Fall 2020 Exam 2 Detailed Key

CHEMISTRY 102 Fall 2020
HOUR EXAM II

The substance with the weakest intermolecular forces (IMF) has the highest vapor pressure at some temperature. NH_3, H_2O, and HF have the relatively strong hydrogen bonding IMF, so they all would have a relatively low vapor

1. Which of the following compounds is expected to have the highest vapor pressure at some temperature, T? pressure. The nonpolar CH_4 and SiH_4 only

nonpolar nonpolar H-bond H-bond H-bonding
a) CH_4 b) SiH_4 c) NH_3 d) H_2O e) HF
LD only LD only

have London dispersion forces. Since CH_4 has lowest molar mass, it has

2. At STP, 1.0 L of $N_2(g)$ reacts completely with 3.0 L of $F_2(g)$ to produce 2.0 L of a product gas. What is the formula of the product? weakest IMF.

At constant T + P, Vαn. A chemical equation gives volume relationships as well as mol relationships at constant T+P. $1N_2 + 3F_2 \rightarrow 2N_xF_y$

a) NF_6 b) N_2F_6 c) N_2F_2
d) NF_3 e) N_2F_3

→ For a balanced equation, the product gas is NF_3.

3. In the early development of rockets, a common fuel mixture consisted of reacting hydrazine (N_2H_4) with dinitrogen tetroxide (N_2O_4), to produce a nitrogen gas and water vapor:

$$2\ N_2H_4(l) + N_2O_4(l) \rightarrow 3\ N_2(g) + 4\ H_2O(g)$$

If N_2H_4 is limiting: $100.0\text{ g } N_2H_4\left(\frac{1\text{ mol } N_2H_4}{32.05\text{ g}}\right)\left(\frac{3\text{ mol } N_2}{2\text{ mol } N_2H_4}\right)\left(\frac{28.02\text{ g } N_2}{1\text{ mol } N_2}\right) = 131.1\text{ g } N_2$

If N_2O_4 is limiting: $175.0\text{ g } N_2O_4\left(\frac{1\text{ mol } N_2O_4}{92.02\text{ g}}\right)\left(\frac{3\text{ mol } N_2}{1\text{ mol } N_2O_4}\right)\left(\frac{28.02\text{ g } N_2}{1\text{ mol } N_2}\right) = 159.9\text{ g } N_2$

If 100.0 g of N_2H_4 and 175.0 g of N_2O_4 are reacted by the above reaction, what mass of nitrogen can be produced? The molar masses of the reactants and products are: N_2H_4, 32.05 g/mol; N_2O_4, 92.02 g/mol; N_2, 28.02 g/mol; H_2O, 18.02 g/mol.

Since N_2H_4 produces smallest amount of N_2, N_2H_4 is limiting

a) 160.0 g b) 87.43 g c) 53.29 g d) 106.6 g e) 131.1 g

and 131.1 g N_2 can be produced.

4. Consider two 1.0 L containers: container A contains 0.50 mol of Ne(g) at 25°C and container B contains 0.50 mol of He(g) at 50.°C. Which of the following statements (a-c) is/are **true** concerning these two containers?

$KE_{Ave} = \frac{3}{2}RT$

He(g) is at higher temperature, so He(g) sample has the largest average kinetic energy, since He(g) is at higher temp and

F a) The average kinetic energy of the Ne atoms in container A is larger than the average kinetic energy of the He atoms in container B. (it has smaller molar mass, He(g) on average is moving faster. He(g) collides

F b) The Ne atoms in container A collide with the walls of the container more frequently than the He atoms in container B. more frequently since moving faster

F c) The pressure in container A is larger than the pressure in container B. $P = \frac{nRT}{V}$

d) All of the above statements (a-c) are true. Container B, at higher temp, has larger P.

e) None of the above statements (a-c) are true.

