

DIESEL MECHANIC



MINING QUALIFICATIONS AUTHORITY

CODE: PDO

MAINTAIN LUBRICATION SYSTEMS

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MODULE OBJECTIVE

- To enable the learner to maintain the lubrication systems of diesel engines.

LEARNING OBJECTIVES

On completion of this module the learner must be able to:

- State the functions of the various components of the lubrication system of a diesel engine.
- State the causes of low and high oil pressure in a diesel engine.
- Maintain the lubrication system of a diesel engine.

ASSESSMENT AND EVALUATION CRITERIA

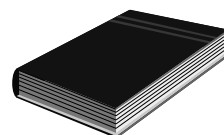
- A theory and practical test will be set at the end of the module and must be completed without using references.
- The learner must correctly state the functions of the various components of the lubrication system as well as the reasons for high and low engine oil pressures.
- The learner will be required to drain and refill the sump of a diesel engine and replace the oil filter.

The following standards must be achieved:

- All the oil must be drained from the sump before the drain plug is replaced.
- The inside and outside of the oil filter body must be cleaned with a solvent.
- After the engine has been started and has run for two minutes, the oil level must be on the "full" mark.
- There must not be any damage to the fasteners on the oil filter body and the drain plug in the sump.
- All the fasteners and the sump plug must be tight.
- When the engine is started there must not be any leaks at the oil filter and the sump plug.
- All safety procedures must be adhered to.

ADDITIONAL RESOURCES

- A demonstration by a competent person e.g. a Training Officer.
- Workshop manual for the diesel engine.
- Audio-visual aids if available.



HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM**PDO****MAINTAIN LUBRICATION SYSTEMS**

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
<ul style="list-style-type: none"> • Use hand tools 	<ul style="list-style-type: none"> • Using damaged tools or wrong tools for the job can cause injury and damage to equipment. 	<ul style="list-style-type: none"> • Always use the correct tool for the job. • Ensure tools are in good condition. • Use tools correctly. • Wear appropriate PPE where necessary. • Always take good care of tools. Maintain, clean and store it properly.

NOTE: Before doing the practical work contained in this module, the learner must study the content of the above HIAC form again and then sign the statement below.

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of Learner: _____

Signature of Training Officer: _____

Date: _____

1. THE LUBRICATION SYSTEM

ITEM / TASK: Introduction

DESCRIPTION:

- No engine can operate without proper lubrication.
- Irreparable damage to the engine can result through lack of lubrication and through using oil, which is contaminated with abrasive material.
- Proper maintenance of the lubrication system and the use of correct and clean lubricant is, therefore, of the utmost importance.

