

5 (a) Define electric potential at a point.

.....

.....

..... [2]

(b) A hydrogen atom may be considered to consist of a proton and an electron separated by a distance of 120 pm, as shown in Fig. 5.1.

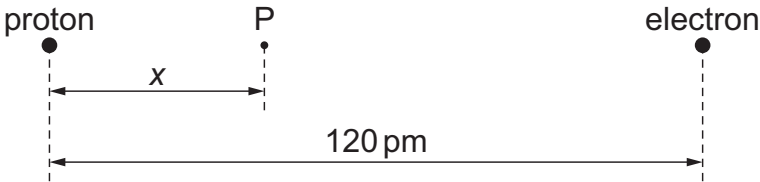


Fig. 5.1

The two particles may be considered as point charges.

Point P lies on the line joining the electron and the proton and is at a variable distance x from the proton.

(i) Show that the electric potential V at point P when $x = 10\text{ pm}$ is equal to 130 V .

[2]

(ii) Calculate, to two significant figures, V when $x = 30\text{ pm}$.

$V = \text{.....} \text{ V}$ [2]

(iii) On Fig. 5.1, draw a cross (x) at one position, other than infinity, where the electric potential is zero. [1]

(iv) On Fig. 5.2, sketch the variation of V with x between $x = 10\text{ pm}$ and $x = 110\text{ pm}$.

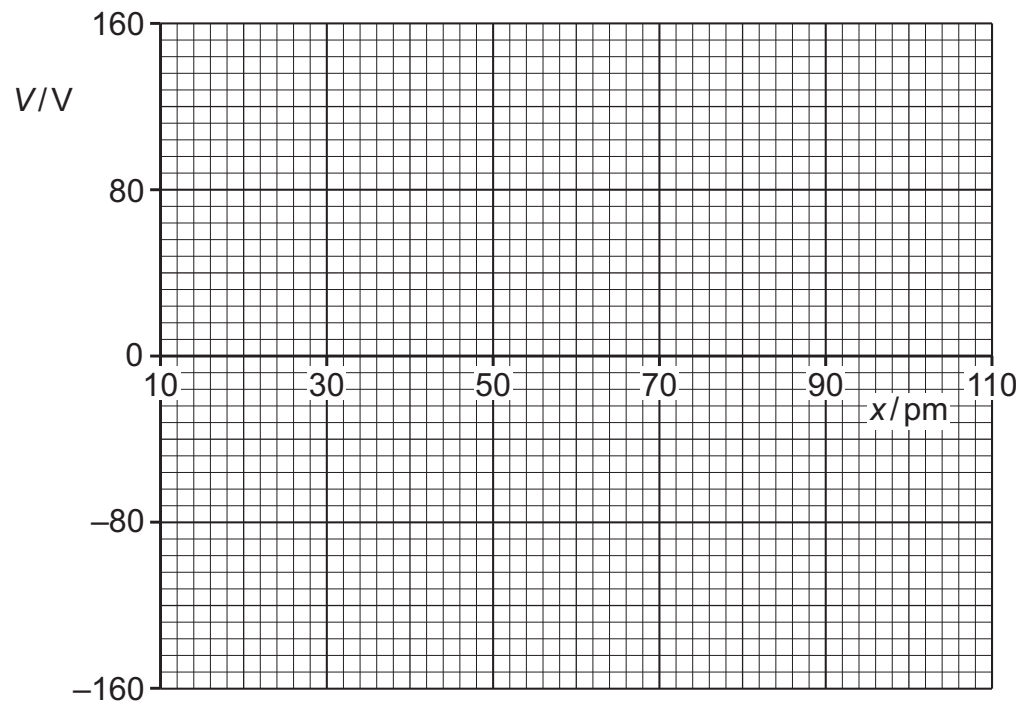


Fig. 5.2

[3]

[Total: 10]

- 5 (a) Explain why the electric potential near an isolated proton is positive.

.....

.....

.....

.....

..... [3]

- (b) An isolated metal sphere is positively charged and has radius R , as shown in Fig. 5.1.

