

**Chem 101B Exam 1 Study Questions**  
**Chapters 10 (partial), 11 & 12 (partial)**

Name: \_\_\_\_\_

Review Tuesday 02/05/2019

Due on Exam Thursday 02/07/2019 (Exam 1 date)

*This is a homework assignment. Please show your work for full credit. If you do work on separate paper, attach the work to these.*

**Useful Information Provided on Exam 1**

**Sections Covered on Exam 1**

$$\ln\left(\frac{P_{\text{vap}1}}{P_{\text{vap}2}}\right) = \frac{\Delta H_{\text{vap}}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

10.1, 10.2, 10.8, 10.9

$$R = 8.314 \text{ J/K}\cdot\text{mol}$$

11.1 – 11.7

$$R = 0.082057 \text{ L}\cdot\text{atm/K}\cdot\text{mol}$$

$$P_{\text{solution}} = \chi_{\text{solvent}} P_{\text{solvent}}^{\circ}$$

12.1 – 12.3

$$P_{\text{solution}} = \chi_A P_A^{\circ} + \chi_B P_B^{\circ}$$

$$\Delta T_f = k_f m_{\text{solute}}$$

$$\Delta T_b = k_b m_{\text{solute}}$$

$$\Pi = MRT$$

$$\chi_A + \chi_B = 1$$

1. Which of the following would you expect to have the lowest melting point?
  - A) F<sub>2</sub>
  - B) Cl<sub>2</sub>
  - C) Br<sub>2</sub>
  - D) I<sub>2</sub>
  - E) All of the above have the same boiling point.
2. Which of the species below would you expect to not exhibit hydrogen bonding?
  - A) NH<sub>3</sub>
  - B) CH<sub>3</sub>OH
  - C) HF
  - D) CH<sub>4</sub>
  - E) all the same
3. *True or False.* Hydrogen bonding is a type of London dispersion force.
  - A) True
  - B) False

4. *True or False?* Liquids with large intermolecular forces tend to have high surface tension.
- A) True
  - B) False
5. When a liquid displays a concave meniscus when sitting in a glass cylinder, which of the following explains this behavior?
- A) It has a low surface tension, and therefore clings to the glass.
  - B) The cohesive forces are stronger than the adhesive forces to the glass.
  - C) The adhesive forces to the glass are stronger than the cohesive forces.
  - D) The liquid's viscosity is low.
  - E) None of these.

6. Given below are the temperatures at which two different liquid compounds with the same empirical formula have a vapor pressure of 400 torr.

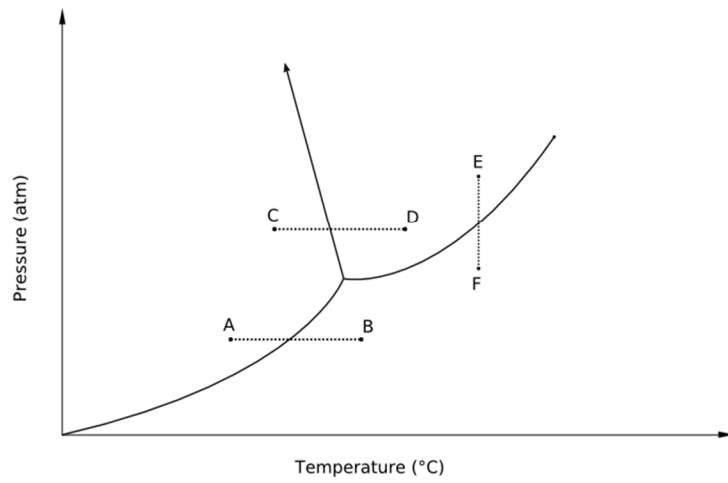
Compound	T (°C)
dimethyl ether, CH <sub>3</sub> -O-CH <sub>3</sub>	-37.8
ethanol, CH <sub>3</sub> CH <sub>2</sub> OH	63.5

Which of the following statements (a-d) is *false*?

