Form

A	B
C	D

Detailed Key Exam 2

PV = constant is Boyle's Law; pressure and volume are inversely related. Plots a, b, and c are great. Plot d is wrong.

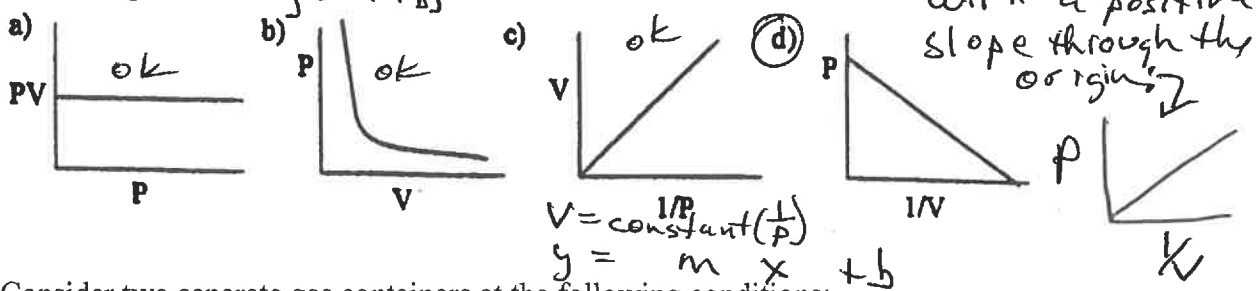
PV = Constant; P = constant$\left(\frac{1}{V}\right)$ is in the form of the straight line equation. A plot of P vs $\frac{1}{V}$ will be linear with a positive slope through the origin.

CHEMISTRY 102A
Exam II

Spring 2023

1	6
14	24

1. Boyle's law can be represented graphically in several ways. Which of the following plots does **not** correctly represent Boyle's law (assuming constant T and n)?



(y = mx + b)

V = constant$\left(\frac{1}{P}\right)$

y = m x + b

2	7
15	25

2. Consider two separate gas containers at the following conditions:

Container A	**Container B**
Contents: $C_2H_6(g)$	Contents: unknown gas
Pressure = P_A	Pressure = P_B
Moles of gas = 1.0 mol	Moles of gas = 2.0 mol
Volume = 1.0 L	Volume = 2.0 L
Temperature = 280 K	Temperature = 560 K

For the gases in the two containers:

$$\frac{P_A V_A}{n_A T_A} = \frac{P_B V_B}{n_B T_B}$$

$$P_B = P_A\left(\frac{V_A}{V_B}\right)\left(\frac{n_B}{n_A}\right)\left(\frac{T_B}{T_A}\right)$$

Which of the following correctly relates P_B to P_A, assuming ideal gas behavior?

a) $P_B = \frac{1}{2} P_A$ b) $P_B = P_A$ c) $P_B = 2P_A$

d) $P_B = 4P_A$ e) $P_B = 8P_A$

$$P_B = P_A\left(\frac{1.0\,L}{2.0\,L}\right)\left(\frac{2.0\,mol}{1.0\,mol}\right)\left(\frac{560\,K}{280\,K}\right) = P_A\left(\frac{1}{2}\right)(2)(2),\ P_B = 2P_A$$

Assuming 100.00 g compd:

mass H = 100.00 − 85.96 g C − 9.12 g N = 4.92 g H

3	8
16	26

3. Tetraphenylporphyrin is composed of only C, H, and N atoms. Experiments reveal that tetraphenylporphyrin is 85.96% C and 9.12% N by mass. What is the empirical formula of tetraphenylporphyrin?

$85.96\,g\,C\left(\frac{1\,mol\,C}{12.01\,g}\right) = 7.1574\,mol\,C/0.651 = 11\,mol\,C \times 2 = 22\,mol\,C$

a) C_7H_5N b) $C_{22}H_{15}N_2$ c) $C_{11}H_8N$

$9.12\,g\,N\left(\frac{1\,mol\,N}{14.01\,g}\right) = 0.6510\,mol\,N/0.651 = 1\,mol\,N \times 2 = 2\,mol\,N$

d) C_7HN_5 e) $C_{11}H_{15}N$

$4.92\,g\,H\left(\frac{1\,mol\,H}{1.008\,g}\right) = 4.881\,mol\,H/0.651 = 7.5\,mol\,H \times 2 = 15\,mol\,H$

$C_{22}H_{15}N_2$ is emp. formula.

