# Physics 102 Spring 2007: Suggested Problems # 1

1. Problem 21-63. (**+10 pts**)

   i. +3 pts - correct free body diagram. (+1 pt for each force)

   ii. +4 pts - correct force equation from Newton's 2nd law. The student does not have to have the same set up, but she must obtain the same relationship between the electrostatic force, weight, and $\theta$.

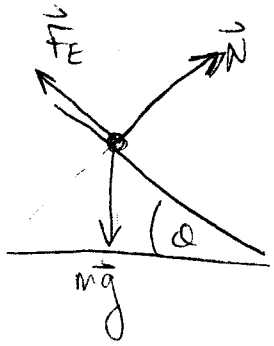
   $$\sin\theta = \frac{F_E}{m\,g}$$

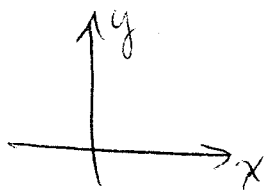
   iii. +2 pts - correct expression for $F_E$ (the electrostatic force).

   $$F_E = \frac{k\,q^2}{l^2}$$

   iv. +1 pt - correct answer for $\theta$ ($\theta \approx 6.6°$).

21-63




Since q is in equilibrium

$$\Rightarrow \sum F_x : +N\sin\theta - F_E\cos\theta = 0 \qquad (1)$$

$$\sum F_y : N\cos\theta + F_E\sin\theta = mg \qquad (2)$$

from (1) $\boxed{N = F_E/\tan\theta}$

$$\Rightarrow (2) \quad F_E\left(\frac{\cos^2\theta}{\sin\theta} + \sin^2\theta\right) = mg$$

$$\Rightarrow F_E\left(\frac{\cos^2\theta}{\sin\theta} + \frac{\sin^2\theta}{\sin\theta}\right) = \frac{F_E}{\sin\theta} = mg$$

so $$\sin\theta = F_E/mg = \frac{kq_1q_2}{mgl^2} = \frac{(9\times10^9)(2\times10^{-8})(2\times10^{-8})}{(.5\times10^{-3})(9.81)(8\times10^{-2})^2}$$

$$\sin\theta = \frac{36\times10^{-7}}{5(9.81)(64)\times10^{-4}\times10^{-4}} = 0.115 \Rightarrow \boxed{\theta \simeq 6.6^\circ}$$

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