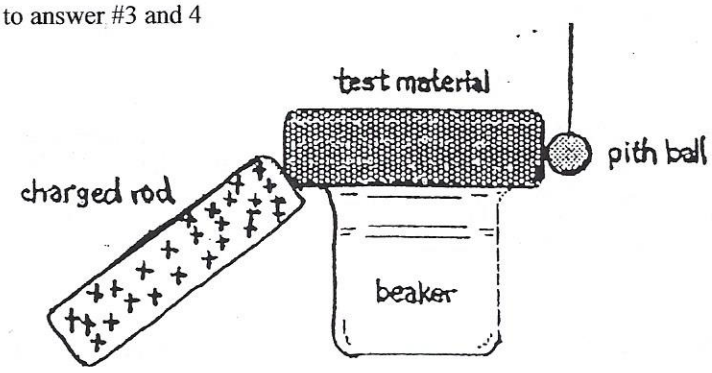
Review – Electrostatics

1. A proton carries a positive charge and an electron carries a negative charge.

2. A glass rod is rubbed with a piece of silk. During the process the glass rod acquires a positive charge and the silk
   a) acquires a positive charge also
   b) acquires a negative charge
   c) remains neutral
   d) could either be positively or negatively charged depending on how hard the rod was rubbed

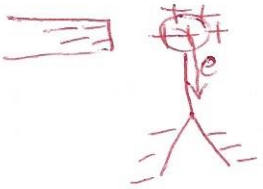
Use the diagram below to answer #3 and 4



3. In the diagram, if the test material is made of a conductor, what charge will be transferred to the pith ball?
   a) neutral charge b) positive charge c) negative charge d) no charge will transfer

4. If the test material in the diagram above is an insulator, what charge will be transferred?
   a) neutral charge b) positive charge c) negative charge d) no charge will transfer

5. Suppose an electroscope has a neutral charge. A negatively charged rod is brought near, but does not touch the electroscope. What be explains what happens?
   a) the leaves become negative and separate
   b) the leaves become positive and separate
   c) the leaves stay neutral and separate
   d) the leave stay together



7. An object charged by contact with a charged rod will
   a) have the opposite charge as the rod
   b) have the same charge as the rod
   c) have a noncontact charge
   d) be neutral

8. An object charged by induction from a charged rod will
   a) have the opposite charge as the rod
   b) have the same charge as the rod
   c) have a noncontact charge
   d) be neutral

9. What is the difference between a good conductor and a good insulator?
   a) electrons are able to move easily in a good conductor
   b) electrons are able to move easily in a good insulator
   c) electrons are tightly held by a good conductor
   d) protons are able to move easily in a good insulator

10. Which of the following statements explains what happens as you rub your feet across a rug?
    a) you are grounded so no charge will build up on you
    b) the rug does not have enough electrons to build up charge
    c) you are given a negative charge while the rug is now positive
    d) protons are rubbed from the rug to you

11. Two charges are sperated by a distance of d. What will happen to the force between the two charges if the distance is increased to 4d?
    a) ¼ as much
    b) 1/16 as much
    c) 4x as much
    d) 2x as much

$F = k\frac{Q_1 Q_2}{r^2}$

12. Gold, when rubbed with fur, acquires an excess of electrons. Brass also acquired electrons when rubbed with fur, though brass acquires fewer than gold. What will happen if brass and gold are rubbed together?

Gold becomes negative and brass becomes positive

13. Four different colored pith balls are attached by different strings to a ring on a ring stand. The yellow ball is charged by induction using a negative rod. The blue ball repels the green ball. The red ball and the blue ball are attracted to the yellow ball. What are the charges of each ball?

Y(+) R(−) B(−) G(−)

14. Sometimes during thunderstorms you fell a "tingling" and the hairs on your body stand on end. Why does this happen?

charged cloud either attracts or repels electrons charging the person by induction. Since all of persons hair has the same charge they repel each other.

15. A piece of plastic has a net charge of +2.00 μC. a) Does it have an excess or deficit of electrons? b) How many electrons are in excess or deficit?

a) deficit b) $Q = ne$

$(2.00 \times 10^{-6}) = n(1.602 \times 10^{-19})$

$n = 1.25 \times 10^{13}$ electrons

16. Two point charges are initially 2.0cm apart and experience a 1.0 N force. If they are moved to a new separation of 8.0cm, what is the force they experience now?

