Name: _____

This is a practice test for CH 232 final exam There are 16 multiple choice/short answer and 8 free response questions and is representative of what could be expected on the actual midterm. Please treat it as a real examination, with no outside help from notes, internet, or peers. A lot of these questions will require you to reference the cover sheet for tabulated data. Take 80 + 20 minutes to complete this practice test and remember to keep in mind significant figures. Once done, let James know for the answer key. Good luck!

**Potentially Useful Information:**

Gas Constant: $0.08206 \frac{L \cdot atm}{mol \cdot K}$

$8.314 \frac{J}{mol \cdot K}$

Planck's constant:
   $6.626 \times 10^{-34}$ J·s

Avogadro's number:
   $6.022 \times 10^{23}$ /mol

$1\ eV = 1.602 \times 10^{-19}$ J

2.54 cm = 1 in

12 in = 1 ft

1 lb = 454 g

$\Delta H_{vap}$ ($H_2O$): 41 kJ/mol
$\Delta H_{fus}$ ($H_2O$): 6.0 kJ/mol

**Densities:**
Water: 1.00 g/cm³
Ethanol: 0.798 g/mL
Carbon (diamond): 3.53 g/cm³
Iron: 7.87 g/cm³

| Temperature (°C) | Water Vapor Pressure (torr) |
|---|---|
| 0 | 4.58 |
| 5 | 6.54 |
| 10 | 9.21 |
| 15 | 12.79 |
| 20 | 17.54 |
| 25 | 23.76 |
| 30 | 31.8 |
| 35 | 45.07 |

| Substance | Specific Heat Capacity $(\frac{J}{g \cdot °C})$ |
|---|---|
| $H_2O(l)$ | 4.184 |
| $H_2O(g)$ | 2.01 |
| $H_2O(s)$ | 2.09 |
| Ti(s) | 0.555 |
| Al(s) | 0.897 |
| Ag(s) | 0.235 |
| Au(s) | 0.129 |
| Cu(s) | 0.385 |
| Fe(s) | 0.412 |
| Air(g) | 1.004 |
| Li(s) | 3.58 |

1 atm=760 torr=760 mmHg=14.7 psi=101.3 kPa

Ethylene glycol:        Density =1.11 g/cm³    Boiling Point= 197 deg C        Kb= 2.26 C/m

The thermophysical properties of Campbell's soup

Thermal diffusivity = 5 x 10⁻⁷ m²/s            Specific heat = 3.93 kJ/kg-K

Thermal conductivity = 0.56 W/m-K            Viscosity = 2.5 mPa-s            Density = 1032 Kg/m³

**TABLE 12.8  Freezing Point Depression and Boiling Point Elevation Constants for Several Liquid Solvents**

| Solvent | Normal Freezing Point (°C) | $K_f$ (°C/m) | Normal Boiling Point (°C) | $K_b$ (°C/m) |
|---|---|---|---|---|
| Benzene (C₆H₆) | 5.5 | 5.12 | 80.1 | 2.53 |
| Carbon tetrachloride (CCl₄) | −22.9 | 29.9 | 76.7 | 5.03 |
| Chloroform (CHCl₃) | −63.5 | 4.70 | 61.2 | 3.63 |
| Ethanol (C₂H₅OH) | −114.1 | 1.99 | 78.3 | 1.22 |
| Diethyl ether (C₄H₁₀O) | −116.3 | 1.79 | 34.6 | 2.02 |
| Water (H₂O) | 0.00 | 1.86 | 100.0 | 0.512 |

**Equations:**

$$PV = nRT$$

$$KE = \frac{1}{2}mv^2$$

$$P_{total} = P_1 + P_2 + P_3 \ldots$$

$$P_n = X_n P_{total}$$

$$KE = \frac{3}{2}RT$$

$$P = \frac{F}{A}$$

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

$$\Delta E = q + w$$

$$q = m \times C_s \times \Delta T$$

$$w = -P\Delta V$$

$$M_1 V_1 = M_2 V_2$$

$$\Delta t_f = i k_f m$$

$$\Delta t_b = i k_b m$$

$$\Pi = iMRT$$

$$[A]_t = -kt + [A]_0$$

$$\ln[A]_t = -kt + \ln[A]_0$$

$$[A]_t = [A]_0 e^{-kt}$$

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

$$t_{1/2} = \frac{\ln(2)}{k}$$

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

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

$$k = Ae^{-\frac{E_a}{RT}}$$

$$\ln(k) = -\frac{Ea}{R}\left(\frac{1}{T}\right) + \ln(A)$$

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{Ea}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

**Oregon State University**

Periodic table of the elements.

