Assignment-2

Two Marks Questions

Q1 List the differences between IC Engines and EC Engines

	IC Engines	EC Engines
(i)	Combustion of air-fuel is ~~inside~~ the engine cylinder	Combustion of air fuel is ~~inside~~ outside the engine cylinder
(ii)	Very noisy operated engine	The engines are running smoothly and silently.
(iii)	higher efficiency about 35-40%	lower efficiency of 15-20%.
(v)	It can work on high grade fuels with proper filtration only	It can use cheaper fuels including solid fuels.

Q2 What are the applications of IC Engines?

IC engines power a vast range of applications, including automobiles like cars and motorcycles, aircraft, ~~ships~~ agricultural equipment such as tractors, and various construction and industrial machines like excavators & pumps.

Q3 Define :-

(i) Brake Power is the actual power output of an engine measured at its crankshaft after internal frictional losses have been overcome. It represents power available to do external work.

(ii) Indicator Power refers to theoritical power produced by an engine's cylinders during combustion or a power indicator device that measures and displays electrical power or an LED power indicator

(iii) Mechanical Efficiency measure the effectiveness with which a mechanical system performs. It is the ratio of the power delivered by a mechanical system to the power supplied to it.

(iv) Thermal Efficiency is the ratio of ~~used~~ useful work output to the total heat energy input of a device.

$$\eta = \frac{W}{Q_H}$$

(v) Specific fuel consumption measures an engine's fuel efficiency by quantifying the fuel mass consumed per unit of power produced over a specific time.

(vi) Mean effective pressure is a theoretical concept representing the average pressure on a piston that would produce the same work output as the actual, fluctuating pressure during an engine's cycle.

Q9 Define Scavenging process in IC Engines.

Scavenging is the process of clearing burnt exhaust gases from engine cylinder and replacing them with a fresh charge of air - fuel - mixture.

This process is essential for maintaining engine efficiency and power output, and it happens during a period when the exhaust port and the intake port are both open.

Q5 Define Refrigerating effect and Tons of refrigeration
Refrigerating effect is the amount of heat a refrigerant absorbs from a space to cool it down, while a ton of refrigeration (TR) is a unit of measurement for this effect, defined as the rate of heat removal needed to melt one short ton of ice in 24 hours.
Mathematically, one ton of refrigeration is equivalent to a specific amount of heat removal per minute or hour.

Q6 Why COP of refrigerator is greater than 1 ?
Refrigerator is designed to move heat from the cold interior to the warmer exterior, not to create that cooling effect from scratch, resulting in a COP greater than 1.

Q7. State the difference between refrigerator & heat pump.
The main difference between refrigerator and heat pump is in their purpose. A refrigerator cools its interior by removing heat, while a heat pump's primary purpose is to provide heat, although many can also cool. It moves heat from a cold source to a warmer space. ~~Refrige~~

Refrigerator is used for food preservation, cold storage. whereas heat pump is used for

Q8 What is meant by coefficient of performance (COP). Show that $(COP)_{heat\ pump} = 1 + (COP)_{refrigerator}$

Coefficient of performance (COP) is a ratio that measures the efficiency of heating and cooling systems. It is calculated by dividing the cooling output by the energy input. A higher ~~efficiency~~ COP indicates higher efficiency.

$$(COP)_{HP} = \frac{\text{desired output}}{\text{input work}} = \frac{Q_1}{W_{net}} = \frac{Q_1}{Q_1 - Q_2} = \frac{Q_1/Q_2}{Q/Q_2 - 1}.$$

$$\left[\text{or } \frac{Q_1}{T_1} = \frac{Q_2}{T_2}\right] \Rightarrow (COP)_{HP} = \frac{T_1/T_2}{T_1/T_2 - 1} = \frac{T_1}{T_1 - T_2}$$

Now, $(COP)_{HP} - 1 = \frac{T_1}{T_1 - T_2} - 1 = \frac{T_1 - T_1 + T_2}{T_1 - T_2} = \frac{T_2}{T_1 - T_2}$

$$\left[\text{as } \frac{T_2}{T_1 - T_2} = (COP)_{ref}\right] \Rightarrow (COP)_{HP} - 1 = (COP)_{ref} \Rightarrow (COP)_{HP} = (COP)_{ref} + 1$$

Q9. What is the function of refrigerant? Name any two refrigerant commercially available at present.

