Science Part I Solutions for Class 10 Science Chapter - Effects Of Electric Current

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Question 1:

Tell the odd one out. Give proper explanation.
a. Fuse wire, bad conductor, rubber gloves, generator.
b. Voltmeter, Ammeter, galvanometer, thermometer.
c. Loud speaker, microphone, electric motor, magnet.

ANSWER:

a. The odd one out is generator. It is an electrical device for producing electricity. Fuse wire, bad conductor and rubber gloves have high resistance and are used for blocking electricity. Thus, they can be used as a safety measure against heavy electricity.

b. The odd one out is thermometer. It is an instrument for measuring the temperature of a body. Rest of the three are electrical instruments based on the phenomenon of electromagnetism and are used for measuring some electrical parameters such as current and voltage.

c. The odd one out is magnet. Loud speaker, microphone and electric motor are based on the phenomenon of electromagnetism.

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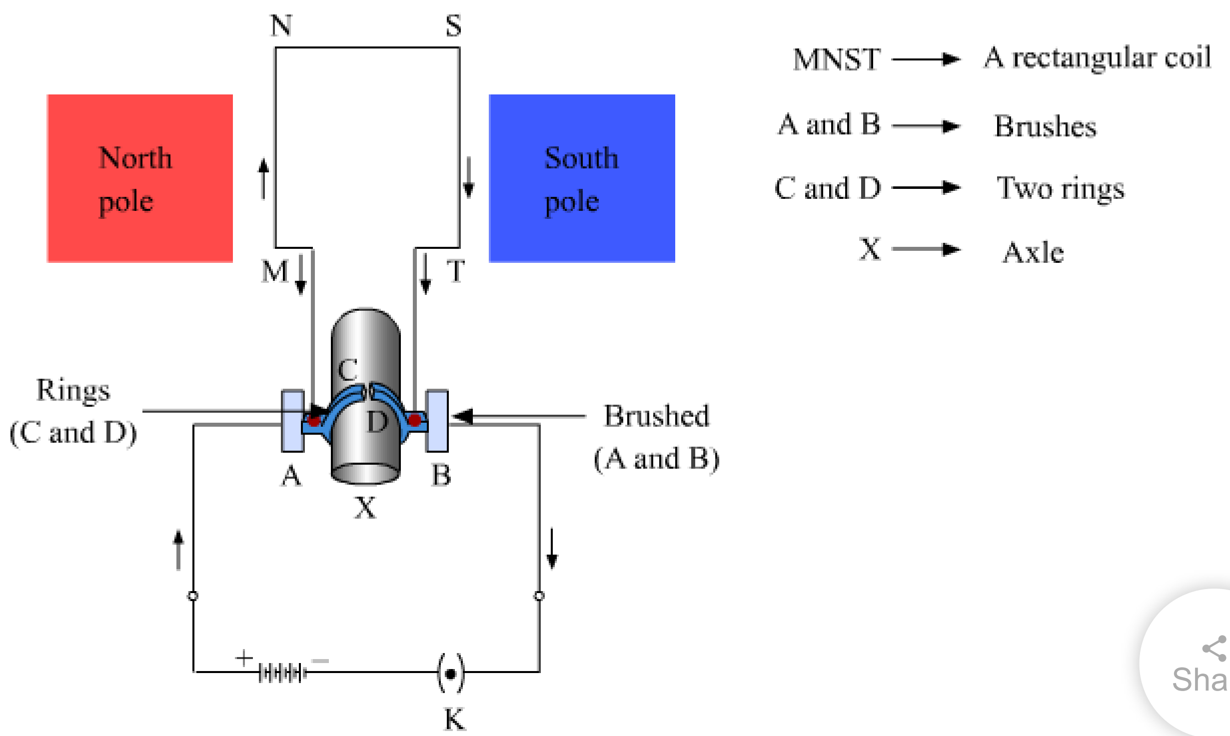
Question 2:

Explain the construction and working of the following. Draw a neat diagram and label it.
a. Electric motor
b. Electric Generator (AC)

ANSWER:

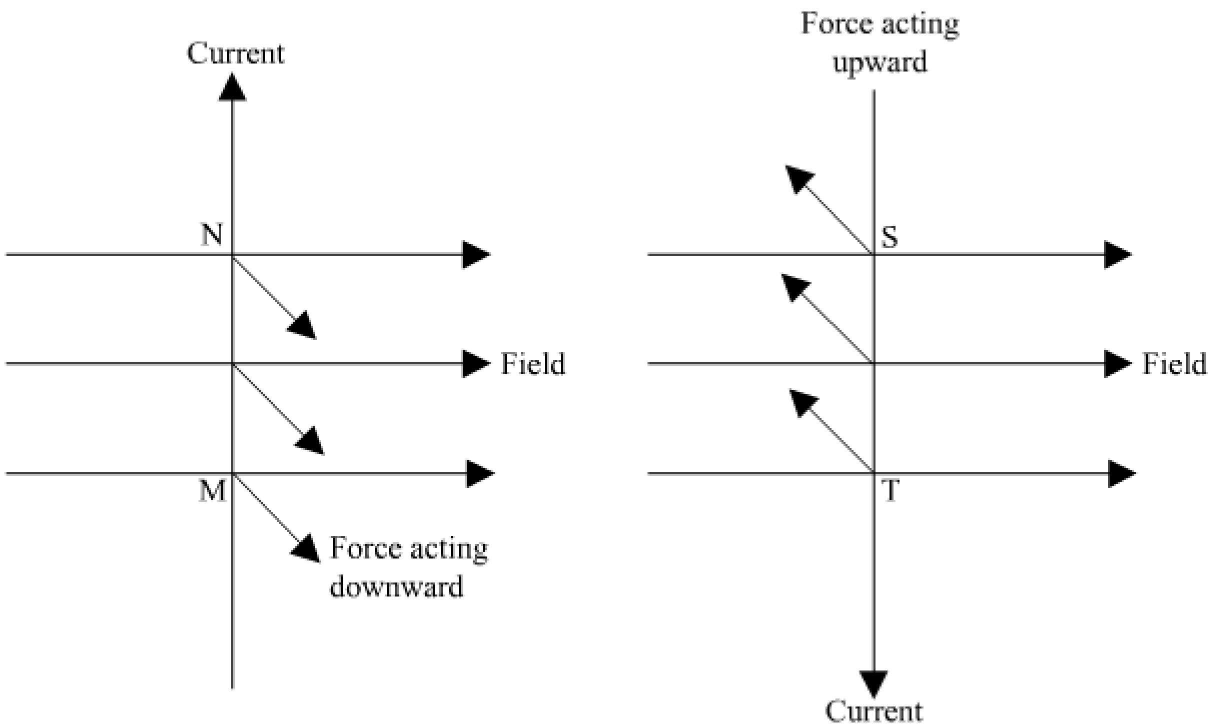
a. **Motor principle:** The basic principle on which the electric motor works is the magnetic effect of current. A current carrying rectangular coil starts rotating when placed in a magnetic field.

Construction:



The given figure illustrates the internal parts of a simple electric motor. A motor consists of a rectangular coil MNST of insulated copper wire. The coil is placed between two magnetic poles such that the magnetic field acts normal on lengths MN and ST. The coil is connected with two carbon brushes at points A and B respectively. The inner sides of these carbon brushes are in contact with half rings C and D, which are insulated and in contact with an axle (not shown in the figure).

