# MODEL ANSWER

**Summer – 17 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 the model answer scheme.*

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

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

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

*5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values 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.*

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| Que. No. | Sub Que | Answer | Marking Scheme |
|---|---|---|---|
| 1 | A) | **Attempt any SIX of the following:** | 12 |
| | a) | **Define Stroke** | 2 |
| | | **Answer:**<br>**Stroke**: Distance travelled by the piston moving from T.D.C. t to the B.D.C. is called stroke. | |
| | b) | **State any two demerits of horizontal I. C. Engine.** | 2 |
| | | **Answer:** *(Any two)*<br>**Demerits of the Horizontal engine :**<br>1) The crank case cannot be used for storing lubricating oil for splash lubrication.<br>2) The weight of the piston is carried by the cylinder liner causes excessive wear at the lower side of the piston.<br>3) The lubricating oil, which dribbles from the bearings does not return to the crank case. This causes more consumption of lubricating oil. | |
| | c) | **List any two applications of two stroke petrol engine** | 2 |
| | | **Answer:** *(Any two)*<br>1. Scooters, Mopeds<br>2. Motor Cycles<br>3. Small Electric Generating Sets<br>4. Pumping Sets<br>5. Out board Motor Boats | |
| | d) | **State any four specifications of two wheeler** | 2 |
| | | **Answer:** *(Any four. Credit should be given to an equivalent answer)*<br>Length: 2012mm, Height: 1090mm, Width: 762mm, Type: Air cooled, Displacement: 124.73cc, Max. net torque: 10.30Nm, Bore: 57.8mm, Compression ratio: 9.2:1, Stroke: | |

| | | | |
|---|---|---|---|
| | | 57.8mm, Max. net power: 7.58KW | |
| | **e)** | **State any two advantages of water cooling system.** | **2** |
| | | **Answer:** *(Any two)*<br>**Advantages of water cooling system**<br>1. Engine can be installed anywhere on the vehicle<br>2. Volumetric Efficiency of water cooled engine is more than air cooled engine<br>3. Uniform cooling of cylinder, cylinder head and valves.<br>4. Specific fuel consumption of engine improves by using water cooling system.<br>5. Engine is less noisy as compared with air cooled engines, as it has water for damping noise. | |
| | **f)** | **Define Brake Thermal Efficiency and Volumetric Efficiency.** | **2** |
| | | **Answer:** *(Definition = 01 Mark Each)*<br>**Brake Thermal Efficiency:**<br>It is the ratio of energy in the brake power to the input fuel energy i.e.<br>$$\eta_{Bth} = \frac{B.P.}{m_f \times c.v.} \times 100\%$$<br>**Volumetric Efficiency:**<br>Volumetric efficiency is an indication of the breathing ability of the engine and is defined as the ratio of the air actually induced at ambient condition to the swept volume of the engine.<br>$$\eta_v = \frac{\text{Volume flow rate of air intake system}}{\text{Rate at which volume displaced by the piston}} = \frac{V_{actual}}{V_{swept}}$$ | |
| | **g)** | **State the function of piston ring and compression ring.** | **2** |
| | | **Answer:**<br>**Function of Piston rings:**<br>1. To provide a pressure seal to prevent blow-by of burnt gases.<br>2. To form the main path for conduction of heat from the piston crown to the cylinder walls.<br>**Function of Compression Ring:**<br>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. | **1**<br><br>**1** |
| | **h)** | **State function of carburettor.** | **2** |
| | | Answer**:** *(Any two)*<br>The main functions of the carburettor are:<br>1) To keep a small reserve of fuel at a constant head.<br>2) To vaporize the fuel to prepare a homogeneous air fuel mixture.<br>3) To supply correct amount of the air fuel mixture at the correct strength under all conditions of load and speed. | |

**B) Attempt any TWO of the following:** **8**

**a) Compare two stroke and four stroke engine.** **4**

**Answer:** *(Any two)*

| SN | TWO STROKE ENGINE | FOUR STROKE ENGINE |
|---|---|---|
| 1 | One **Working Stroke** for **each revolution** of crank shaft. | One **Working Stroke** for **every two revolution** of crank shaft. |
| 2 | Turning moment on the crank shaft is more even due to working stroke of each revolution of the crank shaft, **lighter flywheel** is required and **engine run balanced** | Turning moment on the crankshaft is not even due to one working stroke for every revolution of the crank shaft, **heavy flywheel** is required and **engine run unbalanced** |
| 3 | Engine is light. | Engine is heavy. |
| 4 | **Thermodynamic cycle** is completed in **two stroke of piston** or **one revolution of crank shaft**. | **Thermodynamic cycle** is completed in **Four stroke of piston** or **Two revolution of crank shaft**. |
| 5 | Volumetric efficiency is **less** | Volumetric efficiency is **more** |
| 6 | Engine design is **simple** | Engine design is **Complicated** |
| 7 | More mechanical efficiency due to less friction on **few parts** | Less mechanical efficiency due to less friction on **many parts** |
| 8 | **Less output** due to mixing of fresh charge with burnt gases. | **More output** due to mixing of full fresh charge intake and full burnt gases Exhaust |
| 9 | Thermal efficiency is **less**. | Thermal efficiency is **more.** |
| 10 | Engine runs **hotter**. | Engine runs **cooler**. |
| 11 | Engine requires **less spac**e. | Engine requires **more space**. |

**b) Classify the IC engine on the basis of:** **4**

1) **Cooling**
2) **Cylinder Arrangement**
3) **Camshaft Layout**
4) **Fuel**

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**Answer:** *(01 Mark each)*

1. **Cooling Method:** — **1**
   a) Air cooled engine
   b) Water cooled engine
2. **Cylinder Arrangement:** — **1**
   a) Vertical engine
   b) Horizontal engine
   c) Radial engine
   d) V-engine
   e) Opposed cylinder engine
3. **Camshaft Layout:** — **1**
   a) Overhead Valve camshaft arrangement engine
   b) Under head Camshaft arrangement engine
   c) Double overhead camshaft arrangement engine
4. **Fuel Used:** — **1**
   a) Petrol engine (or Gasoline engine)
   b) Diesel engine
   c) Gas engine

**c) List the different efficiencies of engine and write down the relationship between them.** — **4**

**Answer:** *(01 Mark each)*

Following are the different types of efficiencies of engine:

1. **Mechanical Efficiency:**
   It is the ratio of brake power to indicated power. It is measured in percentage.

$$\text{Mechanical efficiency, } \eta_{mech} = \frac{B.P.}{I.P} \times 100$$

2. **Brake Thermal Efficiency:**

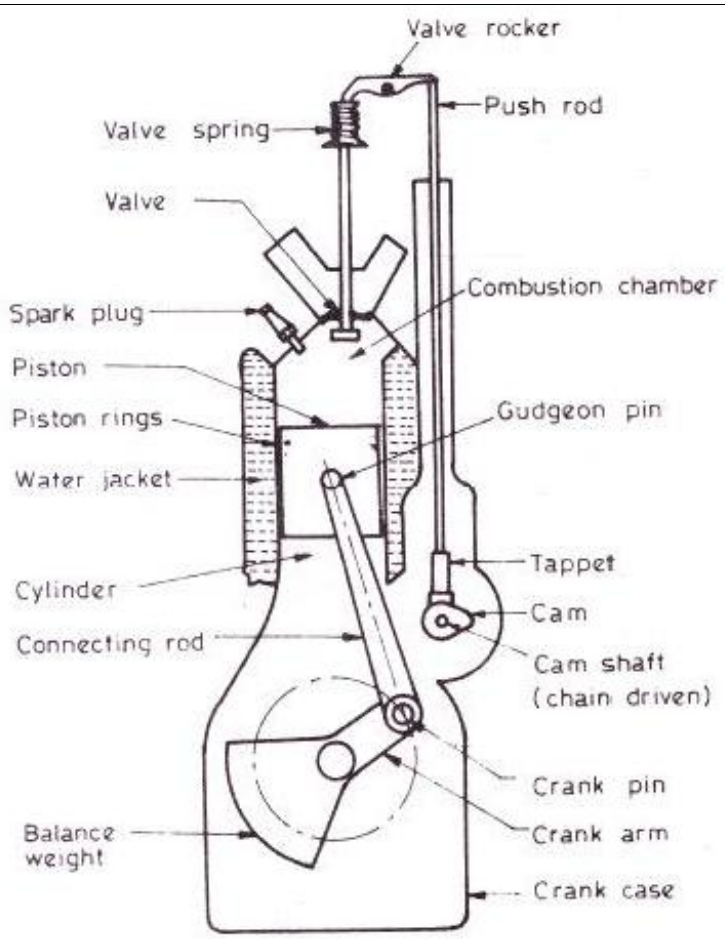
$$\eta_{Bth} = \frac{\text{B.P.}}{m_f \times \text{c.v.}} \times 100\%$$