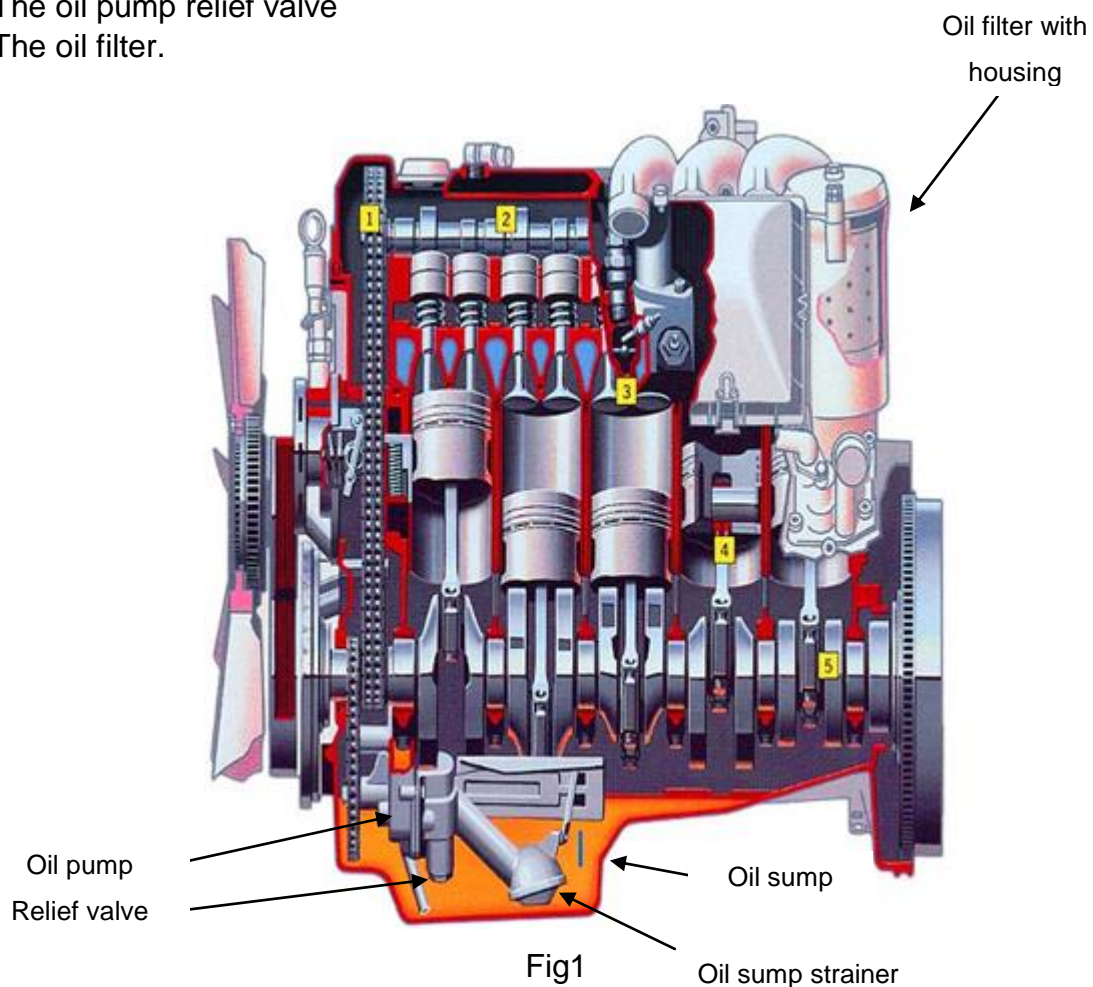
2. COMPONENTS OF THE LUBRICATION SYSTEM

ITEM / TASK: Components of the lubrication system

DESCRIPTION:

The essential component parts of the lubricating system are shown in Fig.1

- The oil pump
- The oil sump strainer
- The oil pump relief valve
- The oil filter.



3. THE OIL PUMP

ITEM / TASK: Types of Oil Pumps

DESCRIPTION:

Gear type oil pump

The oil pump delivers oil under pressure to all the moving parts of the engine. Two types of oil pumps are in use.

It consists of two meshed spur gears enclosed in a housing. There is very little clearance between the gear teeth and housing. One gear is attached to a shaft which is driven through suitable gears from the camshaft or crankshaft of the engine. The other gear is free to revolve on its own bearing. When the pump is in action, the oil is driven between the gear teeth from the inlet side, carried around between the gears and pump housing, and forced out the outlet side. The pressure quantity of the oil supplied by the pump depend upon the speed of the gears.

