2026 Sec 4 Physics Notes (Sample Solutions)
Chapter 14 Current of Electricity

1 Charge and Electric Current

Exercises 1

1 $1.0 / (1.6 \times 10^{-19})$ = <u>6.25×10^{18} electrons</u>

2. $Q = I\,t$ = (0.40 A)(10 × 60 s) = <u>240 C</u> (2sf)

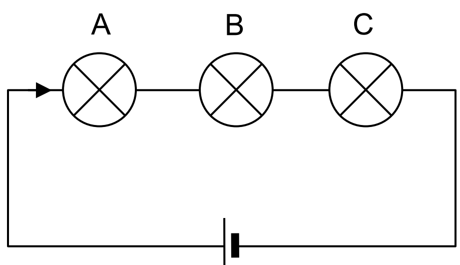
3. $I = Q / t$ = 6.3/0.015 = <u>420 A</u>

4 (a) $t = Q / I$ = 0.0036 / 0.012 = 0.30 s

(b) From the conducting body to earth.

(c) From earth to the conducting body.

5 (a) Arrow(s) through the circuit pointing from the positive terminal towards the negative terminal of the cell.

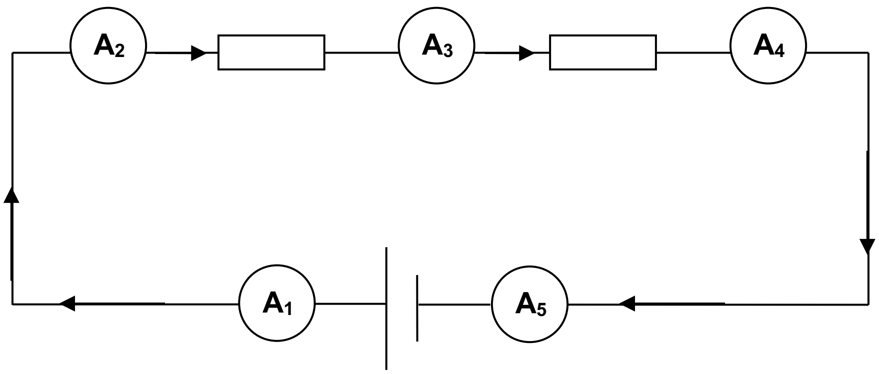


(b) All bulbs will light up at the same time. The battery applies a p.d. simultaneously across each of the bulbs in series *(and the electric field along the connecting wires and bulbs move the electrons at the same time)*. Hence current flows through all bulbs at the same time.

Note: *Think of the flow of current like a metal chain. When you pull at one end of the chain the entire chain moves.) The electrons are linked in a similar way, if one begins to move through the circuit, it will push the electron in front of it and pull the electron behind it. Since all the electrons around the circuit move instantaneously at the same time by the "chain" principle, all the lights should light up at the same moment.*

(c) Since they are identical bulbs in series, the same amount of current flows through each of them. Hence, they will all be equally bright.

6 (a)



(b) All the ammeters show the same reading. Since they are connected in series, the same amount of current flows through each of them.

2 Electromotive Force & Potential Difference

Example 1

(a) Emf = $V_A + V_B$ = 0.80 + 0.70 = 1.50 V

(b) (i) 0.70 V (ii) 1.50 V (iii) 0.50 V (iv) 1.00 V

(c) (i) $V_{sq} = V_q - V_s$ = 1.00 – 0.70 = 0.30 V

(ii) $V_{sr} = V_s - V_r$ = 0.70 – 0.50 = 0.20 V

Exercises 2

1 (a) An emf of 12.0 V means that the battery will convert 12.0 J of chemical potential energy to electrical energy to move 1C of charge round the circuit. [emf = W / Q]

(b) $E = I\,V\,t$ = 3.5 A × 8.0 V × 6.0 s = 168 J

(c) thermal energy

2 (a) 4(1.5 V) = 6.0 V (b) $W = Q\,V$ = 4.0 C × 6.0 V = 24 J

3 (a) 0 V (b) 6.0 V (c) 3.0 V (d) 1.5 V

4 Consider original circuit to have cell with emf V and lamp of resistance R and $V = I\,R$

(a) Very bright. Effective emf = 2V, hence current = 2I

(b) Normal brightness. Effective emf = $V + V - V = V$, hence current = I

(c) Normal brightness. Effective emf = 2V, effective resistance = 2R, hence current = I

(d) Not lighted up.
Polarity of cells are in opposite directions,
Effective emf = 0 V

5 (a) 24 V

(b) 240 V ÷ 20 = 12 V

3 Resistance

Example 2

(a) $\boldsymbol{R = \rho L / A}$

Let resistance of R_B be R.

First consider Wire A' has resistivity twice that of Wire B.

Thus, $R_{A'} = 2R$

In addition, Wire A has thrice the cross sectional area of Wire B.