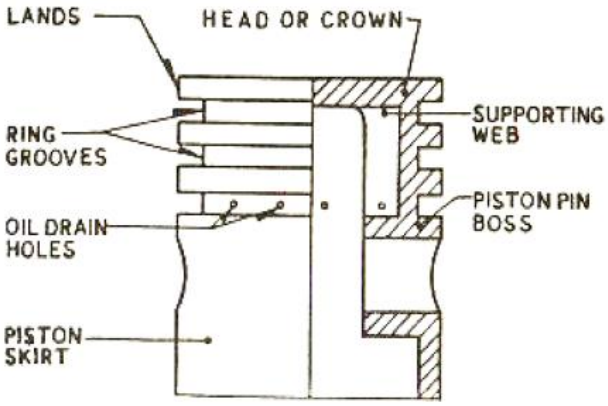
3. **Volumetric Efficiency:**
   Volumetric efficiency is an indication of the breathing ability of the engine and is defined as the ratio of the air actually induced at ambient condition to the swept volume of the engine.
4. 

$$\eta_v = \frac{\text{Volume flow rate of air intake system}}{\text{Rate at which volume displaced by the piston}} = \frac{V_{actual}}{V_{swept}}$$

5. **Overall Efficiency:**
   It is the ratio of work obtained at the crank shaft in a given time to the energy

| | | | |
|---|---|---|---|
| | | supplied by the fuel during the same time<br>$\eta_{Bth} = \frac{B.P.}{m_f \times c.v.} \times 100\%$<br>**6. Indicated Thermal Efficiency:**<br>It is the ratio of indicated power to input fuel energy (i.e. product of mass of fuel and calorific value of fuel)<br>$\eta_{ith} = \frac{I.P.}{m_f \times c.v.} \times 100\%$<br>**7. Air standard efficiency:**<br>It is a thermodynamic efficiency which is mainly a function of compression ratio. It gives the upper limit of the efficiency obtainable from an engine.<br>$\eta_{air\ stand} = 1 - \frac{1}{R_c^{\gamma-1}} \times 100\ \%$<br>**8. Relative Efficiency:**<br>It is the ratio of thermal efficiency to the air standard efficiency.<br>$\eta_{rel} = \frac{\eta_{ith}}{\eta_{air\ stand}} \times 100\%$ | |
| **2** | | **Attempt any FOUR of the following** | **16** |
| | **a)** | **Draw a labelled sketch showing engine nomenclature.** | **4** |
| | | **Answer:** | |




| | | | |
|---|---|---|---|
| | **b)** | **Draw a labelled sketch of piston and specify material used for manufacturing it.** | **4** |
| | | **Answer:** *(Sketch 3 marks, material 1 marks)*   **Material:** Aluminium alloy, Cast iron | **3** **1** |

**c) Differentiate between dry and wet liners.** **4**

**Answer:** *(Any four)*

| S. N. | DRY LINERS | WET LINERS |
|---|---|---|
| 1 | Dry liners are **not in direct contact** with cooling water hence it is known as dry liners. | Wet liners are **in direct contact** with cooling water on the outside hence it is known as dry liners. |
| 2 | It is **difficult to replace** | It is **easy to replace** |
| 3 | **No leak proof joint** is provided in case of dry liners. | **A leak proof joint** are provided in case of wet liners. |
| 4 | In dry liners the casting of cylinder block is **complicated** | In wet liners the casting of cylinder block is **very simple.** |
| 5 | A cylinder block with dry liners is generally **more robust** | A cylinder block with wet liners is generally **less robust compare to dry liner** |
| 6 | For perfect contact between liner and the block casting, **very accurate machining** of block and outer liner surface is required | No such necessity in case of wet liners. |
| 7 | A dry liner **cannot be finished correctly**, before fitting, because of the **shrinkage stress** produced. | A wet liner **can be finished accurately**, before fitting. |

**d) Name the manufacturing method for following:** **4**

**1) Cylinder Block**
**2) Cylinder Head**
**3) Crank shaft**
**4) Oil Sump**

**Answer:** *(One mark each)*

1. **Cylinder Block** :- Casting
2. **Cylinder Head: -** Pressure Die Casting, forming.
3. **Crank shaft**:- Forging
4. **Oil Sump: -** Steel (Pressed steel sheet), Aluminum alloy.

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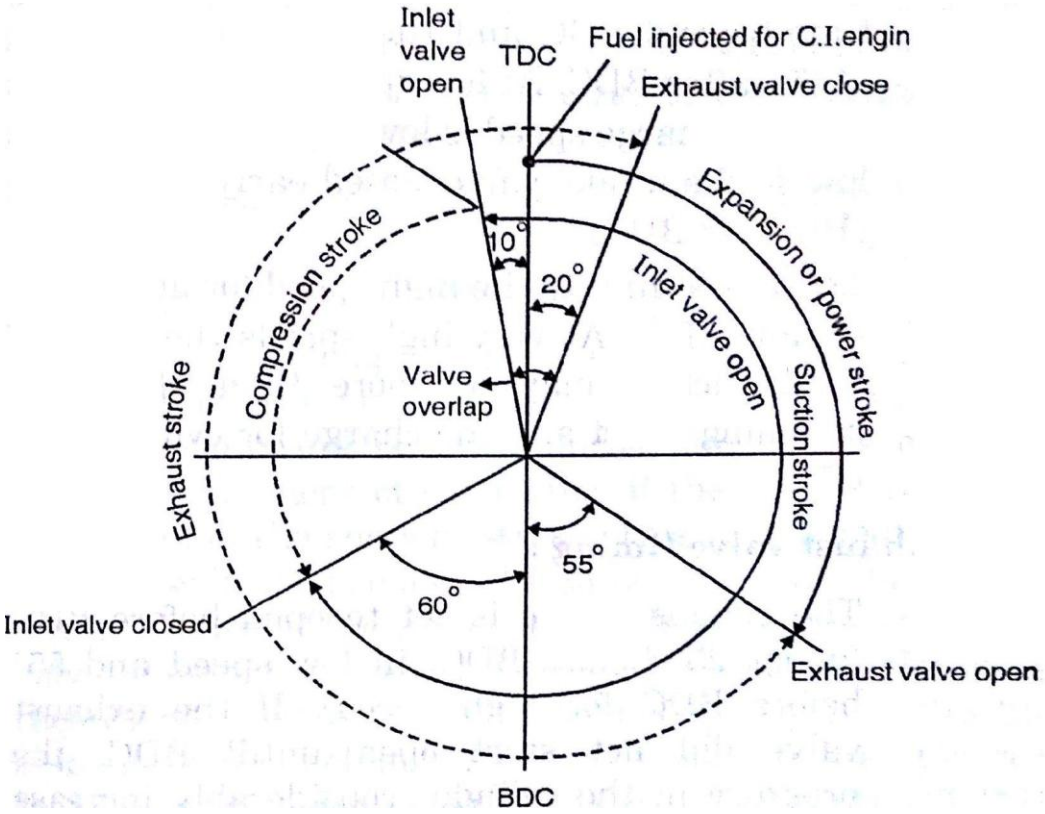
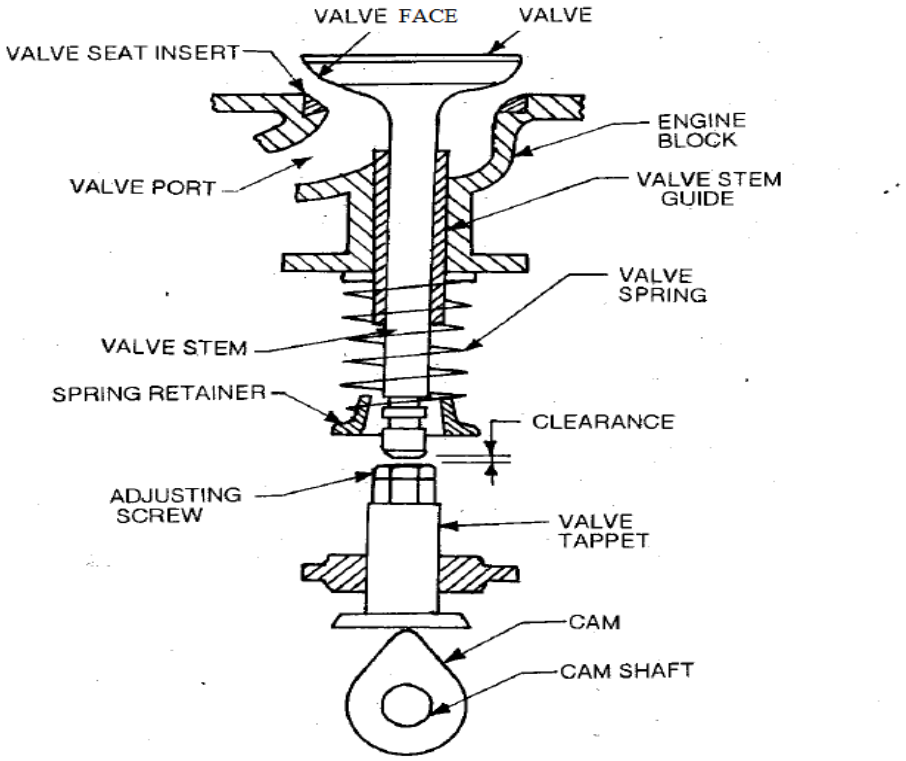
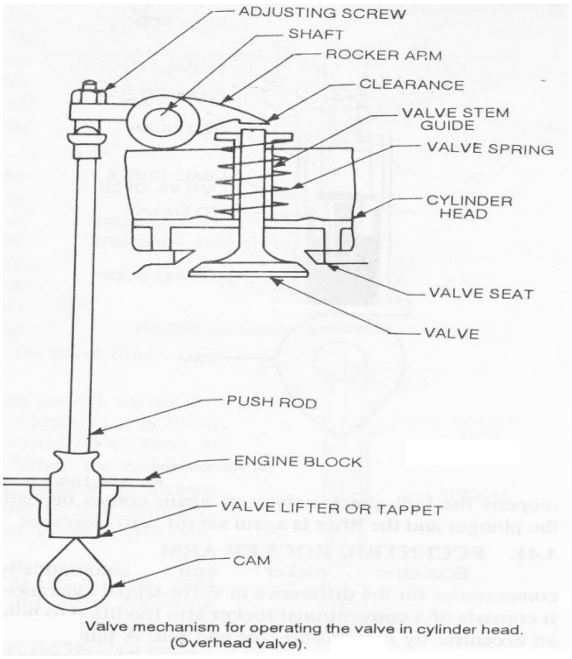
| | | | |
|---|---|---|---|
| | **e)** | **Draw valve timing diagram for 4- stroke C. I. Engine.** | **4** |
| | | **Answer:**   **Figure : Valve Timing Diagram for 4- Stroke C. I. Engine** | |
| | **f)** | **Compare crankshaft and cam shaft any four points.** | **4** |
| | | **Answer:** | |

