Density Lab 2019 - Event Leader Instructions

Event Set up
There are 4 stations in this lab. Students should be given 10 minutes for each station.

Place the Station sheets at each location and allow space between them. Remind students to leave a station the way they found it. If a team gets to a station and something seems to be missing, they should immediately raise a hand to alert the event leader.

When completing the Lab part of the event, teams will be given everything they need except a pen or pencil.

Materials:
Station 1: Plastic Syringe, without needle. Miniature marshmallow, cup for garbage

Station 2: 4 unknown colored liquids in closed vials,
Yellow = baby oil
Green = distilled water
Blue = salt water - ~ 1 tsp of salt, the density needs to be very close to 1.07g/ml
Red = corn syrup
1 empty vial, 1 electronic scale, colored pencils - red, blue, green & yellow

Station 3: 1 small petri dish with various beans in it to match the picture – numbers of each bean are important
Yellow = 7
White = 6
Black = 6
Green = 5
Any density cube
Ruler

Station 4: none

Each team is allowed to bring:
Teams **must have** something to write with. The rules say that they need Z87+ impact glasses, but none of the labs we have in this event will require glasses, so it is okay if they don't have them and you can tell those that brought them that they do not need to wear them.
Teams may also bring: 1 3 ring binder of any size with pages in any form from any source. The pages must be attached to start the event but may be taken out once the event begins. They may also have 2 calculators (not cell phones) of any type.

Running the event
Teams have 10 minutes per station. Teams should leave station pages with the question side down until instructed to flip them over and begin. When each team is done at a station, they should flip the station page back over. Be sure to instruct teams which way to move and allow adequate time for transition between stations.

A copy of the official rules is on the back of this page in case you or the students have a question about the event that wasn't answered here.

Station 1

Materials
Plastic Syringe, without needle
Miniature marshmallow

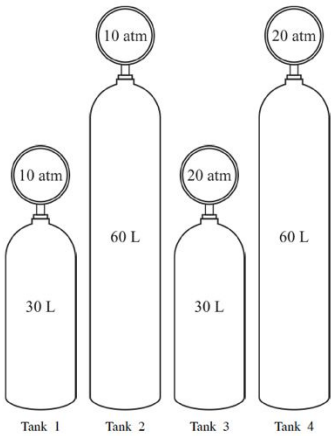
Procedure
1. Remove plunger from the syringe and insert the marshmallow into the syringe.
2. Place plunger back in syringe so the volume reading is approximately at the 10-mL mark.
3. Place your finger over the tip of the syringe.
4. Pull the plunger out to the 30ml mark.
5. Now remove your finger from the end.
6. When you are done, take the marshmallow out and put in the garbage cup at your station.

Describe what happens to the marshmallow. As I pull out the plunger, the marshmallow __1____. This is because the pressure in the syringe ____2_____. When I remove my finger from the end, the marshmallow __3___. This is because the pressure in the syringe ____4_____.

5. What law does this demonstrate?
6. I inflate my bike tire on a cool fall day to 36 psi. I then go on a 10-mile bike ride and stop to check the pressure again. It now says 39 psi. Why is this the case?
    a. The air molecules hit the walls of the tire less frequently
    b. The rubber in the tire reacts with the oxygen in the atmosphere and absorbs more air.
    c. The air molecules speed up and collide with the tire walls more often.
    d. The air molecules diffuse rapidly through the walls of the tire.

7. The volume of 500 mL of neon gas at 400mm Hg is decreased to 250 ml at a constant temperature. What is the new gas pressure?
    a. 200mm Hg
    b. 300mm Hg
    c. 400mm Hg
    d. 800mm Hg