The function of a refrigerant is to transfer heat by absorbing it from a cold environment and releasing it into a warmer one, thereby providing cooling in systems like refrigerators & ACs.

For example: R-134a which is hydrofluorocarbon and R-410A is a non-ozone depleting refrigerant.

Q10 List out some desirable properties of refrigerant

Properties

(i) non-toxicity
(ii) non-flammability
(iii) chemical stability
(iv) should have a low boiling point
(v) high latent heat of vaporization
(vi) high critical temperature.

Q11 What is throttling process?

Throttling is a process in which fluid flow suddenly encounters a restriction like valve or plug, causing a sudden drop in pressure without significant heat or work transfer, resulting in a constant enthalpy state from inlet to outlet.

Q12 heat rejected = 360 KJ/min

Power = 2KW

$$Q_H = 360 \frac{KJ}{min} = \frac{360}{60} KJ/sec = 6KW$$

$$COP_{HP} = \frac{Q_H}{W_{in}} = \frac{6}{2} = 3$$

Q13 $COP_{(heat\ pump)} = 4 \Rightarrow (COP)_{HP} = 1 + (COP)_{ref} \Rightarrow 4 - 1 = (COP)_{ref}$

$(COP)_{ref} = \frac{Q_H}{W_{in}} \Rightarrow$ refrigerating effect $= 3KW \times 1KW = 3KW$

Q14 $(COP)_{ref} = 1.4$

7°C to 23°C $\Rightarrow$ 280K to 296K

$$(COP)_{max} = \frac{T_1}{T_2 - T_1} = \frac{280}{296 - 280} \Rightarrow \frac{280}{16} = 17.5$$

Since the claimed COP of 1.4 is significantly lower than the maximum theoretical COP of 17.5, the claim is valid.

Seven / Eight Marks Question

(1) Explain the various components of IC Engine.

The main components of reciprocating IC Engine are:

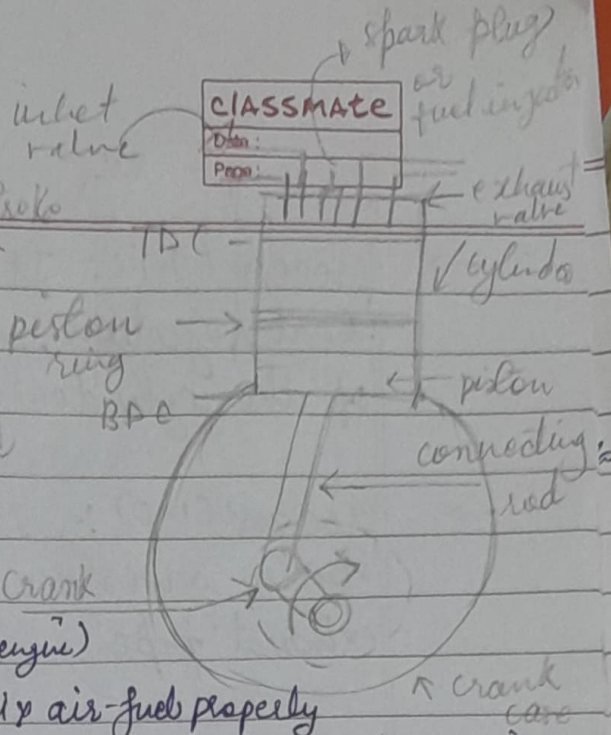
1. Cylinder: It is the main part of the engine inside which piston reciprocates to and fro. It should have high strength to withstand high pressure above 50 bar and temperature above 2000°C. Heavy duty engines are made up of steel alloys or aluminum alloys.

