MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous)

(ISO/IEC - 27001 - 2005 Certified)

MODEL ANSWER

Summer – 2018 EXAMINATION

Subject Title: Automobile Engines

Subject Code: 17408

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given moreimportance.(Not applicable for subject English and Communication Skills).

4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

……….

Q. No.	Sub Que.	Answer	Marking Scheme
1		**Attempt any SIX of the following:**	12
A)	i)	**What is the necessity of the engine lubrication?**	2
		Answer: Need of lubrication system *(any two)* 1. To provide a barrier between moving parts to reduce friction, heat buildup, and wear. 2. To disperse heat - Friction from moving parts and combustion of fuel produce heat that must be carried away. 3. Absorb and suspend dirt and other particles. Dirt and carbon particles need to be carried by the oil to the oil filter where they can be trapped. 4. Neutralize acids that can build up and destroy polished metal surfaces. 5. Coat all engine parts. Oil should have the ability to leave a protective coating on all parts when the engine is turned off to prevent rust and corrosion. 6. Resist sludge and varnish buildup.	2
	ii)	**Define Stroke**.	2
		Answer: Stroke: Distance travelled by the piston moving from T.D.C. to the B.D.C. is called stroke.	2
	(iii)	**What is the Function of Fuel Injector? (any two)**	2
		Answer: Function of fuel injector: *(1 mark for each function)* 1) The injected fuel must be broken in to very fine droplets i.e. good atomization should be obtained. 2) The fuel should be supplied into the combustion chamber within precisely defined period of cycle. 3) The rate of injection should be such that it results in desired heat released pattern.	2

		4) The quantity of fuel metered should vary according to speed and load requirements. 5) The amount of fuel injected per cycle should be metered very accurately. 6) The spray pattern must be such that it results in rapid mixing of air and fuel. 7) The beginning and the end of injection should be sharp. 8) In case of multi cylinder engine the distribution of metered fuel should be same to all cylinders.	
	(iv)	**State two Cooling water additives.**	**2**
		Answer: Cooling water additives*(any two 1 mark each)* 1. Wood alcohol (Methyl alcohol) 2. Denatured alcohol (ethyl alcohol) 3. Glycerin. 4. Ethylene glycol 5. Propylene glycol 6. Mixture of alcohol and glycerin.	**2**
	(v)	**Define Mechanical Efficiency of I.C. Engine.**	**2**
		Answer: Mechanical efficiency: -It is the ratio of brake power to indicated power. It is measured in percentage. $\eta_M = \frac{\text{Brake Power}}{\text{Indicated Power}} = \frac{\text{B.P}}{\text{I.P.}} \text{X}100\%$	**2**
	(vi)	**State the function gasket (any two).**	**2**
		Answer: Function gasket *(any two 1 mark each)* 1.Gasket is placed between cylinder head and cylinder block to retain compression in the cylinder 2. Gasket prevents leakage of the gases from combustion chamber and ensures tight fit joint. 3. Gasket also withstands high pressure and high temperature.	**2**
	(vii)	**Define Brake Power.**	**2**
		Answer: Brake Power: The brake power (B.P.) is the power obtained at the engine flywheel is measured with the help of dynamometer, it is measured in kW. $B.P. = \frac{2\pi NT}{60000}\ \text{KW}$ Where, N=Engine speed in R.P.M. T=Torque in Newton meters	**2**

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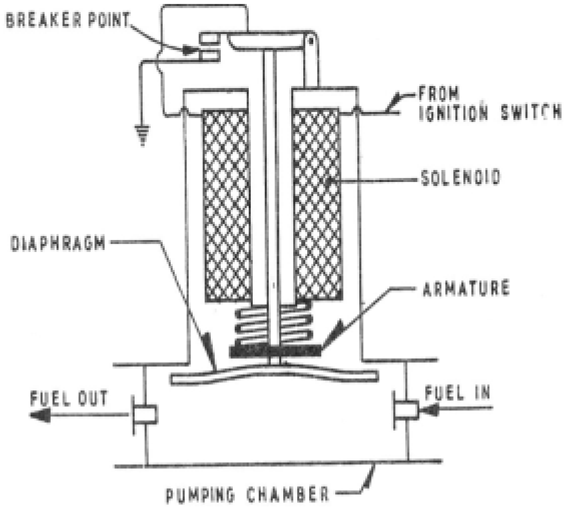
	(viii)	**State the material of cylinder block and its manufacturing method.**	**2**
		Answer: Material - The block is made of Grey cast iron and sometimes aluminum alloy Method- Casting and machining	**1** **1**
B)		**Attempt any TWO of the following:**	**8**
	i)	**Explain the working of electrical fuel Pump with neat sketch.**	**4**
		Answer: ***Sketch 2 mark &explanation 2 mark)*** Figure shows the S.U. electric fuel pump. It consists of a diaphragm which is operated electrically. By turning on the ignition switch, the solenoid winding generates magnetic flux, which pulls the armature and the diaphragm moves up. The upward movement of the diaphragm creates suction, and the fuel is drawn into the chamber through the inlet valve. But as soon as the armature moves up it disconnects the electric supply, the magnetic flux dies and the armature falls down, causing the diaphragm to move to create pressure in the pump chamber. This causes the outlet valve to open and inlet valve to close. The fuel goes out to the carburetor. The downward movement of the armature again sets electric supply to the solenoid, and the same process is repeated, the pump continues to operate until the ignition switch is turned off.  Figure: Electric fuel pump	**2** **2**

ii) **Compare magneto and battery ignition system on the basis of i) Source of current ii) Starting of engine iii) Space iv) Applications.** **4**

Answer:*(1 mark for each point)*

Parameter	Magneto	Battery
Source of Current	It produces current	It supplies current
Starting of engine	Easy	Slightly difficult
Space	Less space	More space
Applications	Motor cycle, scooters	Cars ,buses

4

iii) **Draw the valve timing diagram of a four stroke SI engine and explain in brief**. **4**

Answer: Valve timing diagram (*Sketch 2 mark &explanation 2 mark)*

The opening and closing operation of the inlet and exhaust valves are described as follows:

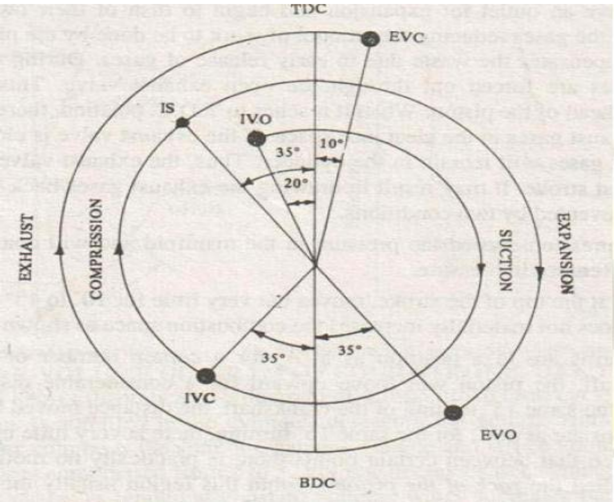
1. The inlet valve normally opens several degrees (10^0 - 30^0) of crankshaft rotation before TDC on the exhaust stroke i.e. intake valve begins to open before the exhaust stroke is finished.

2. The intake valve remains open after the piston has passed BDC (30^0 - 40^0) at the end intake stroke.

3. The exhaust valve opens well before the piston reaches BDC (30^0 to 60^0) on the power stroke.

The exhaust valve remains open after some degrees (8^0 - 10^0) of crankshaft rotation after the piston has passed the TDC and intake stroke has started.

