Date ______ Period ______ Name Per 4-5

20 Study Guide

Use with Chapter 20.

Static Electricity

Vocabulary Review

Write the term that correctly completes each statement. Use each term once.

~~charged~~	~~coulomb~~	~~elementary charge~~
~~charging by conduction~~	~~Coulomb's law~~	~~insulators~~
~~charging by induction~~	~~electroscope~~	~~neutral~~
~~conductors~~	~~electrostatics~~	~~plasma~~

1. insulators Materials through which charges will not move easily are electrical ______.
2. electrostatics The study of electrical charges that can be collected and held in one place is ______.
3. eletroscopes A(n) ______ is a device used to determine charge.
4. elementary charge The magnitude of the charge of an electron is the ______. 1.6×10^{-19} C
5. charging by induction Separating the charges in an object without touching the object is ______.
6. conductors Materials such as metals are electrical ______. They allow charges to move about easily.
7. neutral The positive charge in ______ objects exactly balances the negative charge.
8. charging by conduction Giving a neutral body a charge by touching it with a charged body is ______.
9. Coulombs Law $F = \frac{KQ_1Q_2}{d^2}$ The magnitude of the force between charge q_A and charge q_B, separated by a distance d, is proportional to the magnitude of the charges and inversely proportional to the square of the distance; this is a statement of ______.
10. coulomb The ______ is the SI standard unit of charge.
11. plasma A(n) ______ is a gaslike state of negatively charged electrons and positively or negatively charged ions.
12. charged An object that exhibits electrical interaction after rubbing is said to be ______.

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20 Study Guide

Section 20.1: Electrical Charge

In your textbook, read about charged objects.
Circle the letter of the choice that best completes each statement.

1. Electricity caused by rubbing is _____.
   - a. static electricity
   - b. lightning
   - c. current electricity
   - d. charge
2. An object that exhibits electrical interaction after rubbing is said to be _____.
   - a. positive
   - b. electrical
   - c. charged
   - d. negative
3. Two objects with the same type of charge _____.
   - a. have no affect on each other
   - b. repel each other
   - c. attract each other
   - d. have to be positive
4. Two objects with opposite charges _____.
   - a. have no affect on each other
   - b. repel each other
   - c. attract each other
   - d. have to be negative
5. Two types of charges are _____.
   - a. yellow and green
   - b. top and bottom
   - c. attractive and repulsive
   - d. positive and negative

In your textbook, read about the microscopic reasons for charge.
Answer the following questions.

11. What are the negative and positive parts of an atom?

protons (+) electrons (−)

12. How can an atom become charged?

gain/losing electrons

13. What happens when two neutral objects, such as rubber and fur, are rubbed together?

electrons leave fur and go onto rubber rod. (rubbing!) :)

2

In your textbook, read about conductors and insulators.

Decide whether the examples below are insulators or conductors. Mark the correct column.

Table 2

Example	Insulator	Conductor
14. a material through which a charge will not move easily	X	
15. glass	X	
16. air as a plasma		X
17. aluminum		X
18. an object, held at the midpoint and rubbed only one end, becomes charged only at the rubbed end	X	
19. copper		X
20. dry wood	X	
21. a material through which charges move about easily		X
22. graphite	X	
23. charges removed from one area are not replaced by charges from another area	X	
24. most plastics	X	
25. dry air		X
26. charges applied to one area spread quickly over the entire object		X

Section 20.2: Electrical Force

In your textbook, read about forces on charged bodies and lightning.

For each of the statements below, write true *or rewrite the italicized part to make the statement true.*

1. There are *two* kinds of electrical charges, positive and negative.

True

2. Charges *cannot* exert force on other charges over a distance.

False Can

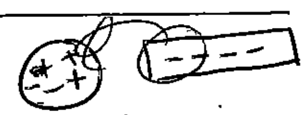
3. The force between two charged objects is *weaker* when the objects are closer together.

F stronger

4. *Opposite* charges repel.

F Like

5. If an electroscope is given a *positive* charge, the leaves will spread.



T

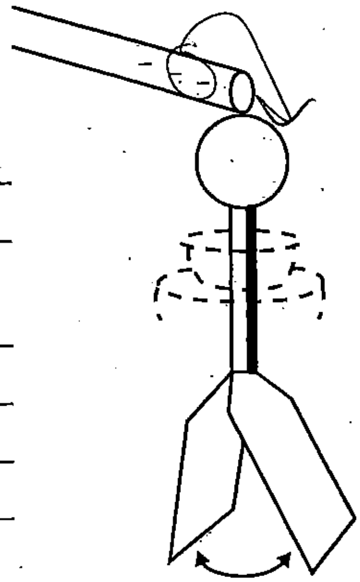
6. Neutral objects can attract charged objects because of separation of charge in the *charged* object.

