Chemistry 1250 - Sp22
Practice Midterm 3

1. Consider a cylinder fitted with a movable piston that can expand against the atmosphere. The initial pressure, volume and absolute temperature inside the cylinder are P_i, V_i and T_i. What is the new **temperature** of the system when the **pressure** is **tripled** and the **volume** is **decreased** to **one half** of the **original** volume?

   a) $(4/9)\ T_i$ b) $6\ T_i$ c) $(3/2)\ T_i$ d) $(1/6)\ T_i$ e) $(2/3)\ T_i$

2. What **volume** will 1.60 g of O_2 occupy at STP? (atomic weights: O = 16.00)

   a) 44.8 L b) 22.4 L c) 11.2 L d) 2.24 L e) 1.12 L

3. The atmosphere in a sealed 1.0-L cylinder at 3.00 atm and 20.0°C contains hydrogen and helium. If the partial pressure of hydrogen is 0.20 atm., what is the **mass** (g) of **helium** in the cylinder? (atomic weights: He = 4.00, H = 1.008)

   a) 0.47 b) 0.32 c) 0.27 d) 3.2 e) 4.7

4. The empirical formula of a volatile liquid is C_2H_4O. A 0.345-gram sample of its vapor occupied 85.0 mL at 100.0°C and 0.942 atm. What is the **molecular formula** for the compound?
(Atomic weights: H = 1.008, C = 12.01, O = 16.00)

a) C_2H_4O b) $C_3H_6O_2$ c) $C_4H_8O_2$ d) $C_6H_{12}O_3$ e) $C_8H_{16}O_4$

5. A mixture of 0.50 mol Ne, 0.50 mol of CO and 0.50 mol of H_2S is introduced into a 10.0 L container at 25°C. The container has a pinhole leak. After a period of time: (atomic weights: H = 1.008, C = 12.01, O = 16.00, Ne = 20.18, S= 32.07)

a) the partial pressure of Ne exceeds that of CO and that of H_2S in the remaining gas

b) the partial pressure of CO exceeds that of Ne and that of H_2S in the remaining gas

c) the partial pressure of H_2S exceeds that of Ne and that of CO in the remaining gas

d) the partial pressures of CO and H_2S are equal and exceed that of Ne in the remaining gas

e) the partial pressures of the all the gases remain equal throughout this time

6. Which of the following, **a-d**, is **NOT** an assumption of the kinetic molecular theory for a gas?

a) Gases are made up of tiny particles in constant chaotic motion.

b) Gas particles are very small compared to the average distance between the particles.

c) Gas particles collide with the walls of their container in elastic collisions.

d) The average velocity of the gas particles is directly proportional to the absolute temperature.

e) Choose this answer if **ALL** statements, **a-d**, are **correct**.

7. The purpose of the van der Waals equation is to give calculated pressures which are closer to the real (measured) pressures than what is obtained by using the Ideal Gas Law. For CO_2 the van der Waals constants, a and b, are 3.59 L^2•atm/mol^2 and 0.0427 L/mol, respectively. For 1.000 mol of CO_2 at 0.0°C in a 3.000 L container one can conclude (to 4 s.f.).

a) The gas is behaving ideally.

b) The molecules experience higher net attraction to each other.

c) The volume of the gas molecules is now a significant fraction of the volume of the container.

d) The average molecular speed has increased.

e) no statement can be made without more information.

8. Calculate the **volume** of **boron hydride**, B_4H_{10}, at 755 torr and 33.0°C required to completely react with 15.7 L of oxygen, O_2, at the same temperature and pressure.
(M.wts. in amu: B_4H_{10} = 53.32, O_2 = 31.998, B_2O_3 = 69.62, H_2O = 18.015)

$$2\ B_4H_{10}(g) + 11\ O_2(g) \rightarrow 4\ B_2O_3(s) + 10\ H_2O(g)$$

a) 2.85 L b) 3.94 L c) 5.20 L d) 9.16 L e) 12.8 L

9. Which of the following statements is **INCORRECT**?

a) HF has a **greater** viscosity than HBr.

b) CH_3OH has a **lower** boiling point than CH_3NH_2.

c) The vapor pressure of solid CO_2 is **higher** than the vapor pressure of solid SO_2 at a given temperature.

d) CH_3F has **weaker** attractive forces than CH_3OH.

e) H_2O has a **higher** critical temperature than H_2S.

