Electrostatics

WORKSHEET #1

Name: ______________________

1. What is the charge on an object that has 1.25×10^{17} e^- (electrons) in excess on its surface?

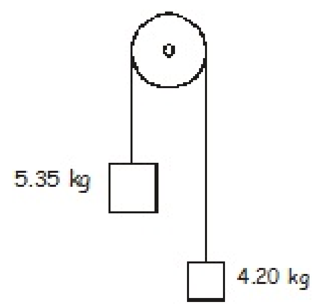
$Q = 1.25 \times 10^{17}\ e^- \cdot 1.60 \times 10^{-19}\ C/e^- =$ $\boxed{0.0200\ C \text{ or } 20\ mC}$

2. What is the magnitude of the force between a charge of 2.35 μC and another with a charge of 1.25 x10^{-4} C separated by 25.0 cm?

$F = k\, q_1 q_2 / r^2$

$= 9.0 \times 10^9\ N{\cdot}m^2/C^2 \cdot 2.35 \times 10^{-6}\ C \cdot 1.25 \times 10^{-4}\ C/(0.250\ m)^2 =$ $\boxed{42.3\ N}$

3. Two masses are strung over a low friction pulley with very lightweight string. (a) What is the acceleration acting on the system? (b) What is the tension in the strings?



a. $F_{sys} = w_1 - w_2 = 5.35\ kg \cdot 9.8\ m/s^2 - 4.20\ kg \cdot 9.8\ m/s^2 = 11.27\ N$

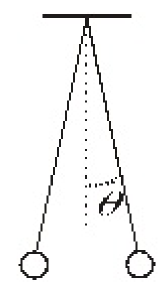
$a_{sys} = F_{sys} / m_{sys} = 11.27\ N / 9.55\ kg = 1.180104712\ m/s^2 =$ $\boxed{1.18\ m/s^2}$

b. $F_{net\,1} = m_1 a_1 = 5.35\ kg \cdot 1.180104712\ m/s^2 = 6.313560209\ N$

$F_{net\,1} = w_1 - T$

$T = w_1 - F_{net\,1} = 52.43\ N - 6.313\ N = 46.117\ N =$ $\boxed{46.1\ N}$

4. Two 25.0 g spheres are hanging from lightweight strings that are each 35.0 cm in length. Each has the same charge. They repel each other and make an angle of 5.00° to the vertical. What is the magnitude of the charge on each sphere?



$d_x = 0.35\ m \cdot \sin(5.00°) = 0.03050451\ m$

$r = 2d_x = 0.06100902\ m$

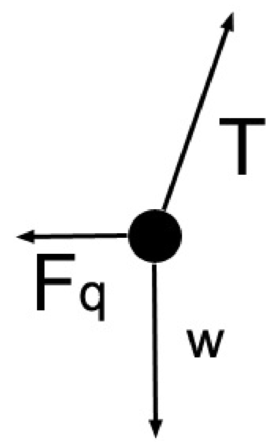
$T_y = w = 0.0250\ kg \cdot 9.8\ m/s^2 = 0.245\ N$

$T_x = T_y \cdot \tan\theta = 0.245\ N \cdot \tan(5.00°) = 0.214347226\ N$

$F_q = k\, q_1 q_2 / r^2 = k \cdot q^2 / r^2$ (since $q_1 = q_2$)

$q = (F_q \cdot r^2/k)^{\frac{1}{2}} = (0.0214347226\ N \cdot (0.06100902\ m)^2 / 9.0 \times 10^9\ N{\cdot}m^2/C^2)^{\frac{1}{2}}$

$= 9.41524721 \times 10^{-8}\ C =$ $\boxed{9.42 \times 10^{-8}\ C}$

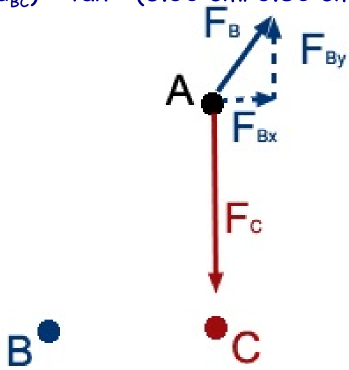


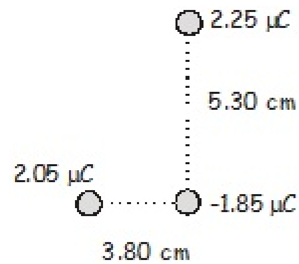
5. Three charges are arranged as shown. Figure 90° angles. What is the magnitude and direction of the force acting on the 2.25 μC charge by the other two charges?

