Electricity and Circuits Test Review **Name:** _____

$$F_e = \frac{k \cdot q_1 \cdot q_2}{d^2} \qquad \Delta V = I \cdot R \qquad P = \frac{\Delta V^2}{R}$$

1. A student is experimenting with neutral objects: a balloon and their own hair. They rub the two together and the balloon becomes charged negatively and the hair becomes charged positively.
   a. What is the relationship between protons and electrons BEFORE the objects are rubbed together? # of protons = # of electrons
   b. What is the relationship between protons and electrons AFTER the objects are rubbed together?
      i. Balloon: # of protons < # of electrons; Hair: # of protons > # of electrons
   c. How did the balloon become charged? The balloon gained electrons

2. Define conductors and insulators and give examples.

	Conductors	**Insulators**
Definition	Allow electrons to flow freely through them	Does not allow electrons to flow freely though them
Examples	Metals such as copper, silver, iron, aluminum, zinc	Plastic, rubber, glass, styrofoam, paper, wood

3. Opposite charges ___attract_____, like charges _____repel_____.

4. Objects 1 and 2 attract each other with an electrostatic force of 27.0 units. If the charge of Object 1 is two-thirds the original value AND Object 2 is doubled AND the distance separating Objects 1 and 2 is tripled, then the new electrostatic force will be ____4___ units.

$F = \frac{k(\frac{2}{3}q_1)(2q_2)}{(3d)^2}$ $\frac{(\frac{2}{3})(2)}{9} \cdot 27 = 4$ units

5. A positively charged balloon is brought near to a neutral, metal bar. When it is held near, what does the charge distribution on the metal bar look like?

In this situation, the metal bar is _____.

Tap to select or deselect answers. Select all that apply.

- positively-charged
- negatively-charged
- polarized — one side negative + one side positive
- electrically neutral — equal # of protons + electrons

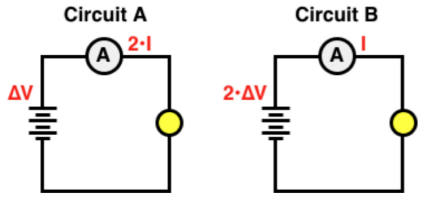
6. Describe, specifically how current is related to:
   a. Voltage: Direct (↑ voltage; ↑ current)
   b. Resistance: Inverse (↑ resistance; ↓ current)

7. What is the direction of electron flow? What is the direction of conventional current?
   Electrons flow from negative to positive terminal on a battery; conventional current flows from positive to negative terminal on a battery.

8. Describe how these factors will result in higher or lower resistance.

	Higher Resistance	Lower Resistance
Thickness of Wire	Thinner Wire	Thicker Wire
Length of Wire	Longer Wire	Shorter Wire
Material	Iron	Copper (better conductor)
Temperature	Higher Temperature	Lower Temperature

9. The current in Circuit A is two times the current in Circuit B. The battery of Circuit A has one-half the voltage of the battery in Circuit B. In which circuit will the bulb be the brightest? Show work to support your claim.



Circuit A: $P = V \cdot I = V(2 \cdot I) = 2VI$

Circuit B: $P = V \cdot I = (2V)(I) = 2VI$ → same!

10. An automobile headlight with a resistance of 30Ω is placed across a 12-V battery. What is the current in the circuit? (*Answer: 0.4A*)

$V = I R$ $12V = I(30\Omega)$ $I = \frac{12}{30} = \boxed{0.4A}$

11. A motor with an operating resistance of 32Ω is connected to a voltage source. The current in the circuit is 3.8A. What power is developed by the motor? (*Answer: 462.08W*)

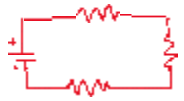
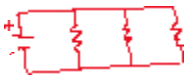
$P = I^2 \cdot R = (3.8)^2 \cdot (32) = 462.08\,W$

12. A 75-W lamp is connected to 120V. What is the resistance of the lamp? (*Answer: 192Ω*)

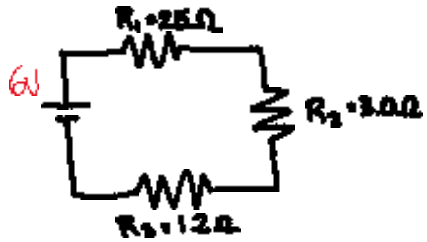
$P = \frac{V^2}{R}$ $\quad 75W = \frac{(120V)^2}{R}$ $\quad R = \frac{120^2}{75} = 192\,\Omega$

