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.

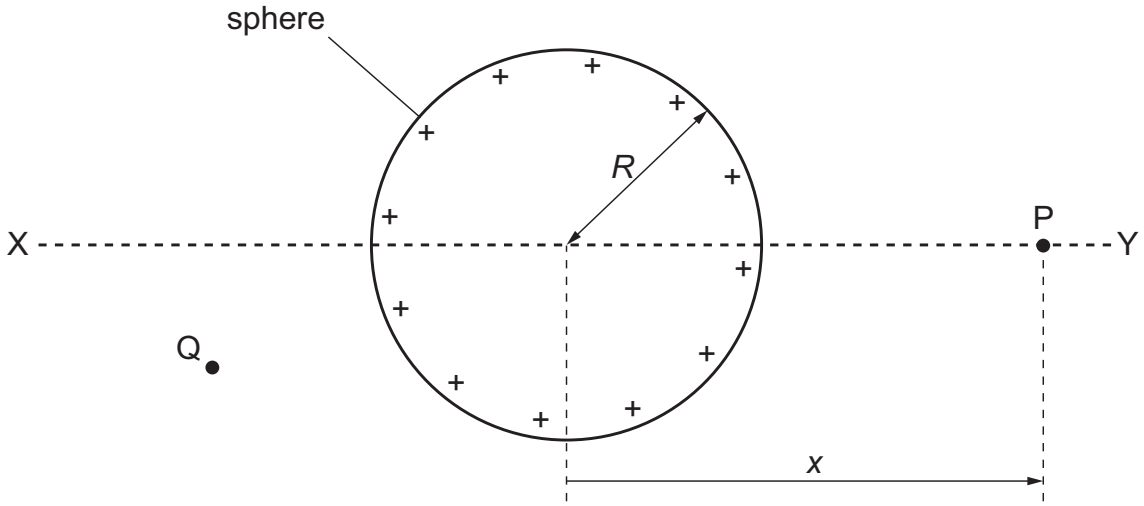

Fig. 5.1

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 $x = R$.

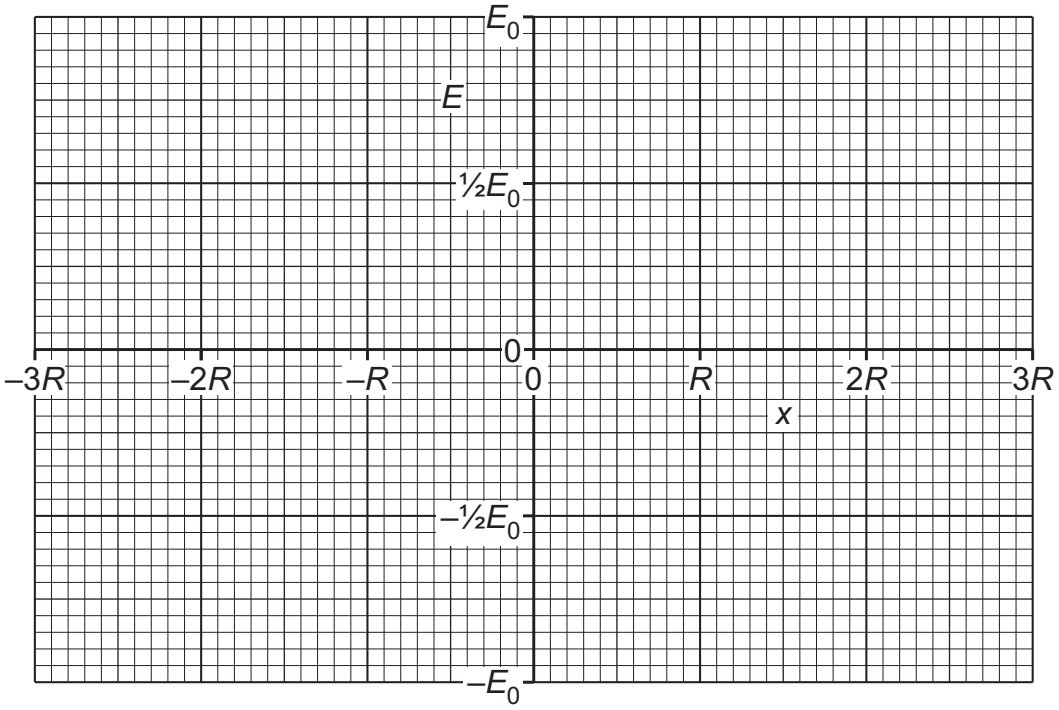

Fig. 5.2

[3]

(c) The proton and the electron in a hydrogen atom are separated by a distance of 5.3×10^{-11} 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 9.0×10^4 V. At a distance of $3r$ from the centre of the sphere, the electric field strength is 2.0×10^5 N C^{-1}.

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

electric field strength = ... N C^{-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]