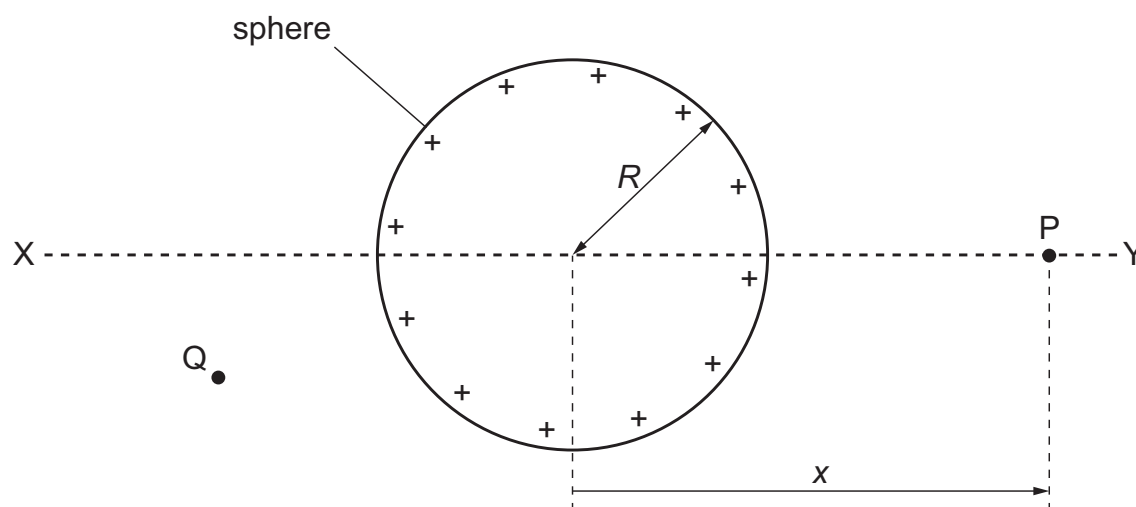


Fig. 5.1

Line XY passes through the centre of the sphere.

Point P lies on line XY at a variable displacement x from the centre of the sphere.

Point Q is at a fixed position that is not on line XY.

The electric field strength at the surface of the sphere is E_0 .

- (i) On Fig. 5.1, draw an arrow at point Q to show the direction of the electric field at that point. [1]

- (ii) On Fig. 5.2, sketch the variation of the electric field E at point P with x for values of x between $x = -3R$ and $x = 3R$. Do **not** include the region inside the sphere between $x = -R$ and $x = R$.

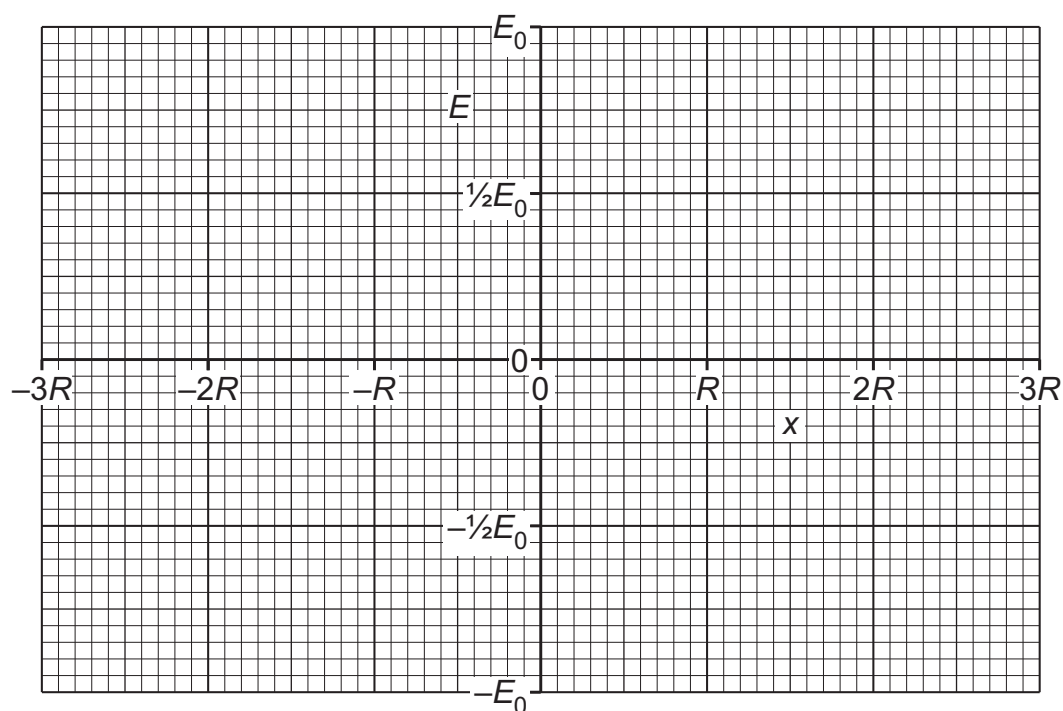


Fig. 5.2

[3]

- (c) The proton and the electron in a hydrogen atom are separated by a distance of $5.3 \times 10^{-11} \text{ m}$.

Calculate the electric potential energy of the proton and the electron.

electric potential energy = J [2]

[Total: 9]

5 (a) Define electric potential at a point.

.....

.....

..... [2]

(b) An isolated solid metal sphere of radius r is given a positive charge.

The potential at the surface of the sphere is $9.0 \times 10^4 \text{ V}$. At a distance of $3r$ from the centre of the sphere, the electric field strength is $2.0 \times 10^5 \text{ NC}^{-1}$.

(i) Determine the electric field strength at the surface of the sphere.

electric field strength = NC^{-1} [2]

(ii) Show that the radius of the sphere is 5.0 cm.

[2]

(iii) Calculate the charge on the sphere.

charge = C [2]

(iv) Use your answer in (b)(iii) to determine the capacitance of the sphere.

capacitance = F [2]

[Total: 10]