4	9
17	27

4. An unknown gas has an average velocity which is ¼ (one-fourth) that of the He average velocity at some temperature. Which of the following is the best choice for the unknown gas?

$$\frac{Rate_A}{Rate_B} = \sqrt{\frac{M_B}{M_A}}$$

Note effusion rate is proportional to average velocity.

a) CH_4 b) SO_2 c) H d) O_2 e) H_2

$$\frac{Rate_{He}}{Rate_{un}} = 4 = \sqrt{\frac{M_{un}}{M_{He}}} = \sqrt{\frac{M_{un}}{4}}$$

$16 = \frac{M_{un}}{4}$, M_{un} = molar mass of unknown = 64 g/mol (SO_2 is the unknown.)

Form

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Assuming Cu is limiting:
$5.00\,g\,Cu \left|\frac{1\,mol\,Cu}{63.55\,g}\right|\frac{1\,mol\,Cu_2S}{2\,mol\,Cu}\left|\frac{159.17\,g\,Cu_2S}{mol\,Cu_2S}\right. = 6.26\,g\,Cu_2S$

Assuming S is limiting:
$1.50\,g\,S \left|\frac{1\,mol}{32.07\,g}\right|\frac{1\,mol\,Cu_2S}{1\,mol\,S}\left|\frac{159.17\,g\,Cu_2S}{mol\,Cu_2S}\right. = 7.44\,g\,Cu_2S$

smaller quantity of product

5 | 23
1 | 19

5. Consider the following reaction between copper and sulfur:

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

If 5.00 g Cu is reacted with 1.50 g S, calculate the theoretical mass of copper(I) sulfide that can form?

From the above calculations, Cu is limiting and 6.26 g Cu_2S can be produced.

a) 7.44 g b) 6.50 g c) 7.26 g d) 4.39 g e) 6.26 g

6 | 24
2 | 20

6. Which of the following statements is **false**?

True a) HCl is a strong electrolyte. HCl = strong acid

True b) $C_{12}H_{22}O_{11}$ is a nonelectrolyte. $C_{12}H_{22}O_{11}$ = covalent compound that is not an acid (or a base)

False c) NH_4NO_3 is a nonelectrolyte. NH_4NO_3 = soluble ionic compd = strong electrolyte

True d) $HC_2H_3O_2$ is a weak electrolyte. $HC_2H_3O_2$ = weak acid

True e) Na_3PO_4 is a strong electrolyte. Na_3PO_4 = soluble ionic compound = strong electrolyte

$Pb(NO_3)_2(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s) + 2NO_3^-(aq)$

7 | 25
3 | 21

7. Douglasite is a mineral which contains chlorine. A 0.455 g sample of douglasite is destroyed, releasing all the chlorine as the chloride ion. It took 37.2 mL of 0.100 *M* $Pb(NO_3)_2$ solution to precipitate all the Cl^- from the douglasite sample as $PbCl_2(s)$. Calculate the mass percent of chlorine in douglasite. The molar mass of Cl is 35.45 g/mol and the molar mass of $PbCl_2$ is 278.1 g/mol. Assume that douglasite contains no Pb^{2+} ions.

mass of Cl^- in douglasite $= 0.0372\,L \left|\frac{0.100\,mol\,Pb(NO_3)_2}{L}\right|\frac{2\,mol\,Cl^-}{1\,mol\,Pb(NO_3)_2}\left|\frac{35.45\,g\,Cl^-}{mol\,Cl^-}\right. = 0.2637\,g\,Cl$

a) 58.0% b) 29.0% c) 26.4% d) 14.5% e) 13.2%

Mass % Cl $= \frac{0.2637\,g\,Cl}{0.455\,g\,douglasite} \times 100 = 58.0\%$

8 | 26
4 | 22

8. Menthol, an aromatic substance used in some cough drops, is composed of C, H, and O. When a 0.1006 g sample of menthol is combusted with excess oxygen, 0.2833 g CO_2 and 0.1160 g H_2O are produced. What is the mass percent of oxygen in menthol?

