CHM-102 Exam II Spring 2002

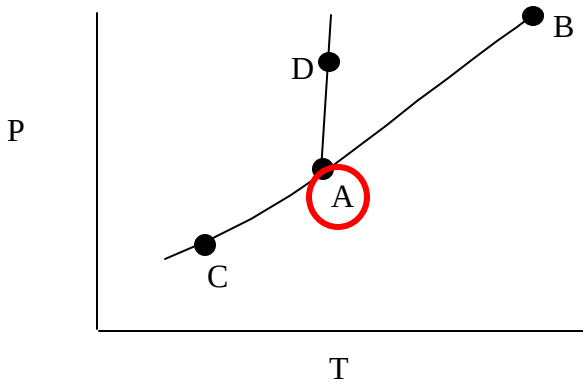
Name _____ *Key* _____ Raw Score _____

T-Score _____

- You will have **one hour** to complete the exam.
- There is **one best answer** to each question and all questions are worth the same number of points.
- ***Sign* your name on the answer sheet** above the General Purpose logo on the front.
- Print and fill in your name (**last name**-space-**first name**) on the back of your answer sheet.
- Be sure to mark the correct answers on your exam booklet so you can compare your answers to the answer key.
- An answer key will be posted immediately following the test at http://aa.uncwil.edu/chm102/keys/. It will also be posted outside DO-236.

1. Which point on the phase diagram below corresponds to the triple point?

   a. A b. B c. C d. D



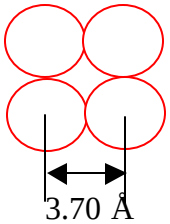
2. How much heat (in kJ) is required to vaporize 100 mL of H_2O given that its density is 1.0 g/mL and its ΔH_{vap} = 40.7 kJ/mol?

   a. 226 kJ b. 733 kJ c. 40.7 kJ d. 4.07 kJ

 # kJ = (100 g H_2O)(1 mol H_2O/18.0 g H_2O)(40.7 kJ/mol) = 226 kJ

3. Gallium crystallizes in a simple cubic unit cell. The length of the unit cell edge is 3.70 Å. What is the radius (in Å) of the Ga atom?

   a. 7.40 Å b. 3.70 Å c. 1.85 Å d. 0.930 Å



4. Which one of the following solids has the lowest melting point?

a. CH_4 b. GeH_4 c. SiH_4 d. SnH_4

The member of the series with the lowest molecular weight will have the smallest London forces and therefore the lowest melting point.

5. Which of the following will hydrogen bond with H_2O when dissolved in water?

a. H_2S b. SiH_4 c. HCl d. NH_3

Only NH_3 from this series can form hydrogen bonds with water. None of the other members of the series contains O, N, or F atoms.

6. Which one of the following is the most soluble in CH_3OH?

a. CCl_4 b. CO_2 c. O_2 d. CH_3CH_2OH

"Like dissolves like". The intermolecular forces in CH_3CH_2OH are most like those in CH_3OH.

7. What is the major intermolecular attractive force responsible for dissolution of $CO_2(l)$ in $CF_4(l)$?

a. hydrogen bonding
b. dipole-dipole interactions
c. London dispersion forces
d. ion-dipole interactions

Both CO_2 and CF_4 are nonpolar molecules.

8. If you drink a 500 mL glass of tap water that is 0.01 part per million (ppm) lead, how many grams of lead have you consumed? (Assume the density of the solution is 1.0 g/mL.)

a. 5×10^{-8} g b. 5×10^{-6} g c. 0.005 g d. 5 g

 # g Pb = (0.01 mg Pb/kg soln)(0.500 kg soln)(1 g/1000 mg) = 5×10^{-6} g

9. A solution is prepared by dissolving 23.7 g of $CaCl_2$ (MW=111 g/mol) in 375 g of water. The density of the resulting solution is 1.05 g/mL. What is the molality of the $CaCl_2$ solution?

a. 0.569 m b. 1.12 m c. 1.14 m d. 5.94 m

m = (23.7 g/111 g mol^{-1})/(0.375 kg solvent) = 0.569 m

10. What is the molarity of **Cl^-** ions in the $CaCl_2$ solution described in question 9?

a. 0.214 M b. 0.427 M c. 0.562 M d. 1.12 M

To find the molarity we must know the volume of the solution. This can be calculated from the mass of the solution since we are given the density of the solution.

