CHM-102 Exam II Summer 2009
Form A

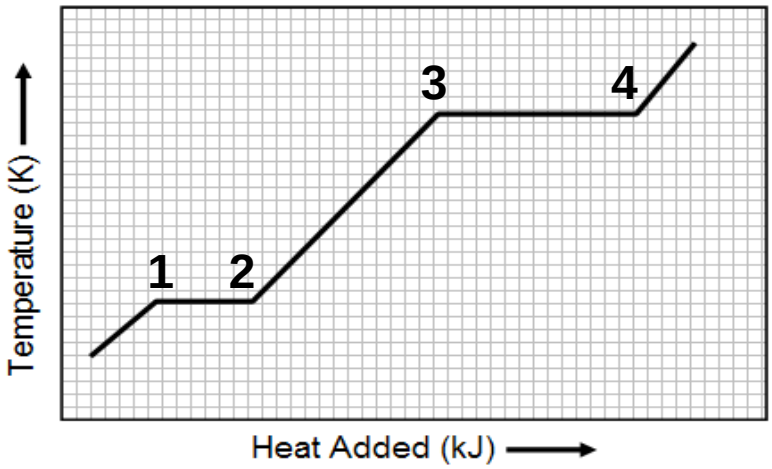
NAME Key Raw Score _____
T-Score _____

- You will have **70 minutes** 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.
- Write the form of the test you are taking next to your name.
- 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 the course website as well as outside DO-236.

1. What amount of heat is given off when 10 g of water, initially at 10 ^{o}C, are converted to ice at 0 ^{o}C? [The specific heat of water is 4.18 J/g·K and ΔH_{fus} = 6.01 kJ/mol]

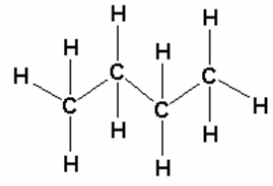
   a. 6.3 x 10^3 J b. 1.2 x 10^3 J c. 3.8 x 10^3 J d. 421 J

2. Shown below is the heating curve for a substance. Which of the following statements is correct?

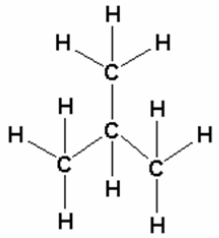


   a) The segment 1 – 2 corresponds to ΔH_{fusion}
   b) The segment 2 – 3 corresponds to the specific heat of the substance as a liquid.
   c) The segment 3 – 4 corresponds to $\Delta H_{vaporization}$
   d) All of the statements are correct.

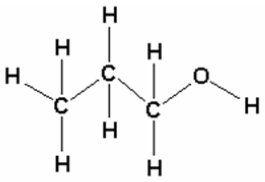
3. Which of the molecules shown below will have the lowest vapor pressure?



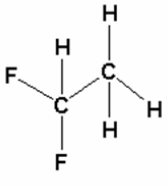
i



ii



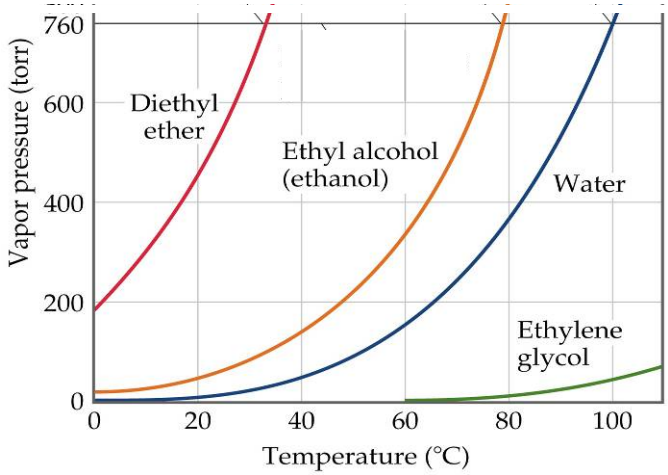
iii



iv

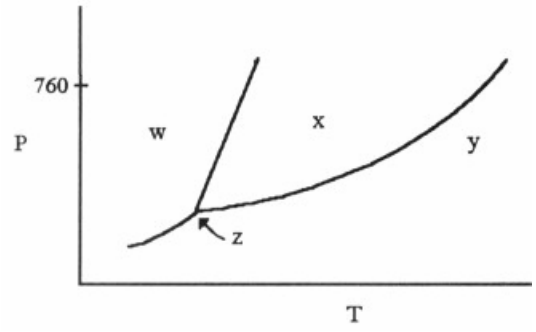
a. i b. ii c. iii d. iv

4. Based on the graph given below, what is the approximate boiling point of ethanol at 0.45 atm pressure?



a. 20 °C b. 40 °C c. 60 °C d. 80 °C

The phase diagram shown below is used to answer questions 5 and 6.



