Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Mark Schemes

Q1.

(a) (i) **either**

(at terminal speed (v)) the viscous force on the droplet = its weight (or mg or the force of gravity on it)

or

viscous force = $6\pi\eta rv$ (where r is the radius of the droplet and η is its viscosity) and weight (= mg) = $4\pi r^3\rho g/3$ ✓

$4\pi r^3\rho g/3 = 6\pi\eta rv$ ✓

(which gives $r = (9\ \eta v/2\rho g)^{½}$)

2

(ii) r (can be calculated as above then) used in the formula $m = 4\ \pi r^3\rho/3$ to find the droplet mess, m [owtte] ✓

alternatively; (from $6\pi\eta rv = mg$) (as all values are known use) $m = 6\pi\eta rv/g$ ✓

1

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

$$Q = \frac{mgd}{v} = \frac{6.8\times10^{-15}\times9.8(1)\times5.0\times10^{-3}}{690} = 4.8\times10^{-19}\ \text{C}$$ ✓

2 sf answer ✓

3

(ii) **any two from**

the charge on each droplet is a whole number × 1.6×10^{-19} C (or × charge of the electron) ✓

the least amount of charge (or the quantum of charge) is the charge of the electron ✓

the quantum of charge is 1.6×10^{-19} C [owtte] ✓

max 2

[8]

Q2.

(a) (i) The number of electrons (per second) in the beam will increase **(1)** because the filament will become hotter and will emit more electrons (per 2 second) **(1)**

2

(ii) the speed (or kinetic energy) of the electrons will increase **(1)**

because the electrons (from the filament) are attracted towards the anode with a greater acceleration (or force) **(1)**

(or gain more kinetic energy in crossing a greater pd)

2

(b) (i) (magnetic) force on each electron in the beam is perpendicular to velocity **(1)**

no work is done on each electron by (magnetic) force so ke (or speed) is constant **(1)**

magnitude of (magnetic) force is constant because speed is constant **(1)**

(magnetic) force is always perpendicular to velocity so is centripetal **(1)**

max 3

(ii) rearranging $r = \frac{mv}{Be}$ gives $\frac{e}{m} = \frac{v}{Br}$ **(1)**

$$\frac{e}{m} = \frac{7.4 \times 10^{6}}{6.0 \times 10^{-4} \times 68 \times 10^{-3}} = 1.81 \times 10^{11}$$ **(1)** C kg^{-1} **(1)**

for correct answer to 2 sf **(1)**

4

(iii) specific charge for the electron ≈ 2000 × specific charge of H^+ **(1)**

(accept = and accept any value between 1800 and 2000)

which was the largest known specific charge before the specific charge of the electron was determined/measured **(1)**

(or which could be due to a much greater charge or a much smaller mass of the electron)

2

[13]