

ANSWER KEY**Part I: Written Task**

1. A
2. B
3. C
4. D
5. D
6. B
7. B
8. D
9. D
10. D
11. C
12. D
13. D
14. C
15. E
16. B
17. A
18. C
19. C
20. D
21. T
22. F
23. F
24. F
25. T
26. F
27. T
28. Ideal
29. Real

30. Real
31. $38.64\text{g} = 39\text{g}$
32. $5.92\text{ L} = 5.9\text{L}$
33. $B > C > A > D$
34. 2.93L
35. a. 99.5% submerged b. 96.9% submerged

Part I: Hands-on Task

36. Acceptable Range = $15.63 - 16.58\text{ cm}^3$
37. Acceptable Range = $19.43 - 19.53\text{ g}$
38. Acceptable Range = $1.17-1.24\text{ g/cm}^3$
39. Acceptable Range = $15.63 - 16.58\text{ cm}^3$
40. Acceptable Range = $44.3 - 44.6\text{ g}$
41. Acceptable Range = $2.7-2.9\text{ g/cm}^3$
42. Acceptable Range = $15.63 - 16.58\text{ cm}^3$
43. Acceptable Range = $143.3-143.5\text{ g}$
44. Acceptable Range = $8.66-9.2\text{ g/cm}^3$
45. Acceptable Range = $2.120 - 2.125\text{ cm}$
46. Acceptable Range = $4.90 - 5.00\text{ g}$
47. Acceptable Range = $.180 - .190\text{ cm}$
48. Acceptable range = $7.11 - 8.08\text{ g/cm}^3$

Part I: Written Task (70 points)

Please write your answers on the provided answer sheet, NOT HERE.

Multiple Choice: 2 points each (40 points total).

- Which of the following is **not** a unit for mass?
 - Liter
 - Kilogram
 - Pound
 - Milligram
- Which of the following is **not** a correct unit for density?
 - g/mL
 - mg/kg
 - kg/L
 - g/cm³
- Which of the following equations is correct for density?
 - Density = Mass/Area
 - Density = Volume/Mass
 - Density = Mass/Volume
 - Density = Mass/Temperature
- Which of the following equations is correct for the ideal gas law?
 - $P/V = nRm$
 - $VT = nRP$
 - $P/V = nRT$
 - $PV = nRT$
- Which of the following is the correct volume of one mole of gas at STP?
 - 24.4 L
 - 2.44 L
 - 2.24 L
 - 22.4 L
- Which gas law explains the relationship between the amount and volume of a gas at STP?
 - Boyle's Law
 - Avogadro's Law
 - Charles' Law
 - Archimedes Principle
- What is the mass of 53 mL of ethyl alcohol, which has a density of 0.79 g/mL?
 - 53 g
 - 42 g
 - 41.9 g
 - 41.8 g
- A doctor's order is for 0.125 g of ampicillin. The liquid suspension on hand contains 250 mg/5.0 mL. How many milliliters of the suspension are required?
 - 1 mL
 - 10 mL
 - 0.0025 mL
 - 2.5 mL
- What is the metric relationship between grams and nanograms?
 - 1 g = 100,000 nanograms
 - 1 g = 1000,000 nanograms
 - 1 g = 10,000,000 nanograms
 - 1 g = 1000,000,000 nanograms
- A sample of carbon dioxide occupies 225.0 mL at 777 mm Hg. What is the volume when the pressure drops to 555 mm Hg?
 - 161 mL
 - 1916 mL
 - 0.62 L
 - 315 mL
- If the pressure of a gas is held constant, what happens to the temperature of the gas as its volume increases?
 - Decreases
 - Does not change
 - Increases
 - Not enough information to determine
- Copper is more dense than wood. If you have 10 kg samples of copper and wood, which is smaller?
 - Both are the same size
 - Not enough information to determine
 - Wood
 - Copper