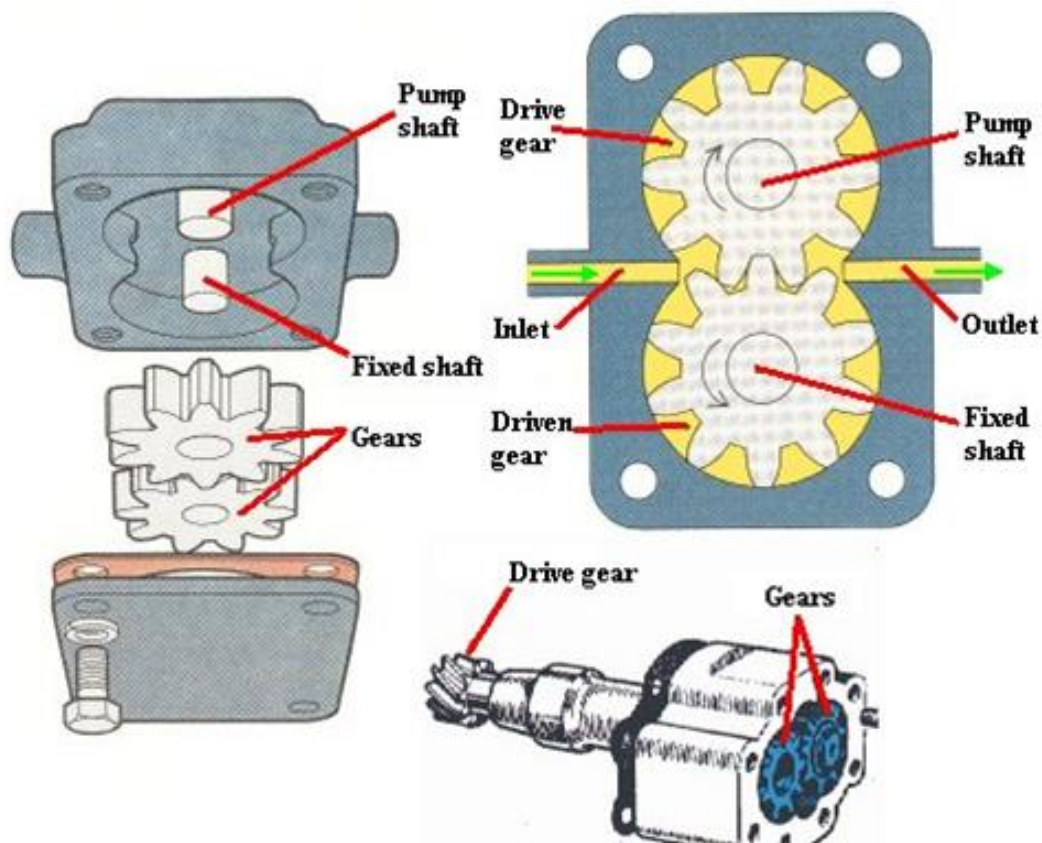


Fig 2

Rotor type oil pump

An engine oil pump in which an internal rotor, e.g., with four external lobes, is used to drive an eccentric external gear, e.g., with five internal lobe-spaces; operates in a similar way to Gear pumps, but has higher pump capacity, and is quieter and more expensive.

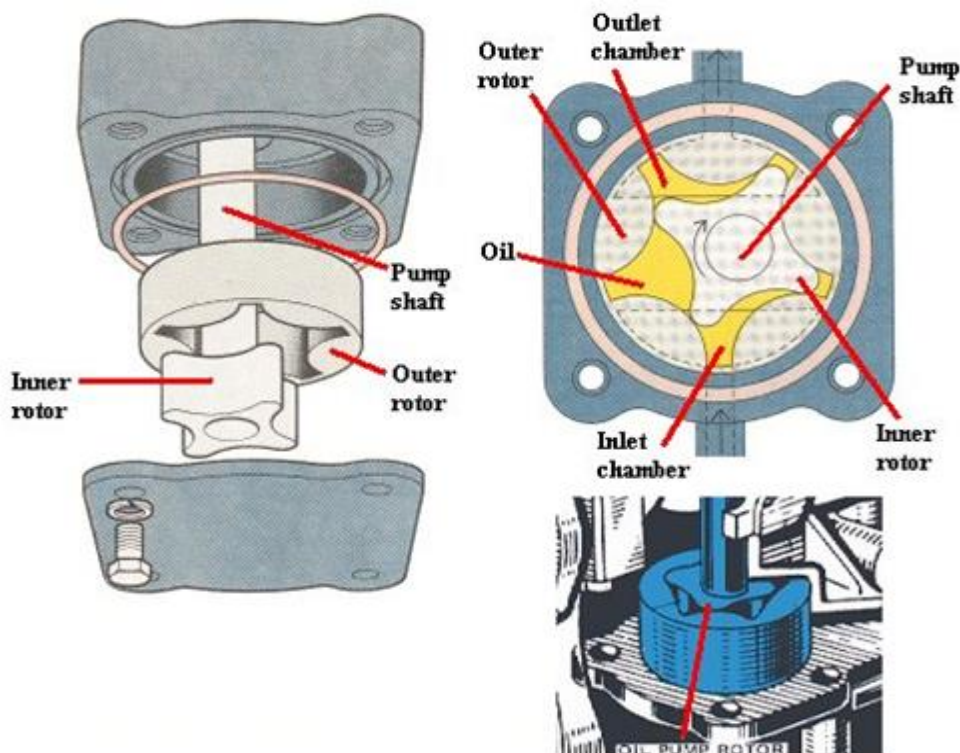


Fig 3

- The pump draws oil through the strainer from the sump and passes it through the oil filter.
- From the oil filter it is delivered to an oil gallery in the cylinder block.
- Holes drilled in the cylinder block feed the oil from the gallery to the main bearings and holes in the crankshaft webs carry oil to the big end bearings.
- The camshaft bushes are also fed from the oil gallery in the cylinder block.
- The gudgeon pin and bushes are lubricated by splash and oil mist (Fig. 4 next page).
- The oil is delivered from the camshaft bushes to the hollow rocker shaft and rocker bushes in the tappet cover (Figs. 5 next page).