$F = k\frac{Q_1 Q_2}{r^2}$ moved 4.0x farther so force is $\frac{1}{16}$ as much $(1.0)\left(\frac{1}{16}\right) = 0.0625\,N$

17. Sphere A carries a net charge and sphere B is neutral. They are placed near each other on an insulated table. Which statement best describes the force between them?
    a) There is no force between them since on is neutral
    b) There is a force of repulsion between them
    c) There is a force of attraction between them
    d) The force is attractive if A is positive and repulsive if A is negative

18. Two charged objects attract each other with a certain force. If the charges on both objects are doubled with no change in separation, the force between them
    a) quadruples
    b) doubles
    c) halves
    d) increase, but we can't tell how much without knowing the distance between them

19. Sphere A carries a net positive charge, and sphere B is neutral. They are placed near each other on an insulated table. Sphere B is briefly touched with a wire that is grounded. Which statement is correct?
a) Sphere B remains neutral
b) Sphere B is now positive
c) Sphere B is now negative
d) Cannot determine

20. An originally neutral electroscope is grounded while a positively charged rod is held near it. After the rod is removed, the electroscope
a) remains neutral
b) is negatively charged
c) is positively charged
d) could be either negative or positive

21. An atomic nucleus has a charge of +40 electrons. An electron is 10^{-9} m from the nucleus. What is the force on the electron?

$$F = \frac{(9.0\times10^{9})(40\times1.602\times10^{-19})(-1.602\times10^{-19})}{(10^{-9})^2} = -9.2\times10^{-9}\text{ N}$$ attractive

22. A +30μC charge is attracted to a -90μC charge with a force of 1.8 N. How far apart are the charges?

$$1.8 = \frac{(9\times10^{9})(30\times10^{-6})(90\times10^{-6})}{r^2} \qquad r = 3.7\text{m}$$

23. What is the charge on 1.00 kg of protons?

$$1.00\text{kg}\times\frac{1\text{ proton}}{1.67\times10^{-27}\text{kg}} = 5.99\times10^{26}\text{ proton}$$

$Q = ne$

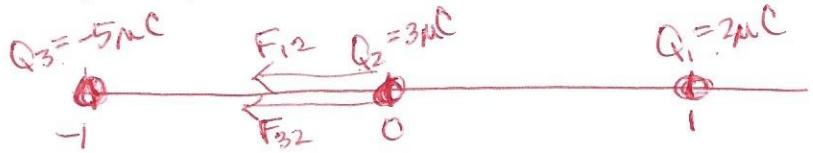
$Q = (5.99\times10^{26})(1.602\times10^{-19})$

$Q = 9.6\times10^{7}\text{ C}$

24. A 1.0 C charge is 15 m form a second charge, and the force between them is 1.0 N. What is the magnitude of the second charge?

$$1.0 = \frac{(9\times10^{9})(1.0)Q_2}{15^2} \qquad Q_2 = 2.5\times10^{-5}\text{ C}$$

25. Three point charges are located at the following positions: $Q_1 = +2.0$ μC at x = 1.00m, $Q_2 = 3.00$ μC at x = 0, and $Q_3 = -5.00$ μC at x = -1.00 m. What is the magnitude and direction of the force acting on the Q_2?



$$F_{12} = \frac{(9\times10^{9})(2\times10^{-6})(3\times10^{-6})}{1.0^2} = .054\text{N (left)}$$

$$F_{32} = \frac{(9\times10^{9})(-5\times10^{-6})(3\times10^{-6})}{1.0^2} = .135\text{N (left)}$$

$F = .189$ N (left)

Review – Voltage and Current

1) A proton, initially at rest, is accelerated through a potential difference of 500V.
   a) What is the kinetic energy of the proton at the end of its acceleration?

$PE = QV = (1.602\times10^{-19})(500) = 8.0\times10^{-17}\ J = KE$

   b) What is the speed of the proton at the end of its acceleration?

$KE = \frac{1}{2}mv^2 \qquad 8.0\times10^{-17} = \frac{1}{2}(1.67\times10^{-27})v^2 \qquad v = 3.1\times10^{5}\ m/s$

2) It takes 10J of energy to move 2.0 C of charge from point A to point B. What is the potential difference between points A and B?

$PE = qV \qquad 10 = (2.0)V \qquad V = 5\ V$

3) The electron-volt is a unit of
   a) voltage b) current c) power d) energy

4) How much work does 9.0 V do in moving 8.5×10^{18} electrons?

$Q = (8.5\times10^{18})(1.602\times10^{-19})$

$W = \Delta PE = QV = (1.36\ C)(9.0\ V) = 12\ J$

5) What current is flowing if 0.47 C of charge pass a point in 0.20 sec?

$I = \frac{Q}{t} = \frac{.47}{.20} = 2.4\ A$

6) A charge of 12 C passes through an electroplating apparatus in 2.0 min. What is the average current?

$I = \frac{12\ C}{120\ sec} = .10\ A$

7) If 3.0×10^{15} electrons flow through a section of wire of diameter 2.0mm in 4.0 s, what is the current in the wire?

$Q = 3.0\times10^{15}(1.602\times10^{-19}) = 4.8\times10^{-4}\ C$

$I = \frac{Q}{t} = \frac{4.8\times10^{-4}\ C}{4.0} = 1.2\times10^{-4}\ A$

8) A 12 V battery is connected to a 100 Ω resistor. How many electrons flow through the wire in 1.0 min?