LiF is ionic, so it has the highest bp. HF can H-bond, so it is next highest bp. F_2 and HCl are about the same size (same molar mass), so the

5. Rank the following substances in order of increasing boiling point (lowest boiling point to highest boiling point). London dispersion forces are about the same for F_2 and HCl.

a) HF < LiF < HCl < F_2 b) F_2 ≤ HCl < HF < LiF c) F_2 < HF < LiF < HCl
d) F_2 < HF < HCl < LiF e) HF < F_2 ≤ HCl < LiF

HCl is polar, so it has additional dipole forces. Between F_2 and HCl, HCl will have stronger IMF and a higher boiling point.

The substance with the strongest intermolecular forces will be the solid at 25°C. All of these are nonpolar substances, so they only exhibit London dispersion forces. I_2 has the largest molar mass, so it has the strongest IMF of these compounds and it is the solid.

6. One of the following substances is a solid at 25°C and 1 atm, while the others are gases at 25°C and 1 atm. Which substance is a solid at 25°C and 1 atm?

a) He b) Ne c) H_2 d) Cl_2 (e) I_2

7. An unknown gas has an effusion rate that is 2.0 times faster than that of $SO_2(g)$. Which of the following is the unknown gas? Let x = unknown gas

SO_2: $32 + 2(16) = 64$ g/mol

a) H_2 b) He c) He_2 (d) CH_4 e) O_2

$\frac{Rate_x}{Rate_{SO_2}} = 2 = \sqrt{\frac{M_{SO_2}}{M_x}}$, $2 = \sqrt{\frac{64}{M_x}}$, $M_x = 16$; the unknown gas is CH_4

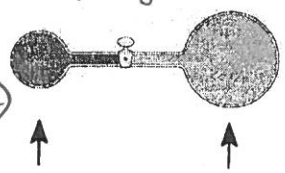
8. A 50.0 mL flask containing $N_2(g)$ at 2.50 atm and a 75.0 mL flask containing Ar(g) at 325 torr are connected by a stopcock (see the illustration below). Treat each gas separately. At constant n + T, Boyle's law applies (PV = constant or $P_1V_1 = P_2V_2$).

For N_2:

$P_2 = \frac{P_1V_1}{V_2} = \frac{2.50\text{ atm}(50.0\text{ mL})}{(500 + 75.0\text{ mL})}$

$P_2 = 1.00\text{ atm} = 760.\text{ torr}$

$P_{N_2,final} = 760.\text{ torr}$



$N_2(g)$	Ar(g)
50.0 mL	75.0 mL
2.50 atm	325 torr

For Ar:

$P_2 = \frac{P_1V_1}{V_2} = \frac{325\text{ torr}(75.0\text{ mL})}{125.0\text{ mL}}$

$P_2 = 195\text{ torr} = P_{Ar,final}$

After the stopcock valve between the two flasks is opened and the gases have time to mix completely, what is the total pressure inside the entire system? Assume temperature is constant. $P_{TOT} = P_{N_2} + P_{Ar} = 760. + 195 = 955\text{ torr}$

(a) 955 torr b) 1120 torr c) 526 torr d) 2230 torr e) 1470 torr

Ethanol with the -OH group can form the relatively strong hydrogen bonding intermolecular forces. Dimethyl ether is polar, but it ~~doesn't~~ can't H-bond.

9. Dimethyl ether ($CH_3–O–CH_3$) and ethanol (CH_3CH_2OH) have the same molecular formula (C_2H_6O), but very different physical properties. For example, dimethyl ether has a vapor pressure of 400 torr at –37.8°C, while ethanol has a vapor pressure of 400 torr at 63.5°C. Which of the following statements (a-d) about these two compounds is **false**?

The forces are stronger in ethanol, so ethanol has the higher boiling point.

T a) Increasing the temperature will increase the vapor pressure of both liquids.

T b) Intermolecular attractive forces are stronger in (liquid) ethanol than in (liquid) dimethyl ether.

(F) c) The normal boiling point of dimethyl ether will be ~~higher~~ lower than the normal boiling point of ethanol.

T d) The reason that the temperature at which the vapor pressure equals 400 torr is higher for ethanol (than for dimethyl ether) is that there is relatively strong hydrogen bonding in ethanol, unlike in dimethyl ether.

e) None of these statements (a-d) is false.

