Name: _____ Date: _____ Period: **B**

Graded problems are worth 2 points each. This assignment is graded out of __ points.

1) If 1 coulomb is equal to the charge of 6.24×10^{18} electrons (or protons), then what is the charge, in coulombs, of a single electron?

2) **Graded**. When charging by friction, it is the electrons, which have a negative charge, that move. Explain, then, how it is possible to give something a positive charge by friction.

3) **Graded**. Kenny rubs a plastic comb with wool and then brings the comb near the head (ball end of the metal rod) of an electroscope, causing the leaves to separate away from each other. Describe what is happening to the charged particles in the electroscope and why this activity causes the leaves to separate.

4) **Graded**. Kenny now touches his comb to the electroscope head. When he pulls the comb away from the electroscope, the leaves stay separated. Explain why they don't go back to a neutral position.

5) **Graded**. Compare and contrast charging by conduction and charging by induction.

6) A positively charged balloon (made of latex, an insulator) is brought into contact with a metal door, which is grounded. Since the door is grounded, electrons should flow into the balloon, neutralize its charge, and leave the balloon and the door both neutral, resulting in the balloon falling to the floor. However, in reality, the balloon sticks to the wall. Explain why the explanation above is flawed, and explain why the balloon stays on the wall.

7) What happens to the electric force between two charged particles as the distance between the particles increases? as the distance decreases?

8) Explain why the forces exerted by two charged particles on each other are equal.

9) **Graded.** What happens to the amount of force between charged objects A and B if the distance between them doubles.
   a. the force doubles
   b. the force quadruples
   c. the force is cut in half
   d. the force is cut to one quarter

10) **Graded**. What happens to the amount of force between charged objects A and B if the charge on A is tripled?
   a. The force triples (becomes 3× the original force)
   b. The force becomes 6× the original force
   c. The force becomes $\frac{1}{3}$ the original force
   d. The force becomes $\frac{1}{6}$ the original force

11) Object A has a charge of $-3.5 \times 10^{-11}\ C$, and object B has a charge of $4.5 \times 10^{-17}\ C$. The distance between them is $2.3 \times 10^{-8}\ m$. What is the force between the objects?

12) **Graded**. Object A has a charge of $-6.5 \times 10^{-8} C$ and object B has a charge of $-3.6 \times 10^{-9}\ C$. The distance between them is $5.5 \times 10^{-5}\ m$. What is the force between the objects?

13) Object A has a charge of $8.6 \times 10^{-3}\ C$. Object B (positively charged) is 3.5 mm away. The force between objects A and B is $6.6 \times 10^{4}\ N$. What is the charge of object B?

14) **Graded**. Object A has a charge of $1.2 \times 10^{-9}\ C$. Object B (negatively charged) is 5.2 cm away. The force between objects A and B is $3.3\ N$. What is the charge of object B?

15) **Graded**. Object A has a charge of $5.5 \times 10^{-7}\ C$ and object B has a charge of $2.9 \times 10^{-8}\ C$. If the magnitude of the force between them is $4.5 \times 10^{5}\ N$, then what is the distance between them?

Selected Answers

1) If 1 coulomb is equal to the charge of 6.24×10^{18} electrons (or protons), then what is the charge, in coulombs, of a single electron?

The charge would be $\frac{1}{6.24 \times 10^{18}} = 1.603 \times 10^{-19}\ C.$

6) A positively charged balloon (made of latex, an insulator) is brought into contact with a metal door, which is grounded. Since the door is grounded, electrons should flow into the balloon, neutralize its charge, and leave the balloon and the door both neutral, resulting in the balloon falling to the floor. However, in reality, the balloon sticks to the wall. Explain why the explanation above is flawed, and explain why the balloon stays on the wall.

Because the balloon is an insulator, the electrons from the ground (and the door) cannot easily move to the balloon to neutralize its charge. The result is that the balloon remains charged and effectively polarizes the particles in the door. The electric force between the balloon and the door keeps the balloon attached to it, and is enough force to hold the balloon up against the force of gravity.

Eventually, the charges will slowly make their way to the balloon, and the result described above will happen… it just takes a lot longer because the balloon insulates against the flow of electrons necessary to make it happen.

7) What happens to the electric force between two charged particles as the distance between the particles increases? as the distance decreases?

As the distance increases, the force decreases. As the distance decreases, the force increases.

8) Explain why the forces exerted by two charged particles on each other are equal.

This is an application of Newton's third law of motion: for every force (including the electrical forces!) there is an equal and opposite reaction force.

11) Object A has a charge of $-3.5 \times 10^{-11}\ C$, and object B has a charge of $4.5 \times 10^{-17}\ C$. The distance between them is $2.3 \times 10^{-8}\ m$. What is the force between the objects?

$$F = k \times \frac{|q_1||q_2|}{d^2}$$

$$F = 9 \times 10^9 \frac{N \cdot m^2}{C^2} \times \frac{(3.5 \times 10^{-11} C)\ (4.5 \times\ 10^{-17}\ C)}{(2.3 \times\ 10^{-8}\ m)^2}$$

$$F =\ 0.027\ N$$

$$or\ 2.7 \times 10^{-2}\ N$$

13) Object A has a charge of $8.6 \times 10^{-3}\ C$. Object B (positively charged) is 3.5 mm away. The force between objects A and B is $6.6 \times 10^4\ N$. What is the charge of object B?

Rearrange this formula: $F = k \times \frac{|q_1||q_2|}{d^2}$ *to solve for the charge of object B* (q_2).

$$\frac{F \times d^2}{k \times |q_1|} = |q_2|$$

$$\frac{(6.6 \times 10^4 N) \times (0.0035\ m)^2}{\left(9 \times 10^9 \frac{N \times m^2}{C^2}\right) \times (8.6 \times 10^{-3}\ C)} = q_2 = 1.04 \times 10^{-8}\ C$$