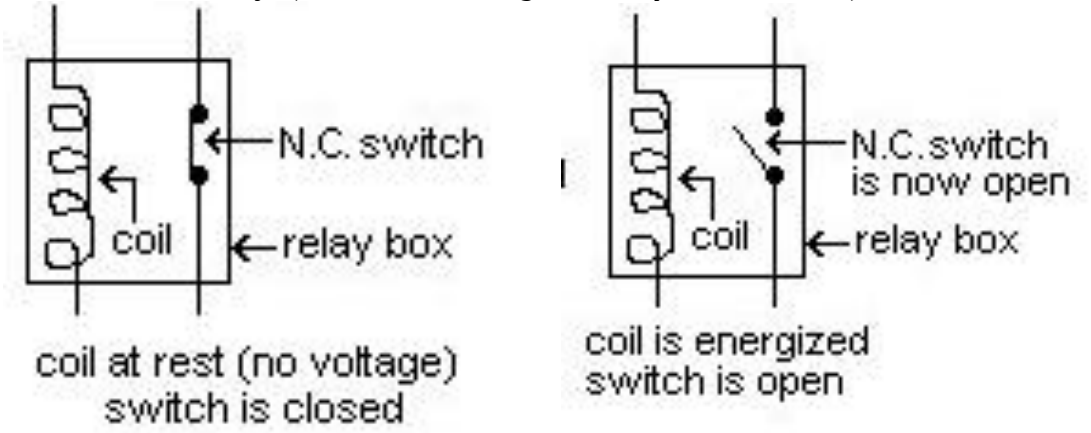
Important Instructions to examiners:

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 judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. N.	Sub Q. N.	Answer	Marking Scheme
1	a)	**Attempt any THREE of the following:**	12
		i) Enlist any two purposes of relay and draw neat sketch of NC relay **Answer :** *(Purpose - 2 marks each and sketch 2 marks)* **Purposes of Relay:** • A Relay is an electric switch that allows a small amount of current to control a high-current circuit. • It controls one electrical circuit by opening & closing contacts in other circuits. **Sketch of NC Relay:** *(Credit should be given to equivalent sketch)* 	2 2

		ii) List any four components used in Lead acid battery and enlist its function.	**4**
		Answer : *(Any four components with function 1marks each)* Batteries are made of five basic components: **1. Positive and negative internal plates:** The positive and negative plates are made up of lead material. The grid provides necessary framework for active material to be pasted onto the plate, making either a positive or a negative plate. The grid not only serves as a support for the fragile active material but also conducts electric current. **2. Plate separators:** These are thin sheets of a porous material placed between the positive and negative plates for preventing contact between them and thus avoiding internal short-circuiting of the battery. A separator must, however, be sufficiently porous to allow diffusion or circulation of electrolyte between the plates. Many batteries have envelope type separators that retain active materials near the plate. **3. Electrolyte:** Electrolyte is an dilute solution of sulfuric acid and water, better known as battery acid .Electrolyte solution consists of 64% water and 36% sulphuric acid, by weight. Electrolyte is both conductive and reactive. **4. A resilient plastic container:** The battery case is made of polypropylene, hard rubber and plastic base materials. Battery case must be capable of withstanding temperature extremes, vibration and acid absorption. Provision in container for cell elements sit on raised supports in the bottom of the case. **5. Lead terminals:** It is the upward extension from each connecting bar which passes through the cell cover for cable connections to the outside circuits. The connection point between the battery and whatever it powers. Some batteries are top-terminal batteries – they have the two main terminals or posts in the cover. The positive terminal post is larger than the negative terminal post. Other batteries are side-terminal batteries. They have the terminals on the side of the battery.	
		iii) Explain the working of engine oil pressure gauge with neat sketch.	**4**
		Answer: *(Working - 2 marks and sketch 2 marks)* ***Similar drawing and description should be considered.*** **Working of electromagnetic engine oil pressure gauge:** Oil pressure gauge shown in the diagram is electrically operated. It displays the actual oil pressure of the engine. The indicator light only warns the driver of low oil pressure. Oil pressure sending unit is screwed into the oil gallery. As oil passes through an oil pressure sender, it moves a diaphragm, which is connected to a variable resistor. This resistor changes the amount of current passing through the circuit. The gauge then reacts to the current and moves a needle over a scale to indicate the oil pressure. As oil pressure changes, the resistance in the oil pressure gauge circuit and the reading on the gauge change accordingly.	**2**

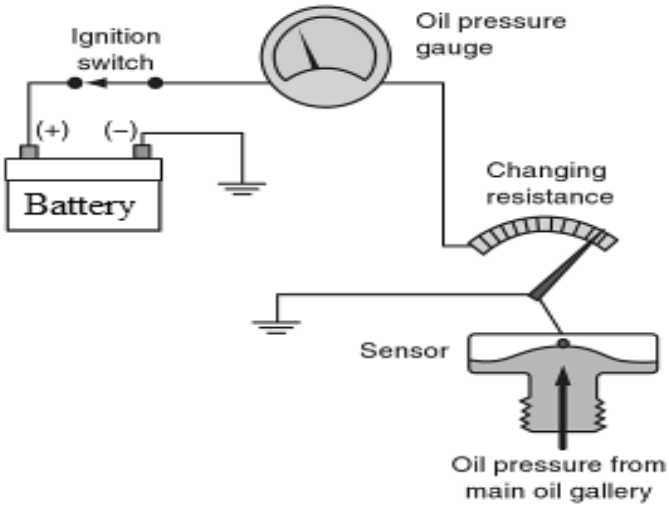


Figure: Electromagnetically operated engine oil pressure gauge

2

OR

Diagram 2 marks and Explanation 2 marks.

Engine Oil Pressure Gauge:

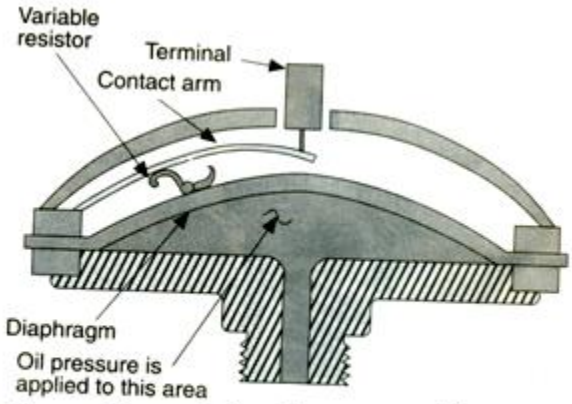


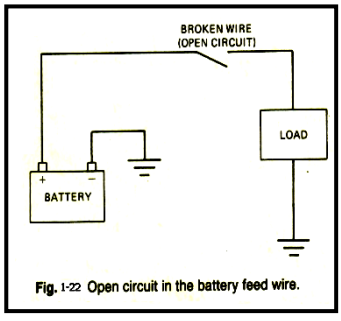
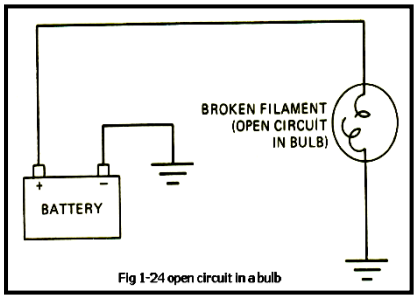
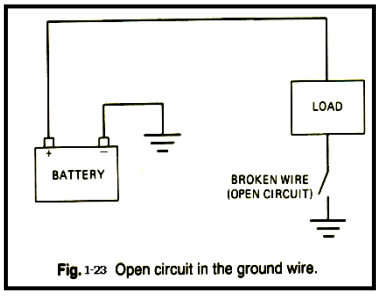
Figure: Piezoresistive Sensor used for measuring Engine oil pressure

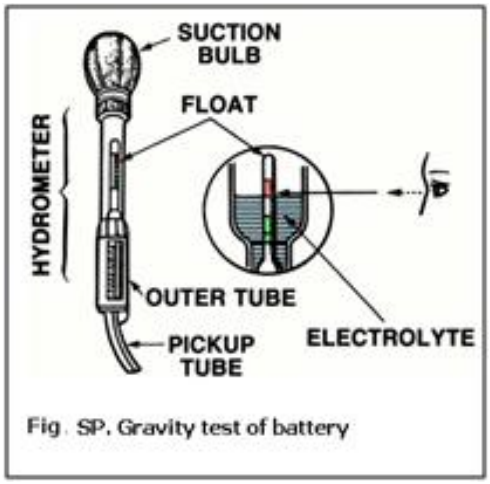
Working:

A piezo-resistive sensor **(Fig.)** is threaded into the oil delivery passage of the engine. The pressure exerted by the oil causes the flexible diaphragm to move. This movement is transferred to a contact arm that slides down the resistor. The position of the sliding contact on the arm in relation to the resistance coil determines the resistance value and the amount of current flow through the gauge to ground.