2



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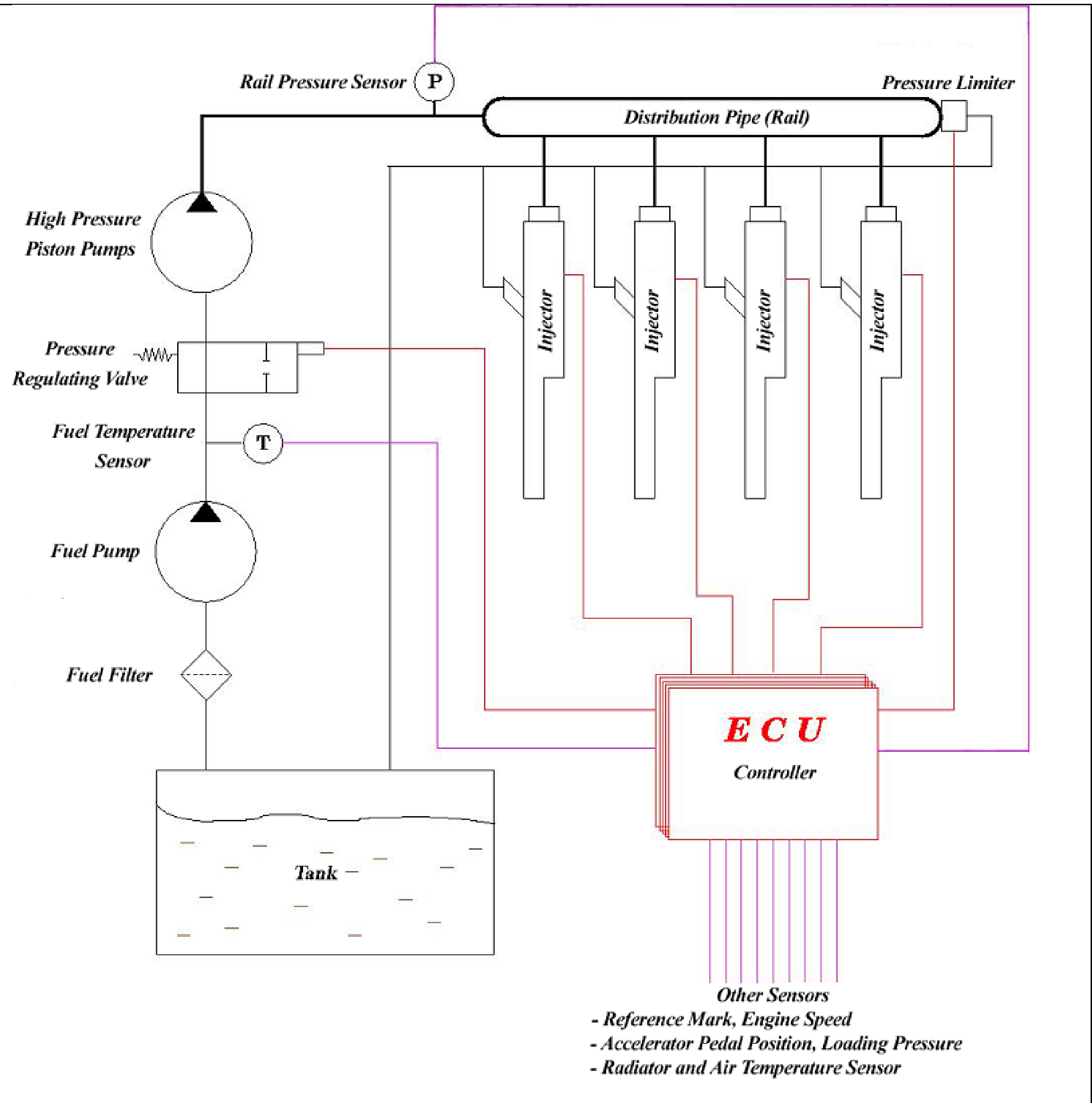
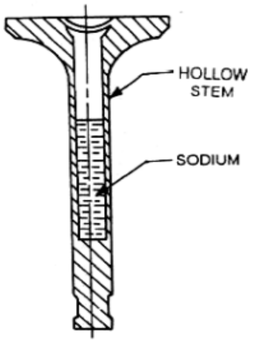
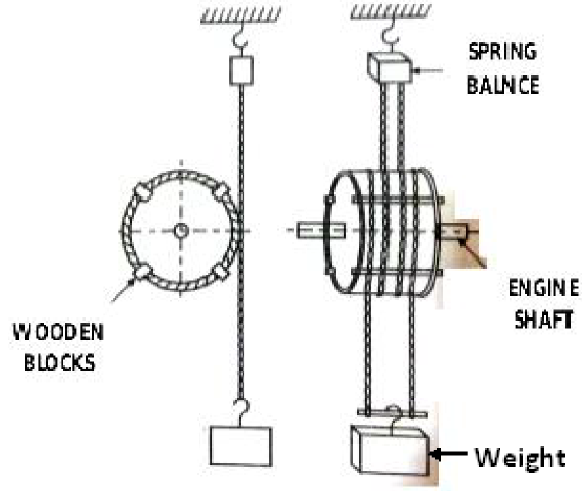
2		**Attempt any FOUR of the following:**	**16**
	a)	**What do you mean by firing order? Give firing order for four cylinder engine.**	**4**
		Answer: Firing order: The sequence in which the power impulses occur in an engine is called the firing order. Firing order for 4 cylinder engine.(Any one) 1-3-4-2 **OR** 1-2-4-3 **OR** 1-4-3-2	**1** **1**
	b)	**State four application of I.C. engine. Write engine specifications for any two wheelers.**	**4**
		Answer: Application of I C engine (*any four 2 marks & specification of any one 2 marks)* 1) In Automotive – i) Two stroke engine – Mopeds, Scooters. ii) Four stroke engine – Light vehicles, Heavy vehicles. 2) Marine Application – Ships, Boat 3) Locomotives – Railway 4) Stationery engines – For lifting water, Generator, Material handling system 5) Aircraft Engines 6) Stationary Engines **Engine specifications for any two wheeler** 1. Engine of Bajaj Discover 125 ST - Air-cooled, 4-stroke 124.6 cc engine - Maximum power of 12.8 Bhp at 9000 rpm - Maximum torque of 11 Nm at 7000 rpm 2. Honda Livo a) BS-IV engine, Air cooled, 4 strokes S I engine. b) Displacement -110 cc , power – 8.31 bhp , c) Max Torque – 9.09 N-m @5000 rpm. d) Bore x Stroke – 50 x 55.6 mm e) C R – 9.9 : 1, Max Speed – 86KMPH **Note- similar specification should be considered.**	**2** **2**
	c)	**State two advantages and two disadvantages of air cooling system.**	**4**
		Answer: **Advantages:** 1. Engine can be installed anywhere on the vehicle 2. Volumetric Efficiency of water cooled engine is more than air cooled engine	**2**

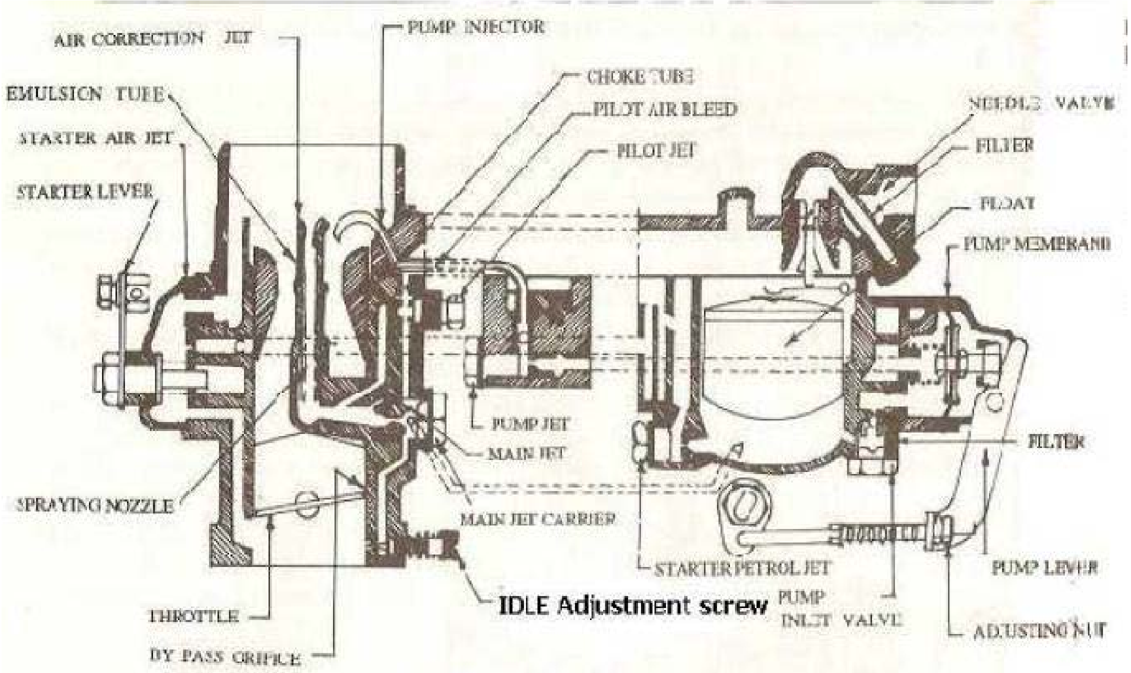
		3. Uniform cooling of cylinder, cylinder head and valves. 4. Specific fuel consumption of engine improves by using water cooling system. 5. Engine is less noisy as compared with air cooled engines, as it has water for damping noise. **Disadvantages:** 1. Uneven Cooling 2. Heat Rejection is very Slow. 3. Not suitable heavy duty Engines.	**2**
	d)	**Explain with neat sketch common rail fuel injection system for CI engine.**	**4**
		Answer: Working of CRDI:(***sketch 2 marks & working 2 marks)*** 1. High pressure pump provides high pressure fuel to the common rail. The common rail stores the fuel and maintains a constant pressure in the common rail line (approximately 1500 bars.). This pressure is continuously available at injectors. 2. The injection pressure is independent of engine speed. The quantity of fuel injected in the combustion chamber is controlled by actuating solenoid valve in the injector. As solenoid is energized, injection begins. Injector pulse width, multiple injections and duration of injection – all are controlled by EDC of CRDI system. 3. The system pressure is controlled by means of a pressure sensor. Pilot injection and possibly a second, third injection is achieved by repeatedly activating solenoid valve, whereas the injection rate can be modified by controlling the nozzle needle movement.	**2**

