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.

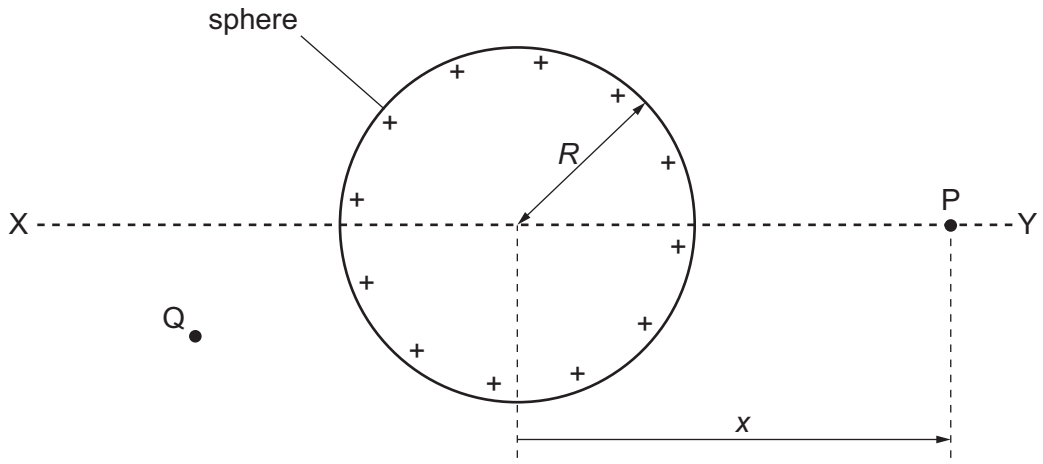

Fig. 5.1

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 $x = R$.

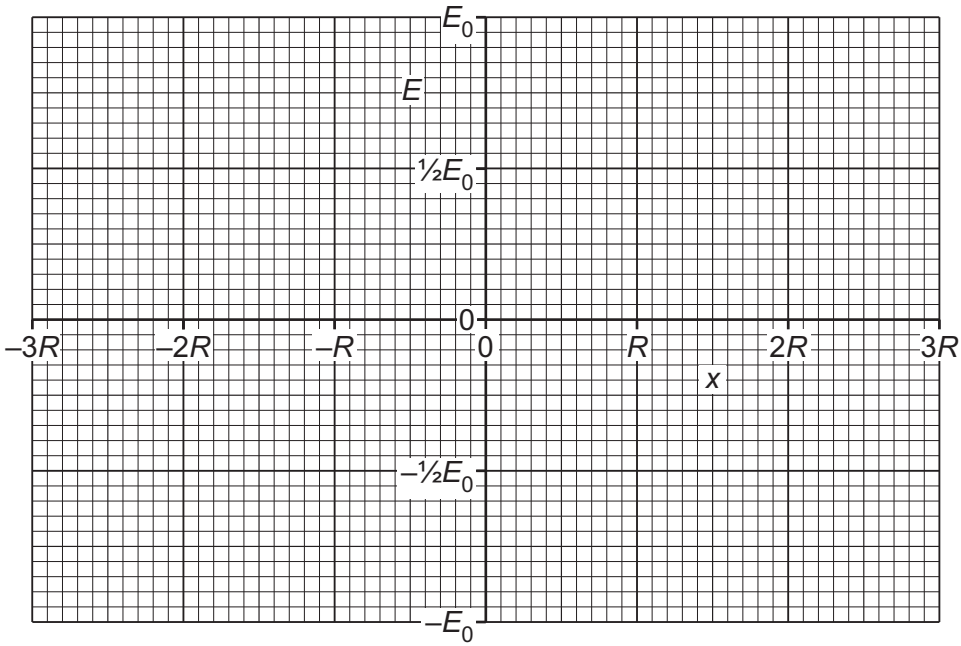

Fig. 5.2

[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]