## Chapter 5 Questions

## Sections 5.1 \& 5.2

1) How does a gas differ from a liquid with respect to the following properties?
a) density
b) compressibility
c) ability to mix with other substances of the same phase to form solutions

2a) Both a liquid and a gas are moved to larger containers. How does their behavior differ? Explain the difference in molecular terms. b) The densities of gases are generally reported in units of $\mathrm{g} / \mathrm{L}$, whereas those for liquids are reported as $\mathrm{g} / \mathrm{mL}$. Explain the molecular basis for this difference.
3) The typical atmospheric pressure on top of Mt. Everest ( $29,028 \mathrm{ft}$ ) is about 265 torr, Convert this pressure to
a) atm
c) pascals
b) mm Hg
d) psi
4) In the Unites States, barometric pressure is measured in inches of Hg (in Hg ). On a beautiful summer day, the barometric pressure is 30.45 in Hg .
a) Convert the pressure to torr.
b) A meteorologist explains that the beautiful weather is due to a "high pressure area". Explain why the term makes sense.
5) Assume you have a cylinder with a movable piston. By what factor would the gas pressure inside the cylinder change by if you
a) decrease the volume by one third while holding the temperature constant.
b) double the Kelvin temperature while holding the volume constant.
c) reduce the amount of gas to half while
keeping the volume and temperature constant.

## Section 5.3

9) Calculate each of the following quantities for an ideal gas:
a) the volume of the gas, in liters, if 1.57 mol has a pressure of 0.860 atm and a temperature of $-12^{\circ} \mathrm{C}$.
b) the absolute temperature of the gas at which $6.79 \times 10^{-2} \mathrm{~mol}$ occupies 164 mL at
693 torr.
c) the pressure, in atm, if $8.25 \times 10^{-2} \mathrm{~mol}$ occupies 255 mL at $15^{\circ} \mathrm{C}$.
d) the volume of 28.0 g of nitrogen dioxide at 280 K and 13.2 psi .
10) A fixed quantity of gas at $23^{\circ} \mathrm{C}$ exhibits a pressure of 748 torr and occupies a volume of 10.3 L.
a) Calculate the volume of the gas will occupy at 23 ${ }^{\circ} \mathrm{C}$ and 1.55 atm .
b) Calculate the volume of the gas if the temperature increase to at $145{ }^{\circ} \mathrm{C}$ with a constant pressure.
c) What is the new volume of the gas at $65^{\circ} \mathrm{C}$ and
3.21 atm ?
d) Determine the pressure of the gas if the volume were squeezed down to $3.4 L$ at constant temperature.
e) At what temperature would you the gas need to be in order to keep the pressure constant, but change the volume to 15.6 L ?
f) If the pressure were changed to 374 mm Hg and the temperature dropped to 148 K , what would be the volume of the gas?
11) A sample of gas occupies a volume of 7.50 L at 0.988 atm and $28.0^{\circ} \mathrm{C}$.
a) Calculate the pressure of the gas if its volume is decreased to 4.89 L at constant temperature.
b) At what temperature in Celsius is the volume of the gas 4.00 L and the pressure of the gas 0.750 atm?
c) If only the gas temperature were changed to 200 $K$, what would the pressure be?
d) If the temperature were doubled, what volume would be needed to keep the pressure the same?

8a) How is the law of combining volumes explained by Avogadro's hypothesis?
b) Consider a 1.0 L flask containing neon gas and 1.5 L flask containing xenon gas. Both gases have the same pressure and temperature. What can be said about the ratio of number of atoms in the two flasks?
e) the mass of Ar gas in a 56.2 L tank at STP. f) the mass of carbon tetrachloride gas in a 16.9 L tank at $300^{\circ} \mathrm{C}$ and 22.6 psi .
g) the pressure of 64.6 g of chlorine gas in a 19.4 L tank at 172 K .
h) the quantity of gas, in moles, if 5.49 L at
$35^{\circ} \mathrm{C}$ has a pressure of 11.25 kPa
10) The Hindenberg was a famous hydrogen filled dirigible that exploded in 1937. If the Hindenberg held $2.0 \times 10^{5} \mathrm{~m}^{3}$ of hydrogen gas at $23^{\circ} \mathrm{C}$ and 1.0 atm, what mass of hydrogen was present?
11) Calculate the number of molecules in a deep breath of air whose volume is 2.55 L at body temperature ( $37{ }^{\circ} \mathrm{C}$ ) and a pressure of 740. torr,
12) If the partial pressure of ozone $\left(\mathrm{O}_{3}\right)$ in the stratosphere is $3.0 \times 10^{-3} \mathrm{~atm}$ and the temperature is 250 K, how many ozone molecules are in a liter?