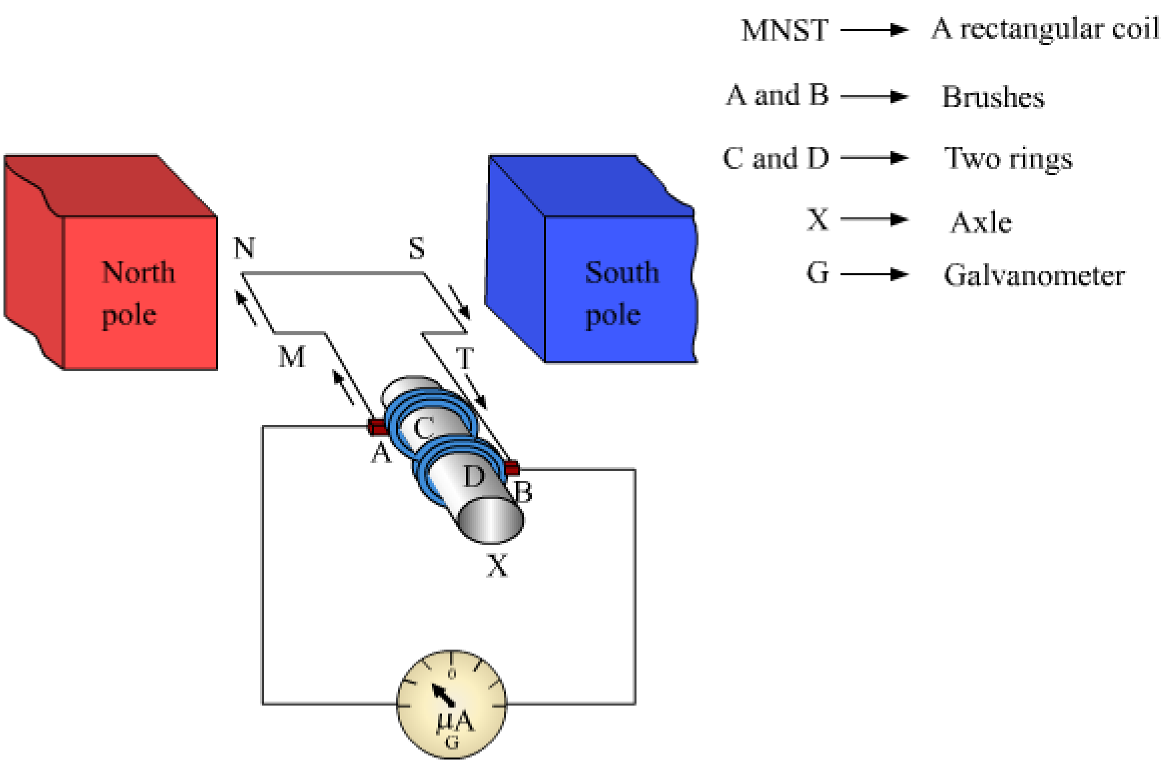
Working: When a current is allowed to flow through the coil MNST by closing the switch, the coil starts rotating anti-clockwise. This happens because a downward force acts on length MN and at the same time, an upward force acts on length ST. As a result, the coil rotates anti-clockwise.



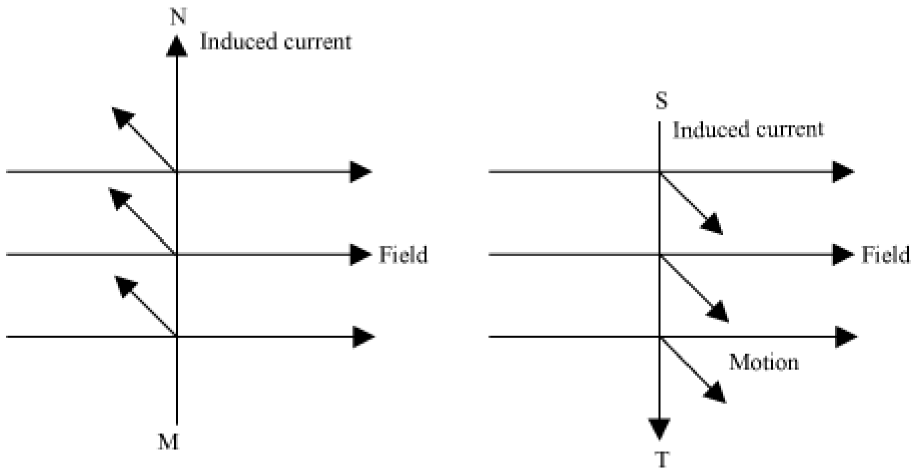
The current in length MN flows from M to N, and magnetic field acts from left to right normal to length MN. Hence, according to Fleming's left hand rule, a **downward** force acts on length MN. Similarly, the current in length ST flows from S to T, and magnetic field acts from left to right normal to its length. Hence, an **upward** force acts on length ST. These two forces cause the coil MNST and the axle to rotate anti-clockwise.
After half-rotation, the position of length MN and ST get interchanged. Simultaneously, half ring D comes in contact with brush A and half ring C comes in contact with brush B respectively. Hence, the direction of current in coil MNST gets reversed and flows through TSNM.
An electric device that reverses the direction of current in a circuit is called a commutator. Thus, the split ring acts as a commutator of the electric motor. Now, due to the reverse direction of current in lengths MN and ST, an upward force acts on length MN, which pushes it up and a downward force acts on length ST, which pushes it down. As a result, the coil MNST further rotates anti-clockwise. The reversal of the current through the coil MNST repeats at each half-rotation, while its anti-clockwise rotation continues.

b. **Electric Generator principle :** An electric generator is a machine that generates ele by rotating its rotor in a magnetic field. Thus, it converts mechanical energy into electr energy.

