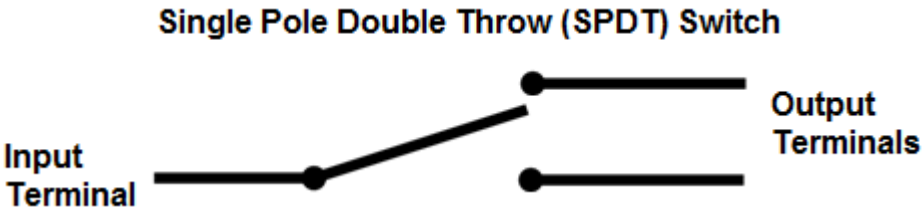
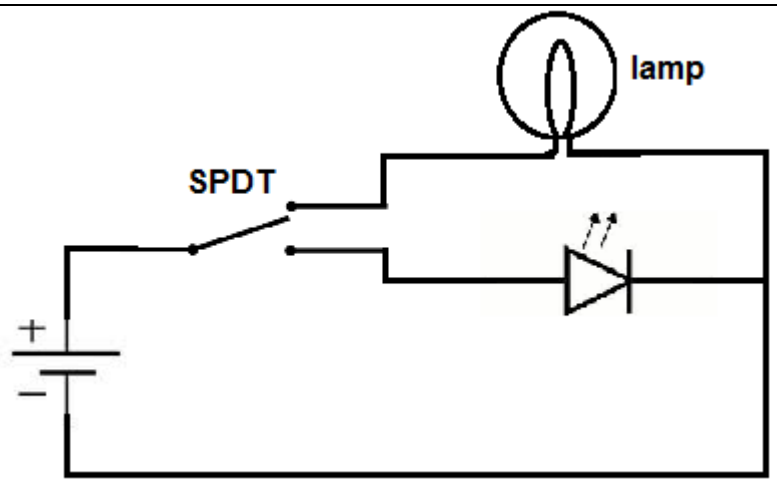
Important Instructions to examiners:
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Model Answer	Marks
Que.1. A) Attempt any THREE of the following.	**12**
a) With a neat sketch illustrate an example of SPDT switch.	**04**
Ans: (Description -2 marks & Sketch -2 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 terminals.  **Example of Single Pole Double Throw (SPDT) Switch in Circuit:** **(Credit may be given to any equivalent example)** 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.	**04**



b) Define battery rating. State two types of battery ratings — **04**

Ans: (definition - 1 mark, explanation of any two types - 03 mark)

Battery ratings: It is a measure of the energy stored in the battery. It is expressed in terms of the period during which the battery will give the rated current before it reaches the specified final voltage. — **01**

Types of Battery ratings: (Any TWO)

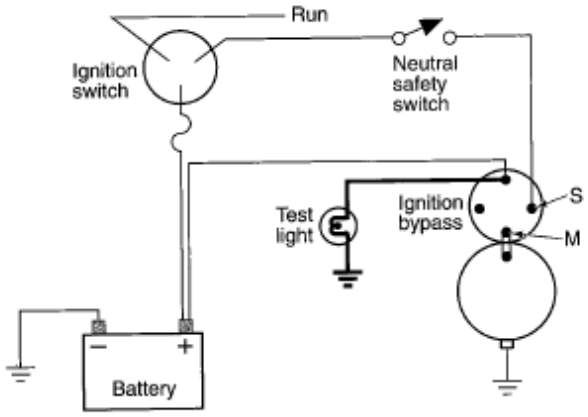
1. Ampere-hours (A-h) is the product of the time that a battery can deliver a certain amount of current (in hours) times that current (in amperes), for a particular discharge period. This is one indication of the total amount of charge a battery is able to store and deliver at its rated voltage. This rating is rarely stated for automotive batteries, except in Europe where it is required by law.

2. Cranking amperes (CA) also sometimes referred to as marine cranking amperes (MCA), is the amount of current a battery can provide at 32 °F (0 °C). The rating is defined as the number of amperes a lead-acid battery at that temperature can deliver for 30 seconds and maintain at least 1.2 volts per cell (7.2 volts for a 12 volt battery).

3. Cold cranking amperes (CCA) is the amount of current a battery can provide at 0 °F (−18 °C). The rating is defined as the current a lead-acid battery at that temperature can deliver for 30 seconds and maintain at least 1.2 volts per cell (7.2 volts for a 12-volt battery). It is a more demanding test than those at higher temperatures. — **03**

4. Hot cranking amperes (HCA) is the amount of current a battery can provide at 80 °F (26.7 °C). The rating is defined as the current a lead-acid battery at that temperature can deliver for 30 seconds and maintain at least 1.2 volts per cell (7.2 volts for a 12-volt battery).

5. Reserve capacity minutes (RCM) , also referred to as reserve capacity (RC), is a battery's ability to sustain a minimum stated electrical load; it is defined as the time (in minutes) that a lead-acid battery at 80 °F (27 °C) will continuously deliver 25 amperes before its voltage drops below 10.5 volts.

c) State the procedure to conduct free speed test.	**04**
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 wise. 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 test 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.  Compare the test results with manufactures specifications. General specifications will be about 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.	**04**

d) State the need of ignition system. Enlist any four components used in ignition system.	**04**
Ans: (Need of ignition system -2marks and Components of ignition system- 2 marks) **Need of ignition system:** • To ignite the compressed air fuel mixture in the engine's combustion chamber. • The ignition should occur at the proper time for combustion to begin. • To start combustion, the ignition system delivers an electric spark that jumps a gap at the combustion chamber ends of the spark plugs. • Ignition system is required to provide sufficient heat to burn the air-fuel mixture • Ignition system should be required to maintain heat for specific time to achieve complete combustion. **Ignition systems consists of components under two categories: (any four of the following)** **Primary Ignition circuit includes following components:** • Battery • Ignition switch • Ballast resistor • Starting by pass • Ammeter • Ignition coil primary windings • Triggering device • Switching device or control module • Ground **Secondary Ignition circuit includes following components:** • Ignition coil Secondary windings • Distributor cap & rotor • Ignition cables • Spark plugs	**02** **02**
Que.1. B) Attempt any <u>ONE</u> of the following.	**06**
a) Draw a neat circuit diagram to describe testing of circuit defects for **i) Open Circuit** **ii) Short Circuit**	**06**
Ans: (Equivalent sketch -2 mark & description -1 marks each circuit defect) **1. 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.	**1**

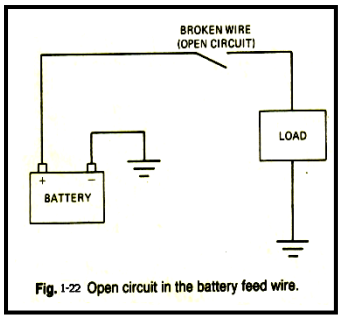


Fig. 1-22 Open circuit in the battery feed wire.

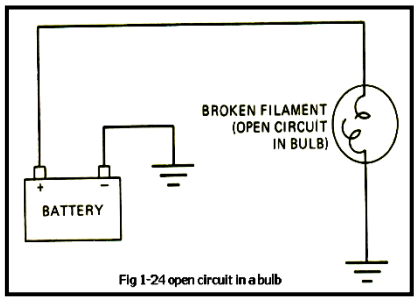


Fig 1-24 open circuit in a bulb

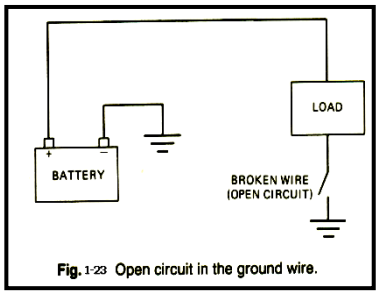


Fig. 1-23 Open circuit in the ground wire.

2

2. Short circuit: (student should explain with any one similar simple sketch)

When the feed or switch wire insulation is damaged and the conductor touches the metal frame, some or all of the current will take this 'easy' path to earth. This alternative path offers the current a short path back to the battery, so the term SHORT CIRCUIT is used to describe this condition. **1**

The extent of the short-to-earth, i.e. the resistance of the alternative path, governs the potential difference that is left to act on the lamp in figure. As the resistance in the short circuit path is reduced, the potential difference across the lamp is also reduced so the effect of the voltage reduction will be a proportional decrease in the lamp brightness.

A dead short describes a very low resistance path to the earth. When this occurs, the very high current flow that results will soon make the cable glow red-hot. This melts the plastic covering of the cable and often starts a fire. Some circuit – protection device such as a fuse is needed if this danger is to be avoided.

