

Name: \_\_\_\_\_

1. If a pair of charges were moved twice as close together, how much larger would the force of attraction be between them?

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

According to Coulomb's Law, force varies inversely with the square of distance, so if  $r' = 0.5 r$ , then the force will be 4X greater.

2. A rubber rod is vigorously rubbed with a piece of fur so that it gains a charge. What happens to give it this charge?

As the fur and rubber are rubbed together, electrons are stripped from the fur and deposited on the rubber causing the fur to gain a net positive charge and the rod to become negative.

3. What is probably the most significant difference between the electromagnetic force and the gravitational force?

Gravitational force can only attract whereas EM forces can repel or attract.

4. A 93.0 g wooden block is set up against a spring. The block rests on a smooth horizontal surface. The block is pushed into the spring, compressing it a distance of 12.0 cm and then released. The spring constant is  $k = 278 \text{ N/m}$ . What is the speed of the block when it leaves the spring?

$$\Delta KE = \Delta PE$$

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

$$\Delta v = x(k/m)^{\frac{1}{2}} = 0.120 \text{ m} \cdot (278 \text{ N/m} / 0.0930 \text{ kg})^{\frac{1}{2}} = 6.560881137 \text{ m/s} = \boxed{6.56 \text{ m/s}}$$

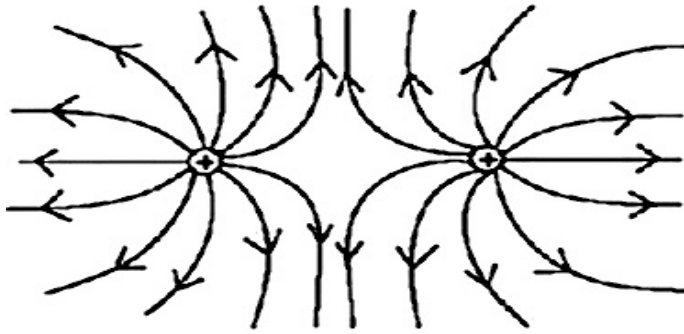
5. Find the force between charges of  $+100.0 \mu\text{C}$  and  $-75.0 \mu\text{C}$ . They are 13.5 cm apart.

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

$$= 9.0 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2 \cdot 100.0 \times 10^{-6} \text{ C} \cdot (-75.0 \times 10^{-6} \text{ C}) / (0.135 \text{ m})^2$$

$$= -3703.703704 \text{ N} = \boxed{-3700 \text{ N or } -3.7 \text{ kN}}$$

6. Draw in the lines of force between the two identical charges as shown below.



7. Why are metals good conductors of electricity?

The outer electrons in metals are very loosely bound (not much energy is required for them to leave their atom), so the electrons flow very easily through the lattice of metal atoms when an electric field is applied causing them to be repelled from the negative side of the field and attracted to the positive side of the field by electrostatic forces.

8. A charge of  $15.5 \mu\text{C}$  is placed  $12.8 \text{ cm}$  from a second charge. If the force between the charges is  $22.5 \text{ N}$ , what is the magnitude of the second charge?

$$\begin{aligned} F &= k q_1 q_2 / r^2 \\ q_2 &= F \cdot r^2 / (k \cdot q_1) \\ &= 22.5 \text{ N} \cdot (0.128 \text{ m})^2 / (9.0 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2 \cdot 15.5 \times 10^{-6} \text{ C}) \\ &= 2.642580645 \times 10^{-6} \text{ C} = \boxed{2.64 \times 10^{-6} \text{ C or } 2.64 \mu\text{C}} \end{aligned}$$

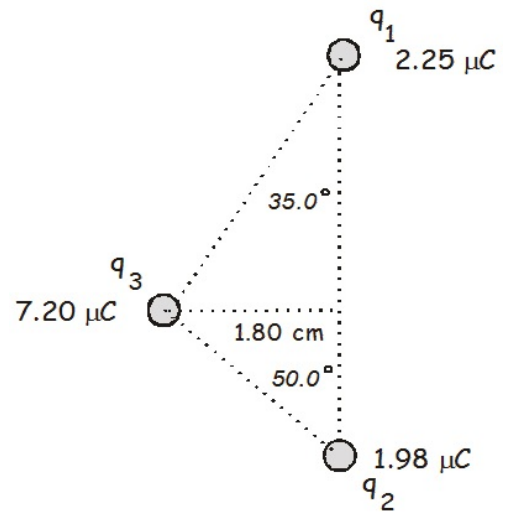
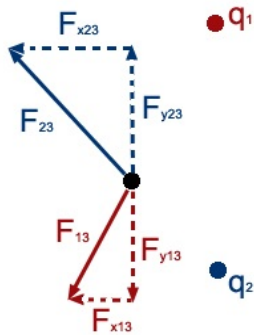
9. An electric field has a value of  $7.50 \times 10^5 \text{ N/C}$ . A positive test charge of  $1.85 \times 10^{-5} \text{ C}$  is placed in the field. What force does the charge experience?

$$F = qE = 1.85 \times 10^{-5} \text{ C} \cdot 7.50 \times 10^5 \text{ N/C} = 13.875 \text{ N} = \boxed{13.9 \text{ N}}$$

10. Three charges are arranged as shown. What is the magnitude and direction of the force acting on the  $7.20 \mu\text{C}$  charge by the other two charges?

$$d_{13} = 1.80 \text{ cm} / \sin(35.0^\circ) = 3.138204232 \text{ cm}$$

$$d_{23} = 1.80 \text{ cm} / \sin(50.0^\circ) = 2.349733121 \text{ cm}$$



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

$$F_{13} = 9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2 \cdot 7.20 \times 10^{-6} \text{ C} \cdot 2.25 \times 10^{-6} \text{ C} / (0.03138204232 \text{ m})^2$$

$$= 148.0454678 \text{ N}$$

$$F_{23} = 9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2 \cdot 7.20 \times 10^{-6} \text{ C} \cdot 1.98 \times 10^{-6} \text{ C} / (0.02349733131 \text{ m})^2$$

$$= 232.3823372 \text{ N}$$

$$F_{x \text{ total}} = F_{x13} + F_{x23}$$

$$= 148.0454678 \text{ N} \cdot \sin(35.0^\circ) + 232.3823372 \text{ N} \cdot \sin(50.0^\circ)$$

$$= -262.9305899 \text{ N} \text{ (negative sign indicating } F_x \text{ is to the left)}$$

$$F_{y \text{ total}} = F_{y13} + F_{y23} = -148.0454678 \text{ N} \cdot \cos(35.0^\circ) + 232.3823372 \text{ N} \cdot \cos(50.0^\circ)$$

$$= 28.10073947 \text{ N}$$

$$F_{\text{total}} = ((-262.9305899 \text{ N})^2 + (28.10073947 \text{ N})^2)^{1/2} = 264.4279612 \text{ N} = \boxed{264 \text{ N}}$$

$$\theta = \tan^{-1}(28.10073947 \text{ N} / -262.9305899 \text{ N}) = \boxed{6.100337271^\circ \text{ N of W or } 173.9^\circ}$$