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

Mark Schemes

Q1.

(a) Mass of alpha particle = $\frac{2\times1.6\times10^{-19}}{4.81\times10^{7}}$ =6.6(53) × 10^{-27} (kg)

Allow mass = 2 × m_p + 2 × m_n = 6.696 × 10^{-27} kg
Allow mass = 4 × 1.66 × 10^{-27} kg = 6.64 × 10^{-27} kg
Allow mass = 4 × 1.67 × 10^{-27} kg = 6.68 × 10^{-27} kg
Allow slight rounding on mass (must be correct to 2 sf)

OR

Correctly re-arranged k.e. equation (with v^2 or v as subject) with 8.1 × 10^{-13} (J) substituted correctly$_1$✔

1.56 × 10^7 seen $_2$✔

*Condone **incorrect mass** in otherwise correct substitution **with v or v^2** **recognisable** as subject .*
Alternative approaches are:

$$v=\sqrt{\frac{E_k\times\text{specific charge}}{e}}$$

$$v=\sqrt{\frac{2\times E_k}{m_\alpha}}$$

Must see answer to at least 2 sf
Must see attempt to use one of the alternative approaches to support correct answer

2

(b) Use of $W = Fs$, F = 8.1 × 10^{-13} ÷ 3.5 × 10^{-2} $_1$✔

(F=) 2.3 × 10^{-11} (N) $_2$✔

Condone POT error
Correct answers gets 2 marks

OR

Use of an appropriate equation of motion to find a **and** $F = ma$

(allow their mass and their velocity in this sub) $_1$✔

Condone POT error

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(F=) 2.3×10^{-11} (N) $_2$✔

Condone POT

OR

Use of an appropriate equation of motion to find t **and** $F = \Delta mv/t$

(allow their mass and their velocity in this sub) $_1$✔

(F=) 2.3×10^{-11} (N) $_2$✔

[answer is

$$\frac{(\text{their speed})^2 \times (\text{their } m_\alpha)}{0.070}$$

Using 2×10^7 m s^{-1} yields(5.71×10^{15} × their m_∞) – allow 1 sf answer in this case

Expect to see 3.8×10^{-11} (N) or 4×10^{-11} (N)]

2

(c) (Number of ions formed over range =)

$5.1 \times 10^4 \times 3.5$ seen **or** 1.785×10^5 (ions) seen

OR

8.1×10^{-13} converted to eV seen $_1$✔

$8.1 \times 10^{-13} \div 1.785 \times 10^5$

OR

$5.06 \times 10^6 \div 1.785 \times 10^5$ seen $_2$✔

Condone POT error in first mark

Ignore units

$8.1 \times 10^{-13} \div (5.1 \times 10^4 \times 3.5)$ is worth 1st and 2nd marks

Condone POT errors in second mark

Correct answer obtains 3 marks

28 (.4) (eV) $_3$✔

99(.3) (eV) scores 1 mark

3

(d) (Q =) $0.85 \times 10^{-3} \times 1.2 \times 10^{-9} = 1.02 \times 10^{-12}$

OR

n = (their Q) $\div 1.6 \times 10^{-19}$ $_1$✔

$n = 6.4 \times 10^6$ (c.a.o.) $_2$✔

Condone one POT error for one mark

2

(e) At 3.5 cm the pd drops / the current begins

OR

When the source is 10 cm away no ionisation occurs in the air gap (because the alpha particles

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have insufficient range to reach the air gap)

OR

When the radioactive source is close enough (approx. 5 cm) ionisation occurs ✔

OR

When beyond 3.5 cm no change in pd / current equals zero

Must be sense of abrupt change

MAX 3

When ionisation occurs / charge carriers are liberated in the air gap:

Allow more ionisation for second mark

resistance has decreased

OR

current increases (from zero)

OR

the potential difference decreases (with a maximum current) (to its minimum value) (across the air gap)✔

From 10 cm separation until 5 cm (approx) separation nothing changes / appreciates that pd is 4500 V / pd across gap = 4500 V until ionisation occurs ✔

Current is produced: the pd across 5 MΩ resistor is 4250 V / most pd is across the 5 MΩ resistor / small pd across air gap ✔

Current is produced and the pd across the air gap is 250 V✔

Current is produced and the pd across the air gap is 250 V✔

3

[12]

Q2.

(a) Length of resistance wire = $50 \times 2 \times 3.14 \times 4 \times 10^{-3} = 1.26$ m ✔

or $50 \times 3.14 \times 8 \times 10^{-3}$

1

Substitution of data in resistance formula

or $A = \rho L/R$ seen ✔

ecf for incorrect length from attempt at a calculation

1

Area of cross section = $2.1(1) \times 10^{-9}$ (m^2) ✔

1

(b) Maximum possible pd across 0.25 kΩ is 9 V ✔

1

(Max power dissipated) = $9^2/250 = 0.32$ W so resistor is suitable ✔

1

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OR

When resistor dissipates maximum power

$V^2 = 0.36 \times 250$ so max $V = 9.5$ *V* ✔

This is higher than the supply pd so this power dissipation so will not be reached ✔

OR

Power dissipated when output is 5 $V = 4^2/250 = 0.064$ W ✔

Which is below the max power dissipation of 0.36 W ✔

$9^2/250 = 0.32$ W with incorrect conclusion scores 1
Second mark implies the first
$9^2/0.36 = 225\ \Omega$ alone is not a useful calculation in the context. Still need to explain the effect of using the 250 Ω
First mark is for a valid useful calculation

(c) Use of potential divider formula to determine resistance of parallel combination ✔

0.313 kΩ ✔

Use of equation for resistors in parallel ✔

540 Ω ✔

Alternative to find resistance of combination
Current in circuit at room temp = 4/250 = 16 mA ✔
Resistance of combination = 5/16mA = 313 Ω ✔
OR

$$\frac{V_{combination}}{V_{250}} = \frac{R_{combination}}{250}$$

$$\frac{5}{4} = \frac{R_{combination}}{250}$$

$R_{combination} = 313\ \Omega$

OR

Current in circuit at room temp = 4/250 = 16 mA ✔

Current in thermistor = 5/750 = 6.7 mA ✔

Current in R = 9.3 mA ✔

R = 5/9.3 = 540 Ω ✔

2sf answer ✔

(only allowed with some relevant working leading to a resistor value)

Max 5

(d) Resistance of <u>thermistor</u> decreases ✔

<u>Output pd decreases since</u>

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resistance of the parallel combination /circuit decreases

1

OR

lower proportion of pd across the parallel combination (or higher proportion across 250Ω)

OR

higher current so greater pd across the 0.25 k resistor ✔

Accept correct consequences for R increasing with temperature for 1 mark

1

[12]

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