Density Lab B

States 2018

13. A rubber stopper sinks in water, but floats in methylene chloride. Place these three substances in order from least density to greatest density.
- Water < methylene chloride < rubber stopper
 - Methylene chloride < rubber stopper < water
 - Rubber stopper < water < methylene chloride
 - Water < rubber stopper < methylene chloride
14. A sample of argon gas is sealed in a container. The volume of the container is doubled. If the pressure remains constant, what happens to the absolute temperature?
- It does not change.
 - It is halved.
 - It is doubled.
 - It is squared.
 - It cannot be predicted.
15. A sealed, rigid container is filled with three ideal gases: A, B, and C. The partial pressure of each gas is known. The temperature and volume of the system are known. What additional information is needed to determine the masses of the gases in the container?
- the average distance traveled between molecular collisions
 - the intermolecular forces
 - the volume of the gas molecules
 - the total pressure
 - the molar masses of the gases
16. Two balloons are at the same temperature and pressure. One contains 14 g of nitrogen and the other contains 20.0 g of argon. Pick the **false** statement from the following list.
- The density of the nitrogen sample is less than the density of the argon sample.
 - The average speed of the nitrogen molecules is the same as the average speed of the argon molecules.
 - The average kinetic energy of the nitrogen molecules is the same as the average kinetic energy of the argon molecules.
 - The volume of the nitrogen container is the same as the volume of the argon container.
 - The number of molecules in the nitrogen container is the same as the number of atoms in the argon container.
17. An experiment to determine the molecular mass of a gas begins by heating a solid to produce a gaseous product. The gas passes through a tube and displaces water in an inverted, water-filled bottle. Which of the following necessary items may be determined after the experiment is completed?
- vapor pressure of water
 - temperature of the displaced water
 - barometric pressure in the room
 - mass of the solid used
 - volume of the displaced water
18. The true volume of a particular real gas is larger than that calculated from the ideal gas equation. This occurs because the ideal gas equation does NOT correct for:
- the attraction between the molecules
 - the shape of the molecules
 - the volume of the molecules
 - the mass of the molecules
 - the speed the molecules are moving
19. Aluminum metal reacts with HCl to produce aluminum chloride and hydrogen gas. How many grams of aluminum metal must be added to an excess of HCl to produce 33.6 L of hydrogen gas, if the gas is at STP?
- 18.0 g
 - 35.0 g
 - 27.0 g
 - 4.50 g
 - 9.00 g
20. A reaction produces a gaseous mixture of carbon dioxide, carbon monoxide, and water vapor. After one reaction, the mixture was analyzed and found to contain 0.60 mol of carbon dioxide, 0.30 mol of carbon monoxide, and 0.10 mol of water vapor. If the total pressure of the mixture was 0.80 atm, what was the partial pressure of the carbon monoxide?
- 0.080 atm
 - 0.34 atm
 - 0.13 atm
 - 0.24 atm
 - 0.48 atm

True-False: 1 point each (7 points total).

21. Charles's Law can be used to explain the relationship between temperature and volume of a gas.
22. A gas at lower temperature has a lower density.
23. One atmosphere is approximately equal to 138000 Pa.
24. Any object made from metal will sink in water.
25. Buoyancy is an upward force exerted by a fluid that opposes the weight of an immersed object.
26. If two objects have the same mass but different volumes, the larger volume item has twice the density.
27. According to Boyle's law, the volume is proportional to the inverse pressure.

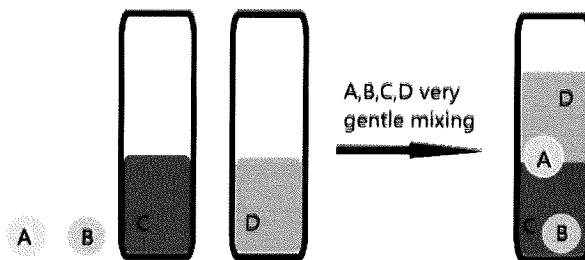
Real-Ideal: 1 point each (3 points total).

- 28-30. Is the substance being described showing real gas or ideal gas behavior. Simply write the word "real" or "ideal" in the space on your answer sheet.
28. There are not attractions between carbon monoxide molecules at 25°C.
29. Oxygen gas just before it liquefies at -196 °C.
30. Ammonia (NH₃ gas) at room temperature.

Short Ans: 5 points each (25 points total)

Remember to round answers to the correct number of significant figures.

31. What is the mass of a 2.0 cm³ piece of gold? The density of gold is 19.32 g/cm³.
32. A sample of gas occupies a volume of 11.1 L at 1.23 atm and 0.0 °C. What volume does the sample of gas occupy at 3.15 atm and 100.0 °C?
33. Use this figure to complete the task. Two objects (A and B), and two liquids (C and D) are mixed very gently in a third tube. Arrange them (A-D) in order of density, from highest to lowest.



34. A spherical ball of density $\rho = 0.70 \frac{\text{kg}}{\text{L}}$ has a radius of $r = 10 \text{ cm}$. If the ball is placed on the surface of water and released, how much of the ball becomes submerged in water?
35. If a person's body has a density of 995 kg/m³, what percentage of the body will be submerged when floating gently in (a) freshwater? (b) salt water with a density of 1027 kg/m³?

Part II: Hands-on Tasks (25 points)

Please write your answers on the provided answer sheet, NOT HERE.

The event supervisor (ES) will have all teams to go to the hands-on station (only 1) during the event. Do NOT go to the station until you are told to by the ES. At the hands-on station you will find 3 blocks (one labeled D, one labeled Al, and one labeled Cu) and a nickel. Please complete the table for each item. Volume, Mass, Diameter, and Thickness measurements are 1 point each. Density answers for cubes are worth 2 points each and the density for the nickel is worth 10 points.

ONLY DO THE MEASUREMENTS AT THE STATION. MEASUREMENTS ARE #s 36, 37, 39, 40, 42, 43, 45, 46, and 47. Do these quickly and then return to your seat. You will do Density Calculations BACK AT YOUR SEAT.

Sample	Volume (cm ³)	Mass (g)	Density (g/cm ³)
Cube D	36.	37.	38.
Cube Al	39.	40.	41.
Cube Cu	42.	43.	44.
Sample	Diameter (cm)	Mass (g)	Thickness (cm)
Nickel	45.	46.	47.

48. What is the density of the Nickel?