Construction: A generator consists of a rectangular coil MNST of insulated copper wire placed between two strong magnetic poles. The two ends of the coil MNST are connected with brushes A and B of rings C and D respectively. The inner sides of the rings are insulated. They are attached with an axle X, which can be rotated mechanically. Brushes A and B are connected with a galvanometer that can measure the flow of current in coil MNST.



Working: When the axle is rotated, lengths MN and ST move up and down respectively. Since lengths MN and ST are moving in a magnetic field, a current gets induced in these lengths caused by an electromagnetic induction. The direction of the induced current in both the lengths is given by **Fleming's right hand rule**.



Since length MN is moving upwards in the magnetic field that acts from left to right, the direction of the induced current will be from M to N. Similarly, the direction of the induced current in length ST will be from S to T. Hence, an induced current will set up in the coil in the direction MNST, which produces deflection in the galvanometer.
After half-rotation, length MN starts moving down, whereas length ST starts moving up direction of the induced current in the coil gets reversed i.e., the induced current will n from T to M via S and N i.e., TSNM. Therefore, we can conclude that **after each half-rotation, the direction of the induced current is reversed**. This current is called an **alternating current (AC). An AC reverses its direction after equal time intervals**.

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Question 3:

Electromagnetic induction means-
a. Charging of an electric conductor.
b. Production of magnetic field due to a current flowing through a coil.
c. Generation of a current in a coil due to relative motion between the coil and the magnet.
d. Motion of the coil around the axle in an electric motor.

ANSWER:

Electromagnetic induction means generation of a current in a coil due to relative motion between the coil and the magnet.

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Question 4:

Explain the difference:
AC generator and DC generator.

ANSWER:

	AC generator	DC generator
i.	It produces alternating current.	It produces direct current.
ii.	It has two simple ring-type commutators.	It has a single split-ring commutator.

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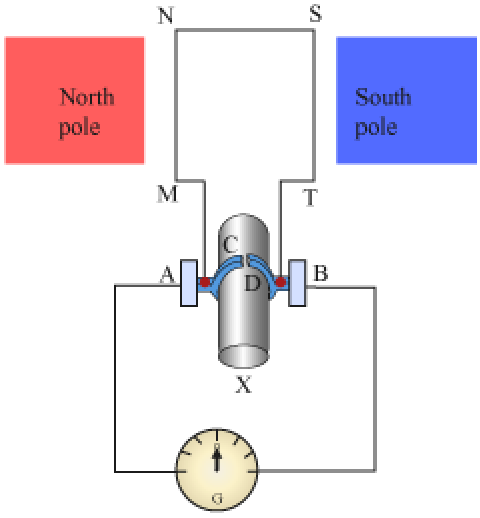
Question 5:

Which device is used to produce electricity? Describe with a neat diagram.
a. Electric motor
b. Galvanometer
c. Electric Generator (DC)
d. Voltmeter

ANSWER:

The device used for producing electricity is Electric generator (DC). It is based on the phenomenon of electromagnetic induction.



Working:

When the axle is rotated, lengths MN and ST move up and down, respectively. Since lengths MN and ST are moving in a magnetic field, a current gets induced in these lengths caused by an electromagnetic induction. The direction of the induced current in both the lengths is given by **Fleming's right hand rule**.
In this arrangement, brush A always remains in contact with the length moving up, whereas brush B always remains in contact with the length moving down. Here, split rings C and D act as a commutator. In this case, the direction of the current induced in the coil will be from M to T via N and S for the first half-rotation, and from T to M via S and N for the second half-rotation of coil MNST. Hence, we get a unidirectional current called **direct current** (DC).

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Question 6:

How does the short circuit form? What is its effect?

