9 (a) State the *principle of moments*.

……..

……..

……. [2]

(b) Fig. 9.1. shows mass A and a negatively charged sphere X balanced on a rod of negligible mass. The rod is free to rotate about the pivot P which is at the center of the rod.

Another negatively charged sphere Y is placed near sphere X.

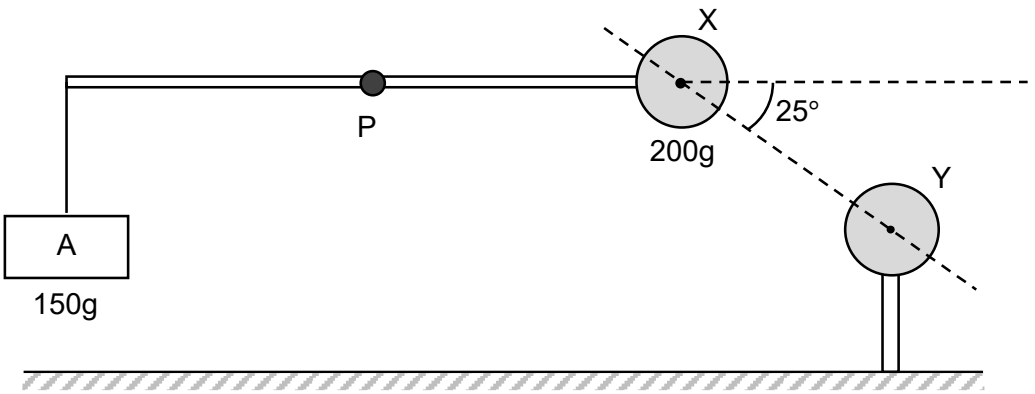


Fig. 9.1

Mass A is 150 g and the mass of sphere X is 200g.

(i) Explain why sphere Y must be negatively charged for the rod to be horizontal, as shown in Fig. 9.1.

……

……

……

…… [2]

(ii) The dotted line XY shows the axis joining the centers of charge of sphere X and sphere Y. The axis XY is 25° below the horizontal. Spheres X and Y are assumed to be point charges.

Calculate the electric force on sphere X

force = ... N [3]

(iii) Sketch the contact force on the rod by pivot P on Fig. 9.1. Label this force N. [1]

(c) Sphere X is now mounted on a rigid rod as shown in Fig. 9.2. The negative charge on sphere X is greater than the negative charge on Y

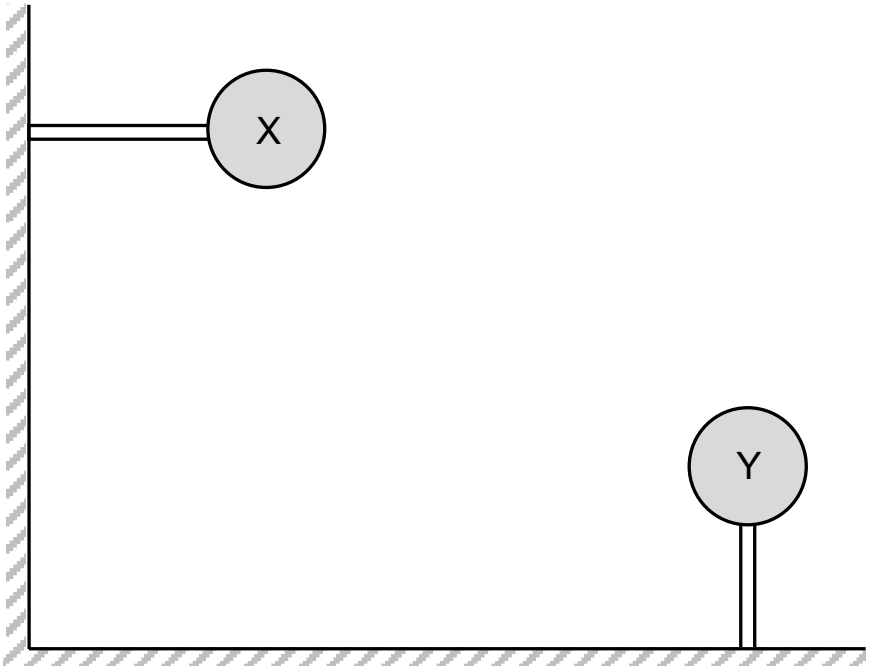


Fig. 9.2

Sketch the electric field between spheres X and Y on Fig. 9.2. [2]

(d) The distance *d* from the centre of charge of sphere X to a point along the line joining the centres of the two spheres is shown in Fig. 9.3.