- A) Increasing the temperature will increase the vapor pressure of both liquids.
  - B) Intermolecular attractive forces are stronger in (liquid) ethanol than in (liquid) dimethyl ether.
  - C) The normal boiling point of dimethyl ether will be higher than the normal boiling point of ethanol.
  - D) The reason that the temperature at which the vapor pressure is 400 torr is higher for ethanol (than for dimethyl ether) is that there is strong hydrogen bonding in ethanol.
  - E) None of these is false.
7. A liquid placed in a closed container will evaporate until equilibrium is reached. At equilibrium, which of the statements (A-D) is *false*?
- A) The partial pressure exerted by the vapor molecules is called the vapor pressure of the liquid.
  - B) Liquid molecules are still evaporating.
  - C) The number of vapor molecules remains essentially constant.
  - D) The rates of condensation and vaporization are equal.
  - E) All of these are true.

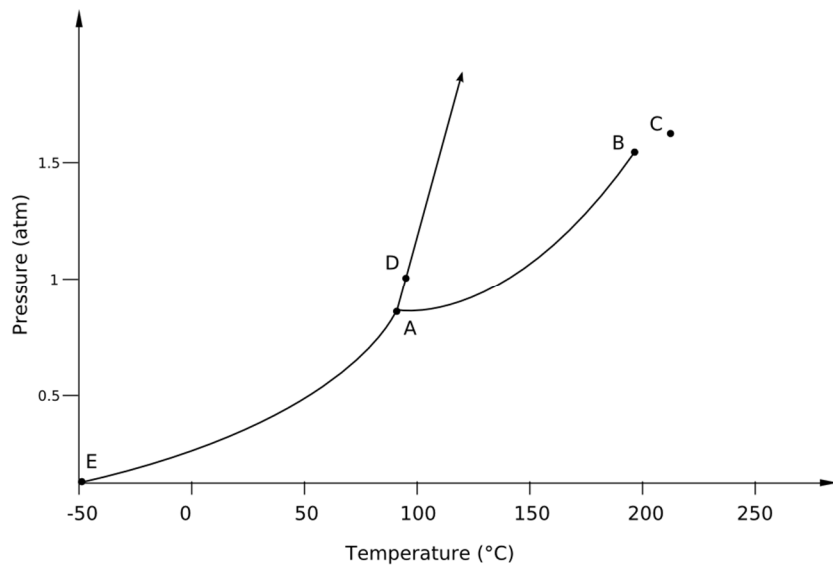
8. The vapor pressure of water at 100.0°C is
- A) 85 torr
  - B) 760 torr
  - C) 175 torr
  - D) 1 torr
  - E) More information is needed.
9. Given  $\Delta H_{\text{vap}}$  for ethanol is 38.6 kJ/mol and its normal boiling point is 78°C, calculate  $P_{\text{vap}}$  of ethanol at 53°C.
- A) 2.8 torr
  - B) 749 torr
  - C) 14.2 torr
  - D) 759 torr
  - E) 276 torr
10. At what pressure will water boil at 80.°C.  $\Delta H_{\text{vap}} = 40.7$  kJ/mol
- A) 0.48 atm
  - B) 1.00 atm
  - C) 1.20 atm
  - D) 2.00 atm
  - E) 5.00 atm
11. How much energy is needed to convert 56.5 grams of ice at -20.00°C to steam at 160.00°C?
- specific heat (ice) = 2.087 J/g°C
  - specific heat (water) = 4.184 J/g°C
  - specific heat (steam) = 2.000 J/g°C
  - enthalpy of fusion = 6.010 kJ/mol
  - enthalpy of vaporization = 40.66 kJ/mol

12. Below is a phase diagram for water without units. If you wish to sublime water, which path should be taken?



- A) A to B
- B) C to D
- C) E to F
- D) B to A
- E) D to C

13. Below is a phase diagram for compound *Y*.



The normal boiling point of *Y* is about:

- A) 90°C
- B) 145°C
- C) 80°C
- D) -50°C
- E) 220°C

14. The resistance of a liquid to an increase in its surface area is the \_\_\_\_\_ of the liquid.

15. 2.50 L of an aqueous solution containing 25.00 g of KCl dissolved in pure water is prepared. The molarity of the solution is:

