Name: _____

Class: _____

Due Date: _____

Physics Topic 43 – Electric Force and Electric Field Strength

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. C: What is *charge q*? Units?

2. C: What is the difference between an *electrical conductor* and an *electrical insulator*? Give two examples of each.

3. C: Two charged objects with the same charge will _____ each other while two charged objects with the opposite charge will _____ each other.

4. C: State the charge, in Coulombs, of each particle:

   a. Neutron
   b. Proton
   c. Electron

5. C: There is a metal sphere which has a net positive charge.

   a. Is there any negative charge in it?

   b. Where does the extra positive charge go?

6. C: State the *law of conservation of charge*.

7. E: A pith ball has a surplus of 4.20×10^{15} electrons. What will be the net charge on this ball in Coulombs?

8. E: A pith ball has a shortage of 1.85×10^{17} electrons. What is the net charge on this ball in Coulombs?

9. E: How many electrons will be contained in a net charge of 1,250 μC?

10. E: A pith ball, which has a residual charge of -36 μC, is brought into contact with a second, identical pith ball which is initially neutral, allowing charge to flow between them. These two balls are then separated.

    a. What will be the final residual charge on each pith ball?

    b. How many extra electrons will be present on each ball after they have been separated?

11. E: A pith ball, which has a residual charge of +54 μC, is brought in contact with a second identical pith ball which has an initial residual charge of -38 μC. What will be the final residual charge on each pith ball after they have been separated?

12. E: A pith ball, which has a residual charge of +66 μC, is brought in contact with a second pith ball which has an initial residual charge of -33 μC and which has twice the surface area of the first pith ball. What will be the final residual charge on each pith ball after they have been separated?

13.C: Define and give the units of each variable in *Coulomb's Law* $\vec{F}_{\text{electric}} = k\frac{q_1 q_2}{r^2}$. What is the minimum number of objects required to use *Coulomb's law*?

14.C: Define relative permittivity ε_{r}.

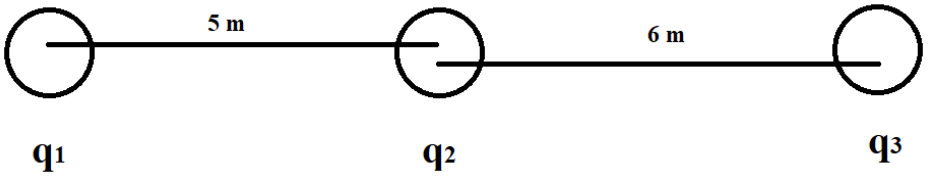
15.E: What will be the magnitude of the electrostatic force between two identical pith balls, each of which has a residual charge of 24.0 μC, which are 15.0 cm apart?

16.E: What will be the magnitude of the electrostatic force between two pith balls 23.0 cm apart if the residual charge on the first ball is -31.0 μC while the residual charge on the second ball is 12.0 μC?

17.E: What will be the electrostatic force between a proton and an electron when they are placed 0.5 Angstroms apart?

18.E: What will be the magnitude of the electrostatic force between two protons in the nucleus of an atom which are approximately 3.00×10^{-15} m apart?

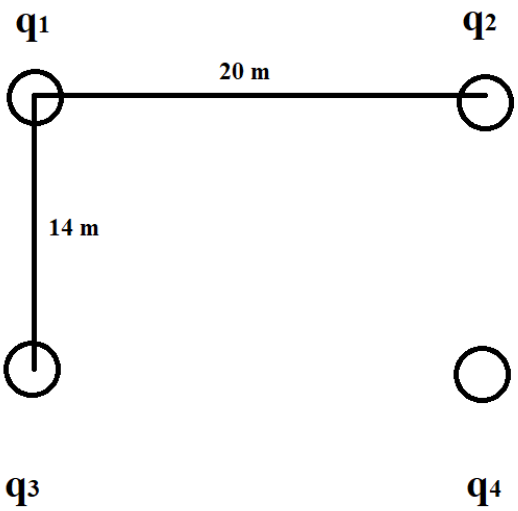
19.E: Use Coulomb's law to determine the electric force on a point charge.



$$q_1 = +2 \times 10^{-9}\ \text{C}$$
$$q_2 = -3 \times 10^{-9}\ \text{C}$$
$$q_3 = +4 \times 10^{-9}\ \text{C}$$