F neutral

7. Lightning bolts *discharge* clouds.

T

In your textbook, read about electroscopes.
Refer to the drawings to answer the following questions.



8. What is the net charge on the electroscope?

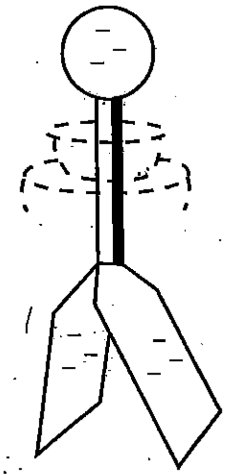
negative

9. By what method is the electroscope being charged?

conduction (charging by contact)

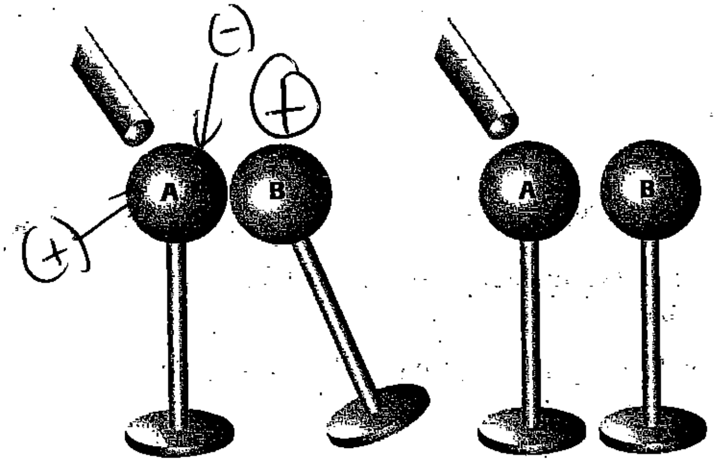
10. The electroscope has a net negative charge. What will happen if the electroscope is touched with an object that has a negative charge?

the leaves will repel (spread out) even further.



11. What will happen if the electroscope is touched with an object that has a positive charge?

the extra e⁻ will leave the electroscope and leaves will come back down.



12. What is the charge on the metal sphere A?

neutral

13. By what method are these metal spheres being charged?

induction (charging w/out contact)

In your textbook, read about Coulomb's law.

Circle the letter of the choice that best completes each statement.

According to Coulomb's law, the magnitude of the force on a charge q_A caused by charge q_B a distance d away can be written $F = K(q_A q_B/d^2)$.

14. The force, F, _____ with the square of the distance between the centers of two charged objects.
    a. varies directly
    b. varies inversely
    c. varies negatively
    d. doesn't vary

Q = coulombs
F = Newtons
d = distance (m)

$F = K\left(\frac{Q_A Q_B}{d^2}\right)$

15. The force, F, _____ with the charge of two charged objects.
    a. varies directly
    b. varies inversely
    c. varies negatively
    d. doesn't vary

Coulomb's Law
$K = 9.0 \times 10^9 \frac{N \cdot m^2}{C^2}$

16. When the charges are measured in coulombs, the distance is measured in meters, and the force is measured in newtons, the constant, K, is _____
    a. 1
    b. 1.60×10^{-19} C
    c. 9.0×10^9 $N{\cdot}m^2/C^2$
    d. unknown

17. Coulomb's law can be used to determine _____ of an electrical force.
    a. the direction
    b. the magnitude
    c. the charge
    d. both the magnitude and the direction

attractive force = (−)F
repulsive force = (+)F

Name: Date:

Chapter 20 Static Electricity- Practice Problems

Use the formula $F = K\frac{(q_1q_2)}{d^2}$ Where $K = 9.0 \times 10^9$ N m^2/C^2

F = force; q = charge; d = distance between charges

$F = K\frac{Q_1Q_2}{d^2}$

1. Two charges, q_1 and q_2, are separated by a distance, *d*, and exert a force, *F*, on each other. Identify what new force would exist if:

$Q_1 = 1C$ $Q_2 = 1C$ $d = 1m$ $F = 1$

a. q_1 is doubled and q_2 is cut in half.

$Q_1 = 2$ $Q_2 = \frac{1}{2}$ $d = 1$ $F = 1$ No effect on force

b. q_1 is tripled and q_2 is doubled.

$Q_1 = 3$ $Q_2 = 2$ $d = 1$ $F = 6$ 6x the force

c. q_2 is cut in half and *d* is tripled.