- A) 0.134 *M*
- B) 10.0 *M*
- C) 7.46 *M*
- D) 0.268 *M*
- E) 0.0671 *M*

16. Calculate the mole fraction of NaCl in a solution prepared by dissolving 117 g NaCl in 1.07 kg H<sub>2</sub>O.
- A)  $9.91 \times 10^{-1}$
  - B)  $1.14 \times 10^{-2}$
  - C)  $6.52 \times 10^{-2}$
  - D)  $1.63 \times 10^{-2}$
  - E)  $3.26 \times 10^{-2}$
17. Find the mass percent of CaCl<sub>2</sub> in a solution whose molarity is 2.25 M and whose density is 1.18 g/mL.
- A) 21.1%
  - B) 26.8%
  - C) 78.9%
  - D) 25.0%
  - E) none of these
18. The vapor pressure of water at 25.0°C is 23.8 torr. Determine the mass of glucose (molar mass = 180 g/mol) needed to add to 500.0 g of water to change the vapor pressure to 22.8 torr.
- A) 21.9 g
  - B) 219 g
  - C) 180 g
  - D) 6.21 kg
  - E) 188 g
19. An ideal solution is formed from a mixture of the nonvolatile solute urea, CO(NH<sub>2</sub>)<sub>2</sub>, and methanol, CH<sub>3</sub>OH. The vapor pressure of pure methanol at 20°C is 89 mmHg. If 4.8 g of urea is mixed with 43.7 g of methanol, calculate the vapor pressure of the methanol solution.
- A) 4.9 mmHg
  - B) 80 mmHg
  - C) 74 mmHg
  - D) 15 mmHg
  - E) 84 mmHg

Use the following to answer questions 20-21:

Solutions of benzene and toluene obey Raoult's law. The vapor pressures at 20°C are: benzene, 76 torr; toluene, 21 torr.

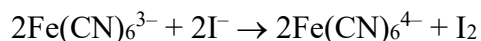
20. What is the mole fraction of benzene in a benzene-toluene solution whose vapor pressure is 65 torr at 20°C?
- A) 0.11
  - B) 0.20
  - C) 0.80
  - D) 0.86
  - E) 0.89
21. If the mole fraction of benzene in a particular benzene-toluene solution is 0.62, what is the mole fraction of benzene in the vapor phase in equilibrium with that solution?
- A) 0.24
  - B) 0.49
  - C) 0.62
  - D) 0.78
  - E) 0.86
22. At a given temperature, you have a mixture of benzene (vapor pressure of pure benzene = 745 torr) and toluene (vapor pressure of pure toluene = 290 torr). The mole fraction of benzene *in the vapor* above the solution is 0.590. Assuming ideal behavior, calculate the mole fraction of toluene *in the solution*.
- A) 0.213
  - B) 0.778
  - C) 0.641
  - D) 0.359
  - E) 0.590
23. The freezing point ( $T_f$ ) for t-butanol is 25.50°C and  $K_f$  is 9.1°C/m. Usually t-butanol absorbs water on exposure to the air. If the freezing point of a 19.7-g sample of t-butanol is measured as 24.59°C, how many grams of water are present in the sample?
- A) 0.10 g
  - B) 0.035 g
  - C) 10. g
  - D) 3.5 g
  - E) 35 g

24. A solution consisting of 0.250 mol of methylbenzene,  $C_6H_5CH_3$ , in 245 g of nitrobenzene,  $C_6H_5NO_2$ , freezes at  $-1.1^\circ C$ . Pure nitrobenzene freezes at  $6.0^\circ C$ . What is the freezing-point depression constant of nitrobenzene?
- A)  $4.6^\circ C/m$
  - B)  $3.5^\circ C/m$
  - C)  $29^\circ C/m$
  - D)  $7.0^\circ C/m$
  - E)  $14^\circ C/m$
25. Consider pure water separated from an aqueous sugar solution by a semipermeable membrane, which allows water to pass freely but not sugar. After some time has passed, the concentration of sugar solution:
- A) will have increased
  - B) will have decreased
  - C) will not have changed
  - D) might have increased or decreased depending on other factors
  - E) will be the same on both sides of the membrane
26. Calculate the osmotic pressure (in torr) of 6.00 L of an aqueous 0.944 M solution at  $30.^\circ C$ , if the solute concerned is totally ionized into three ions (e.g., it could be  $Na_2SO_4$  or  $MgCl_2$ ).
- A) 70.4 torr
  - B)  $5.35 \times 10^4$  torr
  - C)  $3.18 \times 10^4$  torr
  - D)  $1.78 \times 10^4$  torr
  - E)  $5.95 \times 10^3$  torr