mass C $= 0.2833\,g\,CO_2\left(\frac{1\,mol\,CO_2}{44.01\,g}\right)\left(\frac{1\,mol\,C}{1\,mol\,CO_2}\right)\left(\frac{12.01\,g\,C}{mol\,C}\right) = 0.07731\,g\,C$

a) 25% b) 20.% c) 15% d) 10.% e) 5.0%

mass H $= 0.1160\,g\,H_2O\left(\frac{1\,mol\,H_2O}{18.02\,g}\right)\left(\frac{2\,mol\,H}{1\,mol\,H_2O}\right)\left(\frac{1.008\,g}{mol\,H}\right) = 0.01298\,g\,H$

mass O $= 0.1006\,g\,cmpd - 0.07731\,g\,C - 0.01298\,g\,H = 0.01031\,g\,O$

mass % O $= \frac{0.01031\,g\,O}{0.1006\,g} \times 100$

mass % O $= 10.2\%$

9 | 27
5 | 23

9. Menthol, an aromatic substance used in some cough drops, is composed of C, H, and O. When a 0.1006 g sample of menthol is combusted with excess oxygen, 0.2833 g CO_2 and 0.1160 g H_2O are produced. What is the empirical formula of menthol?

$0.07731\,g\,C\left(\frac{1\,mol\,C}{12.01\,g\,C}\right) = 6.437 \times 10^{-3}\,mol\,C / 6.444 \times 10^{-4} = 10\,mol\,C$

a) $C_1H_2O_3$ b) C_2H_4O c) C_3H_5O d) $C_6H_{10}O_2$ e) $C_{10}H_{20}O$

$0.01298\,g\,H\left(\frac{1\,mol\,H}{1.008\,g}\right) = 0.01288\,mol\,H / 6.444 \times 10^{-4} = 20\,mol\,H$

$0.01031\,g\,O\left(\frac{1\,mol\,O}{16.00\,g}\right) = 6.444 \times 10^{-4}\,mol\,O / 6.444 \times 10^{-4} = 1\,mol\,O$

$C_{10}H_{20}O$ = empirical formula

Form $SiO_2 + 3C \rightarrow SiC + 2CO$ balanced equation

A|B
C|D

10 | 1
18 | 14

10. Silicon carbide, SiC, a hard material used as an abrasive on sandpaper, is prepared by the reaction of pure sand, SiO_2, with carbon, C. Carbon monoxide is the other product. Assuming 100% yield, what is the maximum amount of SiC that can be produced from the reaction of 1.11×10^3 g of C and excess SiO_2? The molar mass of C is 12.01 g/mol, the molar mass of SiO_2 is 60.09 g/mol, the molar mass of SiC is 40.10 g/mol, and the molar mass of CO is 28.01 g/mol.

$1.11 \times 10^3 \text{ gC} \left(\frac{1 \text{ mol C}}{12.01 \text{ g}}\right)\left(\frac{1 \text{ mol SiC}}{3 \text{ mol C}}\right)\left(\frac{40.10 \text{ g}}{\text{mol SiC}}\right) = 1.24 \times 10^3 \text{ g SiC}$

a) 7.40×10^2 g SiC b) 1.24×10^3 g SiC c) 2.47×10^3 g SiC

d) 3.71×10^3 g SiC e) 5.56×10^3 g SiC

empirical formula mass $\approx 3(12) + 2(1) + 35.5 = 73.5$ g/mol

11 | 2
19 | 15

11. A compound has an empirical formula of C_3H_2Cl. If the density of the gaseous compound is 2.25 g/L at 120.°C and 250. torr, what is the molecular formula of the compound?