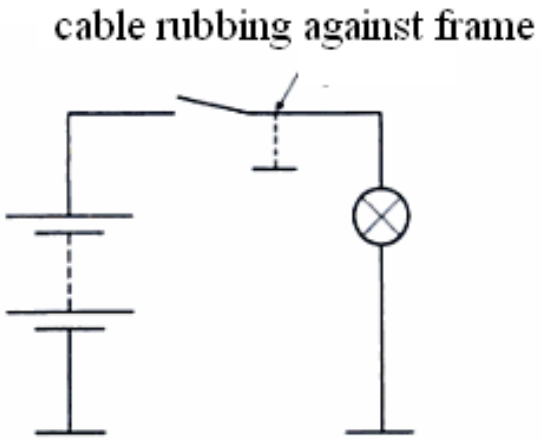


Fig. Short circuit

OR

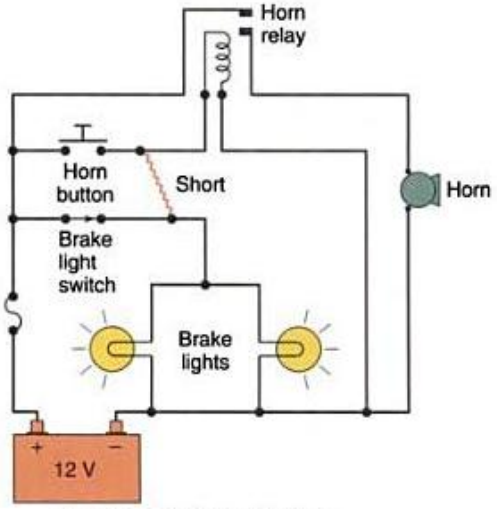
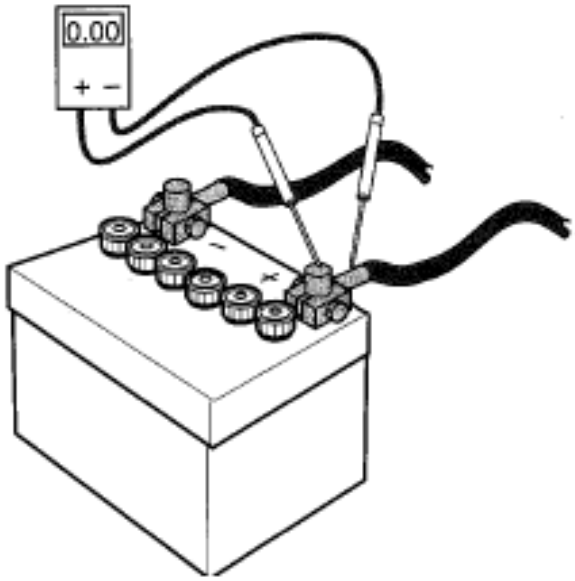


Figure A wire-to-wire short.

2

b) State the importance of battery terminal test. Describe the procedure to conduct the test.	**06**
Ans: (Equivalent Sketch – 2 marks & Description – 4 Marks) The Battery terminal test checks for the poor electrical connections between the battery cables and terminals. This simple test will establish whether or not the terminal connection is good. It is good practice to perform this test anytime the battery cable is disconnected and reconnected to the terminals. By performing this test, comebacks, due to loose or faulty connections, can be reduced. Connect the negative voltmeter test lead to the cable clamp and connect the positive meter lead to the battery terminal as shown in figure. Disable the ignition system to prevent the vehicle from starting. This may be done by removing the ignition coil secondary wire from the distributor cap and putting it to ground  Crank the engine and observe the voltmeter reading. If the voltmeter shows over 0.3 volts, there is a high resistance at the cable connection. Remove the battery cable using the terminal puller. Clean the cable ends and battery terminals.	**4** **2**

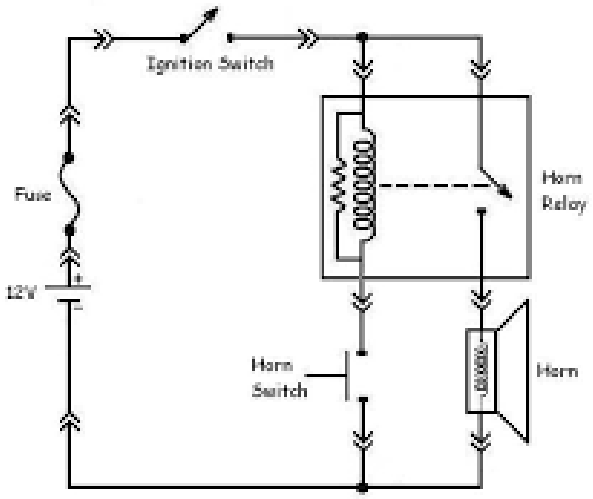
Que.2. Attempt any FOUR of the following.	**16**
a) Describe the operation of relay used in a horn circuit.	**04**

Ans: (Equivalent Sketch – 2 Marks & Description – 2 marks) **2**

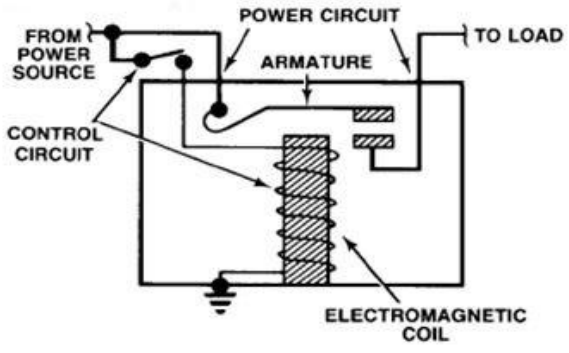
Purpose of relay is to control a larger current carrying circuit with the use of small current carrying circuit. A Relay is an electric switch that allows a small amount of current to control a high-current circuit. When the control circuit switch is open, no current flows to the coil of the relay, so the windings are de-energized.

The most common type of circuit control is to use a relay. Most circuits have battery voltage present to the lower contact plate of the horn switch. When the switch is depressed, the contacts close and complete the circuit to ground. Only the low current is required to operate the relay coil, so the horn switch does not have to carry the heavy current requirements of the horns.

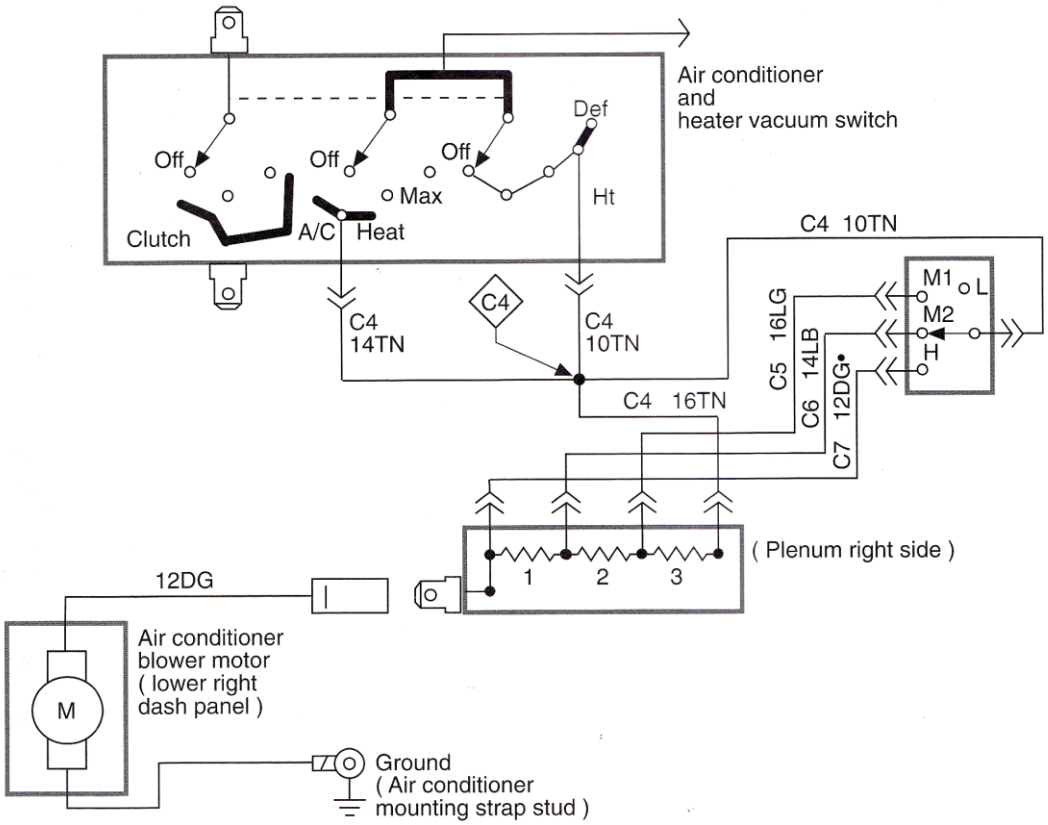
When the horn switch is closed, it energies the relay core. The core attracts the relay armature, which closes the contacts and completes the horn circuit. Current flow from the battery to the grounded horns.



