SCHEME OF VALUATION

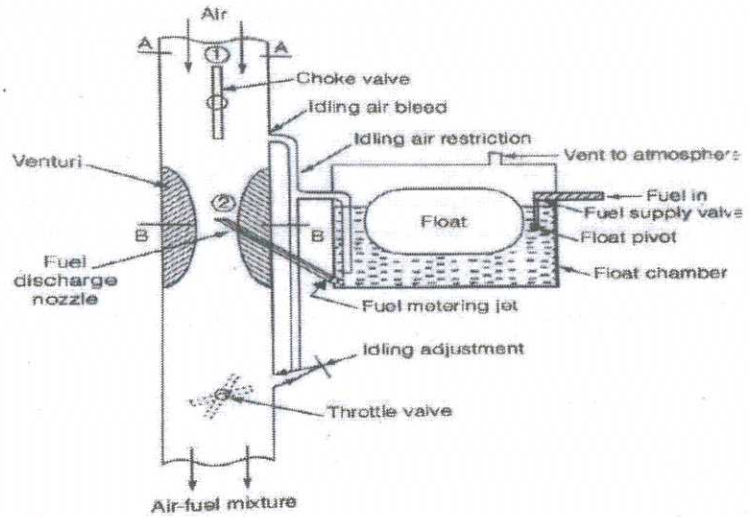
(Scoring Indicators)

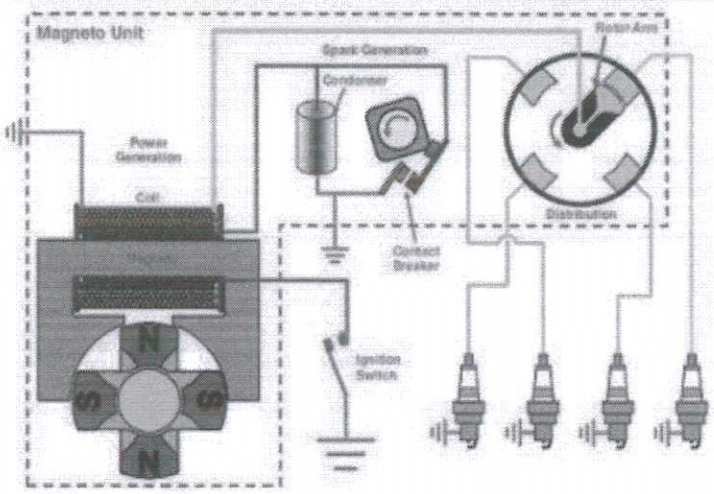
Rision:2015 Course

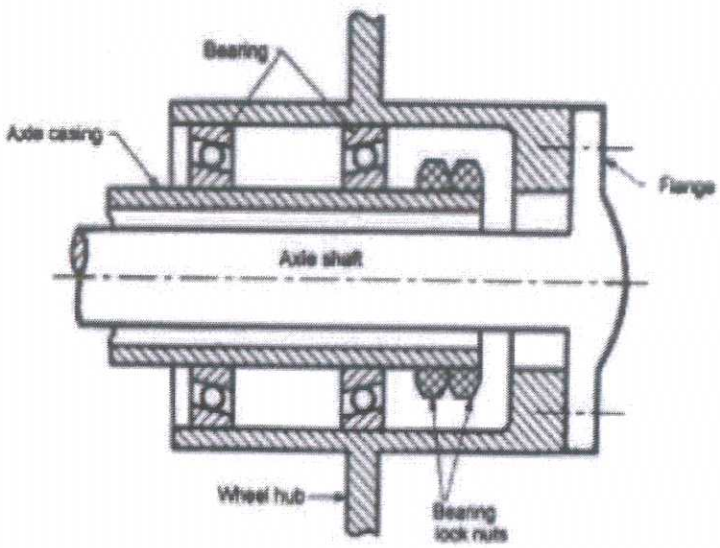
Ce:4022

Crse Title: **AUTOMOBILE ENGINEERING**

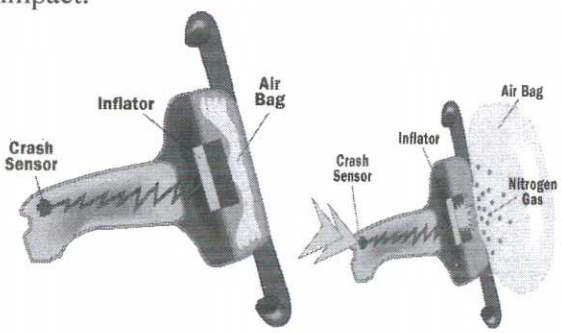
Qtn No	Scoring Indicator	Split up score	Sub Total	Total
	Part A			
1	The function of a governor is to keep the speed of engine constant irrespective of the changes in load on the engine.		2	2
2	1. To permit engagement or disengagement of a gear when the vehicle is stationary and the engine is running. 2.To transmit the engine power to the road wheels smoothly without shock to the transmission system while setting the wheel in motion	0.5 marks for each point	0.5 x 4 =2	2
3	1.Pressed steel disc wheels 2.Wire wheels or Spoked wheels 3.Cast wheels		2	2
4	Bharath stage emission standards (BS-)		2	2
5	The system enables you to easily lock all doors through the operation of the driver's lock. There is no danger of leaving the door in an unlocked position. Small children will be safe in the back seat as you can effortlessly lock the rear doors as well.		2	2

