Name: ______________________________________ Date: __________________ Period: **B**

Test Topics

Your textbook covers electricity in chapter 21.

- Static Electricity
  - Methods of charging an object:
    - Friction, Conduction, Induction, Polarization
  - How an electroscope works
  - Conductors, Insulators, and Semi-conductors
  - Coulomb's Law
- Current Electricity
  - Voltage, Current, and Resistance (what they are, units, factors affecting resistance)
  - Ohm's Law ($V = IR$)
  - Circuits
    - Series and Parallel
    - Voltage Drop
    - Problems finding voltages, amperages, and resistances in circuits
  - Electric Power
  - Circuit Diagrams
- Doing problems using significant figures.

Practice Problems

1) A microwave oven draws 25 A of current from a 120 V wall outlet.

   a. How much power does the oven consume?

   b. If electricity costs $\frac{\$0.15}{kWh}$, how much does it cost to run the microwave oven for 2 minutes and 30 seconds?

   c. A clothes dryer typically will use 750 W of power. How much current does it draw from a 220 V wall outlet?

2) In a circuit hooked up to a battery, which way does the current flow? Which way do the electrons flow? Explain any difference.

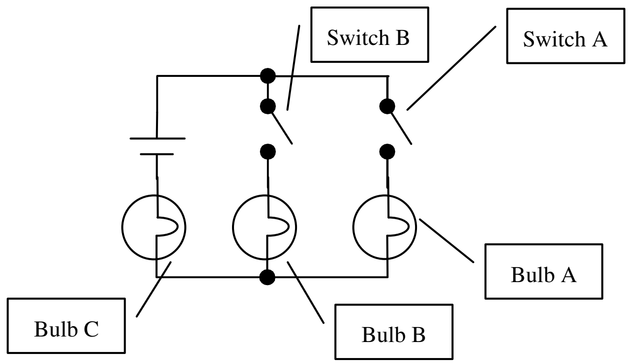
3) Your little brother sticks knife into one part of a wall outlet, but does not get hurt. Why not?

4) You have a series circuit with a 9 V battery, a 1.5 Ω resistor, and a 0.5 Ω bulb. How much power does the bulb consume? How much power does the resistor consume?

5) Explain why we can ignore the resistance of wires when doing calculations for circuits, but we have to be aware of the resistance in real life, where electrical fires are a concern.

6) Why is it hard to create charge on a conductor (like a piece of copper) using friction?

7) Using the circuit below, fill in the behavior (on/off) for each of the bulbs given the switch positions for switches A and B.



Switch A	Switch B	Bulb A	Bulb B	Bulb C
open	open			
closed	open			
open	closed			
closed	closed			

8) An air conditioner draws 1800 W of power when plugged into a 110 V power supply. If electricity is $0.15 per kWh, how much money will it cost to run it for 24 hours?

9) An electric stove draws 3000 W of power. How much energy, in Joules, does it consume in 25 minutes (enough time to cook rice)? Express your answer in scientific notation.

10) A normal incandescent light bulb consumes 60 W of power. A high-efficiency compact fluorescent bulb (CFL) uses 13 W. Each lasts about 10,000 hours before burning out.

   a. If the cost of electricity is $0.15/kWh, how much money will you save over the lifetime of the bulb by using a CFL instead of an incandescent bulb?

   b. A CFL bulb costs $17.95, and an incandescent bulb costs $0.47. Is the CFL worth the extra up-front cost?

11) Object A has a charge of $3.5 \times 10^{-12} C$, and Object B has a charge of $-8.23 \times 10^{-8} C$. What is the magnitude of the force between them when they are $1.24 \times 10^{-5} m$ apart from each other?

12) Object A has a charge of $3.32 \times 10^{-3}\ C$. Object B (positively charged) is 7.3 mm away. The force between objects A and B is $6.16 \times 10^{4}\ N$. What is the charge of object B? Sig figs.

13) A hydrogen atom is approximately $1 \times 10^{-10} m$ in diameter (not radius). 1 Coulomb is equal to the charge of 6.24×10^{18} electrons (or protons). How much force exists between the proton and electron of the atom?

Answers

14) A microwave oven draws 25 A of current from a 120 V wall outlet.

a. How much power does the oven consume?

$$P = IV$$

$$P = 25A \times 120V = 3000\ W$$

b. If electricity costs $\frac{\$0.15}{kWh}$, how much does it cost to run the microwave oven for 2 minutes and 30 seconds?