The oil pressure typically should be between 45 and 70 psi (310 and 483 kPa) when the engine is running at a specified engine speed, with SAE 10W-30 oil, and at operating temperature. A lower pressure is normal at low idle speed.

The oil pressure determines whether or not current flows through the oil pressure gauge winding. With low oil pressure (or with the engine shut off), the oil pressure switch is open and no current flows through the gauge winding. The needle points to L. With oil pressure above a specific limit, the switch closes and current flows through the gauge winding to

		ground. A resistor limits current flow through the winding and ensures that the needle points to about mid-scale with normal oil pressure.	
		iv) Describe Initial charging procedure of battery.	**4**
		Answer : *(Description - 4 marks)* Initial charging procedure: 1. When a new battery has been supplied dry, it is necessary to fill the cells with electrolyte of the correct specific gravity. 2. The battery is allowed to soak. Electrolyte is added to maintain the level between MIN and MAX levels. 3. Charger terminals are connected (+ve to +ve of battery and –ve to –ve of battery). 4. Battery is charged at a constant rate as per battery rating for slow charging. 5. Battery temperature is monitored. If the temperature exceeds 54°C, charging is discontinued to allow battery to cool. 6. When gassing starts, the electrolyte specific gravity is noted. Three successive specific gravity readings taken hourly, if indicating no change, the battery is said to be charged fully.	**4**
	b)	**Attempt any <u>ONE</u> of the following**	**6**
		i) Enlist any three types of circuit defects and describe open circuit with neat sketch.	
		Answer : *(Listing - 2 marks & Description -2 marks & sketch 2 marks)* **Types of circuit defects:** *(any three)* **a) Open circuit** **b) Short Circuit** **c) Short to ground** **d) Resistance in connection (Voltage Drop)**	**2**
		Open circuit: *(student should explain with any one similar simple sketch)* An open circuit is a break in an electric circuit that prevents the flow of electric current. An open circuit may be a broken wire, a faulty set of switch contacts, a faulty component, a blown fuse, or a defective ground. The open, or broken, part of the circuit may be in the supply, or feed, wire from the battery (Fig), in the ground wire (Fig), or in the load itself (Fig). With any of these conditions, the load will not operate.	**2**
		 Fig. 1-22 Open circuit in the battery feed wire.  Fig 1-24 open circuit in a bulb  Fig. 1-23 Open circuit in the ground wire.	**2**

		i) Enlist any four battery tests and explain specific gravity test.	**6**
		Answer : *(Listing - 2 marks each & Description -2 marks & sketch 2 marks)* **Types of battery tests:** *(any Four)* a) Battery terminal test, b) Leakage test, c) Specific Gravity Test, d) Open circuit test, e) Battery drain test. **Specific Gravity Test:** ***(Sketch 2 marks and Explanation 2 marks)*** 1) Remove all battery vent caps. 2) Check the electrolyte level. It must be high enough to withdraw the correct amount of solution into hydrometer. 3) Squeeze the bulb and place the pick-up tube into the electrolyte of a cell. 4) Slowly release the rubber bulb. Draw in enough solution until the float is freely suspended in the barrel. Hold the hydrometer in vertical position. 5) The float rises and specific gravity is read where the float scale intersects the top of the solution. 6) The reading must also be compensated for temperature.  Fig. SP. Gravity test of battery Following table shows specific gravity readings in various stages of charge at a temperature of 80°F (26.7°C). **Specific Gravity** / **Percentage of Charge** 1.265 / 100% 1.225 / 75% 1.190 / 50% 1.155 / 25% 1.120 or lower / Fully discharged	**2** **2** **2**
2		**Attempt any <u>FOUR</u> of the following:**	**16**
		a) Enlist any two purposes of fuses and describe cartridge fuse and maxi fuse with neat sketch.	**4**
		Answer : *(Listing of purposes - ½ marks each & Description -1 marks each & sketch ½ marks each)* **Purposes of fuses:** a) Automotive fuses are used to protect the wiring and electrical equipment for vehicles. b) A **fuse** is a type of resistor that acts as a sacrificial device to provide over-	

current protection, of either the load or source circuit.

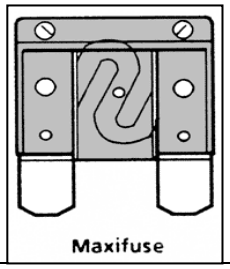
c) Its essential component is a metal wire or strip that melts when too much current flows, which interrupts the circuit in which it is connected.

Cartridge fuse: Cartridge fuses have a cylindrical body terminated with metal end caps. Some cartridge fuses are manufactured with end caps of different sizes to prevent accidental insertion of the wrong fuse rating in a holder, giving them a bottle shape.


Cartridge fuse

MAXI Fuses

Maxi-Fuse is a fast-acting blade fuse, standard for vehicle circuit protection. Designed to provide predictable time delay and low heat dissipation. Color-coded for easy identification of fuse ratings.


Maxifuse

b) Explain working of power window. **4**

Answer : *(Diagram - 2 marks, working- 2 marks ,credit given to equivalent diagram)*

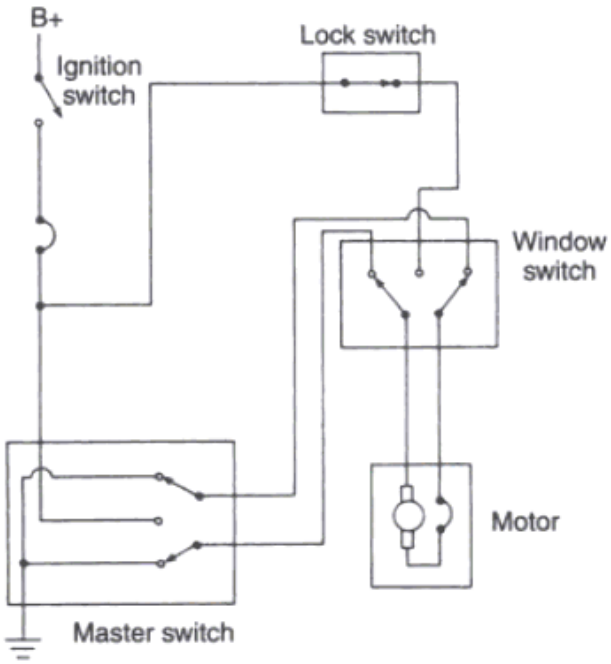
Working of Power window circuit: **2**

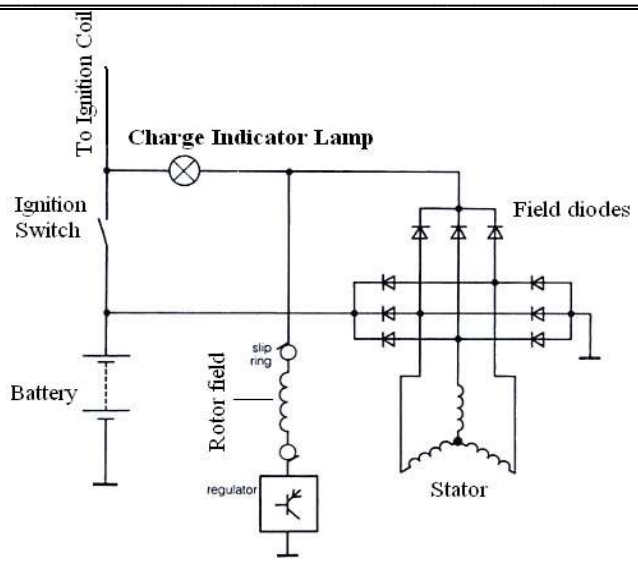
Major components of a typical Power windows system are – master control switch, individual window control switches, lock switch and the window drive motors as shown in figure.

A permanent magnet motor operates each power window. Each motor raises or lowers the glass when voltage is applied to it. The direction that the motor moves the glass is determined by the supply voltage. The motors are permanent magnet reversible DC motors.