OR **2**



(Credit may be given to equivalent figure)

b) Draw a neat simplified wiring diagram of a blower motor.	**04**
Ans : (Credit may be given to Equivalent Circuit diagram)  	**4**
c) Enlist the different components used in an alternator. State importance of voltage regulator.	**04**
Ans: (Listing – 2 Marks & Importance – 2 marks) **Alternator consists of following components: (any Four – ½ marks each)** 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 **Importance of Voltage Regulator: (any Two- 1 mark each)** • Voltage regulator prevents the generation of excessive voltage, thus avoiding damage to the electric units and also overcharging of the battery. • The voltage regulator limits the maximum voltage in the electrical system. • The voltage regulator will also cause the alternator to produce more output, when voltage (pressure) at the electrical system is low. • When the battery is connected to the generator, its voltage will increase until the predetermined voltage is reached. At this stage contacts of the regulator will start opening and closing to maintain required voltage.	**2** **2**

d) State the function of fusible link. Under which condition a fusible link is used?	**04**
Ans: (Function – 2 marks & condition – 2 marks) **Functions of Fusible link:** • Fusible links are short pieces of a smaller diameter wire designed to melt during an over current condition. • The insulation of a fusible link is a special nonflammable material. This allows the wire to melt, but the insulation to remain intact for safety. • It provides protection for the main power wires before they are divided into smaller circuits at the fuse box. • When there is an overload in the circuit, the link melts and opens the circuit. However like fuses, fusible links must be replaced after they have "blown" or melted opened. **Under which condition a fusible link is used:** • Fusible links are used under the conditions where there is need to provide protection for the main power wires before they are divided into smaller circuits at the fuse box. • Fusible links are used in circuits where limiting the maximum current is not extremely critical. • Fusible links are used by the rated current at which they are designed to blow.. • The current capacity is usually determined by its size. • A circuit using 14-gauge wire requires an 18-gauge fusible link for protection.	**2** **2**
e) With a neat sketch describe the working of engine oil pressure gauge.	**04**
Ans: *(Diagram- 2 marks and Explanation- 4 marks. Similar sketch and description should be considered.)* **Engine Oil Pressure Gauge:** **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.	**4**

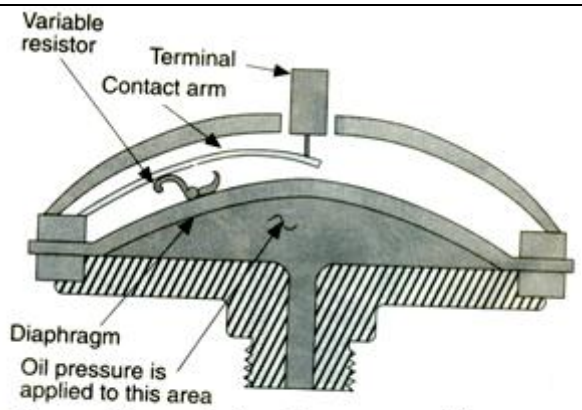


Figure: Piezoresistive Sensor used for measuring Engine oil pressure

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.

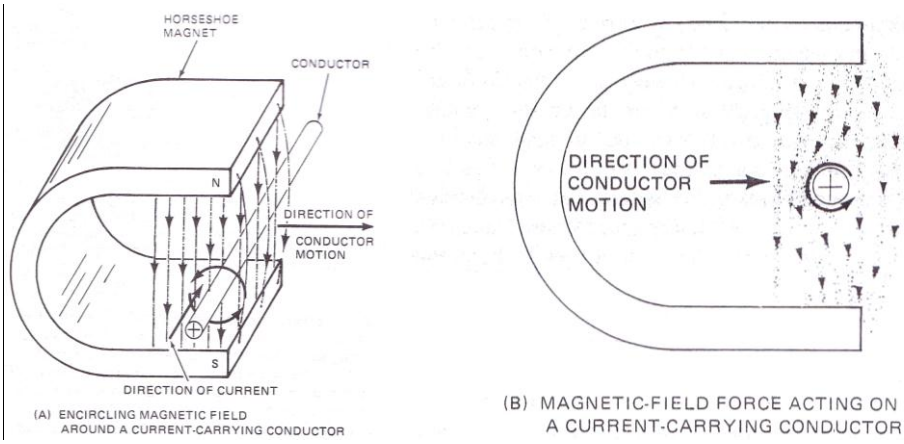
With low oil pressure (or with the engine shut off), the oil pressure switch is open and no current flows through the gauge winding. The needle points to L. With oil pressure above a specific limit, the switch closes and current flows through the gauge winding to ground. A resistor limits current flow through the winding and ensures that the needle points to about mid-scale with normal oil pressure.

f) State the working principle of starter motor. Give the specification of a starter motor used in a 1000 CC petrol engine. **04**

Ans: (working Principle description – 2 marks & specification -2 marks) **2**

Working principle of starter motor: (Credit should be given to sketch)

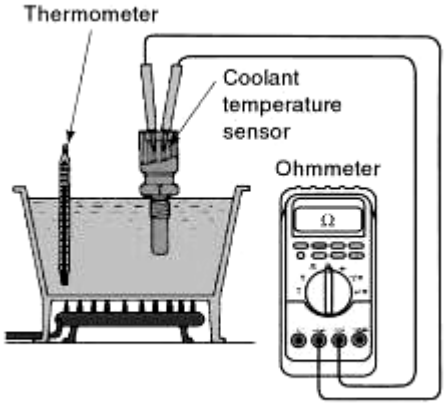
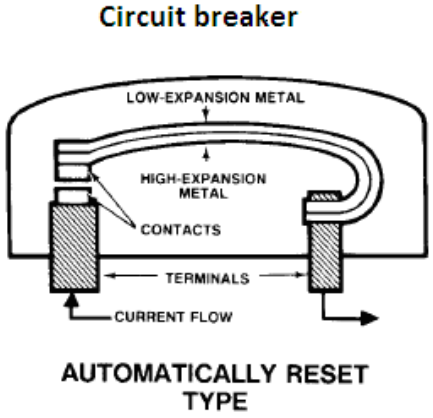
When current flows through a conductor, a magnetic field builds up around that conductor. If the conductor is in a magnetic field, as from a horse shoe magnet, the magnetic field exerts a force on the conductor. This is shown in figure. The cross in the center of the conductor indicates the current is flowing away from the reader. This causes the magnetic field due to the current flow to encircle the conductor in a counterclockwise direction.

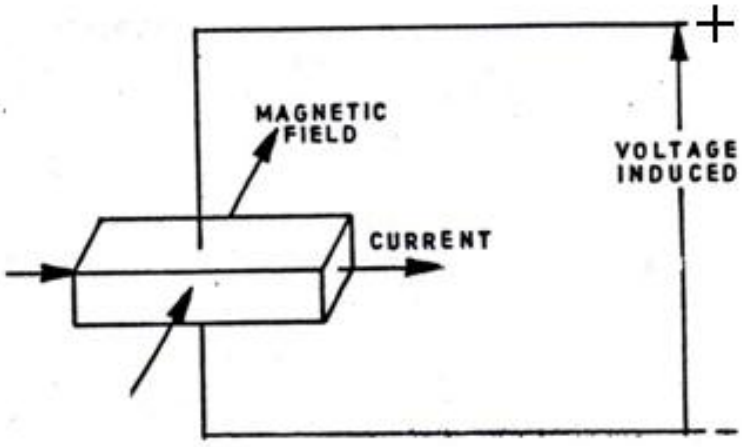
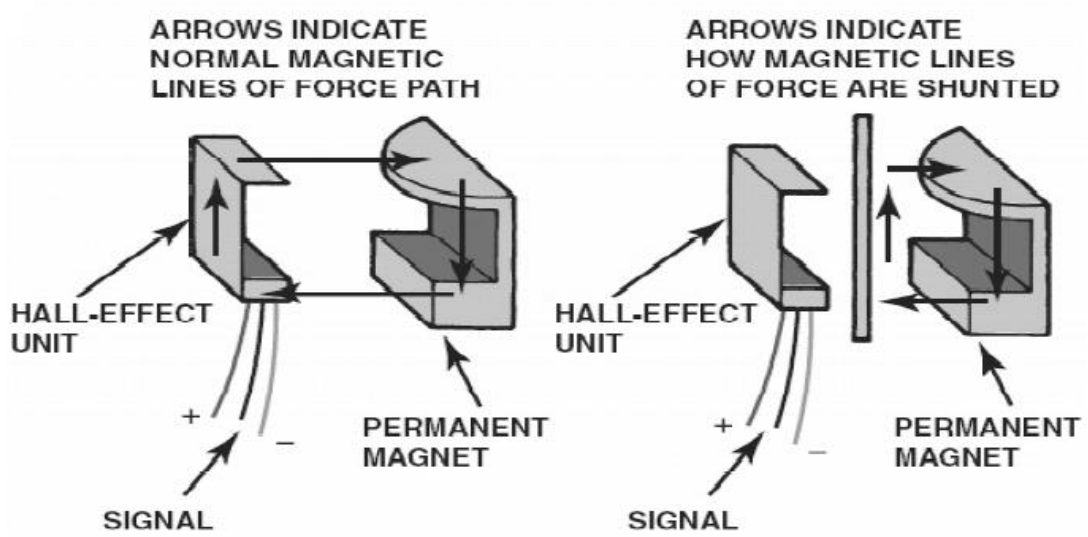