The power used by the microwave oven in 2:30 is : $3000\ W = 0.3\ kW$

Converting the time to hours:

$$2{:}30 = 150\ s \times \frac{(1\ hr)}{3600\ s} = 0.042\ h$$

Calculating the amount of energy used by the microwave oven:

$$0.3\ kW \times 0.042h = 0.0126\ kWh$$

Calculate the cost for the energy used:

$$\frac{\$0.15}{1kWh} \times 0.0126\ kWh = \$0.0189 = \$0.02$$

c. A clothes dryer typically will use 750 W of power. How much current does it draw from a 220 V wall outlet?

$$I = \frac{P}{V} = \frac{750\ W}{220\ V} = 3.41\ A$$

15) In a circuit hooked up to a battery, which way does the current flow? Which way do the electrons flow? Explain any difference.

The current is defined to flow from the positive terminal of the battery to the negative terminal of the battery. The electrons actually flow the other direction (from the negative terminal to the positive terminal). This is for historical reasons. Ben Franklin first proposed the theory of current flow in terms of moving from positive to negative. It was much later that protons and electrons were discovered, exposing Franklin's mistake. By then convention had been established, and we still go by the historical convention.

16) Your little brother sticks knife into one part of a wall outlet, but does not get hurt. Why not?

Because he is not completing a circuit by touching only one socket, the electricity still does not flow. If he were to touch the other socket as well, (or to provide a ground for the electricity by making himself more conductive somehow … like sweating profusely) then there would be a path for electrons to flow, and he would be in danger .

17) You have a series circuit with a 9 V battery, a 1.5 Ω resistor, and a 0.5 Ω bulb. How much power does the bulb consume? How much power does the resistor consume?

To solve this: because this is a series circuit, the current will be equal everywhere. Once you know the current, you can find the voltage drop for each device on the circuit. Once you know the voltage drop for each device and the current, you can calculate the power used by the device.

$$Current\ in\ circuit = \frac{voltage\ of\ circuit}{total\ resistance\ of\ devices\ in\ circuit} = \frac{9\ V}{2.0\ \Omega} = 4.5\ A$$

Voltage drop for each device:

$$V_{bulb} = IR_{bulb} = 4.5\ A \times 0.5\ \Omega = 2.25\ V$$

$$V_{resistor} = IR_{resistor} = 4.5\ A \times 1.5\ \Omega = 6.75\ V$$

Power for each device:

$$Power_{bulb} = IV_{bulb} = 4.5\ A \times 2.25\ V = 10.13\ W$$

$$Power_{resistor} = IV_{resistor} = 4.5\ A \times 6.75\ V = 30.38\ W$$

18) Explain why we can ignore the resistance of wires when doing calculations for circuits, but we have to be aware of the resistance in real life, where electrical fires are a concern.

The resistance of the wires is low compared to other devices on the circuit, so when doing calculations with resistances, and rounding to reasonable values, the impact of the resistance of the wires is negligible. However, when we think about current, $I = \frac{V}{R}$*, so as the resistance becomes smaller, the current increases. If the value of the resistance is near zero, then the current suddenly is VERY large, and could be greater than the current capacity of the wire. As long as other devices are attached to the branch, then the current stays lower because the resistance of the device is high. In real life, we have to guess that sometimes, the device will be taken out of the circuit (a short circuit may be created), which would spike the current, potentially setting the wires on fire.*

19) Why is it hard to create charge on a conductor (like a piece of copper) using friction?

Because the conductor carries charges easily, it will just move them around, and not "hold" on to any electrons that are moved over it. On an insulator, the charge deposited by friction cannot move easily, so it stays put on the insulator. On the conductor, it moves over to something else, so the charge does not stay on the conductor.

20) Using the circuit below, fill in the behavior (on/off) for each of the bulbs given the switch positions for switches A and B.

Switch A	**Switch B**	**Bulb A**	**Bulb B**	**Bulb C**
open	open	*off*	*off*	*off*
closed	open	*on*	*off*	*on*
open	closed	*off*	*on*	*on*
closed	closed	*on*	*on*	*on*

21) An air conditioner draws 1800 W of power when plugged into a 110 V power supply. If electricity is $0.15 per kWh, how much money will it cost to run it for 24 hours?

$P = 1800\ W = 1.8\ kW$ *We do not need the voltage information for this problem.*

$t = 24\ h$

$cost = \frac{\$0.15}{kWh}$

$$Energy\ used = P \times time$$

$$Energy = 1.8\ kW \times 24\ h = 43.2\ kWh$$

$$\frac{\$0.15}{kWh} \times 43.2\ kWh = \$6.48$$

22) An electric stove draws 3000 W of power. How much energy, in Joules, does it consume in 25 minutes (enough time to cook rice)? Express your answer in scientific notation.

$$P = 3000\ W = 3000 \frac{J}{s}$$

$$t = 25\ minutes = 1500\ s$$

$$Energy = Power \times time = 3000 \frac{J}{s} \times 1500\ s = 4.5 \times 10^6\ J$$

23) A normal incandescent light bulb consumes 60 W of power. A high-efficiency compact fluorescent bulb (CFL) uses 13 W. Each lasts about 10,000 hours before burning out.

a. If the cost of electricity is $0.15/kWh, how much money will you save over the lifetime of the bulb by using a CFL instead of an incandescent bulb?