27. What is reverse osmosis?
- A) the application, to a concentrated solution, of a pressure that is greater than the osmotic pressure, such that solvent flows from the concentrated solution to the dilute solution
  - B) the application, to a dilute solution, of a pressure that is greater than the osmotic pressure, such that solvent flows from the concentrated solution to the dilute solution
  - C) the application, to a concentrated solution, of a pressure that is greater than the osmotic pressure, such that solute flows from the concentrated solution to the dilute solution
  - D) the application, to a dilute solution, of a pressure that is greater than the osmotic pressure, such that solute flows from the concentrated solution to the dilute solution
  - E) the application, to a concentrated solution, of a pressure that is greater than the osmotic pressure, such that solvent flows from the dilute solution to the concentrated solution
28. What is the freezing point of an aqueous 1.66 *m* KCl solution? (water  $k_f = 1.86^\circ\text{C}/m$ , assume  $i = \text{moles ions}/\text{moles compound formula units}$ )
- A)  $-3.09^\circ\text{C}$
  - B)  $3.09^\circ\text{C}$
  - C)  $-6.18^\circ\text{C}$
  - D)  $6.18^\circ\text{C}$
  - E)  $0.00^\circ\text{C}$
29. Consider the reaction  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$   
What is the ratio of the initial rate of the appearance of water to the initial rate of disappearance of oxygen?
- A) 1 : 1
  - B) 2 : 1
  - C) 1 : 2
  - D) 2 : 2
  - E) 3 : 2
30. Consider the following rate law:  $\text{Rate} = k[\text{A}]^n[\text{B}]^m$   
How are the exponents  $n$  and  $m$  determined?
- A) by using the balanced chemical equation
  - B) by using the subscripts for the chemical formulas
  - C) by using the coefficients of the chemical formulas
  - D) by educated guess
  - E) by experiment

31. Tabulated below are initial rate data for the reaction



Run	$[\text{Fe}(\text{CN})_6^{3-}]_0$	$[\text{I}^-]_0$	$[\text{Fe}(\text{CN})_6^{4-}]_0$	$[\text{I}_2]_0$	Initial Rate (M/s)
1	0.01	0.01	0.01	0.01	$1 \times 10^{-5}$
2	0.01	0.02	0.01	0.01	$2 \times 10^{-5}$
3	0.02	0.02	0.01	0.01	$8 \times 10^{-5}$
4	0.02	0.02	0.02	0.01	$8 \times 10^{-5}$
5	0.02	0.02	0.02	0.02	$8 \times 10^{-5}$

The experimental rate law is:

- A)  $\frac{\Delta[\text{I}_2]}{\Delta t} = k[\text{Fe}(\text{CN})_6^{3-}]^2[\text{I}^-]^2[\text{Fe}(\text{CN})_6^{4-}]^2[\text{I}_2]$
- B)  $\frac{\Delta[\text{I}_2]}{\Delta t} = k[\text{Fe}(\text{CN})_6^{3-}]^2[\text{I}^-][\text{Fe}(\text{CN})_6^{4-}][\text{I}_2]$
- C)  $\frac{\Delta[\text{I}_2]}{\Delta t} = k[\text{Fe}(\text{CN})_6^{3-}]^2[\text{I}^-]$
- D)  $\frac{\Delta[\text{I}_2]}{\Delta t} = k[\text{Fe}(\text{CN})_6^{3-}][\text{I}^-]^2$
- E)  $\frac{\Delta[\text{I}_2]}{\Delta t} = k[\text{Fe}(\text{CN})_6^{3-}][\text{I}^-][\text{Fe}(\text{CN})_6^{4-}]$