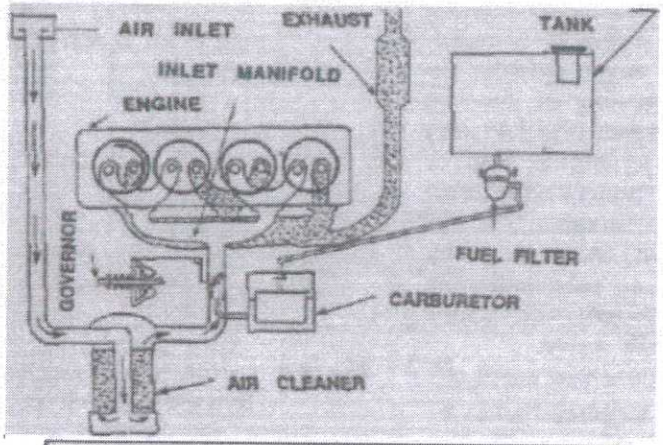
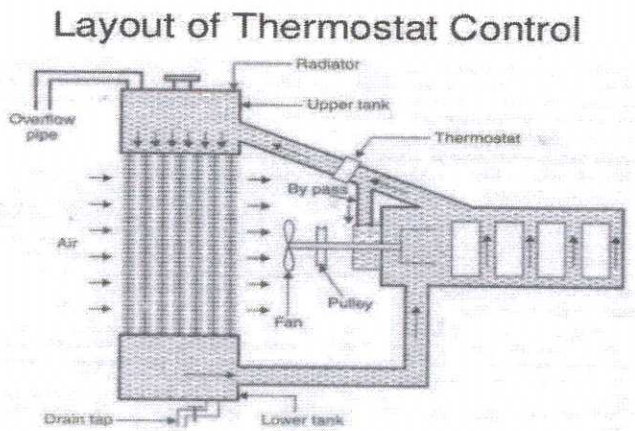
Part B				
1	The Simple carburetor mainly consists of a float chamber, Fuel discharge nozzle, a metering orifice, a venturi, a throttle valve and a choke.  Carburetor Working Float chamber is vented either to the atmosphere or to the upstream side of the venturi. During the suction stroke, air is drawn through the venturi. Venturi is a tube of decreasing cross-section with a minimum area at the throat. Venturi tube is also known as a choke tube and is so shaped that it offers minimum resistance to the air flow. As the air passes through the venturi the velocity increase reaching a maximum at the venturi throat. Correspondingly, the pressure decreases reaching a minimum. From the float chamber, the fuel is fed to a discharge jet, the tip of which is located in the throat of the venturi. Because of the differential pressure between the float chamber and the throat of the venturi, known as **carburetor depression**, fuel is discharged into the air stream. The fuel discharged is affected by the size of the discharge jet and it is chosen to give the required Air fuel ratio.	3marks for fig & 3marks for explanation	3+3=6 marks	6

2	 IGNITION SYSTEM – Magneto System 1. When engine in the system starts it help magneto to rotate and thereby producing the energy in the form of high voltage. 2. The one end of the magneto is grounded through contact breaker and ignition capacitor is connected to it parallel. 3. The contact breaker is regulated by the cam and when the breaker is open, current flows through the condenser and charges it. 4. As the condenser is acting like a charger now, the primary current flow is reduced thereby reducing the overall magnetic field generated in the system. This increases the voltage in the condenser. 5. This increased high voltage in the condenser will act as an EMF thereby producing the spark at the right spark plug through the distributor. 6. At the initial stage, the speed of the engine is low and hence the voltage generated by the magneto is low but as the rotating speed of the engine increases, it also increases the voltage generated by the magneto and flow of the current is also increased. To kick start the engine, we can use an external source such as the battery to avoid the slow start of the engine.		3+3 = 6marks	6
3	1. It's main function is to varry the torque and speed according to the driver's need. When our vehicle is on bump or a speed breaker then at that time vehicle's speed is slow by the application of breaks so at that time we needs more torque pick-up the vehicle otherwise it will stop due to low torque so we have to shift gear from higher to lower to get the required amount of torque that's why gear box needed in our vehicle. 2. One more and important thing , without it we can't drive our vehicle in reverse direction. 3. With the help of gear box we can switch our vehicle in		6marks	6

4	neutral mode. If it is not in our vehicle so we will have to stop engine for parking or stop the vehicle. 3. One more function is to increase the rpm of the main shaft of gear box in 5th gear more the engine's rpm and the ratio for 5th gear is 0.8:1. 4. The function of a gearbox in a car is to increase the range of the rotational speed given to the wheels from a combustion engine. 5. A car's engine cannot be attached directly to the wheels. Car engines can only operate in a relatively small RPM band, and the top speed they could achieve in this band is fairly low. This can be done with help of gear box 6. The main purpose of gears is to transmit power or torque or to change the rotational speed of an output shaft with respect to an input shaft. 7. To provide a means of reversing the vehicle. 8. To multiply (or increase) the torque (turning effort) being transmitted by the engine.  **Full floating axle**	3 marks for fig & 3 for explanantion	3 + 3=6marks	6

