

Electric fields

Name & Set

$$\begin{aligned} \text{permittivity of free space, } \epsilon_0 & 8.85 \times 10^{-12} \text{ Fm}^{-1} \\ \text{Mass of electron, } m_e & 9.1 \times 10^{-31} \text{ kg} \\ \text{Mass of proton, } m_p & 1.7 \times 10^{-27} \text{ kg} \\ \text{Charge on an electron, } e & 1.6 \times 10^{-19} \text{ C} \end{aligned}$$

1 Sketch the electric field in the vicinity of two point charges for charges
(a) Equal magnitude: +Q & -Q,

(b) Equal magnitude: +Q & +Q,

(c) Equal magnitude: -Q & -Q,

(d) Unequal magnitude: +Q & +2Q,

(e) Equal magnitude: -Q & +2Q.

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2 Can electric field lines ever intersect in space? Explain.

[2]

3 (a) When two objects attract one another electrically, must both of them be charged initially? Explain.

[2]

(b) When two objects repel one another electrically, must both of them be charged initially? Explain.

[2]

4 What is the magnitude of the electric charge of the nucleus of C-12?

[2]

5 Find the charge of 1.0 μg of protons.

[2]

Coulomb's law

- 1 A charge of -5.0×10^{-7} C is 10 cm from a charge of $+6.0 \times 10^{-6}$ C. Find the magnitude and direction of the force on each charge.

[2]

- 2 A charge of $+5.00 \times 10^{-9}$ C is attracted by a charge of -3.00×10^{-7} C with a force of 0.135 N. How far apart are they?

[2]

- 3 What is the magnitude and direction of the electrostatic force between two charged bodies placed 1 m apart if the charge on each of them is +1C? Assume that the bodies are vanishingly small compared to distance between them.

[2]

- 4 What is the magnitude and direction of the mutual force between a proton and an electron in a hydrogen atom? Hence calculate the electron's orbital velocity. Take the distance between them to be 5.3×10^{-11} m.

[2]

- 5 (a) Calculate the force between two protons 1mm apart.

[2]

- (b) How does this electrostatic force compare with the gravitational force between them? Work out the ratio of $F_{\text{gravity}} : F_{\text{electrostatic}}$.

[2]

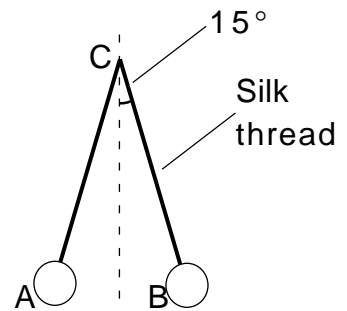
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6 How far should two electrons be if the force they exert on each other is equal to the weight of an electron on the earth's surface?

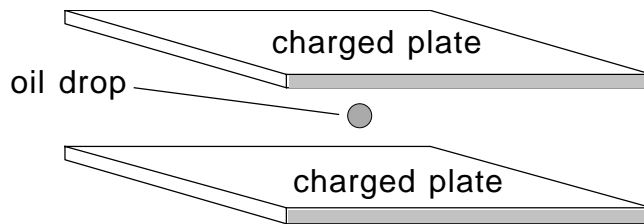
7 Calculate the magnitude and sign of the charge on spheres A and B that will keep them in equilibrium as shown in the diagram on the right. [2]

The mass of each sphere is 1g and they are each suspended by non-conducting threads 1 m long from point C.

Try a simulation of the charged spheres with Interactive Physics.



8 In the oil drop experiment the American physicist Robert Millikan determined the charge on an electron by measuring the total charge on a small drop of oil suspended against the pull of gravity in an electric field between two parallel plates. Draw a free body diagram for the oil drop and calculate the magnitude and direction of the electric field that is required to balance the weight of the drop. Take the diameter of the drop as 3 μm . Assume that it has 4 excess electrons and the density of the oil is 920 kgm^{-3} . Ignore upthrust of air.



[4]