			**2**
	e)	**Explain in brief Valve cooling with neat sketch.**	**4**
		Answer:(***sketch 2 marks & working 2 marks)*** Exhaust valve temperature in modern engine is as high as 750˚C. Thus cooling of exhaust gas becomes very important. Cooling water jackets are arranged near the valves for valve cooling. In many cases nozzles are directed towards hot spot caused by the exhaust valve. In heavy duty engine, sodium cooled valves are used, the working of this valve is stated below – A sodium cooled valve has a hollow stem, which is partly filled by metallic sodium. Sodium melts at 97.5˚C. Thus at operating temperature sodium is in liquid state. When engine runs, valve moves up and down, thus sodium is thrown upward in hotter part of	**2**

		valve. There it absorbs heat, which is later given to cooler stem as it falls back to stem again. This keeps the valve head cool.  Figure: Sodium cooled valve	2
	f)	**State the functions of piston rings. Why a minimum two compression rings are required?**	4
		Answer:*(Sketch-2 marks, Description-2 marks)* **Rope Brake Dynamometer: -** It consists of a number of turns of rope wound around the rotating drum attached to the output shaft. One side of the rope is connected to a spring balance and the other to a loading device. The power absorbed is due to friction between the rope and the drum. The drum there for requires cooling. 1. Start the engine for warm up. 2. Increase the speed of engine simultaneously adding the weights on the loading device. 3. Follow the same process till the engine reaches to a constant speed. At this condition the power developed by an engine is equal to the power absorbed by the rope brake dynamometer. 4. The brake power can be calculated as follows: BP = πDN (W-S)/60 (watt) Where , D = Brake drum diameter (m) W = Weight (N) S = spring scale reading.(N) N= RPM of engine	2

		 ROPE BRAKE DYNAMOMETER	2
3		**Attempt any two of the following:**	**16**
	a)	**Explain with neat sketch solex carburetor.**	**8**
		Answer: Solex carburetor:*(circuit explanation 4 marks & sketch 4 marks)* **1. Starting circuit:** The starter valve is in the form of a flat disc with holes of different sizes. The holes connect petrol jet and starter jet sides to the passage; this passage opens into the air horn just below the throttle valve. The starter lever is operated by the driver from the dashboard, which adjust the position of the starter valve so that either bigger or smaller holes come opposite to the passage. With this special provision for a progressive starter which supplies richer mixture for starting and then gradually weakens it till the engine has reached its normal operating temperature. When the engine reaches to normal working speed and temperature, the starter is brought to “off” position. **2) Idling or low speed circuit:** The idle port is controlled by idle screw. It is provided near throttle valve. As the throttle is almost closed the engine suction is applied at the pilot petrol jet to supplies the petrol. The air is drawn from the pilot air jet and mixes with the petrol and supply to the engine. When the throttle valve is opened the suction decreased at the ideal port and is applied at slow speed opening. **3) Normal running circuit:** During normal running, the throttle valve is opened and engine suction is applied at the main jet, which supplies the fuel. The air enters directly through venturi and mixes with the fuel. The air- fuel mixture is governed by the throttle valve. **4) Acceleration circuit:** For acceleration, extra fuel is required by the engine, which is supplied by the membrane pump. The pump lever is connected to the accelerator. When the accelerator pedal is depressed, the pump lever presses the membrane (diaphragm) forcing the fuel into main jet. When the pedal is returned the membrane moves back sucking the fuel from the float chamber through the	4

ball valve.



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OR

Solex Carburettor:

This is a downdraught type of carburetor with special provision for progressive starter, which supplied richer mixture for starting and gradually weakens it till the engine has reached its operating temperature. Various circuits of carburetor are

1.Starting
2.Idling or Low speed operation
3.Normal running
4. Acceleration pump circuit:

Starting Circuit:

A starter valve is in the form of a flat disc having holes of different sizes. These holes connect the petrol jet and starter jet sides to the passage which opens into the air horn below the throttle valve. The starter lever is operated by the driver, which adjusts the position of the starter valve so that either bigger or smaller hole connects the passage.

After the engine is started, starter lever is brought to second position and smaller hole connects the passage. When the engine reaches the normal running temperature, the starter is brought to ‘Off’ position.

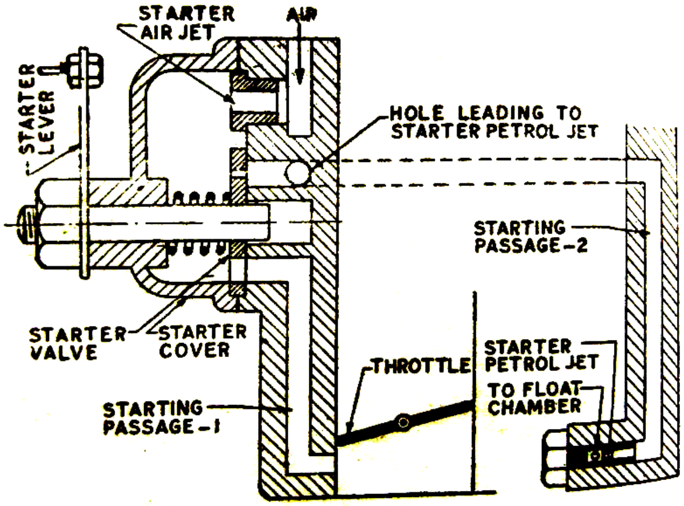


Figure: Progressive starter for solex carburettor

Idling or Low speed operation:

The throttle valve is almost closed. Engine suction is applied at pilot petrol jet. The jet draws petrol from main jet circuit. The air is drawn from pilot air jet. The air and petrol mix in the idle passage. When the throttle valve is opened wide suction decreases at idle port and applied at slow speed openings.

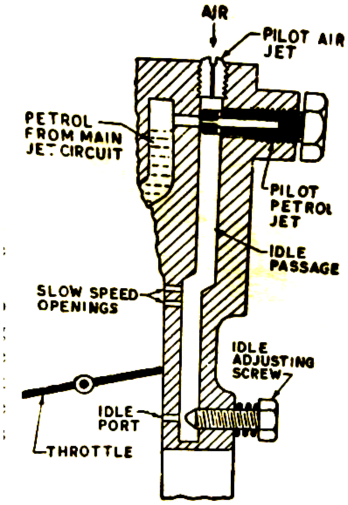


Figure: Idling or Low speed operation

Normal running:

The throttle valve is partly opened and the engine suction is applied at the main jet supplying the fuel. The air enters through venture to mix with the fuel

Acceleration pump circuit:

When an engine at a particular speed is given a sudden acceleration, a flat spot is produced in the carburetor. In this case, the engine generally stalls and then after some time it catches up and accelerates. This happens when the engine is running below 50 kmph. Extra fuel is supplied by membrane pump. The pump lever is connected to the acceleration pedal. After depression of acceleration pedal pump lever presses the membrane forcing the fuel in to the main jet. When the pedal is returned, the membrane moves back sucking the fuel from the float chamber through the ball valve.

