?

A Oil sump

B Oil pump

C Cylinder head & cylinder block

D Radiator assembly

Question 13 Where the thermostat is mostly placed?

A In oil sump

B In oil pump

C In oil cooler

D Inside or outside of cylinder block

Question 14 From which part, the viscous coupling belongs?

A Radiator

B Reservoir

C Cooling fan

D Blower

Question 15 Is the following statement True or False?
Pressure radiator gap have 3 valves

A True

B False

Module	8		
Question	**16**	Is the following statement True or False? In full pressure system, oil from oil sump is pumped under pressure to the various parts requiring lubrication.	A True B False
Question	**17**	The following part is not lubricated by Pressure feed system	A Timing gears B Valve rods and Push rods C Rocker arms D Main bearings of crankshaft
Question	**18**	What is the purpose of crankcase ventilation?	A To remove harmful particles from the engine B To provide proper lubrication to the engine C To provide air for combustion to the engine

D all of the above

Question 19 In which of the following system, lubricating oil is carried in separate tanks from where it is fed to the engine?

A Mist lubrication system

B Wet sump system

C Dry sump system

D Splash system

Question 20 For which rating of engine oil, the viscosity numbering system is used?

A Oil thickness

B Oil weight

C Oil temperature

D Oil gravity

MODULE 9

Question 21 Which of the following energy is absorbed by brake?

A Kinetic energy

B Potential energy

C Strain energy

D Kinetic or potential

Question 22 In which of the following kinetic energy is converted, when brakes are applied on a moving vehicle?

A Mechanical energy

B Heat energy

C Electrical energy

D Potential energy

Question 23 Which is not a drum brake?

A External contracting brake

B Internal expanding brake

C Disc brake

D All of the above

Question 24 What is usually the hand brake of the automobile?

A External contracting brake

B Internal expanding brake

C Disc brake

D Drum brake

Question 25 By which of the following the disc is attached, in disc brake?

A Wheel

B Axle

C Suspension system

D Radiator

Question 26 On which principle, Hydraulic brakes work?

A Law of conservation of momentum

B Law of conservation of energy

C Newton’s Law of motion

D Pascal’s law

Question 27 On which of the following, Hand brake is applicable?

A only front wheels

B only rear wheels

C both front and rear wheels

D None of the above

Question 28 What is the process of removing air from the brake system?

A bleeding

B self-energizing

C servo action

D energization

MODULE	**10**		
Question	**29**	What is the most common type of spring used in modern car suspensions?	A Leaf spring B Coil spring C Air spring D Hung spring
Question	**30**	In which year, the MacPherson strut was developed by Earle S. MacPherson?	A 1907 B 1927 C 1937 D 1947

Question 31 Which one of the following represents the correct specification of a Tyre?

A 155-80-R-13

B R-155-80-13

C 155-80-13-R

D 0155-R-80-13

Question 32 Why spring shackles are used?

A to join Spring and Axle

B to join chassis frame and axle

C to join chassis frame and spring

D to join Spring and knuckle

Question 33 Which material is used for making torsion bar?

A Steel

B Cast iron

C High carbon steel

D Copper

Question 34 How Leaf springs absorb shocks?

A by twisting

B by bending

C by compression

D by tension

Question 35 How Coil springs absorb shocks?

A by bending

B by twisting

C by compression

D by tension

Question 36 What is Un-sprung weight?

A Weigh of vehicle

B Weigh of chassis frame

C Weight of wheels

D Weight of wheels and axles

Question 37 What is Sprung weight?

A Weigh of vehicle minus un sprung weight

B Weigh of chassis frame

C Weight of wheels

D Weight of wheels and axles

Question 38 Why Tire wear at the center?

A Due to low inflation pressure

B Due to high inflation pressure

C Due to positive camber

D Due to excessive play in steering

MODULE 11

Question 39 The following provides a smooth means of disengagement and engagement between the engine and the remainder of transmission system

A Clutch

B Gearbox

C Propeller shaft

D Differential

Question 40 What is the following axle, which form compact unit with gearbox, clutch and engine?

A Tandem axle

B power packed axle

C compact axle

D none of the above

Question 41 Which of the following are absorbed by Sideways forces?

A Coil springs

B Torsion bars

C Air springs

D Leaf springs

Question 42 Which is not a part of driving axle unit?