[Turn over

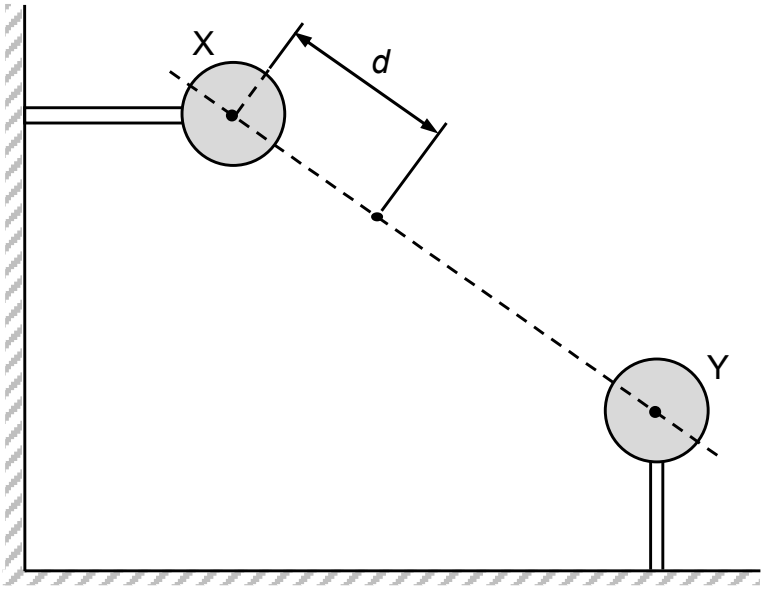
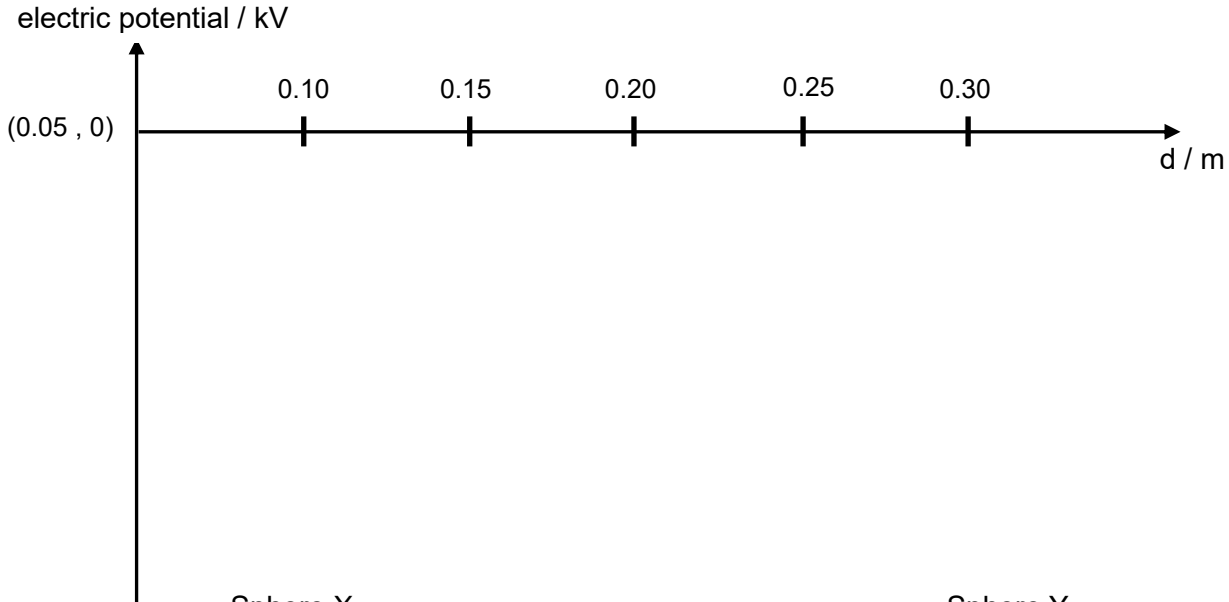


Fig. 9.3

Fig. 9.4 shows the variation with the distance *d* of the electric potential due to sphere X and the electric potential due to sphere Y.



