Electrostatics

WORKSHEET #4

Name: ______________________

1. If a metal sphere is given a positive charge, does its mass change? Why or why not?

   If a metal sphere is given a positive charge, then it has lost some electrons which would change it's mass by a very tiny amount. It would decrease ever so slightly.

2. A balloon is vigorously rubbed with a piece of fur so that it gains a charge. You place it against the wall and it sticks. Does the wall therefore have a positive charge? Explain your answer.

   The negative charge from the balloon would induce a positive charge on the surface of the wall by repelling the negative charges at the wall's surface deeper into the wall and attracting positive charges to the surface. So, the wall still is neutral overall, but seems to have a positive charge at the surface because of the induced migration of charges due to the balloon's charge and close proximity.

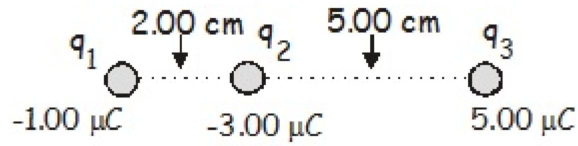
3. A 125 kg 4.00 m plank sticks out from the wall. A cable is hooked to the end of it and ties into the wall above. It makes a 62.0° angle with the plank. A barrel of nails with a total weight of 545 N sits on the plank, 1.10 m from the outside end. Find the tension in the cable and the components of the force exerted by the wall on the plank.

   $w_{plank} = 125\text{ kg} \cdot 9.8\text{ m/s}^2 = 1225\text{ N}$
   pivot point = where plank is attached to wall
   $\Sigma\tau_{clockwise} = \Sigma\tau_{counterclockwise}$
   $1225\text{ N} \cdot 2.00\text{ m} + 545\text{ N} \cdot 2.90\text{ m} = T_y \cdot 4.00\text{ m}$
   $T_y = 1007.625\text{ N}$
   $T = 1007.625/\sin(62.0°) = 1141.206\text{ N} = \boxed{1140\text{ N}}$
   $\Sigma F_{upward} = \Sigma F_{downward}$
   $1225\text{ N} + 545\text{ N} = 1007.625\text{ N} + F_{y\ wall}$
   $F_{y\ wall} = 762.375\text{ N} = \boxed{762\text{ N}}$
   $F_{x\ wall} = T_x = 1141.206\text{ N} \cdot \cos(62.0°) = 535.764\text{ N} = \boxed{536\text{ N}}$

4. Find the force between charges of +100.0 μC and -75.0 μC. They are 13.5 cm apart.

   $F = k\, q_1 q_2/r^2$
   $= 9.0\times10^9\text{ N}\cdot\text{m}^2/C^2 \cdot 100.0\times10^{-6}\ C \cdot (-75.0\times10^{-6}\ C)/(0.135\text{ m})^2$
   $= 3703.703704\text{ N} = \boxed{3.70\times10^3\text{ N or } 3.70\text{ kN}}$

5. Three charges are arranged as shown. Find the force acting on the center charge.

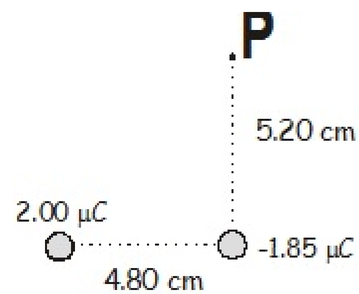


$F_{total} = F_1 + F_3$
$F_1 = k\, q_1q_2/r^2$
$= 9.0\times10^9\ N\cdot m^2/C^2 \cdot (-1.00\ \mu C) \cdot (-3.00\ \mu C)/(0.0200\ m)^2$
$= 67.5\ N$
$F_2 = 9.0\times10^9\ N\cdot m^2/C^2 \cdot 5.00\ \mu C \cdot (-3.00\ \mu C)/(0.0500\ m)^2$
$= 54.0\ N$
$F_{total} = 67.5\ N + 54.0\ N =$ **121.5 N to the right**

6. A charge of 15.5 μC is placed 12.8 cm from a second charge. If the force between the charges is 22.5 N, what is the magnitude of the second charge?

$F = k\, q_1q_2/r^2$
$q_2 = Fr^2/kq_1 = 22.5\ N \cdot (0.128\ m)^2/(9.0\times10^9\ N\cdot m^2/C^2 \cdot 15.5\times10^{-6}\ C) = 2.64258\times10^{-6}\ C =$ **2.64 μC**

7. Three charges are arranged as shown. (a) Find the electric potential at P. (b) How much work would it take to bring in a charge of 1.25 μC from infinity to point P?



a. $d_2 = ((5.20\ cm)^2 + (4.80\ cm)^2)^{/12} = 7.0767224\ cm$
$V = k(q_1/r_1 + q_2/r_2)$
$= 9.0\times10^9\ N\cdot m^2/C^2\ (-1.85\ \mu C/0.0520\ m + 2.00\ \mu C/0.070767224\ m)$
$= -6.583727\times10^4\ V =$ **-6.58×10^4 V or -65.8 kV**

b. $W = \Delta U_E = qV$
$= 1.25\ \mu C \cdot -6.583727\times10^4\ V$
$= -0.08229659\ J =$ **- 0.0823 J or - 82.3 mJ**

8. A proton is accelerated from rest through a potential difference of 9.0 V. Find (a) the energy of the particle, and (b) the speed of the particle.

a. $\Delta KE = \Delta U_E = qV = 1.6\times10^{-19}\ C \cdot 9.0\ V =$ **1.44×10^{-18} J or 1.44 aJ or 9.0 eV**

b. $\Delta KE = \frac{1}{2} m\Delta v^2$
$\Delta v = (2\Delta KE/m)^{\frac{1}{2}} = (2 \cdot 1.44\times10^{-18}\ J/1.67\times10^{-27}\ kg)^{\frac{1}{2}} = 41\,527.7\ m/s =$ **41 500 m/s**