Molar mass $= M = \frac{dRT}{P} = \frac{2.25 \text{ g/L}(0.08206)(393 \text{ K})}{250. \text{ torr}\left(\frac{1 \text{ atm}}{760 \text{ torr}}\right)} = 220.6$ g/mol

a) C_3H_2Cl b) $C_6H_4Cl_2$ c) $C_9H_6Cl_3$ d) $C_{12}H_8Cl_4$ e) $C_{15}H_{10}Cl_5$

$\frac{\text{molar mass}}{\text{empirical mass}} = \frac{220.6}{73.5} = 3$; molecular formula $= C_9H_6Cl_3$

12 | 3
20 | 16

12. Which of the following three compounds (a-c) has the largest mass percent of carbon?

a) CH_2O
b) $C_2H_4O_2$
c) $C_6H_{12}O_6$
d) All of these compounds (a-c) have the same mass percent of carbon present.

All of these compound have the same empirical formula of CH_2O. All these compounds will have the same mass percent of C, H, and O.

Consider the following gases for the next two questions:

Ne N_2 Ar H_2

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

13 | 4
21 | 17

13. Which gas has the smallest average kinetic energy at 300. K?

Because all of these gas samples are at 300. K, all will have the same KE_{Ave}.

a) Ne b) N_2 c) Ar d) H_2

e) All of the gases have the same average kinetic energy at 300. K.

14 | 5
22 | 18

14. Which gas has the slowest average velocity at 300. K?

$KE = \frac{1}{2}mv^2$; at constant temp of 300 K, the lightest gas has the fastest average velocity.

a) Ne b) N_2 c) Ar d) H_2

20 g/mol 28 g/mol 40 g/mol 2 g/mol

e) All of the gases have the same average velocity at 300. K.

The slowest gas will have the largest mass. This is Ar.

Form A|B C|D

$2Al(NO_3)_3(aq) + 3K_2CO_3(aq) \rightarrow Al_2(CO_3)_3(s) + 6KNO_3(aq)$

This is the balanced formula equation. K^+ and NO_3^- are the spectator ions. The net ionic equation is: $2Al^{3+}(aq) + 3CO_3^{2-}(aq) \rightarrow Al_2(CO_3)_3(s)$

15|18 6|9

15. When aluminum nitrate [$Al(NO_3)_3$] reacts with potassium carbonate (K_2CO_3), a precipitate forms. Which of the following is the correct net ionic equation for the precipitation reaction?

a) $K^+(aq) + NO_3^-(aq) \rightarrow KNO_3(s)$

b) $2\ Al^+(aq) + CO_3^{2-}(aq) \rightarrow Al_2CO_3(s)$

c) $K^{2+}(aq) + 2\ NO_3^-(aq) \rightarrow K(NO_3)_2(s)$

d) $Al^{3+}(aq) + 3\ CO_3^-(aq) \rightarrow Al(CO_3)_3(s)$

e) $2\ Al^{3+}(aq) + 3\ CO_3^{2-}(aq) \rightarrow Al_2(CO_3)_3(s)$

If $Al(NO_3)_3$ is limiting: $0.0750\,L\left(\frac{0.200\ mol\ Al(NO_3)_3}{L}\right)\left(\frac{1\ mol\ Al_2(CO_3)_3}{2\ mol\ Al(NO_3)_3}\right) = 0.00750\ mol\ Al_2(CO_3)_3$

16|19 7|10

16. If 75.0 mL of 0.200 *M* $Al(NO_3)_3$ reacts with 100.0 mL of 0.200 *M* K_2CO_3, how many moles of precipitate can form assuming 100% yield?

If K_2CO_3 limiting: $0.1000\,L\left(\frac{0.200\ mol\ K_2CO_3}{L}\right)\left(\frac{1\ mol\ Al_2(CO_3)_3}{3\ mol\ K_2CO_3}\right) = 0.00667\ mol\ Al_2(CO_3)_3$

a) 0.0200 mol b) 0.0150 mol c) 0.00750 mol d) 0.00667 mol e) 0.00500 mol

K_2CO_3 limits and 0.00667 mol $Al_2(CO_3)_3(s)$ can form.