2. Cylinder head: The top end of the cylinder is covered by cylinder head over which inlet and exhaust valve, spark plug or injectors are mounted.

3. Piston transmits the force exerted by the burning of charge to the connecting rod.

4. Connecting rod converts reciprocating motion of the piston into circular motion of the crank shaft in the working stroke.

5. Crank shaft converts the reciprocating motion of the piston into the rotary motion with the help of connecting rod.



6. Inlet valve controls the admission of charge or air inside the cylinder.

7. Exhaust valve controls the removal of burnt gas after combustion

8. Spark plug used to ignite fuel (Petrol engine)

9. Carburetor used in petrol engine to mix air-fuel properly

10. Fuel injector used in Diesel engine to spray fuel inside engine

Q2. Explain the construction & working of 4 stroke Petrol Engine with p-v & t-s diagram with suitable sketch.

The four stroke petrol engine works on the principle of the otto cycle. ~~The~~ It comprises of the following process.

→ process (0-1):-
During this process, the piston sucks (pulls) the air-fuel mixture inside the cylinder at constant pressure P_1.

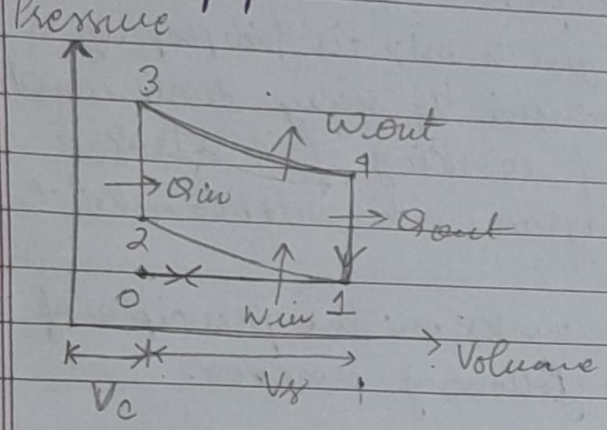
→ process (1-2): It is an adiabatic compression process in which the piston compresses the air-fuel mixture inside the cylinder from pressure P_1 to P_2.

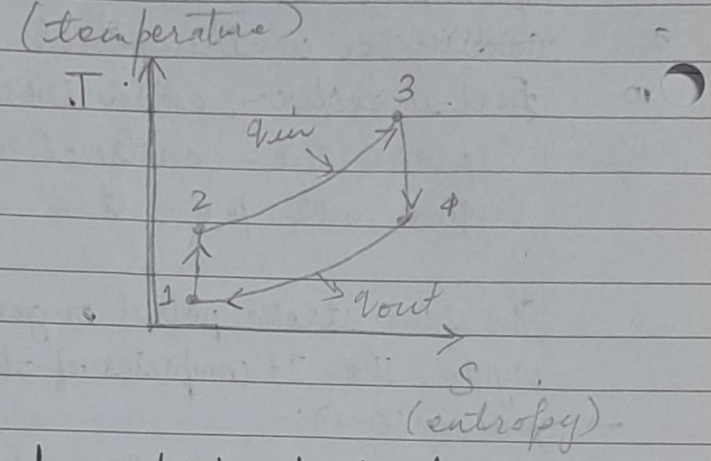
→ process (2-3): It is a constant volume heat addition process. In this process, a spark plug produces a spark, to ignite the fresh charge (air+fuel) which causes the pressure inside the combustion chamber to raise from P_2 to P_3.

