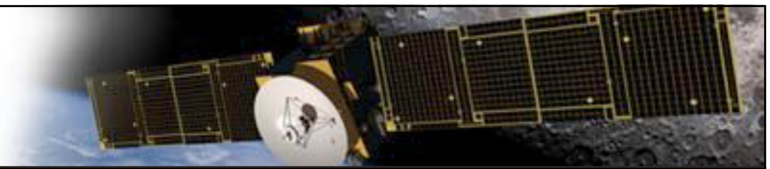
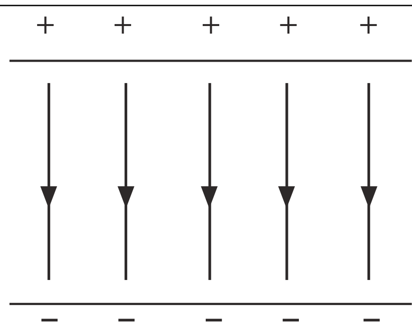
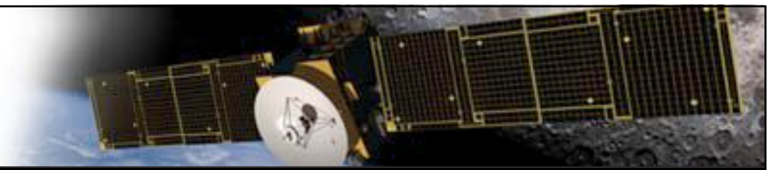
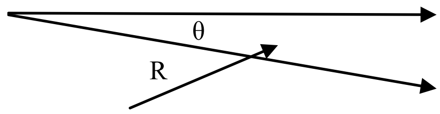


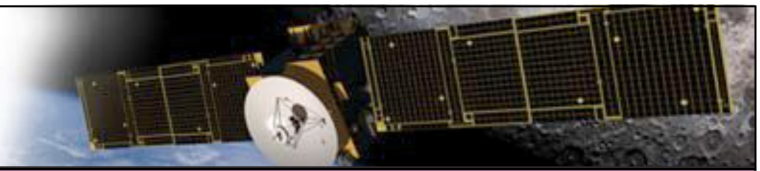
Motion and Forces in Electric and Magnetic Fields: Set 13

Set	Problem	Solution
13	1	$E = \frac{F}{q}$ $= \frac{7.2\times10^{-13}\ \text{N}}{1.6\times10^{-19}\ \text{C}}$ $= 4.5\times10^{6}\ \text{N C}^{-1}$
	2	Field strength E is given by $E = \frac{F}{q}$ for which the units are N C^{-1} But $W = Eqd\ ?\ Vq$ $Ed = V$ $E = \frac{V}{d}$ for which the units are V m^{-1}
	3a	
	3b	$E = \frac{F}{q}$ $F = Eq$ $ma = Eq$ $a = \frac{Eq}{m}$ $= \frac{(2.5\times10^{4}\ \text{N C}^{-1})(1.6\times10^{-19}\ \text{C})}{(9.11\times10^{-31}\ \text{kg})}$ $= 4.39\times10^{15}\ \text{m s}^{-2}$ (this is the acceleration caused by the field) $v = \frac{s}{t}$ $t = \frac{s}{v}$ $= \frac{0.0300\ \text{m}}{2.9\times10^{7}\ \text{m s}^{-1}}$ $= 1.03\times10^{-9}\ \text{s}$ (this is the time spent in the field by the speeding electron) $v = u + at$ $= 0 + (4.39\times10^{15}\ \text{m s}^{-2})(1.03\times10^{-9}\ \text{s})$ $v = 4.54\times10^{6}\ \text{m s}^{-1}$ (this is the new perpendicular velocity component)



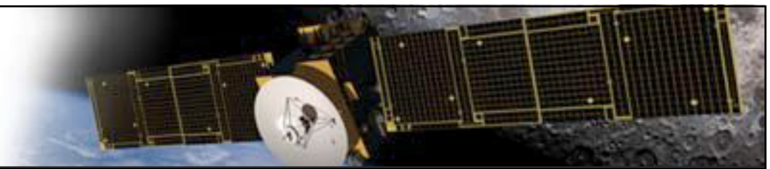
Motion and Forces in Electric and Magnetic Fields: Set 13

