Section B

Answer **one** question from this section in the spaces provided.

8 **(a)** An oil drop is released from rest at time $t = 0$ in air. It accelerates downwards and reaches a constant velocity of magnitude v_0 at $t = 12\,\mu s$.

(i) On Fig. 8.1, sketch a graph to show the variation with t of the displacement of the oil drop from $t = 0$ to $t = 20\,\mu s$.

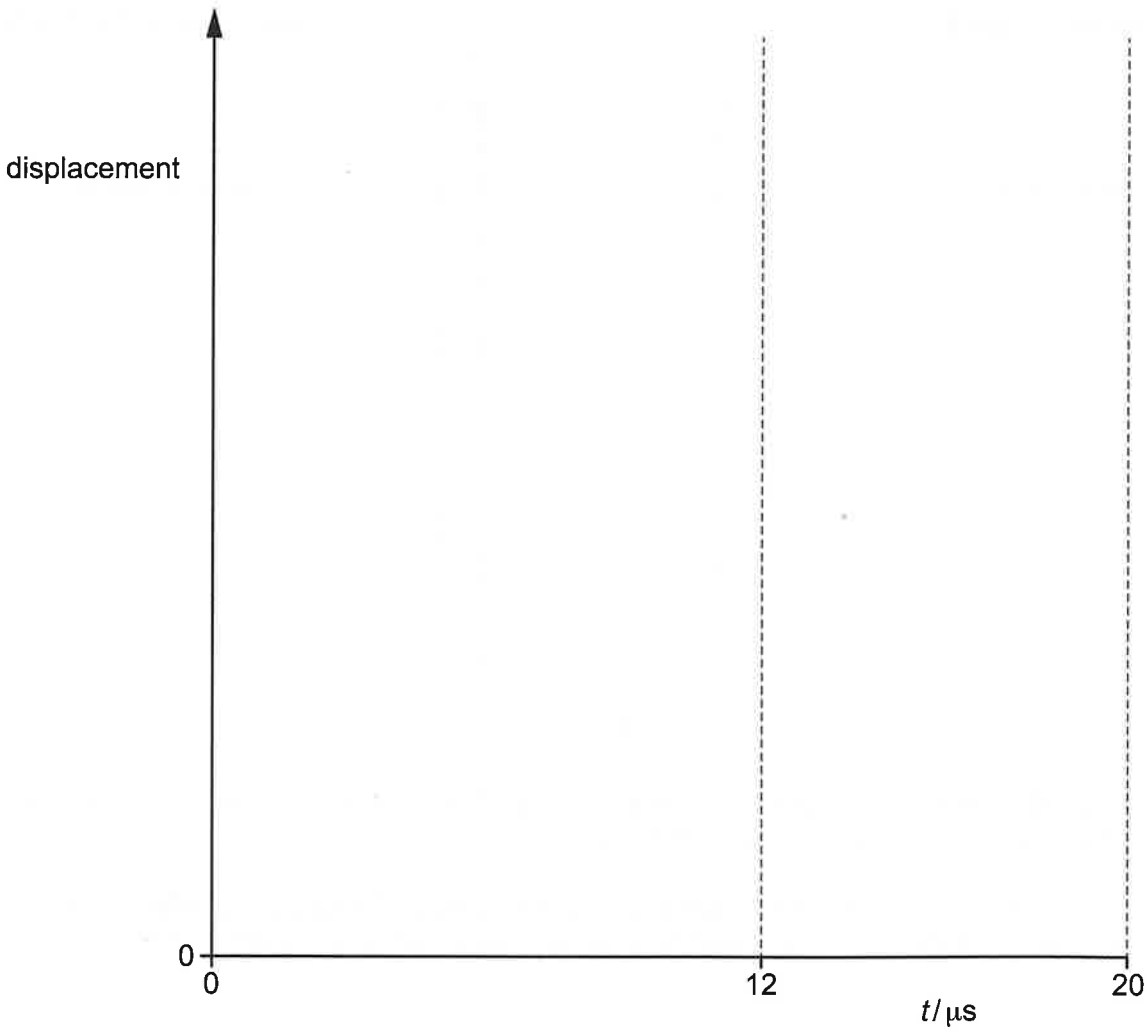

Fig. 8.1

[3]

DO NOT WRITE IN THIS MARGIN

(ii) The upthrust on the oil drop is negligible and can be ignored.