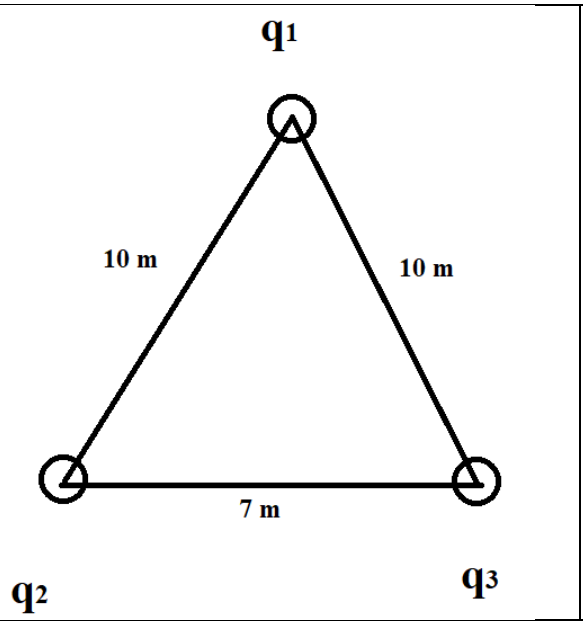
a. q_1 and q_2 are fixed. Find the force on q_3.
b. q_1 and q_3 are fixed. Find the force on q_2.

20.E: Use Coulomb's law to calculate the electric force on a point charge. The point charges q_1, q_2, and q_3 are fixed. Find the force on q_4.



$$q_1 = +2 \times 10^{-9}\ \text{C}$$
$$q_2 = -3 \times 10^{-9}\ \text{C}$$
$$q_3 = -4 \times 10^{-9}\ \text{C}$$
$$q_4 = +5 \times 10^{-9}\ \text{C}$$

21.E: Use Coulomb's law to calculate the electric force on a point charge. Point charges q_2 and q_3 are fixed. Find the force on q_1.



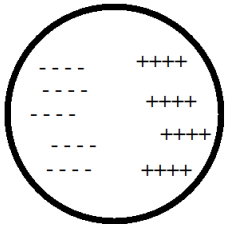
$$q_1 = +2 \times 10^{-9}\ \text{C}$$
$$q_2 = -3 \times 10^{-9}\ \text{C}$$
$$q_3 = -3 \times 10^{-9}\ \text{C}$$

22.C: Explain the meaning of charge being quantized.

23.C: Give an example of how two objects can transfer electric charge by

a. friction

b. electrostatic induction



c. contact

d. grounding/earthing

24.C: Define *electric field strength* $\vec{E} = \frac{\vec{F}}{q} = k\frac{q_1}{r^2}$. What is the minimum number of objects required to use the equation for *electric field strength*?

25. C: Draw a graph of *electric field vs. distance* of a positively charged solid conducting sphere.

26. C: Draw a graph of *electric field vs. distance* of a positively charged solid insulating sphere.

27. E: What will be the strength of the electric field at a point in space where a 5.00 μC charge feels an electrostatic force of $F = 0.0450$ N?

28. E: A charge of 8.50 μC is placed in a uniform electric field which has an intensity of $E = 8.00 \times 10^3 \ \frac{\mathrm{N}}{\mathrm{C}}$. What will be the magnitude of the resulting force?

29. E: A proton is placed in a uniform electric field which has an intensity of $6.50 \times 10^5 \ \frac{\mathrm{N}}{\mathrm{C}}$.

    a. What will be the magnitude of the resulting electrostatic force?

    b. What will be the resulting acceleration of the proton as a result of this field?

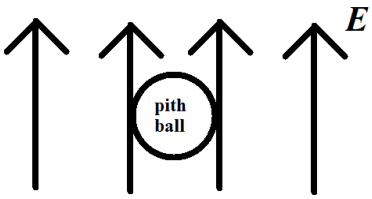
30. E: What will be the electric field strength 45.0 cm from a pith ball which has a residual charge of 5.50 μC?

31. E: What will be the electric field strength a distance 2,450 Angstroms from the nucleus of

    a. a helium atom?

    b. a carbon atom?

32. E: A small pith ball, which has a mass of 0.056 g and contains a residual charge of 5.00 μC, is sitting in a vertically oriented electric field as shown below. The force of gravity acting downward on this ball is exactly balanced by the electric field directed upward.

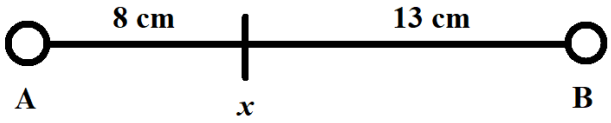


    a. What will be the gravitational force acting on the pith ball?

    b. What will be the magnitude of the electrostatic force acting on the pith ball?

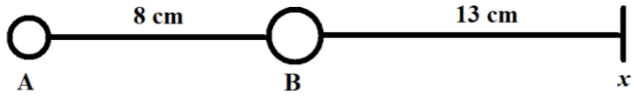
    c. What is the magnitude of the electric field that is supporting this ball?

