Class 10 Science · Chapter 11: Electricity

Answer key and marking scheme · 20 marks · about 40 minutes · based on NCERT

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1. The total charge carried by 2.5×10^{19} electrons is [1]

(a) 4 C (b) 0.4 C
(c) 40 C (d) 1.6 C

Answer: (a) Each electron carries 1.6×10^{-19} C, so $Q = 2.5 \times 10^{19} \times 1.6 \times 10^{-19}$ C = 4 C.

2. A cell drives a current of 0.6 A through a coil. The coil is replaced by another of three times the resistance, on the same cell. The current now is [1]

(a) 0.2 A (b) 1.8 A
(c) 0.6 A (d) 0.3 A

Answer: (a) I = V/R: with V unchanged, three times the resistance gives one-third the current, 0.6 A / 3 = 0.2 A.

3. Meena keeps a manganin wire at room temperature and measures the current through it for several values of potential difference. Her graph of V against I is [1]

(a) a straight line meeting the V-axis above the origin (b) a straight line through the origin
(c) a curve that bends upward (d) a line parallel to the I-axis

Answer: (b) At constant temperature V is directly proportional to I for a metallic conductor, so the V-I graph is a straight line passing through the origin.

4. Leela sets up a circuit to study a resistor. Meter M_1 is joined in line with the resistor, so that the whole current passes through it; meter M_2 is joined between the two ends of the resistor. M_1 and M_2 must be, respectively, [1]

(a) two ammeters (b) a voltmeter and an ammeter
(c) an ammeter and a voltmeter (d) two voltmeters

Answer: (c) An ammeter is always connected in series with the part whose current it measures; a voltmeter is always connected in parallel across the two points whose potential difference it measures.

5. A 2 m length of uniform nichrome wire has a resistance of 14 Ω. The resistance of a 50 cm piece cut from it is [1]

(a) 3.5 Ω (b) 56 Ω
(c) 7 Ω (d) 0.875 Ω

Answer: (a) $R \propto l$. The piece is 0.5 m / 2 m = 1/4 of the length, so R = 14 Ω / 4 = 3.5 Ω.

6. Resistors of 3 Ω and 6 Ω are joined first in series and then in parallel, each time across the same 6 V supply. Find the ratio of the heat produced per second in the series arrangement to that in the parallel arrangement. [2]

Series: Rs = 3 + 6 = 9 Ω, $P = V^2/R = 36/9 = 4$ W. Parallel: 1/Rp = 1/3 + 1/6 = 1/2, Rp = 2 Ω, P = 36/2 = 18 W. Ratio = 4 : 18 = 2 : 9.

- Rs = 9 Ω and Rp = 2 Ω (1)
- heat per second 4 W and 18 W, ratio 2 : 9 (1)

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7. A dry cell lying on a shelf, connected to nothing, already has a potential difference across its terminals. Yet once it lights a torch bulb it slowly runs down. Explain both observations. [2]

The chemical action within the cell generates the potential difference across its terminals even when no current is drawn. When the bulb is connected, the potential difference sets charges in motion; to maintain this current the cell must keep expending its stored chemical energy, so it slowly runs down.

- chemical action produces the potential difference even with no current drawn (1)
- maintaining a current uses up the cell's stored chemical energy (1)

8. Priya says the alloy constantan should conduct better than the metal manganese, because constantan is made of copper and nickel, both good conductors. Test her claim using the resistivities: constantan $49 \times 10^{-6}\ \Omega$ m, manganese $1.84 \times 10^{-6}\ \Omega$ m. [2]

Constantan's resistivity is 49/1.84 ≈ 27 times that of manganese, so a constantan wire of the same length and thickness has about 27 times the resistance ($R = \rho l/A$). Her claim is wrong: manganese conducts better. The resistivity of an alloy is generally higher than that of its constituent metals.

- compares resistivities: constantan about 27 times manganese (1)
- concludes manganese conducts better; alloys generally have higher resistivity (1)

9. An electric kettle has an element of resistance 46 Ω and works on a 230 V supply. (i) Find the current it draws and its power. (ii) How long will it take to supply 207 kJ of heat to the water, if all the heat produced goes into the water? [3]

(i) $I = V/R = 230/46 = 5$ A; $P = VI = 230 \times 5 = 1150$ W. (ii) $H = Pt$, so $t = 207000\ J / 1150\ W = 180$ s = 3 minutes.

- $I = V/R = 5$ A (1)
- $P = VI = 1150$ W (1)
- $t = H/P = 180$ s (1)

10. A kitchen circuit at 230 V is protected by a 10 A fuse. A 1150 W microwave oven, a 460 W mixer and a 69 W tube light are running together, connected in parallel. (i) Find the current through each and the total current. (ii) Can a 1 kW toaster be switched on as well without the fuse melting? Show why. [3]

In parallel each appliance has the full 230 V across it, and $I = P/V$. Microwave 1150/230 = 5 A; mixer 460/230 = 2 A; light 69/230 = 0.3 A. The currents add: total 7.3 A. (ii) The toaster would draw 1000/230 ≈ 4.35 A, making the total about 11.65 A, more than 10 A: the fuse would melt. So no.

- each current from $I = P/V$ at the full 230 V: 5 A, 2 A, 0.3 A (1)
- currents add: 7.3 A (1)
- toaster 4.35 A takes the total to 11.65 A, above 10 A, so the fuse melts (1)

11. A lamp maker's leaflet for its filament lamps contains three points. Explain each: (i) a warning that the glass becomes very hot within minutes of switching on; (ii) the filament is held on insulating supports; (iii) the bulb is filled with nitrogen and argon. [3]

(i) Most of the power consumed by the filament appears as heat; only a small part is radiated as light, so the lamp and its glass get very hot. (ii) The supports keep the filament thermally isolated as far as possible, so it stays hot. (iii) Nitrogen and argon are chemically inactive, which prolongs the life of the filament.

- most of the filament's power becomes heat, little as light (1)
- insulating supports: thermal isolation of the filament (1)
- chemically inactive gases prolong the filament's life (1)