Use the following to answer questions 32-35:

A general reaction written as  $\text{A} + 2\text{B} \rightarrow \text{C} + 2\text{D}$  is studied and yields the following data:

$[\text{A}]_0$	$[\text{B}]_0$	Initial $\Delta[\text{C}]/\Delta t$
0.150 M	0.150 M	$8.00 \times 10^{-3}$ mol/L·s
0.150 M	0.300 M	$1.60 \times 10^{-2}$ mol/L·s
0.300 M	0.150 M	$3.20 \times 10^{-2}$ mol/L·s

32. What is the order of the reaction with respect to B?

- A) 0  
 B) 1  
 C) 2  
 D) 3  
 E) 4

33. What is the order of the reaction with respect to A?

- A) 0
- B) 1
- C) 2
- D) 3
- E) 4

34. What is the overall order of the reaction?

- A) 0
- B) 1
- C) 2
- D) 3
- E) 4

35. What is the numerical value of the rate constant?

- A) 0.053
- B) 1.19
- C) 2.37
- D) 5.63
- E) none of these (A-D)

Use the following to answer questions 36-38:

The reaction  $\text{H}_2\text{SeO}_3(aq) + 6\text{I}^-(aq) + 4\text{H}^+(aq) \rightarrow 2\text{I}_3^-(aq) + 3\text{H}_2\text{O}(l) + \text{Se}(s)$  was studied at  $0^\circ\text{C}$  by the method of initial rates:

$[\text{H}_2\text{SeO}_3]_0$	$[\text{H}^+]_0$	$[\text{I}^-]_0$	Rate (mol/L s)
$1.0 \times 10^{-4}$	$2.0 \times 10^{-2}$	$2.0 \times 10^{-2}$	$1.66 \times 10^{-7}$
$2.0 \times 10^{-4}$	$2.0 \times 10^{-2}$	$2.0 \times 10^{-2}$	$3.33 \times 10^{-7}$
$3.0 \times 10^{-4}$	$2.0 \times 10^{-2}$	$2.0 \times 10^{-2}$	$4.99 \times 10^{-7}$
$1.0 \times 10^{-4}$	$4.0 \times 10^{-2}$	$2.0 \times 10^{-2}$	$6.66 \times 10^{-7}$
$1.0 \times 10^{-4}$	$1.0 \times 10^{-2}$	$2.0 \times 10^{-2}$	$0.41 \times 10^{-7}$
$1.0 \times 10^{-4}$	$2.0 \times 10^{-2}$	$4.0 \times 10^{-2}$	$13.4 \times 10^{-7}$
$1.0 \times 10^{-4}$	$4.0 \times 10^{-2}$	$4.0 \times 10^{-2}$	$5.33 \times 10^{-6}$

36. The rate law is
- Rate =  $k[\text{H}_2\text{SeO}_3][\text{H}^+][\text{I}^-]$
  - Rate =  $k[\text{H}_2\text{SeO}_3][\text{H}^+]^2[\text{I}^-]$
  - Rate =  $k[\text{H}_2\text{SeO}_3][\text{H}^+][\text{I}^-]^2$
  - Rate =  $k[\text{H}_2\text{SeO}_3]^2[\text{H}^+][\text{I}^-]$
  - Rate =  $k[\text{H}_2\text{SeO}_3][\text{H}^+]^2[\text{I}^-]^3$
37. The numerical value of the rate constant is
- $5.2 \times 10^5$
  - $2.1 \times 10^2$
  - 4.2
  - $1.9 \times 10^{-6}$
  - none of these
38. The unit of the rate constant is
- mol/L-s
  - $\text{L}^5/\text{mol}^5\text{-s}$
  - $\text{mol}^5/\text{L}^5\text{-s}$
  - $\text{L}^6/\text{mol}^6\text{-s}$
  - $\text{L}^5/\text{mol}^5\text{-s}^5$

Use the following to answer questions 39-42:

The following questions refer to the reaction shown below:

	Initial [A]	Initial [B]	Initial Rate of Disappearance of A
Experiment	(mol/L)	(mol/L)	(mol/L·s)
1	0.160	0.150	0.075
2	0.160	0.300	0.300
3	0.080	0.300	0.075

39. What is the rate law for this reaction?
- Rate =  $k[\text{A}][\text{B}]$
  - Rate =  $k[\text{A}]^2[\text{B}]$
  - Rate =  $k[\text{A}][\text{B}]^2$
  - Rate =  $k[\text{A}]^2[\text{B}]^2$
  - Rate =  $k[\text{B}]$

40. What is the magnitude of the rate constant for the reaction?
- A) 130
  - B) 1.0
  - C) 119
  - D) 4.2
  - E) 3.1
41. What are the units for the rate constant for this reaction?
- A)  $\text{L/mol}\cdot\text{s}$
  - B)  $\text{L}^2/\text{mol}^2\cdot\text{s}$
  - C)  $\text{mol/L}\cdot\text{s}$
  - D)  $\text{L}^3/\text{mol}^3\cdot\text{s}$
  - E)  $\text{mol}^3/\text{L}$
42. What is the order of this reaction?
- A) 4
  - B) 3
  - C) 2
  - D) 1
  - E) 0
43. The reaction  $2\text{A} + 5\text{B} \rightarrow \text{products}$  is second order in A and second order in B. What is the rate law for this reaction?
- A)  $\text{rate} = k[\text{A}]^2[\text{B}]^5$
  - B)  $\text{rate} = k[\text{A}]^2[\text{B}]^2$
  - C)  $\text{rate} = k[\text{A}]^2[\text{B}]^2$
  - D)  $\text{rate} = k[\text{A}]^5[\text{B}]^2$
  - E)  $\text{rate} = k[\text{A}]^{2/7}[\text{B}]^{5/7}$

## Answer Key

1.	A
	Chapter/Section: 10.1
2.	D
	Chapter/Section: 10.1
3.	B
	Chapter/Section: 10.1
4.	A
	Chapter/Section: 10.2
5.	C
	Chapter/Section: 10.2
6.	C
	Chapter/Section: 10.8
7.	E
	Chapter/Section: 10.8
8.	B
	Chapter/Section: 10.8
9.	E
	Chapter/Section: 10.8
10.	A
	Chapter/Section: 10.8
11.	warm ice: 2358.3 J melt ice: 18848.0 J warm water: 23639.6 J boil water: 127513.9 J warm steam: 6780 J Q = 179.1 kJ
	Chapter/Section: 10.8
12.	A
	Chapter/Section: 10.9
13.	B
	Chapter/Section: 10.9
14.	surface tension
	Chapter/Section: 10.2
15.	A
	Chapter/Section: 11.1
16.	E
	Chapter/Section: 11.1
17.	A
	Chapter/Section: 11.1
18.	B
	Chapter/Section: 11.4
19.	E
	Chapter/Section: 11.4

20.	C
	Chapter/Section: 11.4
21.	E
	Chapter/Section: 11.4
22.	C
	Chapter/Section: 11.4
23.	B
	Chapter/Section: 11.5
24.	D
	Chapter/Section: 11.5
25.	B
	Chapter/Section: 11.6
26.	B
	Chapter/Section: 11.7
27.	A
	Chapter/Section: 11.6
28.	C
	Chapter/Section: 11.7
29.	B
	Chapter/Section: 12.1
30.	E
	Chapter/Section: 12.3
31.	C
	Chapter/Section: 12.3
32.	B
	Chapter/Section: 12.3
33.	C
	Chapter/Section: 12.3
34.	D
	Chapter/Section: 12.3
35.	C
	Chapter/Section: 12.3
36.	E
	Chapter/Section: 12.3
37.	A
	Chapter/Section: 12.3
38.	B
39.	D
	Chapter/Section: 12.3
40.	A
	Chapter/Section: 12.3
41.	D
	Chapter/Section: 12.3
42.	A
	Chapter/Section: 12.3

43.	C
Chapter/Section: 12.3	