The master control switch provides overall system control. A lock switch is safety device to prevent children from opening the windows without the driver's knowledge.

Circuit breakers are generally used on power windows to open the circuit if an overload occurs. Without a circuit breaker to open, the motor may be damaged trying to move the window against the ice. As ice is removed, the breaker will cool, close and allow future window operation.

		 **Figure** A simplified power window circuit.	**2**
		c) Describe with neat sketch, working of charge indicator light circuit	**4**
		Answer : *(Diagram - 2 marks, working- 2 marks ,credit given to equivalent diagram)* **Operation of Charge Indicator Light Circuit:** • When the engine is to be started, the ignition is switched on. • This connects the Charge Indicator Lamp to the battery and makes a circuit through rotor field and regulator to earth. • At this stage the charge indicator lamp is illuminated and the field is excited to the extent controlled by the wattage of the lamp; a typical lamp size is 12V, 2W. • As alternator speed is raised, the potential difference on the output side of the field diodes is increased. • This gradually reduces the voltage applied to the lamp so the light slowly fades and goes out when the output voltage of the alternator equals the battery voltage; i.e. when the alternator "cuts –in" and starts to charge. • When this happens the field diodes will be providing the entire field current.	**2**



2

d) Explain the concept of jump starting with sketch **4**

Answer : *(Procedure – 2 marks & sketch – 2 marks)*

Jump starting of a battery:

Jump starting requires proper battery connecting procedures to prevent sparks. Jump start a vehicle using following procedure:

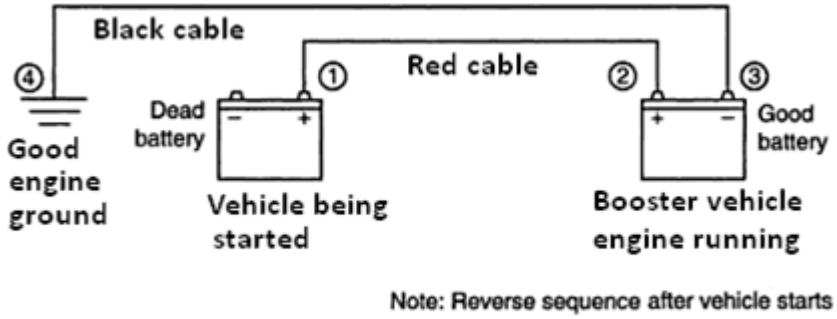
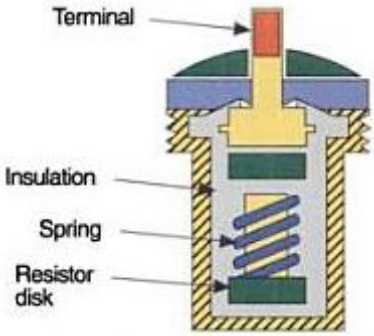
1. Engage the parking brake and put the transmission in park or neutral.
2. Make sure the two vehicles are not touching.
3. Turn on the heater blower motor in the vehicle with the dead battery. This will allow the battery to help absorb any damaging voltage spikes. Turn off all other switches and lights.
4. Connect the two positive cables using the positive jumper leads.
5. Connect one end of the negative jumper lead to the booster battery.
6. Lastly connect the other lead of the negative jumper lead to a good ground on the vehicle with the dead battery. This location could be the vehicle frame or the engine block.
7. Start the jumper vehicle and run at fast idle and try to start the disabled one.
8. Crank the engine. As soon as the dead vehicle starts, disconnect the jumper cables in reverse order of connection.
9. Run the host vehicle at 2000 rpm to allow charging system to recharge the battery.

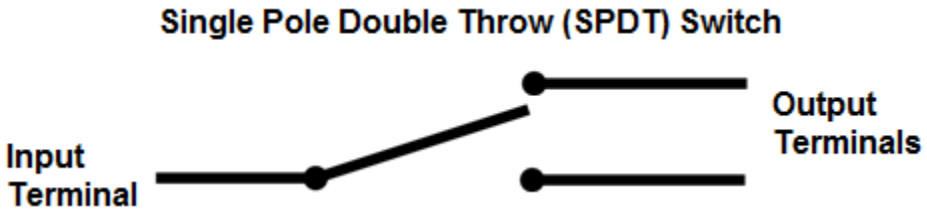
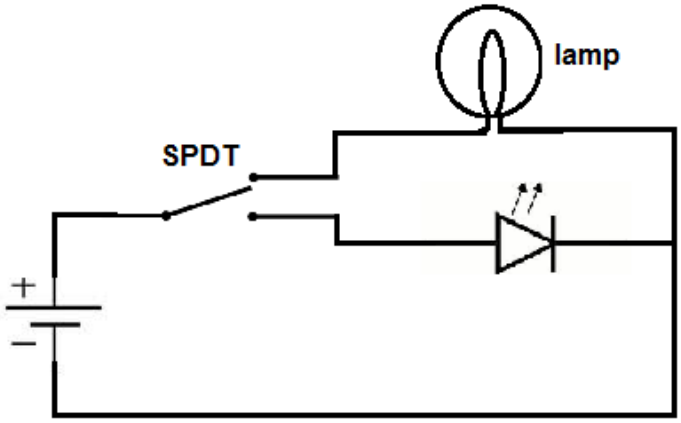
Connection Steps: 1-2-3-4 Disconnection Steps: 4-3-2-1

Using this method ensures that any possible sparks occur away from the battery.

Note: The battery jumper leads should be high quality and have large wire gauge (such as 4 gauge) to safely carry the current necessary to jump start a vehicle.

2

		 Jump Starting Sequence	2
		e) Draw neat labeled wiring diagram and describe working of temperature gauge.	**4**
		Answer : *(working – 2 marks & sketch – 2 marks) Credit should be given to equivalent sketch.* **Coolant Temperature gauge:** This gauge indicates engine coolant temperature. It should normally indicate between C (Cold) and H (hot). The sending unit is typically a variable resistor such as a thermistor. It regulates the current flow through the temperature gauge winding. With low coolant temperature, sender resistance is high and current low is low. The needle points to C. As coolant temperature increases, sender resistance decreases and current flow increases. The needle moves toward H. The temperature gauge on a digital panel is of the bar type with a set number of segments. The number of illuminated bars varies according to the current from the gauge sender. With low coolant temperature, sender resistance is high and few segments are turned on. As coolant temperature increases, sender resistance decreases and the number of illuminated segments increases. 	**2** **2**
		f) Enlist type of switches and explain any SPDT switch.	**4**
		Answer : *(Types -2 marks & SPDT switch description -2 marks)* **Types of switches:** • Single Pole Single Throw (SPST) • Single Pole Double Throw (SPDT) • Multiple Pole Multiple Throw (MPMT or Gang Switch) • Momentary Contact Switch • Mercury Switch • Bimetallic Switch (Temperature)	**2**

		Single Pole Double Throw (SPDT) switch: *(Description -1 marks & Sketch -1 marks)* A Single Pole Double Throw (SPDT) switch is a switch that only has a single input and can connect to and switch between 2 outputs. This means it has one input terminal and two output.  **Single Pole Double Throw (SPDT) Switch in Circuit:** ***(Credit may be given to any equivalent example)*** **OR** Below is an example of a circuit which utilizes a single pole double throw switch. You can see above how a SPDT can be wired up to put a circuit in either one of two modes. When the switch is connected one way, the lamp will turn on, while the LED is off. When connected the other way, the LED then turns on, and the lamp shuts off. This shows the dynamic 2-mode capacity that SPDT switches allow.  	**1** **1**
3		**Attempt any <u>FOUR</u> of the following.**	**16**
		a) Enlist any two function of starter drive and draw neat labelled sketch of bendix drive	**4**
		Answer : *(Any two functions- 2 marks,sketch-2 marks)* **Function:-** 1) To transmit the turning force to the engine when the starting motor runs and to disconnect the starting motor from the engine immediately after the engine has started. 2) To provide a gear reduction ratio between the starting motor and the engine. 3) When the engine starts and is running under its own power, the ring gear attempts to	**2**

drive the pinion gear faster than the starter motor. Thus to protects the starter motor from getting driven by the started engine, vehicle need starter drive. It is necessary to avoid damage of starter motor while engine is running, hence drives are used.

4) It ensures the starter motor engagement while cranking, and immediate disengagement upon engine starting. This prevents the engine from driving and damaging the starter.