→ process (3-4): It is an adiabatic expansion in which the high pressure gases expand inside the cylinder from P_3 to P_4

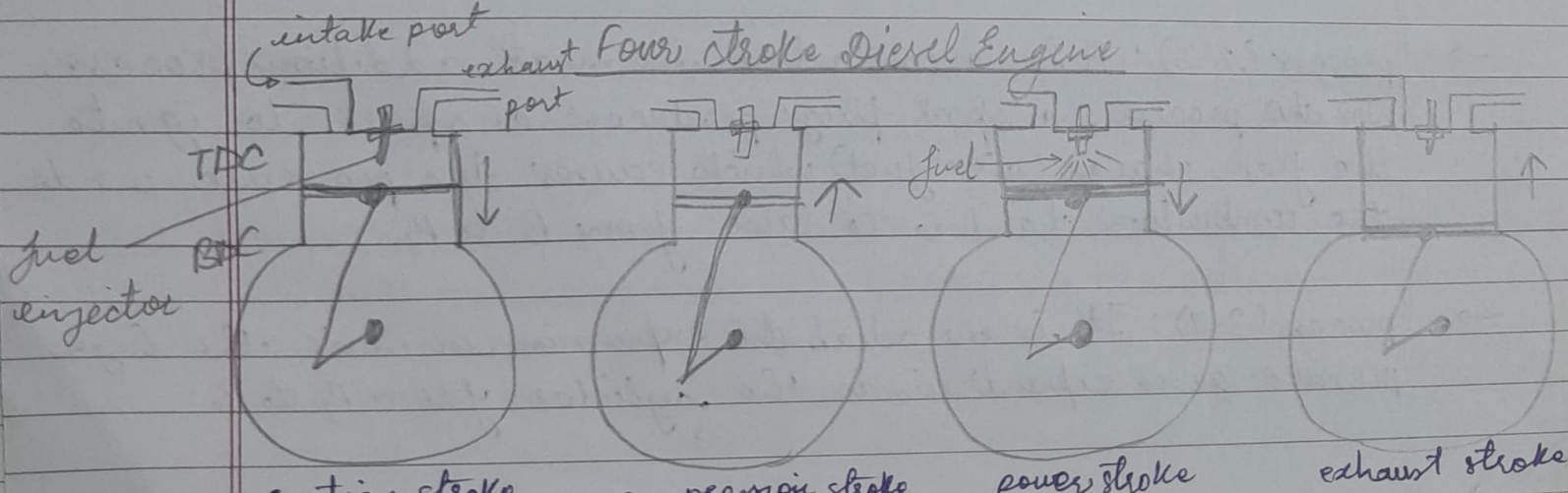
→ process (4-1): It is ~~an adiabatic~~ a constant volume heat rejection, during which the heat is rejected outside of the cylinder.

→ process (1-0) :- It is a constant pressure process in which burn gases are released from the cylinder into the exhaust pipe.

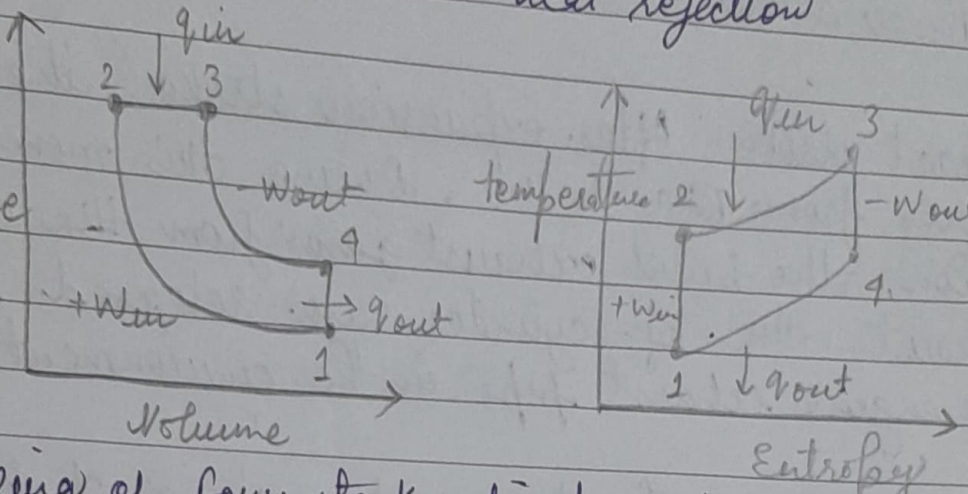




Q3 Explain the construction and working of 4-stroke Diesel Engine with p-v and T-s diagram. with suitable sketch.
Four stroke diesel engine is also known as the compressed ignition (CI) engine since in this kind of engine the combustion occurs due to the compressing air more than fuel self-ignition temperature.



