Form A|B C|D

Detailed Solutions

CHEMISTRY 102 All of the answers are nonpolar substances, so they only exhibit London dispersion forces. I_2 has the largest
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1. 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?
molar mass, so I_2 has the strongest LDF. The solid will be the substance with the strongest intermolecular forces and this will be I_2.

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

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2. 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

$$2 = \frac{Rate_x}{Rate_{SO_2}} = \sqrt{\frac{M_{SO_2}}{M_x}} = \sqrt{\frac{64}{M_x}} \qquad 4 = \frac{64}{M_x}, \; M_x = 16; \; CH_4 \text{ has a molar mass of 16 g/mol.}$$

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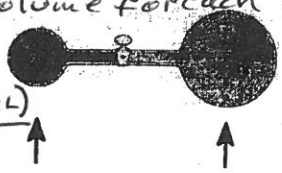
3. A 50.0 mL flask containing N_2(g) at 2.50 atm and a 75.0 mL flask containing Ar(g) at 325 torr are connected by a stopcock (see the illustration below). Treat each gas separately. At constant n & T, Boyle's law applies ($P_1V_1 = P_2V_2$). The final volume for each gas will be 50.0 + 75.0 = 125.0 mL.



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

For N_2:

$$P_2 = \frac{P_1V_1}{V_2} = \frac{2.50 \text{ atm}(50.0 \text{ mL})}{125.0 \text{ mL}}$$

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

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

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

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4. 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**?
Ethanol, with the –OH group, can form the relatively strong hydrogen bonding interactions. Dimethyl ether is polar so it exhibits dipole forces. For similar sized molecules, H-bonding forces are stronger than dipole forces.

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. H-bonding in ethanol stronger than dipole forces in dimethyl ether.
(F) c) The normal boiling point of dimethyl ether will be higher than the normal boiling point of ethanol. Ethanol, with the H-bonding forces, will boil at higher temperatures.
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.

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Nonelectrolytes will be polar covalent compounds that are not acids. This is PCl_3 and $C_{12}H_{22}O_{11}$. LiOH and NH_4NO_3 are soluble ionic compounds, so they are strong electrolytes. HNO_3 is one of the 6 strong acids to memorize and it is as strong electrolyte.

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

NE PCl_3 SE LiOH SE HNO_3 NE $C_{12}H_{22}O_{11}$ SE NH_4NO_3

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

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6. 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?

$3\,Ag^+ + AsO_4^{3-} \rightarrow Ag_3AsO_4(s)$; assumes all As ends up in Ag_3AsO_4 precipitate.

$$\text{mass As} = 0.0500\,\text{L}\left(\frac{0.0500\,\text{mol Ag}^+}{\text{L}}\right)\left(\frac{1\,\text{mol Ag}_3\text{AsO}_4}{3\,\text{mol Ag}^+}\right)\left(\frac{1\,\text{mol As}}{1\,\text{mol Ag}_3\text{AsO}_4}\right)\left(\frac{74.92\,\text{g As}}{\text{mol As}}\right) = 0.06243\,\text{g As}$$

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

$$\text{mass \% As} = \frac{\text{mass As}}{\text{mass pesticide}} \times 100 = \frac{0.06243\,\text{g As}}{1.22\,\text{g pesticide}} \times 100 = 5.12\%\,\text{As}$$

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7. You have a 1.0 *M* solution of aqueous HF. What ions and/or molecules are present in this solution? HF is a weak acid, so it is a weak electrolyte which only partially breaks up into H^+ and F^- ions.

a) Only H^+ ions and F^- ions are present. HF mostly stays together in water.

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.

HF, H^+, F^-, and H_2O will all be present.

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

4 moles nitro → 12 mol + 6 mol + 10 mol + 1 mol = 29 mol gas

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

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

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.

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

$$P_{TOT} = \frac{n_{TOT}RT}{V} = \frac{0.290\,\text{mol}\left(0.08206\,\frac{\text{L atm}}{\text{K mol}}\right)(773\,\text{K})}{10.0\,\text{L}} = 1.84\,\text{atm}$$

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

$4\,HCl(g) + 1\,O_2(g) \rightarrow 2\,H_2O(g) + 2\,Cl_2(g)$ 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

$$20.\,\text{mol HCl}\left(\frac{1\,\text{mol O}_2}{4\,\text{mol HCl}}\right)\left(\frac{32.00\,\text{g O}_2}{\text{mol O}_2}\right) = 160\,\text{g O}_2$$

Gases deviate from ideal behavior because they do exhibit intermolecular forces and they do have a volume. A gas that deviates the most will have the strongest intermolecular forces and the largest size. All of these answers

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10. Four of most abundant gases in air are Ne, CO_2, O_2, and N_2. Consider four separate 2.5 L samples of each individual gas at 208 K and 6.25 atm. Which gas sample would behave **least** ideally?

contain nonpolar substances, so they only exhibit London dispersion

a) Ne (b) CO_2 c) O_2 d) N_2

forces. CO_2, with the largest molar mass, has the strongest intermolecular forces; it also has the biggest size. $CO_2(g)$ will deviate the most.