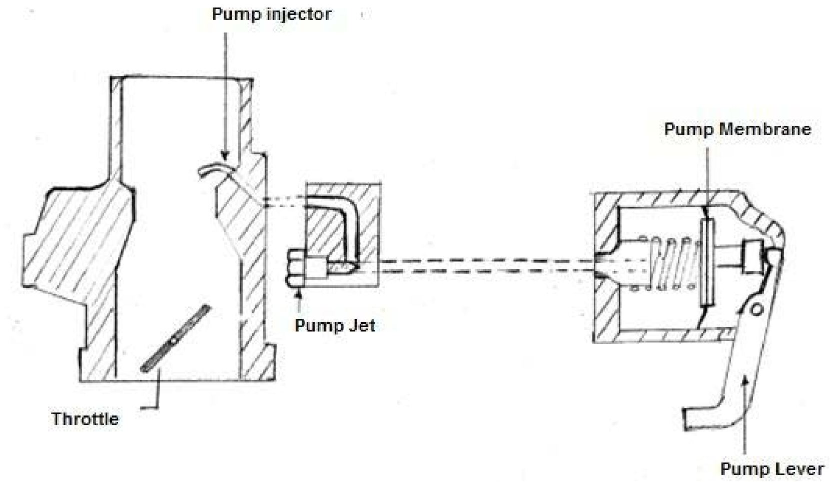


Figure: Acceleration Circuit

b) **List the types of lubrication systems. Explain the pressure lubrication.** **8**

Answer:*(Listing types of lubrication systems 1 Marks, Explanation 4 Marks, Figure 3 Marks)*

Types of lubrication systems are

1. Petroil Lubrication system
2. Splash Lubrication system
3. Dry sump lubrication
4. Pressure Lubrication system

1

Pressure Lubrication system:

Working:-

In the pressure lubrication system oil pump takes the oil from the wet sump through strainer and delivers it through a filter to the main oil gallery at a pressure of 200 to 400 kPa. The oil pressure is controlled by means of a pressure-relief valve situated in the filter unit or the pump housing. From the main gallery the oil goes through the drilled passages to main bearings from where some of the oil after lubricating the main bearings falls back to the sump, some is splashed to lubricate cylinder walls while the rest goes through a hole to the crank pin from where a hole in the lubricating connecting rod web leads it to the gudgeon pin. **4**

After lubricating gudgeon pin bearings the oil falls back or effects ring lubrication. The oil that falls on cylinder walls drains back into the oil pan and is recalculated through lubricating system.

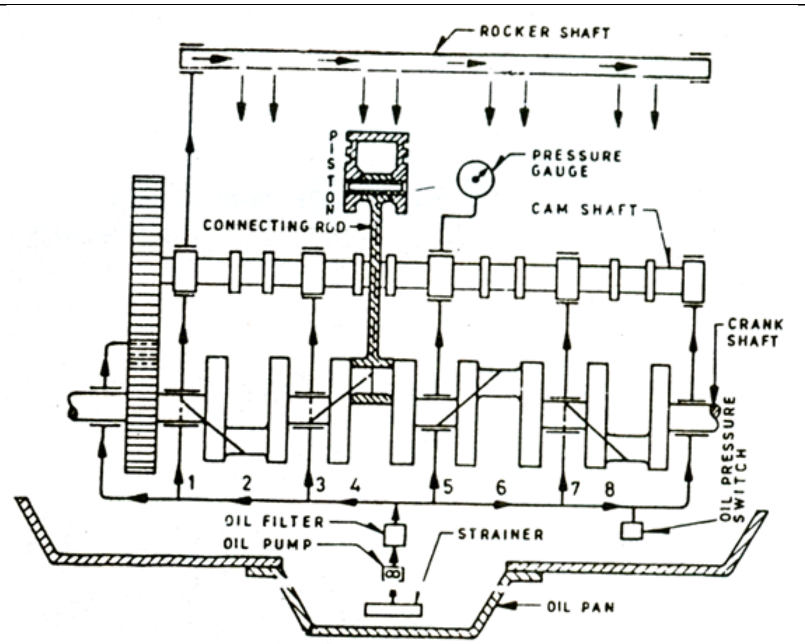


Figure:- Pressure Lubrication System

OR

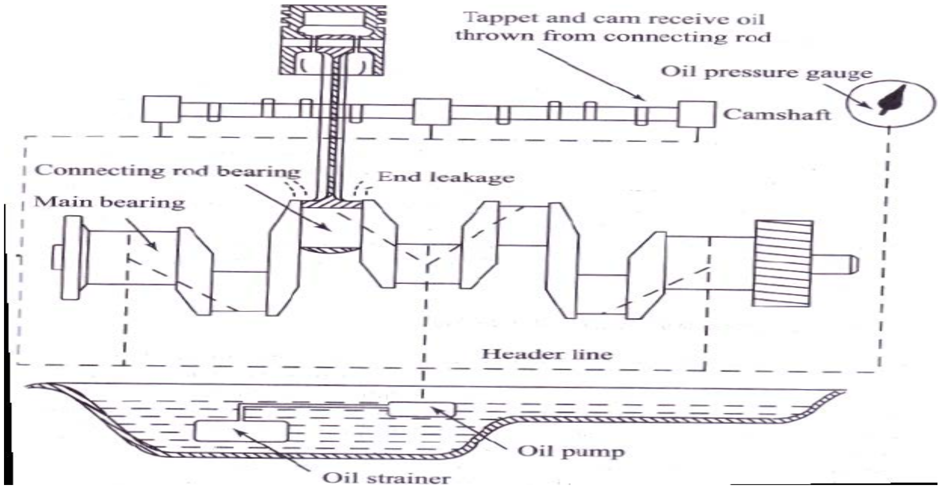


Figure:- Pressure Lubrication System

3

c) **i) Compare Dry liner and Wet liner (Any four points).** **4**

Answer: (*Any* four *differences, 1 Marks each)*

Sr. No.	Dry liner	Wet liner
1	Dry liner is **not in direct contact** with of cooling water	Wet liner **is in direct contact** with of cooling water cooling water
2	It is **difficult to replace**	It is **easy to replace**
3	**No leak proof joint** is	**A leak proof joint** between cylinder

4

	provided	casting and liner has to be provided
4	**The casting** of cylinder block **is complicated**	**The casting** of cylinder block **is simplified**
5	Block is **more robust**	Block is **less robust**
6	**Very accurate machining of block** and outer liner surface **is required**	**Very accurate machining of block** and outer liner surface **is not required**
7	A dry liner **cannot be finished accurately** before fitting	A wet liner **can be finished accurately** before fitting

	ii)	**ii) State two functions of flywheel and piston rings each.**	**4**
		Answer: ***(Two Function of flywheel 2Marks, Two Function of* piston rings, 2*Marks)*** **Functions of flywheel**: 1. Flywheel absorbs energy during power stroke and supplies it during remaining strokes. 2. Flywheel keeps the crankshaft rotating at the uniform speed throughout in spite of uneven power impulses of engine cylinders. 3. Flywheel carries the drive from the starting motors to crankshaft while the starting the engine. **Functions of piston rings:** 1. To provide a pressure seal to prevent blow-by of burnt gases. 2. To form the main path for conduction of heat from the piston crown to the cylinder walls. 3. To control the flow of oil to the skirt and rings themselves in adequate quantity while preventing an excessive amount reaching the combustion chamber with consequent waste and carbonization.	**2** **2**
4.		**Attempt any FOUR of the following:**	**16**
	a)	**What is scavenging? Describe any one method of scavenging.**	**4**
		Answer:*(Definition 2 marks ,Explanation of any one method,1Mark,Figure 1Mark)* **Scavenging: *(Suitable credit shall be given if only diagram is drawn)*** Scavenging is process of removing the exhaust gases (combustible products) from the cylinder with help of incoming fresh charge in two stroke engine. During the downward movement of the piston the mixture in the crankcase is compressed and pushed into the cylinder through the transfer port, which pushes out the exhaust gases through the exhaust port at the same time filling the cylinder with new charge, is called cross- flow scavenging **Methods:** **(1) Cross Flow Scavenging:-** In this method, the inlet port and exhaust port are situated on the opposite sides of engine cylinder.	**2** **1**