	The full-floating axle is used in most heavy trucks. These axle shafts may be removed and replaced without removing the wheels or disturbing the differential. Each wheel is carried on the end of the axle tube on two ball bearing or roller bearings, and the axle shafts are bolted to the wheel hub. The wheels are driven through a flange on the ends of the axle shaft which is bolted to the outside of the wheel hub. The bolted connection between the axle and wheel does not make It can be found on the rear of some 4x4s, but it is generally reserved for vehicles that are designed for severe duty, or are intended to carry heavy loads. This type of axle uses an axle shaft on each side that is simply splined at both ends or splined on the inner end and has a drive flange on the outer end. The shaft mates to the differential in the same way as a semi-floater. However, the outer end of the shaft differs. Here, the splined end of the shaft slides into a locking hub or an internal splined steel drive plate that bolts to a hub cap, similar to what is found on a front axle. In some cases, the drive flange may be part of the shaft itself. In either case, the axle shaft is allowed to float in the system.			
5	1. It provides softer suspension. 2. It reduces wheel wobbling. 3. It reduces the tendency of fitting of the wheel on one side due to road vibration. 4. It provides more space for engine accommodation. 5. It promotes under steer which results low un sprung weight. 6. The movement of the spring on one wheel is not transmitted to the other wheel.	1 marks for each	1 x 6 =6marks	6
6	Brake bleeding is the procedure to evacuate air bubbles present in the brake lines and hose pipes of hydraulic braking systems. As brake fluid is incompressible liquid and air is compressible gas so it reduces the hydraulic pressure built up in the brake lines and hence reduces the braking efficiency. There are four main methods of bleeding: • **The pump and hold method**, the brake pedal is pressed while one bleed screw at a time is opened, allowing air to escape. The bleed screw must be closed before releasing the pedal. • In the **vacuum method**, a specialized vacuum pump is attached to the bleeder valve, which is opened and fluid extracted with the pump until it runs clear of bubbles. • In the **pressure method**, a specialized pressure pump is attached to the master cylinder, pressurizing the system, and the bleeder valves are opened one at a time until the fluid is clear of air. • In **the reverse method**, a pump is used to force fluid through the bleeder valve to the master cylinder. This method may have advantages in some cases, however it is not in common usage.		6marks	6

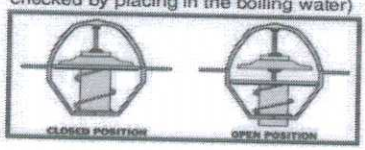
7	An airbag is a vehicle occupant restraint system using a bag designed to inflate extremely rapidly then quick deflate during a collision. It consists of the airbag cushion, a flexible fabric bag, inflation module and impact sensor. The purpose of the airbag is to provide the occupants a soft cushioning and restraint during a crash event. It can reduce injuries between the flailing occupant and the interior of the vehicle. The airbag provides an energy absorbing surface between the vehicle's occupants and a steering wheel, instrument panel, as well as the body pillars, headliner, and windshield. Modern vehicles may contain multiple airbag modules in various configurations including, driver, passenger, side curtain, seat-mounted side impact, knee bolster, inflatable seat-belt, front right and left side sensors and pedestrian airbag modules. During a crash, the vehicle's crash sensors provide crucial information to the airbag electronic controller unit (ECU), including collision type, angle and severity of impact. Using this information, the airbag electronic controller unit's crash algorithm determines if the crash event meets the criteria for deployment and triggers various firing circuits to deploy one or more airbag modules within the vehicle. Working as a supplemental restraint system to the vehicle's seat-belt systems, airbag module deployments are triggered through a pyrotechnic process that is designed to be used once. Newer side-impact airbag modules consist of compressed air cylinders that are triggered in the event of a side on vehicle impact.  Normal condition after crashing		6marks	6

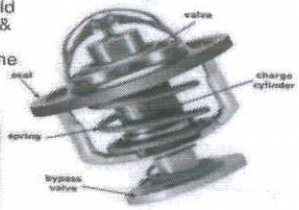
Part C				
III (a)	The fuel supply system of spark ignition engine consists of: (i) Fuel tank (ii) Fuel filter (iii) Sediment bowl (iv) Fuel lift pump (v) Carburettor (vi) Fuel pipes (vii) Inlet manifold In some spark ignition engine, the fuel tank is placed above the level of the carburettor. The fuel flows from the fuel tank to the carburettor under the action of gravity. There are one or two filters between the fuel tank and the carburettor. A transparent sediment bowl is also provided to hold the dust and dirt of the fuel. If the tank is below the level of the carburettor, a lift pump is provided in between the tank and the carburettor for forcing fuel from the tank to the carburettor of the engine. The fuel comes from the fuel tank to the sediment bowl and then to the lift pump. From there the fuel goes to the carburettor through suitable pipe. From the carburettor, the fuel goes to the engine cylinder, through the inlet manifold of the engine.  Fuel system of spark ignition engine.	Drawing 4 marks + Explanation 5 marks	4 + 4 =8marks	8
III(b)	 	Fig 3 marks and 4 for explanation	3+4=7 marks	7

Thermostat

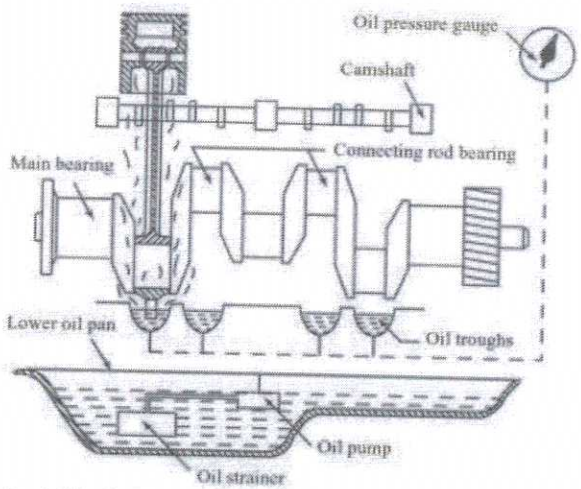
- Placed between the cylinder head and top radiator hose.
- Regulates engine coolant temperature
- The temperature that the thermostat opens is called ***thermostat rating***. (85-90° C most common)
- Solid Expansion design – wax pellet expands as temp increases, valve begins opening at rating & is completely open within 10 degrees

If it fails in open position, engine runs cold resulting in poor mileage and high wear & tear.
If it fails closed, creates temperature in the engine well beyond normal limits. Many types of damage may occur. (Can be checked by placing in the boiling water)





IV (a) Splash lubrication system is used on small, stationary four-stroke engines. In this system, the cap of the big end bearing on the connecting rod is provided with a scoop which strikes and dips into the oil-filled through at every revolution of the crank shaft and oil is splashed all over the interior of crank case into the piston and over the exposed portion of the cylinder is shown in the figure below.