5. The point marked by the arrow "z" in the phase diagram is the

a. triple point
b. critical point
c. melting point
d. boiling point

6. The region "x" corresponds to the:

a. Gas phase
b. Critical point
c. Liquid phase
d. Solid phase

7. ium metal crystallizes with a body-centered-cubic unit cell. The volume of the unit cell is $3.97 \times 10^{-22} cm^3$. What is the atomic radius of cesium in pm?

a. 265 pm
b. 735 pm
c. 1060 pm
d. 2038 pm

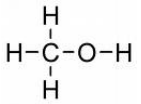
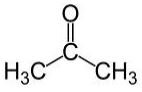
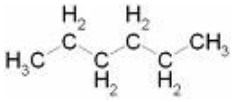
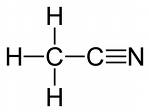
8. Which one of the following crystal structures is the <u>least</u> efficient for packing atoms?

a. simple cubic
b. body-centered cubic
c. face-centered cubic
d. all of these are equally efficient

9. _____ solids consist of atoms or molecules held together by dipole-dipole forces, London disperson forces, and/or hydrogen bonds.

a. Ionic
b. Covalent-network
c. Metallic
d. Molecular

10. Which of the following liquids is <u>immiscible</u> with water?

a. Methanol
b. acetone
c. hexane
d. acetonitrile

11. The Henry's law constant for $N_2(g)$ at 25 °C is 6.40×10^{-4} *M* atm^{-1}. What mass (in g) of $N_2(g)$ will dissolve in 1000 mL of aqueous solution if the pressure of N_2 gas is 0.800 atm?

a. 2.05×10^{-3} g
b. 5.12×10^{-4} g
c. 5.12×10^{-3} g
d. 1.43×10^{-2} g

12. Determine the molarity of a solution prepared by dissolving 5.5 g of HCl in 200 g of C_2H_6O if the density of the resulting solution is 0.79 g/mL.

a. 21 M b. 0.93 M c. 0.58 M d. 1.72 M

13. What is the mole fraction of urea (MW = 60) in a solution prepared by dissolving 16 g of urea in 39 g of water (MW = 18) assuming the density of the resulting solution is 1.2 g/mL?

a. 0.58 b. 0.37 c. 0.13 d. 0.11

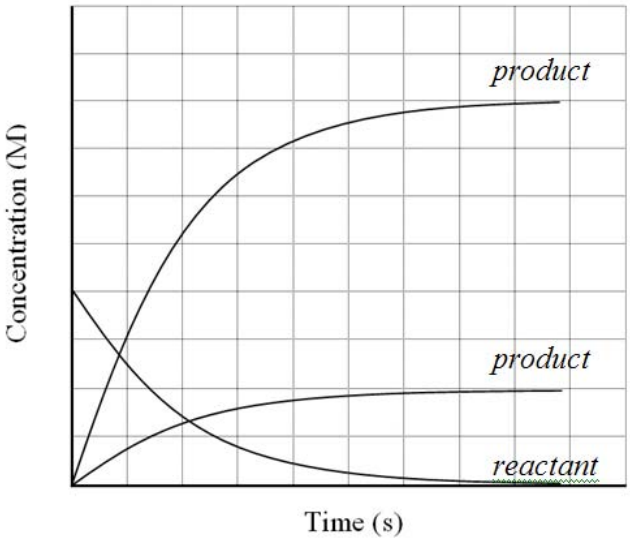
14. Which one of the following solutions will have the highest boiling point?

a. 0.25 M $C_6H_{12}O_6$ b. 0.10 M Na_3PO_4
c. 0.75 M CH_3OH d. 0.40 M $CaCl_2$

15. An aqueous solution of NaCl boils at 102 °C. What is the freezing point of this solution? (K_b for water = 0.512 °C/m; K_f for water = 1.86 °C/m)

a. -7.3 °C b. -2.0 °C c. -3.6 °C d. -14 °C

16. Which of the reactions below is consistent with the following concentration profiles for reactant and products?



a. $2\ NO_{3(g)} \rightarrow 2\ NO_{2(g)} + O_{2(g)}$

b. $2\ H_2O_{2(l)} \rightarrow 2\ H_2O_{(l)} + O_{2(g)}$

c. $2\ N_2O_{5(g)} \rightarrow 4\ NO_{2(g)} + O_{2(g)}$

d. $2\ NaClO_{3(s)} \rightarrow 2\ NaCl_{(s)} + 3\ O_{2(g)}$

17. The following experimental data were collected for the reaction

$$2\ A + 3\ B \longrightarrow \text{products}$$

Experiment #	Reactant A (M)	Reactant B (M)	Initial rate (M/s)
1	0.15	0.15	1.2×10^{-2}
2	0.32	0.53	2.6×10^{-2}
3	0.45	0.15	3.6×10^{-2}
4	0.15	0.30	1.2×10^{-2}

What is the rate law for the reaction?