10. Which of the following compounds is **INCORRECTLY** paired with the intermolecular forces that exist between neighboring molecules?

a) SCl_6 London forces only

b) OF_2 London forces only

c) PBr_3 London forces, dipole-dipole forces

d) CH_3F London forces, dipole-dipole forces

e) $CH_3C(=O)OH$ London forces, dipole-dipole forces, hydrogen bonding

11. Calculate the amount of heat (kJ) required to heat 125 g of mercury (Hg) from 25.0°C to its boiling point (357°C) and then vaporize it? (specific heat of liquid Hg = 0.138 J/g•°C, ΔH_{vap} = 292 J/g)

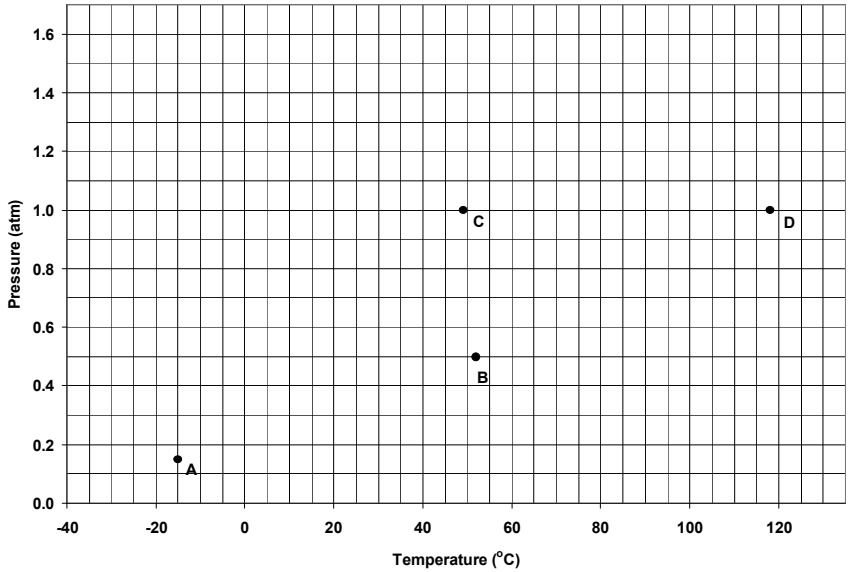
a) 42.2 kJ b) 47.4 kJ c) 30.8 kJ d) 36.5 kJ e) 5.73 kJ

For question 12, it would be helpful to sketch a phase diagram for an imaginary compound (the points are already plotted for you):

triple point = 52 °C, 0.5 atm critical point = 329 °C, 5.8 atm (not shown)

normal melting point = 49 °C normal boiling point = 118 °C

vapor pressure of solid at -15 °C = 0.15 atm



12. Which of the following statements is **INCORRECT** about the compound?

a) **Increasing** the **temperature** from 0 °C to 60 °C at 0.7 atm will cause **fusion** to occur.

b) The solid is **less** dense than the liquid.

c) The solid **can** melt at temperatures below 49 °C when the **pressure** is **increased**.

d) **Condensation** occurs if the pressure is increased from 0.1 atm to 0.5 atm at 0 °C.

e) The solid will **sublime** rather than melt when the temperature is **raised** if the **pressure** is **0.3** atm.

13. The unit cell of an ionic compound is described as having cations, A, in a simple cubic arrangement with cations, B, at the body center of the cube and anions, X, at the center of each face. What is the **empirical formula** of the compound?

a) ABX_3 b) AB_2X_2 c) AB_2X_4 d) A_2BX_2 e) $A_2B_2X_3$

14. An element crystallizes in a body centered cubic lattice and has a radius of 1.247 Å. The density is 7.20 g/cm^3. What is the **atomic weight**?

a) 45.0 b) 47.9 c) 52.0 d) 54.9 e) 55.8

15. Choose the member of each of the following pairs that are expected to have the **HIGHER** normal melting point.

SiC or H_2O HF or NaCl Mo or Sn Fe_2O_3 or KCl

a) SiC	NaCl	Sn	Fe_2O_3
b) SiC	NaCl	Mo	Fe_2O_3
c) SiC	HF	Mo	KCl
d) H_2O	NaCl	Mo	KCl
e) H_2O	HF	Sn	Fe_2O_3

16. Which of the following statements is(are) **FALSE**?

1. The **hexagonal** close-packed structure is **ABABAB**---.
2. **Neighboring molecules** in a **molecular solid** are held together by **covalent bonds**.
3. Ionic substances are **good conductors** of electricity.
4. Atoms in a solid consisting of only one element has **6 nearest neighbors** if the crystal structure has a face-centered cubic structure.
5. LiF has the NaCl structure. Thus, each Li^+ has **6 nearest neighbor** F^- ions.