L soln = (23.7 g + 375 g)(1 mL soln/1.05 g soln) = 0.3797 L

M_{Cl^-} = (2)(23.7 g)/111 g mol^{-1})/(0.3797 L) = 1.12 M

11. Which one of the following concentration expressions will vary with temperature?

a. mole fraction b. molarity c. molality d. ppm

Molarity contains a volume term. The volume of a solution is a function of its temperature. None of the other concentration units are based on volume.

12. Which one of the following conditions is most effective for increasing the solubility of CO_2(g) in a soft drink?

a. decreasing CO_2(g) pressure and lowering the soft drink temperature
b. increasing total pressure by adding N_2(g) and raising the soft drink temperature
c. increasing CO_2(g) pressure and lowering the soft drink temperature
d. increasing CO_2(g) pressure and raising the temperature of the soft drink

Henry's Law states that the concentration of a gas in a solution will increase with increasing pressure of the gas above the solution. Also, the concentration of a gas in a solution always decreases with increasing temperature.

13. The exothermic step in the dissolution of NaCl in water is

a. separation of the ions in the salt
b. separation of the water molecules
c. hydration (solvation) of the ions of the salt by the water molecules
d. all these step are exothermic because the salt dissolved

Energy is released (exothermic process) when water molecules hydrate the Na^+ and Cl^- ions through ion-dipole interactions.

14. Which one of the following solutions will have the highest boiling point?

a. 0.1 m Na_2SO_4 *i = 3* $\Delta t_b = iK_bm$
b. 0.25 m CH_3OH *i = 1*
c. 0.20 m NaCl *i = 2*
d. 0.20 m $Al(NO_3)_3$ *i = 4*

15. Determine the boiling point of a solution prepared by dissolving 56.0 g of Na_2SO_4 (FW = 142) in 350 g of water. The K_b for water is 0.52 °C/m.

a. 98.2 ° b. 100.6 °C c. 101.8 °C d. 104.1 °C

$\Delta t_b = iK_bm = (3)(0.52)(56/142/.350) = 1.8$ °C
The new boiling point would be 100 + 1.8 = 101.8 °C

16. Consider the table below for the reaction A + B → C.

Time (s)	[A] (mol/L)
0.0	0.200
10.0	0.140
20.0	0.100
30.0	0.071
40.0	0.050

What is the average rate (mol/L· s) between 10 s and 20 s?

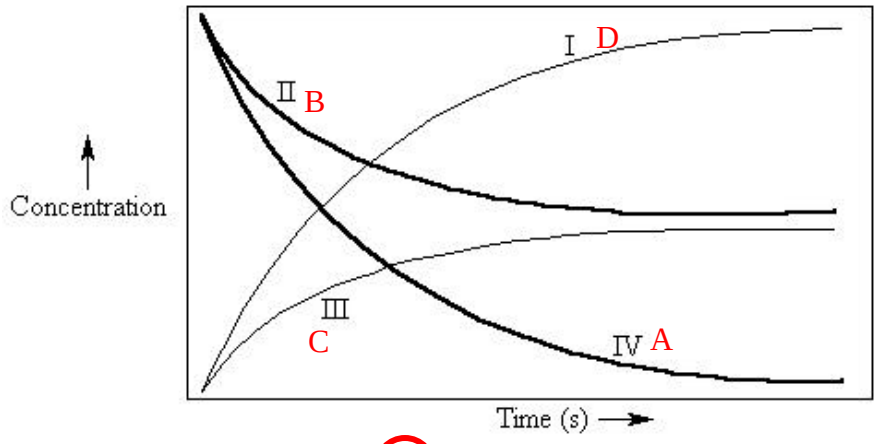
a. 9.5×10^{-3} b. 8.0×10^{-3} c. 5.0×10^{-3} d. 4.0×10^{-3}