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

Use the following data for a <u>first-order reaction</u> to answer questions 18 to 20.

Time (s)	Reactant (M)
2	4.24
4	3.00
6	2.12
8	1.50
10	1.06
12	0.75

18. What is the average reaction rate between 6 and 10s?

a. 1.06 Ms^{-1}
b. 0.265 Ms^{-1}
c. 3.77 Ms^{-1}
d. 0.530 Ms^{-1}

19. What is the half-time ($t_{1/2}$) for the reaction?

a. 4.00 s
b. 8.00 s
c. 1.81 s
d. 6.00 s

20. What is the rate constant (k) for the reaction?

a. 2.77 s
b. 5.77 s^{-1}
c. 5.77 s
d. 0.173 s^{-1}

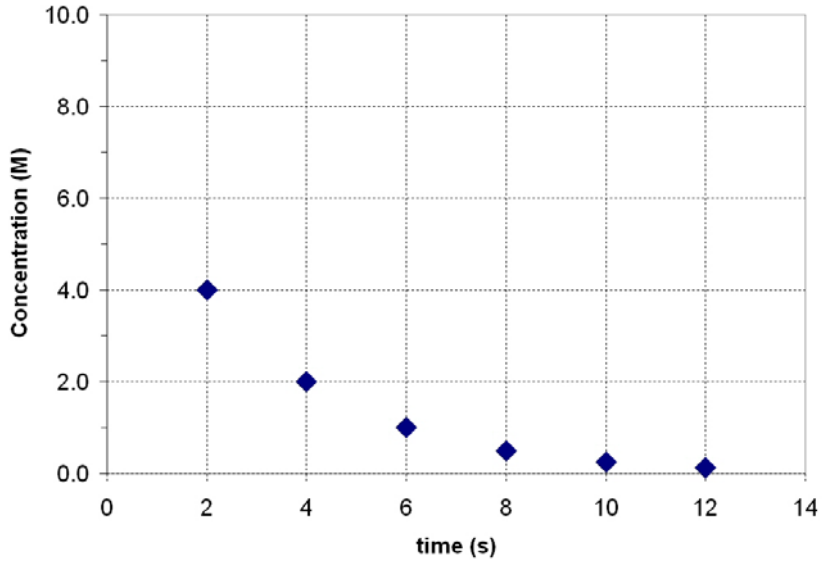
21. Methanol reacts with oxygen according to the following balanced equation.

$$2\ CH_3OH(aq)\ +\ 3\ O_2(g) \longrightarrow 2\ CO_2(g)\ +\ 4\ H_2O(g)$$

Increasing which of the following would be <u>most effective</u> in increasing the rate of the reaction?

a. the concentration of CH_3OH
b. the partial pressure of O_2
c. the concentration of CO_2
d. insufficient information to answer the question

22. The following data were collected for a first-order reaction. What was the concentration of reactant at t = 0?



a. 9.0 M b. 8.0 M c. 7.0 M d. 6.0 M

23. At elevated temperatures, nitrogen dioxide decomposes to nitrogen oxide and oxygen:

$$NO_2\ (g) \rightarrow NO\ (g) + \frac{1}{2}O_2\ (g)$$

The reaction is second order in NO_2 with a rate constant of 0.543 $M^{-1}s^{-1}$ at 300 °C. What would happen if the temperature were raised to 450 °C?

A. The rate constant for the reaction will increase.
B. The activation energy for the reaction will increase.
C. Nothing, because monomolecular reactions are independent of temperature.
D. The reaction will become endothermic.

Important Formulas and Constants

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

$$X_a = \frac{n_a}{n_T} \qquad P_a = X_a P_T \qquad \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} \qquad q = \Delta H_{vap} m \qquad q = cm\Delta t$$

$R = 0.0821\ \text{L·atm·K}^{-1}\text{·mol}^{-1}$
$K = {}^{\circ}C + 273$
1 atm = 760 mmHg = 760 torr = 101.3 kPa

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

$$M = \frac{moles_{solute}}{L_{solution}} \qquad m = \frac{moles_{solute}}{kg_{solvent}} \qquad ppm = \frac{mg_{solute}}{kg_{solution}} \qquad ppb = \frac{\mu g_{solute}}{kg_{solution}}$$

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

$$Rate = \frac{-\Delta[A]}{\Delta t} \qquad Rate = k[A]^m[B]^n \qquad \ln[A] = -kt + \ln[A]_0$$

$$t_{1/2} = \frac{0.693}{k} \qquad k = Ae^{\frac{-E_a}{RT}}$$