$Q_1 = 1$ $Q_2 = \frac{1}{2}$ $d = 3$ $F = \frac{Q_1 \cdot Q_2}{d^2} = \frac{1 \times \frac{1}{2}}{9} = \frac{1}{2} \times \frac{1}{9} = \frac{1}{18}$ Force

2. An electric force of 0.030 N acts between two charges that are 7.2 cm apart. Calculate the force acting between the charges if the distance between them is reduced to 1.5 cm.

$Q_A \cdot Q_B$ will be the same for both distances

$F = \frac{KQ_1Q_2}{d^2}$

$KQ_1Q_2 = Fd^2 = (.03)(.072m)^2 = 1.55 \times 10^{-4}$

$F = \frac{KQ_1Q_2}{d^2} = \frac{1.55 \times 10^{-4}}{(.015)^2}$

$F = .6912N$

3. Two charged spheres are separated by 315 mm. What is the force between them if the charge on one sphere is $+9.6 \times 10^{-7}$ C and the charge on the other sphere is -2.2×10^{-5} C?

$F = ?$

$Q_1 = 9.6 \times 10^{-7} C$

$Q_2 = -2.2 \times 10^{-5} C$

$d = 315 mm = .315 m$

$F = K\frac{Q_1Q_2}{d^2} = 9 \times 10^9 N \cdot \frac{m^2}{C^2} \left(\frac{(9.6 \times 10^{-7} C)(-2.2 \times 10^{-5} C)}{(.315 m)^2}\right)$

$F = -1.92 N$ attractive

4. Determine the force of attraction between a proton and an electron that are separated by 7.5×10^{-8} m. The q for a proton is $+1.60 \times 10^{-19}$ C and the q for an electron is -1.60×10^{-19} C.

$F = ?$

$d = 7.5 \times 10^{-8} m$

$Q_1 = 1.6 \times 10^{-19} C$

$Q_2 = -1.6 \times 10^{-19} C$

$F = \frac{KQ_1Q_2}{d^2} = \frac{9 \times 10^9 \frac{N m^2}{C^2}(1.6 \times 10^{-19} C)(-1.6 \times 10^{-19} C)}{(7.5 \times 10^{-8} m)^2}$

$F = 4.10 \times 10^{-14} N$

$F = \frac{KQ_1Q_2}{d^2}$ $K = 9.0 \times 10^9 \, N \cdot m^2/C^2$

5. A positive charge of 3.4×10^{-7} C exerts a repulsive force (+) of 9.0 N on a second charge 4.0 cm = .04 m away. Determine the second charge.

$Q_2 = \frac{Fd^2}{KQ_1} = \frac{(9N)(.04m)^2}{9 \times 10^9 \frac{Nm^2}{C^2}(3.4 \times 10^{-7}C)} = 4.71 \times 10^{-6} C$

6. An attractive force (−) of 0.87 N exists between a positive charge of 5.0×10^{-6} C and a negative charge of -1.5×10^{-6} C. What is the distance between the charges?

$d = \sqrt{\frac{KQ_1Q_2}{F}} = \sqrt{\frac{(9 \times 10^9)(5 \times 10^{-6})(+1.5 \times 10^{-6} C)}{+.87}}$

$d = .279 \, m$

7. Two positively charged spheres, A and B, are separated by 0.25 m. The charge on sphere A is one-third the charge on sphere B. Find the charge on each sphere if the force of repulsion is (+) 125 N.

$Q_A = X$ 1.7×10^{-5} $F = \frac{KQ_AQ_B}{d^2}$ $Q_A = \frac{Q_B}{3}$

$Q_B = 3X$ 5.1×10^{-5}

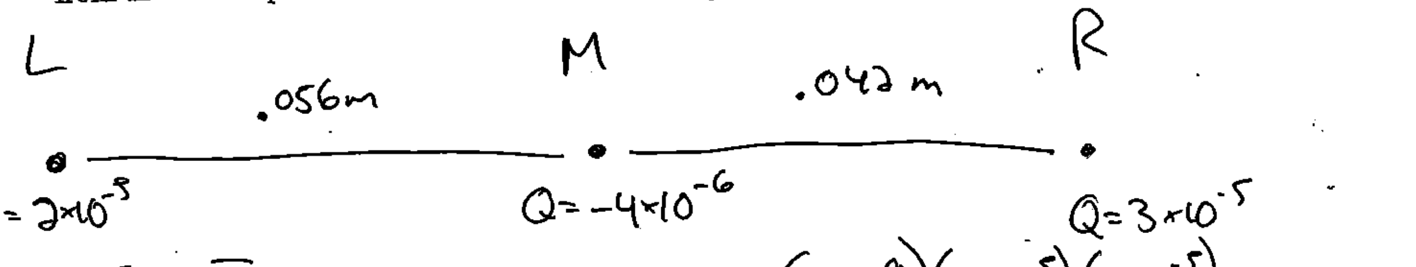
$125 N = \frac{9 \times 10^9 \frac{N \cdot m^2}{C^2}(x)(3x)}{(.25m)^2}$ $3x^2$