Theoretical yield of Cu_2S = $10.0\,g\,Cu_2S_{actual}\left(\frac{1.00\,g\,theoretical}{0.730\,g\,actual}\right) = 13.7\,g\,Cu_2S$

CHEMISTRY 102 In order to have an actual yield of 10.0 g, Fall 2020
HOUR EXAM II the reaction needs a theoretical yield of 13.7 g.

10. Consider the following reaction:

$13.7\,g\,Cu_2S\left(\frac{1\,mol\,Cu_2S}{159.17\,g}\right)\left(\frac{2\,mol\,Cu}{1\,mol\,Cu_2S}\right)\left(\frac{63.55\,g\,Cu}{mol\,Cu}\right) = 10.9\,g\,Cu$

$$2\,Cu(s) + S(s) \rightarrow Cu_2S(s)$$

If the reaction has a 73.0% yield, what mass of copper is needed to obtain an actual yield of 10.0 g of Cu_2S?

a) 3.99 g Cu b) 5.47 g Cu c) 7.99 g Cu

(d) 10.9 g Cu e) 15.2 g Cu

mass O in 100.00 g compd = 100.00 − 50.80 − 16.04 = 33.16 g O

11. A compound containing only Zn, O, and P is 50.80% Zn and 16.04% P by mass. What is the empirical formula of the compound?

$50.80\,g\,Zn\left(\frac{1\,mol\,Zn}{65.39\,g}\right) = 0.7769\,mol\,Zn/0.5179 = 1.5\,mol\,Zn$

a) $Zn_4O_9P_3$ b) $Zn_2O_4P_3$ c) ZnO_3P

$16.04\,g\,P\left(\frac{1\,mol\,P}{30.97\,g}\right) = 0.5179\,mol\,P/0.5179 = 1\,mol\,P$

d) $Zn_3O_6P_3$ (e) $Zn_3O_8P_2$

$33.16\,g\,O\left(\frac{1\,mol\,O}{16.00\,g}\right) = 2.0725\,mol\,O/0.5179 = 4\,mol\,O$

$(Zn_{1.5}PO_4)_{x2}$

$Zn_3P_2O_8$ is empirical formula

12. Which of the following statements is **false** concerning ideal gases?

T a) For a mixture of gases, the total pressure is the sum of the partial pressures of all the gases present. Dalton's law of Partial Pressure

T b) At constant P and n, a plot of volume (L) vs. temperature (K) is linear. This is Charles's law [V = constant(T)], which is in y = mx + b form (straight line)

(F) c) At constant V and T, the moles of gas present is inversely related to the pressure of the gas sample. PV = nRT; at constant V and T, n is directly related to pressure.

T d) At constant n and T, as the volume of a gas sample increases, the pressure of the gas decreases. Boyle's law (PV = constant)

T e) At constant P and T, a 2.0 L sample of $N_2(g)$ contains twice the number of molecules as a 1.0 L sample of $SO_3(g)$. Avogadro's Law [V = constant(n)] The sample with twice the volume has twice the number of moles of gas particles present.

13. How many of the following five compounds are nonelectrolytes in water?

(NE) PCl_3 SE LiOH ionic soluble SE HNO_3 strong acid (NE) $C_{12}H_{22}O_{11}$ SE NH_4NO_3 ionic soluble (composed of NH_4^+ and NO_3^- ions)

a) 0 (None are nonelectrolytes.) b) 1 (c) 2 d) 3 e) 4

Non electrolytes are covalent compounds that are not acids. PCl_3 and $C_{12}H_{22}O_{11}$ are covalent compounds that are not acids. LiOH and NH_4NO_3 are soluble ionic compounds, so they are strong electrolytes. HNO_3 is a strong acid, so it is a strong electrolyte.