particle A = 2.25 μC, particle B = 2.05 μC, particle C = -1.85 μC

$d_{BA} = (d_{BC}^2 + d_{CA}^2)^{\frac{1}{2}} = ((3.80\text{ cm})^2 + (5.30\text{ cm})^2)^{\frac{1}{2}} = 6.521502894\text{ cm}$

$\triangle ABC = \tan^{-1}(d_{CA}/d_{BC}) = \tan^{-1}(5.30\text{ cm}/3.80\text{ cm}) = 54.3601908°$





$F_C = kq_1q_2/r^2$

$= 9.0\text{x}10^9\text{ N}\cdot\text{m}^2/C^2 \cdot (-1.85\text{x}10^{-6}\text{ C}) \cdot 2.25\text{x}10^{-6}\text{ C} / (0.0530\text{ m})^2$

$= -13.33659665\text{ N}$

$F_B = 9.0\text{x}10^9\text{ N}\cdot\text{m}^2/C^2 \cdot 2.05\text{x}10^{-6}\text{ C} \cdot 2.25\text{x}10^{-6}\text{ C} / (0.06521502894\text{ m})^2$

$= 9.760757113\text{ N}$

$F_{Bx} = 9.760757113\text{ N} \cdot \cos(54.3601908°) = 5.687473828\text{ N}$

$F_{By} = 9.760757113\text{ N} \cdot \sin(54.3601908°) = 7.932529286\text{ N}$

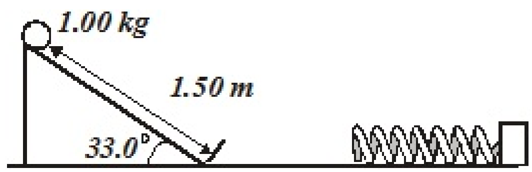
$F_{Ay} = 7.932529286\text{ N} + (-13.33659665\text{ N}) = -5.404067364\text{ N}$

$F_{Ax} = 5.687473828\text{ N}$

$\theta = \tan^{-1}(-5.404067364\text{ N}/5.687473828\text{ N}) = -43.53632047° = -43.5°$

$F_A = ((5.687473828\text{ N})^2 + (-5.404067364\text{ N})^2)^{\frac{1}{2}} = 7.845463824\text{ N} =$ **7.85 N @ - 43.5°**

6. A 1.00 kg ball rolls 1.50 m down a ramp that is at an angle of 33.0° to the horizontal into a spring that has a spring constant of 125 N/m it compresses the spring, and then goes into a harmonic motion deal. The spring rests on a smooth surface. Find (a) the speed of the ball at the bottom of the ramp, (b) the distance the spring is compressed, (c) the potential energy stored in the spring, (d) the maximum acceleration acting on the ball by the spring, (e) the period of the harmonic motion, and (f) the frequency of the harmonic motion.



a. $\Delta h = 1.50\text{ m} \cdot \sin(33.0°) = 0.8169585525\text{ m}$

$\Delta KE = \Delta PE$

$\frac{1}{2} m\Delta v^2 = mg\Delta h$

$v = (2g\Delta h)^{\frac{1}{2}} = (2 \cdot 9.8\text{ m/s}^2 \cdot 0.8169585525\text{ m})^{\frac{1}{2}} = 4.001548154\text{ m/s} =$ **4.00 m/s**

b. $\Delta KE = \Delta PE_{spring}$

$\frac{1}{2} m\Delta v^2 = \frac{1}{2}k\Delta x^2$

$\Delta x = v(m/k)^{\frac{1}{2}}$

$= 4.001548154\text{ m/s} \cdot (1.00\text{ kg}/125\text{ N/m})^{\frac{1}{2}} = 0.3579093475\text{ m} =$ **0.358 m or 35.8 cm**

c. $PE_{spring} = \frac{1}{2} kx^2 = 0.5 \cdot 125\text{ N/m} \cdot (0.3579093475\text{ m})^2 = 8.006193814\text{ J} =$ **8.01 J**

d. $a = F/m = kx/m = 125\text{ N/m} \cdot 0.3579093475\text{ m} / 1.00\text{ kg} = 44.73866844\text{ m/s}^2 =$ **44.7 m/s²**

e. $T = 2\pi(m/k)^{\frac{1}{2}} = 2\pi(1.00\text{ kg}/125\text{ N/m})^{\frac{1}{2}} = 0.5619851785\text{ s} =$ **0.562 s**

f. $f = 1/T = 1/0.5619851785\text{ s} = 1.779406359\text{ Hz} =$ **1.78 Hz**