Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Mark Schemes

Q1.

(a) (pd across the variable resistor) = 11.25 (V) seen

For **Max 1**:

OR

Use of $V_0 = \frac{R_1}{R_1 + R_2} \times V_{in}$

Condone mix up of R_1 and R_2

OR

use of V_1: $V_2 = R_1 : R_2$ or $\frac{V_1}{V_2} = \frac{R_1}{R_2}$

Condone $V = 12\ V$ and $R = 25\ \Omega$ leading to an answer of 1.56 Ω or 1.6 Ω

OR

(I =) 0.45 A ✔

Condone $V = 12\ V$ and $R = 25\ \Omega$ leading to $I = 0.48\ A$ and an answer of 1.56 Ω or 1.6 Ω

(R =) 1.7 (Ω) ✔ **c.a.o**

Accept a correctly rounded answer to 2 or more significant figure.
(Calculator displays 1.66666666)

2

(b) Clear read-off seen on graph of I = 1.7 A

Within $\frac{1}{2}$ square of accuracy (1.65 A to 1.75 A)

OR

use of $V = IR$ ✔

Accept $\frac{8}{1.65}$ = 4.8(4) or $\frac{8}{1.75}$ = 4.5(7) in use of $V = IR$
(condoning 'read-off' to within 1 square of accuracy)

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Don't need to see read-off for use of $V = IR$

8 × 1.7 = 13.6 would be insufficient as use of and in this case MP1 can only be scored where read-off is seen.

(R =) 4.7 (Ω)

Allow answer in range 4.57 to 4.85

Do not accept 1 significant figure in answer

2

(c) As voltage increases the current increases / as the voltage increases more electrons move through the wire (per second) ✔

More collisions (per second) between the (conduction) electrons and the lattice ions / Vibration of the lattice ions increases ✔

Allow vibration of the ions in the filament / wire / metal increases

(Rate of) vibration of the lattice ions increases causing a greater number of collisions **per second** causing increased resistance ✔

Accept rate of collisions for number of collisions per second.

Talk out on MP3 where current decreases.

3

(d) use of $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ or $R_T = \frac{R_1 \times R_2}{R_1 + R_2}$

allow use of $\frac{1}{6} + \frac{1}{25}$ *seen without subject*

Alternative MP1:

($I_T = I_{lamp} + I_{XY} = 2.48\ A$*)* ***and*** *use of* $V = IR$

Accept a correctly rounded answer to 2 or more significant figure.

(R =) 4.8(4) (Ω)

(Calculator displays 4.838709677)

2

(e) use of $P = \frac{V^2}{R}$ by substitution of V = 12 V and $R = 4.8\ \Omega$

Ecf from part (d) for MP1 and MP2

MP1:

Condone use of $R = 6\ \Omega$ *or* $R = 25\ \Omega$ *in this substitution for MP1 (where not ecf from part (d)*

OR

Condone use of $P = IV$ *or use of* $P = I^2R$ *by substitution of their (battery)* I *and ecf* R *from part (d). Must have clearly identified* I *in working in*

part (d) or by use of $I = \frac{12}{\text{ecf } R}$ *here*

(P =) 30 (W) ✔

Ecf answer must be $\frac{12^2}{R \text{ on answer line in part (d)}}$

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(Calculator display for non-rounded answer 29.76)

Penalise answers with more than two digits that have been rounded to 1 significant figure.

2

(f) Wider range in Figure 4's circuit **and** lower efficiency in Figure 4's circuit

Details:

Voltage range is wider 0–12 V (in Figure 4's circuit) compared to 0.75 V – 12 V (in Figure 2's circuit) / can't get voltages between 0 and 0.75 V In Figure 2 / wider range when using **XY** as a potentiometer

OR

bulb won't light at lower voltages, so control is unaffected ✔

Condone referring to Figure 2 as Figure 3.

Allow 'can get zero volts in Figure 4'

At any particular voltage across lamp more power dissipated in circuit in Figure 4 / any voltage across the lamp there is always 12 V across the resistor in Figure 4's circuit which produces more heating (whereas only the remaining portion of 12 V is across the resistor in Figure 2's circuit) / for any current in the lamp there is always more current in Figure 4's circuit which produces more heating ✔

Current splits in Figure 4 is insufficient

3

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Q2.

(a) 0.879 (m ✔)

1

(b) correctly determines R_4 **OR** divides their incorrect R_4 by their part **(a)** $_1$ ✔

Correct answer gives 0.15(1) (Ω m^{-1}).

$_1$ ✔ *Correct* $R_4 = 0.13(3)\ \Omega$

$_{12}$ ✔ *Allow a correction to* m *if their part* ***(a)*** *is in mm*

$_2$ ✔ *Condone 3 sf answer*

2

(c) micrometer screw gauge

OR

digital (vernier) callipers $_1$✔

Treat references to zero error as neutral unless explicitly linked to reducing random error.

For $_1$ ✔ *allow 'micrometer' or 'screw gauge' or travelling microscope.*

Reject '(vernier) callipers'.

repeat readings at different points (along the wire)

OR

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repeat readings in different directions / orientations

OR

repeat readings AND reject / discard anomalies $_2$✔

Accept "readings" for "measurements".

Repeat "experiment" is insufficient.

calculate average / mean (from repeated readings) $_3$✔

for $_3$✔ some mention of repeat (readings) owtte must be seen somewhere in body of answer

3

(d) use of $A = \frac{\pi d^2}{4}$ $_1$✔

ρ = their **(b)** × 1.1(3) × 10^{-7} (Ω m) $_2$ ✔

for $_1$✔ allow POT in d; either $A = \frac{\pi \times 0.38^2}{4}$ ***OR***

$A = \pi \times 0.19^2$ ***OR*** $A = 1.1(3)\ (\times 10^{-7})$ *seen*

For $_2$ ✔ expected answer is 1.7 × 10^{-8} (Ω m)

If no other mark given, allow 1 mark for 6.8 × 10^{-8} (Ω m)

2

(e) decrease R_1 / 2.2 MΩ by a factor of 30

OR

increase R_2 / 3.9 kΩ by a factor of 30

OR

increase R_3 / 75 Ω by a factor of 30 ✔

unless quantitative change identified, must give new resistance, eg

(new) R_1 is 73 $k\Omega$

(new) R_2 is 120 $k\Omega$

(new) R_3 is 2.3 $k\Omega$

1

(f) 2.1 (mm) ✔

allow > 2 sf answer rounding to 2.1 (mm)

1

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