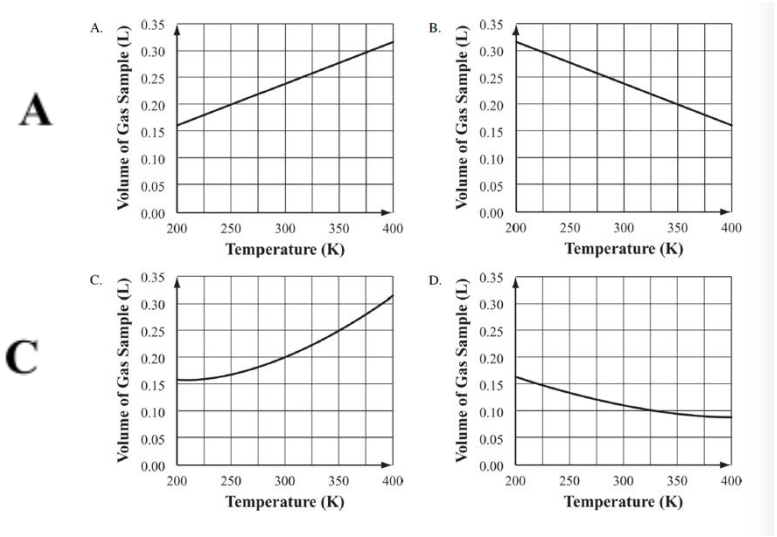
8. These four tanks in the diagram to the right contain compressed nitrogen gas. The temperature of each tank is the same. Which of the tanks has the MOST number of particles?
    a. Tank 1
    b. Tank 2
    c. Tank 3
    d. Tank 4



Station 1 – page 2

9. When a scuba diver is deep underwater and breathes out, air bubbles rise towards the surface. How do the bubbles deep underwater compare to bubbles near the surface?
    a. The number of molecules in the bubbles near the surface is greater and the diameter of the bubbles near the surface increases
    b. The number of molecules in the bubbles near the surface decreases and the diameter of the bubbles near the surface decreases
    c. The number of molecules in the bubbles near the surface remains the same and the diameter of the bubbles near the surface increases
    d. The number of molecules in the bubbles near the surface remains the same and the diameter of the bubbles near the surface decreases

10. Assuming pressure is held constant, which of the following graphs shows how the volume of an ideal changes with temperature?



11. A student has 90.0 g of Argon gas in a sealed 500.0 L container at 50.0^0C. What is the pressure of the gas in the container? The atomic mass of Argon is 39.95u. Remember significant figures.

12. Given 4.80 g of O_2 gas at 0^0 C and 1 atmosphere of pressure, calculate each of the following. The atomic mass of O is 16u.
    a. The number of moles of O_2
    b. The number of atoms of O_2

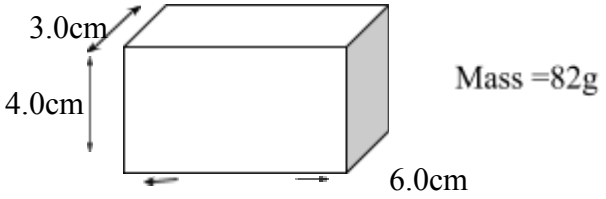
c. The volume of the O_2 gas

Station 2

Materials
4 unknown colored liquids in closed vials
1 empty vial
1 electronic scale
Colored Pencils - red, blue, green & yellow

