Mixed Gas Laws Worksheet

1) How many moles of gas occupy 98 L at a pressure of 2.8 atmospheres and a temperature of 292 K?

$PV=nRT$

$(2.8\,atm)(98L) = n(0.0821)(292K)$

$n = 11\,mol$

2) If 5.0 moles of O_2 and 3.0 moles of N_2 are placed in a 30.0 L tank at a temperature of 25° C, what will the pressure of the resulting mixture of gases be?

$P_{O_2}(30.0) = (5.0)(0.0821)(298)$

$P_{O_2} = 4.1\,atm$

$P_{N_2}(30.0) = (3.0)(0.0821)(298)$

$P_{N_2} = 2.4\,atm$

$P_{O_2} + P_{N_2} = 6.5\,atm$

* could also add mo... find total pressure.

3) A balloon is filled with 35.0 L of helium in the morning when the temperature is 20.0° C. By noon the temperature has risen to 45.0° C. What is the new volume of the balloon?

$\frac{35.0L}{293K} = \frac{V_2}{318}$

$V_2 = 38.0L$

4) A 35 L tank of oxygen is at 315 K with an internal pressure of 190 atmospheres. How many moles of gas does the tank contain?

$(190)(35) = n(0.0821)(315)$

$n = 260\,mol$

5) A balloon that can hold 85 L of air is inflated with 3.5 moles of gas at a pressure of 1.0 atmosphere. What is the temperature in ^{0}C of the balloon?

$(1.0\text{atm})(85\text{L}) = (3.5\text{mol})(0.0821)\,T$

$T = 296\text{K} - 273 = \boxed{23^\circ\text{C}}$

6) $CaCO_3$ decomposes at 1200^0 C to form CO_2 gas and CaO. If 25 L of CO_2 are collected at 1200^0 C, what will the volume of this gas be after it cools to 25^0 C?

$\frac{25\text{L}}{1473\text{K}} = \frac{V_2}{298}$

$\boxed{V_2 = 5.1\text{L}}$

7) A helium balloon with an internal pressure of 1.00 atm and a volume of 4.50 L at 20.0^0 C is released. What volume will the balloon occupy at an altitude where the pressure is 0.600 atm and the temperature is -20.0^0 C?

$\frac{(1.00\text{atm})(4.50\text{L})}{293\text{K}} = \frac{(0.600)V}{253\text{K}}$

$\boxed{V = 6.48\text{L}}$

8) There are 135 L of gas in a container at a temperature of 260^0 C. If the gas was cooled until the volume decreased to 75 L, what would the temperature of the gas be?

$\frac{135\text{L}}{533\text{K}} = \frac{75\text{L}}{T_2}$

$T_2 = 296\text{K} - 273\text{K} = \boxed{23^\circ\text{C}}$

9) A 75 L container holds 62 moles of gas at a temperature of 215° C. What is the pressure in atmospheres inside the container?

$P(75L) = (62mol)(0.0821)(488K)$

$P = 33atm$

13)

10) 6.0 L of gas in a piston at a pressure of 1.0 atm are compressed until the volume is 3.5 L. What is the new pressure inside the piston?

$(1.0atm)(6.0L) = P_2(3.5L)$

$P_2 = 1.7atm$

11) A gas canister can tolerate internal pressures up to 210 atmospheres. If a 2.0 L canister holding 3.5 moles of gas is heated to 1350° C, will the canister explode?

$P(2.0L) = (3.5mol)(0.0821)(1623K)$

$P = 230atm$

yes, it will explode b/c the internal pressure of 230atm exceeds the capacity of the canister.

12) The initial volume of a gas at a pressure of 3.2 atm is 2.9 L. What will the volume be if the pressure is increased to 4.0 atm?

$(3.2atm)(2.9L) = (4.0atm)V_2$

$V_2 = 2.3atm$

13) An airtight container with a volume of 4.25×10^4 L, an internal pressure of 1.00 atm, and an internal temperature of 15.0^0 C is washed off the deck of a ship and sinks to a depth where the pressure is 175 atm and the temperature is 3.00^0 C. What will the volume of the gas inside be when the container breaks under the pressure at this depth?

$$\frac{(1.00\text{atm})(4.25\times10^4\text{L})}{288\text{K}} = \frac{(175\text{atm})V_2}{276\text{K}}$$

$$\boxed{V_2 = 233\text{L}}$$

14) Two flasks are connected with a stopcock. Flask #1 has a volume of 2.5 L and contains oxygen gas at a pressure of 0.70 atm. Flask #2 has a volume of 3.8 L and contains hydrogen gas at a pressure of 1.25 atm. When the stopcock between the two flasks is opened and the gases are allowed to mix, what will the resulting pressure of the gas mixture be?

Since the volume will increase the pressure of each will decrease.

