FLINN SCIENTIFIC

Name____

Magdeburg Hemispheres Worksheet

Data

Diameter of Magdeburg hemisphere: ______________

Force required to separate the hemispheres, Trial 1: _______________

Force required to separate the hemispheres, Trial 2: _______________

Force required to separate the hemispheres, Trial 3: _______________

Post-Lab Calculations and Questions

1. Calculate the average force required to separate the hemispheres.

2. Calculate the inside area bounded by the circumference of the Magdeburg hemispheres. *Hint:* The area of a circle is πr^2.

3. Calculate the pressure holding the Magdeburg hemispheres together just before they separate. Convert the pressure to pounds per square inch (psi).

4. Just before the Magdeburg hemispheres separate, what "occupies" the space inside the stretched hemispheres?

5. What causes the loud "pop" when the two hemispheres separate?

Pressure Paradox Worksheet

Observations

Apparent Weight of Foam Sphere versus Steel Sphere when held in palms

Apparent Weight of Foam Sphere versus Steel Sphere when hanging between thumb and index finger

Mass of Foam Sphere: ______________________

Mass of Steel Sphere: _______________________

Post-Lab Questions

1. Define pressure.

2. Which sphere has the greater mass? How does the actual mass compare to the sphere that appeared to weigh more while held in the palm of the hand? How does it compare to sphere that appeared to weigh more while held by the thumb and index finger?

3. Which ball has greater surface area contacting the palm of the hand?

4. When the spheres are held in the palm of the hand, what physical property is actually felt?

5. Is it better to compare the weight of two objects by holding them in the palms of your hand or by hanging the objects between your fingertips? Explain.

Boyle's Law Worksheet

Data

Barometric pressure: _______________

Trial 1				Trial 2			
Gauge Pressure	**Volume of Air in Syringe**	**Total Pressure**	$P \times V$	**Gauge Pressure**	**Volume of Air in Syringe**	**Total Pressure**	$P \times V$

Post-Lab Questions *(Answer on a separate sheet of paper.)*

1. Convert the local barometric pressure to psi units and enter the value to the nearest psi in the Data and Results Table. Some appropriate conversion factors are as follows: 1 atm = 760 mm Hg = 29.92 in Hg = 14.7 psi
2. The pressure gauge measures the relative pressure in psi above atmospheric pressure. For each pressure reading in the Data and Results Table, add the local barometric pressure to the gauge pressure to determine the total pressure of air inside the pressure bottle. Enter the total pressure to the nearest psi in the data table.
3. Plot a graph of volume on the *y*-axis versus total pressure on the *x*-axis. *Note:* The origin of the graph should be (0,0). Choose a suitable scale for each axis so that the data points fill the graph as completely as possible. Remember to label each axis and give the graph a title.
4. Describe the shape of the graph. Draw a best-fit straight or curved line, whichever seems appropriate, to illustrate how the volume of a gas changes as the pressure changes.
5. The relationship between pressure and volume is called an "inverse" relationship—as the pressure increases the volume of air trapped in the syringe decreases. This inverse relationship may be expressed mathematically as $P \propto 1/V$. Another way of expressing an inverse relationship between two variables is to say that the product of the two variables is a constant ($P \times V =$ constant). Multiply the total pressure (P) times the volume (V) for each set of data points. Enter the results in the data table.
6. How constant is the $P \times V$ "constant?" Explain any possible sources of error.

Pascal's Law Worksheet

Data Table 1

Syringe system	Plunger Pressed	Observations
3-mL/3-mL	3-mL	
3-mL/20-mL	3-mL	
	20-mL	
1-mL/20-mL	1-mL	
	20-mL	

Data Table 2

Syringe system	Syringe	Initial Distance (cm)	Final Distance (cm)	Net Plunger Movement (cm)
3-mL/3-mL	3-mL			
3-mL/20-mL	3-mL			
	20-mL			
1-mL/20-mL	1-mL			
	20-mL			

Post-Lab Questions (Answer on a separate sheet of paper.)

1. Review your observations. Was it easier to move the 20-mL plunger by pressing the 1-mL plunger, or to move the 1-mL plunger by pressing the 20-mL plunger? Which plunger has the larger surface area? Use Pascal's law to explain the result.
2. Use the measurements from the Data Table to determine the ideal mechanical advantage of the following syringe systems.

   Input: 1-mL, Output: 20-mL

   Input: 3-mL, Output: 20-mL

   Input: 3-mL, Output: 3-mL

   Input: 20-mL, Output: 3-mL

   Input: 20-mL, Output: 1-mL
3. Compare the mechanical advantage calculations from Question 2 to how hard or easy it was to move the respective input plunger. Is it better to have a mechanical advantage greater than one or less than one?
4. Refer to Figure 10. Who would Pascal predict as the winner in a "thumb wars" match between A and B? Why?

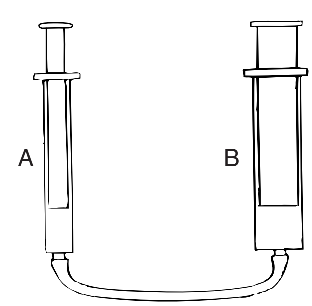

Figure 10.