Exam 1A
Chem 1142
Spring 2019

Name:_____

MULTIPLE CHOICE. [3 pts ea.] Enter the best response on your scantron sheet. [**60 pts total.**]

Q1. Which intermolecular force depends upon the total number of electrons in the substance?
A) London dispersion
B) Dipole-dipole
C) Hydrogen-bonds
D) Ion-dipole

Q2. Which molecule will possess dipole-dipole intermolecular forces?
A) CH_2Cl_2
B) CO_2
C) F_2
D) BeF_2

Q3. Which molecules can undergo hydrogen-bonding with one another?
A) CH_3OCH_3
B) $CH_3CH_2CH_2F$
C) CH_3NH_2
D) CH_2O

Q4. Which ion will undergo the **strongest** ion-dipole interaction when dissolved in water?
A) sodium ion
B) chloride ion
C) oxide ion
D) aluminum ion

Q5. ΔH_{vap} for water is +44.0 kJ/mol. How much heat is gained/lost (state which) when 5.0 g of water evaporates?
A) 12 kJ of heat is lost by water
B) 12 kJ of heat is gained by water
C) 160 kJ of heat is lost by water
D) 160 kJ of heat is gained by water

Q6. What is **always** true for a substance at its boiling point?
A) The vapor pressure is equal to 760 mmHg
B) Air bubbles form inside the liquid and rise to the surface
C) Its temperature must be at or above 100 °C
D) The vapor pressure is equal to air pressure

Q7. When comparing the following enthalpies of phase transition, which is always true:
A) $\Delta H_{vap} < \Delta H_{fus} < \Delta H_{sub}$
B) $\Delta H_{vap} > \Delta H_{fus} > \Delta H_{sub}$
C) $\Delta H_{sub} > \Delta H_{vap} > \Delta H_{fus}$
D) $\Delta H_{sub} < \Delta H_{vap} < \Delta H_{fus}$

Q8. The place on a phase-diagram where three phases coexist is called:
A) The triple point
B) The melting point
C) The critical point
D) The tertiary point

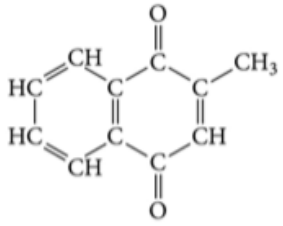
Q9. Experimentally, crystal structure can be best determined using which of the following techniques:
A) Nuclear magnetic resonance spectroscopy
B) Emission spectroscopy
C) X-ray diffraction
D) Cryogenic viscometry

Q10. The most efficient packing method for cubic unit cells is
A) Simple cubic
B) Face-centered cubic
C) Body-centered cubic
D) Corner-faced cubic

Q11. If an atom is present at the **corner** of a cubic unit cell, what fraction is inside the cell?
A) 1
B) 1/2
C) 1/4
D) 1/8

Q12. An example of a network covalent solid is
A) diamond(s)
B) sodium chloride(s)
C) aluminum(s)
D) xenon(s)

Q13. What type of solvent would vitamin K_3 (shown below) be most likely to dissolve in?



A) Polar solvents
B) Non-polar solvents
C) Both polar and non-polar solvents
D) Not possible to determine

Q14. In general, gas solubility _____ as the temperature is increased
A) increases
B) decreases
C) is unchanged

Q15. Oxygen gas has a Henry's law constant of 1.3×10^{-3} M·atm^{-1} at 25 °C in water. What pressure of oxygen would be required above water for the oxygen concentration to be 0.013 M?
A) 10. atm
B) 0.10 atm
C) 1.0×10^{2} atm
D) 13 atm

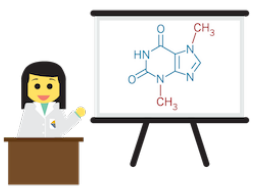
Q16. A sample of water that contains 15 mg of $PbCl_2$ in 150 g of solution would have a mass concentration of
A) 10 %
B) 1.0 %
C) 100 ppm
D) 0.10 ppb

Q17. What is the **molal concentration** of 25.0 g of CH_2O dissolved in 75.0 g of water? The final solution volume is 99.5 mL.
A) 8.37 M
B) 25.0 M
C) 8.33 m
D) 11.1 m

Q18. Which solution will have the greatest osmotic pressure at 37 °C?
A) 0.10 M glucose
B) 0.10 M $FeCl_3$(aq)
C) 0.10 M NH_4NO_3(aq)
D) 0.10 M NaCl(aq)

Q19. What is the theoretical value for the van't Hoff factor for the soluble ionic compound, $Sr(OH)_2$?
A) 1
B) 2
C) 3
D) 4
E) 5

Q20. Which solution would be expected to have the **highest** freezing point?
A) pure H_2O(l)
B) 0.10 M NaCl(aq)
C) 0.20 M $CaCl_2$(aq)
D) 0.30 M glucose(aq)



Short Response.

Show ALL work to receive credit. Be sure to use the conversion-factor (dimensional-analysis) method for all problems involving conversions!