O_2: $(0.70\text{atm})(2.5\text{L}) = (6.3\text{L})(P_2)$ $\quad H_2$: $(1.25\text{atm})(3.8\text{L}) = (6.3\text{L})P_2$

$P_{O_2} = 0.28\text{atm}$ $\quad P_{H_2} = 0.75\text{atm}$

$P_T = 0.28\text{atm} + 0.75\text{atm}$

$$\boxed{P_T = 1.0\text{atm}}$$

15) A weather balloon has a volume of 35 L at sea level (1.0 atm). After the balloon is released it rises to where the air pressure is 0.75 atm. What will the new volume of the weather balloon be?

$$(1.0\text{atm})(35\text{L}) = (0.75\text{atm})V_2$$

$$\boxed{V_2 = 47\text{L}}$$

Name _____ Period ____
Date _____

Gas Laws Review

1. Under what conditions do gases usually not show "ideal gas" behavior?

Low temp & High Pressure

when they are close together they have ~~strong~~ stronger attractive forces.

2. Convert 788 mm Hg to atm.

$$788\text{mm Hg} \left| \frac{1\text{atm}}{760\text{mm Hg}} \right. = \boxed{1.04\text{atm}}$$

3. Convert 135 K to degrees Celsius.

$135\text{K} - 273 =$

4. Calculate the mass of 1.00 L of carbon monoxide (CO) at STP.

$(1\text{atm})(1\text{L}) = n\,(0.0821)(273)$

$n = 0.0446\text{mol} \left| \frac{28.01\text{g}}{1\text{mol}} \right. = \boxed{1.25\text{g}}$

OR b/c @ STP

$1.00\text{L} \left| \frac{1\text{mol}}{22.4\text{L}} \right.$

0.0446mol

5. Calculate the pressure from 8.63 moles of O_2 at 85°C in a 2.38 L flask.

$P(2.38\text{L}) = (8.63\text{mol})(0.0821)(358\text{K})$

$P = 106\text{atm} \Rightarrow \boxed{110\text{atm}}$

6. A gas tank is initially at 2.5 atm. It is heated from 280 K to 340 K at constant volume. What is the new pressure?

$$\frac{2.5\text{atm}}{280\text{K}} = \frac{P_2}{340\text{K}} \qquad \boxed{P_2 = 3.0\text{ atm}}$$

7. A 12.0 L sample of nitrogen has a pressure of 540 kPa at 150 °C. The gas is compressed to 1.20 L and the temperature is lowered to 50 °C. What is the new pressure?

$$\frac{(540\text{kPa})(12.0\text{L})}{423\text{K}} = \frac{P_2(1.20\text{L})}{323\text{K}} \qquad \boxed{P_2 = 4100\text{kPa}}$$

8. Calculate the density of helium that is required to inflate a balloon to 4.0 L tank at 305 K and 2.5 atm?

$d = \frac{PM}{RT}$ $\quad \frac{4.00\text{g}}{\text{mol}}$

$$d = \frac{(2.5\text{atm})(4.00\text{g/mol})}{(0.0821)(305\text{K})}$$

$\boxed{d = 0.40\text{ g/L}}$

9. Compare the diffusion rates of helium and radon.

$$\frac{\text{Rate He}}{\text{Rate Rn}} = \sqrt{\frac{222}{4}}$$

He diffuses 7.4 times faster than Rn

10. A sample of ozone is collected over water at 27 °C and at a barometric pressure of 765 torr. What is the partial pressure of the ozone gas?

look up P_{H_2O} @ 27°C = 26.7 torr * will be given on test

$P_{atm} = P_g + P_{H_2O}$

$765\ torr = P_g + 26.7\ torr$

$P_g = 738.3\ torr$

11. Are volume and temperature inversely or directly related? Give a real life example.

directly – hot air balloon fills w/ gas when heated by the flame

12. A mixture of gases contains N_2, O_2, and CO_2. If the total pressure of the mixture is 10.0 atm and N_2 = 2.0 atm and O_2 = 3.5 atm, what is the partial pressure of CO_2?

$P_T = P_{N_2} + P_{O_2} + P_{CO_2}$

$10.0\ atm = 2.0\ atm + 3.5\ atm + P_{CO_2}$

$P_{CO_2} = 4.5\ atm$

13. If a sample contains 8 moles of H_2, 3 moles of O_2, and 2 moles of He in a 7 liter vessel at 19 °C, determine the partial pressure of each gas and the total pressure of the mixture in units of atm.

$P_{H_2}(7L) = 8(0.0821)(292)$

$P_{H_2} = 27.4\ atm$

$P_{O_2}(7L) = (3)(0.0821)(292)$

$P_{O_2} = 10\ atm$

$P_{He}(7L) = 2(0.0821)(292)$

$P_{He} = 6.85\ atm$

$P_T = 27.4\ atm + 6.85\ atm + 10\ atm$

$P_T = 44\ atm$

14. If a gas sample with a pressure of 86.2 kPa contains 53% methane gas, what is the partial pressure of methane?

$86.2\ (0.53) = 45.7\ kPa$

15. What are the five main parts of the Kinetic Molecular Theory?

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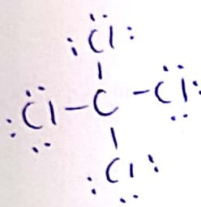
Intermolecular Forces Worksheet

Answers are on page 3 & 4. **Do the problems on your own BEFORE looking at the answers.**

