5 Fig. 5.1 shows two small metal spheres X and Y each weighing 1.5×10^{-4} N carrying a charge of −3.2 nC and −1.6 nC respectively. Sphere X is fixed at its position while sphere Y is suspended from an insulating string that is attached to a fixed point P.

An external force *F* is applied on sphere Y in the direction shown. Sphere Y settles at equilibrium where the string makes an angle of 10° with the vertical and the centre of the two spheres are separated by a horizontal distance 0.050 m. The line joining the centres of X and Y is horizontal.

The diameter of each of the spheres is negligible compared to the separation between them.

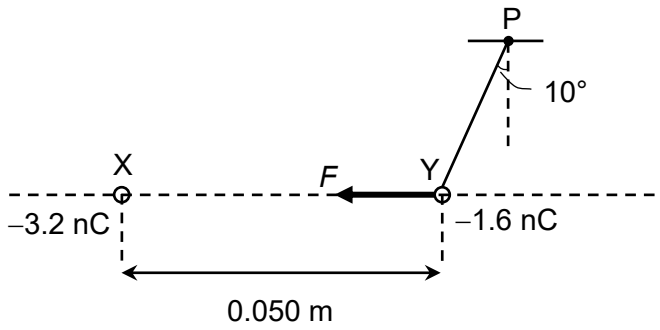

Fig. 5.1 (not to scale)

(a) (i) Calculate the electric force acting on sphere Y.

electric force = ... N [2]

(ii) Calculate the magnitude of *F*.

F = ... N [3]

(a) (iii) State and explain whether your answer in **(a)(ii)** would be larger, smaller or unchanged if the diameter of each of the spheres is no longer negligible compared to the separation of the spheres.

Assume that the weight of the spheres remains unchanged.

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.....

.....

[2]

.....

(b) The force *F* is now removed. Sphere Y swings downwards and moves past point Q, which is located vertically below point P as shown in Fig. 5.2.

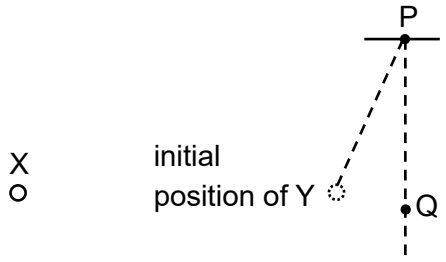

Fig. 5.2 (not to scale)

Explain why the gain in kinetic energy of sphere Y is **not** equal to the loss in gravitational potential energy as it moves from its initial position to Q.

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[1]