Rate = $-\Delta[A]/\Delta t = -(0.100 - 0.140)/(20.0 - 10.0) = 4.0 \times 10^{-3}$

17. Consider the following reaction.

$$2\ A + B \longrightarrow C + 2\ D$$

The graph below shows how the concentrations of reactants and products vary with time for this reaction. Which one of the following curves represents the change in the concentration of "C" with time?



a. I b. II c. III d. IV

18. Select the rate law that corresponds to the data shown below for the reaction:

$$2\,A + 3\,B \rightarrow \text{products.}$$

Experiment Number	[A] (*M*)	[B] (*M*)	Initial Rate (*M*/s)
1	0.060	0.030	0.0248
2	0.020	0.030	0.00276
3	0.020	0.090	0.00828

a. Rate = $k[A]^2[B]^3$
b. Rate = $k[A]^2[B]$
c. Rate = $k[A]^4$
d. Rate = $k[A][B]$

In Experiments 1 and 2, the concentration of B remains constant while the concentration of A triples. The rate of the reaction goes up by a factor of 9. Therefore the reaction is second-order with respect to reactant A. In experiments 2 and 3, the concentration of A remains constant while the concentration of B goes up by a factor of 3. The rate of the reaction goes up by a factor of 3. Therefore, the reaction is first-order with respect to reactant B.

19. Which of the following plays a part in determining the rate of a chemical reaction?

a. temperature
b. concentration of reactants
c. presence of a catalyst
d. all of the above

20. Data for the following first-order reaction at 25°C are listed below.

$$2\,C \rightarrow \text{products}$$

Time (min)	[C]
0	0.100
7.2	0.075
17.3	0.050
34.5	0.025

What is the rate constant of this reaction at 25 °C?

a. 25.0 min^{-1}
b. 0.0400 min^{-1}
c. 17.3 min^{-1}
d. 0.00217 min^{-1}

$ln[C] = -kt + ln[C]_0$ *$ln[.075] = -k(7.2) + ln[0.100]$* *$k = 0.0400\ min^{-1}$*

21. For the reaction 2A + B → C, the rate law is Rate = $k[A][B]^2$. If the concentrations of **both** A and B are doubled what will happen to the rate of the reaction?

a. increase by 8 times
b. increase by 6 times
c. increase by 4 times
d. increase by 2 times

$Rate_1 = k[A][B]^2$

$Rate_2 = k[2A][2B]^2$

$Rate_2/Rate_1 = k[2A][2B]^2/k[A][B]^2 = 8$

In other words, doubling the concentration of A will cause the rate to double. Doubling the concentration of B will cause the rate to increase by a factor of 4. The overall increase in the rate is therefore 2 x 4 = 8.

Constants and Equations

R = 0.0821 L· atm/K· mol c = 3.00 x 10^{8} m/s h = 6.63 x 10^{-34} J· s

$PV = nRT$ $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$ $PV = \frac{mRT}{M}$ $P_T = P_1 + P_2 + P_3 + ...$

$X_a = \frac{n_a}{n_T}$ $P_a = X_a P_T$ $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

For sc: $2r = a$ For fcc: $4r = a\sqrt{2}$ For bcc: $4r = a\sqrt{3}$

$C_g = kP_g$ $P_A = \chi_A P_A^0$ $\Delta T_b = iK_b m$ $\Delta T_f = -iK_f m$

$Rate = \frac{-\Delta[A]}{\Delta t}$ $Rate = k[A]^m[B]^n$ $\ln[A] = -kt + \ln[A]_0$ $t_{1/2} = \frac{0.693}{k}$

Use the space below for scratch paper. A periodic table is on the back of this page.

PERIODIC TABLE OF THE ELEMENTS

IA												IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H 1.008	IIA						VIIIB			IB	IIB						2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 0 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	IIIB	IVB	VB	VIB	VIIB				IB	IIB	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 108.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Ha (262)	106 Unh (263)	107 Uns (262)		109 Une (266)									

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)