$cost = \frac{\$0.15}{kWh}$

$life\ of\ bulb = 10000\ h$
$= 3.6 \times 10^7 s$

$P_{normal} = 60\ W = 60 \frac{J}{s}$

$P_{CFL} = 13\ W$

First, figure out how much energy is used over the lifetime of the bulbs.

$$E_{normal} = P_{normal} \times life\ of\ bulb$$

$$life\ of\ bulb = 10000\ h \times 3600 \frac{s}{h} = 3.6 \times 10^7 s$$

$$E_{normal} = 60 \frac{J}{s} \times (3.6 \times 10^7 s) = 2.16 \times 10^9 J$$

$$E_{CFL} = 13 \frac{J}{s} \times (3.6 \times 10^7 s) = 4.68 \times 10^8 J$$

Next, figure out how the cost of running each bulb over the lifetime of the bulb. We'll first have to convert the energy used by each bulb to kWh:

$$1\ kWh \times 1000 \frac{W}{kW} \times 3600 \frac{s}{h} \times \frac{1 \frac{J}{s}}{1\ W} = 3.6 \times 10^6 J$$

Continued on next page…

$$E_{normal} = 2.16 \times 10^9 J \times \frac{1\ kWh}{3.6 \times 10^6\ J} = 722.22\ kWh$$

$$cost_{normal} = \frac{\$0.15}{kWh} \times 722.22\ kWh = \$108.33$$

$$E_{CFL} = 4.68 \times 10^8 J \times \frac{1\ kWh}{3.6 \times 10^6\ J} = 130\ kWh$$

$$cost_{CFL} = \frac{\$0.15}{kWh} \times 130\ kWh = \$19.50$$

The savings realized will be the difference in money spent on energy between the bulbs:

$$cost_{normal} - cost_{CFL} = money\ saved$$

$$\$108.33 - 19.50 = \$88.83$$

b. A CFL bulb costs \$17.95, and an incandescent bulb costs \$0.47. Is the CFL worth the extra up-front cost?

Yes.

24) Object A has a charge of $3.5 \times 10^{-12} C$, and Object B has a charge of $-8.23 \times 10^{-8} C$. What is the magnitude of the force between them when they are $1.24 \times 10^{-5} m$ apart from each other?

$$F = \frac{kq_1q_2}{d^2}$$

Because we are looking for magnitude, we can ignore the signs.

$$F = \frac{\left(9 \times 10^9 \frac{Nm^2}{C^2}\right)(3.5 \times 10^{-12}\ C)(8.23 \times 10^{-8}\ C)}{(1.24 \times 10^{-5}\ m)^2}$$

$$F = \frac{2.59 \times 10^{-9}\ Nm^2}{1.54 \times 10^{-10}\ m^2} = 16.86\ N$$

25) Object A has a charge of $3.32 \times 10^{-3}\ C$. Object B (positively charged) is 7.3 mm away. The force between objects A and B is $6.16 \times 10^{4}\ N$. What is the charge of object B? Sig figs.

Through the magic of algebra, we can manipulate $F = \frac{kq_1q_2}{d^2}$ *to look like this:* $\frac{Fd^2}{kq_1} = q_2$.

$$\frac{(6.16 \times 10^{4}\ N)(0.0073\ m)^2}{\left(9 \times 10^{9} \frac{Nm^2}{C^2}\right)(3.32 \times 10^{-3}\ C)} = q_2$$

$$\frac{3.3\ Nm^2}{2.99 \times 10^{7} \frac{Nm^2}{C}} = q_2$$

$$1.1 \times 10^{-7}\ C = q_2$$

26) A hydrogen atom is approximately $1 \times 10^{-10} m$ in diameter (not radius). 1 Coulomb is equal to the charge of 6.24×10^{18} electrons (or protons). How much force exists between the proton and electron of the atom?

$$Charge\ of\ single\ proton = \frac{1}{6.24 \times 10^{18}} = 1.6 \times 10^{-19}\ C$$

$$F = \frac{kq_1q_2}{d^2} = \frac{\left(9 \times 10^{9} \frac{Nm^2}{C^2}\right)(1.6 \times 10^{-19}\ C)(-1.6 \times 10^{-19}\ C)}{(1 \times 10^{10}\ m)^2}$$

$$F = \frac{2.3 \times 10^{-28}\ Nm^2}{1 \times 10^{20}\ m^2} = 2.3 \times 10^{-48}\ N$$