a) 3, 4 b) 1, 3, 4 c) 2, 3, 5 d) 3, 4, 5 e) 2, 3, 4

17. For which of the following combinations would the **solubility** be the **LOWEST**?

a) Na_2SO_4 in CCl_4

b) HF in C_2H_5OH

c) CH_3CN in H_2O

d) Br_2 in C_6H_6

e) NH_4Cl in H_2O

18. Which of the following, **a-d**, **INCORRECTLY** identifies the most important **solute-solvent** attractions in the given solution?

a) C_2H_5-O-C_2H_5 in H_2O	London, dipole-dipole and hydrogen bonding
b) $CaCl_2$ in CH_3OH	ion-dipole
c) CH_3NH_2 in CCl_4	London
d) CH_3OH in $CHBr_3$	London, dipole-dipole and hydrogen bonding

e) Choose this answer if **ALL** statements, **a-d**, are **correct**.

19. An aqueous solution is 5.31**%** (by mass) glucose, $C_6H_{12}O_6$. What **mass** (in g) of solution is required to give 0.0109 moles of $C_6H_{12}O_6$? (At. Wts.: H = 1.008, C = 12.01, 0 = 16.00; Mol. Wts.: $C_6H_{12}O_6$ = 180.16, H_2O = 18.02)

a) 14.0 b) 28.0 c) 37.0 d) 45.0 e) 50.0

20. Which of the following aqueous solutions should have the **HIGHEST** osmotic pressure?

a) 0.012 M K_2SO_4 at 25°C

b) 0.011 M $FeCl_3$ at 50°C

c) 0.011 M $FeCl_3$ at 25°C

d) 0.02 M KCl at 25°C

e) 0.02 M KCl at 50°C

21. What **mass** of sucrose, $C_{12}H_{22}O_{11}$ should be dissolved in 4.00 x 10^2 g water to produce a solution that boils at 101.36°C? (K_b = 0.512°C/m) (Mol. Wts.: $C_{12}H_{22}O_{11}$ = 342.30, H_2O = 18.02)

a) 241 g b) 273 g c) 305 g d) 364 g e) 392 g

22. Which of the following statements is **FALSE**?

a) The vapor pressure of a solution with a nonvolatile solute is due just to the solvent.

b) A 0.10 ***m*** solution of $CaSO_4$ would be expected to exhibit more ion pairing than a 0.10 ***m*** solution of KCl.

c) The vapor pressure of a solution of a nonvolatile solute is lower than that of the pure solvent.

d) The vapor pressure of a solution increases with increasing temperature.

e) In water, hydrophilic colloid particles tend to separate from the water.

23. The following rate data were obtained at 25°C for the indicated reaction. What is the rate-law expression for the reaction?

$$A + 2\,B \rightarrow 3\,C$$

Exp.	[A] (M)	[B] (M)	rate of reaction (M/min)
1	0.20	0.20	2.00×10^{-4}
2	0.20	0.40	1.60×10^{-3}
3	0.40	0.80	1.024×10^{-1}

a) rate = $k[A]\,[B]$ b) rate = $k[A]\,[B]^2$ c) rate = $k[A]^2[B]^2$

d) rate = $k[A]^2[B]^3$ e) rate = $k[A]^3\,[B]^3$

24. A reaction is **second order** in **A**, **1/2 order** in **B** and **3/2 order** in **C**. The initial rate of the reaction is 1.0×10^{-6} M/sec and the rate constant is 70.7 $M^{-3}s^{-1}$. If the initial concentration of A is 0.0100 M and B is 0.0200 M what is the **initial concentration** of **C**?

a) 3.0×10^{-5} M b) 0.0050 M c) 0.010 M d) 0.020 M e) 0.040 M

25. The reaction A → B + C is known to be **zero**-order in A with a rate constant of 5.0×10^{-2} M/s at 25°C. An experiment was run at 25°C where $[A]_0 = 1.0$ M. After 5.0 seconds, the **rate** (M/s) is

