4 **(a)** A spherical oil drop has a radius of 1.2×10^{-6} m. The density of the oil is $940\,\text{kg}\,\text{m}^{-3}$.

(i) Show that the mass of the oil drop is 6.8×10^{-15} kg.

[2]

(ii) The oil drop is charged. Explain why it is impossible for the magnitude of the charge to be 8.0×10^{-20} C.

....

....[1]

(b) The charged oil drop in **(a)** is in a vacuum between two horizontal metal plates, as illustrated in Fig. 4.1.

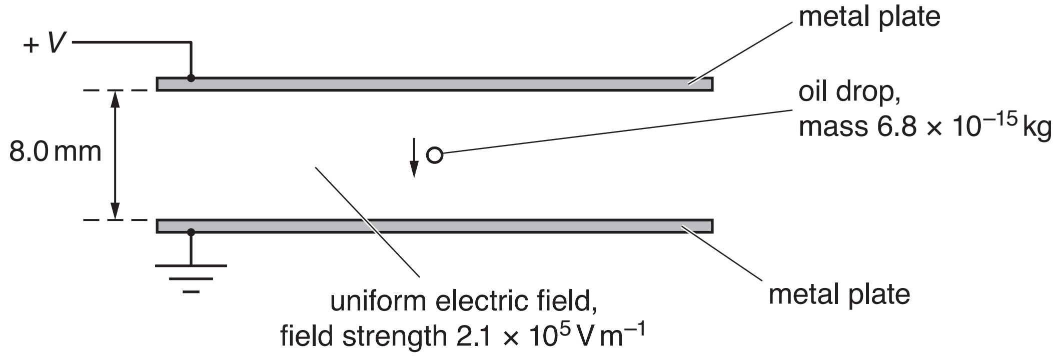

Fig. 4.1

The plates are separated by a distance of 8.0 mm. The electric field between the plates is uniform and has a field strength of $2.1 \times 10^{5}\,\text{V}\,\text{m}^{-1}$.

The oil drop moves vertically downwards with a constant speed.

(i) Calculate the potential difference V between the plates.

V = ... V [2]

(ii) Explain how the motion of the oil drop shows that it is in equilibrium.

....

....[1]

(iii) Determine the charge on the oil drop.

charge = ... C

sign of charge ....
[3]

(c) The magnitude of the potential difference between the plates in **(b)** is decreased.

(i) Explain why the oil drop accelerates downwards.

....

....

....

....[2]

(ii) Describe the change to the pattern of the field lines (lines of force) representing the uniform electric field as the potential difference decreases.

....

....[1]

(d) Two types of force, X and Y, can act on an oil drop when it is in air, but cannot act on an oil drop when it is in a vacuum. Force X can act on an oil drop when it is stationary or when it is moving. Force Y can only act on an oil drop when it is moving.

State the name of:

(i) force X

....[1]

(ii) force Y.

....[1]

[Total: 14]