| S N | CRANK SHAFT | CAM SHAFT |
|---|---|---|
| 1 | It is the part of an engine where the brake power is available. | This shaft is used to operate inlet and outlet valves. |
| 2 | Two revolutions per power stroke in four stroke engine. | One revolution per power stroke in four stroke engine. |
| 3 | Available in both two stroke as well as in Four stroke engine. | Available only in four stroke engine. |
| 4 | More in weight | Less weight. |
| 5 | Crank shaft is located in crankcase | Cam shaft is located either in the crankcase or on the cylinder head. |

| | | | | | |
|---|---|---|---|---|---|
| | | 6 | It consists of crankpin, main journal bearing, crank web, oil holes, etc. | It consists of integrated cams and gear. | |
| **3** | | **Attempt any FOUR of the following:** | | | **16** |
| | **a)** | **List various valve operating mechanism and explain any one.** | | | |
| | | **Answer:** *(List- 1 mark, Explanation 1 marks & sketch 2 marks)*<br>Valve operating mechanisms<br>1)Mechanism for operating the valve in engine block (Straight poppet valve mechanism )<br>2) Mechanism for operating the valve in cylinder head(Overhead poppet Valve)<br><br>**i ) Straight poppet overhead valve mechanism**<br>Valves in the head are operated either by tappet rods extending up the side of the cylinders, or by means of an overhead camshaft. As the cam rotates 1800, it lifts the valve-tappet or the lifter which actuates the push rod. The push rod rotates the rocker arm about a shaft or a ball joint in some designs. This causes one end of the arm to push down the valve to open it. The valve is opened and the valve port is connected with the combustion chamber. As the cam rotates further 1800 the valve spring closes the valve and the push rod is pushed back to its original position.<br>  <br><br>Figure: Straight poppet Overhead valve operating mechanism<br><br>**Overhead Valve Arrangement:**<br>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 | | **1**<br>**1**<br>**2** |

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.



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

**Overhead Cam:**

Figure shows single row valves operated by a single overhead camshaft and an inverted bucket type follower. With this type of follower, the camshaft is arranged directly over the valve stems. This type of mechanism is direct and very rigid so that valve movement follows precisely the designed cam-profile lift. Moreover, valve stems are not subjected to side-thrust which means less wear. Tappet clearances are also quite small and do not require adjustment very often.

**Overhead camshaft - operated inverted bucket type**

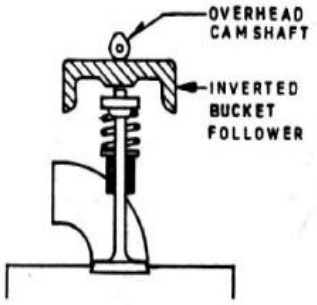


Fig. Overhead camshaft-operated mechanism with inverted bucket type follower (Single row valves)

or

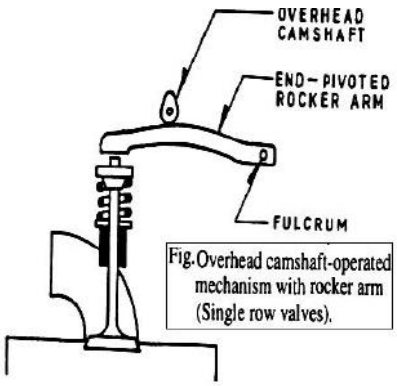
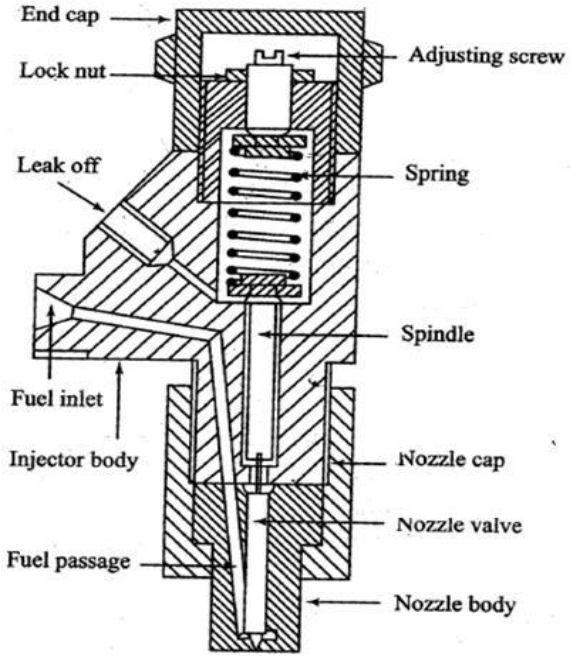
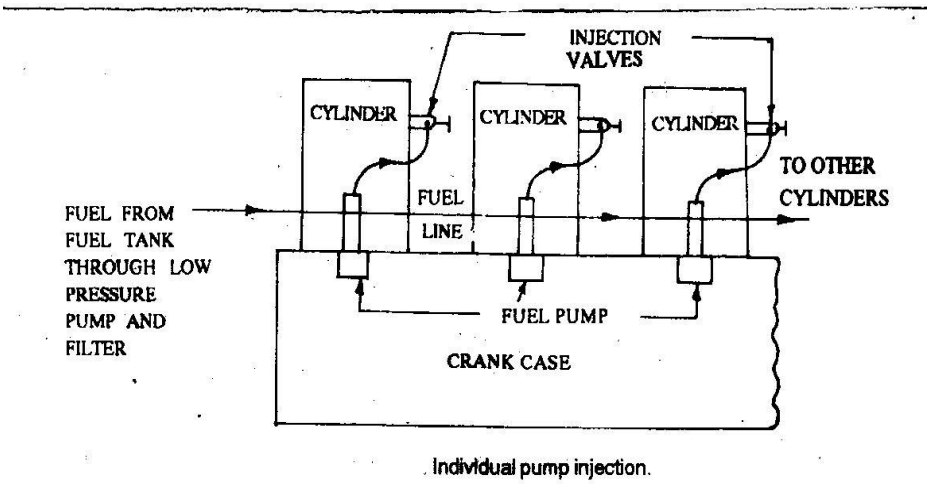
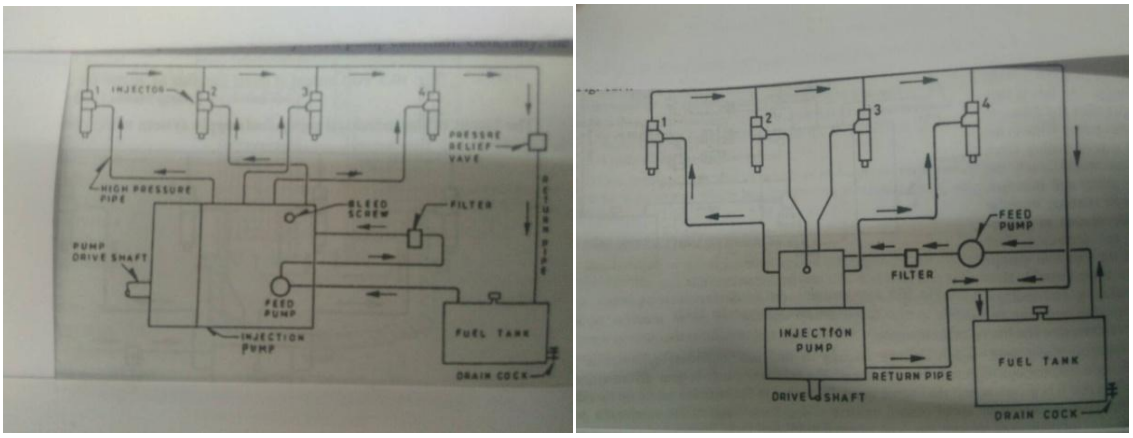