a) 5.0×10^{-2} b) 2.5×10^{-2} c) 1.25×10^{-2}

d) 1.0×10^{-3} e) 5.0×10^{-3}

26. The reaction $A_2 \rightarrow B + C$ obeys the rate law

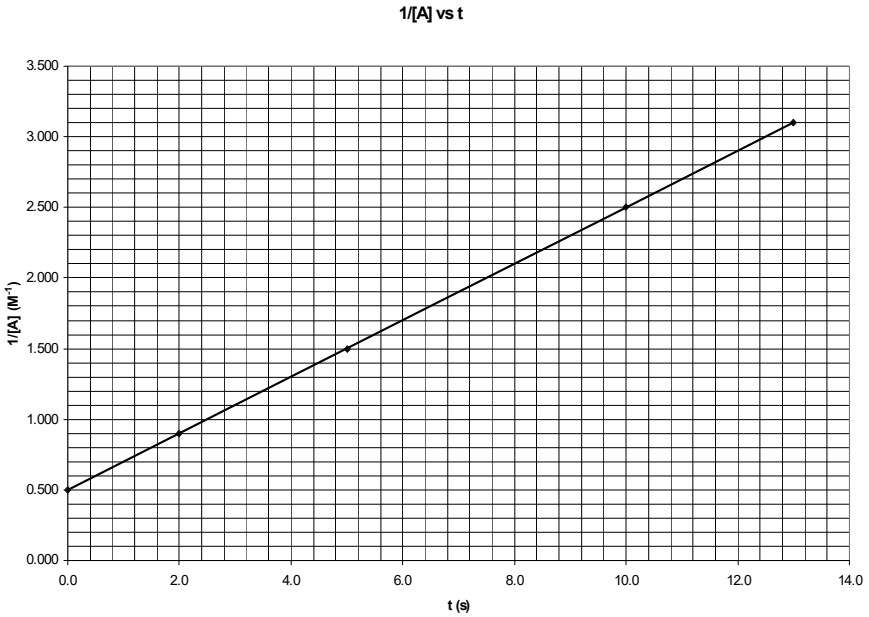
rate = $(1.0 \times 10^{-2}\ min^{-1})\ [A_2]$ at 298 K

How **long** (in min) will it take for the reactant to reach 60% of its initial concentration?

a) 3.9 b) 5.1 x 10 c) 9.0 x 10

d) 6.5×10^{2} e) 1.5×10^{3}

27. The following graph is obtained from concentration and time data. What is the **first half-life**, $t_{1/2}$ (secs) (at the start of the reaction)?



a) 2.50 b) 3.47 c) 5.00 d) 10.0 e) 0.347

28. The rate constant for a reaction at 40.0°C is exactly three times that at 20.0°C. Calculate the Arrhenius **energy of activation**, E_a, for the reaction.

a) 30.0 kJ/mol b) 366 kJ/mol c) 41.9 kJ/mol

d) 3.20 kJ/mol e) 200 kJ/mol

29. Given the following mechanism, which answer below contains all species which may be classified as **catalyst(s)** in the formation of XO_2 from X and O_2 ($X + O_2 \rightarrow XO_2$)?

$$X + YO_2 \longrightarrow XO + YO$$
$$XO + YO \longrightarrow XO_2 + Y$$
$$Y + O_2 + Z \longrightarrow YO + ZO$$
$$YO + ZO \longrightarrow YO_2 + Z$$

a) YO_2 only b) YO and ZO c) XO, YO_2, and Z

d) XO, YO, Y and ZO e) YO_2 and Z

30. Consider the following hypothetical reaction and the established rate law. Select an acceptable mechanism.

$A_2 + B_2 \rightarrow X + Y$ rate = k $[A_2]$ $[B_2]/[Y]$ (exp rate law)

a) $A_2 \rightleftarrows 2\,A$ (fast)

$B_2 + A \rightarrow C$ (slow)

$C + A \rightarrow X + Y$ (fast)

b) $A_2 + B_2 \rightleftarrows C$ (fast)

$C \rightarrow X + Y$ (slow)

c) $A_2 \rightleftarrows C + Y$ (fast)

$B_2 + C \rightarrow X$ (slow)

d) $B_2 \rightarrow 2\,B$ (slow)

$B + A_2 \rightarrow C$ (fast)

$C + B \rightarrow X + Y$ (fast)

e) $B_2 \rightleftarrows 2\,B$ (fast)

$B \rightarrow C + Y$ (slow)

$A_2 + C + B \rightarrow X$ (fast)

USEFUL INFORMATION

R = 0.08206 L-atm/mol-K = 8.3145 J/mol-K

Avogadro's number = 6.02×10^{23} particles/mole

$1\ \text{Å} = 1 \times 10^{-10}\ \text{m} = 1 \times 10^{-8}\ \text{cm}$

molar volume at STP = 22.41L

$KE = \frac{1}{2}\, mv^2$, $KE_{avg} = \frac{1}{2}\, mu^2$, total average KE per mole = 3/2 RT

$$S_{gas} = k_H * P_{gas}$$

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

$$u = \sqrt{\frac{3RT}{M}}$$

$$\mathcal{M} = \frac{RT}{P} D$$

$$ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta Hv}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right) \qquad \log\left(\frac{P_2}{P_1}\right) = \frac{\Delta Hv}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right) \qquad ln(P) = \frac{-\Delta Hv}{R}\left(\frac{1}{T}\right) + C$$