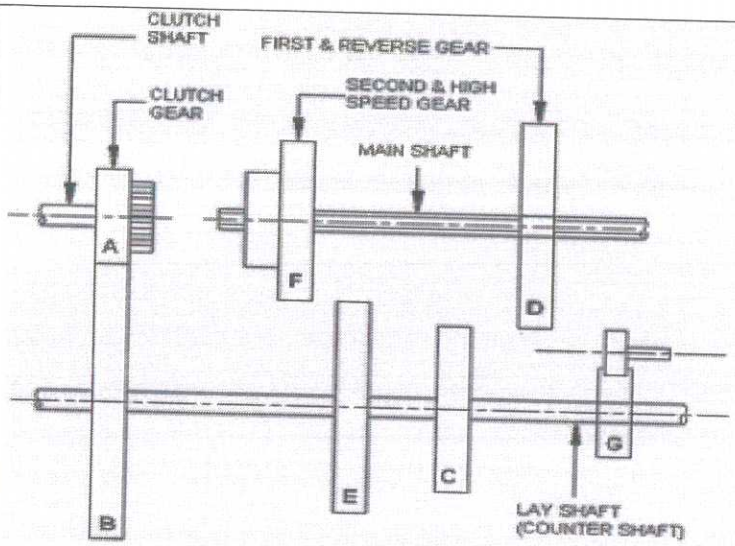
A hole is drilled through the connecting rod cap through which the oil passes to the bearing surface. Oil pockets are provided to catch the splashed oil over all the main bearings and also the cam shaft bearings. From these pockets oil passes to the bearings through drilled hole. The surplus oil dripping from the cylinder flows back to the oil sump in the crank case.

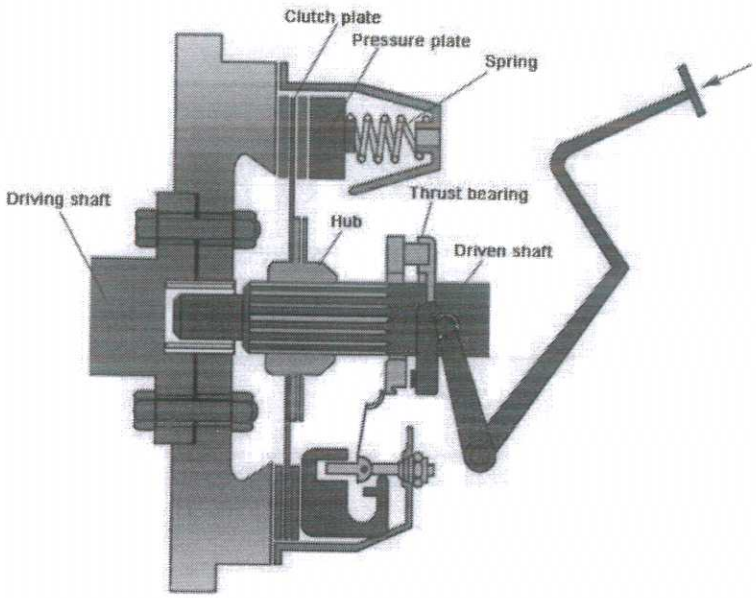
Fig 4 marks & 4 marks for explnantion

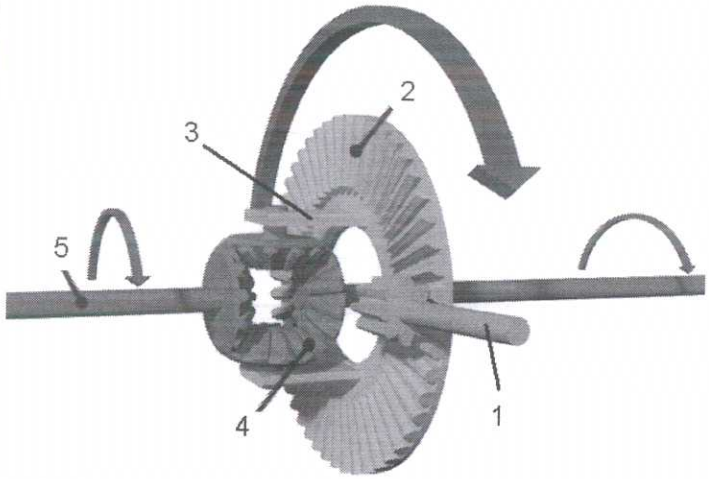
4+4=8 marks

8

IV (b)	AIR COOLING SYSTEM	WATER COOLING SYSTEM	One marks for each	1x7 = 7marks	7
	1.Due to direct transfer of heat from engine to air, no water jacket, radiator and water pump are required. Therefore weight is reduced.	Need for pump and radiator increases weight and air resistance of vehicle.			
	2.Engine is smaller in size and its design much simpler.	Engine has larger dimensions and its design is more complex.			
	3.Warm-up performance of air-cooled engine is better. This results in low wear to cylinders.	Warm-up performance is poor and results in greater cylinder wear.			
	4.Volumetric efficiency of air-cooled engine is lower due to higher cylinder head temperatures.	Volumetric efficiency of water-cooled engines is higher.			
	5.Air cooling cannot be employed for high specific output engines due to complex nature of fins required.	Since heat transfer coefficient of water is about 350 times that of air, water cooling can be used for high specific output engines.			
	6.Air cooled engine can take up some degree of damage. A broken fin does not affect the engine much.	Water cooling system requires more maintenance. A slight leakage of radiator may result in engine breakdown.			
	7.Air cooled engine is less sensitive to climatic conditions. Anti-freeze solution is not needed.	Engine performance is more sensitive to climatic conditions. Cold weather starting requires use of anti-freeze solutions.			