$R = \frac{V}{I} \qquad 100 = \frac{12}{I} \qquad I = .12\ A \qquad .12 = \frac{Q}{60} \qquad Q = 7.2\ C$

$I = \frac{Q}{t} \qquad Q = ne \qquad 7.2 = n(1.602\times10^{-19}) \qquad n = 4.5\times10^{19}\ electrons$

9) A heavy bar is 20 cm long and of rectangular cross-section, 1.0 cm x 2.0 cm. What is the voltage drop along its length when it carries 4000Amps of current? (The resistivity of copper is 1.69×10^{-8})

$R = \rho\left(\frac{L}{A}\right) = 1.69\times10^{-8}\left(\frac{.20}{(.01)(.02)}\right) = 1.69\times10^{-5}\ \Omega$

$R = \frac{V}{I} \qquad 1.69\times10^{-5} = \frac{V}{4000} \qquad V = .068\ V$

10) A 10.0 cm nichrome wire has a radius of 0.50 mm and a resistivity of 100 x 10^{-8}. If the wire carries a current of 0.50 Amps, what is the voltage across the wire?

$R = (100 \times 10^{-8})\left(\frac{.10}{\pi (.0005)^2}\right) = .127\Omega$ $\quad R = \frac{V}{I}$ $\quad .127 = \frac{V}{.50}$ $\quad V = .064V$

11) A 4000Ω resistor is connected across 220V. What current will flow?

$4000 = \frac{220}{I}$ $\quad I = .055\ A$

12) A light bulb operating at 110 V draws 1.40 Amps of current. What is its resistance?

$\frac{110}{1.40} = 79\Omega$

13) Consider two copper wires. One has twice the length of the other. How do the resistivities of these two wires compare?

a) both wires have the same resistivity
b) the longer wire has twice the resistivity of the shorter one
c) the longer wire has four times the resistivity of the shorter one
d) none of the above

↑ this is a constant of the material

14) A 1.0 mm diameter copper wire (resistivity 1.69 x 10^{-8}) carries a current of 15 Amps. What is the potential difference between two points 100m apart?

$R = (1.69 \times 10^{-8})\left(\frac{100}{\pi (.0005)^2}\right) = 2.15\Omega$ $\quad R = \frac{V}{I}$ $\quad 2.15 = \frac{V}{15}$ $\quad V = 32V$

15) A 1.5 cm square rod, 4.0 m long, measures 0.040 Ω. What is the resistivity?

$.040 = \rho\left(\frac{(4.0)}{(.015)(.015)}\right)$ $\quad \rho = 2.25 \times 10^{-6}$

16) What is the resistance of a circular rod 1.0 cm in diameter and 45 m long, if the resistivity is 1.4 x 10^{-8}?

$R = (1.4 \times 10^{-8})\left(\frac{45}{\pi (.005)^2}\right) = .0080\Omega$

17) A lamp uses a 150 W bulb. If it is used at 120 V, what current does it draw?

$P = VI$ & $150 = 120\ I$ $\quad I = 1.25A$

18) What is the resistance of a 100 W bulb designed to be used in a 120 V circuit?

$P = \frac{V^2}{R}$ $\quad 100 = \frac{120^2}{R}$ $\quad R = 144\Omega$

19) A wire carries a steady current of 0.10 Amps over a period of 20 s. What total charge passes through the wire?

$I = \frac{Q}{t}$ $\quad .10 = \frac{Q}{20}$ $\quad Q = 2C$

20) What potential difference is required to cause 2.0 Amps to flow through a resistance of 8.0 Ω?

$R = \frac{V}{I}$ $\quad 8.0 = \frac{V}{2.0}$ $\quad$ 16V

21) A 200 Ω resistor is rated a 0.25 W. What is the voltage?

$P = \frac{V^2}{R}$ $\quad .25 = \frac{V^2}{200}$ $\quad V = 7.1\,V$

22) A 1500W heater is connected to a 120V line for 2.0 hrs. How much heat energy is produced?

$P = IV$

$1500 = I(120)$

$I = \frac{12.5\,C}{s} \times 7200\,s = 90000\,C$

$E = QV = (90000)(120) = 1.08 \times 10^7\,J$

23) If the voltage across a circuit of constant resistance is doubled, the power dissipated by that circuit will

a) quadruple b) double c) decrease by half d) decrease to one-fourth $P = \frac{V^2}{R}$

24) A toaster is rated 800 W at 120 V. What is the resistance of its heating element?

$P = \frac{V^2}{R}$ $\quad 800 = \frac{120^2}{R}$ $\quad R = 18\,\Omega$

25) 4.00 Amps is flowing through an 8.00 Ω resistor. How much power is being dissipated?

$P = I^2R = (4.00)^2(8.00) = 128\,W$

26) A 150 W light bulb running on 110V draws how much current?

$P = VI$ $\quad 150 = 110\,(I)$ $\quad I = 1.4\,A$

27) How much energy does a 25 W soldering iron use in 8.0 hours?

$P = \frac{E}{t}$ $\quad 25 = \frac{E}{28800}$ $\quad E = 720000\,J$

28) 14 Amps of current flows through a 8.0 Ω resistor for 24 hours. How much does this cost if energy costs \$0.09/kWh?

$P = I^2R = (14)^2(8.0) = 1568\,W = 1.568\,kW$

$1.568\,kW \times 24\,hrs = 37.6\,kW \cdot hr$

$37.6\,kW \cdot hr \times \frac{\$\,0.09}{kW \cdot hr} = \$\,3.39$