For Examiner's Use

4 **(a)** Define *electric potential* at a point.

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.....[2]

(b) Two small spherical charged particles P and Q may be assumed to be point charges located at their centres. The particles are in a vacuum.

Particle P is fixed in position. Particle Q is moved along the line joining the two charges, as illustrated in Fig. 4.1.

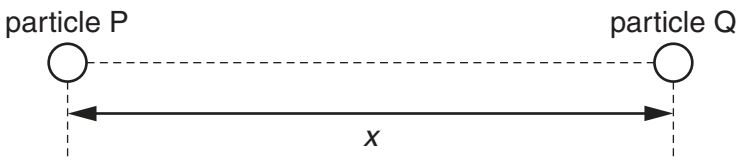

Fig. 4.1

The variation with separation x of the electric potential energy E_P of particle Q is shown in Fig. 4.2.

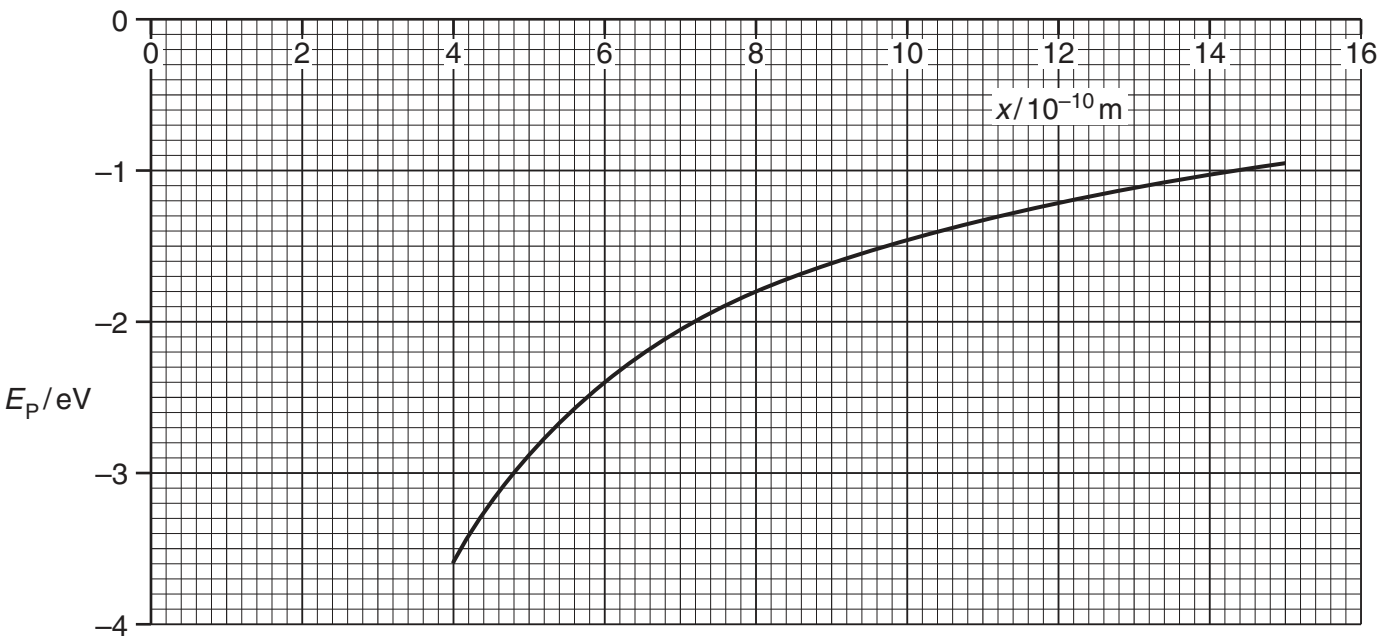

Fig. 4.2

(i) State how the magnitude of the electric field strength is related to potential gradient.

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.....[1]

(ii) Use your answer in **(i)** to show that the force on particle Q is proportional to the gradient of the curve of Fig. 4.2.

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.....[2]

(c) The magnitude of the charge on each of the particles P and Q is 1.6×10^{-19} C.
Calculate the separation of the particles at the point where particle Q has electric potential energy equal to –5.1 eV.

separation = ... m [4]

(d) By reference to Fig. 4.2, state and explain

(i) whether the two charges have the same, or opposite, sign,

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.....[2]

(ii) the effect, if any, on the shape of the graph of doubling the charge on particle P.

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