17|20 8|11

$mol\ NO_3^- = 0.0750\,L\left(\frac{0.200\ mol\ Al(NO_3)_3}{L}\right)\left(\frac{3\ mol\ NO_3^-}{mol\ Al(NO_3)_3}\right) = 0.0450\ mol\ NO_3^-$

17. If 75.0 mL of 0.200 *M* $Al(NO_3)_3$ reacts with 100.0 mL of 0.200 *M* K_2CO_3, what is the concentration of nitrate ions after the reaction has gone to completion?

Total volume solution = 75.0 + 100.0 = 175.0 mL = 0.175 L

a) 0.600 *M* b) 0.257 *M* c) 0.200 *M* d) 0.189 *M* e) 0.107 *M*

$M_{NO_3^-} = \frac{mol\ NO_3^-}{total\ volume} = \frac{0.0450\ mol\ NO_3^-}{0.175\,L} = 0.257\,M$

18|21 9|12

18. Consider the following **unbalanced** equation:

Initial	10 molecules	10 molecules	0	0
Change	−8	−10	+8	+12
After	2 molecules	0	8 molecules	12 molecules

$4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(g)$

A container initially has 10 molecules of O_2 and 10 molecules of NH_3. Assuming the NH_3 and O_2 molecules react to completion by the above reaction, how many total molecules (reactant molecules plus product molecules) will be present in the container?

See ICA table above. Note that O_2 is limiting.

a) 18 molecules b) 20 molecules c) 22 molecules

Total molecules after rxn = 2 + 8 + 12 = 22 molecules

d) 24 molecules e) 26 molecules

$H_2SO_4(aq) + 2\ NaOH(aq) \rightarrow 2\ H_2O(l) + Na_2SO_4(aq)$

19|22 10|13

19. A 10.00-mL sample of sulfuric acid (H_2SO_4) from a car battery requires 35.08 mL of 2.13 *M* sodium hydroxide (NaOH) for complete reaction. What is the molarity of the sulfuric acid?

$mol\ H_2SO_4 = 0.03508\,L\left(\frac{2.13\ mol\ NaOH}{L}\right)\left(\frac{1\ mol\ H_2SO_4}{2\ mol\ NaOH}\right) = 3.736 \times 10^{-2}\ mol\ H_2SO_4$

a) 3.74 *M* b) 7.48 *M* c) 14.9 *M* d) 2.50 *M* e) 5.00 *M*

$M_{H_2SO_4} = \frac{mol\ H_2SO_4}{volume} = \frac{3.74\ mol\ H_2SO_4}{0.01000\,L} = 3.74\,M$

Form A|B C|D

Let H_xA = ascorbic acid where x = number of acidic H^+ ions.

$H_xA + x\,NaOH \rightarrow x\,H_2O + Na_xA$

Molar mass $C_6H_8O_6$ = 176 g/mol

mol H_xA = 1.76 g (1 mol H_xA / 176 g) = 0.0100 mol H_xA

20|10 23|4

20. Ascorbic acid, a weak acid commonly known as vitamin C, has a molecular formula of $C_6H_8O_6$. A 1.76 g sample of ascorbic acid dissolved in some water requires 25.0 mL of 0.800 *M* NaOH for complete neutralization. Which of the following is the best formula for ascorbic acid?

mol NaOH = 0.0250 L (0.800 mol NaOH / L) = 0.0200 mol NaOH

a) $HC_6H_7O_6$
b) $H_2C_6H_6O_6$
c) $H_3C_6H_5O_6$
d) $H_4C_6H_4O_6$
e) $H_8C_6O_6$

mol NaOH / mol H_xA = x/1 = x (from balanced equation)

mol NaOH / mol H_xA = 0.0200 mol NaOH / 0.0100 mol H_xA = 2 = x

Ascorbic acid is a diprotic acid. Formula = $H_2C_6H_6O_6$

21|11 24|5

21. A 2.00 L sample of O_2(g) was collected over water at a total pressure of 785 torr and 25°C. When the O_2(g) was dried (water vapor removed), the gas had a volume of 1.94 L at 25°C and 785 torr. Calculate the vapor pressure of water at 25°C.