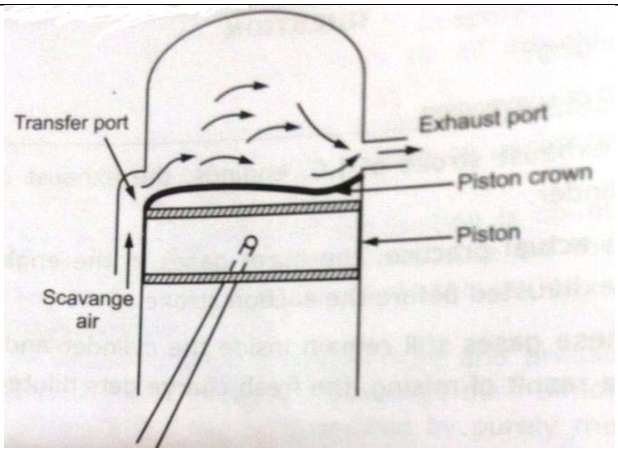


Figure: Cross Flow Scavenging

(2) Back Flow or Loop Scavenging :-

In this method, the inlet and outlet ports are situated on the same side of the engine cylinder

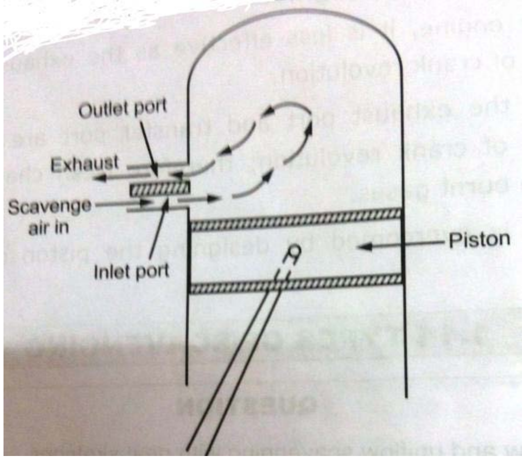
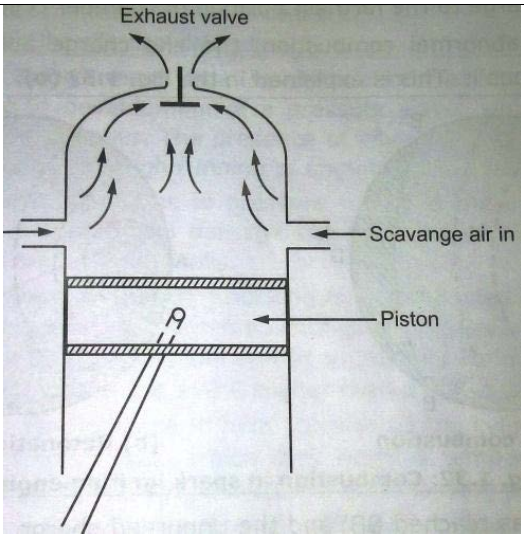


Figure: Back Flow or Loop Scavenging

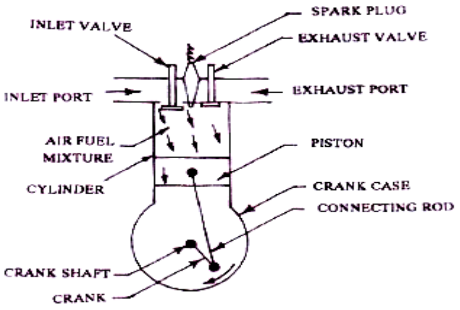
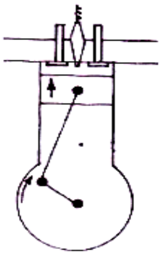
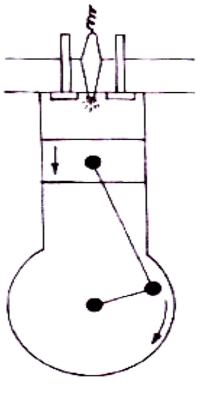
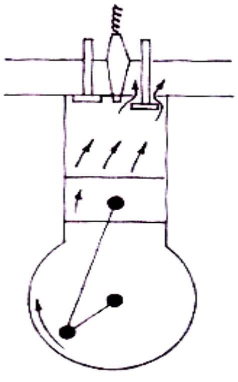
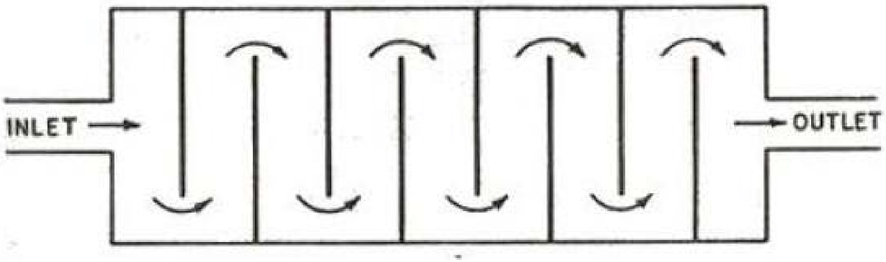
(3) Uni- flow Scavenging:-

In this method, the fresh charge, while entering from one side (or sometimes two sides) of the engine cylinder pushes out the gases through exhaust valve situated on the top of the cylinder.

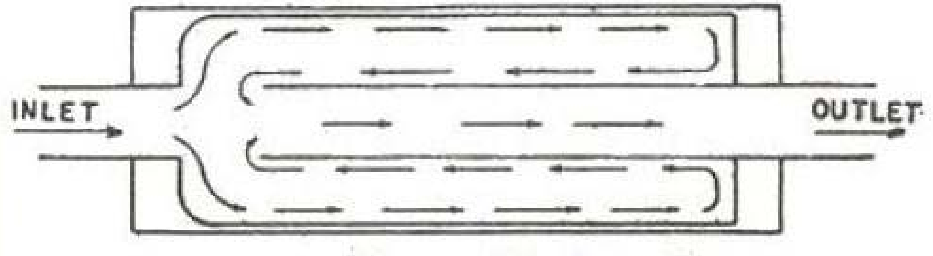
1

		 Figure : Uni- flow Scavenging	
	b)	**Define i) Indicated power ii) Frictional power.**	**4**
		Answer:*(Definition of* Indicated power *,2 Mark, Definition of* , Frictional power *2 Marks)* **i) Indicated Power:** It is the power developed by the engine above the piston in the combustion chamber by burning of fuel. It is measure on the top of piston. $$I.P. = \frac{\text{mf X CV}}{60000}\ \text{KW}$$ Where, mf=mass of fuel in kg CV=Calorific value of fuel in J/Kg-K **Frictional power:** The difference between the Indicated power and Brake power is called as frictional power. It is the power lost in overcoming the friction between the moving parts. FP= IP-BP Where, FP= Frictional power IP= Indicated power BP= Brake power **OR** **Friction Power:** It is the power consumed by the engine to overcome the frictional loses. F. P. = I.P - B.P.	**2** **2**
	c)	**State the materials of cylinder head and crankshaft also write their manufacturing process.**	**4**
		Answer: ***(1 mark for material, 1 mark for manufacturing method of each)*** **Cylinder Head:** Material: Gray cast iron, Aluminum alloy Manufacturing Method: Casting, forming.	**2**