Process 1-2: isentropic compression
Process 2-3: constant pressure heat addition
Process 3-4: isentropic expansion
Process 4-1: constant volume heat rejection



Working of four stroke diesel engine is :-

Suction stroke : When the piston moves from TDC to BDC, the piston creates a vaccum inside the cylinder. Hence due to the pressure difference between intake manifold and cylinder, air enters into the cylinder. During this suction stroke, the inlet valve is open and at the end of the suction stroke inlet valve closes

Compression stroke : After suction stroke is done, the piston starts to move from BDC to TDC. During this movement, the piston compresses the air to high pressure inside the cylinder. During compression, both valves are closed. After the compression of air, the fuel injector sprays the fuel inside the cylinder, hence fuel gets ignited.

Power stroke : Combustion starts, high-pressure gases expand inside the cylinder and push the piston

downwards. During expansion, both valves are closed. Due to expansion stroke; power is obtained from the engine. Hence expansion stroke is also called a Power stroke.

Exhaust stroke: After expansion stroke, the piston moves from BDC to TDC. During this movement of the piston, the burnt exhaust gases from ~~the engine~~ exhaust valve of cylinder are released through the engine exhaust pipe in the environment

Q9 Explain the construction and working of 2-strokes Petrol Engine with the help of neat sketch.

A two-stroke petrol engine completes a power cycle in two strokes of the piston. Key components include the piston, connecting rod, crankshaft, cylinder, spark plug, and ports for intake, exhaust and tranfer.
The cycle involves an upward stroke for compression & intake, and a downward stroke ~~fo from~~ for power & exhaust / tranfer, which are combined in two strokes and one revolution of the crankshaft.

→ Down stroke: The piston moves from TDC to BDC letting the fresh air enter the combustion chamber. The fresh air-fuel mixture gets into ~~to~~ the combustion chamber through the crankcase. In this stroke, the crankshaft makes the rotation of 180.