Fig. Overhead camshaft-operated mechanism with rocker arm (Single row valves).

| | | | |
|---|---|---|---|
| | **b)** | **List any four needs and requirements of fuel injection system and explain.** | **4** |
| | | **Answer:** *(Any four)*<br>**Needs and Requirements of fuel injection system**<br>1) **Metering** – The fuel injection system must measure the fuel supplied to the engine very accurately as fuel requirements vary from low to high engine speeds.<br>2) **Time**- Fuel injection system must supply the fuel at the proper time according to engine requirement<br>3) **Pressure**- The fuel injection system must pressurize the fuel to open the injection nozzle to inject fuel into the combustion chamber.<br>4) **Atomize**- The fuel must be atomized when it is supplied to the combustion chamber since atomized fuel will burn easily.<br>5) **Distribution**- In case of multi cylinder engine the distribution of metered fuel should be same to all cylinders.<br>6) **Control, start and stop injection-** The injection fuel must start and end quickly. | |
| | **c)** | **Explain construction and working of fuel injector in C.I. Engine.** | **4** |
| | | **Answer:** *(Diagram-2 marks, explanation-2 marks)*<br>**Diesel Fuel Injector:** The injector assembly consists of - i) a needle valve ii) a compression spring iii) a nozzle iv) an injector body. When the fuel is supplied to lift the injection pump it exerts sufficient force against the spring to lift the nozzle valve, fuel is sprayed into the combustion chamber in a finely atomized particles. After, fuel from the delivery pump gets exhausted; the spring pressure pushes the nozzle valve back on its seat. For proper lubrication between nozzle valve and its guide a small quantity of fuel is allowed to leak through the clearance between them and then drained back to fuel tank through leak off connection. The spring tension and hence the valve opening pressure is controlled by adjusting the screw provided at the top.<br>  <br><br>**Figure: Diesel Fuel Injector** | **2**<br><br>**2** |

| | | | |
|---|---|---|---|
| | **d)** | **Draw layout of inline type individual pump fuel injection system.** | **4** |
| | | **Answer:**<br>  <br><br>Individual pump injection.<br>**OR**<br>  <br> | **4** |
| | **e)** | **List type of air cleaners and explain dry type air cleaner with suitable sketch** | **4** |
| | | **Answer:** *(List typse-1 mark, Diagram-2 marks, explanation-1 marks)*<br>**Types of air cleaner:**<br>The air cleaners generally used are of following types-<br>1. Oil bath type air cleaner.<br>2. Dry type air cleaner<br>3. Oil wetted type air cleaner<br>4. Paper pleated type air cleaner<br>5. Centrifugal type air cleaner<br>**Dry type air cleaner:** It is light duty air cleaner. It does not contain oil path. It consists of cleaning element only and not the oil bath. The cleaning element is a specially pleated paper element, over which is put a fire mesh screen to provide strength. This cleaning element is enclosed in silencing chamber. | **1**<br><br>**1** |

| | | | |
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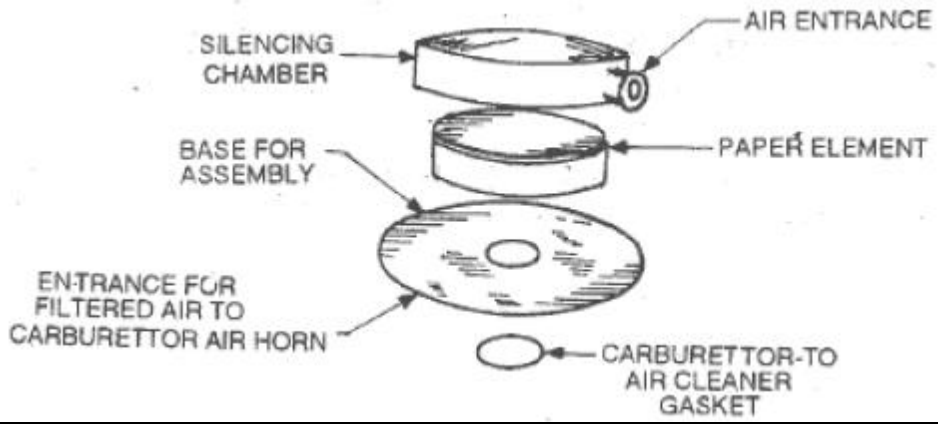
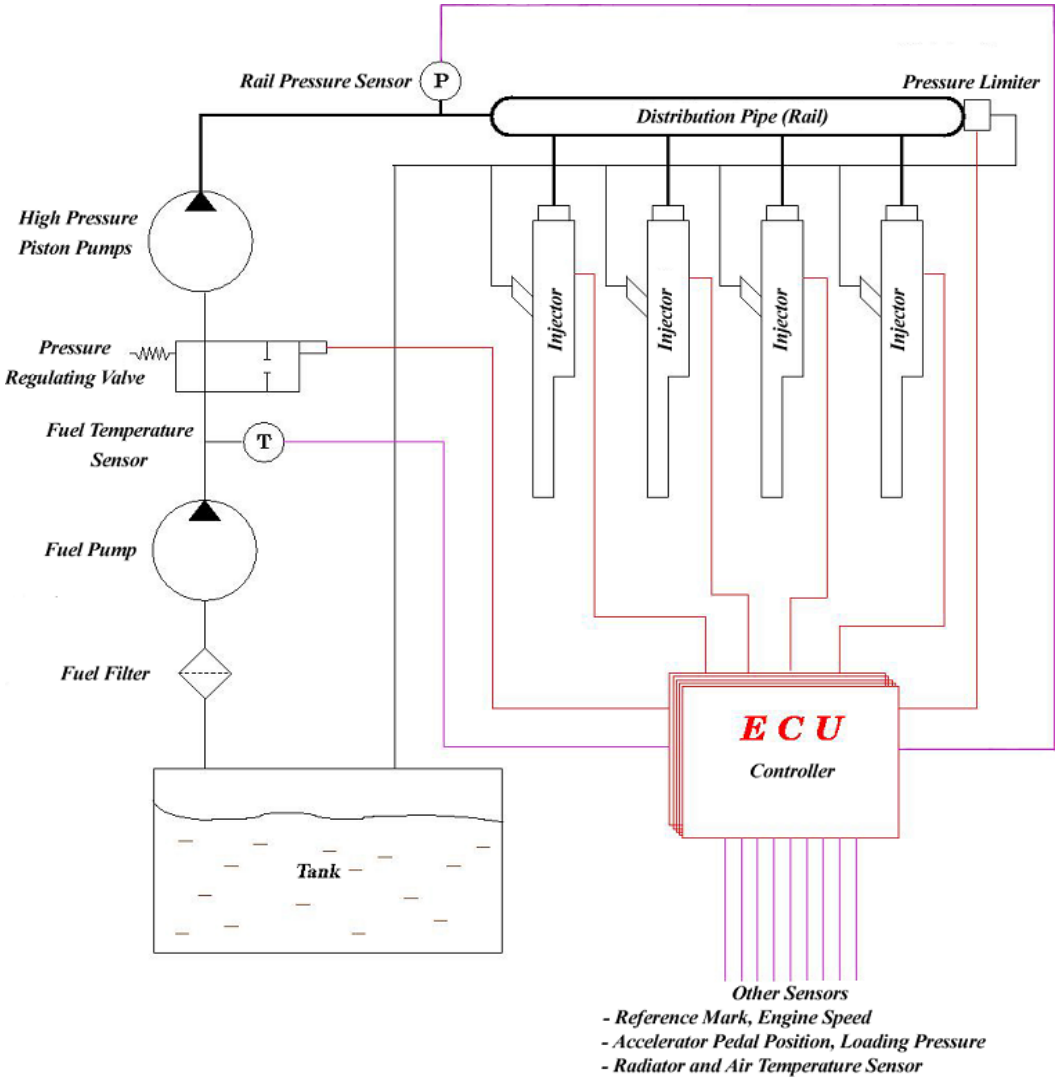
| | |  | 2 |
| | **f)** | **Draw layout of common rail fuel supply system.** | **4** |
| | | **Answer:**<br>  | **4** |