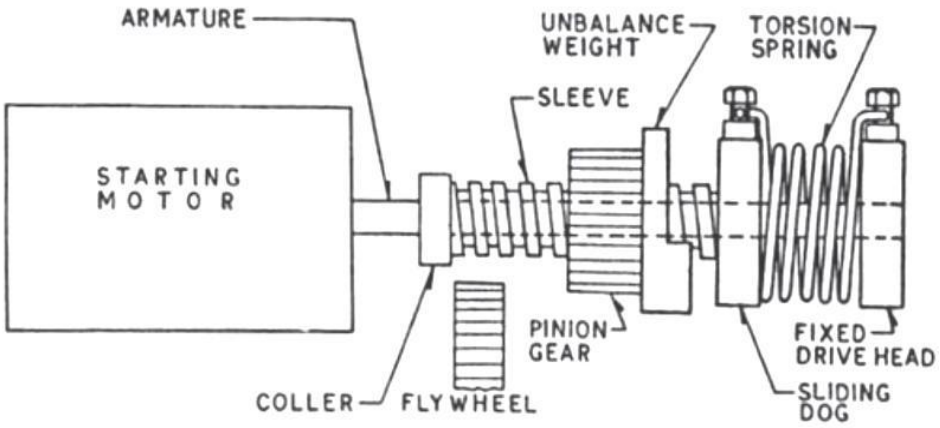


Fig. Bendix Drive

2

b) List four components of conventional ignition system and state there function

Answer:- *(List:1 mark,functions:3 marks)*

Components

i) Ignition coil
ii) Distributor
iii) Spark plug
iv) Condenser

i) Ignition Coil: An ignition coil (also called a spark coil) is an induction coil in an automobile's ignition system which transforms the battery's low voltage (6 to 12 volts) to the thousands of volts needed to create an electric spark in the spark plugs to ignite the fuel.

ii) Distributor:

- To interrupt the flow of current through the primary winding so that a high voltage is produced in the secondary winding.
- To distribute the high voltage surge to different plugs at the right moment.
- To provide advance/retard an ignition timing.

		• To provide drive to oil pump and mechanical fuel feed pump. **iii) Spark plug :** • Purpose of spark plug is to provide an arc to ignite the air fuel mixture within the combustion chamber of a SI engine. • Spark at the plug electrodes must be regular and synchronously timed with respect to the cylinder piston position at all speeds and loads of an engine. • The spark should be sufficiently strong so as to start proper ignition of even lean charge. • Being the hottest component in the SI engine, it dissipates the heat effectively to the cylinder head. This avoids abnormal combustion. • The duration of spark should be sufficient enough so as to sustain the flame and avoid flame quenching in turbulent mixtures. **iv) Condenser :** The condenser is used to prevent the arc action in case of ignition system with distributor contact points. Also improve the life of contact breaker points.	
		c) State the function of: **1) Crank shaft position sensor.** **2) Detonation sensor.**	**4**
		1) Function of the Camshaft position Sensor: *(2 marks)* 1. The camshaft sensor informs the PCM of the camshaft position relative to the crankshaft. By monitoring the camshaft position, the PCM remains informed as to the timing of the opening and closing of the intake valves. By monitoring the camshaft sensor and comparing it with the crankshaft sensor, the PCM knows when each cylinder is approaching top dead center and where the valves are positioned. 2. Ignition and fuel injector timing relies on this information. This is especially helpful with sequential fuel injection. Sequential fuel injection fires individual injectors at a specific point in the cylinder's compression stroke. The cam sensor (in conjunction with the crank sensor) also allows the PCM to determine which cylinder is on its compression stroke.	**2**

		2) Function of Detonation Sensor: *(2 marks)* 1. A large spark-advance is needed to obtain maximum power and economy from an engine. But when the spark is over-advanced, combustion knock will occur. To overcome this problem a detonation sensor is used. The detonation sensor detects the engine detonation and sends the voltage signal to the Engine control unit. The ECU uses the detonation sensor signal to control timing. **2.** The detonation sensor signal is an input to the ECM which then retards the computed ignition timing signal already advanced by the igniter circuit. i.e. the ignition timing is retarded to make the engine work without detonation.	**2**
		d) Describe the testing procedure of the following alternator components : **i) Rotor** **ii) Stator**	**4**
		Answer: **Rotor Testing:** *(2 marks)* Remove the rotor from end frame 1) Extract the retainer plate screws 2) Remove the retainer plate 3) Remove the end frame bearing 4) Remove the three attaching screws & separate the stator from end frame. 5) Attach one lead of a 110 volts test lamp or an ohmmeter to either slip ring & outer lead to the rotor- shaft or poles. 6) Note down reading of ohmmeter 7) Attach lamp or ohmmeter connections to each slip ring 8) Note down reading of ohmmeter or observe the lamp light 9) Connect 12 V battery and an ohmmeter in series with the slip rings of rotor 10) Record reading of ammeter 11) Connect an ohmmeter in series with slip ring of rotor 12) Record reading of ohmmeter **Stator Testing:** *(2 marks)* 1. Connect the test lamp or ohmmeter to the stator frame & one of the stator leads. 2. Record reading of ohmmeter / lamp illumination 3. Connect the test lamp or ohmmeter between each pair of stator leads	**2** **2**

		4. Record reading of the ohmmeter / lamp illumination. If the ohmmeter reads infinity between any two of the three stator windings, the stator is open and, therefore, defective. The ohmmeter should read infinity between any stator lead and the steel laminations. If the reading is less than infinity, the stator is grounded. Stator windings can be tested if shorted because the normal resistance is very low.	
		e) Enlist any four components of starting system and explain working of starting system circuit with neat sketch	**4**
		Answer: *(List-1 marks,working-2 marks, sketch-1marks)* **Components of starting system** 1) Battery. 2) Ignition switch 3) Neutral safety switch 4) Solenoid **Working :** The Electric Starter Motor converts electrical current into rotary motion. In doing so iconverts electrical energy into mechanical energy. The interaction of two magnetic fields produce this rotational force. The field coils (either electromagnetic or permanent) located in the housing produce magnetic flux lines. Within the stationary field coils is the armature, a loop of wire (conductor) with one end connected to B+, the other to B-. When current is applied to the armature flux lines circle the loop in one direction on one side and in the opposite direction on the other side. The interaction of the flux lines on the armature and the flux lines from the field coil cause the armature to rotate. The armature will only rotate to the point where the magnetic force is equal on both sides. (Armature 90o to magnetic flux lines of field) For the armature to continue to rotate, the polarity or direction of current flow must be reversed. Through the brushes and the commutator, the current flow is reversed as the magnetic forces become equal, causing the armature to continue to rotate. This constant reversal of current flow in the armature provides continual rotation.	**1** **2**

Sketch :

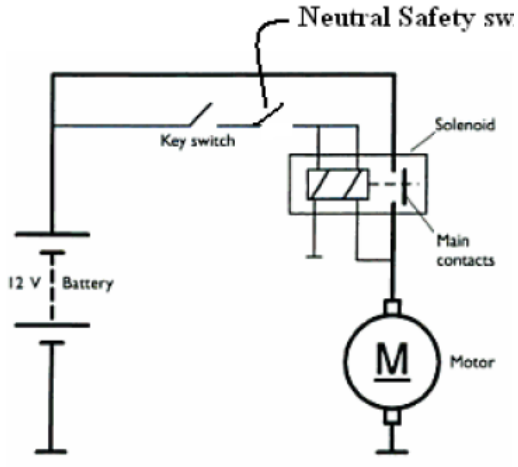


Figure: Basic Starter Circuit

1

4	a)	**Attempt any THREE of the following:**	12
		i) Differentiate between conventional and electronic ignition system	4

Answer (*any 4 points***)**

Sr. No.	Conventional ignition system	Electronic ignition system
1	Spark timing is not depends upon speed	Proper spark timing is achieved throughout the speed range
2	Moderate energy output from the ignition coil is obtained.	High energy output from the ignition coil is obtained.
3	Noise occurs during high speed	It gives noiseless operation at high speed;
4	Some carbon deposition occurs on Spark plug electrode .	Spark plug electrode remains clean off carbon deposits & ash deposits.
5	More Emissions occurs	Reduction in emission.
6	Less output power	Increased output power

ii) Describe the operation of distributor less ignition system with block diagram. 4

Answer: The Distributor less ignition system consists of three main components:

i. An ECU
ii. Crankshaft speed and crankshaft position sensor.

iii. Ignition coils

- The system is generally used for four cylinder or six cylinder engines. The basic principle is that of the 'Lost Spark'.
- The distribution of the spark is achieved by using two double ended coils, which are fired alternately by using ECU.
- The timing is determined by using information from a crank shaft speed and crankshaft position sensors as well as some other sensors such as engine load, coolant temperature and detonation sensor etc.
- The coil pack (2 ignition coils for four cylinder engine) gets triggered twice in each cycle of operation by using ECU, so that flow of current through one of the two primary windings is stopped.
- When the flow of current is stopped, the magnetic field in the primary winding collapses suddenly and a high voltage is produced in the secondary winding.
- When one of the coils is fired, a spark is delivered to two companion cylinders, either 1 and 4 or 2 and 3 for four cylinder engine, at the end of compression and exhaust respectively.
- The spark delivered to the cylinder on the compression stroke will ignite the mixture.
- The spark produced in the other cylinder will have no effect, as this cylinder will be completing its exhaust stroke.

