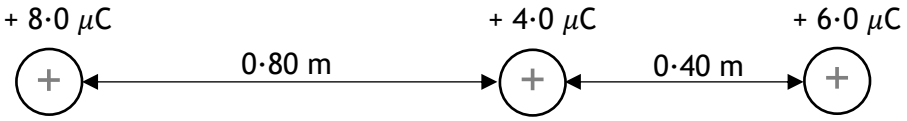
Homework – Electric Fields

1. Three point charges are positioned as shown in the diagram below.



(a) Calculate the electrostatic force acting between the + 8·0 μC charge and the + 4·0 μC charge.

(b) Calculate the electrostatic force acting between the + 4·0 μC charge and the + 6·0 μC charge.

(c) Calculate the resultant force acting on the + 4·0 μC charge due to the other two charges.

The + 4·0 μC charge is now removed.

(d) Calculate the electric field strength at position X, due to the + 8·0 μC charge.

(e) Calculate the electric field strength at position X, due to the + 6·0 μC charge.

(f) Calculate the electric field strength at position X, due to both charges.

(g) Calculate the electric potential at position X, due to the + 8·0 μC charge.

(h) Calculate the electric potential at position X, due to the + 6·0 μC charge.

(i) Calculate the electric potential at position X, due to both charges.

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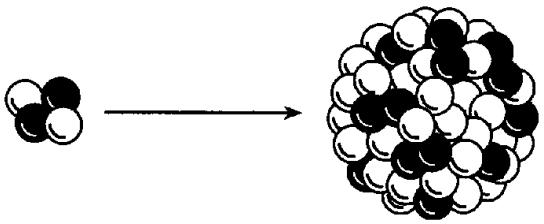
2. In a Rutherford scattering experiment, an alpha particle with a velocity of $2{\cdot}0 \times 10^{6}$ ms^{-1} is fired at a target of gold foil in a vacuum. The mass of an alpha particle is taken to be $6{\cdot}7 \times 10^{-27}$ kg and the atomic number of gold is 79.

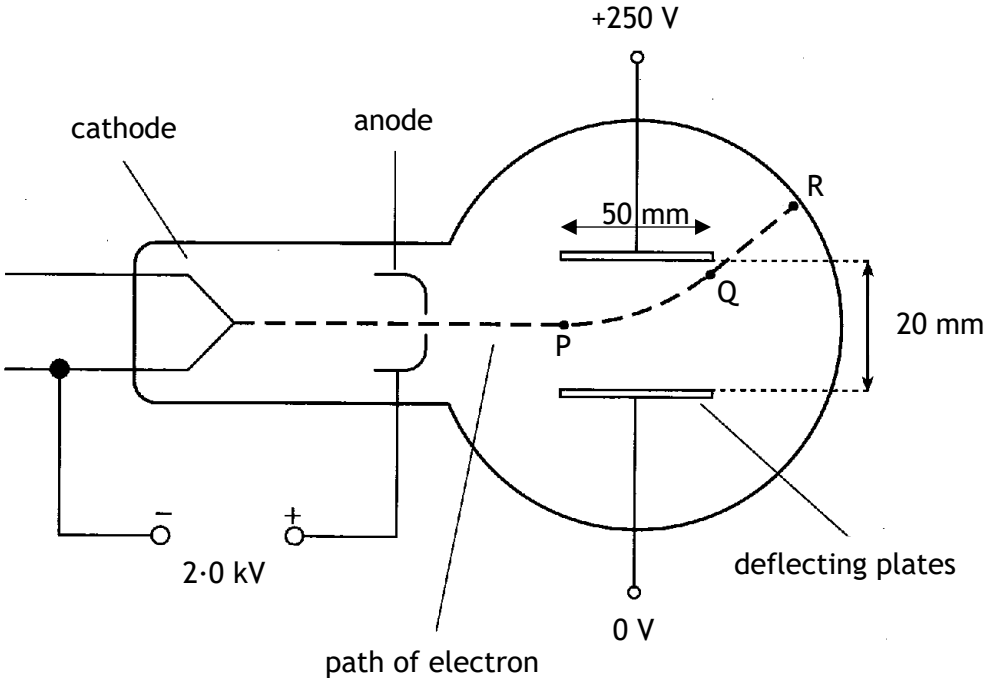


alpha particle gold nucleus

Calculate the distance of closest approach for a head-on collision between the alpha particle and a gold nucleus.

Homework – Electric Fields

3. In a cathode ray tube, electrons emitted from the cathode are accelerated from rest through a potential difference of 2·0 kV, as shown in the diagram below.



(a) Calculate the speed of the electron as they reach the anode.

(b) After leaving the anode, the electrons pass between two parallel deflecting plates separated by 20 mm. The deflecting plates are 50 mm long. The potential difference between the deflecting plates is 250 V.

The electrons follow path PQR.

(i) By considering the forces acting on the electrons, explain the shape of the path between:

(A) P and Q;

(B) Q and R.

Assume gravitational effects to be negligible.

(ii) Calculate the time taken for an electron to pass between the deflecting plates.

(iii) Calculate the electric field strength between the deflecting plates.

(iv) Calculate the acceleration of the electrons between the deflecting plates.

(v) Calculate the vertical displacement of the electron between positions P and Q.

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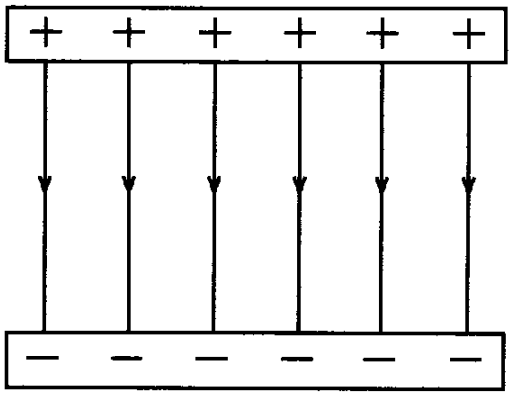
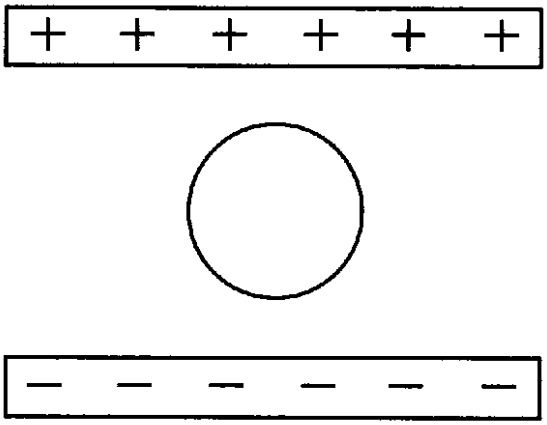
4. The electric field pattern between two parallel metal plates is shown below.



An uncharged, conducting sphere is placed between the plates as shown in the new diagram.



(a) Using the diagram predict what the electric field pattern between the plates would look like.

(b) Using the same diagram, show the charge distribution on the sphere.

(c) State the magnitude of the electric field strength inside the sphere.