$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$, For just O_2, n_{O_2} and T are constant, so $P_1V_1 = P_2V_2$.

a) 24 torr b) 15 torr c) 30. torr d) 78 torr e) 785 torr

$P_1 = \frac{P_2V_2}{V_1} = \frac{785\text{ torr}(1.94\text{ L})}{2.00\text{ L}} = 761\text{ torr} = P_{O_2}$, $P_{H_2O} = P_{TOT} - P_{O_2} = 785 - 761$

P_{H_2O} = 24 torr

22|12 25|6

22. If a student needs to prepare a 0.10 *M* solution of $NaHCO_3$, what volume of solution can be prepared using 0.37 g of $NaHCO_3$? (The molar mass of $NaHCO_3$ is 84.01 g/mol.)

0.37 g $NaHCO_3$ (1 mol $NaHCO_3$ / 84.01 g) (1 L $NaHCO_3$ / 0.10 mol $NaHCO_3$) = 0.0441 L = 44 mL can form.

a) 3.5 mL b) 4.4 mL c) 16 mL d) 35 mL e) 44 mL

23|13 26|7

23. Sulfuric acid can be produced by the following 3-step process:

$4\,FeS_2 + 11\,O_2 \rightarrow 2\,Fe_2O_3 + 8\,SO_2$
$2\,SO_2 + O_2 \rightarrow 2\,SO_3$
$SO_3 + H_2O \rightarrow H_2SO_4$

Use balanced equation to follow sulfur in FeS_2 to sulfur in H_2SO_4.

How many moles of H_2SO_4 can be produced when 5.00 moles of FeS_2 reacts completely with excess O_2 and H_2O? Assume 100% yield for each reaction.

5.00 mol FeS_2 (8 mol SO_2 / 4 mol FeS_2)(2 mol SO_3 / 2 mol SO_2)(1 mol H_2SO_4 / 1 mol SO_3) = 10.0 mol H_2SO_4

a) 2.50 mol b) 5.00 mol c) 10.0 mol d) 12.2 mol e) 20.0 mol

24|14 27|8

24. Ar boils at a temperature very close to the boiling point of one of the following substances. Which substance below has a boiling point similar to that of Ar?

a) HF
b) Cl_2
c) Ne
d) F_2
e) HCl

Ar is nonpolar with a molar mass of ~40 g/mol. Ar only exhibits London dispersion forces. Ar will boil at about the same temp. as another nonpolar compound having about the same molar mass. This is F_2 which is nonpolar and has a molar mass of 38 g/mol. Ne at 20 g/mol will have a lower bp than Ar. Cl_2 at 70.9 g/mol will have a higher bp than Ar. HF can H-bond, so it has a higher bp. HCl also has a higher boiling point since it is polar (has LDF + dipole forces).

Form A|B C|D

Pressure and temperature are constant, so V∝n. This tells us that the balanced equation gives mol ratios but also gives volume ratios. Since H_2 is used up faster than C_2H_2 (from the 2:1 ratio in the balanced equation) then H_2 is limiting. In 1 minute:

25|15 11|1

25. Ethyne can be converted to ethane by the reaction:

$$C_2H_2(g) + 2\,H_2(g) \rightarrow C_2H_6(g)$$

$n_{H_2} = \frac{PV}{RT} = \frac{25.0\,atm(2000\,L)}{0.08206(573\,K)} = 1063.4\,mol\,H_2$

$mol\,C_2H_2$ produced (in theory) $= 1063.4\,mol\,H_2\left(\frac{1\,mol\,C_2H_6}{2\,mol\,H_2}\right) = 531.7\,mol\,C_2H_6$

C_2H_2 flows into a reaction vessel at 25.0 atm and 300.°C with a flow rate of 2000. L/min. Hydrogen at 25.0 atm and 300.°C flows into the reaction vessel also at a flow rate of 2000. L/min. If 480 mol of C_2H_6 are formed per minute of reaction, what is the percent yield of the reaction?

a) 90.% b) 80.% c) 50.% d) 45% e) 40.%

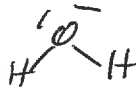
$\%\,yield = \frac{actual}{theoretical} \times 100 = \frac{480\,mol\,C_2H_6}{531.7\,mol\,C_2H_6} \times 100 = 90.3\% = 90.\%$