$V = IR$ $\quad P = VI = I^2R = \frac{V^2}{R}$ $\quad R_{Total} = R_1 + R_2 + R_3 + \ldots$ in series $\quad \frac{1}{R_{Total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$ in parallel

1. Fill in the following chart, organizing characteristics of series and parallel circuits:

	Series	**Parallel**
How it Looks	 all in a row, one path for current	 multiple paths for current
Voltage	$V_{total} = V_1 + V_2 + V_3$ voltage drop across each resistor / light bulb	$V_{total} = V_1 = V_2 = V_3$ Each resistor / lightbulb has same voltage
Current	$I_{total} = I_1 = I_2 = I_3$ current remains constant	$I_{total} = I_1 + I_2 + I_3 + \ldots$ current gets divided due to branches / multiple paths
Equivalent Resistance	$R_{eq} = R_1 + R_2 + R_3$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
Features	If one component goes out, all components go out.	If one component goes out, the other will remain on

2. A series circuit with three resistors with a total potential difference of 6V. Find the missing values and draw the direction of the current.



$R_{eq} = 2.5 + 3.0 + 1.2 = 6.7\,\Omega$

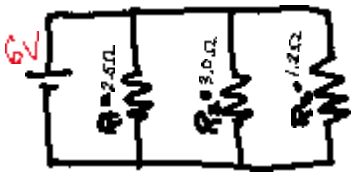
$\frac{6V}{6.7\Omega} = 0.896A$

Total Resistance: 6.7Ω
Total Current: 0.896A
Total Voltage: 6V

	Resistance (R)	Current (I) same	Voltage	Power = V·I
R_1	2.5Ω	0.896A	2.24V	2.0W
R_2	3.0Ω	0.896A	2.69V	2.4W
R_3	1.2Ω	0.896A	1.08V	0.97W

total = 5.37W

3. A parallel circuit with three resistors with a total potential difference of 6V. Find the missing values and draw the direction of the current.



$\frac{1}{R_{eq}} = \frac{1}{2.5} + \frac{1}{3.0} + \frac{1}{1.2}$ $\quad R_{eq} = 0.638\,\Omega$

Equivalent Total Resistance: 0.638Ω
Total Current: 9.4A
Total Voltage: 6V

$\frac{6V}{0.638} = 9.4A$

	Resistance (R)	Current (I)	Voltage same	Power = V·I
R_1	2.5Ω	2.4A	6V	14.4W
R_2	3.0Ω	2.0A	6V 6V	12.0W
R_3	1.2Ω	5.0A		30.0W

total ↓ 9.4A

56.4W total

4. Compare and contrast the circuits from #2 and #3. What was the same and what was different? What causes these differences?

Series the current remained constant, and the voltage got divided amongst the resistors. The resistors produced less power overall and if they were lightbulbs, they would be less bright compared to the ones in parallel.

Parallel the current was divided amongst the resistors due to the multiple paths but the voltage remained constant. The resistors produced more power overall and if they were lightbulbs, they would be brighter than the ones in series.

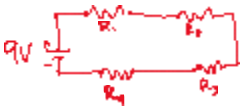
5. A wire with a total resistance of 60Ω is cut into 5 equal pieces. If these 5 pieces of wire are then arranged in parallel, what will the new total resistance be?

$\frac{60\Omega}{5} = 12\Omega$ ← resistance of each piece

$\frac{1}{R_{eq}} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12} + \frac{1}{12} + \frac{1}{12} = \frac{5}{12}$

$R_{eq} = \frac{12}{5} = 2.4\Omega$

6. A series circuit has 4 resistors with equal resistance and a total potential difference of 9V. Draw the circuit and determine the resistance of each resistor if the current is 0.31A.



$V = 9V$
$I = 0.31A$
$R_{eq} = ?$

$R_{eq} = \frac{9V}{0.31A} = 29.0\Omega$

$R_{eq} = R_1 + R_2 + R_3 + R_4$ ← all equal

$R_{eq} = 4x \quad 29 = 4x$

$x = 7.25\Omega$ each resistor

7. A parallel circuit has 3 resistors with equal resistance and a total potential difference of 4.5V. Draw the circuit and determine the resistance of each resistor if the current is 3.38A.

$V = 4.5V$
$I = 3.38A$
$R_{eq} = ?$

$R_{eq} = \frac{4.5V}{3.38A} = 1.33\Omega$

parallel

$\frac{1}{1.33} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{1.33} = \frac{3}{R}$

$R_1 = R_2 = R_3$

$x = 3.99\Omega$ each resistor