2

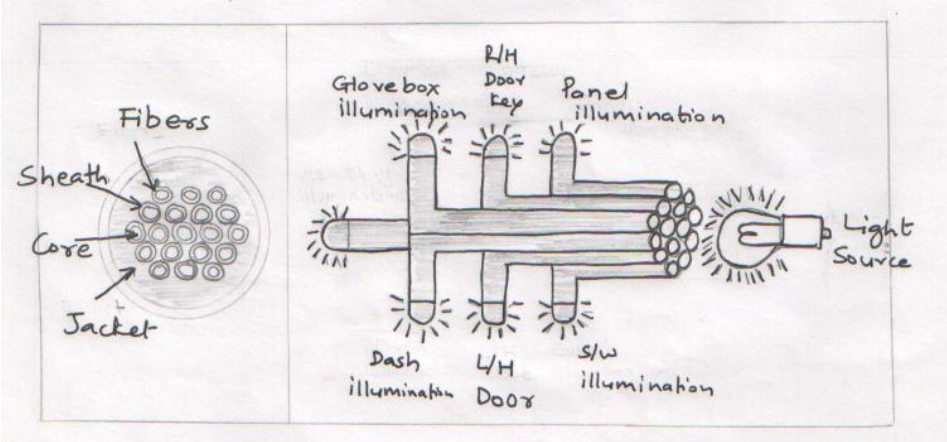
In figure, the circular magnetic field to the left of the conductor is in the same direction as the straight line magnetic field from the magnet. To the right of the conductor, the circular magnetic field

is in the opposite direction. This weakens the field to the right of the conductor. Therefore, the resulting magnetic field distorts around the conductor. Magnetic lines of force try to shorten themselves. This causes the bent lines of force in the magnetic field patter to try to straighten out. As they do. They try to push the conductor to right. The more current flowing, the more the lines of force will be distorted around the conductor. This results in a stronger push on the conductor. **Specification of a starter motor used in a 1000 CC petrol engine:** • Nominal Voltage – 12 Volts • Nominal Current – 30 amperes • Speed – 6400 rpm • Output – 1.2 kW • Rating – 30 seconds • Number of poles – 4 • Direction of rotation – clockwise as viewed from pinion side • Brush length – standard:12.4mm • Number of pinion teeth – 8 • Magnetic switch operating voltage – 8 volts maximum	
Que.3. Attempt any FOUR of the following.	**16**
a)Describe the operation of Automatic headlight dimming system	**4**
Ans: (***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	**4**

vehicle is closer.	
b) Describe step-wise procedure to test engine coolant sensor.	**4**
Ans: (Description – 4 marks & credit should be given to equivalent sketch) **The following procedure is followed to diagnose engine coolant temperature sensor.** • Remove the ECT sensor from the engine • Place it in a container of water with thermometer. • Make sure that more than half of the sensor is submerged in the water. • Connect a pair of ohmmeter leads to the sensor terminals. • Heat the water in the container and measure the resistance at different temperatures. • The sensor should have the specified resistance of 0.98 to 1.34 KΩ at 40^0 C and 0.22 to 0.35 KΩ at 80^0 C  Figure Testing a coolant temperature sensor in hot water using a thermometer and an ohmmeter.	**4**
c) With a neat sketch describe working of automatic resetting type circuit breaker.	**4**
Ans: (Sketch – 2 marks & working -2 marks) The automatic resetting type circuit breaker is designed to open when circuit current exceeds a given level. It uses a bimetallic strip that opens if current draw is excessive.  **Automatic Resetting type of Circuit breakers-** Automatic resetting type of circuit breaker uses a thermally sensitive element (bimetal strip) that snaps open the contact points when	**2**

overheated by excessive amperage. But after a short cooling-down period, the circuit breaker resets itself. The bimetal strip has two metals of different coefficient of expansion. There is nothing to replace. Circuit breakers range from 5 to 50 amperes.	**2**
d) Describe the use of Hall Effect sensor used for triggering of primary circuit in ignition system.	**4**
Ans: (Equivalent Sketch -2 marks & Description -2 marks) 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. **Principle of Hall Effect:**  **OR**  	**2** **2** **2**

e) State the function of detonation sensor and cylinder identification sensor used in ignition system.	**4**
Ans: (Function of each sensor – 2 marks each) **Detonation Sensor:** 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. 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. **Cylinder Identification sensor:** The function of cylinder identification sensor used in ignition system is to detect the position of the engine camshaft. Camshaft position is used to identify when piston 1 is 26° before top dead center (BTDC) of its compression stroke. The DIS module uses the CID signal to select the proper coil to fire. It uses a Hall-effect pickup.	**2** **2**
Que.4.A) Attempt any <u>THREE</u> of the following.	**12**
a) Enlist any two applications of fiber optics in an automobile. Describe its working.	**04**
Ans: (Applications -1 marks & Working – 3 marks) **Some of the application of fiber optics include: (any two- ½ marks each)** • 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 **Working: (Description- 2 marks each & Sketch – 1 mark)** • 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	**1**

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.  	**2** **1**
b) Name the sensors used in park assist system. Describe the purpose of the system.	**04**
Ans: (List of Sensor – 1 mark & Purpose – 3 marks, credit should be given to sketch) **Sensors used in park assist system:(Any Two – ½ marks each)** • Ultrasonic sensor • Front sensor detecting the distance of object(Photo type) • Rear sensor for detecting the distance of object(Photo type) • Camera used as video sensor / Visual sensor. **Purpose of Park Assist system**: Parking sensors make reversing into tricky/ tight spaces easier and help prevent minor damage to a vehicle. In cities, you will find yourself having to maneuver your car into some tight parking spots. The result can often be minor damage. The park assist system sensors make it easier by warning when you're getting too close to something, preventing small knocks and scratches. The system has up to six ***ultrasonic sensors*** located in the rear - and sometimes the front - bumpers. Each of the sensors receives battery voltage and ground from the park assist module. Each sensor has a dedicated serial bus communication circuit to the module. Compact, and painted in the body colour, they blend in well and are barely visible. The sensors monitor a range of up to 150 centimeters behind and, depending on the model, in front of the vehicle. The system comes into action when reverse gear is engaged, or at very low speed. It uses the principle of the echo sounder to detect obstacles and their distance from	**1** **3**

your car. If it senses you are too close. If your car has a radio or radio navigation display this gives you extra help by showing exactly how close any obstacles are.

The park assist system is a parking aid that alerts the driver to obstacles located in the path immediately behind the vehicle / in the path of vehicle. Ultrasonic sensors evaluate attributes of a target by interpreting the echoes from sound waves. When an object is detected, the system uses an LED display and warning chimes to provide the driver with visual and audible warning of the object's presence. It starts to sound an intermittent warning tone which gets faster the nearer you are. The warning signal becomes continuous when the vehicle gets so close that will result in a collision.