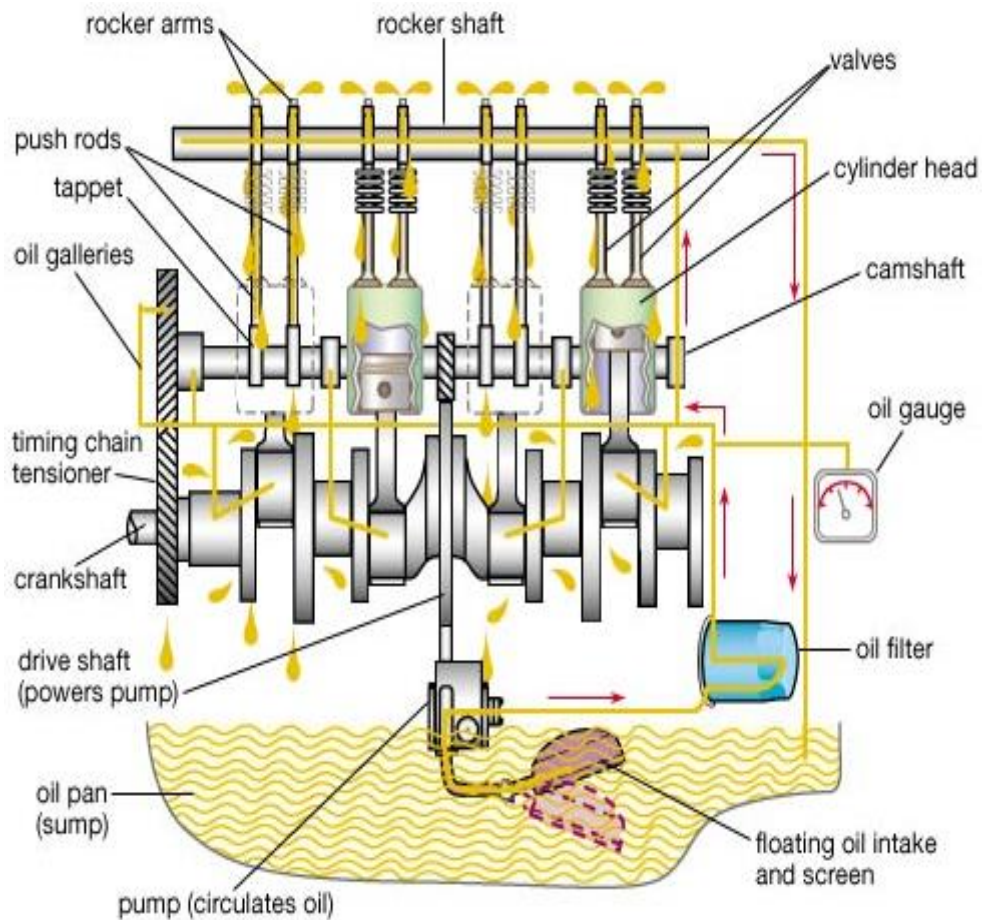


Fig 4



Oil is delivered from the rocker shaft to the rocker bushes

Fig 5

- The overflow of oil from the rocker /cam shaft flows from the cylinder head down the timing chain. In some engines oil will be delivered to the timing gears via a steel tube connected to an oil channel in the block. (Fig. 6)

Oil will flow down
the timing chain
from the camshaft or
rocker shaft.

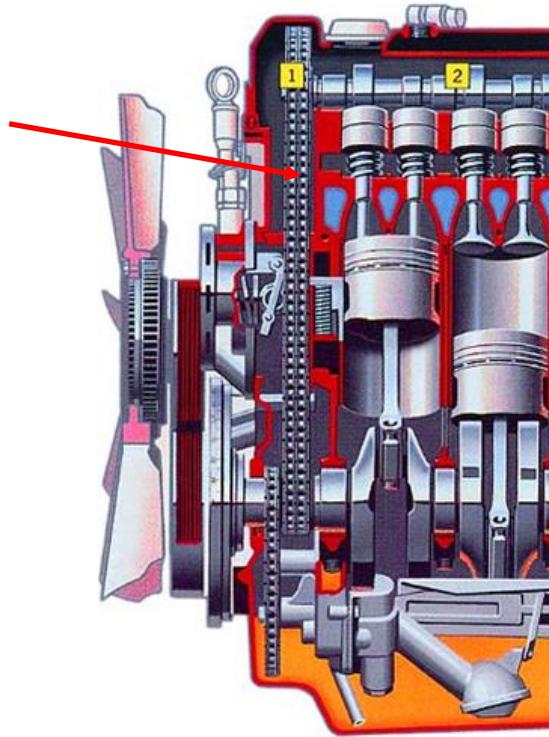


Fig 6

4. OIL STRAINER

ITEM / TASK: The oil strainer

DESCRIPTION:

An oil strainer consists of a perforated gauze wire, and its purpose is to prevent large objects from entering the sump or the lubricating system.