1. Predict the molecular shape of each of the following:



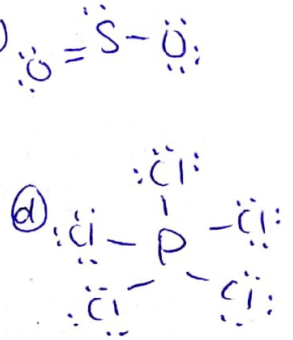
a. H_2S H–S–H bent

b. CCl_4 tetrahedral

c. SO_2 bent

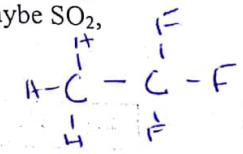
d. BrF linear :Br–F:

d. PCl_5 trigonal bipyramid



2. List **all** types of IMFs that would occur in each of the following (you should have a good enough understanding of electronegativities to answer all of these, except maybe SO_2, without look up the electronegativity numbers).

a. CH_3CF_3 dipole-dipole, LD

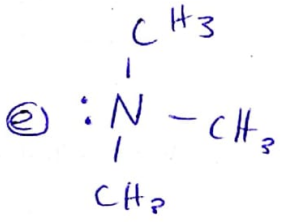


b. CCl_4 LD

c. SO_2 dipole-dipole, LD

d. BrF dipole-dipole, LD

e. $(CH_3)_3N$ dipole-dipole, LD



f. PCl_5 LD

3. H_2S, O_2 and CH_3OH all have comparable molecular masses. List the **dominant** type of IMF for the pure substances, then rank the strength of each compound based on IMFs within the samples.

(1 = strongest, 2 = in between, 3 = weakest).

Substance	IMF	Relative Strength
HBr	dipole-dipol	2
O_2	LD	3
CH_3OH	HB	1

4. Circle all of the species below that can form a hydrogen bond in its pure form. Explain why the other species couldn't hydrogen bond.

C_2H_6 CH_3NH_2 KCl $CH_3CH_2CH_2OH$ CH_3OCH_3

* H must be bonded to N, O, F to create HB*

5. Rank the following compounds from weakest intermolecular forces to strongest. Justify your answers.

H_2S	I_2	N_2	H_2O
DD	LD	LD	HB
LD	254 g/mol	28 g/mol	LD
			DD

1 4

N_2, I_2, H_2S, H_2O

6. Rank the following from weakest intermolecular forces to strongest. Justify your answers.

H_2Se	H_2S	H_2Po	H_2Te
(2)	(1)	(4)	(3)

Increase LD w/ increase in mass b/c larger objects have stronger attraction to each other

Q20. We see similar trends with other compounds.

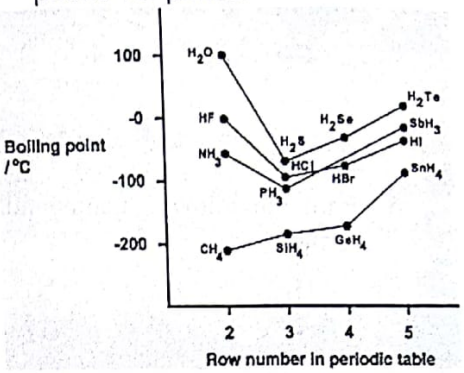
a) Which three compounds deviate from the linear relationship that seems to be present between bp and row number (in Graph 2)? H_2O, HF, NH_3

b) This indicates that the three compounds listed in part a have Stronger (stronger or weaker) intermolecular forces than expected.

c) Besides H, which other elements are in these three compounds? N, O, F

d) Complete the following:

Graph 2: Selected boiling points vs. period

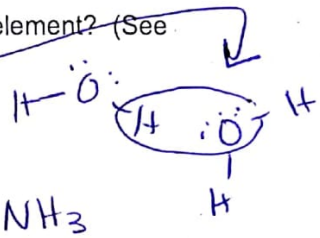


Compounds containing a hydrogen atom bonded to the elements N, O, and F form very strong intermolecular forces.

These forces are called hydrogen bonds.

e) Are hydrogen bonds the same as covalent bonds between H and another element? (See Table 1). no it's the attraction b/t molecules

If not, are hydrogen bonds stronger than covalent bonds? (See Table 1). no



Q21. Compare the boiling points of NH_3 and SbH_3 in Graph 2. $SbH_3 > NH_3$

a) Which is more polar, NH_3 or SbH_3? NH_3

b) Which can hydrogen bond, NH_3 or SbH_3? NH_3

c) Based on polarity and hydrogen bonding, which do you expect should have the stronger intermolecular forces? $H-B \rightarrow NH_3$

d) Which is shown in Graph 2 to have stronger intermolecular forces? SbH_3

e) Provide an explanation. the mass of Sb is so much greater than N

Exercises

This activity is based on sections 9.6 on non-covalent interactions (intermolecular forces). Refer to these sections for additional reading. I also recommend the in-chapter exercises and problem boxes in Sec. 9.6 (p. 409-418) and Questions for Review and Thought (Chapter 9: # 54-62 (bold).

Answer key to this activity will be posted online.