		Crankshaft:- Material: Alloy steel, SG iron. Manufacturing Method: Forging	**2**
	d)	**Explain the function of i) Thermostat ii) Pressure cap.**	**4**
		Answer: Thermostat: 1. To regulate the circulation of water in cooling system and to maintain the normal working temperature of the engine parts during different operating conditions. 2. To keep a rigid control over the cooling. It helps the engine to reach the operating temperature as soon as possible after starting the engine. **Pressure cap:** 1) Pressure cap forms an air tight seal due to which the coolant is maintained at some pressure higher than the atmosphere. 2) High pressure causes rise in boiling point of the coolant. Approximately for 10 kPa increase in pressure, the B.P raises by 2.5°C.	**2** **2**
	e)	**Explain the working of four stroke petrol engine.**	**4**
		Answer:*(Any one diagram-2 marks, Description-2 marks)* **Working of four stroke petrol engine:** **1. Suction stroke:** During this stroke, inlet valve is open and exhaust valve is closed. The piston moves from TDC to BDC and crank shaft rotates through 180°. The downward movement of the piston sucks air-fuel mixture in the cylinder from the carburetor through the open inlet valve. **2. Compression Stroke:** During compression stroke, the piston moves upward (from BDC to TDC), thus compressing the charge. Both the inlet and exhaust valves remain closed during the compression stroke. **3. Power stroke or Working stroke:** At the end of the compression stroke the charge (air-fuel mixture) is ignited with the help of a spark plug located on the cylinder head. The high pressure of the burnt gases forces the piston towards BDC. Both the valves are in closed position. Of the four strokes only during this stroke power is produced. **4. Exhaust Stroke:** At the end of power stroke the exhaust valve opens and the inlet valve remains closed. The piston move from BDC to TDC position which pushes the burnt gases outside the combustion chamber. Crankshaft rotates by two complete revolutions through 720^0.	**2**

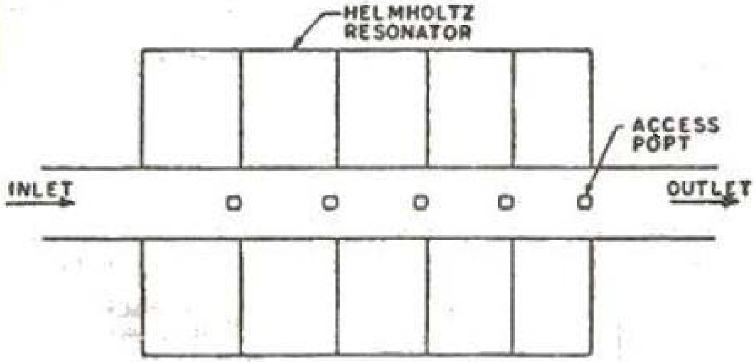
		 (A) Suction  (B) Compression  (C) Power  (D) Exhaust	2 2
	f)	**State the function of exhaust manifold. Explain any one type of silencer.**	4
		Answer: ***(function any one -1 mark, Diagram-1 marks, and explanation-2 mark)*** 1) The function of an exhaust manifold is to expel the exhaust gases from the combustion chamber of each cylinder out to the atmosphere through the exhaust pipe after combustionstroke is completed. 2) To keep back pressure minimum. **Types of mufflers:** 1. Baffle type 2. Wave cancellation type 3. Resonance type 4. Absorber type 5. Combined Resonance and absorber type **1. Baffle type silencers:** It consists of a number of baffles spot welded inside the cylindrical body. The purpose of these baffles is to close the direct passage of the exhaust gases, thus the gases travel a longer path in the muffler.  	1 2 1

2. Wave cancellation type: In this type of muffler, the exhaust gases entering the mufflers are divided into two parts to flow in the muffler. The lengths of these paths are so adjusted that after they come out of the muffler, crests of one wave coincide with the troughs of the second wave, thus cancelling each other and reducing the noise to zero theoretically. This is achieved if the lengths of the two paths differ by half the wavelength. But this is not practically achieved, because the noise created by exhaust gases is a combination of different frequencies at different engine speeds. However, appreciable noise is reduced.



Wave cancellation type muffler.

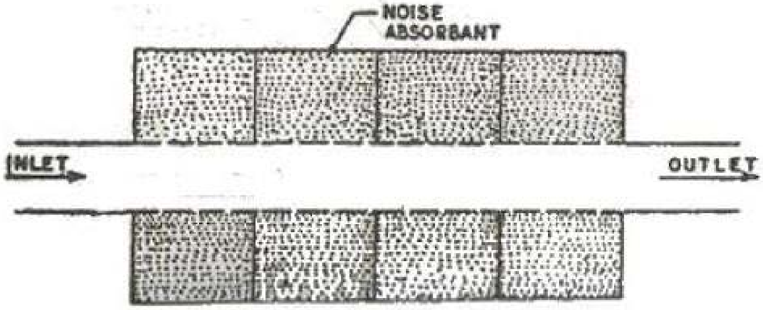
3. Resonance Type: It consists of a number of Helmholtz resonators in series through which a pipe having access port passes. Helmholtz is the name of a person who originated the idea of this type of muffler. The exhaust gases flow through this pipe. The resonators eliminate the fundamental and higher harmonics of the engine noise.



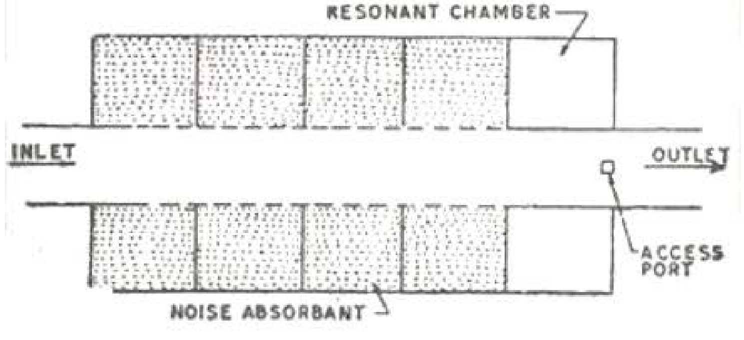
Resonance type muffler.

4.Absorber type :

It consists of a perforated tube, around which a sound absorbing material, like fiber glass or steel wool is placed. The exhaust gases pass through the perforated tube. The sound absorbing material reduces the high pressure fluctuation of the exhaust gases thus reducing the noise intensity.



5. Combined Resonance and absorber type: Sometimes, a resonance chamber is provided at one end or in the middle of the straight through absorber type muffler, to reduce the pressure and noise still further. In some designs, the resonance chamber is a separate unit called a resonator, which is connected in series to the muffler.



Combined resonance and absorber type muffler.

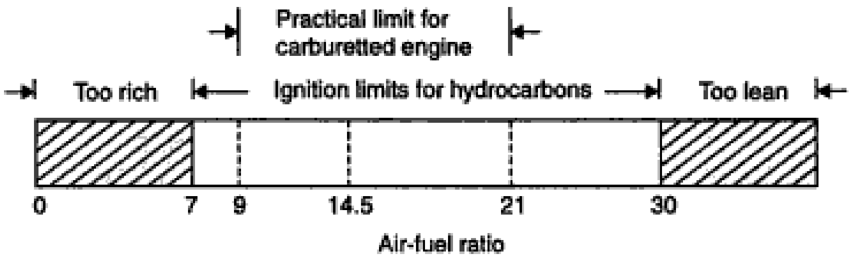
5 **Attempt any FOUR of the following:** **16**

a) **Describe four properties of lubricating oil.** **4**

Answer: Properties of lubricating oil (*Any four 1 marks each)*

1) Viscosity:- Viscosity is a measures of the flow ability of an oil under a particular temperature and pressure
2) Flash Point or Fire Point: - The lowest temperatures at which the oil flashes and fires, known as flash and fire points. These two temperatures must be sufficiently high for any lubricating oil to avoid flash or burn during use.
3) Cloud: - The low temperature at which the lubricant changes from liquid state to a plastic or solid state is called cloud point. In some cases the oil appears to be cloudy at the start of solidification.
4) Carbon Residue**:-** Lubricating oils being the chemical compounds of carbon and hydrogen, when burnt deposit carbon on the engine parts. This should be as low as possible for lubricating oil.
5) Corrosion: - A lubricant should not corrode the working parts.
6) Pour Point: - The lowest temperature at which the oil pours is called its pour point. Below this temperature the oil becomes plastic, so it does not produce hydrodynamic lubrication and therefore cannot be used below this temperature.
7) Colour: - This test is not so important except for checking the uniformity of any given grade of oil.