ANSWER:

Short circuit occurs when naked live and neutral wires touch each other.
In such situations, the resistance of the circuit becomes very less. Now, according to Ohm's law, current is inversely proportional to resistance. Thus, the decrease in value of resistance of the circuit raises the current to a significant amount. As a result, the wires become hot and sparks are caused by Joule's heating effect of current.

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Question 7:

Give Scientific reasons.
a. Tungsten metal is used to make a solenoid type coil in an electric bulb.
b. In the electric equipment producing heat e.g. iron, electric heater, boiler, toaster etc, an alloy such as Nichrome is used, not pure metals.
c. For electric power transmission, copper or aluminium wire is used.
d. In practice the unit kWh is used for the measurement of electrical energy, rather than joule.

ANSWER:

a. Tungsten metal is used to make a solenoid type coil in an electric bulb because its melting point is very high. Thus, when a high amount of current is passed through it, it becomes red hot and emit lights without getting burnt.

b. In the electric equipment producing heat, such as iron, electric heater, boiler, toaster etc., an alloy such as Nichrome is used, not pure metals because of the following reasons:
(i) Resistivity of Nichrome is more compared to pure metal.
(ii) Melting point of Nichrome is high as compared to pure metal.
(iii) Nichrome does not get oxidised when heated in air whereas metal does.

c. For electric power transmission, Copper or Aluminium wire is used because they provide low resistance path to the flow of current. Thus, the power loss in the low resistance transmission wire will be less.

d. In practice, the unit kWh is used for the measurement of electrical energy, rather than joule. This is because joule is a very small unit and the energy consumption in day to day life is very large i.e. it comes in figures of 10^6 to 10^8. Thus, to reduce the complexity of handling such large figures, a bigger unit was required. This bigger unit used for the measurement of electrical energy is kWh and is related to joule as
1 kWh = 3.6×10^6 J
Hence, the energy reading commercially became simpler by using this bigger unit instead of joule.

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Question 8:

Which of the statement given below correctly describes the magnetic field near a long, straight current carrying conductor?
a. The magnetic lines of force are in a plane, perpendicular to the conductor in the form of straight lines.
b. The magnetic lines of force are parallel to the conductor on all the sides of conducto
c. The magnetic lines of force are perpendicular to the conductor going radially outword.
d. The magnetic lines of force are in concentric circles with the wire as the center, in a plane perpendicular to the conductor.

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ANSWER:

The correct statement describing the magnetic field near a long, straight current carrying conductor is:
The magnetic lines of force are in concentric circles with the wire as the center, in a plane perpendicular to the conductor.

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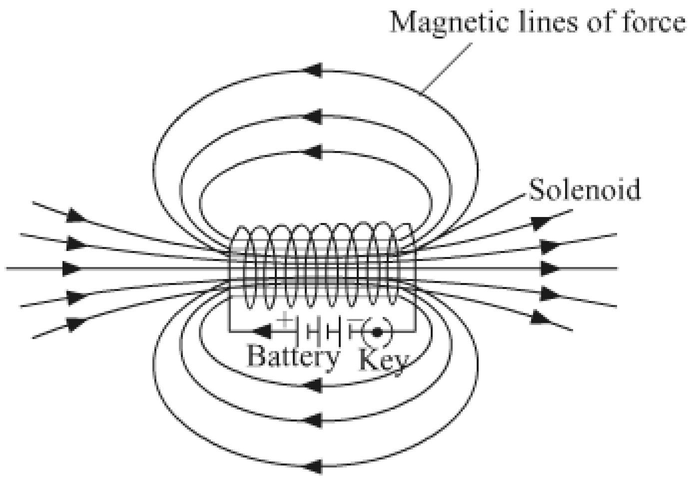
Question 9:

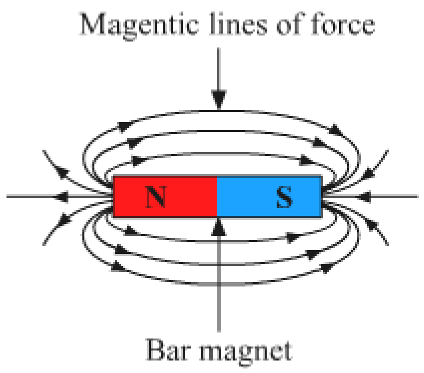
What is a solenoid? Compare the magnetic field produced by a solenoid with the magnetic field of a bar magnet. Draw neat figures and name various components.