V(a)	 This gear box consists of a clutch shaft or lay shaft and main shaft. The clutch shaft has one gear. The lay shaft has four gears. All four gears from an integral part of the counter shaft. First gear: Gear D mesh with gear C, gear F not meshes with gear E. Thus drive is transmitted along gears A B C D Gear A is smaller than gear B and gear C is smaller than gear D. Consequently the speed of main shaft is reduced. Second gear: Gear F mesh with gear E. When the clutch shaft is rotating, the transmission takes place between gears A & B and E & F; Gear F rotates main shaft. Third Gear: In this gear F is directly mesh with A. The main shaft is direct contact with the clutch shaft. Thus main shaft aquires the same speed of clutch shaft. Reverse gear: Transmission takes place from gears A to B,G to idler and then to D. The smaller intermediate gear (idler) causes the reverse position of the gear box.	4 for fig & 4 explanation	4+ 4 =8 marks	8
V(b)	A single plate clutch is consisting of various parts; for proper working. They are arranged in a systematical order. Mainly it consists of a clutch plate with both side friction lining and some other parts which helps in the proper functioning of a clutch like flywheel, pressure plate, thrust bearing, hub, springs and input mechanism for engaging and disengaging of clutch. Clutch plate is attached with the hub between flywheel and the pressure plate, it moves axially on driven shaft. In singe plate clutch; clutch plate should have both side friction lining because it is mounted between pressure plate and flywheel, friction is responsible for the torque transmission. The pressure plate is attached with the flywheel and springs. Pressure plate helps to push the clutch plate towards the flywheel. A lever is attached to thrust bearings with some mechanism on driven shaft which transmits input and output	Fig 3 +4 explanation	3+ 4=7 marks	7

	motion from clutch pedal.  Working of single plate clutch is very simple. A mechanism is responsible for the engagement and disengagement of clutch. We easily engage and disengage the torque transmitting shafts just by apply some force on the paddle of automobile. A lever is attached to the paddle which is responsible for the force transmission from the paddle. When pedal is pressed spring is compressed and engine is free to move without any load. Lever is attached in such a manner when we press the clutch paddle thrust bearing moves forward and pressure plate moves backward or it moves away from the flywheel; due to this the connection between the clutch plate and flywheel released and shafts are disengaged. This time we can easily change gears in case of automobiles. Again if we want to engage the shafts just release the clutch paddle; then springs attached to the pressure plate push the pressure plate forward. Clutch plate is mounted between the pressure plate and flywheel on the hub. Clutch plate has both side friction lining that's why it mounted in between pressure plate and flywheel and helps in torque transmission.			
VI (a)	When an automobile travels around a corner, the distance traveled by the outside wheels is greater than that traveled by the inside wheels. If the wheels are mounted on dead axles so that they turn independently of each other, like the front wheels of an ordinary passenger vehicle, they will turn at different speeds to compensate for the difference in travel. But, if the wheels are driven positively by the engine, a device is necessary which will permit them to revolve at different speeds without interfering with the propulsion system. To accomplish this purpose a system of gears called the differential is provided.		8marks	8



Action	Results	Crown wheel	Sun Gears	Star Gear
One wheel jacked and rotated, Gear engaged	Engine rotates	Rotates	Only jacked side rotates	All rotate
Two wheels jacked and one rotated	Other wheel will rotate in opposite direction	Does not rotate	Both rotate	All rotate
Tractor moving in straight ahead position	Both wheels rotate with same speed	Rotates with the cage	Both rotate with the cage	Do not rotate independently but with the cage
Tractor turning left or right	Turning side rotates with slow speed. Other wheel rotates faster	Rotates	Turning side rotates slower, other side rotates faster	All rotate
Diff locked (side dog coupling engaged with crown-wheel	Both wheels rotate with same speed	Rotates with the cage	Both gears rotate with same speed (with the cage)	Do not rotate independently but with the cage

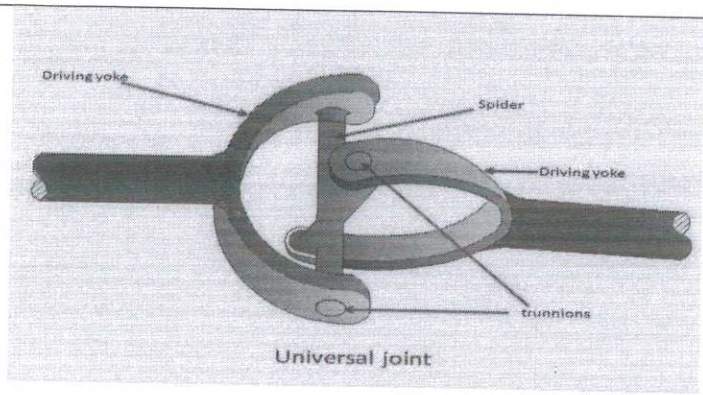
VI (b) A universal joint is a joint or coupling connecting rigid rods whose axes are inclined to each other, and is commonly used in shafts that transmit rotary motion. It consists of a pair of hinges located close together, oriented at 90° to each other, connected by a cross shaft. The universal joint is not a constant-velocity joint.