## Section 5.4

15) Which gas is most dense at 1.00 atm and 298 K?
a) $\mathrm{CO}_{2}, \mathrm{~N}_{2} \mathrm{O}$ or $\mathrm{Cl}_{2}$. Explain.
b) $\mathrm{SO}_{3}, \mathrm{HF}$, or CO . Explain.

16a) Calculate the density of $\mathrm{NO}_{2}$ gas at 0.970 atm and $35^{\circ} \mathrm{C}$.
b) Calculate the molar mass of a gas if 2.50 g occupies 0.875 L at 685 torr and $35^{\circ} \mathrm{C}$.
17) From the following data, calculate the molar mass of the unknown vapor: mass of vapor = 1.012 g , volume of gas $=354 \mathrm{~cm}^{3}$, pressure $=$ 742 torr, temperature $=99^{\circ} \mathrm{C}$.
187) Magnesium can be used as a "getter" in evacuated enclosures, to react with the last traces of oxygen. If an enclosure of 0.382 L has a partial pressure of $\mathrm{O}_{2}$ of $3.5 \times 10^{-6}$ torr at 27 ${ }^{\circ} \mathrm{C}$, what mass of magnesium will react according to the following reaction?
$2 \mathrm{Mg}(\mathrm{s})+\mathrm{O}_{2}(\mathrm{~g})$--> $2 \mathrm{MgO}(\mathrm{s})$

## Section 5.5

22) Consider a mixture of two gases, $A$ and $B$, confined to a closed vessel. A quantity of a third gas, C , is added to the same vessel at the same temperature. How does the addition of gas C affect the following:
a) the partial pressure of gas A
b) the total pressure of the vessel
c) he mole fraction of gas B
23) A mixture containing 2.50 g each of $\mathrm{CH}_{4}(\mathrm{~g})$, $\mathrm{C}_{2} \mathrm{H}_{4}(\mathrm{~g})$ and $\mathrm{C}_{4} \mathrm{H}_{10}(\mathrm{~g})$ is contained in a 1.50 L flask at a temperature of $15^{\circ} \mathrm{C}$.
a) Calculate the partial pressure of each of the gases in the mixture.
b) Calculate the total pressure of the mixture.
24) A scuba diver's tank contains 0.29 kg of $\mathrm{O}_{2}$ compressed to a volume of 2.30 L ,
a) Calculate the gas pressure inside the tank at $9^{\circ} \mathrm{C}$.
b) What volume would this oxygen occupy at $26^{\circ} \mathrm{C}$ and 0.95 atm?
25) A 250 mL aerosol spray can contains 2.30 g of propane $\left(\mathrm{C}_{3} \mathrm{H}_{8}\right)$ as a propellant. If the can is at 296 $K$, what is the pressure in the can?
26) Calcium hydride reacts with water to form hydrogen gas:
$\mathrm{CaH}_{2}(\mathrm{~s})+2 \mathrm{H}_{2} \mathrm{O}(\mathrm{l})-->\mathrm{Ca}(\mathrm{OH})_{2}(\mathrm{aq})+2 \mathrm{H}_{2}(\mathrm{~g})$ How many grams of $\mathrm{CaH}_{2}$ are needed to generate $10.0 \mathrm{~L}^{2}$ of $\mathrm{H}_{2}$ gas if the pressure is 740 . torr at $23^{\circ} \mathrm{C}$ ?
27) The metabolism of glucose in bodies produces $\mathrm{CO}_{2}$ which is expelled from our lungs as a gas:
$\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}(\mathrm{aq})+6 \mathrm{O}_{2}(\mathrm{~g})-->6 \mathrm{CO}_{2}(\mathrm{~g})+6 \mathrm{H}_{2} \mathrm{O}(\mathrm{l})$ Calculate the volume of dry $\mathrm{CO}_{2}$ produced at body temperature $\left(37^{\circ} \mathrm{C}\right)$ and 0.985 atm when 4.00 g of glucose is consumed.
28) The primary ingredient in gasoline is octane $\left(\mathrm{C}_{8} \mathrm{H}_{18}\right)$. When 1 gallon of gasoline is burned, 2.92 kg of octane is consumed in a combustion reaction. At 22 OC and 0.95 atm ,
a) How many liters of oxygen are used to burn the octane?
b) How many liters and grams of carbon dioxide are produced?
29) A mixture of gases contains $0.75 \mathrm{~mol} \mathrm{~N}_{2}, 0.30$ $\mathrm{mol} \mathrm{O}_{2}$ and 0.15 mol CO . If the total pressure of the mixture is 1.56 atm , what is the partial pressure each component?
30) A 5.50 g piece of dry ice, solid carbon dioxide, is placed in a 10.0 L vessel that already contains air at 705 torr and 297 K . After the carbon dioxide has vaporized into the vessel, what will be the partial pressure of the carbon dioxide and the total pressure in the vessel?
31) At a certain temperature, a mixture of gases has a total pressure of 890 torr. The mixture is $75 \%$ nitrogen, 19\% oxygen and 6\% argon by mass. What are the partial pressures of the individual gases?