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

In both containers, mass doesn't change because mass is conserved in a chemical reaction. In order for the density (mass/volume) to change, the volume of the container must change. Note that as reactions occurs, the moles of gas decrease.

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

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?

$PV = nRT$

Assume a constant external pressure and assume a constant temperature.

Rigid container (constant V): as n decreases, P decreases. A rigid container has constant volume, so density is constant since mass is constant.

Flexible container (constant P): as n decreases, V decreases at constant T. As V decreases, density will increase.

(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.

$$Fe(NO_3)_3(aq) + 3\,KOH(aq) \rightarrow Fe(OH)_3(s) + 3\,KNO_3(aq)$$

Consider the following information for the next two questions.

If $Fe(NO_3)_3$ limiting: $0.2000\,L\left(\frac{0.10\,mol\,Fe(NO_3)_3}{L}\right)\left(\frac{1\,mol\,Fe(OH)_3}{1\,mol\,Fe(NO_3)_3}\right) = 0.020\,mol\,Fe(OH)_3(s)$

When 200.0 mL of 0.10 *M* $Fe(NO_3)_3$ is mixed with 100.0 mL of 0.10 *M* KOH, a precipitate forms.

If KOH limiting: $0.1000\,L\left(\frac{0.10\,mol\,KOH}{L}\right)\left(\frac{1\,mol\,Fe(OH)_3}{3\,mol\,KOH}\right) = 0.0033\,mol\,Fe(OH)_3(s)$

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

KOH produces smallest precipitate amount, so KOH is limiting and $0.0033\,mol\,Fe(OH)_3$ can form.

(a) 0.0033 mol b) 0.0050 mol c) 0.010 mol d) 0.020 mol e) 0.030 mol

Moles Fe^{3+} initially $= 0.2000\,L\left(\frac{0.10\,mol\,Fe(NO_3)_3}{L}\right)\left(\frac{1\,mol\,Fe^{3+}}{1\,mol\,Fe(NO_3)_3}\right) = 0.020\,mol\,Fe^{3+}$

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

Since $0.0033\,mol\,Fe(OH)_3(s)$ formed, $0.0033\,mol\,Fe^{3+}$ was used up to form precipitate.

a) 0.00 *M* b) 0.033 *M* c) 0.040 *M* (d) 0.056 *M* e) 0.067 *M*

Excess $Fe^{3+} = 0.020\,mol - 0.0033 = 0.0167\,mol\,Fe^{3+}$

$$M_{Fe^{3+}} = \frac{0.0167\,mol\,Fe^{3+}}{(0.200 + 0.100\,L)} = 0.056\,M$$

Form A|B C|D

the compound with the weakest intermolecular forces has the highest vapor pressure. NH_3, H_2O, and HF all exhibit hydrogen bonding, so these all will have a relatively low vapor pressure. Between CH_4 and SiH_4, both only exhibit London dispersion forces, and since CH_4 has smaller molar, CH_4 has weakest intermolecular forces. So CH_4 has highest vapor pressure.

14|23 10|1 14. Which of the following compounds is expected to have the highest vapor pressure at some temperature, T?

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

15|24 11|2 15. 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?

At constant T and P, $V \propto n$. A chemical equation gives mole ratios as well as volume ratios.

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

$1\,N_2 + 3\,F_2 \rightarrow 2\,N_xF_y$

For a balanced reaction, the product is NF_3.

16|25 12|3 16. 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 limiting: $100.0\,g\,N_2H_4\left(\frac{1\,mol\,N_2H_4}{32.05\,g}\right)\left(\frac{3\,mol\,N_2}{2\,mol\,N_2H_4}\right)\left(\frac{28.02\,g\,N_2}{mol\,N_2}\right) = 131.1\,g\,N_2$

If N_2O_4 limiting: $175\,g\,N_2O_4\left(\frac{1\,mol\,N_2O_4}{92.02\,g}\right)\left(\frac{3\,mol\,N_2}{1\,mol\,N_2O_4}\right)\left(\frac{28.02\,g\,N_2}{mol\,N_2}\right) = 159.9\,g\,N_2$

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 quantity, N_2H_4 is limiting and 131.1 g N_2 can be produced.

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

17|26 13|4 17. 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?

→ A + higher temp, He(g) sample has the largest KE_{Ave} ($KE_{Ave} = \frac{3}{2}RT$).

He molecules are smaller and are at a higher temperature, so He(g) particles are moving faster.

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.

F b) The Ne atoms in container A collide with the walls of the container more frequently than the He atoms in container B. He(g) is moving faster, so collides more frequently.

F c) The pressure in container A is larger than the pressure in container B.

d) All of the above statements (a-c) are true.

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

$PV = nRT$; at higher T, container B has higher pressure.

18|27 14|5 18. Rank the following substances in order of increasing boiling point (lowest boiling point to highest boiling point).