Working: When the driving shaft is rotating, the driven shaft also rotates. At the same time the universal joints permits angular motion and propeller shaft can rotate at any angle thus the power is transmitted from the gear box to the propeller shaft at any particular angle

3 marks for fig & 4 for explanation

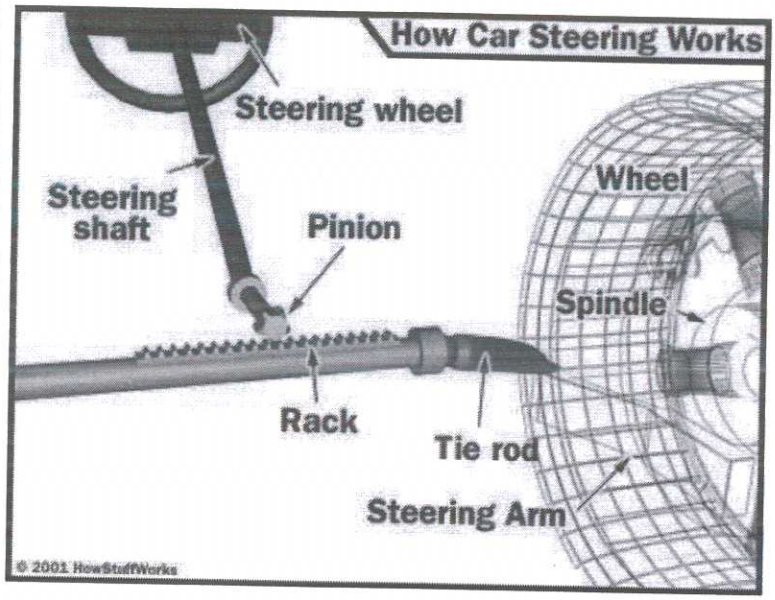
3+4=7 marks

7



Universal joint

VII (a)



4 marks for drawing & 4 for explanation

4+4=8 marks

8

Rack-and-pinion steering is quickly becoming the most common type of steering on cars, small trucks and SUVs. It is actually a pretty simple mechanism. A rack-and-pinion gearset is enclosed in a metal tube, with each end of the rack protruding from the tube. A rod, called a **tie rod**, connects to each end of the rack.

The **pinion gear** is attached to the **steering shaft**. When you turn the steering wheel, the gear spins, moving the rack. The tie rod at each end of the rack connects to the **steering arm** on the **spindle** (see diagram above).

The rack-and-pinion gear set does two things:

1. It converts the rotational motion of the steering wheel into the linear motion needed to turn the wheels.

2. It provides a gear reduction, making it easier to turn the wheels.

On most cars, it takes three to four complete revolutions of the steering wheel to make the wheels turn from lock to lock (from

far left to far right).

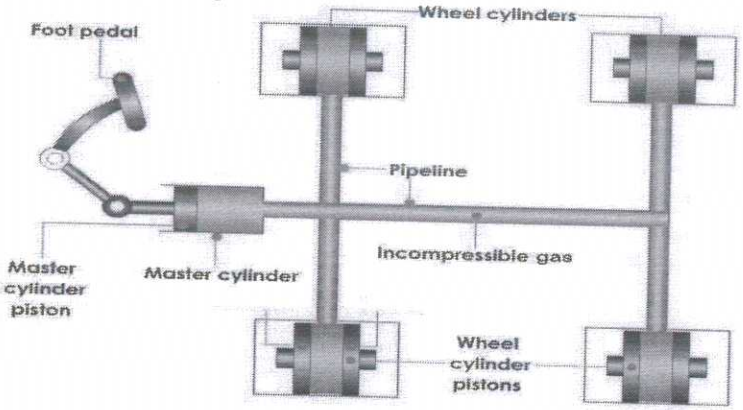
The **steering ratio** is the ratio of how far you turn the steering wheel to how far the wheels turn. For instance, if one complete revolution (360 degrees) of the steering wheel results in the wheels of the car turning 20 degrees, then the steering ratio is 360 divided by 20, or 18:1.

A higher ratio means that you have to turn the steering wheel more to get the wheels to turn a given distance. However, less effort is required because of the higher gear ratio

VII(b)

	TUBED TYRE	TUBELESS TYRE
	A tube inside a tire would simply collapse in case of puncture and the air in the tyre goes out in no time.	Tubeless tyre retains air pressure and helps avoid sudden air loss in the case of a puncture.
Fuel Efficiency	Tube tyres are not so fuel efficient When compared to Tubeless tyres.	Tubeless tyres are more fuel efficient.
Weight	Tube tyres weigh more because of the tube placed inside them.	Tubeless tyres are light weight because of no tube inside the tyre.
In case of puncture	The tube in the tube tyres will explode suddenly in case of puncture causing loss of control of the vehicle which may result in accidents.	Tubeless tyres make driving safe and easy and there is no loss of control of the vehicle in case of puncture.
Repair Profess	The puncture repairing process of tube tyre involves a complicated process of removing the tyre from the vehicle and removing tube from the tyre, etc.	The puncture repairing process of a Tubeless tyre can be Done without removing the tyre and is very simple compared to a tubed tyre.
Cost of Tyre	The tube tyres are of less cost and are available in every size for every vehicle.	The tubeless tyres are costly and are not available for all types of vehicles.
Punctures	The tube tyres are	The tubeless tyres are

7marks 7

		more prone to punctures because of the tubes placed in them.	durable and last longer because of no tube is placed in them.			
	Repair Cost	The tube tyre puncture repair cost is less when compared to that of the tubeless tyre.	The tubeless tyre Puncture repair cost is very high and can be repaired instantly.			
VI II (a)	A brake which uses air as a working fluid is known as pneumatic brake. The system actuated to apply this phenomenon is know as pneumatic brake system. An pneumatic brake system or a compressed air brake system is a type of friction brake for vehicles in which compressed air pressing on a piston is used to apply the pressure to the brake pad needed to stop the vehicle.  **WORKING OF PNEUMATIC BRAKE SYSTEM** 1. When the brake pedal is depressed, the brake valves varies its position and compressed air is admitted into the wheel brake chambers. 2. In the chambers the air acts upon flexible diaphragms, moves them the pushes out the rods connected with the levers of the brake gear cams. 3. The cams turn and separate the shoes thus braking the wheels. 4. When the brake pedal is released, the supply of compressed air is cut off from the brake chambers and they are connected to the atmosphere. 5. The pressure in the chambers drops, the brake shoes are returned to their initial position and the wheels run free. 6. The brake valve is equipped with a servo mechanism which ensures that the braking force on the shoes is proportional to the force applied to the pedal. 7. Besides the valve imparts a relative reaction to the	Fig 3 marks+ explanation 4 marks	3+4=7 marks	7

movement of the pedal so that the driver can sense the degree of brake application.