Set	Problem	Solution
13	3b (-cont)	 $R^2 = (2.9\times10^7)^2 + (4.5\times10^6)^2$ $R = \sqrt{(8.41\times10^{14}) + (2.06\times10^{13})}$ $= \sqrt{(8.62\times10^{14})}$ $= 2.94\times10^7\ \text{m s}^{-1}$ The angle θ has $\tan\theta = \frac{4.54\times10^6}{2.9\times10^7}$ $= 0.1566$ $\theta = 8.89°$
	3c	The electron experiences a force at right angles to its initial direction of motion. This gives the electron a velocity component at right angles to its original direction of motion \while the initial velocity component remains unchanged.
	3d	The electrons are deflected in order to direct them to particular points (pixels) on the CRT screen.
	3e	$E_k = Vq$ $= (1800\ \text{V})(1\text{e})$ $= 1800\ \text{eV}$ $= 2.9\times10^{-16}\ \text{J}$
	3f	$E = \frac{V}{d}$ $= \frac{1800\ \text{V}}{0.0300\ \text{m}}$ $= 6.0\times10^4\ \text{V m}^{-1}$
	4	The field inside a conductor (such as a hollow metal box) is independent of the field outside. Thus, fields from outside will not interfere with the workings of the component in the box.
	5a	$E = \frac{V}{d}$ $V = Ed$ $= (2.2\times10^4\ \text{V m}^{-1})(0.003\ \text{m})$ $= 66\ \text{V}$ $W = Vq$ $= (66\ \text{V})(5.0\times10^{-9}\ \text{C})$ $= 3.3\times10^{-7}\ \text{J}$
	5b	$E = \frac{V}{d}$ $V = Ed$ $= (2.2\times10^4\ \text{V m}^{-1})(0.003\ \text{m})$ $= 66\ \text{V}$
	6	$E = \frac{V}{d}$ $= \frac{12\ \text{V}}{0.120\ \text{m}}$ $= 100\ \text{V m}^{-1}$

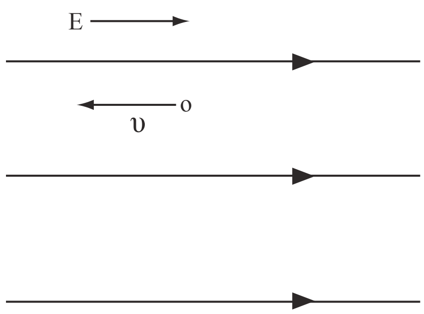
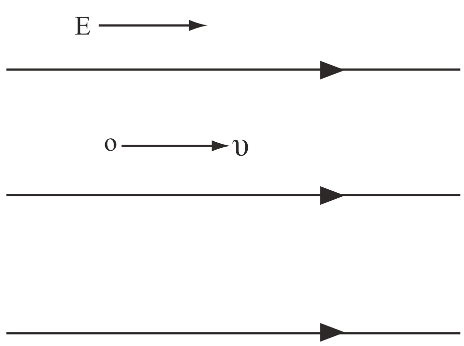


Motion and Forces in Electric and Magnetic Fields: Set 13

Set	Problem	Solution
13	7a	$E_k = Vq$ $= (5000\text{ V})(1\text{e})$ $= 5000\text{ eV}$
	7b	$E_k = Vq$ $= (5000\text{ V})(1.6\times10^{-19}\text{ C})$ $= 8.00\times10^{-16}\text{ J}$
	8a	$E_k = Vq$ $= (5000\text{ V})(2\text{e})$ $= 10\,000\text{ eV}$ $= 10.0\text{ keV}$
	8b	$E_k = Vq$ $= (5000\text{ V})(3.2\times10^{-19}\text{ C})$ $= 1.60\times10^{-15}\text{ J}$
	9a	$E = \frac{V}{d}$ $= \frac{1.5\times10^{4}\text{ V}}{2.7\times10^{?4}\text{ m}}$ $= 5.6\times10^{7}\text{ V m}^{-1}$
	9b	$E_k = Vq$ $= (1.5\times10^{4}\text{ V})(1.6\times10^{-19}\text{ C})$ $= 2.4\times10^{-15}\text{ J}$
	10a	On a dry day, such a shirt becomes electrostatically charged by friction with the wearer and with the surroundings such as the driver's seat. Dust particles are attracted to charged objects because the large charge nearby separates the surface charge on the dust. This leads to a net attraction as the charges attracted to the shirt are nearer (by the thickness of a dust particle) than those that are repelled.
	10b	$E = \frac{F}{q}$ $F = Eq$ $= (9.0\text{ N C}^{-1})(4.0\times10^{?6}\text{ C})$ $= 3.6\times10^{-5}\text{ N}$
	10c	$E_k = Vq$ $V = \frac{E_k}{q}$ $= \frac{3.6\times10^{-7}\text{ J}}{4.0\times10^{?6}\text{ C}}$ $= 0.090\text{ V}$ $E = \frac{V}{d}$ $d = \frac{V}{E}$ $= \frac{0.090\text{ V}}{9.0\text{ N C}^{-1}}$ $= 0.010\text{ m (10 mm)}$
	11a	An electrostatic precipitator attracts small particles because the large charge on the nearby precipitator separates the surface charge on the particles. This leads to a net attraction as the charges attracted to the shirt are nearer (by the thickness of a smoke particle) than those that are repelled.