## Sections 5.6 \& 5.7

27) What change or changes in the state of a gas bring about the following effects?
a) The number of impacts per unit time on a given container wall increases.
b) The average energy of impact of molecules with the wall of the container decreases.
c) The average distance between the molecules increases.
d) The average speed of molecules in the gas mixture is increased.
28) Suppose you have two 1.00 L flasks, one containing $\mathrm{N}_{2}$ at STP and the other containing $\mathrm{CH}_{4}$ at STP. How do these systems compare with respect to
a) number of molecules
b) density
c) average kinetic energy of the molecules
d) rate of effusion through a pinhole leak

## Review

1) Write net ionic equations for the following reactions:
a) The combustion of butane $\left(\mathrm{C}_{4} \mathrm{H}_{10}\right)$
b) the synthesis of aluminum chloride
c) the neutralization of solid calcium hydroxide with a solution of perchloric acid
d) oxidation of iron by aqueous copper (II) chloride
e) decomposition of liquid water
2) A big firework has 30.0 g of magnesium. As the magnesium burns in oxygen, it forms a compound. How much of the compound is created during the explosion and subsequent burning?
3) Ethlyene glycol is used as antifreeze in automobiles. It contains $38.7 \% \mathrm{C}, 9.7 \% \mathrm{H}$ and $51.6 \%$ O. The molar mass is $62.1 \mathrm{~g} / \mathrm{mol}$. What is the molecular formula of ethylene glycol?

29a) Place the following gases in order of increasing average molecular speed at 300 K : $\mathrm{CO}_{2}, \mathrm{~N}_{2} \mathrm{O}, \mathrm{HF}, \mathrm{F}_{2}, \mathrm{H}_{2}$
b) Calculate and compare the rms speeds of $\mathrm{H}_{2}$ and $\mathrm{CO}_{2}$ at 300 K .
30) The temperature of a 5.00 L container of $\mathrm{N}_{2}$ is increased from $20^{\circ} \mathrm{C}$ to $250^{\circ} \mathrm{C}$. Predict the temperature change on the following properties: a) average kinetic energy of the particles
b) rms speed
c) force of impact of molecules with the walls of the container
d) number of particles in the container
e) total number of collisions with the wall per second
f) effusion of the gas through a hole
4) The following data is found for the isotopes of an element:

| Mass (amu) | Abundance (\%) |
| :--- | :--- |
| 105.91 | 1.25 |
| 107.90 | 0.89 |
| 109.90 | 12.49 |
| 110.90 | 12.80 |
| 111.90 | 24.13 |
| 112.90 | 12.22 |
| 113.90 | 28.73 |
| 115.90 | 7.49 |

Determine the identity of the element.
5) A 2.00 gram strip of zinc is placed in 100 mL of $0.15 \mathrm{M} \mathrm{AgNO}_{3}$ solution. How many grams of silver should form?