Strainers do not require any special attention.

To ensure cleanliness, two strainers are normally incorporated, namely

- The oil filter strainer (Fig. 7).
- The oil sump strainer (Fig. 8).



Fig 7



Fig 8

5. THE RELIEF VALVE

ITEM / TASK: The relief valve

DESCRIPTION:

The relief valve controls the oil pressure, so preventing excessive oil pressure in the lubricating system.

It consists of a spring-loaded valve situated on the outlet side of the pump in the main oil channel. (Fig.9).



Fig 9

As soon as the pressure in the system rises above that of the relief valve spring pressure, the valve is forced off its seat and the oil escapes back to the sump, thus relieving the pressure.

6. THE OIL FILTER

ITEM / TASK: The oil filter

DESCRIPTION:

Oil filters remove the harmful abrasive particles, which may have entered the oil system of a machine or engine.

There are basically two types of oil filters in use today, namely:

- the replaceable cartridge type. (fig. 10)
- the throw away "spin-on" canister type.(fig. 11)

The construction of the filtering element or cartridge in both of these types of oil filters is the same as the cartridge in the dry type air cleaner. The only difference is that the filtering material is treated so that it can be used with oil.

NB: It is not recommended that these filters be reused, even if washed.

The outer and inner shells of the filter cartridges are made of thin perforated metal or mesh. The filtering media is made of thick heavy paper, which is very much like blotting paper. It is pleated to give increased filtering surface area.



Fig 10



Fig 11

7. FAULT FINDING LUBRICATION SYSTEMS

ITEM / TASK: Introduction

DESCRIPTION:

Knowing the circulation system for the oil and the functions of the different components in the lubricating system, makes it easy to do faultfinding.

Two types of faults may occur in the lubrication system, namely,

- Low oil pressure, and
- High oil pressure.

The possible causes of low oil pressure

- Incorrect grade of lubricating oil (i.e. too thin).
- Worn or damaged engine bearings.
- Insufficient oil in the sump.
- Oil pump worn.
- Pressure relief valve sticking in the open position.
- Broken relief valve spring.
- Choked oil filter.
- Blocked sump strainer.

The possible causes of high oil pressure

- Incorrect grade of lubrication oil.
- Pressure relief valve sticking in the closed position.

DO THE SELF-TEST BEFORE CONTINUING WITH THE REST OF THE MODULE.

SELF TEST 1



Answer the following questions without using references:

1. What is the function of the following components in the lubrication system?

(a) The oil strainer and filter.

(b) The relief valve.

(c) The oil pump.

2. What are the causes of:

(a) Low oil pressure?

(b) High oil pressure?

Check your answers against your notes, and if they are not all correct, study the notes again and re-do the test.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

8. REPLACE OIL FILTERS

ITEM / TASK: Replace a cartridge type oil filter

DESCRIPTION:

The oil filter is secured by one centre bolt or the lid will screw on to the housing(Fig. 12). It is replaced as described below.



Fig 12

- Stop and isolate the engine.
- Drain all the oil from the sump.
- Clean the outside surrounding area of the filter.
- Remove the centre bolt or filter housing. Take care as this housing is made of plastic or aluminium.
- Remove the filter from its seat.
- Remove the cartridge from the housing and throw it away.
- Wash the filter housing and the centre bolt in a detergent or solvent.
- Rinse the parts in clean water.
- Wipe the parts with a clean dry linen cloth. Never use waste.
- Remove the gasket from the mounting face.
- Wipe all the old oil off the mounting face.
- Wipe the gasket with clean oil and install it in the groove on the mounting face.

- Place the new cartridge correctly into the filter housing. Make sure the coil spring is in place and that the cartridge faces the correct direction.
- Place the complete assembly onto the mounting face. Make sure the filter housing is seated properly on the gasket.
- Tighten the centre bolt or housing lid.
- Replace the sump drain plug and refill the engine with the recommended clean oil to the indicated level mark.
- Start the engine and run it for about two minutes.
- Check for oil leaks at the oil filter and at the sump plug.
- Retighten the bolts if necessary.
- Stop the engine and wait for about two minutes.
- Check the oil level and, if necessary, top up to within $\pm 2\text{mm}$ of the indicated level mark with the recommended new oil.
- Clean up any spilt oil.