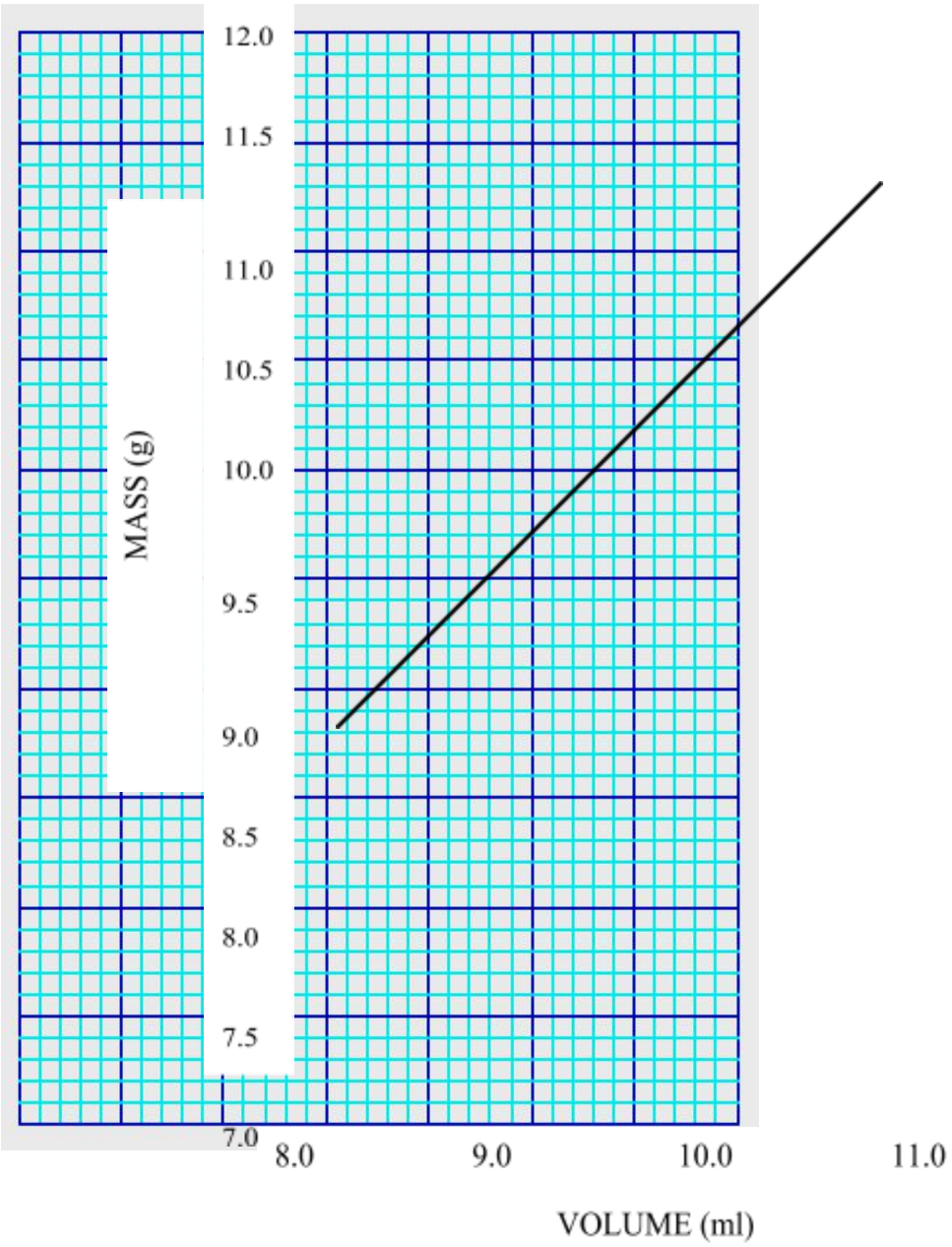
Procedure

1. Use the supplies at this station to find the mass of all the unknown liquids.
2. Knowing that there are 20.0 ml of each liquid in the vials, determine the densities of each liquid. Remember significant figures.
3. Color the graduated cylinder on your answer sheet to show how the liquids would appear if they were all poured into one cylinder.
4. Calculate the density of the wood block shown below. Remember significant figures.
5. Draw and label the block and color it black to indicate where it would be if dropped into the cylinder with the liquids.



Mass =82g

Station 2 – page 2



6. The line drawn on the graph above represents the density a particular liquid. What is the density of the line drawn on the graph?

7. Which one of the four liquids has a density closest to the density of the line drawn on the graph?

8. If the dots fall above the line, are the liquids more or less dense than the line drawn?

Station 3

Materials
1 small petri dish with various beans in it.
cube
Ruler

Procedure
Look at the petri dish at this station. Use the data in the table to help you answer questions 1 – 3.

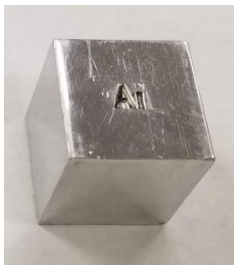
Bean	Picture	Mass of 1 bean (g)
A		0.14
B		0.28
C		0.14
D		0.22

1. Which bean has the highest mass density?
2. Which bean has the highest number density?
3. Imagine the beans are really molecules in a mixture. What is the mole percent of Bean C? There are a total of 24 beans in the dish. Show your work for full credit on this question.

In a solution, there is 130.0 mL (140.703 g) solvent and 6.24 mL (8.0609 g) solute present in a solution. Remember significant figures in your answers below.

4. Find the mass percent of the solute.
5. Find the volume percent of the solute.

6. This cube is pure Copper. It has a mass of 146.0g. The molar mass of Copper is 63.5460 g/mol. How many atoms of copper are in this block?



The density of aluminum is 2.7 g/cm^3.

7. Determine the mass of the aluminum cube. It has the same dimensions as the cube at this station.

Station 3 – page 2

This sheet of aluminum foil has a mass of 2.93g. It is 15 cm wide x 30.0 cm long.