ANSWER:

A solenoid is a long straight insulated wire, such as a copper coil, often wrapped around a cylinder-shaped body. The diameter of the solenoid is lesser than its length. It produces a magnetic field when electric current is passed through it.
Magnetic field produced by a solenoid is shown below:



Magnetic field produced by a bar magnet is shown below:



On comparing field lines produced by a solenoid with that produced by a bar magnet, we observe that they are very much identical. Thus, a solenoid acts as a bar magnet when current is passed through it.

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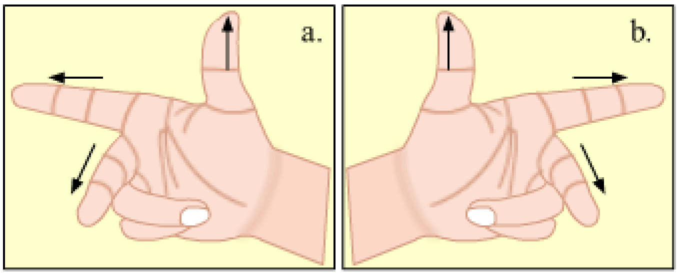
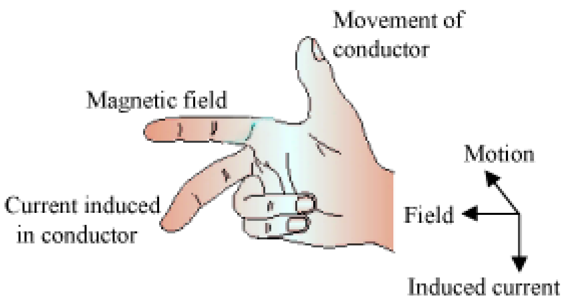
Question 10:

Name the following diagrams and explain the concept behind them.



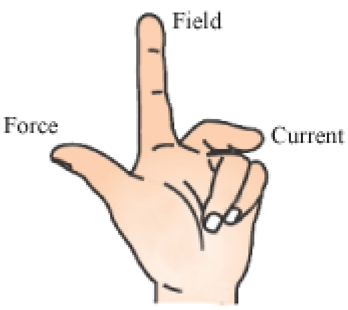
ANSWER:

a. It represents **Fleming's right hand rule** used for finding the direction of induced current with respect to the directions of the magnetic field and motion of the conductor.



The direction of current induced in a conductor can be obtained by holding the thumb, the index finger, and the middle finger of your right hand mutually perpendicular to each other. In this situation, the thumb indicates the direction of the motion of the conductor, the index finger points along the magnetic field, and the middle finger points along the current induced in the conductor.

b. It represents **Fleming's left hand rule** used for finding the direction of magnetic force when a current carrying conductor is placed in a magnetic field.



This rule states that if you stretch the thumb, index finger, and middle finger of your left hand such that they are mutually perpendicular to each other, then your index finger represents the direction of the field, the middle finger represents the direction of the current, and the thumb represents the direction of the force experienced by the conductor.

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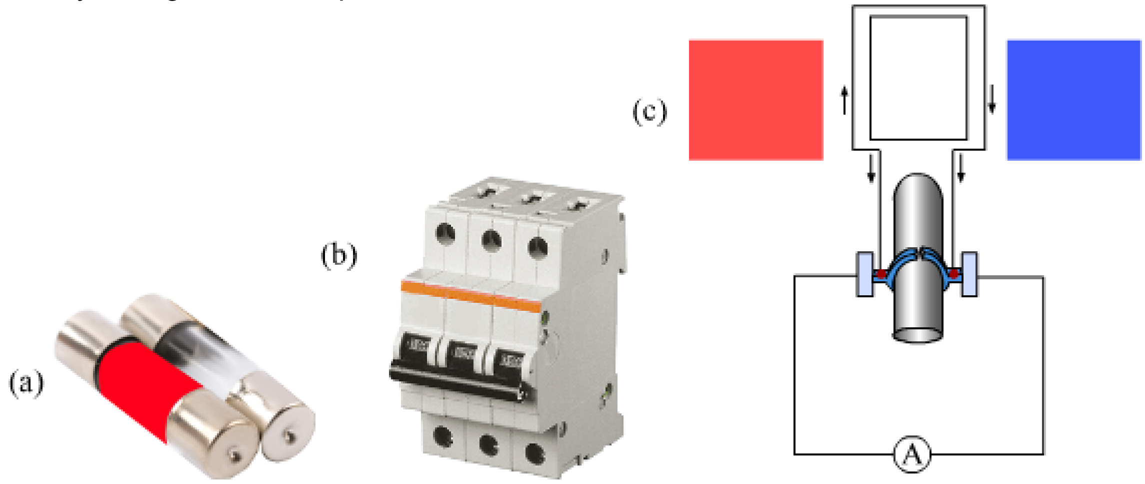
Question 11:

Identify the figures and explain their use.



ANSWER:

(a) Figure (a) represents a fuse. An electric fuse is a safety device that protects the wiring against excessive heating caused by an excess supply of current. It melts when heavy current flows through the circuit, thereby causing the circuit to become open.

(b) Figure represents an MCB. An MCB is a device which functions as a fuse, but does not require replacement. MCB falls down to break the circuit when heavy amount of current flows through it. Once the fault is rectified, the MCB is reset.

(c) Figure (c) represents a DC generator. It is a device that generates electricity by rotating its rotor in a magnetic field. Thus, it converts mechanical energy into electrical energy.

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Question 12:

Solve the following example.
a. Heat energy is being produced in a resistance in a circuit at the rate of 100 W. The current of 3 A is flowing in the circuit. What must be the value of the resistance?
b. Two tungsten bulbs of wattage 100 W and 60 W power work on 220 V potential diffe
If they are connected in parallel, how much current will flow in the main conductor?
c. Who will spend more electrical energy? 500 W TV Set in 30 mins, or 600 W heater in 2 mins?
d. An electric iron of 1100 W is operated for 2 hrs daily. What will be the electrical

consumption expenses for that in the month of April? (The electric company charges Rs 5 per unit of energy).

ANSWER:

a. Given:
Power, P =100 W
Current, I = 3 A
Resistance, R = ?
We know, $P = I^2R$
$\Rightarrow R = \frac{P}{I^2} = \frac{100}{9} \simeq 11\ \Omega$

b. Power of first bulb, P_1 = 100 W
Power of second bulb, P_2 = 60 W
Now,
Resistance of first bulb, $R_1 = \frac{V^2}{P_1} = \frac{220\times220}{100} = 484\ \Omega$
Resistance of second bulb, $R_2 = \frac{V^2}{P_2} = \frac{220\times220}{60} = 806.7\ \Omega$
When the bulbs are connected in parallel, their equivalent resistance is
$R_{\text{eq}} = \frac{R_1\times R_2}{R_1+R_2} = \frac{484\times806.7}{484+806.7} = 302.5\ \Omega$
Current flowing in the main conductor is
$I = \frac{V}{R_{\text{eq}}} = \frac{220}{302.5} = 0.72\ \text{A}$

c. We know,
$\text{Electrical energy } (E) = \text{Power } (P) \times \text{Time } (t)$
For TV set,
$E = 500 \times 30 \times 60 = 900000\ \text{J}$
For heater,
$E = 600 \times 20 \times 60 = 720000\ \text{J}$
Thus, TV set consumes more electrical energy.

d. Electric power required for working of iron, P = 1100 W
Duration for which the iron is operated daily = 2 h = $2 \times 60 \times 60 = 7200$ s
Electric energy consumed by iron in 7200 s is
$E = 1100 \times 7200 = 7920000\ \text{J}$
Thus, total energy consumed in the month of April,
$E' = E \times 30 = 7920000 \times 30 = 237600000\ \text{J}$
We know,
$1 \text{ unit} = 3.6 \times 10^6\ \text{J}$
$\text{or, } 1\ \text{J} = \frac{1}{3.6\times10^6}\text{unit}$
Thus,
$237600000\ \text{J} = \frac{237600000}{3.6\times1000000} = 66 \text{ units}$
Cost of 1 unit of energy = Rs 5
Thus, total electrical consumption expenses for the month of April = 66×5 = Rs 330

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