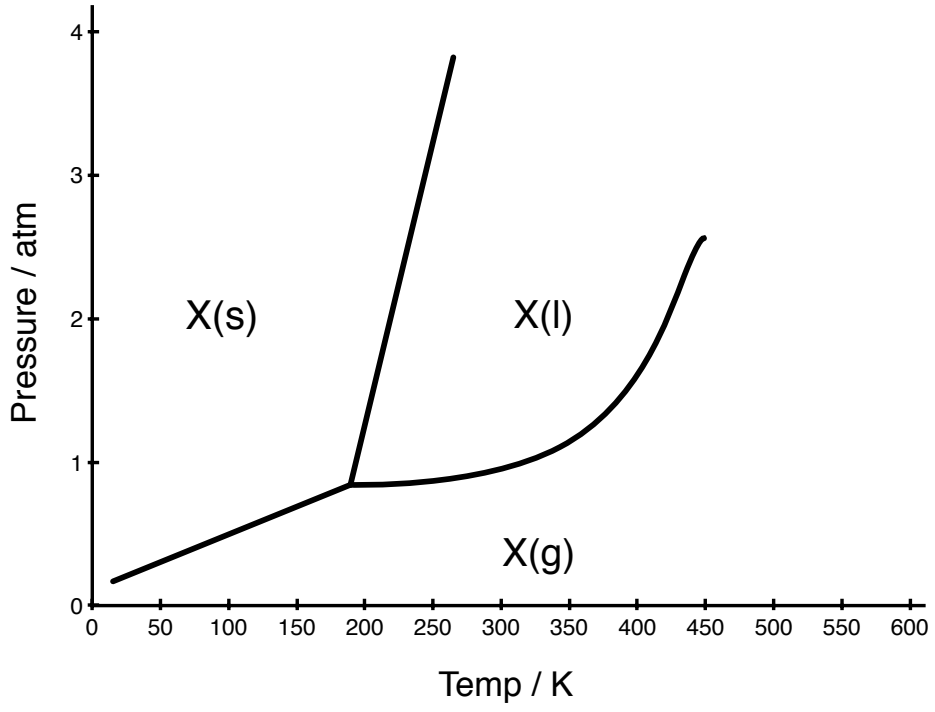
Q21. [10 pts.] 12.0 g of an unknown substance (non-electrolyte) is dissolved in 95.0 g of water, forming a solution that freezes at −1.40 °C. What is the molar mass of this substance? $k_f(H_2O) = 1.86\ ^\circ C/m$

Q22. [10 pts.] Calculate the density (in units of g/cm^3) of scandium (Sc) if it crystallizes in a face-centered cubic unit cell with an edge length of 464 pm. As part of your answer, sketch the unit cell and explain how you determine the number of atoms inside of it!

Q23. [5 pts.] There are two structural isomers of C_2H_6O with condensed formulas of CH_3OCH_3 and CH_3CH_2OH.

Which isomer would be expected to have the **greatest vapor pressure**? Explain! *Draw out valid Lewis structures as part of your answer.*

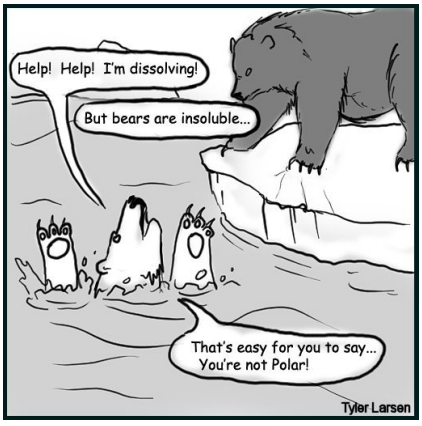
Q24. [5 pts.] Estimate the normal boiling point of the substance whose phase diagram is reproduced below. Explain your work.



Q25. [10 pts.] Concentrated HCl(aq) is 36.0 % by mass. Convert this to **molar concentration** given the density of the solution is 1.20 g/mL.

BONUS Question:

For two substances to mix and dissolve in one another, what can you say about the strengths of the interactions between the solute and solvent molecules? (solute-solute, solvent-solvent, solute-solvent)



Useful Information

Periodic Table of the Elements

IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA
1																	2
H																	He
1.01	2											13	14	15	16	17	4.00
3	4											5	6	7	8	9	10
Li	Be											B	C	N	O	F	Ne
6.94	9.01											10.81	12.01	14.01	16.00	19.00	20.18
11	12											13	14	15	16	17	18
Na	Mg	3	4	5	6	7	8	9	10	11	12	Al	Si	P	S	Cl	Ar
22.99	24.31											26.98	28.09	30.97	32.07	35.45	39.95
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
39.10	40.08	44.96	47.87	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.39	69.72	72.61	74.92160	78.96	79.90	83.80
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
85.47	87.62	88.91	91.22	92.91	95.94	[98]	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.76	127.60	126.90	131.29
55	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba*	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
132.91	137.33	174.97	178.49	180.95	183.84	186.21	190.23	192.22	195.08	196.97	200.59	204.38	207.20	208.98	[210]	[210]	[222]
87	88	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Fr	Ra**	Lr	Rf	Db	Sg	Bh	Hs	Mt									
[223]	[226]	[262]	[261]	[262]	[266]	[264]	[265]	[268]	[269]	[272]	[277]		[285]		[289]		[293]

	57	58	59	60	61	62	63	64	65	66	67	68	69	70
*	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
	138.91	140.12	140.91	144.24	[145]	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.04
	89	90	91	92	93	94	95	96	97	98	99	100	101	102
**	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No
	[227]	232.04	231.04	238.03	[237]	[244]	[243]	[247]	[247]	[251]	[252]	[257]	[258]	[259]

1 atm = 101,325 Pa = 760 mmHg = 760 torr

$T/\mathrm{K} = t/^{\circ}\mathrm{C} + 273.15$

$$R = 0.08206 \frac{\mathrm{atm} \cdot \mathrm{L}}{\mathrm{mol} \cdot \mathrm{K}}$$

$R = 8.3145\ \mathrm{J/mol \cdot K}$

$\Delta T_b = ik_b m$

$\Delta T_f = ik_f m$

$\Pi = iMRT$

$k_f(H_2O) = 1.86\ ^{\circ}\mathrm{C/m}$

$k_b(H_2O) = 0.52\ ^{\circ}\mathrm{C/m}$

$c = kP$

$N_A = 6.022 \times 10^{23}\ \mathrm{mol}^{-1}$