8. What is the area density of the aluminum foil?

A standard roll of aluminum foil is 10.67m x 304mm.

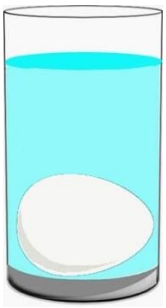
9. What is the mass of the entire roll of aluminum foil?

Remember that Volume = length x width x height and Volume = mass/density.

10. Knowing these equations, what is the thickness of this aluminum foil in cm?

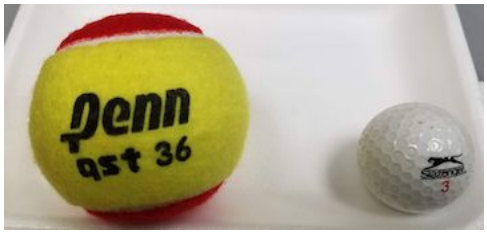
Station 4

1. This egg has a mass of 70g. If we weigh the water displaced, what will the mass be?
    a. The water will have a higher mass than the egg
    b. The water will have a lower mass than the egg
    c. The water will have the same mass as the egg
    d. The water will have half the mass of the egg



2. This boat is halfway underwater. If we weigh the water displaced and measure the water displaced, which of the following would be true?
    a. Half the mass of the boat and people will be displaced, and half the volume of the boat will be displaced
    b. The mass of the boat and people will be displaced, and the volume of the boat will be displaced
    c. The mass of the boat and people will be displaced, and half the volume of the boat will be displaced
    d. Half the mass of the boat and people will be displaced, and the volume of the boat will be displaced

3. Find the weight of the air in a room at sea level with dimensions of 10.0m x 8.0m x 2.0m. The weight density of air at sea level is 1.225 kg/m^3.



tennis ball golf ball

4. Which of these balls has the highest buoyancy force – the tennis ball or the golf ball?

Station 4 – page 1

5. Selina ties some helium balloons to her mailbox before her sister's birthday party in January. They are fully filled with no holes, but when she comes back an hour later, they look like this picture to the right. Which of the following is the best explanation of why this happened?

   a. The helium gas is more active in the winter season.
   b. Air outside the balloon leaks into the balloons.
   c. As the temperature decreases, the helium in the balloon contracts.
   d. Outdoor air pressure is more than the indoor air pressure at the store.

6. Scuba divers often carry tanks of compressed air in their cars from the dive shop to the water where they want to dive. They are always warned not to leave these tanks in a car with the windows up in the summer because the inside of the car can get very hot and heating the gas causes the pressure to increase, so the tanks could explode. Which statement below best explains why the pressure increases in the tank when the gas is heated?
   a. The gas molecules expand
   b. The gas molecules chemically react
   c. The gas molecules become electrically charged
   d. The gas molecules collide more often with the container

Below is a table showing the composition of the Earth's atmosphere.

Elements Name	Volume Percent (v/v)	ppm (v/v)
Nitrogen	78.084	780,840
Oxygen	20.946	209,460
Water Vapor	4.0%	40,000
Argon	0.934	9,340

7. Which of the following statements is true based on the data in this table?
   a. For 100 L of air, there are 78.084 L of Nitrogen
   b. For 100 grams of air molecules, there are 78.084 grams of Nitrogen
   c. For 1 L of air, there are 78.084g of Nitrogen
   d. For 100 moles of air molecules, there are 78.084 moles of Nitrogen

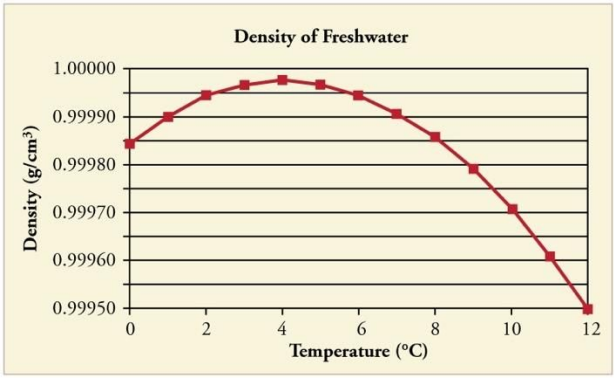
Station 4 – page 3

Sophia saw a TV show where they said they could make baby carrots float in water and she wanted to try at home. She put 150.0 ml of water in a glass and added a baby carrot. It settled to the bottom of the cup. She measured salt with an electronic scale and continued adding and stirring until the carrot did float in the water! She added 7.0 g of salt in total, which brought her final volume to 155 ml.