2

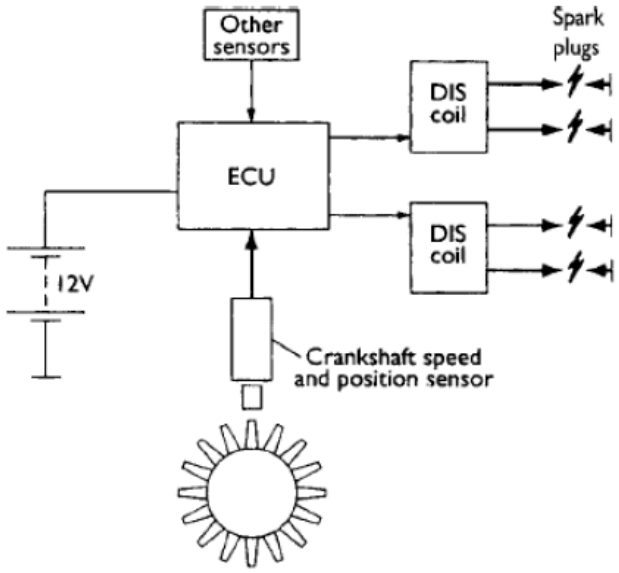


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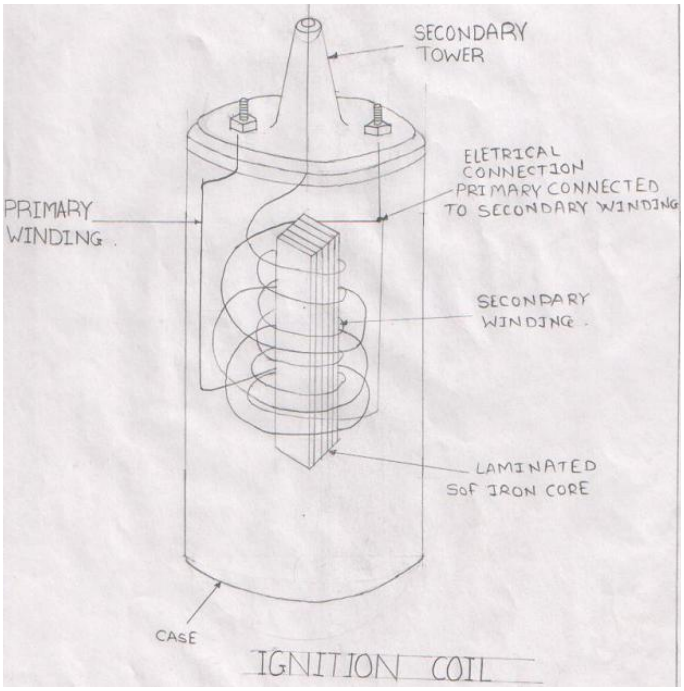
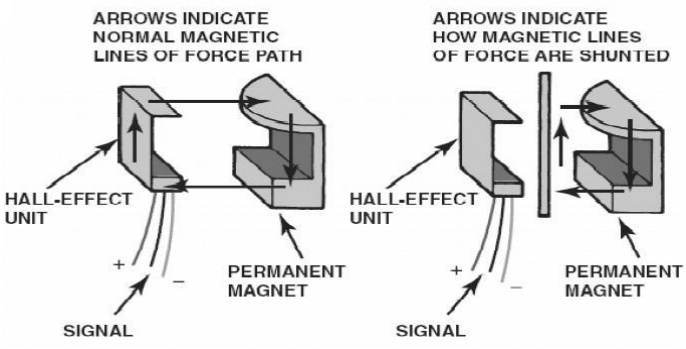
Figure: Block diagram of distributor less ignition system

		iii) Draw a neat labelled diagram of ignition coil	**4**
	1	**Answer:** *(diagram:3 marks, labelled: 1 marks)*  	
		iv) Enlist method of triggering primary circuit. Explain any one	**4**
		Answer: *(Method: 1 marks, Explanation: 2 mark & sketch 1 marks)* (*Credit should be given to appropriate description)* **Methods triggering primary circuit**. • Inductive pick up, • hall effect • Optical method. **Hall Effect** When a moving metallic shutter diverts the magnetic field from reaching the Hall sensor, the Hall-sensor produces a voltage signal. When the shutter blade moves and allows the magnetic field to reach the Hall sensor, the Hall-sensor does not generate voltage signal. After leaving the Hall layer, the signal is routed to an amplifier where it is conditioned, the signal is sent to the ECU (Primary circuit switching unit). The electronic control units can be designed to either turn on or turn off the ignition coil primary current when the shutter blades are blocking. As the central shaft of the distributor rotates, the chopper plate attached under the rotor arm alternately covers and uncovers the Hall chip. The number of vanes corresponds with the	**1** **2**

number of cylinders. In constant dwell systems the dwell is determined by the width of the vanes. The vanes cause the Hall chip to be alternately in and out of a magnetic field. The result of this is that the device will produce almost a square wave output, which can then easily be used to switch further electronic circuits