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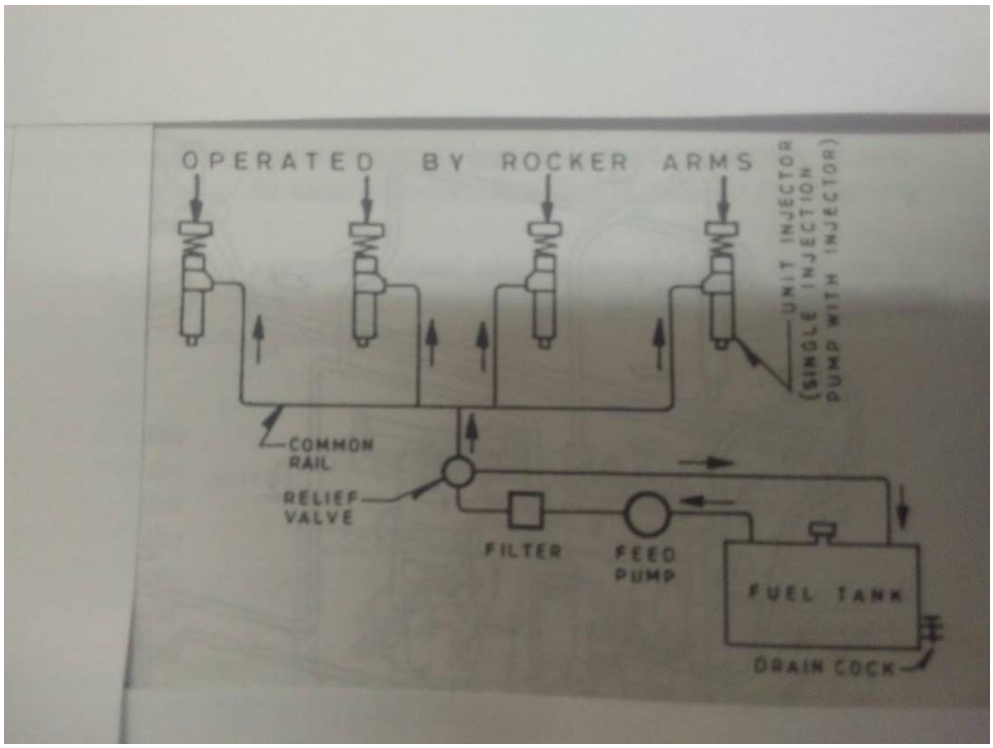
| | | **OR**   | |
| **4** | | **Attempt any FOUR of the following:** | **16** |
| | **a)** | **Explain working of Magneto ignition system with suitable sketch.** | **4** |
| | | **Answer:** *(Explanation 2 marks, figure 2 marks )*<br>**Magneto ignition system:** *(Note: Credit shall be given to any other suitable sketch)*<br>Magneto is mounted on the engine and replaces all the components of the coil ignition system except the spark plug. A magneto when rotated by the engine is capable of producing a very High voltage and does not need a battery as a source of external energy.<br>A schematic diagram of a high tension magneto ignition system is shown Figure. The high tension magneto incorporates the windings to gen-rate the primary voltage as well as to step up the voltage and thus does not require a separate coil to boost up the voltage required to operate the spark plug. Magneto can be either rotating armature type or rotating magnet type. In this type, the armature consisting of the primary and secondary windings all rotate between the poles of a stationary magnet. With the help of a cam, the primary circuit flux is changed and a high voltage is produced in the secondary circuit. At start the cranking speed is low the current generated by the magneto is quite small. As the engine speed increases the flow of current also increases. | |

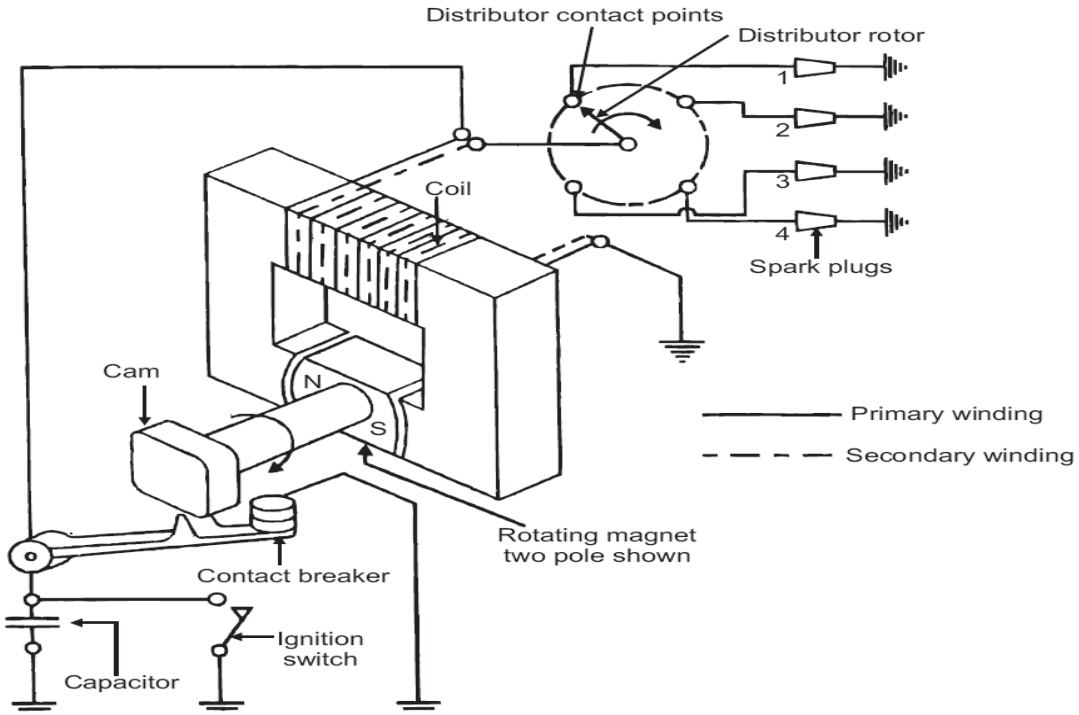



**Figure : Schematic Diagram of Magneto Ignition System**

| | | | |
|---|---|---|---|
| | **b)** | **List types of muffler and explain any one with suitable sketch.** | **4** |

**Answer:** *(Note: List muffler types-1 mark, Diagram -2 marks and explanation-1 mark of any one type)*

**Types of muffler:** The mufflers are usually of the following types:

1. Baffle type 2. Wave cancellation type 3. Resonance type 4. Absorber type

**1. Baffle type muffler:**

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.

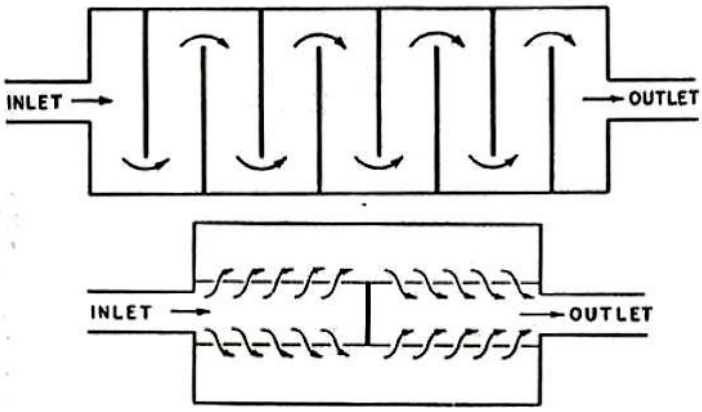
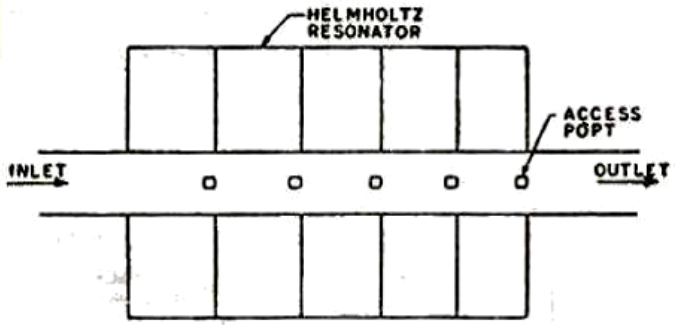



Figure: Baffle type silencers

**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.

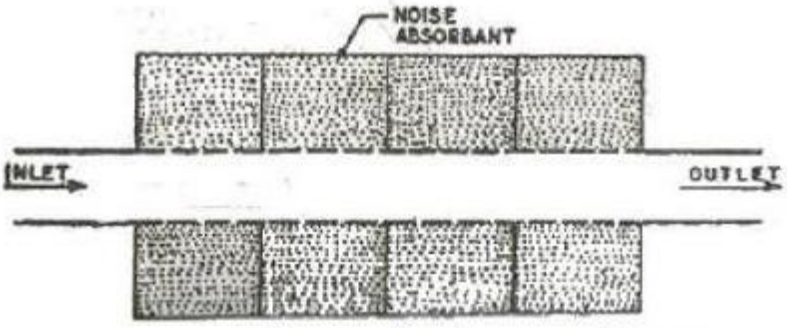
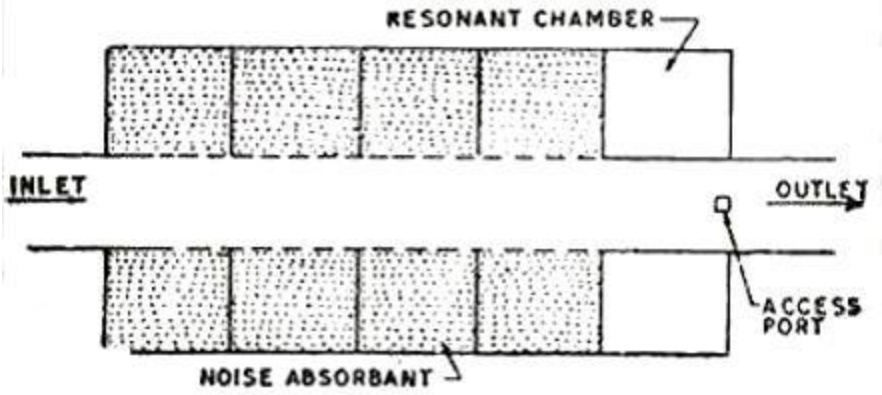