$3x^2 = 8.68 \times 10^{-10}$

$x^2 = 2.89 \times 10^{-10}$

$x = 1.70 \times 10^{-5}$

8. Three particles are placed in a straight line. The left particle has a charge of $+2.0 \times 10^{-5}$ C, the middle particle has a charge of -4.0×10^{-6} C, and the right particle has a charge of $+3.0 \times 10^{-5}$ C. The left particle is 56 mm from the middle particle and the right particle is 42 mm from the middle particle. Find the net force on the left particle.



Net Force = $F_{LR} + F_{LM}$

Net F = 562.3 + (−229.6)

= 332.7 N

$F_{LR} = \frac{KQ_LQ_R}{d^2} = \frac{(9 \times 10^9)(2 \times 10^{-5})(3 \times 10^{-5})}{(.098m)^2} = 562.3 N$

$F_{LM} = \frac{KQ_LQ_M}{d^2} = \frac{(9 \times 10^9)(2 \times 10^{-5})(-4 \times 10^{-6})}{(.056)^2} = -229.6 N$

Name: Period: Date:

Electric Fields Worksheet

Formulas: Magnitude of an electric field, (E): $E = F/q$ or $E = kQ/d^2$ $E = \frac{F}{Q} = \frac{\frac{KQ_1Q_2}{d^2}}{Q}$

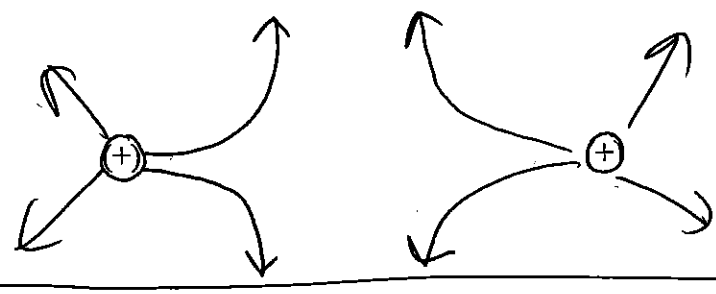
Magnitude of an electric field, (E): $E = V/d$

Work done on an electric field (W): $W = V \times q$

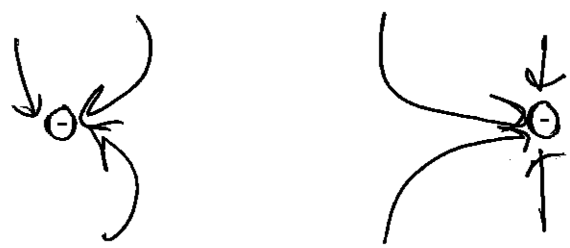
E = electric field (N/C); F = force (N); q = charge (C);
V = voltage or potential difference (J/C); W= work (J) (also equal to energy; 1 J = 1 Nm)

1. Sketch in the electric fields around the following charged objects.

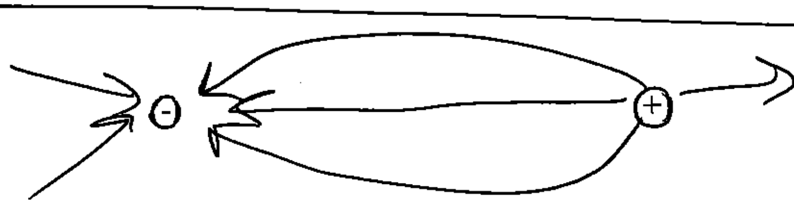
a.



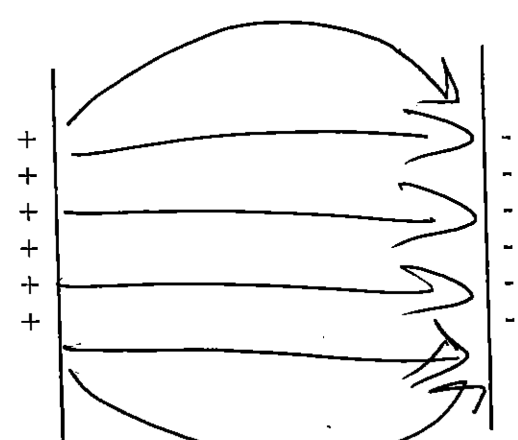
b.



c.



d.



