PHYS1022 Electricity and Magnetism

Problem Sheet 2: for workshops

Note that these questions will not be marked, but will be demonstrated in Workshops. Assessed problems are to be found at http://www:masteringphysics.com or from the PHYS1022 web pages.

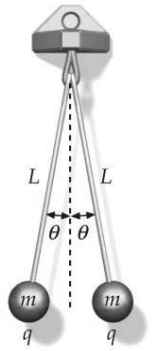
1. Calculate the circumference of a circle of radius R by performing an integral over infinitesimal lengths of the circumference.

2. Use the result for the circumference of a circle to compute the surface area of a disc.

3. If a circular disc of material of radius R has a surface charge density given by $\rho = r \sin\phi$ Cm^{-2} (with r and ϕ the polar coordinates on its surface) compute the total charge on the disc using integration.

4. An electron has an initial velocity of 2×10^6 m/s in the *x* direction. It enters a uniform electric field $\underline{E}$ = (400 N/C) $\hat{\jmath}$ which is in the *y* direction.
(a) Find the acceleration of the electron.
(b) How long does it take for the electron to travel 10 cm in the *x* direction in the field?
(c) By how much, and in what direction (up or down), is the electron deflected after travelling 10 cm in the *x* direction in the field?

5. Two small spheres of mass *m* are suspended from a common point by threads of length *L*. When each sphere carries a charge *q*, each thread makes an angle θ with the vertical as shown in the figure. Show that the charge *q* is given by



$$q = 2L\sin\theta\sqrt{\frac{mg\tan\theta}{k}}$$

where *k* is the Coulomb constant $k = \frac{1}{4\pi\varepsilon_0}$.

Please provide a clearly labelled diagram of all the forces acting on one sphere.

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Problem Sheet 1: tutorials

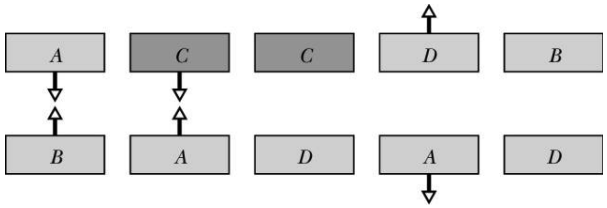
These problem sheets are designed to provide problems for you to discuss in tutorials with your tutors. They should re-enforce the material we are studying in the lectures.

Problems for tutorials

1. Three equal positive point charges are situated at the corners of an equilateral triangle. Sketch the electric field lines in the plane of the triangle.

2. Derive the formula $s = ut + \frac{1}{2} at^2$ and explain its relevance to a charged particle in a constant electric field. How would you proceed if the electric field were not constant?

3. The figure shows five pairs of plates: A, B and D are charged plastic plates and C is an electrically neutral copper plate. The electrostatic forces between the pairs of plates are shown for three pairs. For the remaining two pairs, do the plates repel or attract each other? Explain your reasoning in each case, and draw the charges for the third pair.



4. The figure shows three electric field lines. What is the direction of the electrostatic force on a positive test charge placed at (a) point A and (b) point B?
At which point, A or B, will the acceleration of the test charge be greater if the charge is released? Explain.