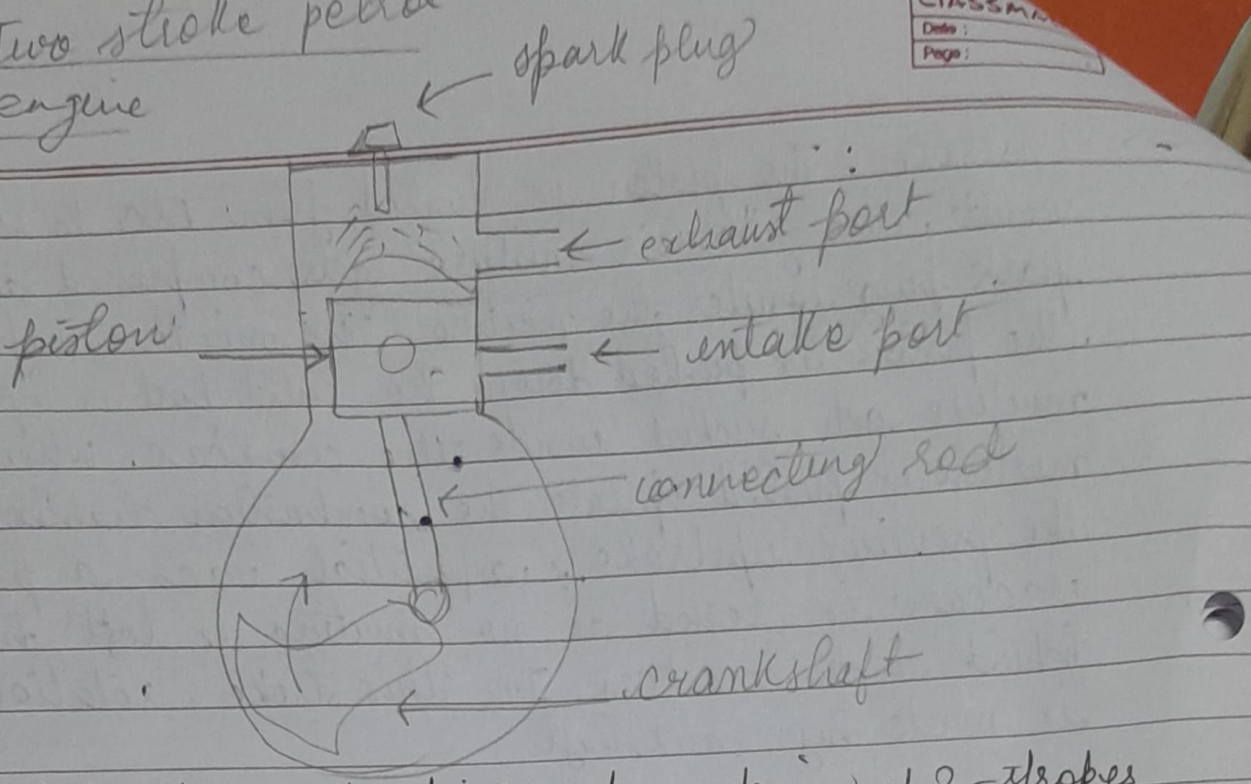
→ Upstroke : The piston is pushed from BDC to TDC. As a result, the fuel-air mixture gets compressed and the spark plug ignites the mixture. The mixture expands and the piston is pushed down. The inlet port is opened, the mixture gets sucked inside the crankcase. When the mixture is pushed up into the combustion chamber during the previous upstroke, a partial vacuum is created as no mixture is left behind in the crankcase. In this stroke, rotation of 180° is made by crankshaft.

From the 2nd downstroke onwards the exhaust gases get expelled out from one side while a fresh mixture enters into the combustion chamber simultaneously. Both things happen at the same time which makes it a 2-stroke engine.

~~The exhaust gases are expelled from the 2nd downstroke onwards from one side while simultaneously a fresh~~

Q5 Explain the construction and working of 2-strokes Diesel Engine with the help of neat sketch.

Two stroke petrol engine



Qs. Explain the construction and working of 2-strokes Diesel Engine with the help of neat sketch.

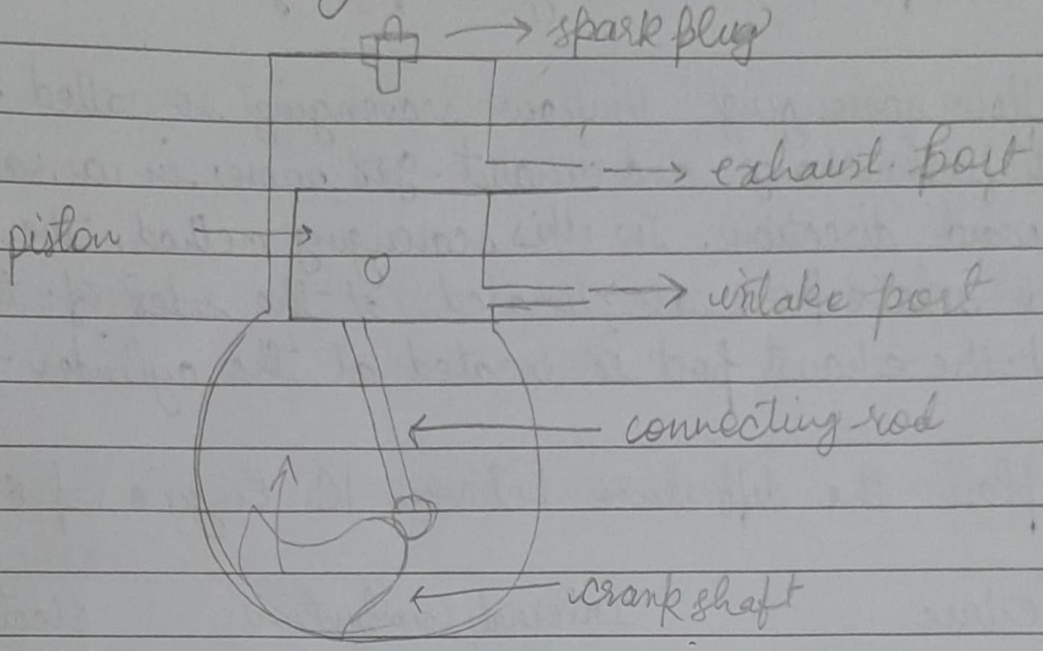
A two-stroke diesel engine completes a power cycle in two strokes of the piston. Construction includes a piston, connecting rod, crankshaft and cylinder with ports.