9. OIL CLASSIFICATION

ITEM / TASK: What is Oil Viscosity?

DESCRIPTION:

Viscosity, by definition, is an oil's resistance to flow and shear. It is the single most critical physical property of the oil as it affects both the wear rate and the fuel efficiency.

Water is a low viscosity fluid; syrup is a high viscosity fluid. With oil, like syrup, as you increase the temperature, the viscosity lowers, meaning it flows faster, or more easily.

The most common unit of measure for viscosity is the Kinematic viscosity and this is usually quoted in data sheets at 40°C and 100°C. The commonly used unit of measure is centistokes but the correct SI unit of measure is mm²/s.

Kinematic Viscosity is a measure of the fluids resistance to flow and shear under the forces of gravity, or how easily the oil flows to the different parts of the engine.

Kinematic Viscosity (ASTM D445/ISO3105): 1 centi-Stoke (cSt) = 1 mm²/s.

Absolute Viscosity is a measure of a fluid's internal resistance to flow and may be thought of as a measure of fluid friction and of the oil's film strength to support a load.

Dynamic or Absolute Viscosity: 1 milliPascal second (mPa·s) = 1 centi-Poise (cP)

High-temperature high-shear-rate (HTHS) viscosity is an indicator of an engine oil's resistance to flow in the narrow confines between fast moving parts in fully warmed up engines. The most common test for this is ASTM D 4683 as it closely mimics the conditions found in an engine's crankshaft and connecting rod journal bearings, as well as other narrow regions such as between the cam and follower on flat bucket tappets. This measurement influences such factors as fuel consumption, valve-train wear and bearing protection.

Cold cranking viscosity simulates the viscosity of an oil in crankshaft bearings during start up on a cold winter morning. The test determines if an engine can be cranked over fast enough to start under extreme cold ambient conditions. ASTM Method D 5293 simulates an oil's cranking resistance when cold, and thus indicates the lowest temperature at which an engine is likely to start.

Cold pumpability measures the resistance of an oil to pumping through the engine after a cold start. The most widely used test is ASTM D 4684. If an oil's viscosity becomes too high, pumping will be hindered with possible cavitation issues. Viscosity here becomes an important factor in determining whether the engine runs with sufficient lubrication after starting in severe cold conditions. The Cold Pumpability test is always conducted at 5°C colder than the Cold Cranking test to ensure the pump can deliver the oil to the bearings

How is viscosity rated on engine oils?

The Society of Automotive Engineers (SAE) developed a scale for both engine and transmission oils. The measurement is undertaken in a laboratory in accordance with standard procedures. W is Winter and oils with the W must meet the requirements of the Cold Cranking and Cold Pumping criteria.

SAE Viscosity Grades for Engine Oils (SAE J300) - December 1999					
Grade	Absolute Viscosity (cP)		Kinematic Viscosity (cSt)		HTHS (cP) 150°C
	Maximum Cold Cranking	Maximum Cold Pumping	Minimum	Maximum	High-Temperature-High-Shear
0W	6 200 @ -35°C	60 000 @ -40°C	3.8	-	-
5W	6 600 @ -30°C	60 000 @ -35°C	3.8	-	-
10W	7 000 @ -25°C	60 000 @ -30°C	4.1	-	-
15W	7 000 @ -20°C	60 000 @ -25°C	5.6	-	-
20W	9 500 @ -15°C	60 000 @ -20°C	5.6	-	-
25W	13 000 @ -10°C	60 000 @ -15°C	9.3	-	-
20	-	-	5.6	<9.3	2.6
30	-	-	9.3	<12.5	2.9
40	-	-	12.5	<16.3	2.9 (1)
40	-	-	12.5	<16.3	3.7 (2)
50	-	-	16.3	<21.9	3.7
60	-	-	21.9	<26.1	3.7
Note (1) - for 0W-40, 5W-40 & 10W-40 oils (2) - for 15W-40, 20W-40, 25W-40 and SAE40 oils					

J306 Viscosity Classification for Automotive Gear Oils			
Effective from 1st January 2005			
SAE Viscosity Grade	Maximum Temperature for a viscosity of 150,000 cP (°C)	Minimum Viscosity at (cSt) a 100°C	Maximum Viscosity at (cSt) a 100°C
	ASTM D 2983	ASTM D 445	ASTM D 445
70W	-55	4.1	--
75W	-40	4.1	--
80W	-26	7	--

85W	-12	11	--
80	--	7	<11.0
85	--	11	<13.5
90	--	13.5	<18.5
110	--	18.5	<24.0
140	--	24	<32.5
190	--	32.5	<41.0
250	--	41	--
		Must maintain its viscosity after 20 hours in the CEC L-45-A-99 test.	