LiF is ionic, so has strongest IM forces and highest boiling point. Of the 3 covalent compounds, HF can form H-bonding, so HF has next highest bp. Both Ar and HCl have similar molar masses, so their LD forces are about the same strength. But HCl is polar while Ar is nonpolar, so HCl has additional dipole forces and will boil at a higher temperature than Ar.

a) HF < LiF < HCl < Ar b) Ar < HCl < HF < LiF c) Ar < HF < LiF < HCl

d) Ar < HF < HCl < LiF e) HF < Ar < HCl < LiF

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A synthesis reaction has only 1 product.

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19. Which of the following reactions (a-d) is **incorrectly** classified?

yes a) $Na_2CO_3(aq) + ZnCl_2(aq) \rightarrow 2\ NaCl(aq) + ZnCO_3(s)$ precipitation reaction

NO b) $2\ KClO_3(s) \rightarrow 2\ KCl(s) + 3\ O_2(g)$ ~~synthesis~~ decomposition reaction

Yes c) $Mg(s) + 2\ HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$ single displacement reaction

Yes d) $H_3PO_4(aq) + 3\ KOH(aq) \rightarrow 3\ H_2O(l) + K_3PO_4(aq)$ acid-base reaction

e) All of the above reactions (a-d) are correctly classified.

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

20. Consider the following reaction:

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

In order to have an actual yield of $10.0\ g\ Cu_2S$, we need a theoretical yield of $13.7\ g\ Cu_2S$.

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?

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

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

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21. 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?

In 100.00 g compound:

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

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

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

$(Zn_{1.5}PO_4)\times 2$

$Zn_3P_2O_8$ is empirical formula.

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

d) $Zn_3O_6P_3$ e) $Zn_3O_8P_2$

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22. 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. This is Dalton's law of partial pressure.

T b) At constant P and n, a plot of volume (L) vs. temperature (K) is linear. $V = T\left(\frac{nR}{P}\right) = T(\text{constant})$. This is in the form of the straight line equation $y = mx + b$. So V vs T plot is linear.

F c) At constant V and T, the moles of gas present is ~~inversely~~ directly related to the pressure of the gas sample. $P = n\left(\frac{RT}{V}\right) = n(\text{constant})$; At constant V + T, P is directly related to moles.

T d) At constant n and T, as the volume of a gas sample increases, the pressure of the gas decreases. $PV = nRT = \text{constant}$; P and V are inversely related.

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 $SO_3(g)$. $V = n\left(\frac{RT}{P}\right)$; at constant P and T, Volume is proportional to moles. If volume is doubled, moles must be doubled.

Form A|B C|D

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

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

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23. 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 in aspirin = 1.00 g − 0.6004 g C − 0.04475 g H = 0.3548 g O

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

$\text{mass \% O} = \frac{0.3548\text{g O}}{1.00\text{ g aspirin}} \times 100 = 35.5\%\text{ O}$

d) 16.4% e) 47.0%

So in 1.00 g aspirin, there is 0.6004 g C, 0.04475 g H, and 0.3548 g O.

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24. 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) $C_{12}H_{13}O_2$

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

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

$C_9H_8O_4$ is the empirical formula.

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25. 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)?

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

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

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

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.

26|8 H|22

26. 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?

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

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

$\text{Molar mass X} = \frac{80.0\text{g X}}{6.614\text{mol X}} = 12.1\text{ g/mol}$; this is Carbon.

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

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27. What volume of a 0.300 *M* $CaCl_2$ solution is needed to prepare 240. mL of a 0.100 *M* Cl^- solution? $CaCl_2(aq) \rightarrow Ca^{2+}(aq) + 2Cl^-(aq)$

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

d) 240. mL e) 480. mL

$\text{Volume} = 0.240\text{ L}\left(\frac{0.100\text{mol Cl}^-}{\text{L}}\right)\left(\frac{1\text{mol } CaCl_2}{2\text{mol Cl}^-}\right)\left(\frac{1\text{ L } CaCl_2}{0.300\text{mol } CaCl_2}\right) = 0.0400\text{L} = 40.0\text{mL}$

Form

A|B
C|D

$Ba(OH)_2(aq) + 2HCl(aq) \rightarrow 2H_2O(\ell) + BaCl_2(aq)$

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28. 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?

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

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

(d) 400. mL e) 500. mL

$P \cdot M = dRT$, $d = M\left(\frac{P}{RT}\right)$; at constant P and T, molar mass (M) is directly proportional to density. Since the unknown gas is 2.19 more dense than O_2, the unknown gas has a molar mass which is 2.19 times greater than the molar mass of O_2.

29|29
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29. 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?

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

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

Molar mass = $2.19(32) = 70.1$ g/mol; $\frac{70.1}{14} = 5$; $(CH_2)_{xs}$ C_5H_{10} is the molecular formula.

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30. 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 temperature and low pressure. Answer C has the lowest P and highest T.

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31. 25.0 mL of 0.50 *M* $Pb(NO_3)_2$ is added to four separate beakers containing:

Using the 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?

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

All will form a precipitate as Pb^{2+} is added.

32. My answers for this Chemistry 102 exam should be graded with the answer sheet associated with:

a) Form A b) Form B c) Form C d) Form D e) Form E