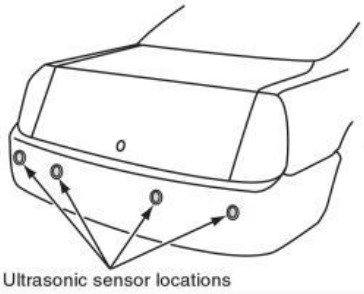
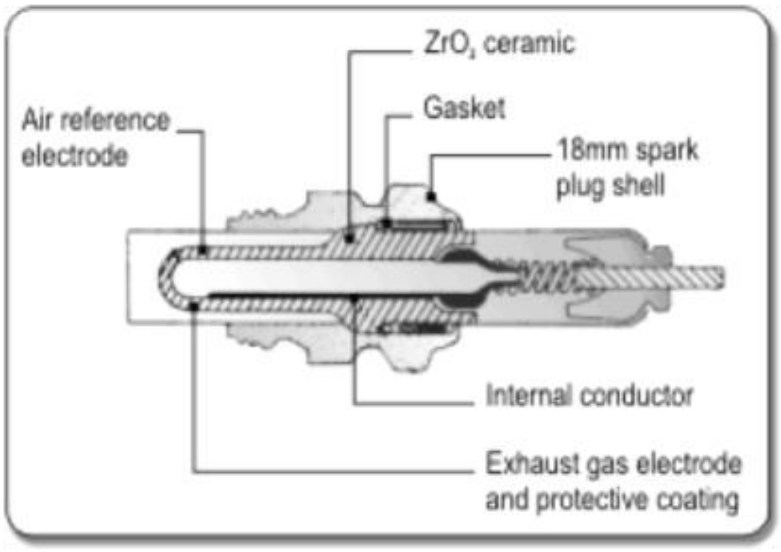


Figure Ultrasonic sensors used for back-up obstacle detection are usually located in the rear fascia/bumper.

c) Draw a neat labeled diagram indicating the construction of oxygen sensor. **04**

Ans: (Simplified / similar other labeled diagram may be credited) **4**



OR

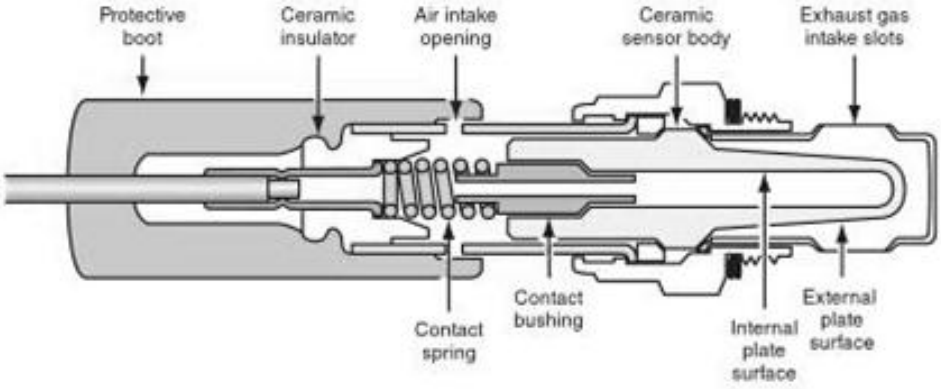
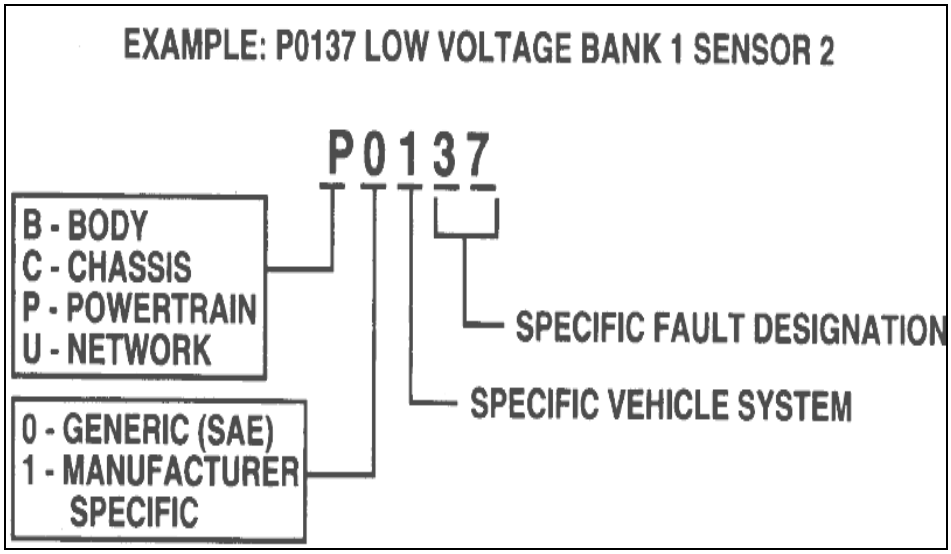


FIGURE Typical oxygen sensor

d) Describe any one of the diagnostic trouble code (DTC) as mentioned in SAE J-2012 standards. **04**

Ans: (Marks should be given to equivalent example of any DTC.) **4**

SAE J-2012 (Diagnostic Trouble Codes) defines a set of diagnostic trouble codes (DTCs) where industry uniformity has been achieved. DTCs (five digits) consist of an alpha character followed by four characters. The first digit of the code indicates if the DTC is generic or manufacturer specific. A "0" indicates the code is generic while a "1" indicates it is manufacturer specific. The second digit indicates the vehicle the vehicle system that generated the fault code.



Que.4.B) Attempt any ONE of the following.	**06**
a) State the importance of field current draw test. Describe the procedure to conduct this test.	**06**
Ans: (Importance – 2 mark & Procedure – 4marks, credit may be given to sketch) **Importance of Field current draw test:** The field current draw test determines if there is current available to the field windings. Because field current is required for the production of a magnetic field, it is necessary to determine if the current is flowing to the field coil. **Field current draw test Procedure.** To perform the field current-draw test using the ammeter function of the digital multimeter (DMM) the following steps are carried out 1. Confirm that the battery is fully charged 2. Connect a carbon pile across the battery. Make sure the knob is turned to the off position prior to making the connection. 3. Place the DMM in the 10-amp mode and locate the induction pickup-clamp around the field circuit wire going to the alternator. if a pickup clamp is not available, the DMM test leads will need to be connected in series to the field circuit. 4. Start the engine and run it at 2000 rpm. 5. Using the carbon pile, load the alternator to the rated output current. 6. Measure the amperage in the field circuit. Check result with manufacturer's specifications. Readings typically range between 3 and 7 amps. If the readings are within the specification limits, then the field current is good. If the readings are over specifications, a shorted field circuit or bad regulator may be the problem. If the readings are too low, then there is high electrical resistance that may be caused by worn brushes.	**2** **4**
b) With a neat sketch describe the procedure to conduct Jump starting of a battery and list down the safety precautions.	**06**
Ans: (Procedure – 3 marks & sketch – 2 marks & precautions – 1 mark) **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.	**3**

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.

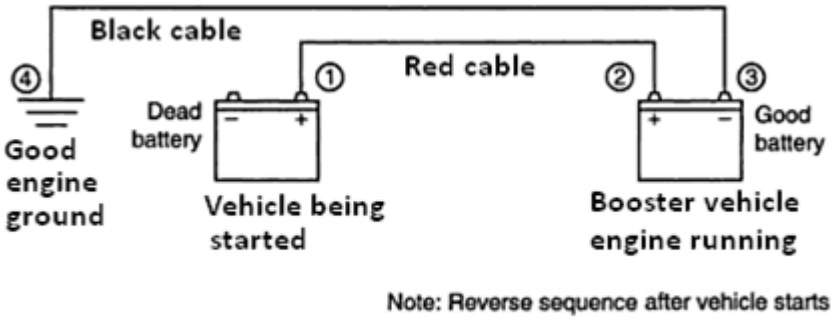
8. Crank the engine. As soon as the dead vehicle starts, disconnect the jumper cables in reverse order of connection.

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.