8. What is the Mass/Volume % of the salt in the solution?

9. A solution is prepared by dissolving 0.009 grams of sodium chloride, or NaCl, in water and then diluting it to a total volume of 1.0 liter. Calculate the parts per billion of NaCl in this solution.

10. Look at the graph to the right. At when temperature is freshwater the densest?



Source
https://courses.lumenlearning.com/physics/chapter/13-2-thermal-expansion-of-solids-and-liquids/

11. A 100. cm^3 lead block weighs 11N. It is carefully submerged in a container of mercury. One cm^3 of mercury weighs 0.13 N.

    a. What volume of mercury is displaced?
    b. What is the buoyant force on the lead?
    c. Will the lead block sink or float in the mercury?

ANSWER SHEET
2019 Regional Science Olympiad – Density Lab

Team Member(s)/Student(s):

_____

School:

_____

Reminders to student participant(s):

1.) Write your school's name and participant(s) names on each page of answer sheet.

2.) Turn off cell phones and other mobile devices.

** for scorer use only **	
Points for Station 1	
Points for Station 2	
Points for Station 3	
Points for Staton 4	
PRELIM SCORE (prior to any tie breaks)	
Tie break (if necessary during final scoring)	
FINAL SCORE	

Breaking ties:
number of points per page, in reverse order (1st tie break = nPoints on station 4, 2nd = nPoints on Station 3, etc.)

Reminder to scorers:

have a second scorer double-check the counts and sums!

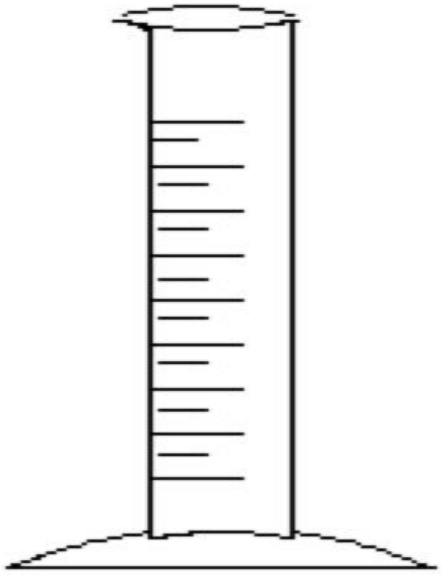
You can use the back of this sheet as scratch paper if needed, but only the math in the answer boxes will be graded. Please clearly mark your answer in the box!

Station 1			
#1 (1 pt)	EXPANDS or CONTRACTS	**#6 (1 pt)**	
#2 (1 pt)	INCREASES or DECREASES	**#7 (1 pt)**	
#3 (1 pt)	EXPANDS or CONTRACTS	**#8 (1 pt)**	
#4 (1 pt)	INCREASES or DECREASES	**#9 (1 pt)**	
#5 (1 pt)		**#10 (1 pt)**	

#11 (3pts)	
#12a (2 pts)	
#12b (2 pts)	
#12c (2 pts)	

Station 2

Liquid Color	#1 Mass (1pt each)	#2 Density g/ml (2 pts each)
Blue		
Green		
Red		
Yellow		
Wood Block	**82 g**	**#4 Density in g/cm^3:**

#3 & #5 **1 pt for each correct liquid, 2 pts for correct block placement**	 **Each long line on this graduated cylinder is 10 ml**

#6 (2pts)	
#7 (1pt)	
#8 (1pt)	

Station 3

#1 (1pt)	
#2 (1pt)	
#3 (2pts)	
#4 (2pts)	
#5 (2pt)	
#6 (2pt)	
#7 (2pt)	
#8 (2pt)	
#9 (3pt)	
#10 (2pt)	

Station 4	
#1 (1pt)	
#2 (1pt)	

#3 (2pts)			
#4 (1pt)			
#5 (1pt)			
#6 (1pt)			
#7 (1pt)			
#8 (2pt)			
#9 (2pt)			
#10 (2pt)			
#11 a (2pt)	**#11 b (2pt)**	**#11 c (2pt)**	