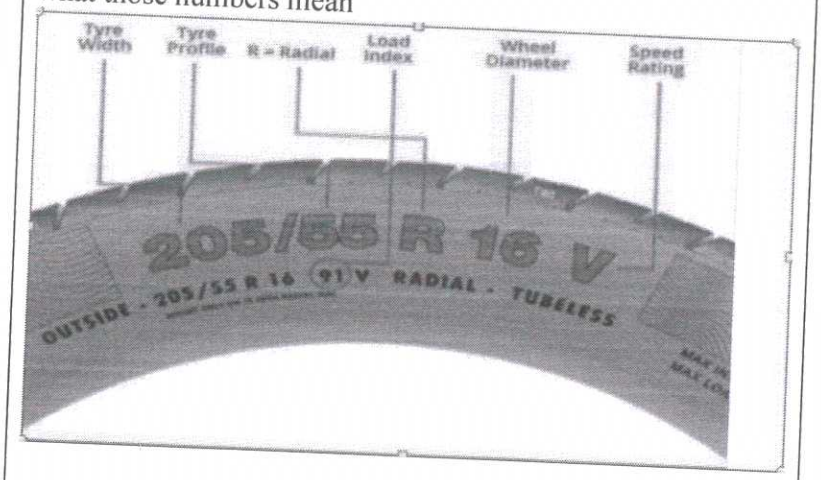
VI II(b)

TYRE SIZE

Along with the manufacturer's name and the name of the tyre (i.e. Bridgestone Ecopia), there's always a set of numbers and letters that relate to the size of the tyre. Here's a rundown on what those numbers mean

7

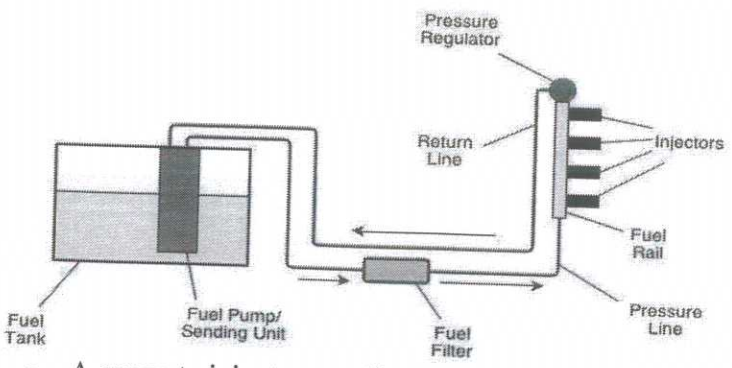
7



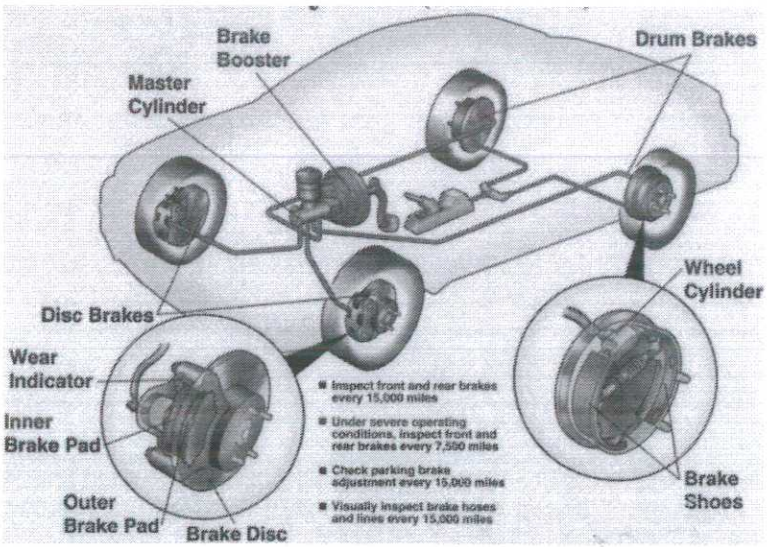
Example: 215/60R15
215 is the width of the tyre in millimetres. 60 is the aspect ratio or tyre profile. R means it is radial construction.
15 is the diameter of the wheel rim in inches.

WHEEL SIZE

The wheel size is the size designation of a wheel given by its diameter, width, and offset. ... For example, 17x8.5 +35, the wheel's diameter is 17 inches, its width is 8.5 inches, and it has a +35 positive offset.