$E = \frac{F}{Q}$ $E = \frac{V}{d}$ $work = V \times Q$

2. A positive charge of 2.4 x 10^{-6} C is acted on by a force of 0.43 N at a certain distance. What is the electric field intensity at that distance?

$F = .43 N$
$Q = 2.4 \times 10^{-6} C$
$E = ?$

$E = \frac{F}{Q} = \frac{.43 N}{2.4 \times 10^{-6} C} = 1.8 \times 10^5 \frac{N}{C}$
179,000 N/C

3. What is the amount of charge on an object that is acted on by a force of 3.60 x 10^{-6} N at a point where the electric field intensity is 1.60 x 10^{-5} N/C?

$E = 1.6 \times 10^{-5} N/C$
$F = 3.6 \times 10^{-6} N$
$Q =$

$Q = \frac{F}{E} = \frac{3.6 \times 10^{-6} N}{1.6 \times 10^{-5} N/C} = .225 C$

4. The electric field intensity between two charged plates is 2.80 x 10^4 N/C. The plates are 0.0640 m apart. What is the potential difference between the plates in volts?
voltage

$E = 2.8 \times 10^4 \frac{N}{C}$
$d = .064 m$
$V = ?$

$E = \frac{V}{d}$
$V = E \times d$
$= (2.8 \times 10^4 \frac{N}{C})(.064 m) = 1792 \frac{N \cdot m}{C}$
1792 J/C = 1792 V

5. A voltmeter connected between 2 plates registers 38.2 V. The plates are separated by a distance of 0.046 m. What is the electric field intensity between the plates?

$V = 38.2 V = 38.2 \frac{N \cdot m}{C}$
$d = .046 m$
$E = ?$

$E = \frac{V}{d} = \frac{38.2 \frac{N \cdot m}{C}}{.046 m} = 830.43 N/C$

6. How much work is done to transfer 0.47 C of charge through a potential difference of 12 V?

$V = 12 V$
$Q = .47 C$
$work = ?$

$Work = V \times Q = 12 V \times .47 C$
$work = 5.64 J$

$\frac{J}{C} \times C$

7. A 9.0 V battery does 1.0 x 10^3 J of work transferring charge. How much charge is transferred? 1000

$V = 9V$
$work = 1000 J$
$Q =$

$Q = \frac{work}{V}$
$Q = \frac{1000 J}{9 J/C} = 111.1 C$

5 electrons

8. A dust particle, carrying 5 elementary units of charge (electrons) is accelerated through a potential of 3.0×10^3 volts. Compute its resulting kinetic energy in joules.

Energy (work) = ?

$V = 3000\ V = 3000\ J/C$

$Q = 5\ e^- \left(\frac{1.6\times10^{-19} C}{e^-}\right) = 8\times10^{-19} C$

$\text{Work} = V \times Q$

$= (3000\ J/C)(8\times10^{-19} C)$

$\text{work} = 2.4\times10^{-15} J$

9. A force of 7.60×10^3 N acts on a charge of 1.60×10^{-2} C over a distance of 0.0440 m. What is the potential difference of this system?

$V = ?$

$F = 7.6\times10^3\ N$

$Q = 1.6\times10^{-2} C$

$d = .0440 m$

$E = \frac{F}{Q}$ → $E = \frac{V}{d}$

$\frac{F}{Q} = \frac{V}{d}$

or

$\text{work} = V\times Q$

$V = \frac{\text{work}}{Q} = \frac{Fd}{Q}$

$V = \frac{F\cdot d}{Q} = \frac{(7.6\times10^3 N)(.0440 m)}{1.6\times10^{-2} C} = 20{,}900 V$

10. How much work is done by a system in which the force is 6.8×10^4 N, the potential difference is 4.2 V, and the electric field intensity is 1.2×10^{-3} N/C?

Work = ?

$F = 6.84\times10^4 N$

$V = 4.2\ V = 4.2\ J/C$

$E = 1.2\times10^{-3}\ N/C$

$\text{work} = V\times Q \leftarrow Q = \frac{F}{E}$

$\text{work} = \frac{V\times F}{E} = \frac{(4.2\ J/C)(6.84\times10^4 N)}{1.2\times10^{-3} N/C}$

$\text{work} = 2.38\times10^8 J$