Figure: Absorber type Silencer

**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

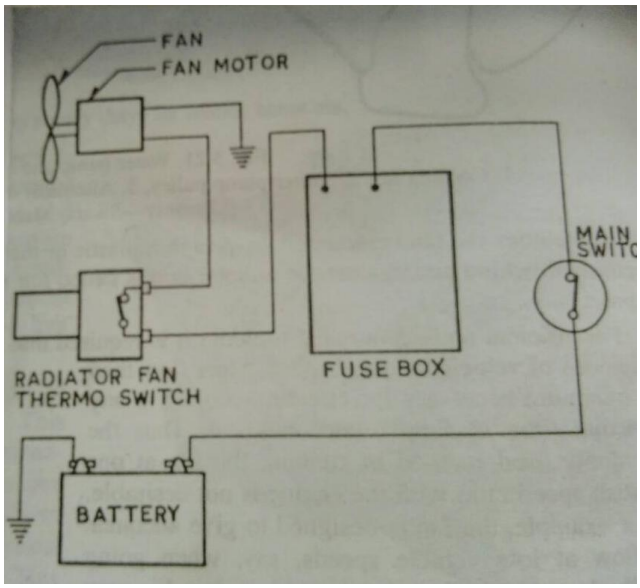


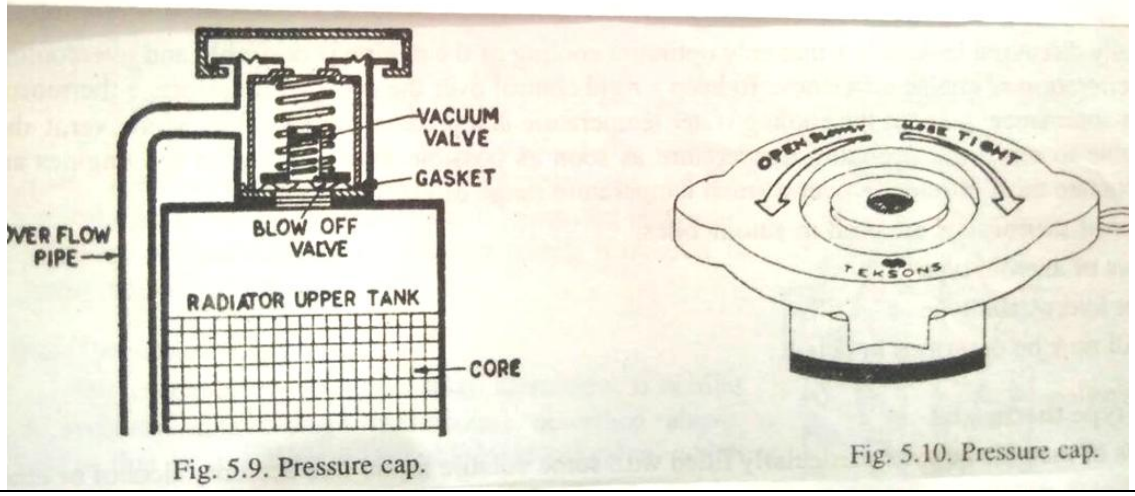

Combined resonance and absorber type muffler.

**c) Compare Battery and magneto ignition system.** **4**

**Answer:** *(Any 4 points)*

| Sr. No. | Battery ignition system | Magneto ignition system. |
|---|---|---|
| 1 | Current is obtained from the battery | Current is generated by the magneto |
| 2 | Spark is good even at low speed | Poor sparking at low speed |
| 3 | Starting of engine is easy | Difficult starting |
| 4 | If the battery is discharged, the engine cannot be started | No such difficulty as battery is not needed |
| 5 | Occupies more space | Occupies less space |
| 6 | Complicated wiring | Simple wiring |
| 7 | More costly | Less costly |
| 8 | Spark intensity falls as the engine | Spark intensity improves as the engine |

| | | | | | |
|---|---|---|---|---|---|
| | | | speed rises | speed rises | |
| | | 9 | Used in cars, Buses, Trucks | Used in Motorcycles, Scooters, racing cars | |
| | **d)** | **Explain electrically driven fan circuit with suitable sketch.** | | | **4** |
| | | **Answer:***(Description 2 marks, circuit diagram 2 marks)*<br>The fan is driven by a separate electric motor which is supplied with power directly from the electric circuit of the engine. A thermostat switch is placed at an appropriate place in the cooling system and depending upon the cooling system temperature it operates to switch to On or OFF the fan motor. It has been found that under ordinary condition only about 5 % of the time the fan motor remains in ON position, while 95% of the time it is off.<br>  <br><br>**Fig. Electrically driven fan circuit** | | |
| | **e)** | **Overcooling and under cooling of engine is not desirable, explain Why?** | | | **4** |
| | | **Answer:**<br>The cooling system is needed to keep the engine from not getting so hot as to cause problems and yet to permit it to run hot enough to ensure maximum efficiency of the engine. During the process of converting the thermal energy to mechanical energy, high temperatures are produced in the cylinders because of combustion process. A large portion of this heat is transferred to the cylinder head and walls, piston and valves. Unless this excess heat is carried away and these parts are adequately cooled, the engine will be damaged. So the adequate cooling system must be provided **to prevent the damage of mechanical parts as well as to obtain maximum performance of the engine.** | | | **4** |

| | | | |
|---|---|---|---|
| | **f)** | **Explain construction and working of pressure cap used in cooling system** | **4** |
| | | **Answer:***(Description 2 marks, figure2 marks)*<br>Pressure cap contains a pressure valve and a vacuum valve. When due to severe working conditions, the coolant starts boiling and vaporizes the pressure in the system exceeds a certain predetermined (50-100kPa) value, the pressure blow off valve opens releasing the excess pressure to the atmosphere through the overflow pipe.<br>If due to any reason vacuum is created inside, the vacuum valve operates to avoid collapse of the radiator. This value is usually set to operate when vacuum exceeds 5kPa.<br>  <br>Fig. 5.9. Pressure cap. Fig. 5.10. Pressure cap. | **2**<br>**2** |
| **5** | | **Attempt any FOUR of the following** | **16** |
| | **a)** | **Draw neat labelled sketch of dry sump lubrication system for multi cylinder and describe its working.** | **4** |
| | | **Answer:** *(Working 2 marks, Sketch 2 marks)*<br>In this system the lubricating oil is not stored in the oil sump.<br>This system is employed in some racing car engines for situations where the vehicle has to be operated at very steep angles.<br>If ordinary pressure system of lubrication is used in such a case, the situation may arise when there is no oil at the place where oil pump is installed. To avoid such situation dry sump system is used.<br>Two pumps are used instead of single oil pump<br>The scavenge pump A is installed in the crankcase portion which is the lowest.<br>It pumps oil to a separate reservoir B, from where the pressure pump C pimps the oil through filter D, to the cylinder bearings.<br>Oil pressure is @ 400-500 kpa at main & big end bearing | **2**<br>**2** |