4

		8) Specific Gravity: - Specific gravity of lubricating oil varies considerably and hence should not be regarded as the main indication of its lubricating property. 9) Neutralisation Number: - Oil may contain impurities, if not removed during refining, which have deleterious effect on the properties of the oil.	
	b)	**Define:** **i) Compression Ratio ii) Swept Volume.**	**4**
		Answer : ***(2 mark each)*** **i) Compression Ratio:-** This indicates the extent to which the charge in the engine is compressed .This is calculated as the ratio of the volume above the piston at B.D.C. to the volume above the piston at T.D.C. If ‘R’ is the compression ratio, then, $R = \frac{V_c + V_s}{V_c}$ **ii) Swept Volume:** The volume swept by the piston in moving from T.D.C. to B.D.C. It is expressed in terms of cubic centimeter (cm^3) and given by $Vs = \mathrm{A\,X\,L} = \frac{\pi}{4}\mathrm{d}^2\ \mathrm{x\,L}$	**2** **2**
	c)	**Explain the air fuel requirements for SI engine.**	**4**
		Answer: Air Fuel Requirements for SI engine, at lean & rich ends of the scale, where the heat released by spark is no longer sufficient to initiate combustion in the neighboring UN burnt mixture. The flame will propagate only if the temperature of the burnt gases exceeds approximately 1250^0 C in the case of hydrocarbon-air mixture. The lower & upper Air Fuel Requirements for SI engine(ignition limits) depend upon mixture ratio & flame temperature. The ignition limits are wider at increased temperature because of higher rates of reaction.  Theoretical Air Fuel Requirements for SI engine(Ignition limits for Hydrocarbon fuels) are 7:1 to 30:1 Actual Air Fuel Requirements for SI engine (Ignition limits for hydrocarbon fuels) are 9:1 to 21:1	**2** **2**

<table>
<tr><td></td><td>d)</td><td>Explain with neat sketch positive crank case ventilation.</td><td>4</td></tr>
<tr><td></td><td></td><td>Answer: <i>(Sketch-2 marks, Description-2 marks)</i>
Positive Crankcase Ventilation System: Since water vapour in exhaust and blow by gases enter crankcase due to various reasons there is every chance that these contaminants will cause sludge and corrode metal parts. Therefore a mean of removing these contaminants before they can act on the oil is essential. In Positive Crankcase Ventilation system the un-burnt gases are re-circulated into the combustion chamber and burnt with the fresh charge. Another reason of using crankcase ventilation is to relieve any pressure build-up in the crankcase which may cause crankshaft seal leakage.</td><td>2</td></tr>
<tr><td></td><td></td><td>The figure shows the intake manifold return PCV system. It has a tube leading from the crankcase or else the rocker arm cover through a flow control valve into the intake manifold usually just below the carburetor. To provide proper ventilation of the interior of the engine, fresh air is usually drawn through a rocker arm cover opposite that containing the PCV system

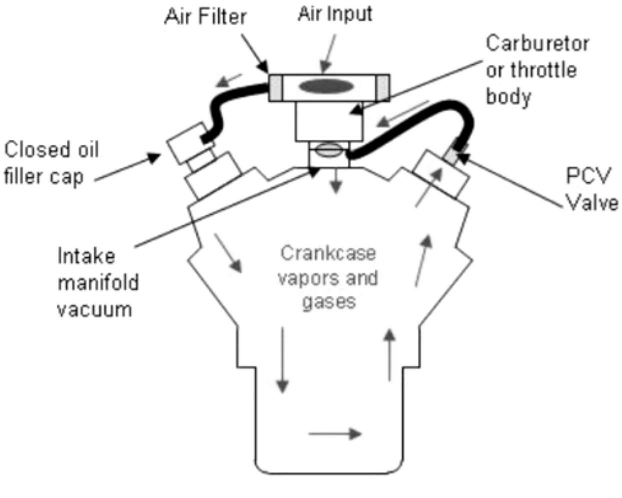
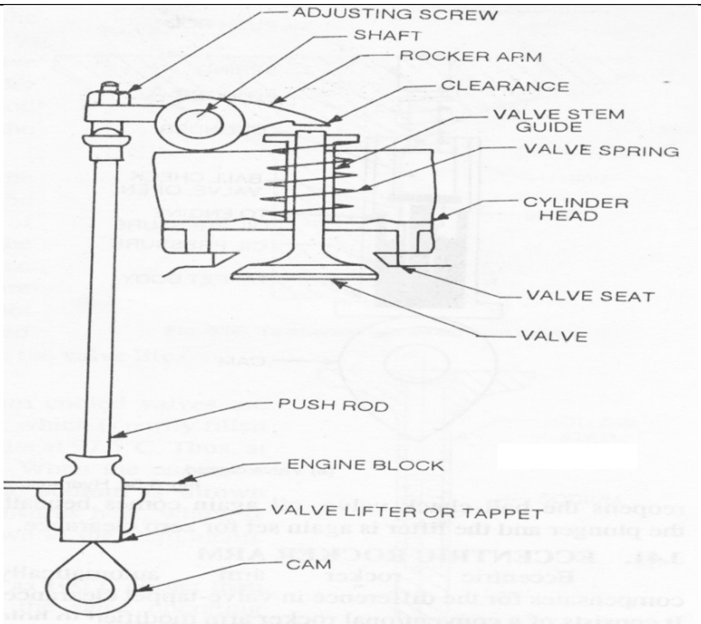


Figure: PCV system.</td><td>2</td></tr>
<tr><td></td><td>e)</td><td>Explain with neat sketch overhead valve mechanism.</td><td>4</td></tr>
<tr><td></td><td></td><td>Answer:- Overhead valve mechanism:<i>(Sketch-2 marks, Description-2 marks)</i>
Figure shows the valve mechanism to operate the valve when it is in the cylinder head (in I and F head design). This type of mechanism requires two additional moving parts the push rod and rocker arm. As the cam rotates, it lifts the valve- tappet or the lifter which actuates the push rod. The push rod rotates the rocker arm about a shaft- the rocker –arm shaft, or a ball joint in some designs to cause one end to push down on the valve stem to open the valve, thus connecting the valve port with the combustion chamber.</td><td>2</td></tr>
</table>



Valve mechanism for operating the valve in cylinder head. (Overhead valve).

2

OR

Overhead valve mechanism

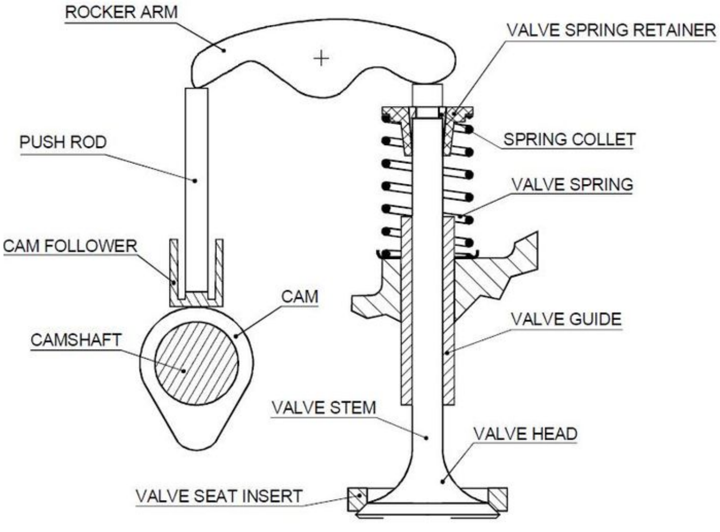


Figure: Overhead Valve Operating Mechanism

Working: As the camshaft rotates, each off-center (eccentric) cam lobe pushes against a lifter or tappet. The upward motion of the lifter transfers through the push rod to the rocker arm. This upward motion changes to downward motion as the rocker arm pivots. The downward motion opens the valve. As the camshaft continues to rotate, the lobe passes by the lifter and allows the valve to close. A spring (attached to the valve) returns the valve to its seated position.