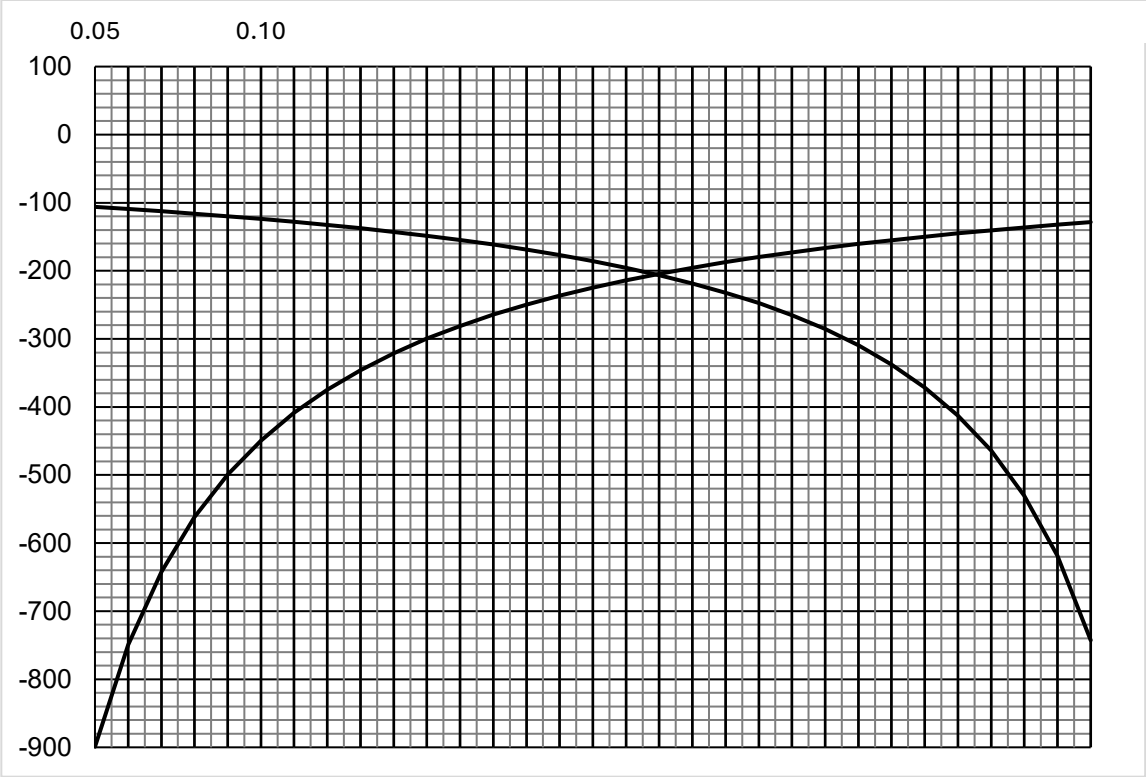


Fig. 9.4

(i) An electron moves along the line joining the centres of both spheres.

Describe how the electric potential energy of the electron changes as it moves from d = 0.05 m to d = 0.35 m.

……...

……...

……...

……...

…… [3]

(ii) Determine the potential energy of an electron at d = 0.30 m.

potential energy = ... J [3]

(iii) At a particular distance between the charged spheres, the net electric force on the electron is zero. Explain the relative magnitude and direction of the potential gradient of sphere X to the potential gradient of sphere Y at this point.

……...

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……...

……...

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……...

…… [4]

[Total: 20]

END OF PAPER