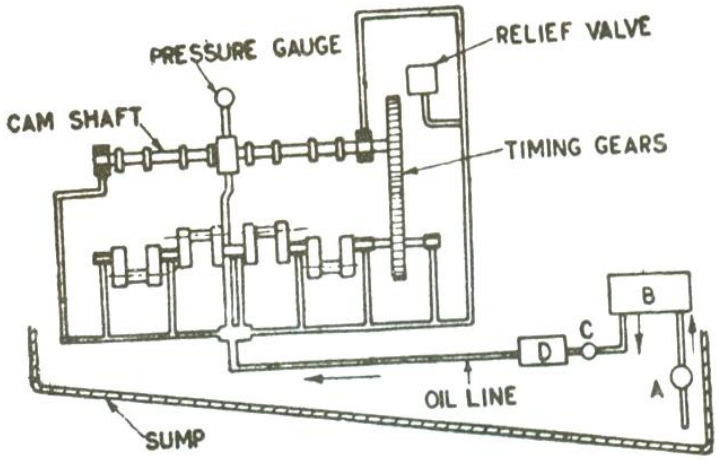
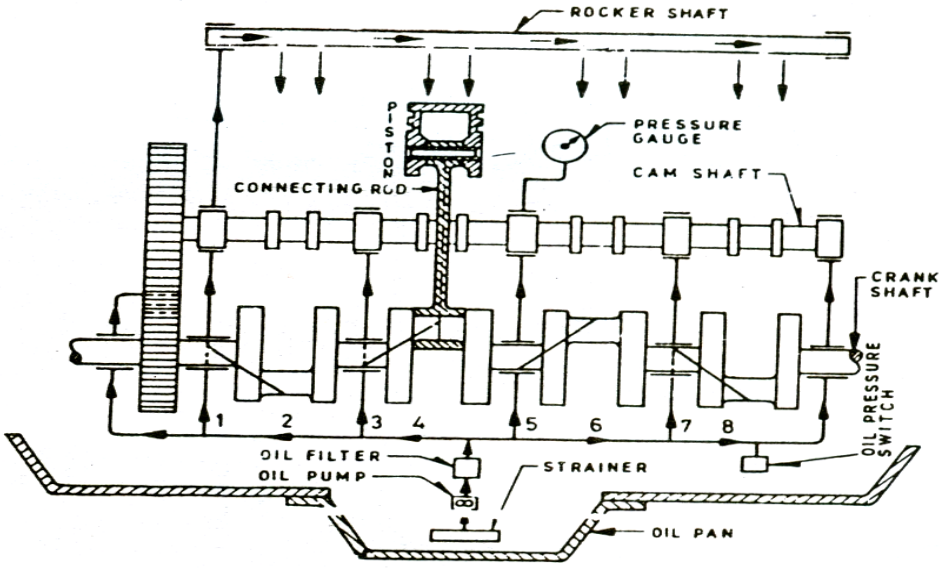
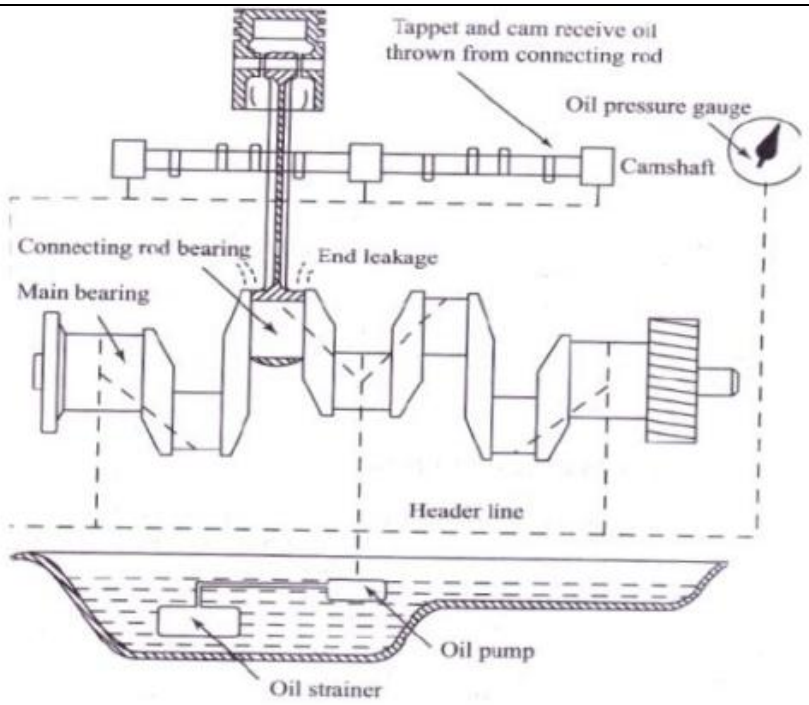
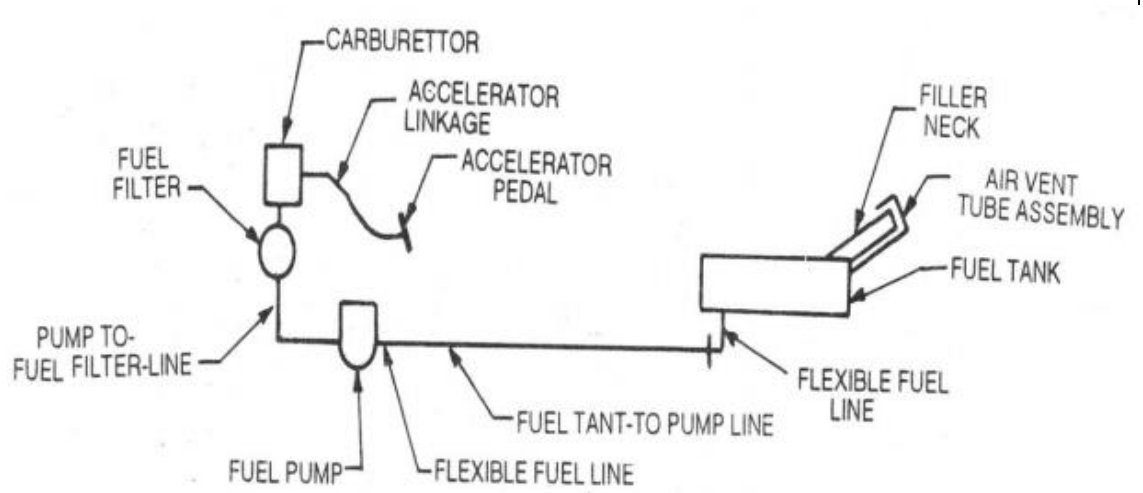


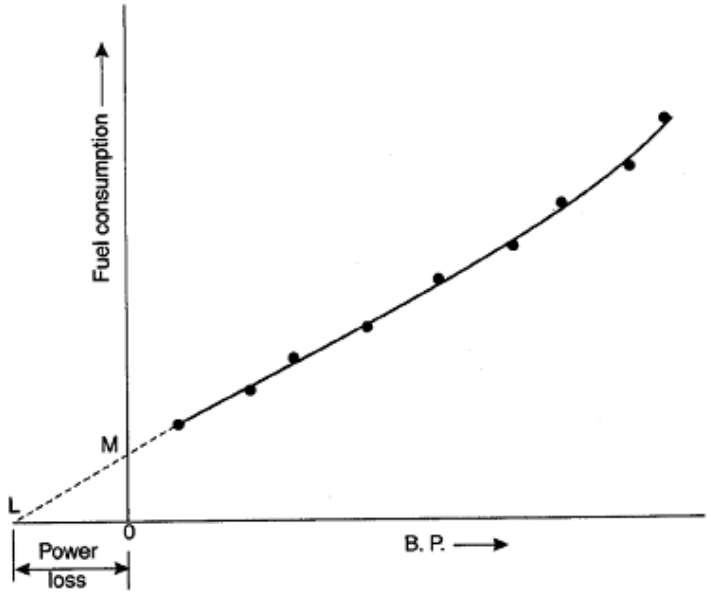

Fig. 6.12. Dry sump system

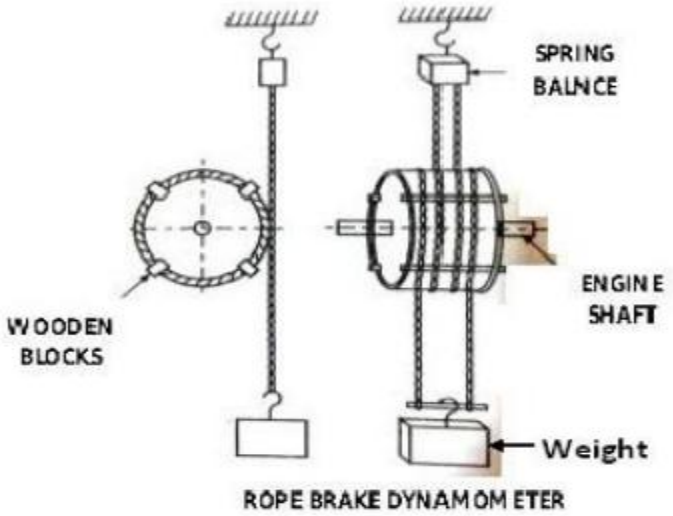
| | | | |
|---|---|---|---|
| | **b)** | **Draw a labelled sketch of pressure feed lubrication system.** | **4** |
| | | **Answer:** *(Sketch 3marks, labeling 1 marks)*   Fig. 6.9. Pressure system of lubrication. **OR** | **4** |