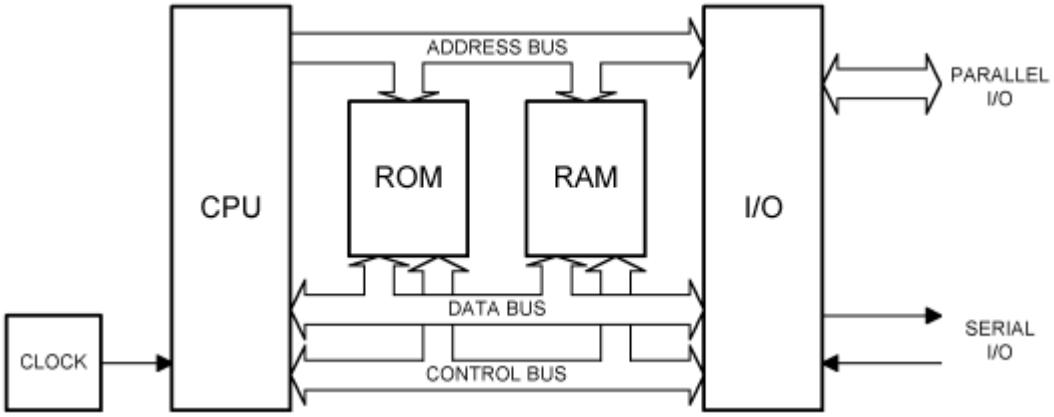
Jump Starting Sequence

2

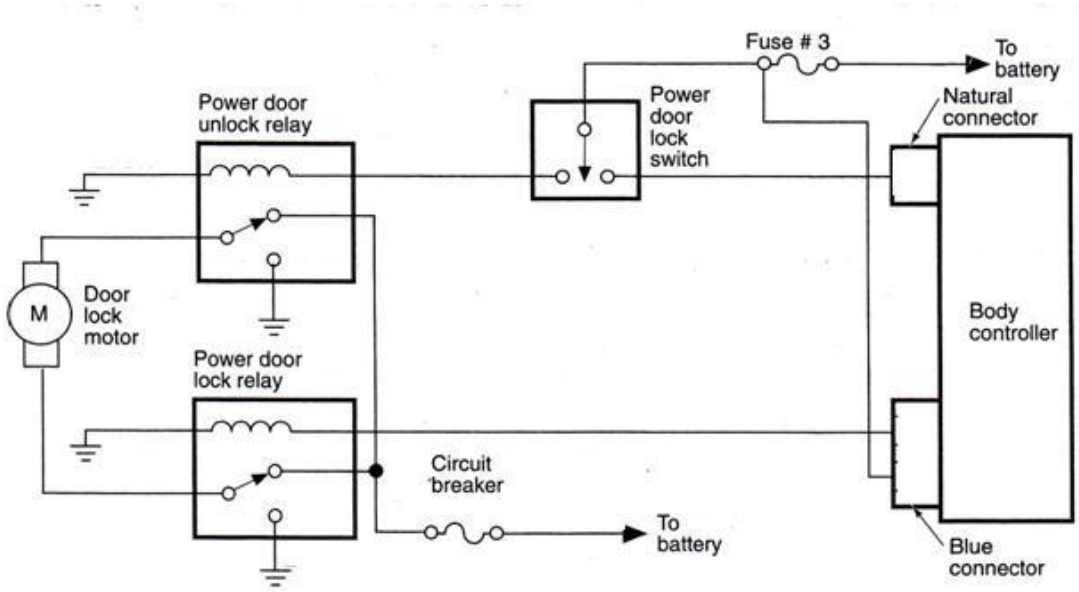
Precautions: (any two – ½ mark each)

i) DO NOT lean directly over the battery while making jumper connections.
ii) Make sure the two vehicles are not touching each other.
iii) For each vehicle engage the parking brake and put the transmission in neutral or park.
iv) Turn off the ignition switch and all accessories on both vehicles.

1

Que.5. Attempt any FOUR of the following.	**16**
a)Draw a neat block diagram to indicate the use of microprocessor in cars.	**04**
Ans: (Equivalent Block diagram -4marks) **The block diagram of a typical microprocessor system is shown below:**  	**04**
b) Describe the operation of automatic door lock system	**04**
Ans: (Description- 4 marks & credit should be given to 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.	**04**

Automatic door lock system:



c) Describe the concept of dry charged batteries. **04**

Ans: (Description - 4 marks) **04**

Dry Charged or Maintenance free battery:

The battery is built, charged, washed and dried, sealed, and shipped without electrolyte. It can be stored for 12 to 18 months. When put into use, it requires adding electrolyte and charging. Some lead−acid batteries are sealed, that is, there are no removable caps to check electrolyte or replenish it. Some of these batteries have a small eye" to indicate charge level. Still others are sealed, but include connections to external vent tubes.

- No provision of addition of electrolyte.
- Sell made up of Ca, Cadmium, Strontium.
- Reduces gassing.(conversion in H2 & O2).
- Not used Antimony
- Ca, Cadmium, Strontium Reduces vaporization
- Small vent.
- Pressure greater than atm vapour escape.
- Not necessary to add water.
- Hydrometer is used to indicate symbol

d) State the principle used in measuring pressure inside intake manifold. Describe it's working. **04**

Answer : (Principle-2 marks & working - 2 marks; credit given to sketch) **02**

Principle used in measuring pressure inside intake manifold:

This sensor is used to measure the amount of vacuum in the intake manifold because the amount of intake manifold vacuum is directly related to engine load. The ECU takes this information and uses it to calculate the correct amount of fuel to inject, when to ignite (ignition timing retard or

advance) and other function. The pressure of the air, or air–fuel mixture, in the engine intake manifold varies with the load on the engine. For example, with the throttle valve fully closed and the engine being used for downhill braking, the manifold pressure will be very low (near perfect vacuum). With the throttle fully open and the vehicle accelerating up an incline the manifold pressure will be higher, i.e. very little vacuum. The pressure inside the intake manifold is known as absolute pressure (i.e. it is measured from absolute zero pressure, or complete vacuum, upwards). **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.	**02**
e) Write down the procedure applied to conduct tests on rotor & stator for open and short.	**04**
Answer :(Procedure of rotor & stator - 2 marks each; credit given to equivalent sketch) **Procedure applied to conduct tests on rotor & stator** **For Rotor Testing:** 1.Remove the rotor from end frame 2.Extract the retainer plate screws 3.Remove the retainer plate 4.Remove the end frame bearing 5.Remove the three attaching screws & separate the stator from end frame Attach one lead of a 110 volts test lamp or an ohmmeter to either slip ring & outer lead to the rotor- shaft or poles. 7.Note down reading of ohmmeter 8.Attach lamp or ohmmeter connections to each slip ring 9.Note down reading of ohmmeter or observe the lamp light 10.Connect 12 V battery and an ohmmeter in series with the slip rings of rotor 11.Record reading of ammeter OR 12.Connect an ohmmeter in series with slip ring of rotor 13.Record reading of ohmmeter	**02**