$3Ag^+ + AsO_4^{3-} \rightarrow Ag_3AsO_4$; assumes all As in pesticide ends up as As in Ag_3AsO_4

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mass As $= 0.0500\,L\left(\frac{0.0500\,mol\,Ag^+}{L}\right)\left(\frac{1\,mol\,Ag_3AsO_4}{3\,mol\,Ag^+}\right)\left(\frac{1\,mol\,As}{1\,mol\,Ag_3AsO_4}\right)\left(\frac{74.92\,g\,As}{mol\,As}\right) = 0.06243\,g\,As$

14. All the arsenic in 1.22 g of a pesticide was converted to AsO_4^{3-} by suitable chemical treatment. All the AsO_4^{3-} was then reacted with Ag^+ to form Ag_3AsO_4 as a precipitate. It took 50.0 mL of 0.0500 *M* $AgNO_3$ to precipitate all the AsO_4^{3-}. Assuming 100% yield, what is the mass percent of As in the pesticide?

mass % As $= \left(0.06243\,g\,As / 1.22\,g\,pesticide\right) \times 100 = 5.12\%\,As$

a) 2.39% As b) 5.12% As c) 14.1% As d) 7.06% As e) 4.54% As

HF is a weak acid. Weak acids only partially dissociate

15. You have a 1.0 *M* solution of aqueous HF. What ions and/or molecules are present in this solution? in water. so HF, H^+, F^-, and H_2O molecules are all present in a 1.0M HF solution.

a) Only H^+ ions and F^- ions are present.
b) Only HF molecules and H_2O molecules are present.
c) HF molecules, H^+ ions, F^- ions, and H_2O molecules are all present.
d) Only H^+ ions, F^- ions, and H_2O molecules are present.
e) Only HF molecules are present.

16. Explosives are usually effective if they produce a large number of gaseous molecules as products. Nitroglycerin, for example, detonates according to the equation:

4 mol nitro $\rightarrow$ 12 mol + 6 mol + 10 mol + 1 mol = 29 mol gas produced

$$4\,C_3H_5N_3O_9(s) \rightarrow 12\,CO_2(g) + 6\,N_2(g) + 10\,H_2O(g) + O_2(g)$$

$P_{TOT} = n_{TOT}RT/V$

If 0.0400 mol of nitroglycerin explodes in a 10.0 L rigid container, calculate the total pressure of all gases present assuming the temperature is 500.°C.

$n_{TOT} = 0.0400\,mol\,nitro\left(\frac{29\,mol\,gas}{4\,mol\,nitro}\right) = 0.290\,mol\,gas\,total$

a) 0.0634 atm b) 10.6 atm c) 1.84 atm d) 21.1 atm e) 5.23 atm

$P_{TOT} = \frac{(0.290\,mol)(0.08206)(773\,K)}{10.0\,L} = 1.84\,atm$

17. Consider the following **unbalanced** reaction:

$4HCl(g) + 1O_2(g) \rightarrow 2H_2O(g) + 2Cl_2(g)$ is balanced equation

How many grams of O_2 are necessary to react completely with 20. mol of HCl?

a) 640 g H_2O b) 160 g O_2 c) 320 g O_2 d) 2600 g O_2 e) 1300 g O_2

$20.\,mol\,HCl\left|\frac{1\,mol\,O_2}{4\,mol\,HCl}\right|\frac{32.00\,g\,O_2}{mol\,O_2} = 160\,g\,O_2$

mass of C in aspirin $= 2.20\text{ g } CO_2\left(\frac{1\text{ mol } CO_2}{44.01\text{ g}}\right)\left(\frac{1\text{ mol C}}{1\text{ mol } CO_2}\right)\left(\frac{12.01\text{ g C}}{\text{mol C}}\right) = 0.6004\text{ g C}$

mass of H in aspirin $\rightarrow 0.400\text{ g } H_2O\left(\frac{1\text{ mol } H_2O}{18.02\text{ g}}\right)\left(\frac{2\text{ mol H}}{1\text{ mol } H_2O}\right)\left(\frac{1.008\text{ g H}}{\text{mol H}}\right) = 0.04475\text{ g H}$

mass of O in aspirin $= 1.00\text{ g aspirin} - 0.6004\text{ g C} - 0.04475\text{ g N} = 0.3548\text{ g O}$

18. You take a 1.00 g sample of aspirin (a compound consisting solely of carbon, hydrogen, and oxygen), burn it in excess oxygen, and collect 2.20 g of carbon dioxide and 0.400 g of water. The molar mass of aspirin is between 160 and 190 g/mol. What is the mass percent of oxygen in aspirin?

mass % O $= (0.3548\text{ g O}/1.00\text{ g aspirin})100 = 35.5\%\text{ O}$

a) 35.5% b) 23.5% c) 30.0%

d) 16.4% e) 47.0%

In 1.00 g aspirin, we have 0.6004 g C, 0.04475 g H, and 0.3548 g O.