| | | | |
|---|---|---|---|
| | **c)** | **Classify lubricating oils using viscosity (SAE) and load severity (API) rating.** | **4** |
| | | **Answer:**<br>**1. On the basis of Viscosity :**<br>Lubricating Oils Classify in terms of Viscosity at -18 $^0$C or in cold climates.<br>a) SAE 5W b) SAE 10W c) SAE 20 W<br>Lubricating Oils Classify in terms of Viscosity at 99 $^0$C or in hot climates.<br>a) SAE 20 b) SAE 30 c) SAE 40 d) SAE 50<br>Multi grade oils shown as SAE 20 W/50<br><br>**2. On the basis of Service Rating :**<br>C- series<br>a) CA: Use in gasoline and naturally aspirated diesel engine operated on low sulphur fuel.<br>b) CB: Use in gasoline, naturally aspirated diesel engine operated on high sulphur fuel.<br>c) CC: Use for lightly supercharge diesel engine.<br>d) CD: Use in highly turbocharger diesel engine.<br>S- series<br>a) SA : Mineral oil , may contain anti-formant and poor point depressant<br>b) SB : Mineral oil , containing additive impart sum oxidation stability & anti- scuff protection<br>c) SC, SD & SE: Meets automotive manufactures specifications. | **2**<br><br>**2** |

| | | | |
|---|---|---|---|
| | **d)** | **Draw a labeled sketch of pump feed fuel supply system and state location of each component.** | **4** |
| | | **Answer:**<br>The pump feed system is shown in the figure above. In this system, a steel pipe carries the fuel to the fuel pump which pumps it into the float chamber of the carburetor through a flexible pipe. If the fuel pump is mechanical, it has to be driven from the engine camshaft and hence placed on the engine itself. However electrically operated pump can be placed anywhere. It is mostly located at the rear in the fuel tank reducing the tendency of forming vapor lock. The system provides the fuel requirement at various engine speeds efficiently.<br>  <br> | |
| | **e)** | **List methods to find out frictional power and explain Willian's Line Method in brief.** | **4** |
| | | **Answer:**<br>Methods to find frictional power.<br>The friction force power of an engine is determined by the following methods :<br>(a) Willan's line method.<br>(b) Morse test.<br>(c) Motoring test.<br>At a constant engine speed the load is reduced in increments and corresponding B.P. and gross fuel consumptions readings are taken. A graph is then drawn of fuel consumption against B.P. as in Fig. The graphs draw is called the Willian's line (analogous to Willian's line for a steam engine) and extrapolated back to cut the B.P. axis at the point L. The reading OL is taken as the power loss of the engine at that speed. The fuel consumption at zero B.P. is given by OM; and if the relationship between fuel consumption and B.P. is assumed to be liner then a fuel consumption OM is equivalent to a power loss of OL.<br>Frictional power loss (F.P.) = OL | **1**<br><br><br><br><br><br>**3** |

| | | | |
|---|---|---|---|
| | | **Willian's Line Method :**<br>  <br><br>Fig. Willan's line method. | |
| | **f)** | **List the dynamometers used in engine testing and explain rope brake dynamometer.** | **4** |
| | | **Answer:** *(For list 1 mark, Explanation 3 marks. Credit should be given for sketch)*<br>1. Prony Brake Dynamometer 2. Rope Brake Dynamometer<br>3. Hydraulic Dynamometer 4. Eddy Current Dynamometer<br>**Rope brake dynamometer**:<br><br>Dynamometer is a device for measuring force and torque and hence power. It may work on the principal of absorption Transmission, in which case it is known as Transmission Dynamometers. 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**<br><br>**3** |



ROPE BRAKE DYNAMOMETER

Working:-
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:

$$BP = \pi DN ( W-S)/60 \text{ (watt)}$$

Where , D = Brake drum diameter (m)
W = Weight (N)
S = spring scale reading.(N)
N= RPM of engine.

| | | | |
|---|---|---|---|
| **6** | | **Attempt any TWO of the following:** | **16** |
| | **a)** | **How you will calculate the indicated power of four cylinder petrol engines by Morse Test.** | **8** |
| | | **Answer:**<br>**Procedure to conduct Morse Test:**<br>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.<br>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.<br>Where BP = Brake power<br>IP = Indicated power<br>FP = Frictional power<br>Let F.P. of cylinder 1,2,3,4 be F1, F2, F3, F4 respectively.<br>Then total FP of engine = F1+F2+F3+F4<br>Let IP of cylinder 1 2 3 and 4 be I1, I2 I3 & I4 respectively.<br>The total IP of engine is given by,<br>= I1 +,I2+ I3 + I4<br>The total BP of engine when all cylinders are working<br>BP= Total IP – Total FP<br>B= (I1 +,I2+ I3 + I4) – (F1+F2+F3+F4)----------1<br>When cylinder 1 is cut off, the BP developed by the remaining three cylinders,<br>B1 = (0 +,I2+ I3 + I4) – (F1+F2+F3+F4)----------2<br>Subtracting (2) from (1) we get<br>B- B1 = I1<br>Therefore IP of cylinder 1<br>I1 = B-B1<br>Similarly ,<br>IP of cylinder 2, I2 = B-B2<br>IP of cylinder 3, I3= B-B3<br>IP of cylinder 4, I4 = B-B4<br>Total IP of Engine= I1+I2+I3+I4<br>**Friction Power = I.P – B.P** | **4**<br><br>**4** |
| | **b)** | **Following readings were noted during a test on a single cylinder of two stroke petrol engine. Engine is motored by a electric motor and frictional power recorded on wattmeter is 1.5 KW.**<br><br>**Net brake load = 2.0 N**<br>**Dia of brake wheel =110 cm**<br>**Engine speed = 595 rpm**<br>**Fuel consumption = 2.01 Kg/hr.**<br>**C. V of fuel =44000 KJ/Kg**<br>**Find mechanical efficiency and brake thermal efficiency.** | **8** |
| | | **Solution:**<br>Given data :<br>No of stroke = 2 F.P. = 1.5 kW Net Brake load = w = 2.0 N C.V=44000 KJ/Kg<br>Dia of brake wheel= 110cm = 1.1 m<br>Radius of Drum = R=1.1/2 = 0.55 m<br>Speed = N= 595rpm<br>Fuel Consumption = Mf = 2.01Kg/Hr = 2.01/36000 = $5.58X10^{-4}$Kg/Sec | |

| | | | |
|---|---|---|---|
| | | (i) Mechanical efficiency<br>B.P = 2πNT/60000 KW<br><br>Torque = brake Net load x Drum of Radius<br>T= W X R = 2.0 * 0.55 = 1.1 Nm<br><br>B.P = 2πX595X1.1/60000 KW = 0.0685 KW.<br><br>I.P = B.P + F.P = 0.0685 + 1.5 = 1.5685 KW<br><br>**Mechanical efficiency** =( B.P/ I.P) X100 = ( 0.0685/1.5685)X100 = 1.430 %<br>ii) Brake thermal efficiency<br>$$\eta_{Bth} = \frac{B.P.}{m_f \times c.v.} \times 100\%$$<br>$\eta_{bth}$ = (0.0685/5.58X10$^{-4}$X44000)X100<br>= 0.278 %<br>**Note – Given data of Brake load is not suitable or wrong value therefore results are deviated.** | |
| | **c)** | **An I.C. engine uses 6 kg fuel having calorific value 44000 kJ/kg. in one hour. The brake power developed is 18kW. The temperature of 11.5 kg of cooling water found to rise through 25 $^{0C}$ per minute. The temperature of 4.2 kg of exhaust gas with specific heat 1 kJ/kg K was found to rise though 220 $^{0C}$. Draw heat balance sheet for the engine.** | **4** |
| | | **Solution:**<br>Given data :<br>Mass of Fuel = 6 Kg/hr = 6/60 = 0.1 Kg/min. BP = 18 KW CV = 44000 kJ/kg<br>Mass of cooling water Mw = 11.5 Kg/min Cpw = 4.187 kJ/kg K<br>Temp rise of cooling water Δtw= 25 $^{0C}$<br>Mass of exhaust gas Meg = 4.2 Kg/hr =4.2/60 Kg/min = 0.7 Kg/min<br>Temp rise of gas Δtg= 220 $^{0C}$ Cpg = 1 kJ/kg K<br>i) Heat equivalent in Fuel Hf = Mf x C V = 0.1 x 44000 = 4400 Kg/min<br>ii) Heat converted in B P Hb = B P x 60 = 18 x 60 = 1080 Kg/min<br>iii) Heat carried by cooling water Hw = Mw x Cpw x Δtw<br>Hw = 11.5 x 4.187 x 25 = 1203.76 Kg/min<br>iv) Heat in Exhaust Gas Hg = Mg x Cpg x Δtg<br>Hg = 0.7 x 1 x 220 = 154 Kg/min<br>v) Heat lost as Unaccounted Ha = Hf- (Hb+Hw+Hg) | |

Ha = 4400 – (1080+1203.76+154) = 1962.24 Kg/min

| Parameter | Value (Kg/min) | Parameter | Value (Kg/min) |
|---|---|---|---|
| Heat equivalent in Fuel Hf | 4400 Kg/min | Heat converted in B P Hb | 1080 Kg/min |
| | | Heat carried by cooling water Hw | 1203.76 Kg/min |
| | | Heat in Exhaust Gas Hg | 154 Kg/min |
| | | Heat lost as Unaccounted Ha | 1962.24 Kg/min |
| Hf | 4400 KJ/min | Total | 4400 KJ/min |