33.E: Determine the magnitude and direction of the electric field at point *x*.



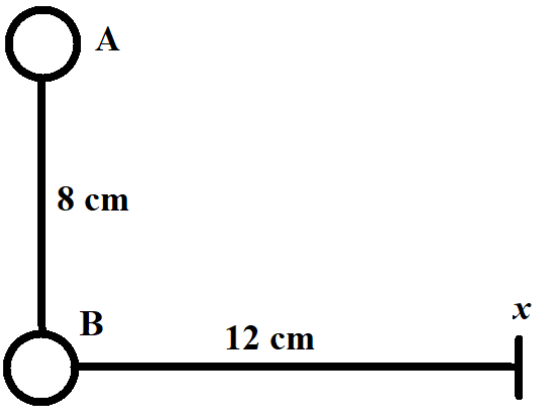
$Q_{\mathrm{A}} = -5.00 \times 10^{-6}\ \mathrm{C}$
$Q_{\mathrm{B}} = +7.20 \times 10^{-6}\ \mathrm{C}$

34.E: Determine the magnitude and direction of the electric field at point *x*.



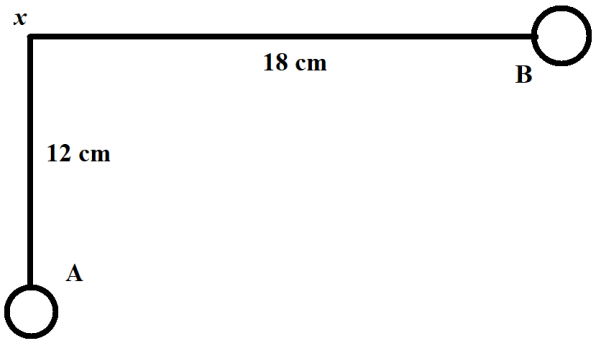
$Q_{\mathrm{A}} = -5.00 \times 10^{-6}\ \mathrm{C}$
$Q_{\mathrm{B}} = +7.20 \times 10^{-6}\ \mathrm{C}$

35.E: Determine the magnitude and direction of the electric field at point *x*.



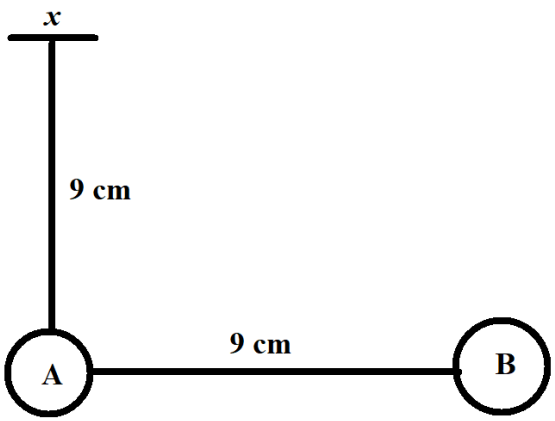
$Q_{\mathrm{A}} = +1.20 \times 10^{-5}\ \mathrm{C}$
$Q_{\mathrm{B}} = -8.00 \times 10^{-6}\ \mathrm{C}$

36.E: Determine the magnitude and direction of the electric field at point *x*.



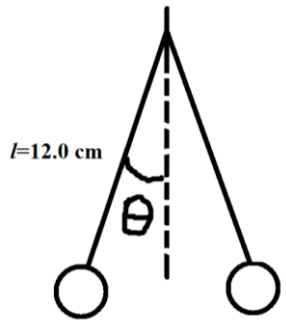
$Q_{\mathrm{A}} = -8.00 \times 10^{-6}\ \mathrm{C}$
$Q_{\mathrm{B}} = +1.20 \times 10^{-5}\ \mathrm{C}$

37.E: Determine the magnitude and direction of the electric field at point x.



$Q_{\mathrm{A}} = -8.00 \times 10^{-6}\ \mathrm{C}$
$Q_{\mathrm{B}} = -5.00 \times 10^{-6}\ \mathrm{C}$

38.E: Two pith balls, each of which is suspended from the end of a piece of very thin thread, are attached to a common point of suspension. Each pith ball has a mass of 0.130 g and each piece of thread is 12.0 cm long. Each of the two pith balls is given a net charge and as a result the two balls repel one another until the angle between a pith ball and the vertical increases to 16.0°.



a. What will be the magnitude of the electrostatic force between these two balls?

b. Determine the magnitude of the charge on each ball if the charge is distributed evenly between the two balls.

c. Assuming that this charge is negative, how many excess electrons would be found on each ball?