19. You take a 1.00 g sample of aspirin (a compound consisting solely of carbon, hydrogen, and oxygen), burn it in excess oxygen, and collect 2.20 g of carbon dioxide and 0.400 g of water. The molar mass of aspirin is between 160 and 190 g/mol. Which of the following is the molecular formula of aspirin?

$0.6004\text{ g C}\left(\frac{1\text{ mol C}}{12.01\text{ g}}\right) = 0.04999\text{ mol C}/0.02218 = 2.25 \times 4 = 9\text{ C}$

a) $C_6H_8O_5$ b) $C_9H_8O_4$ c) $C_8H_{10}O_5$

$0.04475\text{ g H}\left(\frac{1\text{ mol H}}{1.008\text{ g}}\right) = 0.04439\text{ mol H}/0.02218 = 2 \times 4 = 8\text{ H}$

d) $C_{10}H_6O_4$ e) $C_{12}H_{13}O_2$

$0.3548\text{ g O}\left(\frac{1\text{ mol O}}{16.00\text{ g}}\right) = 0.02218\text{ mol O}/0.02218 = 1 \times 4 = 4\text{ O}$

$C_9H_8O_4$ is the empirical formula.

$C_9H_8O_4$ has a molar mass of 180 g/mol, so $C_9H_8O_4$ is also the molecular formula.

20. When 1.00 L of 1.00 *M* H_3PO_4 is reacted with 1.00 L of 1.00 *M* $Ca(OH)_2$, what mass of water is produced (assuming 100% yield)?

$2\,H_3PO_4(aq) + 3\,Ca(OH)_2(aq) \rightarrow 6\,H_2O + Ca_3(PO_4)_2(s)$

a) 6.00 g H_2O b) 9.01 g H_2O c) 18.0 g H_2O

If H_3PO_4 limiting $= 1.00\text{ L}\left(\frac{1.00\text{ mol } H_3PO_4}{\text{L}}\right)\left(\frac{6\text{ mol } H_2O}{2\text{ mol } H_3PO_4}\right)\left(\frac{18.02\text{ g}}{\text{mol } H_2O}\right) = 54.0\text{ g } H_2O$

d) 36.0 g H_2O e) 54.0 g H_2O

If $Ca(OH)_2$ limiting $= 1.00\text{ L}\left(\frac{1.00\text{ mol } Ca(OH)_2}{\text{L}}\right)\left(\frac{6\text{ mol } H_2O}{3\text{ mol } Ca(OH)_2}\right)\left(\frac{18.02\text{ g}}{\text{mol } H_2O}\right) = 36.0\text{ g } H_2O$

$Ca(OH)_2$ is limiting and 36.0 g H_2O can be produced.

21. A binary compound is composed of an unknown element X and hydrogen. The compound has three times as many H atoms as X atoms in the molecular formula and is 80.0% X by mass. Which of the following could be the element X?

mol X in compd $= 20.0\text{ g H}\left(\frac{1\text{ mol H}}{1.008\text{ g H}}\right)\left(\frac{1\text{ mol X}}{3\text{ mol H}}\right) = 6.614\text{ mol X}$

100.0 g compd contains 80.0 g X and 20.0 g H.

a) N b) C c) B d) Be e) He

molar mass X $= \frac{80.0\text{ g X}}{6.614\text{ mol X}} = 12.1\text{ g/mol}$; Carbon is best choice.