When falling at constant velocity, two forces act on the oil drop.

On Fig. 8.2, draw and label these two forces.

Fig. 8.2

[2]

(b) The oil drop has a negative charge and is between two horizontal, parallel metal plates a distance of 0.20 m apart, as shown in Fig. 8.3.

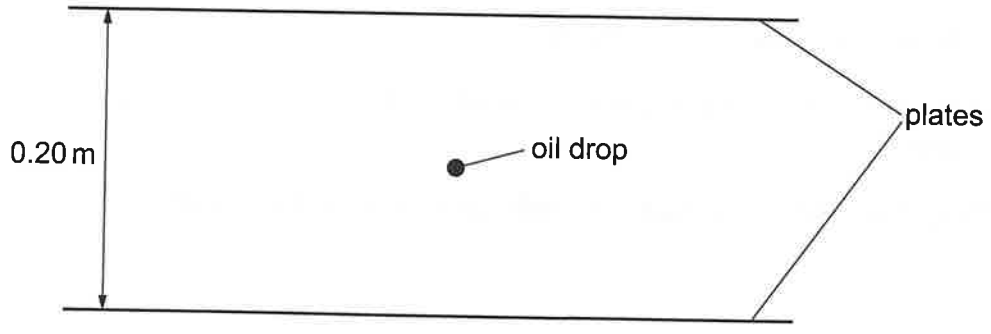

Fig. 8.3 (not to scale)

At t = 20 μs a potential difference (p.d.) of 5030 V is switched on across the plates.

This causes the oil drop to accelerate upwards until it is once again travelling at a constant velocity with magnitude v_0.

(i) On Fig. 8.3, draw field lines to represent the electric field between the plates. [2]

(ii) The mass of the oil drop is 8.2×10^{-16} kg.

Calculate the magnitude of the charge on the oil drop.

charge = ... C [4]

(iii) The oil drop has a negative charge.

Determine the number of electrons transferred to or from the oil drop to give it a negative charge.

State the direction of electron transfer as to or from the oil drop.

number of electrons transferred = ...

direction of electron transfer = ...

[2]

DO NOT WRITE IN THIS MARGIN

(c) A different oil drop of mass 8.2×10^{-16} kg has a positive charge of 1.1×10^{-18} C. The oil drop is held at rest close to a fixed solid metal sphere **in a vacuum**, as shown in Fig. 8.4.

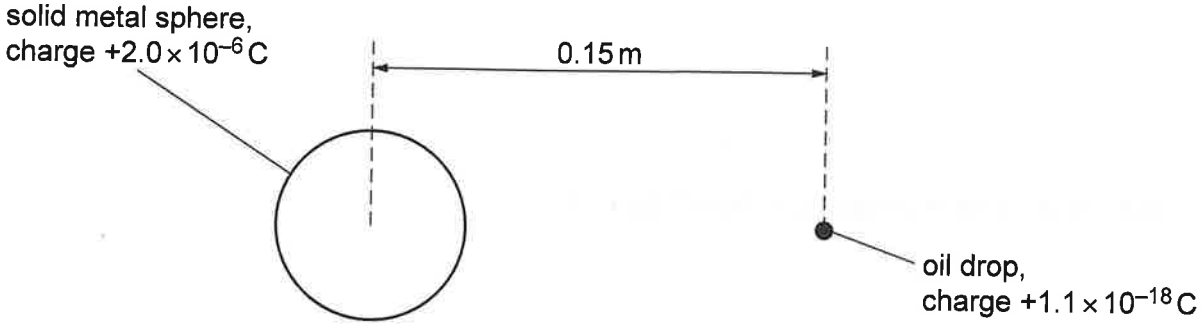

Fig. 8.4

The centres of the two objects are separated by a distance of 0.15 m.

The charge on the sphere is $+2.0 \times 10^{-6}$ C and can be considered as a point charge at the centre of the sphere.

The oil drop is now released.

(i) Calculate the initial acceleration of the oil drop.

acceleration = ... $m\,s^{-2}$ [3]

(ii) Describe and explain how the motion of the oil drop varies with time after it is released.

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..... [4]

[Total: 20]