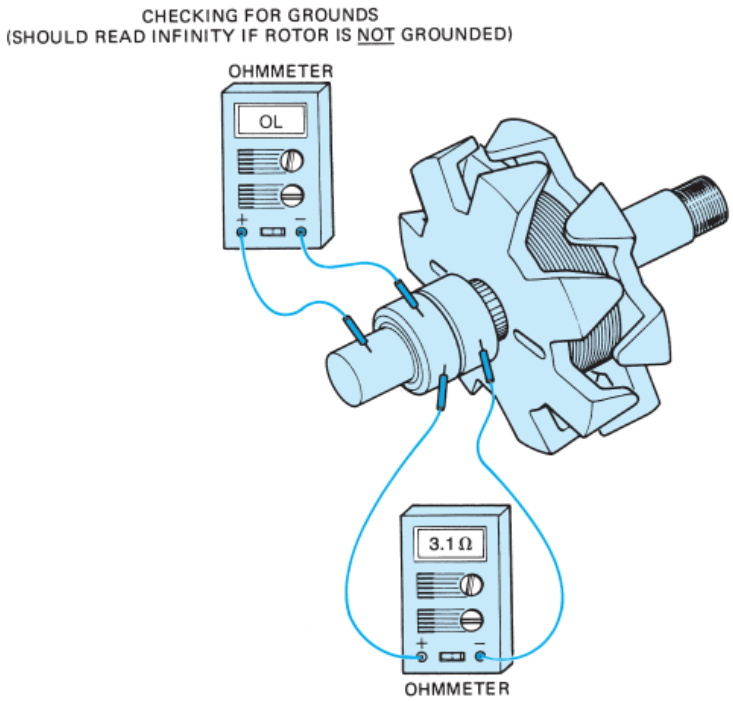
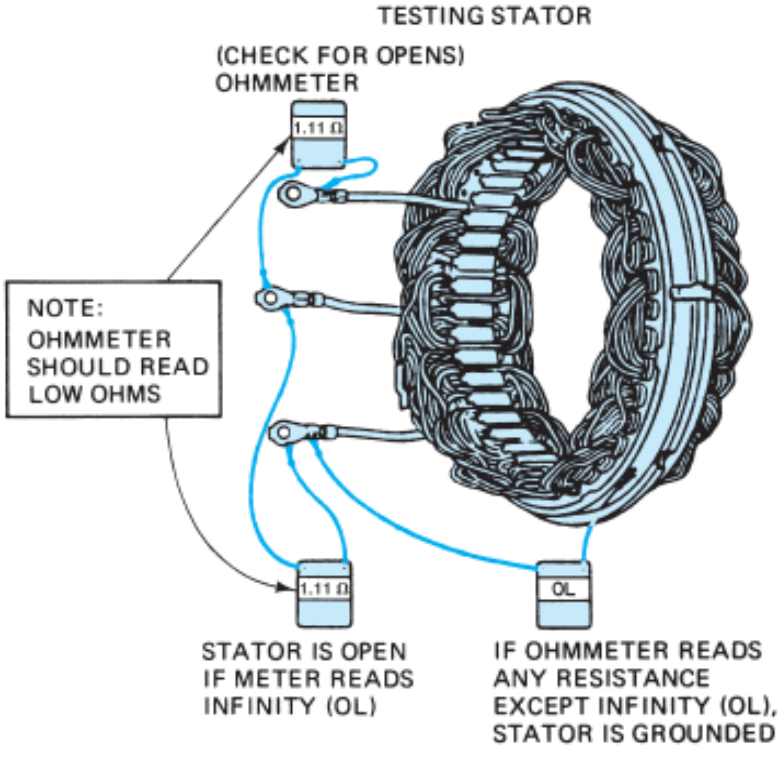
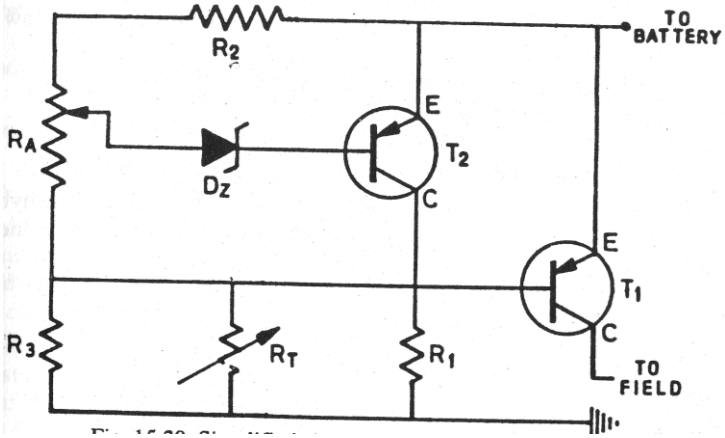
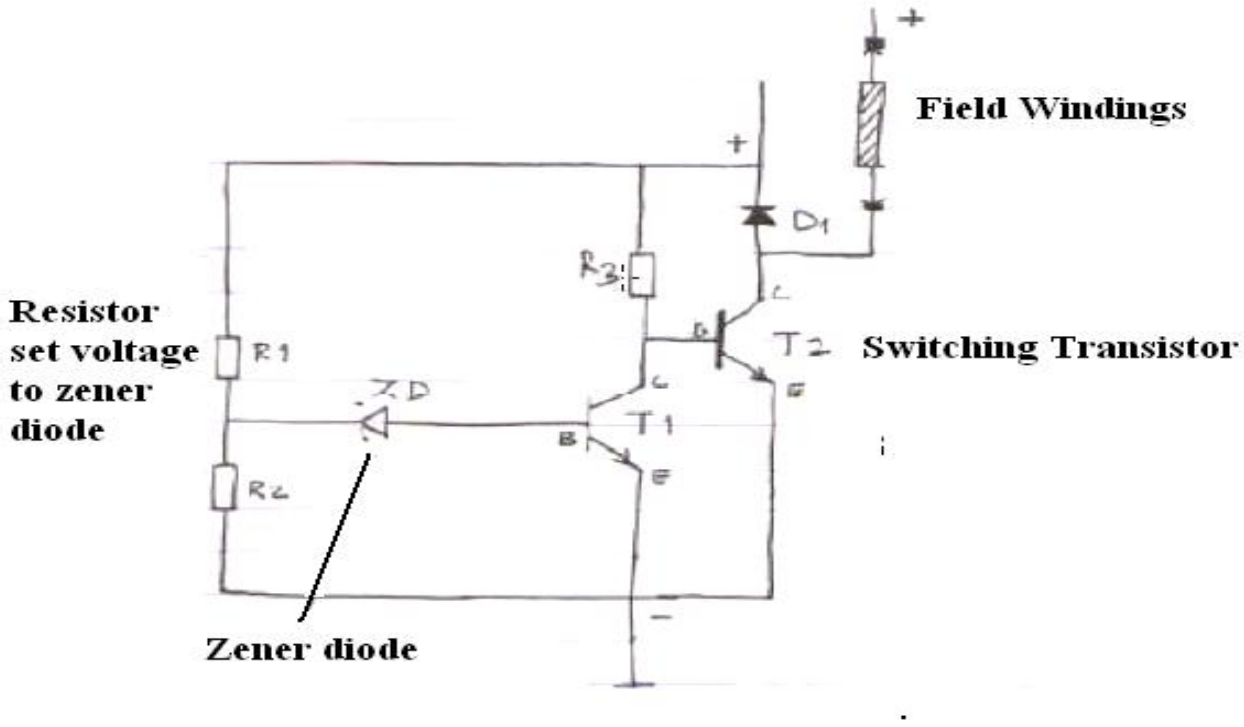


FIGURE : Testing a rotor using an ohmmeter.

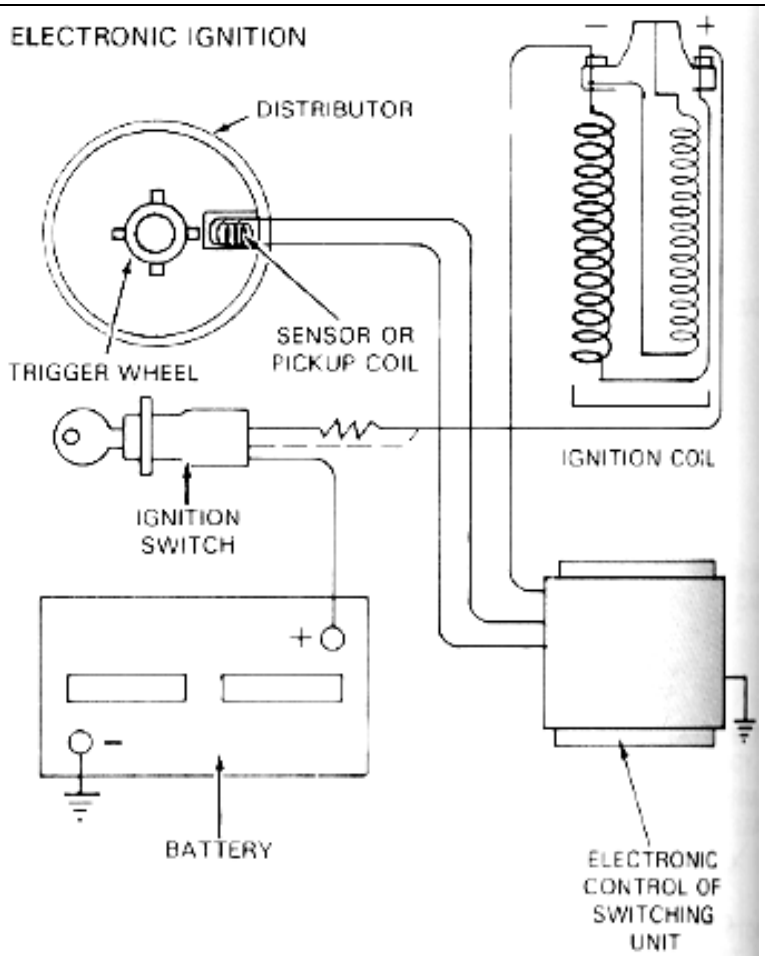
For Stator Testing:

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
4. Record reading of the ohmmeter / lamp illumination