22. What volume of a 0.300 *M* $CaCl_2$ solution is needed to prepare 240. mL of a 0.100 *M* Cl^- solution?

$CaCl_2(aq) \rightarrow Ca^{2+}(aq) + 2\,Cl^-(aq)$

$CaCl_2$ is soluble, so exists as Ca^{2+} and $2\,Cl^-$ in solution.

a) 40.0 mL b) 80.0 mL c) 120. mL

d) 240. mL e) 480. mL

$\text{Volume} = 0.240\text{ L}\left(\frac{0.100\text{ mol Cl}^-}{\text{L}}\right)\left(\frac{1\text{ mol } CaCl_2}{2\text{ mol Cl}^-}\right)\left(\frac{1\text{ L } CaCl_2}{0.300\text{ mol } CaCl_2}\right) = 0.0400\text{ L}$

$= 40.0\text{ mL}$

Gases deviate from ideal behavior because they do exhibit intermolecular forces, and they do have a volume. All of these answers are nonpolar substances that exhibit only London dispersion forces. The gas with the strongest IMF and largest size will behave

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23. The five most abundant gases in a sample of air are N_2, O_2, Ar, CO_2, and Ne. Consider five separate 2.5 L samples of each individual gas at 352 K and 6.25 atm. Which gas sample would behave **least** ideally?

least ideally. This is CO_2. Since CO_2 has the largest

a) N_2 b) CO_2 c) Ar d) O_2 e) Ne

molar mass, it will have the strongest LD forces and largest size; it will deviate most from ideal gas behavior.

24. Consider the following balanced equation between gas X to form gas X_2:

Since mass is conserved in a chemical reaction, the mass will be constant. As the reaction occurs, the big change is the moles of gas decreases by a factor of 2.

$$2\,X(g) \rightarrow X_2(g)$$

Equal moles of X are placed in two separate containers. One container is rigid so the volume cannot change; the other container is flexible (like a balloon) so the volume changes in order to keep the internal pressure equal to the external pressure. The above reaction is run in each container. Which of the following is **true** concerning the pressure and density of the gas inside each container as reactants are converted to products? Assume a constant external pressure and assume a constant temperature.

$PV = nRT$

Rigid container (volume constant): as moles decrease, P decreases. Since mass and volume are constant, density is constant.

a) Rigid container: Pressure decreases, density is constant;
Flexible container: Pressure is constant, density increases.

b) Rigid container: Pressure is constant, density is constant;
Flexible container: Pressure is constant, density increases.

c) Rigid container: Pressure decreases, density increases;
Flexible container: Pressure increases, density is constant.

d) Rigid container: Pressure is constant, density is constant;
Flexible container: Pressure decreases, density is constant.

Flexible container: The pressure will be constant (equal to the external pressure). As mol of gas decrease, volume of container must decrease to keep pressure constant. Density increases since we have the same mass in a smaller volume.

$$2\,Fe(NO_3)_3(aq) + 3K_2CO_3(aq) \rightarrow Fe_2(CO_3)_3(s) + 6KNO_3(aq)$$

Consider the following information for the next two questions.

If $Fe(NO_3)_3$ limiting: $0.200\,L\left(\frac{0.10\,mol\,Fe(NO_3)_3}{L}\right)\left(\frac{1\,mol\,Fe_2(CO_3)_3}{2\,mol\,Fe(NO_3)_3}\right) = 0.010\,mol\,Fe_2(CO_3)_3$

When 200.0 mL of 0.10 *M* $Fe(NO_3)_3$ is mixed with 250.0 mL of 0.10 *M* K_2CO_3, a precipitate forms.

