Pages 239–241 Exam practice questions

1 C

2 A

3 A

4 B

5 B

6 A

7 B

8 D

9 D

10 B

11 **a)** 0.4 A [1]

b) Current at normal operating temperature = horizontal portion of graph = 0.2 A. [1] $R = \frac{V}{I} = \frac{6\text{ V}}{0.2\text{ A}} = 30\ \Omega$. [1]

c) The metal in the filament of the bulb is initially cold. This means its resistance is low and a larger amount of current can flow through the filament. [1] The filament heats up as more current passes through it and the resistance increases, gradually limiting the current to a maximum value. [1]

d) Total charge, ΔQ = area under *I*–*t* graph from 0–500 ms. This can be approximated by dividing the area under the graph into regular shapes and calculating each shape's area/charge, or you could use a square counting technique – where each small square is equivalent to $(0.1\text{ A} \times 20 \times 10^{-3}\text{ s})$ $= 2 \times 10^{-3}$ C.

The four triangles have a charge of:

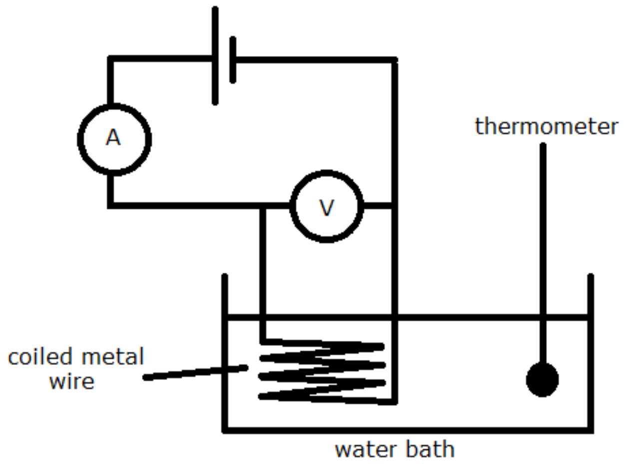
$$\left(\frac{1}{2} \times 0.4 \times 40 \times 10^{-3}\right) + \left(\frac{1}{2} \times 0.1 \times 100 \times 10^{-3}\right) + \left(\frac{1}{2} \times 0.07 \times 260 \times 10^{-3}\right) + \left(\frac{1}{2} \times 0.03 \times 160 \times 10^{-3}\right) = 0.0245\text{ C}$$

The three rectangles have a charge of:

$$(0.3 \times 100 \times 10^{-3}) + (0.23 \times 160 \times 10^{-3}) + (0.2 \times 200 \times 10^{-3}) = 0.1068\text{ C}$$

Total charge = 0.1313 C = 0.13 C (2 s.f.) correct method [1]; answer [1]

12 a)



Correct electrical circuit [1]; suitable apparatus to vary *T* [1]

b) i) Set up apparatus as in Figure 7.

ii) Adjust temperature to 0 ˚C using ice.

iii) Measure and record current, p.d. and temperature. [1]

iv) Change temperature on water bath to 10 ˚C.

v) Repeat step (iii).

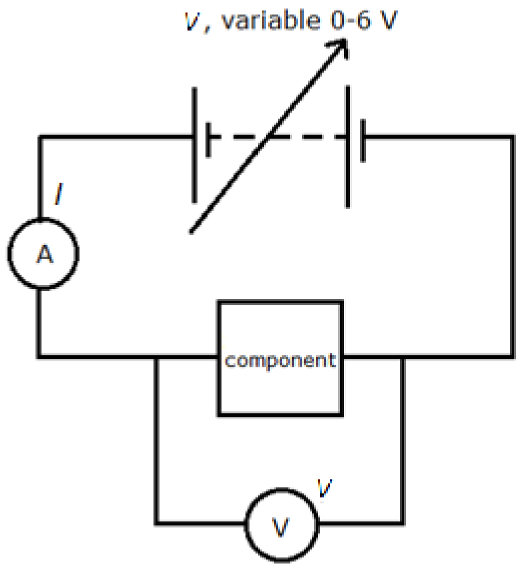
vi) Repeat for 10 ˚C temperature increments up to 100 ˚C. [1]

vii) Calculate values of *R* for each temperature using, $R = \frac{V}{I}$. [1]

c) The temperature at and below [1] which a material becomes superconducting. [1]

13 a) A conductor that obeys Ohm's Law ($I \propto V$). [1]

b)



c) i) Adjust power supply so that voltmeter reads 1.0 V

ii) Measure and record p.d., *V*, and current, *I*. [1]

iii) Alter p.d., *V*, across the component in increments of 1.0 V.

iv) Repeat step (ii). [1]

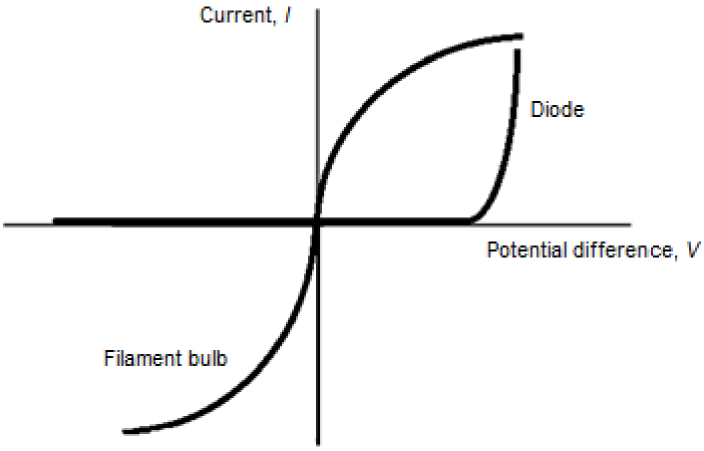
v) Reverse bias the component. [1]

vi) Repeat steps (i) to (iv), recording values as negative. [1]

vii) Calculate values of: $R = \frac{V}{I}$, for each current, p.d. pair. [1]

viii) If the component is 'ohmic' then the values of *R* will all be very similar with no trend. [1]

