4   (a) Define *electric field strength*.

....

....[1]

(b) Two very small metal spheres X and Y are connected by an insulating rod of length 72 mm. A side view of this arrangement is shown in Fig. 4.1.
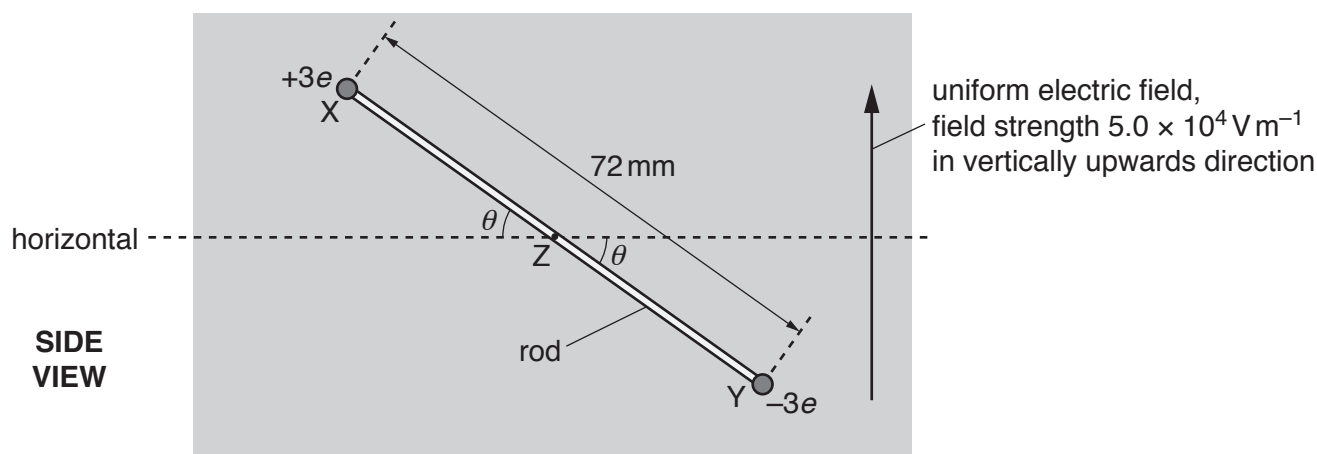

Fig. 4.1 (not to scale)

Sphere X has a charge of +3e and sphere Y has a charge of –3e, where e is the elementary charge. The rod is held at its mid point Z at an angle θ to the horizontal. The rod and spheres have negligible mass and are in a uniform electric field. The electric field strength is $5.0 \times 10^4 \, V \, m^{-1}$. The direction of this field is vertically upwards.

(i) The electric field is produced by applying a potential difference of 4.0 kV between two charged parallel metal plates.

1.   Calculate the separation between the plates.

separation = ... m [2]

2. Describe the arrangement of the two plates. Include in your answer a statement of the sign of the charge on each plate. You may draw on Fig. 4.1.

....

....

....

....[2]

(ii) Determine the magnitude and direction of the force on sphere Y.

magnitude = ... N

direction ....
[2]

(iii) The electric forces acting on the two spheres form a couple. This couple acts on the rod with a torque of 6.2×10^{-16} N m.

Calculate the angle θ of the rod to the horizontal.

$\theta =$ .... ° [2]

[Total: 9]