Name of the Student:_____
Max. Marks : 18 Marks **Time : 18 Minutes**

Mark Schemes

Q1.

(a) **The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2 mark (L1), 3 or 4 mark (L2) and 5 or 6 mark (L3) answer. Guidance provided in section 3.10 of the *Mark Scheme Instructions* document should be used to assist marking this question.**

L3 5-6 marks	Candidate will draw a useful diagram, and give a coherent well-structured attempt at explaining how energy and velocity are measured with some equations and the use made of the measurements.	The student presents relevant information coherently, employing structure, style and sp & g to render meaning clear. The text is legible.
L2 3-4 marks	The response explains that velocity and kinetic energy were measured and attempts to explain the method used but lacks detail in one or both aspects. The response should show some attempt to structure the account.	The student presents relevant information and in a way which assists the communication of meaning. The text is legible. Sp & g are sufficiently accurate not to obscure meaning.
L1 1-2 marks	The response explains that velocity and kinetic energy were measured but gives little or no significant detail. The account may lack structure.	The student presents some relevant information in a simple form. The text is usually legible. Sp & g allow meaning to be derived although errors are sometimes obstructive.
0 marks	Little or no discussion of relevant content.	The student's presentation, spelling, punctuation and grammar seriously obstruct understanding.

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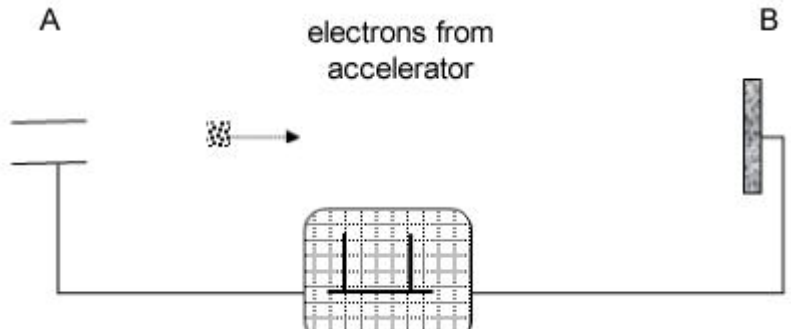

The following statements could be present:

useful diagram
pulses of electrons produced in an accelerator
electron beam detected as it passes A and B
time of flight measured with oscilloscope
velocity = AB / time
each pulse of electrons raises temperature of aluminium plate
temperature rise of plate measured
energy landing on plate $mc\Delta\theta$
energy of electron = $mc\Delta\theta/n$ *(n = number of electrons hitting the plate)*
e and v measured for different electron energies
compared with prediction from relativity.

6

(b) Ke measured = 2.4 MeV = $2.4\times10^{6}\times1.6\times10^{-19} = 3.84\times10^{-13}$J✔
Ke predicted = 2.99×10^{13}✔
Difference = 0.85×10^{-13} J✔
% difference = 28% on predicted / 22% on measured✔

or

Calculation of Ke predicted in J as shown above.✔✔
Conversion of energy to MeV.✔
Measured energy is higher than that predicted by more than experimental error can justify (about 28%).✔

4

[10]

Q2.

(a) At terminal speed (v)), the viscous force on the droplet = its weight

For weight: allow mg or the force of gravity on it
For viscous force: allow 'drag' or 'resistance' or 'friction'
Not upthrust.

$6\pi\eta rv = 4\pi r^3\rho g / 3$ ✓

1

Manipulation leading to $r = (9\ \eta v / 2\rho g)^{1/2}$ ✓

1

(b) r (can be calculated as above then) used in the formula $m = 4\pi r^3\rho / 3$ to find the droplet mass, m ✓ (WTTE)
Alternative ; (from $6\pi\eta rv = mg$: as all values are known use) $m = 6\pi\eta rv / g$ ✓

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1

(c) electric force (or QV / d) = the droplet weight (or mg) ✓

*Do not give 1st mark if **e**V / d given instead of Q V / d*

1

Q =

$$\frac{mgd}{V} = \frac{3.4 \times 10^{-15} \times 9.8(\ 1) \times 15.0 \times 10^{-3}}{1560} = \mathbf{3.2 \times 10^{-19}\ C}\ ✓$$

1

(d) Millikan's conclusion: Electron charge is (-)1.6 × 10^{-19} C (WTTE) ✓

The charge on each droplet is a whole number × 1.6 × 10^{-19} C which agrees with Millikan ✓

Student's results suggest -3.2 x 10^{-19} C as smallest quantum of charge ✓

allow multiple or n, where n is an integer

3

[8]

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