	f)	**State tow merits and demerits of vertical engine.**	**4**
		Answer: Merits and demerits of vertical engine. **Merits of vertical engine :-*(any two)*** 1) In case of vertical engine the crankcase is at bottom so it is easy to store lubricating oil for flash lubrication. 2) The lubricating oil which dribbles from bearing and other engine parts is easily collected in the crankcase and then reuse after filtering. 3) The weight of piston is carried by crank therefore the weight of piston does not wear cylinder liner during motion.	**2**
		Demerits of vertical engine :-*(any two)* 1) It gives the vertical vibration to the vehicle chassis frame which can be felt by the passengers. 2) Bonnet height cannot be minimizing. 3) Engine Foundation Bolt may get fatigue failure.	**2**
6		**Attempt any Two of the following:**	**16**
	a)	**What are the various methods for measuring frictional power? Describe Morse test.**	**8**
		Answer: Various methods for measuring frictional power :- 1) Motoring test 2) Willian's line method 3) Morse test	**2**
		Morse test for finding out frictional power. In this method the BP of whole engine is first of all measured at a certain speed and load with the help of dynamometer. Then from total number of cylinders of the engine one of the cylinders is cut out by short circuiting the spark plug or by disconnecting the injector. The output is measured by keeping the speed constant. The difference in the outputs is measure of the indicated power of disconnecting cylinders. Thus for each cylinder the IP is obtained and then is added together to find the total IP of the engine.	**2**
		Where BP= Brake power IP= Indicated power FP = Frictional power Let F.P. of cylinder 1,2,3,4 be F1, F2, F3, F4 respectively. Then total FP of engine = F1+F2+F3+F4 Let IP of cylinder 1 2 3 and 4 be $I_{1,\ I2}$ I_3& I_4 respectively. The total IP of engine is given by, $= I_1 +_{,}I_2+ I_3 + I_4$ The total BP of engine when all cylinders are working BP= Total IP – Total FP	**2**

$B = (I_1 +_, I_2 + I_3 + I_4) – (F1+F2+F3+F4)$----------1

When cylinder 1 is cut off, the BP developed by the remaining three cylinders,

$B_{1=}$ $(0 +_, I_2 + I_3 + I_4) – (F1+F2+F3+F4)$------------2

Subtracting (2) from (1) we get

$B - B_1 = I_1$

Therefore, IP of cylinder 1, $I_1 = B-B_1$

Similarly ,

IP of cylinder 2, $I_2 = B-B_2$
IP of cylinder 3, $I_3 = B-B_3$
IP of cylinder 4, $I_4 = B-B_4$

Total IP of Engine = $I_1+I_2+I_{3+}I_4$

Friction Power F.P. = I.P – B.P

2

b) **A four stroke cycle diesel engine gave the following data during a trial of 50 minutes duration. Brake Power = 37 kw, Fuel used = 10 kg, Calorific value of fuel =46000 KJ/kg, Air used per kg of fuel = 35kg, Temperature of exhaust gas. = 380^{o}c, Room temp. = 20 ^{o}C, Sp. Heat of exhaust gases = 1.005 KJ /kg K, Mass of jacket cooling water circulated = 750 kg, Temperature of jacket cooling water at inlet and outlet 20 ^{o}C and 70 ^{0} C respectively. Draw heat balance sheet on minute basis.**

8

Answer: Given Data:-

Duration of trial =50 minutes
Brake Power = 37 kw
Fuel used per min = 10 kg
Calorific value of fuel =46000 KJ/kg
Air used per kg of fuel = 35kg
Temperature of exhaust gas. = 380^{o}c
Room temp. = 20 ^{o}C
Sp. Heat of exhaust gases = 1.005 KJ /kg K= cp_{eg} = 1.0055 KJ/Kg^{0}K
Mass of jacket cooling water circulated = 750 kg
Temperature of jacket cooling water at inlet and outlet 20 ^{o}C and 70 ^{0} C respectively

Solution:

1) Total heat (Energy) input

Fuel used = 10 kg for 50 min.

Therefore, mass flow rate of fuel m_f is,

m_f = 10/50 kg/min = 0.2 kg/min

CV of fuel = 46000 kJ/kg

$\text{Input Heat} = \dot{m}_f \times \text{C.V}$ **2**

= 0.2 X 46000 = 9200 kJ/min

Total heat (Energy) input = 9200 kJ/min

Consider Total heat (Energy) input = 9200 kJ/min As 100 %

2) Heat energy Converted in to B.P.

Brake Power = 37 kw **1**

B.P = 37 kJ/sec

= 37 x 60

= 2220 kJ/min

Heat energy Converted in to B.P. = 2220 kJ/min

Heat energy Converted in to B.P. in percentage = (2220/9200) x 100 = 24.13 %

3) Heat lost in to Exhaust Gas.

Air used per kg of fuel = 35kg / kg of fuel used for 50 min trial

Total air used for trial is= 35 x 10 = 350 kg

Therefore, mass flow rate of air m_a is,

m_a = 350 / 50 = 7 kg/min **1**

Mass of Exhaust gas $m_{eg} = m_f + m_a$

m_{eg} = 0.2 + 7

m_{eg} = 7.2 kg/min

$\text{Heat lost in to Exhaust Gas} = \dot{m}_{eg} \times cp_{eg} \times \Delta T_{eg}$

= 7.2 x 1.005 x (380-20)

= 2604.9 kg/min

Heat lost in to Exhaust Gas = 2604.9 kg/min

Heat lost in to Exhaust Gas in percentage = (2604.9/9200) x 100 = 28.31 %

4) Heat energy lost in to cooling water

Mass of jacket cooling water circulated = 750 kg for 50 min trial

Therefore, mass flow rate of fuel m_w is,

m_w= 750/50 kg/min = 15 kg/min

assume, cp_w = 4.2 kJ/kg K **1**

$\text{Cooling water heat} = m_w \times cp_w \times \Delta T_w$

= 15 X4.2 X(70-20)

= 3150 kJ/min

Heat energy lost in to cooling water = 3150 kJ/min

Heat energy lost in to cooling water in percentage = (3150/9200) x 100 = 34.23 %

5) Unaccounted Heat loss =

= Total heat (Energy) input – (Heat energy Converted in to B.P. + Heat

lost in exhaust gas + Heat energy lost in to cooling water)
= 9200 – (2220 + 2604.9 + 3150)
= 1225.1 kJ/min

Unaccounted Heat loss in percentage = (12258.1/9200) x 100 = 13.31 %

1

Heat balance sheet

Parameter	**kJ/min Basis**	**Percentage (%) basis**
Input Heat	9200	100
Heat converted in to B.P.	2220	24.13
Heat lost in to Exhaust Gas	2604.9	28.31
Heat lost in to cooling water	3150	34.23
Unaccounted Heat loss	1225.1	13.31

2

b) **The following readings were noted during a trial on a single cylinder 2- stroke diesel engine. Engine is motored by an electric motor and frictional power loss recorded on wattmeter is 1.25 kw. Net brake load = 225 N, diameter of brake wheel = 100 cm, Engine speed = 500 rpm, Fuel consumption = 2.04 kg/hr, Calorific value of fuel = 42000KJ/kg, Find Mechanical efficiency and brake thermal efficiency.**

8

Answer:

Given Data:-

Frictional Power, F.P. = 1.25 kw
Net brake load, W = 225 N
Diameter of brake wheel, D = 100 cm,
Radius of brake wheel, R = 50cm = 0.5m
Engine speed, N = 500 rpm
Fuel consumption, m_f = 2.04 kg/hr = 2.04/(60x60) = 5 x 10^{-4} kg/min
Calorific value of fuel. C.V. = 42000KJ/kg

(i) Mechanical Efficiency, $\eta_{mech} = \frac{\text{B.P.}}{\text{I.P.}} \times 100\%$

B.P. of the engine, $\text{B.P.} = \frac{2\pi\ \text{N T}}{60 \times 1000}$

Torque on the engine, T = W X Radius of brake drum

T = 225 X 0.5

T = 112.5 Nm

2

$$\text{B.P.} = \frac{2\pi\ \text{N T}}{60 \times 1000}$$

$$\text{B.P.} = \frac{2\times 3.14\times 500\times 112.5}{60\times 1000} = 5.887\ \text{kW}$$

B.P. of the engine = 5.887 kW

Indicated power of engine, I.P. = B.P. + F.P.

= 5.887 + 1.25 = 7.137 kw

I.P. of the engine = 7.137 kW

1

$$\eta_{mech} = \frac{\text{B.P.}}{\text{I.P.}}\times 100\%$$

$$\eta_{mech} = \frac{5.887}{7.137}\times 100\%$$

2

Mechanical Efficiency, $\eta_{mech} = 82.48\%$

ii) Brake thermal efficiency, $\eta_{Bth} = \frac{\text{B.P.}}{m_f \times \text{c.v.}}\times 100\%$

3

$$= \frac{5.887}{5\times 10^{-4}\times 42000}\times 100$$

$$\eta_{Bth} = 28.03\%$$

Brake thermal efficiency = 28.03 %