→ Upstroke (compression and injection):
The piston moves upward from the BDC to TDC. As it moves up, it compresses the air already inside the cylinder while both intake and exhaust port are closed. Now the air is highly compressed and hot at the top of TDC.
The fuel injector sprays diesel fuel into this superheated compressed air causing it to ignite and burn immediately.

→ Downstroke (Power and scavenging)
The pressure from the combustion forces the piston downward, which is the power stroke.

As the piston moves down, high pressure exhaust gases begin to escape. Simultaneously, a fresh charge of pre-pressurized air is pushed from the crankcase. At BDC the cylinder is full of fresh air & exhaust gases have been expelled. The cycle then restarts & with the upstroke

2 stroke Diesel Engine



Q6. Explain various types of scavenging processes used in IC engines.

The three types of scavenging methods are used in two-stroke engines are:

(i) Cross flow scavenging: The cross-flow type scavenging has an inlet port and the exhaust port that are located on the opposite side to each other.
When the charge enters into the engine from the intake port, due to the hump shape of a piston, this incoming charge moves upwards & pushes the upper burnt gases to the doorside and then these gases goes outwards through the exhaust port.

(ii) loop scavenging: In this scavenging method, the intake port and exhaust port are located at the same side in the engine. In this method, the size of the intake port is a large size to enter a large volume of charge inside the cylinder, and the size of the exhaust port is small to flow out burnt gases quickly.

(iii) Uniflow scavenging: Uniflow scavenging so called because both fresh charge and exhaust gas move in a same upward direction. In this scavenging method, the one or two intake ports are located at the sides of the cylinder and the exhaust port is located at the cylinder head.

Q7 Explain the difference between IC Engine & EV.

	Feature	Internal Combustion Engine	Electric Vehicle
1.	Power source	gasoline, diesel or other fuels	electricity from a rechargeable battery or fuel cell.
2.	mechanism	Burn fuel to create mechanical energy through pistons, crankshafts, and other complex parts.	Uses an electric motor to convert electrical energy into mechanical energy
3.	cost	cheaper to purchase initially but more expensive to run per mile due to fuel costs	more expensive to purchase initially but cheaper to run per mile due to lower fuel and

4.	Efficiency	~~≈ 30%~~ engine efficiency ≈ 30%	motor efficiency ≈ 80%.
5.	gear system	needs complex gear system	needs only one gear
6.	Charging time	short refilling time (< 5 min)	long charging time (0.5 - 8 hr)
7.	emissions	produces green house gases	zero tailpipe emissions
8.	Operation noise	noisy operation	quiet operation
9.	Fuel tank and fuel weight	Fuel tank takes less space and weight is less	Battery takes large space and are very heavy.
10.	Braking energy	braking energy is not recovered	It can recover braking energy.