IX (a)	MPFi is a fuel injection technique used in gasoline engines.Multi port fuel injection injects fuel into the intake ports of each cylinder's intake valve, rather than at a central point within an intake manifold like in spark plugs. It can be sequential, in which injection is timed to coincide with each cylinder's intake stroke. **Multi-port Fuel Injection**  • A separate injector supplies the correct quantity of fuel to each of the engine cylinders by a fuel-rail according to the firing order or in a 'particular sequence'. This system provides further precision by varying the fuel quantity and injection timing by governing the each injector separately and thereby improving the performance and controlling the emissions. • The return valve returns fuel in case the fuel is oversupplied. Also the pressure regulator regulates the pressure of the intake fuel. Fuel filter contains small sized membranes which filters and absorbs the undesirable matters of size 30 to 40 microns. • The fuel and air are mixed in intake manifold and each manifold is controlled by an ECU(Electronic Control Unit). fuel pressure runs between 3 to 5 bars.	4 marks for fig & 4 for explanation	4+4=8 marks	8
IX (b)	Turbochargers were originally known as turbo superchargers when all forced induction devices were classified as superchargers. The key difference between a turbocharger and a conventional supercharger is that a supercharger is mechanically driven by the engine, often through a belt connected to the crankshaft, whereas a turbocharger is powered by a turbine driven by the engine's exhaust gas. Compared with a mechanically driven supercharger, turbochargers tend to be more efficient, but less responsive. Twincharger refers to an engine with both a supercharger and a turbocharger. An intercooler is any mechanical device used to cool a fluid, including liquids or gases, between stages of a multi-stage compression	3.5 marks for each (turbocharger & intercooler)	3.5+3.5=7 marks	7

	Process, typically a heat exchanger that removes waste heat in a gas compressor. They are used in many ways, including air compressors, air conditioners, refrigeration, and gas turbines, and automotive engines. Here they are widely known as an air-to-air or air-to-liquid cooler for forced induction(turbocharged or supercharged) internal combustion engines to improve their volumetric efficiency, which they do by increasing intake air density through nearly constant pressure cooling.			
X(a)	a. Unburned Hydro Carbons (UBHC): The major sources of UBHC in an automobile are the engine exhaust, evaporative losses from fuel system, blow by loss and scavenging in case of 2-stroke petrol engines. Unburned or partially burned hydrocarbons in gaseous form combine with oxides of nitrogen in the presence of sunlight to form photochemical smog. UBHC + NOx Photochemical smog The products of photochemical smog cause watering and burning of the eyes and affect the respiratory system, especially when the respiratory system is marginal for other reasons. Some of the high molecular weight aromatic hydrocarbons have been shown to be carcinogenic in animals. Some of the unburned hydrocarbons also serve as particulate matter in atmosphere. b. Carbon monoxide: Carbon monoxide is formed during combustion in engine only when there is insufficient supply of air. The main source is the engine exhaust. The toxicity of carbon monoxide is well known. The hemoglobin the human blood which carries oxygen to various parts of the body has great affinity towards carbon monoxide than for oxygen. When a human is exposed to an atmosphere containing carbon monoxide, the oxygen carrying capacity of the blood is reduced and results in the formation of carboxy hemoglobin. Due to this the human is subjected to various ill effects and ultimately leads to death. The toxic effects of carbon monoxide are dependent both on time and concentration as shown in the diagram. c. Oxides of Nitrogen (NOx) : Oxides of nitrogen (NO, NO2,N_2O_2 etc) are formed at higher combustion temperature present in engines and the engine exhaust is the major source. Like carbon monoxide, oxides of nitrogen also tend to settle on the hemoglobin in blood. Their most undesirable effect is their tendency to join with moisture in the lungs to form dilute nitric acid. Because the amounts formed are minute and dilute, their effect is very small but over a long period of time cam be cumulatively undesirable, especially when the respiratory problems for other reasons are found. Another effect is that, the oxides of nitrogen are also one of the essential components for the formation of photochemical smog.		8marks	8

	d. Sulphur dioxide: Sulphur dioxide from automotive vehicle is very less when compared to that emitted by burning coal. Sulphur dioxide combines with moisture in atmosphere and forms sulphuric acid at higher temperatures. This comes to the earth as acid rain. Much of the sulphur dioxide combines with other materials in the atmosphere and forms sulphates which ultimately form particulate matter e. Particulates: Particulate matter comes from hydrocarbons, lead additives and sulphur dioxide. If lead is used with the fuel to control combustion almost 70% of the lead is airborne with the exhaust gasses. In that 30% of the particulates rapidly settle to the ground while remaining remains in the atmosphere. Lead is well known toxic compound. Particulates when inhaled or taken along with food leads to respiratory problems and other infections. Particulates when settle on the ground they spoil the nature of the object on which they are settling. Lead, a particulate is a slow poison and ultimately leads to death.			
X(b)	 An anti-lock braking system (ABS) is a safety anti-skid braking system used on aircraft and on land vehicles, such as cars, motorcycles, trucks and buses. ABS operates by preventing the wheels from locking up during braking, thereby maintaining tractive contact with the road surface. ABS is an automated system that uses the principles of threshold braking and cadence braking, techniques which were once practiced by skilful drivers before ABS braking systems were widespread. ABS operates at a much faster rate and more effectively than most drivers could manage. Although ABS		7marks	7

generally offers improved vehicle control and decreases stopping distances on dry and some slippery surfaces, on loose gravel or snow covered surfaces ABS may significantly increase braking distance, while still improving steering control.

Operation

Typically ABS includes a central electronic control unit (ECU), four wheel speed sensors, and at least two hydraulic valves within the brake hydraulics. The ECU constantly monitors the rotational speed of each wheel; if it detects the wheel rotating significantly slower than the speed of the vehicle, a condition indicative of impending wheel lock, it actuates the valves to reduce hydraulic pressure to the brake at the affected wheel, thus reducing the braking force on that wheel; the wheel then turns faster. Conversely, if the ECU detects a wheel turning significantly faster than the others, brake hydraulic pressure to the wheel is increased so the braking force is reapplied, slowing down the wheel. This process is repeated continuously and can be detected by the driver via brake pedal pulsation. Some anti-lock systems can apply or release braking pressure 15 times per second.[24] Because of this, the wheels of cars equipped with ABS are practically impossible to lock even during panic braking in extreme conditions.

The ECU is programmed to disregard differences in wheel rotative speed below a critical threshold, because when the car is turning, the two wheels towards the center of the curve turn slower than the outer two. For this same reason, a differential is used in virtually all road going vehicles.