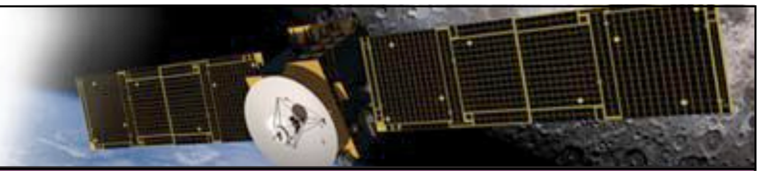


Motion and Forces in Electric and Magnetic Fields: Set 13

Set	Problem	Solution
13	11b	This reduces the particulate emissions from the chimneys stacks, so fewer people are concerned (the resultant emissions are basically invisible gases) and there are fewer harmful environmental effects from dust-sized emissions.
	12	With one end closer to the high voltage, there is a large potential difference between the ends of the tube. This is the condition required to light it up. When the tube is at right angles, the ends are approximately equal distances from the high voltage so there is a small PD between the ends insufficient to light up the tube.
	13	$E_k = Vq$ $\frac{1}{2}mv^2 = Vq$ $v^2 = \frac{2Vq}{m}$ $v = \sqrt{\frac{2Vq}{m}}$ $= \sqrt{\frac{2(800)(1.6\times10^{-19}\text{ C})}{(1.67\times10^{-27}\text{ kg})}}$ $= \sqrt{1.53\times10^{11}}$ $= 3.91\times10^{5}\text{ m s}^{-1}$
	14a	
	14b	$E_k = Vq$ $= (2500\text{ V})(1e)$ The electron gains 2500 eV (4.00×10^{-16} J)
	14c	$E_k = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2E_k}{m}}$ $= \sqrt{\frac{2(4\times10^{-16})}{9.11\times10^{-31}}}$ $= 2.96\times10^{7}\text{ m s}^{-1}$
	14d	

Motion and Forces in Electric and Magnetic Fields: Set 13

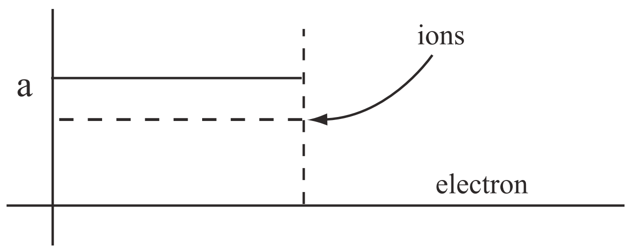
Set	Problem	Solution
13	14e	The magnitude of the proton charge is the same as the electron charge, so the energy gained must be the same
	14f	The proton mass is much greater than the electron's mass so the proton's final velocity must be considerably less.
	15a	$E_k = Vq$ $= (4000\ \text{V})(1\text{e})$ The electron gains 4000 eV (6.40 × 10^{-16} J) $E_k = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2E_k}{m}}$ $= \sqrt{\frac{2(6.4 \times 10^{?16})}{9.11 \times 10^{?31}}}$ $=?3.75 \times 10^{7}\ \text{m s}^{-1}$
	15b	$E = \frac{V}{d}$ $= \frac{200\ \text{V}}{0.100\ \text{m}}$ $= 2000\ \ \text{V m}^{-1}$ $E = \frac{F}{q}$ $F = Eq$ $= (2000\ \ \text{V m}^{-1})(1.6 \times 10^{?19}\ \text{C})$ $= 3.2 \times 10^{-16}\ \text{N}$
	15c	Cannot decipher diagram drawing!
	16a	The field accelerates the electrons, which would collide with and lose energy to any air molecules between them and the target.
	16b	$E = \frac{F}{q}$ $F = Eq$ $ma = Eq$ $a = \frac{Eq}{m}$ $= \frac{\left(\frac{V}{d}\right)q}{m}$ $= \frac{Vq}{dm}$ $= \frac{(2000\ \text{V})(1.6 \times 10^{-19}\ \text{C})}{(0.0500\ \text{m})(9.11 \times 10^{-31}\ \text{kg})}$ $= 7.02 \times 10^{15}\ \text{m s}^{-2}$



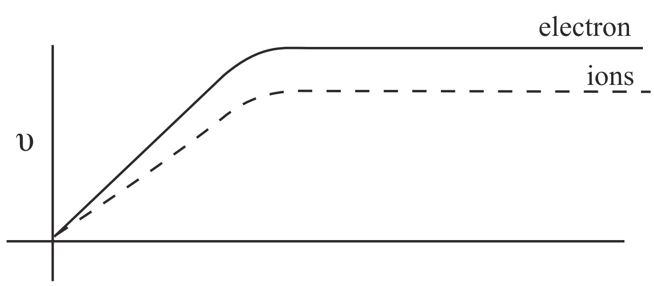
Motion and Forces in Electric and Magnetic Fields: Set 13

Set	Problem	Solution
13	16c	Need diagram!
	16d	(i), (ii), (iii) below

(i)



(ii)



(iii)