API (American Petroleum Institute)

This is the more basic as it is split (for passenger cars) into two categories.

S = Petrol and C = Diesel, most oils carry both petrol (S) and diesel (C) specifications.

"S" Status Service Gasoline Engines

SN Introduced in October 2010

Introduced in October 2010 for 2011 and older vehicles, designed to provide improved high temperature deposit protection for pistons, more stringent sludge control, and seal compatibility. API SN with Resource Conserving matches ILSAC GF-5 by combining API SN performance with improved fuel economy, turbocharger protection, emission control system compatibility, and protection of engines operating on ethanol-containing fuels up to E85.

SM Introduced on 30 November 2004

Category SM oils are designed to provide improved oxidation resistance, improved deposit protection, better wear protection, and better low-temperature performance over the life of the oil. Some SM oils may also meet the latest ILSAC specification and/or qualify as Energy Conserving. They may be used where API Service Category SJ and SL earlier categories are recommended.

SL	2001 Gasoline Engine Service	Category SL was adopted to describe engine oils for use in 2001. It is for use in service typical of gasoline engines in present and earlier passenger cars, sports utility vehicles, vans and light trucks operating under vehicle manufacturers recommended maintenance procedures. Oils meeting API SL requirements have been tested according to the American Chemistry Council (ACC) Product Approval Code of Practice and may utilize the API Base Oil Interchange and Viscosity Grade Engine Testing Guidelines. They may be used where API Service Category SJ and earlier categories are recommended.
SJ	1997 Gasoline Engine Service	Category SJ was adopted in 1996 to describe engine oil first mandated in 1997. It is for use in service typical of gasoline engines in present and earlier passenger cars, vans, and light trucks operating under manufacturers recommended maintenance procedures. Oils meeting API SH requirements have been tested according to the American Chemistry Council (ACC) Product Approval Code of Practice and may utilize the API Base Oil Interchange and Viscosity Grade Engine Testing Guidelines. They may be used where API Service Category SH and earlier categories are recommended.
SH	Obsolete	For model year 1996 and older engines.
SG	Obsolete	For model year 1993 and older engines.
SF	Obsolete	For model year 1988 and older engines.
SE	Obsolete	For model year 1979 and older engines.
SD	Obsolete	For model year 1971 and older engines.
SC	Obsolete	For model year 1967 and older engines.
SB	Obsolete	For older engines. Use only when specifically recommended by the manufacturer.
SA	Obsolete	For older engines; no performance requirement. Use only when specifically recommended by the manufacturer.
"C"	Status	Service Diesel Engines
CJ-4	Current -	Introduced in 2006 for high-speed four-stroke engines. Designed to

	2006	meet 2007 on-highway exhaust emission standards. CJ-4 oils are compounded for use in all applications with diesel fuels ranging in sulphur content up to 500ppm (0.05% by weight). However, use of these oils with greater than 15ppm sulfur fuel may impact exhaust after treatment system durability and/or oil drain intervals. CJ-4 oils are effective at sustaining emission control system durability where particulate filters and other advanced after treatment systems are used. CJ-4 oils exceed the performance criteria of CF-4, C-4, AH-4 and C-4.
CI-4 Plus	Current - 2004	Used in conjunction with API C-4, the " CI-4 PLUS" designation identifies oils formulated to provide a higher level of protection against soot-related viscosity increase and viscosity loss due to shear in diesel engines. Like Energy Conserving, CI-4 PLUS appears in the lower portion of the API Service Symbol "Donut."
CI-4	Severe-Duty Diesel Engine Service	The CI-4 performance requirements describe oils for use in those high speed, four-stroke cycle diesel engines designed to meet 2004 exhaust emission standards, to be implemented October 2002. These oils are compounded for use in all applications with diesel fuels ranging in sulfur content up to 0.05% by weight. These oils are especially effective at sustaining engine durability where Exhaust Gas Recirculation (EGR) and other exhaust emission componentry may be used. Optimum protection is provided for control of corrosive wear tendencies, low and high temperature stability, soot handling properties, piston deposit control, valve train wear, oxidative thickening, foaming and viscosity loss due to shear. CI-4 oils are superior in performance to those meeting API CH-4, CG-4 and CF-4 and can effectively lubricate engines calling for those API Service Categories.
CH-4	Severe-Duty Diesel Engine Service	This service oils are suitable for high speed, four-stroke diesel engines designed to meet 1998 exhaust emission standards and are specifically compounded for use with diesel fuels ranging in sulfur content up to 0.5% weight. CH-4 oils are superior in performance to those meeting API CF-4 and API CG-4 and can effectively lubricate engines calling for those API Service Categories.
CG-4	Obsolete	This category describes oils for use in high speed four-stroke-cycle diesel engines used in both heavy-duty on-highway (0.05% wt sulfur fuel) and off-highway (less than 0.5% wt sulfur fuel) applications. CG-4 oils provide effective control over high temperature piston deposits, wear, corrosion, foaming, oxidation stability, and soot accumulation. These oils are specially effective in engines designed to meet 1994 exhaust emission standards and may also be used in engines requiring API Service Categories CD, CE, and CF-4. Oils designed for this service have been in existence since 1994.

