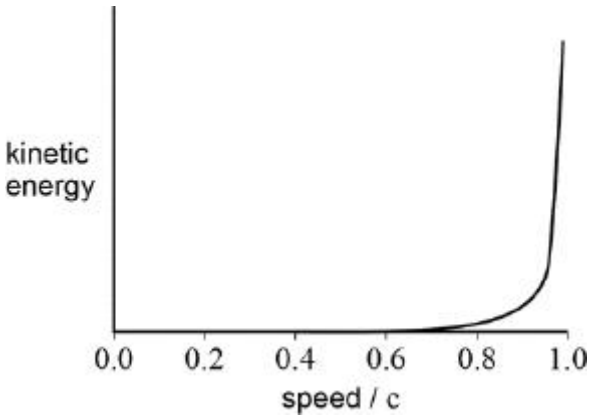
Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Mark Schemes

Q1.

(a) C ✔



Only answer

1

(b) KE = total energy – rest energy ✔

$$m_0c^2 = \frac{m_0c^2}{\sqrt{1-\frac{v^2}{c^2}}} - m_0c^2 \checkmark$$

To give $v = 0.87c$ OR 2.6×10^8 m s^{-1} ✔

MP2 requires the use of the idea that the KE is equal to the rest energy.
(calculator values are 0.8660 and 2.59808×10^8)

3

(c) mass is related to energy through

$E = mc^2$ ✔

When an object stores energy this appears as an increase in observed mass.

OR

A spring gains (elastic potential) energy so observed mass must also increase. ✔

Treat any idea that 'the difference in observed mass is negligible' as neutral.

Max 2

[6]

Q2.

(a) **A** is filament ✔

B is the anode ✔

V_1 is the p.d. to supply energy/ drive current to heat **A**. ✔

V_2 is the p.d./produces accelerating electric field to accelerate electrons.

Allow heated cathode

4

(b) (Atom diameter about 0.1 nm)

Allow 0.05 nm to 0.1 nm for wavelength

So wavelength should be about 0.05 nm ✔

$\lambda = \frac{h}{\sqrt{2meV}}$ seen ✔

Ecf for wavelength for MP 2, 3, 4

Rearranged with substitutions of h, m, e to give

$V = \frac{h^2}{2me\lambda^2}$ ✔

= 600 V ✔

Allow 1 sf answer

4

(c) State inverse relationship between wavelength and momentum ✔

De Broglie hypothesis suggests that λ will decrease/increase if the momentum increases/decreases

Identify link between V_2 and momentum of electrons. ✔

Allow qualitative statements.

Measure V_2 to determine (KE of electrons and therefore) momentum/speed of electrons

Identify how ring diameter is related to wavelength. ✔

Measure ring diameter as increased/decreased diameter indicates increased/decreased wavelength

State change in ring diameter due to change in V_2 (which is consistent with de Broglie hypothesis) ✔

(De Broglie hypothesis therefore supported by) increasing/decreasing V_2 resulting in decreased/increased ring diameter.

4

(d)

STM	TEM	
Moving electrons can cross a potential barrier.	Moving electrons can be deflected by a magnetic field.	✓
Moving electrons can be deflected by a magnetic field.	Moving electrons can be deflected by a magnetic field.	
Moving electrons can be deflected by a magnetic field.	Moving electrons can cross a potential barrier.	
Moving electrons can cross a potential barrier.	Moving electrons can cross a potential barrier.	

Tick in first box ✔

Only answer

1

[13]