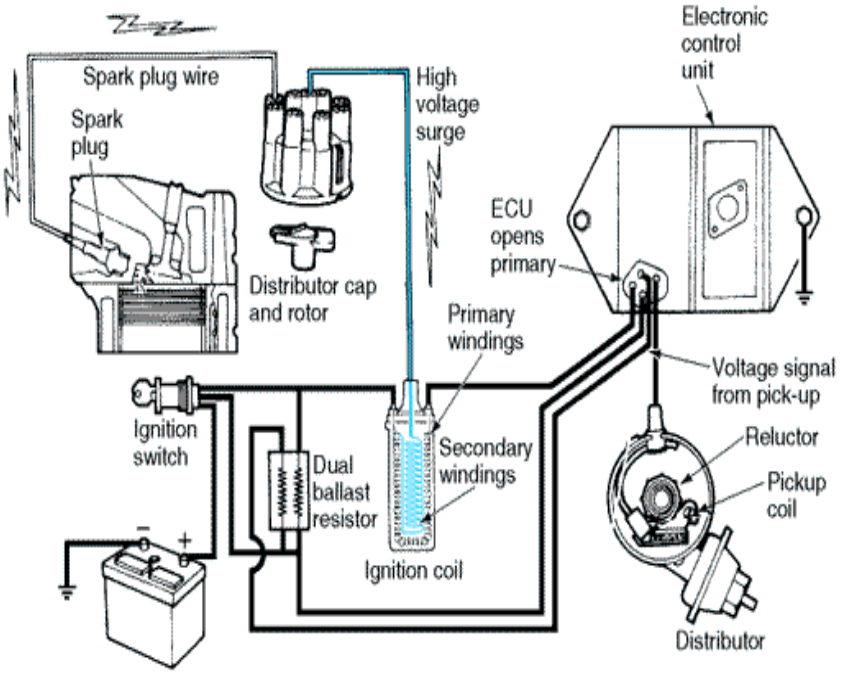


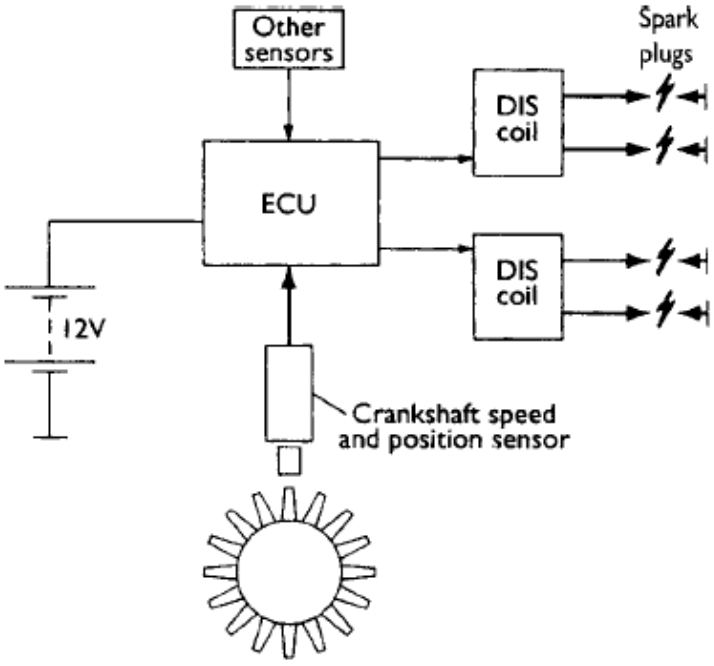
• If the ohmmeter reads infinity between any two of the three stator windings, the stator is open and, therefore, defective. The ohmmeter should read infinity between any stator lead and the steel laminations. If the reading is less than infinity, the stator is grounded. Stator windings can be tested if shorted because the normal resistance is very low.	
f) Draw a neat circuit diagram to show electronic voltage regulation system.	**04**
Answer : (Equivalent sketch- 4 marks) **Electronic voltage regulator-**  In Above Figure: T1 & T2 = Transistor; Dz = Zener diode & Resistors = R_1, R_2 & R_3, R_A & R_T **OR**  Figure : Elecronic Voltage Regulation system	**4**

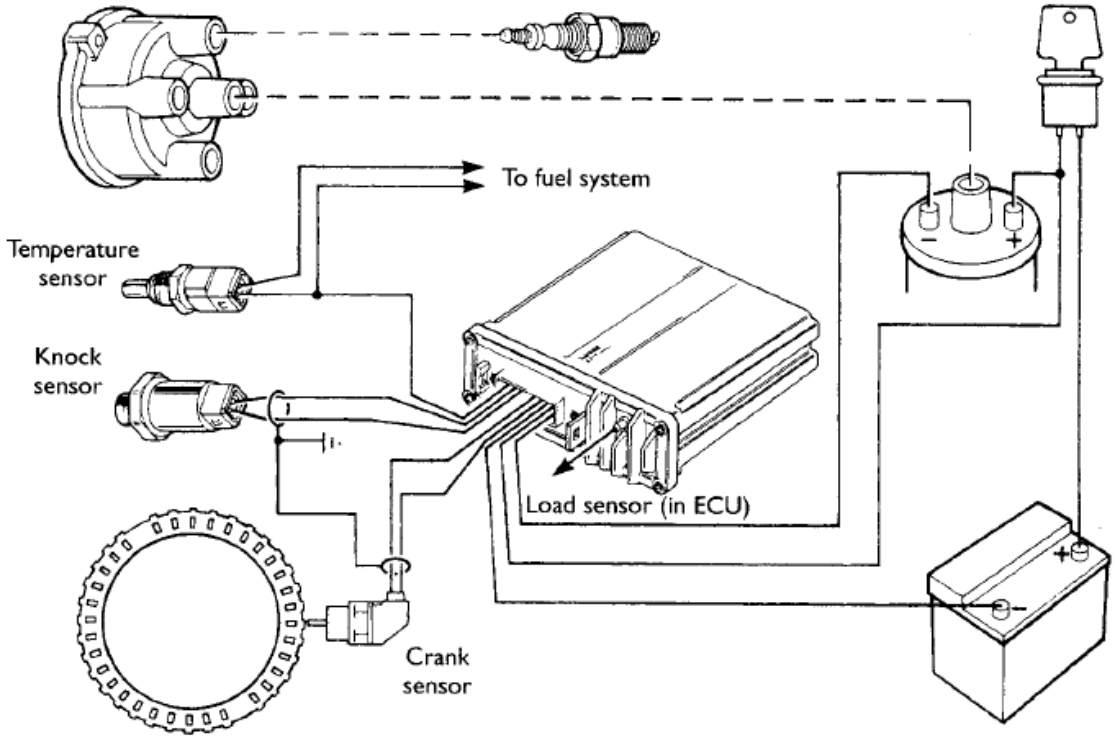
Que.6. Attempt any FOUR of the following.	**16**
a) State four factors affecting battery life.	**04**
Ans:(Any four- 1 mark each) **Factors Affecting Battery Life:** All storage batteries have a limited service life, but many conditions can decrease service life. 1. Improper Electrolyte Level. 2. Corrosion of terminals and conductors or battery material. 3. Overcharging 4. Undercharge / Sulphation 5. Poor Mounting 6. Cycling 7.Temperature-high temperature during charging 8.Vibration	**4**
b) Describe the importance of insulated circuit resistance test in starting system.	**04**
Ans: (Importance description- 4 marks, credit should be given to sketch) **Importance of Insulated circuit resistance test or Voltage Drop Test:** 1. This test is need to located high resistance in the starter circuit voltage is dropped when current flows through resistance. 2. Voltage Drop Test checks for high resistance across a cable/connection 3. In automotive circuits even the smallest loss of voltage will cause poor performance. 4. Testing for Excessive Voltage Drop Determine if there is resistance in the circuit by measuring the voltage drop across each connection and component in the starter circuit while cranking the engine. 5. Measure the voltage drop between the battery post and the connecting cable, the solenoid posts and the wires that attach to them, and across the solenoid itself. 6. Also check the connection on the starter, alternator (feed and ground side) and the ground strap connection to the engine block and body.	**4**
c) Draw a neat block diagram to show the operation of Electronic Spark timing.	**04**
Answer :(Equivalent sketch – 4 marks)	**4**


ELECTRONIC IGNITION
DISTRIBUTOR
SENSOR OR PICKUP COIL
TRIGGER WHEEL
IGNITION COIL
IGNITION SWITCH
BATTERY
ELECTRONIC CONTROL OF SWITCHING UNIT

OR


Spark plug wire
Spark plug
High voltage surge
Electronic control unit
ECU opens primary
Distributor cap and rotor
Primary windings
Voltage signal from pick-up
Ignition switch
Dual ballast resistor
Secondary windings
Reluctor
Pickup coil
Ignition coil
Distributor

d) Describe the operation of computer controlled ignition system.	**04**
Ans : (Sketch – 2 Marks & explanation – 2 Marks) **Operation of Computer controlled OR Distributor less coil ignition system:** **The distributor less ignition system consists of three main components:** ii. An ECU iii. Crankshaft speed and crankshaft position sensor. iv. 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.  **OR**	**02** **02**



e) State the importance of trickle charging. Describe its procedure. **04**

Answer : (Importance – 2 marks & procedure- 2 marks)

Importance of Trickle Charging:

- It can be charged at a similar rate as its self-discharging rate (of about 5 % of the normal charging current), thus maintaining a full capacity battery**.**
- With this process sulphated battery can be recovered.
- We can restore the battery to a fully charged state.
- It minimizes the chances of overcharging the battery.

2

Procedure Of Trickle Charging of Battery:

i) When batteries are left in storage for longer periods they are subjected to self discharge.

ii) During `TRICKLE CHARGING` a continuous charging at very low charging rate of about 5 percent of the normal charging current is employed for keeping the battery in proper condition.

iii) Trickle charging is employed on batteries used for display purpose and on vehicle doing very little running.

iv) However continuous trickle charging should not be used and it is recommended that only during day time the battery should be connected to trickle charge while during the night it should be disconnected.

2