$P_A = X_A P_A^{\circ}$ $\Delta P = X_{solute} P_A^{\circ}$ $\Delta T = iK_f m$ $\Delta T = iK_b m$ $\Pi = iMRT$

$$[A]_t = -kt + [A]_0 \qquad \frac{1}{[A]_t} = kt + \frac{1}{[A]_0} \qquad \ln[A]_t = -kt + \ln[A]_0$$

$$t_{1/2} = \frac{0.693}{k} \qquad t_{1/2} = \frac{1}{k[A]_0} \qquad t_{1/2} = \frac{[A]_0}{2k}$$

$$k = Ae^{-E_a/RT} \qquad \ln(k) = -\left(\frac{E_a}{R}\right)\left(\frac{1}{T}\right) + \ln(A)$$

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right) \qquad \log\left(\frac{k_2}{k_1}\right) = \frac{E_a}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB		IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1.008 **H** 1																4.003 **He** 2
2	6.941 **Li** 3	9.012 **Be** 4										10.81 **B** 5	12.011 **C** 6	14.007 **N** 7	15.999 **O** 8	18.998 **F** 9	20.179 **Ne** 10
3	22.990 **Na** 11	24.305 **Mg** 12										26.98 **Al** 13	28.09 **Si** 14	30.974 **P** 15	32.06 **S** 16	35.453 **Cl** 17	39.948 **Ar** 18
4	39.098 **K** 19	40.08 **Ca** 20	44.96 **Sc** 21	47.88 **Ti** 22	50.94 **V** 23	52.00 **Cr** 24	54.94 **Mn** 25	55.85 **Fe** 26	58.93 **Co** 27	58.69 **Ni** 28	63.546 **Cu** 29	65.38 **Zn** 30	69.72 **Ga** 31	72.59 **Ge** 32	74.92 **As** 33	78.96 **Se** 34	79.904 **Br** 35	83.80 **Kr** 36
5	85.47 **Rb** 37	87.62 **Sr** 38	88.91 **Y** 39	91.22 **Zr** 40	92.91 **Nb** 41	95.94 **Mo** 42	98 **Tc** 43	101.07 **Ru** 44	102.91 **Rh** 45	106.42 **Pd** 46	107.87 **Ag** 47	112.41 **Cd** 48	114.82 **In** 49	118.69 **Sn** 50	121.75 **Sb** 51	127.60 **Te** 52	126.90 **I** 53	131.39 **Xe** 54
6	132.91 **Cs** 55	137.33 **Ba** 56	138.91 **La** 57	178.39 **Hf** 72	180.95 **Ta** 73	183.85 **W** 74	186.21 **Re** 75	190.23 **Os** 76	192.22 **Ir** 77	195.08 **Pt** 78	196.97 **Au** 79	200.59 **Hg** 80	204.38 **Tl** 81	207.2 **Pb** 82	208.98 **Bi** 83	209 **Po** 84	210 **At** 85	222 **Rn** 86
7	223 **Fr** 87	226.03 **Ra** 88	227.03 **Ac** 89	261 **Rf** 104	262 **Ha** 105	263 **Sg** 106	262 **Ns** 107	265 **Hs** 108	266 **Mt** 109	269 110	272 111	277 112						

Lanthanide Series	140.12 **Ce** 58	140.91 **Pr** 59	144.24 **Nd** 60	145 **Pm** 61	150.36 **Sm** 62	151.96 **Eu** 63	157.25 **Gd** 64	158.93 **Tb** 65	162.50 **Dy** 66	164.93 **Ho** 67	167.26 **Er** 68	168.93 **Tm** 69	173.04 **Yb** 70	173.04 **Lu** 71
Actinide Series	232.04 **Th** 90	231.04 **Pa** 91	238.03 **U** 92	237.05 **Np** 93	**Pu** 94	**Am** 95	**Cm** 96	**Bk** 97	**Cf** 98	**Es** 99	**Fm** 100	**Md** 101	**No** 102	**Lr** 103

A PERIODIC CHART OF THE ELEMENTS
(Based on ^{12}C)

Chemistry 1250

Answers to Practice Midterm 3

1) C	11) A	21) D
2) E	12) D	22) E
3) A	13) A	23) E
4) D	14) C	24) C
5) C	15) B	25) A
6) D	16) E	26) B
7) B	17) A	27) A
8) A	18) D	28) C
9) B	19) C	29) E
10) B	20) B	30) C