CF-2	Obsolete	Service typical of two-stroke cycle diesel engines requiring highly effective control over cylinder and ring-face scuffing and deposits. Oils designed for this service have been in existence since 1994 and may be used when API Service Category CD-II is recommended. These oils do not necessarily meet the requirements of API CF or CF-4 unless they pass the test requirements for these categories.
CF	Obsolete	Service typical of indirect-injection diesel engines and other diesel engines that use a broad range of fuel types, including those using fuel with high sulfur content; for example, over 0.5% wt. Effective control of piston deposits, wear and copper-containing bearing corrosion is essential for these engines, which may be naturally aspirated, turbocharged or supercharged. Oils designated for this service have been in existence since 1994 and may be used when API Service Category CD is recommended.
CF-4	Obsolete	Service typical of high speed, four-stroke cycle diesel engines. API CF-4 oils exceed the requirements for the API CE category, providing improved control of oil consumption and piston deposits. These oils should be used in place of API CE oils. They are particularly suited for on-highway, heavy-duty truck applications. When combined with the appropriate S category, they can also be used in gasoline and diesel powered personal vehicles i.e., passenger cars, light trucks and vans when recommended by the vehicle or engine manufacturer.
CE	Obsolete	Service typical of certain turbocharged or supercharged heavy-duty diesel engines, manufactured since 1983 and operated under both low speed, high load and high speed, high load conditions. Oils designed for this service may also be used when API Service Category CD is recommended.
CD-II	Obsolete	Service typical of two-stroke cycle diesel engines requiring highly effective control of wear and deposits. Oils designed for this service also meet all performance requirements of API Service Category CD.
CD	Obsolete	Service typical of certain naturally aspirated, turbocharged or supercharged diesel engines where highly effective control of wear and deposits is vital, or when using fuels with a wide quality range (including high-sulfur fuels). Oils designed for this service were introduced in 1955 and provide protection from high temperature deposits and bearing corrosion in these diesel engines.
CC	Obsolete	Service typical of certain naturally aspirated, turbocharged or supercharged diesel engines operated in moderate to severe-duty service, and certain heavy-duty gasoline engines. Oils designed for this service provide protection from bearing corrosion, rust, corrosion and from high to low temperature deposits in gasoline

engines. They were introduced in 1961.

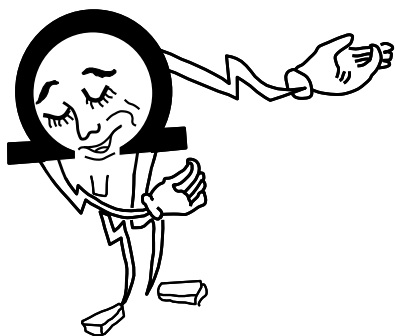
CB Obsolete

Service typical of diesel engines operated in mild to moderate duty, but with lower quality fuels, which necessitate more protection from wear and deposits; occasionally has included gasoline engines in mild service. Oils designed for this service were introduced in 1949. They provide necessary protection from bearing corrosion and from high temperature deposits in naturally aspirated diesel engines with higher sulfur fuels.

CA Obsolete

Service typical of diesel engines operated in mild to moderate duty with high quality fuels; occasionally has included gasoline engines in mild service. Oils designed for this service provide protection from bearing corrosion and ring-belt deposits in some naturally aspirated diesel engines when using fuels of such quality that they impose no unusual requirements for wear and deposits protection. They were widely used in the 1940s and 1950s but should not be used in any engine unless specifically recommended by the equipment manufacturer.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



REMEMBER ALWAYS WORK SAFE

Once you have passed the entire practices, you are now at liberty to request a Formative Assessment from your Assessor.