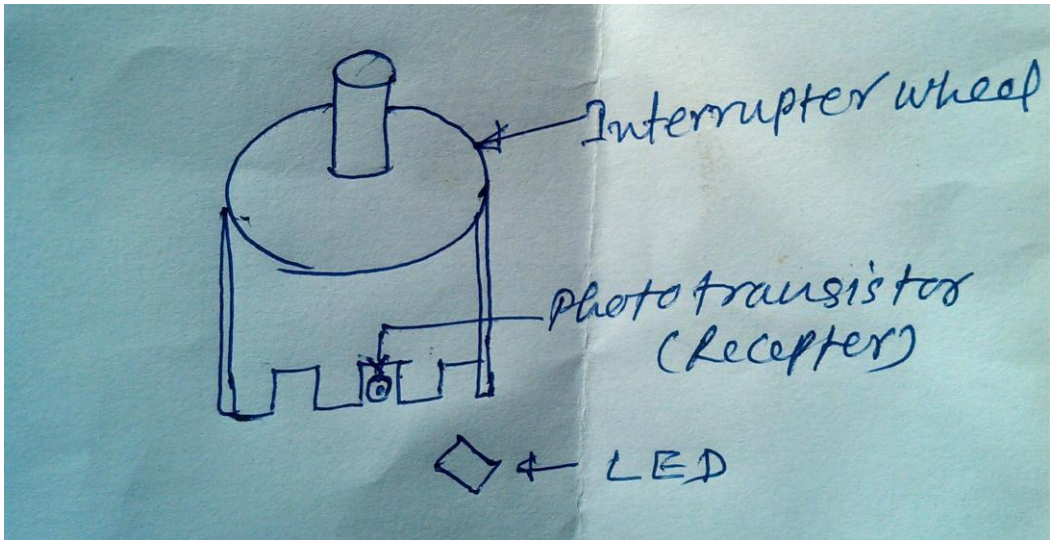


1

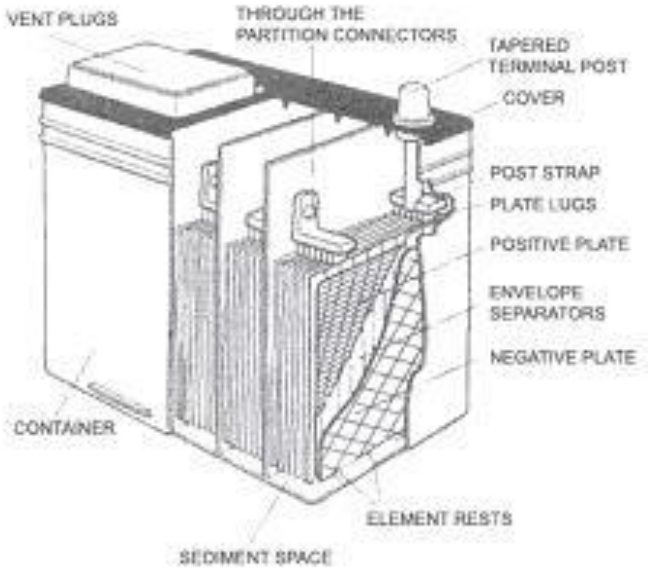
OR

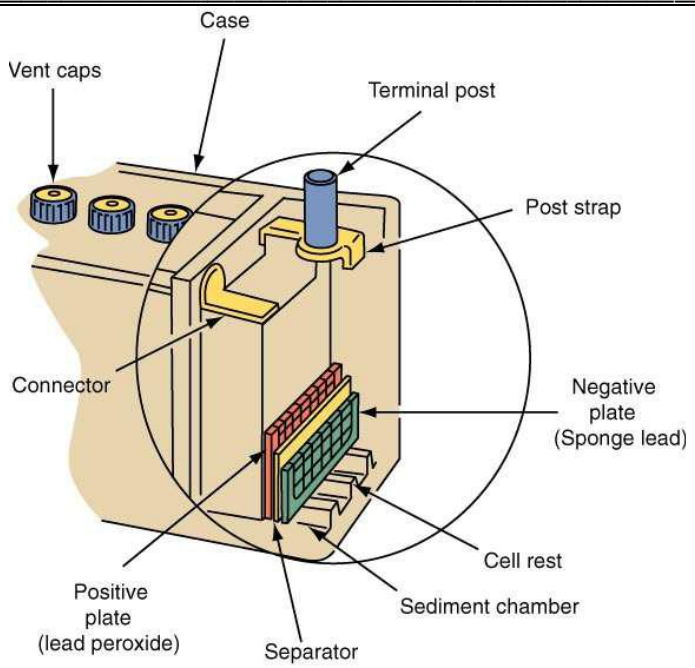
Optical method for triggering primary circuit:

• An optical triggering mechanism consists of a light emitting diode (LED) and a light sensitive photo transistor (photocell) and also a slotted disc called a light beam interrupter.
• The slotted disc is attached to the distributor shaft.
• The LED and photocell are situated over & under the slotted disc opposite to each other.
• As the slotted disc rotates between the LED and the photocell, light from LED shines through the slots.
• The intermittent flashes of the LED are translated into voltage pulses by the photocell.
• Where the voltage signal occurs, the control unit turns 'ON' the primary circuit.
• when the disc interrupts the light and the voltage signal is not given, the control system turns the primary circuit 'OFF' causing the magnetic field in the primary coil to collapse and sending high voltage to the spark plug through secondary winding.



1

	b)	**Attempt any <u>ONE</u> of the following.**	**6**
		i) Describe the construction and working of lead acid battery.	**6**
		Answer: *(construction – 2marks, working- 2 marks, Diagram - 2 marks)* **Construction of lead acid battery:** Batteries are made of five basic components: i. A resilient plastic container. ii. Positive and negative internal plates made of lead. iii. Plate separators made of porous synthetic material. iv. Electrolyte, a dilute solution of sulfuric acid and water, better known as battery acid. v. Lead terminals, the connection point between the battery and whatever it powers. A battery consists of number of cells, generally six for 12V battery. Each cell consists of positive and negative plates separated by a separator and connected in series with positive and negative terminals of battery respectively. The plates are immersed in a solution of sulfuric acid, which acts as electrolyte. Each plate consists of a grid upon which is attached the active material, lead dioxide on the negative plates, pure lead on the positive plates.  **OR**	**2** **2**



Working:
When the battery is discharged (when it is subjected to an electrical load), acid from the electrolyte combines with the active plate material. This releases energy and converts the plate material to lead sulfate. The electrolyte becomes less acidic in the process, and the specific gravity of the solution drops. When a battery is recharged, the opposite occurs: the lead sulfate reverts back to active material, and the electrolyte becomes more acidic with a higher specific gravity. The chemical reaction during discharging is as below:

$Pb + PbO2 + 2H2SO4 \rightarrow 2PbSO4 + 2H2O$

2

ii) Describe the construction and working of alternator. **6**

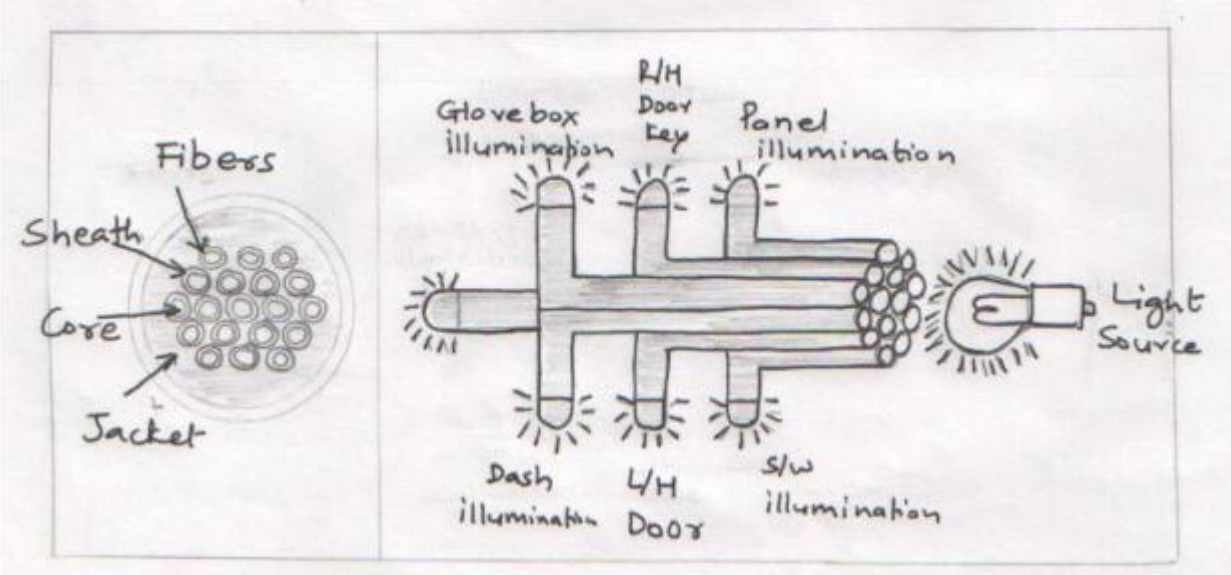
Answer: Construction – 3 marks and working -3 marks. Credit should be given to Schematic diagram showing working principle. **3**

Construction of Alternator:
Alternator consists of following components:
i. Stator
ii. Rotor mounted on alternator shaft
iii. Drive end Frame or Housing
iv. Rectifier end Frame or Housing
v. Voltage regulator & rectifier
vi. Slip rings & brushes
vii. Pulley & cooling fan
Alternator stator, rotor, rectifier and regulator are assembled using two end frames, made of aluminium for better heat dissipation. Power diodes are embedded in a heat sink and are mounted on an insulated plate. The cooling fan is connected to the drive shaft. The rotor houses field winding and provides the magnetic field across the two pieces. The stator is a laminated construction with the stator winding wound in three phases. Each phase is soldered to the pair of diodes. The slip ring and brush arrangement provides electrical connection across