Therefore, in total,

$R_A = 2R / 3 = 2/3\ R_B$

(b) Resistivity $\rho = R A / L$ = 6.0 Ω (1.0 × 10^{-6} m^2)/ 1.5 m = <u>4.0 × 10^{-6} Ω m</u>

Example 3

(a) I = Emf / R_T = 2.0 V ÷ 4.0 **Ω** = 0.50 A

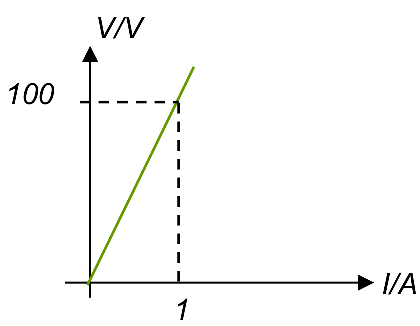
(same current flows through the cell and 4.0 Ω resistor)

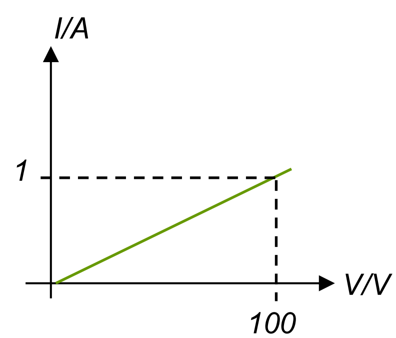
(b) I through cell = 2.0 V ÷ 8.0 **Ω** = 0.25 A

I through 4.0 Ω resistor = 0 A (Short-circuit across 4.0 Ω resistor)

Example 4

Draw the V against I graph and I against V graph for an ohmic conductor that has a 100 Ω resistance.





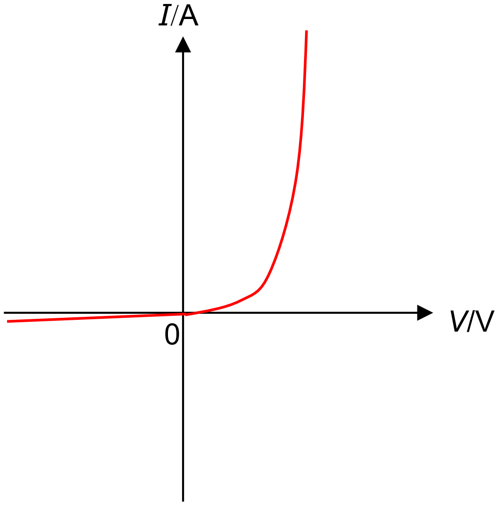
Exercises 3

1 $L_1 = (L_2/R_2) \times R_1 = (3.5\text{ m} / 20\ \Omega) \times 50\ \Omega = 8.75\text{ m} = \underline{8.8\text{ m}}$ (2sf)

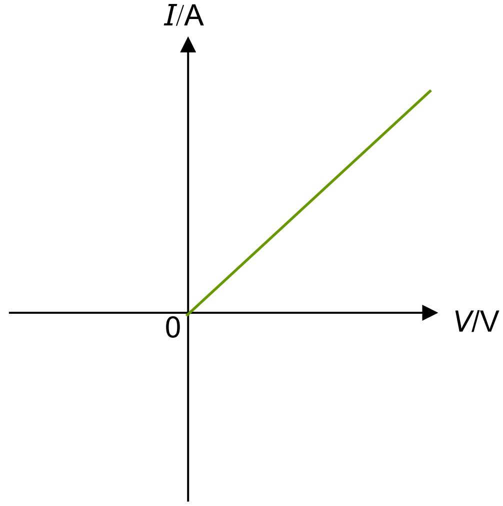
2 $R \propto 1/A$ and $R \propto 1/d^2$ where d is the diameter of the wire.
Therefore $R_B = R_A \times (d_A)^2/(d_B)^2$

Since $d_A = 2d_B$,
$R_B = R_A \times (2d_B)^2/(d_B)^2$
$= 25.8\ \Omega \times 4 = 103.2\ \Omega$
$= \underline{103\ \Omega}$ (3sf)

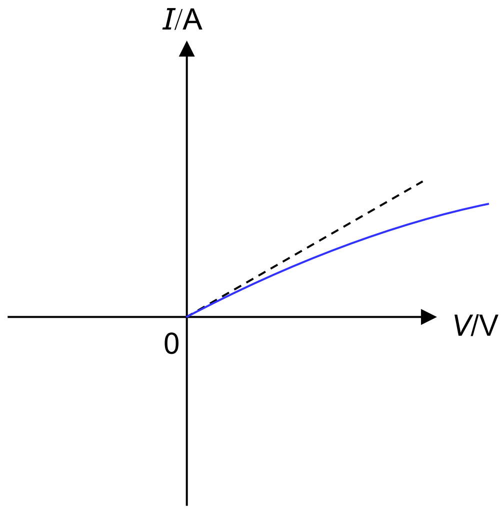
3 (i) a diode



(ii) a pure metal (temperature kept constant)



(iii) Filament lamp



4 (ai) 4.0 V

(aii) $R = V / I = 4.0\text{ V} \div 0.035\text{ A} = 114.3 = \underline{110\ \Omega}$ (2 sf)

(bi) $R = V / I = 8.0\text{ V} \div 0.045\text{ A} = 177.7 = \underline{180\ \Omega}$ (2 sf)
Note it is a common mistake to define resistance as the rate of change of V with respect to I.

(bii) Resistance of lamp increases as current increases.

5

(a)(i) When V is negative, the current I is zero.

(a)(ii) When V is positive, the current will remain at zero from V = 0 V to V = 0.6 V.
For V > 0.6 V, the current will <u>increase at an increasing rate</u>.

(a) [Reading from graph]
When V = 0.80 V, current I = 10 mA.
Applying formula $V = R \times I$, $R = 0.80\text{ V} / (10 \times 10^{-3}\text{ A}) = 80\ \Omega$

(b) I do not agree with the student.
From $R = V / I$, when I is zero, the value of R will be <u>infinite</u>.