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

Mark Schemes

Q1.

(a) Drop stationary so

Electric force is opposite (in direction) to the weight

AND

electric field downwards/top plate positive/(electric) force towards positive plate so Q negative ✔

Give credit to answers shown on the diagram
Allow forces expressed in symbols
Do not allow suggestion that viscous force is involved
Accept idea that the drop is attracted towards the positive plate.
Accept bottom plate negative as an alternative to top plate positive.

1

(b) (In free fall at terminal speed)

$mg = 6\pi\eta rv$ ✔

Use of m = volume × density AND $V = \frac{4}{3}\pi r^3$ ✔

(to give $r = 5.9 \times 10^{-7}$ m)

(use of volume of sphere and density)

to give answer that rounds to $m = 7.7 \times 10^{-16}$ (kg) ✔

At least 2 sf.

3

(c) $\frac{vQ}{d} - mg = 6\pi\eta r v_2$ ✓ ✔

Convincing algebra combining with $mg = 6\pi\eta r v_1$

to give v_2/v_1 = answer ✔

MP2 is contingent on MP1

2

(d) Use of equation from **(c)** ✔

to show $Q = 4.9 \times 10^{-19}$ C ✔

Evidence of dividing their Q by 1.6×10^{-19} to give a consistent conclusion ✔

Use of means by substitution or manipulation

Accept answer that rounds to between 4.8 and 5.0 × 10^{-19} C

Using the 'show that' value for the mass gives

$Q = 4.96 \times 10^{-19}$ C

Only condone ecf in MP3 for an arithmetic error in the determination of Q.

3

(e) Value of viscosity affects calculation of mass/radius of droplet ✔

'affects' can be either increase or decrease in MP1

Smaller value of viscosity gives smaller force on droplet so smaller calculated weight/mass ✔

In MP2 allow use of relationship between the radius of the drop and the viscosity.

Evidence of MP1 is likely to be seen in MP2.

Do not condone use of $mg = 6\pi\eta rv$ on its own

Ref to equation

AND

as mass is smaller then Q smaller (therefore e smaller). ✔

*Appropriate means either the equation from **(c)** or relationship between weight and electric field force (e.g weight = mg = EQ)*

3

[12]

Q2.

(a) Frequency (of rotation) of W when no reflected light seen ✔

and idea that this is the lowest frequency ✔

MP2 is contingent on MP1

Do not accept 'first frequency' for MP2

2

(b) Either

Calculate using equation (max measurable speed)
= 2.5×10^{8} m s^{-1}

Condone alternative methods e.g. comparison of times etc.

OR

Calculate value of f_0 (needed) = 12(.25) Hz/735 rev min^{-1} ✔

Unit needed for MP1

Conclusion: No as

the largest possible speed is less than the speed of light

OR

the frequency required to find the speed of light is greater than the maximum frequency. ✔

Condone ecf in MP2 only for an arithmetic error in MP1 e.g. incorrect conversion to Hz.

2

(c) ε_0 related to electric field strength (due to charged object) in free space ✔

Accept vacuum for free space

μ_0 related to magnetic flux density/magnetic field strength (due to current carrying wire) in free space ✔

If no other mark given, award MAX 1 for

ε_0 *related to electric field (in free space)*

AND

μ_0 *related to magnetic field (in free space)*

2

[6]