		the regulator and field winding. **Working of Alternator:** As alternator gets drive from the engine, rotor provides rotating magnetic field. The conductors in the stator are subjected to changing magnetic field. Due to change in magnetic field, associated with the stator windings AC is generated. This AC current is rectified using power diodes. The alternator receives current for excitation from battery. The alternator output is regulated by a voltage regulator and it is connected to battery using a diode trio.	**3**
5		**Attempt any FOUR of the following.**	**16**
		a) Describe the operation of Automatic Headlight dimming.	**4**
		Answer: **(*Description – 4 marks & credit should be given to sketch)*** Automatic Headlight Dimming automatically switches the headlights from high beams to low beams under two different conditions: • When light from oncoming vehicles strikes the photocell-amplifier, or • Light from the taillights of a vehicle being passed strikes the photocell-amplifier. Modern automatic headlight dimming systems use solid-state circuitry and electromagnetic relays to control the beam switching. **Most systems consist of the following major components:** 1. Light sensitive photocell and amplifier unit. 2. High-low beam relay 3. Sensitivity control 4. Dimmer switch 5. Flash-to-pass relay 6. Wiring harness • The photocell is a variable resister that uses light to change resistance. The photocell-amplifier is usually mounted behind the front grill. • The sensitivity control is a potentiometer which sets the intensity level at which the photocell amplifier will energize. • The sensitivity can be adjusted to the surrounding ambient light conditions by the driver with the help of a control knob. • An increase in the sensitivity level will make the headlights switch to a low beam sooner (Approaching vehicle is far away). • A decrease in the sensitivity level will switch the headlights to low beams when the approaching vehicle is closer.	
		b) Describe the testing procedure of oxygen sensor	**4**
		TEST PROCEDURE USING A SCAN TOOL A good oxygen sensor should be able to sense the oxygen content and change voltage outputs rapidly. How fast an oxygen sensor switches from high (above 450 m V) to low (below 350 m V) is defined by use of oxygen sensor *cross counts.* One cross count is the change of an oxygen sensor voltage from high to low (from low to high voltage is not counted) in 1 second (or 1.25 seconds, depending on scan tool and computer speed). Typical oxygen sensor cross counts	

		include: NOTE: Oxygen sensor cross counts can be determined using a scan tool or other suitable tester that reads computer data information or frequency. Carburetted engine at 2,000 engine rpm: more than 3 cross counts are normal. Fuel-injected engine at 2,000 engine rpm: more than 10 cross counts are normal In cases, the higher the number of cross counts, the better. If the cross counts are low (or zero), the oxygen sensor may be contaminated or the fuel delivery system is delivering a constant rich or lean air/fuel mixture. **OR** **TEST PROCEDURE WITHOUT A SCAN TOOL** The oxygen sensor can be checked for proper operation using a digital high-impedance voltmeter. *Step* 1. With the engine off, unplug the oxygen sensor at the terminal. *Step* 2. Install a jumper wire (or wires if an electrically heated oxygen sensor). NOTE: The jumper wire permits access to the electrical connection between the sensor and the computer and still maintains the correct operation of the system. A breakout box can also be used instead of using a jumper wire. *Step* 3. Start the engine and allow it to reach closed-loop operation. *Step* 4. In closed loop, the oxygen sensor voltage should be constantly changing as the fuel mixture is being controlled. **Results:** If the oxygen sensor fails to respond and its voltage remains about 450 m V, the sensor may be defective and require replacement. Before replacing the oxygen sensor, check the manufacturer's recommended procedures. If the oxygen sensor reads high all the time (above 550 m V), the fuel system could be supplying too rich a fuel mixture or the oxygen sensor may be contaminated. If the oxygen sensor voltage remains low (below 350 m V), the fuel system could be supplying too lean a fuel mixture. Check for a vacuum leak or partially clogged fuel injector(s). Before replacing the oxygen sensor, check the manufacturer's recommended procedures.	
		c) Explain fibre optics in automotive electronics.	**4**
		Answer: : (Description- 2 marks each,applications-2 & *credit should be given to sketch*) **Working** • The invention of fiber optics has provided a means of illuminating several objects with a single light source. • Plastic fiber optic strands made from a special plastic (**polymethylmethacrylate plastic)** are used to transmit light from the source to the object to be illuminated. • This plastic helps to keep the light rays parallel even in the presence of extreme bends in the plastic. • The strands of plastic are sheathed by a polymer that insulates the light rays as they travel within the strands. • The light rays travel through the strands by means of internal reflections.	

Some of the application of fiber optics include:
• Fender-mounted turn signal lights
• lighting ash trays
• illuminating instrument panels
• dash lighting over switches
• Ignition key "halo" light.
• Door Keys
• Panel Illumination
• Dash illumination



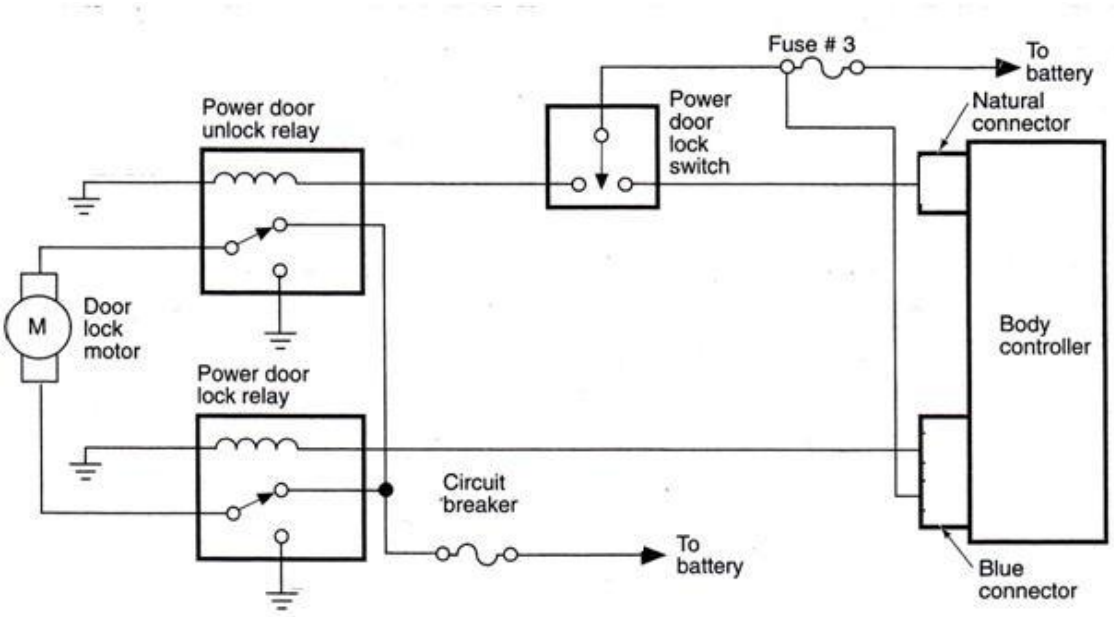
d) State the purpose of OBD -II. **4**

Answer: *(Any four purpose -1 Mark each)*
Purposes of OBD-II: (*any four*)
1. To enable the computer systems to monitor the ability of systems and components to maintain low emission.
2. The standardized data link connector, that allows for these tools to communicate with the PCM.
3. Identifying faults in the computer-controlled systems and to notify the driver by means of a malfunction indicator light if the emission related fault causes an increase in emission up to 1.5 times the allowable standard.
4. In addition a diagnostic trouble code (DTC) was stored in the computer's memory.
5. For easier diagnosis of a problem by a technician by using added information stored in the PCM.
6. It brings standardization in components and systems used by various automobile manufacturers. e.g. Data link connectors, data circuits, diagnostic tests and diagnostic trouble codes and generic codes.
7. It provides almost complete engine control and also monitors parts of the chassis, body and accessory devices, as well as the diagnostic control network of a vehicle.

		e) Write the procedure for sound test for testing electronic fuel injector.	**4**
		Answer: **Procedure for sound test for testing electronic fuel injector:** The use of auto fuel injectors is a sophisticated way to provide the right fuel and air mix to an engine for a vehicle. The small cylindrical fuel injectors play a specific role in a larger fuel intake system, along with other elements like the fuel pump and the fuel tank. Over time, fuel injectors may need to be maintained or checked for proper functioning. 1. The electronic fuel injection system relies on electronic signals that control how these items operate 2. Along with checking a fuel injector electronically, you can listen for certain kinds of sounds that will tell you when a fuel injector might not be working correctly. 3. A clunking sound or similar warning sound may show that the fuel injector is not functioning the way it should. 4. If the injector electrical leads are difficult to access, an injector power balance test is hard to perform. As an alternative, start the engine and use a technician stethoscope to listen for correct injector operation. 5. A good injector makes a rhythmic clicking sound as the solenoid is energized and de energized several times each second. 6. If clunk- clunk instead of steady click-click is heard, chances are the problem injector has been found. 7. Cleaning or replacement is in order. 8. If an injector does not produce any clicking noise, the injector, connecting wires or PCM may be defective. 9. When the injector clicking noise is erratic, the injector plunger may be sticking. 10. If there is no injector clicking noise, proceed with the injector resistance test and light to locate the cause of problem. 11. If a stethoscope is not handy, use a thin steel rod, wooden dowel, or fingers to feel for a steady on/off pulsing of the injector solenoid.	
		f) Describe the operation of common anti-theft system	**4**
		Answer: **Working of common anti-theft system:** Anti-theft systems are warning systems designed to scare off car thieves by sounding alarms and/or disabling the ignition system. The common components include: • An electronic control module • Door switches at all doors • Trunk key cylinder switch • Hood switch • Starter relay • Horn relay	