14 a)

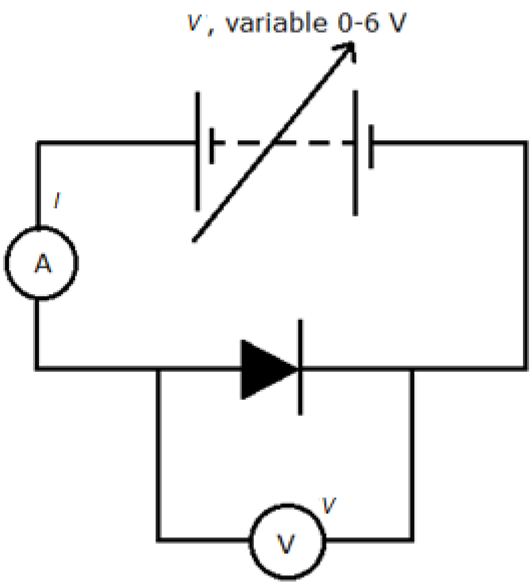


Correct diode [1]

Correct filament bulb [1]

b) Resistance, $R = \frac{V}{I}$. As *V* increases, so does *I*, but proportionately less than the increase in *V* [1]. This indicates that the ratio $R = \frac{V}{I}$ increases with *V* [1].

c)



Correct symbols [1]

Correct connections [1]

d) **i)** Adjust power supply so that voltmeter reads 0.5 V.

ii) Measure and record p.d., *V*, and current, *I*. [1]

iii) Alter p.d., *V*, across the component in increments of 0.5 V up to 3.0 V.

iv) Repeat (ii). [1]

v) Reverse bias the component. [1]

vi) Repeat (i) to (iv), recording values as negative. [1]

15 a) $V = 6.0\text{ V} - 1.8\text{ V} = 4.2\text{ V [1]}$

b) $I = \frac{V}{R} = \frac{4.2\text{ V}}{1.4 \times 10^3\ \Omega}\text{ [1]} = 3.0 \times 10^{-3}\text{ A [1](2 s.f.)}$

c) $R = \frac{V}{I} = \frac{1.8\text{ V}}{3.0 \times 10^{-3}\text{ A}}\text{ [1]} = 600\ \Omega\text{ [1] (2 s.f.)}$

d) Higher resistance in the circuit will result in a smaller current [1] and hence a lower value of *V* [1].

16 a) $A = \pi r^2 \Longrightarrow R = \frac{\rho l}{\pi r^2} = \frac{0.82\ \Omega\text{ m} \times 8.0 \times 10^{-2}\text{ m}}{\pi \times (1.4 \times 10^{-2}\text{ m})^2}\text{ [1]} = 106.5\ \Omega = 110\ \Omega\text{ [1] 2 s.f.)}$

b) Increasing x4 length = increasing x4 resistance [1]. Halving the radius means that the area decreases by a factor of x4 [1] – the overall effect is for the resistance to increase by a factor or 16 to 1760 Ω [1].

17 a) $R = \frac{\rho l}{A} = \frac{1.7 \times 10^{-8}\ \Omega\text{ m} \times 0.60\text{ m}}{1.3 \times 10^{-7}\text{ m}^2}\text{ [1]} = 0.078\ \Omega\text{ [1](2 s.f.)}$

b) $V = IR = 2.2 \times 0.078 = 0.156\text{ V [1]};$

b) p.d across terminals of the supply $V_T = V_{\text{wire 1}} + V_{\text{wire 2}} + V_{\text{lamp}}$

= 0.156 V + 0.156 V + 12.0 V = 12.3 V

Pages 242–243 Stretch and challenge questions

18 A

19 a) Current flows and power is converted/heat energy produced (in the thermistor).

Calculation $P = V^2/R = 25/120 = 0.2$ W.

This causes the temperature of the thermistor to rise and its resistance to fall.

Increased current flow so more heat energy produced.

Cycle continues until thermistor overheats/is destroyed.

b) 50 Ω as the variation of $R_{\text{thermistor}}$ would be relative to (50 + 120) Ω. (The change in potential is the change in $R_{\text{thermistor}}$ relative to the smallest total resistance).

c) 50 Ω is the smallest resistance and might be too little to prevent the 'thermal runaway' described in part (a).

20 a) $A = \frac{V}{l}$; and $R = \frac{\rho l^2}{V}$

b) $\frac{V}{\rho} = \frac{l^2}{R}$ OR $\frac{\rho}{V} = \frac{R}{l^2}$

c) $\frac{R_{old}}{l_{old}^2} = \frac{R_{new}}{l_{new}^2}$

$\frac{2.7}{32^2} = \frac{R_{new}}{120^2}$

R_{new} = 38 Ω