If K_2CO_3 limiting: $0.250\,L\left(\frac{0.10\,mol\,K_2CO_3}{L}\right)\left(\frac{1\,mol\,Fe_2(CO_3)_3}{3\,mol\,K_2CO_3}\right) = 0.0083\,mol\,Fe_2(CO_3)_3$

25. How many moles of precipitate can form in this reaction?

K_2CO_3 is limiting and 0.0083 mol of $K_2(CO_3)_3$ can form.

a) 0.0050 mol b) 0.013 mol c) 0.010 mol d) 0.0083 mol e) 0.020 mol

Initial mols Fe^{3+}: $0.200\,L\left(\frac{0.10\,mol\,Fe(NO_3)_3}{L}\right)\left(\frac{1\,mol\,Fe^{3+}}{1\,mol\,Fe(NO_3)_3}\right) = 0.020\,mol\,Fe^{3+}$ initially

26. Calculate the concentration of Fe^{3+} ions in the final solution after precipitate formation is complete.

Mole Fe^{3+} reacted: $0.250\,L\left(\frac{0.10\,mol\,K_2CO_3}{L}\right)\left(\frac{2\,mol\,Fe(NO_3)_3}{3\,mol\,K_2CO_3}\right)\left(\frac{1\,mol\,Fe^{3+}}{1\,mol\,Fe(NO_3)_3}\right) = 0.0167\,mol\,Fe^{3+}$ reacted

a) 0.0074 *M* b) 0.022 *M* c) 0.028 *M*

excess $Fe^{3+} = 0.0200 - 0.0167 = 0.0333\,mol\,Fe^{3+}$ in excess

d) 0.0086 *M* e) 0.00 *M*

$$[Fe^{3+}]_{excess} = \frac{0.0333\,mol\,Fe^{3+}}{0.450\,L} = 0.074\,M$$

$Ba(OH)_{2(aq)} + 2HCl_{(aq)} \rightarrow 2H_2O_{(l)} + BaCl_{2(aq)}$

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$0.0200\ mol\ Ba(OH)_2 \left(\frac{2\ mol\ HCl}{1\ mol\ Ba(OH)_2}\right)\left(\frac{1\ L\ HCl}{0.100\ mol\ HCl}\right) = 0.400\ L = 400.\ mL$

27. If you dissolve 0.0200 mol of barium hydroxide in enough water to make 250. mL of solution, what volume of 0.100 *M* hydrochloric acid is required to react completely with the barium hydroxide?

a) 100. mL b) 200. mL c) 300. mL

d) 400. mL e) 500. mL

$P \cdot M = dRT$; at constant T + P, the molar mass of

28. An unknown gas has an empirical formula of CH_2. The density of the unknown gas is 2.19 times greater than the density of $O_2(g)$ at the same temperature and pressure. Which of the following is the molecular formula of the unknown gas?

CH_2: 12+2(1) = 14 g/mol empirical mass

gas is directly proportional to the density. The unknown gas must have a molar mass that is 2.19 times heavier than O_2. molar mass = 2.19(32.00) = 70.1; $\frac{70.1}{14} = 5$; $(CH_2)_{x5} = C_5H_{10}$

a) CH_2 b) C_2H_4 c) C_3H_6 d) C_4H_8 e) C_5H_{10}

29. Real gases go not always obey the ideal gas equation, PV = nRT. Under which of the following conditions will a gas behave **most** ideally?

a) P = 1.0 atm, T = 273 K
b) P = 0.50 atm, T = 200 K
c) P = 0.50 atm, T = 400 K
d) P = 2.0 atm, T = 400 K
e) P = 2.0 atm, T = 200 K

A gas behaves most ideally at high temperatures and low pressures. Answer C has the highest T and lowest P.

30. 25.0 mL of 0.50 *M* $Pb(NO_3)_2$ is added to four separate beakers containing:

From solubility rules:

Beaker I:	50.0 mL of 0.25 *M* NaCl	$PbCl_2(s)$ forms
Beaker II:	50.0 mL of 0.25 *M* NaOH	$Pb(OH)_2(s)$ forms
Beaker III:	50.0 mL of 0.25 *M* Na_3PO_4	$Pb_3(PO_4)_2(s)$ forms
Beaker IV:	50.0 mL of 0.25 *M* Na_2SO_4	$PbSO_4(s)$ forms

After addition of the $Pb(NO_3)_2$ solution, in how many of the beakers will a precipitate form?

All will form a precipitate when $Pb^{2+}(aq)$ is added.

a) 0 (none) b) 1 c) 2 d) 3 e) 4 (all)