		• Alarm For the system to operate, it must first be armed. This is done when the ignition switch is turned off and all the doors are locked electrically by either the door switches or the remote keyless system. When the system is armed, a security light will illuminate for approximately 30 seconds and is ready to function. If any one of the doors is open, the system will not arm until it is closed. The alarms are triggered by any of the following events: • Opening any door without using the key in one of the front doors. • Removing the trunk lock cylinder. • Turning the ignition switch to the ON position. • Opening the hood. Once the alarm is triggered, the module flashes the park and tail lamps, sounds the horn, and signals the PCM to prevent injector operation.	
6		**Attempt any <u>FOUR</u> of the following.**	**16**
		a) Describe the automatic door lock system.	**4**
		Answer: Description – 4 marks. Credit should be given to equivalent Sketch. **Operation of automatic door lock system:** Motors used in power door locks are of permanent magnet type and are operated through a relay by conventional switches. These motors are controlled by a double pole double throw switch that is externally grounded. A clockwise rotation of the motor output shaft extends the shaft to unlock the door. When polarity is reversed, the output shaft rotates anticlockwise retracting the shaft to lock the doors. The purpose of automatic door lock system is to prevent entry to engine, passenger and trunk compartments of the car as well as to prevent a thief from driving the car away. The automatic door lock system is an additional safety and convenience system. The system may use the body computer to control the door lock relays, or a separate controller. The controller (or body computer) takes the place of the door lock switches for automatic operation.	

Automatic door lock system:



b) Explain the working of MAP sensor. **4**

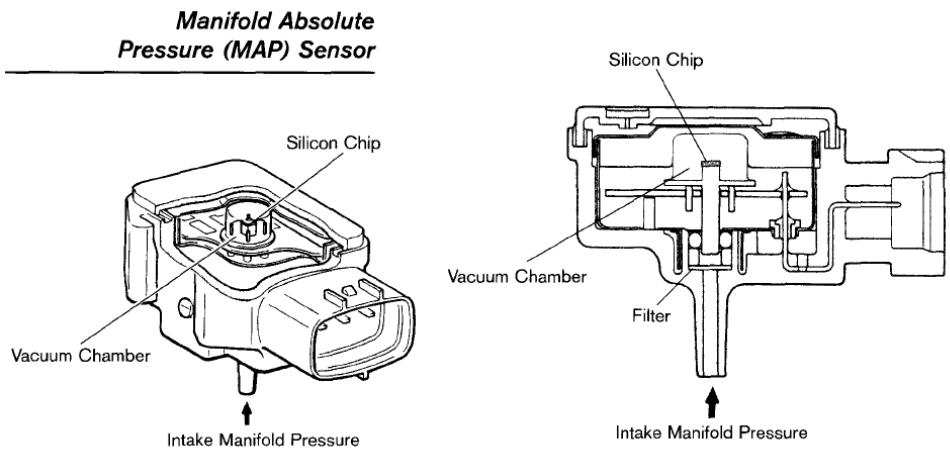
Answer: Description – 4 marks. Credit should be given to equivalent Sketch.

Working of MAP sensor:

In the MAP sensor there is a silicon chip mounted inside a reference chamber. One side of the chip is the reference pressure. This reference pressure is a calibrated pressure; On the other side is the pressure to be measured. The silicon chip changes its resistance with the change in pressure. This change in resistance alters the voltage signal which tells the ECU there was a change in pressure.

There are two types that are commonly used. One of these gives a variable voltage output to represent.

In variable voltage MAP sensor, it receives a 5 V supply from the ECU. Variations in manifold pressure (vacuum) cause the small silicon diaphragm to deflect. This deflection alters the resistance of the resistors in the sensor's bridge circuit and the resulting electrical output from the bridge circuit is proportional to manifold pressure.



c) Define the following terms: **4**

i) Drive Cycle

ii) Trip

Answer: ***(Equivalent points should be given credit)***

i) Drive cycle: **2**

A drive cycle may be defined as an engine startup and vehicle operation that allows the PCM to enter closed loop and allows all the monitors to complete their function.

OR

An OBD- II drive cycle is a method of driving that begins with an engine starts. The engine is then run until the system goes into closed loop. The drive cycle continues to include whatever specific operating conditions are necessary either to initiate and complete a specific monitoring sequence or to verify a symptom or verify a repair.

ii) Trip: **2**

A trip is defined as an engine operating drive cycle that contains all of the necessary conditions for a particular test to be performed.

OR

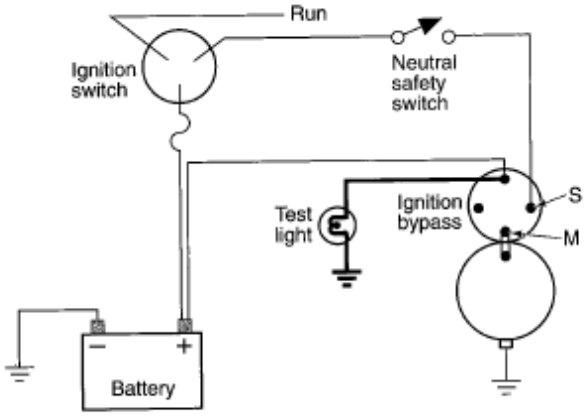
A trip for a particular diagnostic test is defined as a key on and key off cycle in which all the enabling criteria for a given diagnostic test have been met.

d) Describe the operation of keyless entry system. **4**

Answer:*(Explanation 4 Marks, credit given to equivalent figure)*

The keyless entry system allows the driver to unlock the doors or trunk lid from outside the vehicle without using a key. The main components of the keyless entry system include:

		1) A control module 2) A coded button keypad located on the driver's door 3) Door lock motors The keypad consists of five normally open, single-poles, and single-throw switches. Each switch represents two numbers 1-2, 3-4, 5-6, 7-8, 9-0. The keypad is wired into the circuit to provide input to the control module. The control module is programmed to lock the doors with door lock motors when the 7-8, and 9-0 switches are closed at the same time. The driver's door can be unlocked by entering a five-digit code through the keypad. Remote controlled keyless entry systems are also available. They use a hand held transmitter attached as a key chain. It can be operated within a range of 25 to 50 feet and from any direction. The operating is done by a button press, then driver door is unlocked, theft security is disarmed. During exit, lock button locks all doors.	
		e) Explain the free speed testing procedure in starting system.	**4**
		Ans: (Step wise Procedure – 4 mark & Credit should be given to equivalent sketch) The free speed test determines the free rotational speed of the armature. This test is also referred to as the no-load test. With the starter removed from the vehicle perform the test as follows: 1. Place the starter motor into a secure vise. 2. Attach an rpm indicator to the armature shaft at the drive housing end. 3. Connect a remote starter switch between the BAT and S terminals of the solenoid. 4. Connect the jumper cables, as shown the below figure. 5. Connect the large red and black test leads of the tester across the battery, observing the polarity. 6. Select INT 18V. 7. Zero ammeter 8. Connect the green amps inductive probe around the jumper cable from the battery negative terminal to starter frame. 9. Place the teat selector to the STARTING position. 10. Load the battery by rotating the load control knob until a voltage reading of 10 volts is obtained. 11. Switch to EXT 18V position. 12. Close the remote starter switch while reading the ammeter, voltmeter and Tachometer scales.	



6000 to 12000 rpm with a current draw of 60 to 85 amperes. Voltage should remain at 10 volts. If the test results are within specifications, the starter motor is ready to be reinstalled into the vehicle

If the current draw was excessive and rpm slower than specifications, there is excessive resistance to rotation. This could be caused by – worn bushings or bearings, shorted armature, grounded armature, shorted field windings, and bent armature.

If there was no current draw and the starter did not rotate, this could be caused by - open field winding, open armature winding, broken brush or brush spring.

Low armature speed with low current draw indicates excessive resistance. There may be poor connections between the commutator and the brushes.
If the armature speed and current draw readings are high, checks for a shorted field winding.