A Differential

B Final drive

C Propeller shaft

D Half shafts

Question 43 Where the overdrive is located??

A Between transmission and engine

B Between transmission and propeller shaft

C Between transmission and rear axle

D Between transmission and differential

Question 44 Which of the following is not part of automatic transmission?

A Epicyclical gearbox

B Torque convertor

C Multi-plate clutch

D Sliding mesh gearbox

Question 45 Where Mechanical clutches are used?

A In master cylinder

B In cable or linkages

C In wheel cylinder

D In salve cylinder

Question 46 By which of the following, clutch plate lining is made?

A Steel material

B Aluminum material

C Spring material

D Frictional material

Question 47 Where hydraulic clutches are used?

A In cable or linkage

B In air reservoir

C In master cylinder

D In booster assembly

Question 48 Where the pilot bearing is fixed?

A In gear box

B In flywheel

C In clutch paddle

D In automatic transmission

Question 49 Which of the following shaft is not a part of manual transmission?

A Cam shaft

B Output / secondary shaft

C Reverse gear shaft

D Input / primary shaft

Question 50 Is the following statement True or False?
Automatic vehicle has a clutch system

A True

B False

MODULE	12		
Question	**51**	What is the correct sequence of flow of current, in Battery coil ignition system?	A Battery – Ammeter – Ignition coil – Distributor – Spark plug B Battery – Ignition coil – Ammeter – Distributor – Spark plug C Battery – Ammeter – Distributor – Ignition coil – Spark plug D Battery – Distributor – Ammeter – Ignition coil – Spark plug
Question	**52**	Which of the following provides a reservoir for the current (induced in the primary circuit), at the time of brake?	A induction coil B distributor C condenser D governor

Question 53 In a four stroke engine, how the drive shaft is rotated in distributor?

A At half the engine speed

B equal to the engine speed

C one and half times the engine speed

D At double the engine speed

Question 54 Which of the following is known as ‘Breaker less Ignition system?

A Capacitive discharge Ignition system

B Electronic Ignition system

C Battery coil ignition system

D Magneto Ignition system

Question 55 How to find the total voltage Vt in series circuit?

A V total = 1/V1+1/V2+1/V3….

B V total = I/R1+ I/R2 + I/R3

C V total = I/V1+ I/V2 + I/V3

D V total = V1 +V2 +V3……

Question 56 Is the following statement true or false?

The gap between two spark plug is usually 3 mm

A TRUE

B FALSE

Question 57 What is Ohm's law?

A V=IR

B V=I/R

C V=V/R

D V=I2/R

MODULE	13		
Question	**58**	Electrical circuits in the on-board diagnostics (OBD) system are being diagnosed. Tech A says that it's important to check for voltage drops on the power side of the circuit. Tech B says that it's important to check for voltage drops at the circuit ground connections. Who is correct?	A Tech A B Tech B C Both Techs A & B D Neither Tech A nor Tech B
Question	**59**	A fault code that begins with the letter "P" would MOST likely address a fault in the:	A Exhaust system B Power door lock wiring C HVAC system D Interior lighting system

Question 60 Which of the following is the best place to start gathering information and planning a diagnostic pathway based on suspected systems and components?

A The owner’s manual

B Diagnostic trouble codes (DTCs) and customer information

C The service manual

D Technical service bulletins

Question 61 On-board diagnostic (OBD) systems help the service tech do all of these EXCEPT:

A Work more efficiently

B Take the guesswork out of diagnosing vehicle problems

C Determine exactly where faults exist

D Access data for today’s sophisticated vehicles

Question 62 How fault codes on today's vehicles are categorized?

A By vehicle’s model

B By vehicle’s year

C By vehicle’s make

D By vehicle’s system

Question 63 For which of the following vehicles, OBD-II scanner is used?

A Model 1970 – 1980

B Model 1981 – 1990

C Model 1991 – 1995

D Model 1996 onward

Question 64 A fault code that begins with the letter "B" would MOST likely address a fault in the:

A Ignition system

B Exhaust system

C Taillight circuit

D Transmission

Question 65 What ECU stands for?

A Electronics control unit

B Electrical control unit

C Electronic central unit

D External computing unit

Question 66 What ECT stands for?

A Electronic control terminal

B Electronic control transmission

C Electrical control transmission

D External control transmission

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