26|16 12|2

26. Consider the following compounds:

Compound

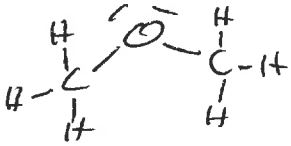
water, H_2O H-bonding



methanol, CH_3OH H-bonding

ethanol, CH_3CH_2OH H-bonding

dimethyl ether, $CH_3–O–CH_3$ no H-bonding



NO O–H covalent bonds in this compound.

ethylene glycol, $HO–CH_2–CH_2–OH$ H-bonding

Which compound will have the highest vapor pressure at room temperature?

The substance with the weakest intermolecular forces has the highest vapor pressure. Only dimethyl ether can not form the relatively strong H-bonding interactions, so dimethyl ether has the weakest IMF and highest vapor pressure.

a) water, b) methanol c) ethanol

d) dimethyl ether e) ethylene glycol

27|17 13|3

27. What happens to the vapor pressure of a gas over a liquid as the strength of the intermolecular forces increase (at constant temperature)?

T a) Vapor pressure decreases because the molecules are held more strongly in the liquid phase and not as many molecules can escape into the gas phase.

no b) Vapor pressure decreases because the molecules do not have as much kinetic energy.

no c) Vapor pressure increases because the molecules in the gas phase attract more molecules into the gas phase.

no d) Vapor pressure increases because a higher temperature is needed to vaporize the liquid and pressure is greater at higher temperature.

no e) Vapor pressure depends on the identity of the substance; some substances will have a higher vapor pressure with increasing intermolecular forces and some substances will have a lower vapor pressure with increasing intermolecular forces.

Form A|B C|D

LiF is ionic and the other compounds are covalent. Ionic compounds have much stronger IMF as compared to covalent compounds. LiF boils at highest temperature. NH_3 can H-bond, so NH_3 has next highest boiling point: NO and O_2 have about the same molar mass, so have approximately equivalent London Dispersion forces. But NO is polar, so it has additional dipole forces that the nonpolar O_2 molecules do not have. NO boils at a higher temp. than O_2. Putting all this together, the bp order is $O_2 < NO < NH_3 < LiF$.

28|28 28|28

28. Rank the following substances in order of increasing boiling point (lowest boiling point to highest boiling point).

LiF NH_3 NO O_2

a) $O_2 < NO < NH_3 < LiF$ b) $NO < O_2 < LiF < NH_3$

c) $LiF < NH_3 < NO < O_2$ d) $LiF < NH_3 < O_2 < NO$

e) $LiF < NO < O_2 < NH_3$

29|29 29|29

29. Shown below are the postulates of the kinetic molecular theory:

I. Gases are mostly empty space; the volume of the gas particles is negligible.
II. Gas particles are in constant random motion.
III. Gas particles neither attract nor repel each other.
IV. Pressure is due to collisions of gas particles with the walls of the container.
V. The average kinetic energy of a gas sample is proportional to the Kelvin temperature.

For real gases, gas particles do have a volume and gas particles do attract one another with intermolecular forces.

Which of the above postulates do **not** always hold true for real gases?

a) I and II b) I and III c) III and IV d) II and IV e) II and III

NR = no reaction

30|30 30|30

30. Consider the products for the following four aqueous reactions:

I. $K_2S(aq) + NaCl(aq) \rightarrow$ NR
KCl + Na_2S are soluble.

II. $AgNO_3(aq) + MgCl_2(aq) \rightarrow$ AgCl(s) forms.

III. $CuCl_2(aq) + Na_2SO_4(aq) \rightarrow$ NR
$CuSO_4$ and NaCl are soluble.

IV. $Li_2CO_3(aq) + Ni(NO_3)_2(aq) \rightarrow NiCO_3(s)$ forms.

In how many of the above four reactions does a precipitate form?

a) 0 (none) b) 1 c) 2 d) 3

e) 4 (A precipitate forms in all the reactions.)

31. 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