**Multiple Choice** (16 Questions)

1) Consider the system $SO_{2(g)} + CO_{2(g)} \rightleftharpoons CO_{(g)} + SO_{3(g)}$    Kc=6.76

    $[SO_2] = 1.03$                 $[CO_2] = 1.56\ M$              $[CO]=2.93$             $[CO_3] = 2.90$

Which of the following are true?

A) The system is at equilibrium
B) The system is not at equilibrium and more product will form
C) The system is not at equilibrium and more reactant will form
D) The system is not at equilibrium and more product will be needed to add
E) The system is not at equilibrium and more reactant will be needed to add

2) An ideal gas fills a balloon at a temperature of 27°C and 1 atm pressure. By what factor will the volume of the balloon change if the gas in the balloon is heated to 127°C at constant pressure?

    a) 27/127            b) 3/4         c) 4/3         d) 2/1         e)127/27

3) Consider a continuous-flow device used to kill bacteria in Campbell's tomato soup. Tomato soup enters a 1.25 inch 316 stainless steel tube at 15°C at a volumetric flowrate of 8.0 L/min. Superheated steam heats the tomato soup to the desired exit temperature of 85°C necessary to kill off bacteria. What is overall *heat transfer rate* required to heat the tomato soup? *Heat transfer rate is just the amount of energy per time, otherwise known as a watt, or Joules per second.*

a) 37 watts
b) 280 watts
c) 38,000 watts
d) 43,000 watts
e) 280,000 watts
f) 2,300,000 watts

4) A student mixes two aqueous chemicals and filters out some solid. Which of the following pairs of reactants could the student have filtered? There may be more than one.

a) $NaCl_{(aq)}$ and $KOH_{(aq)}$
b) $NH_4OH_{(aq)}$ and $BaCl_{2(aq)}$
c) $NaCl_{(aq)}$ and $AgNO_{3(aq)}$
d) $K_2SO_{4(aq)}$ and $NH_4OH_{(aq)}$
e) $Pb(NO_3)_{2(aq)}$ and $KCl_{(aq)}$

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$
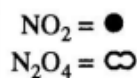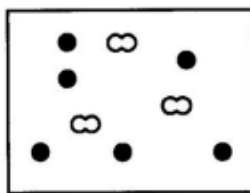
**5) The diagram on the left represent a reaction at equilibrium. What must be true?**

$NO_2 = \bullet$
$N_2O_4 = \infty$

A) $K = 0$                 E) not enough info
B) $0 < K < 1$
C) $K = 1$
D) $K > 1$

Composition (at% Ag)
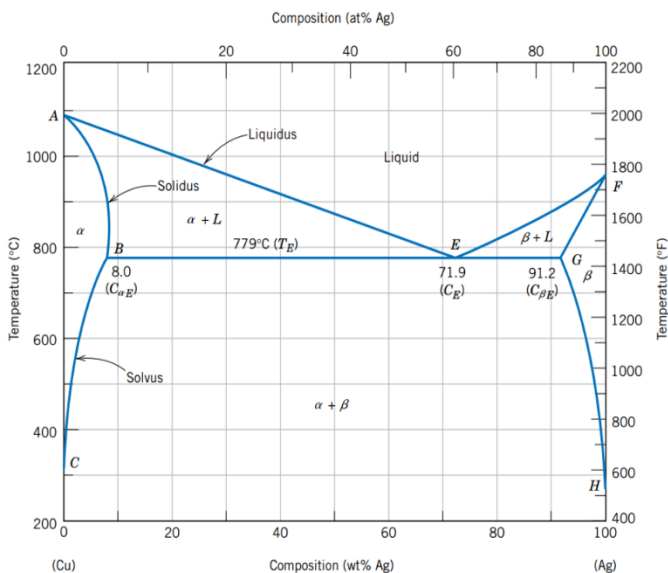
**6) The following is a phase diagram for a silver copper alloy. The eutectic point (E) is the temperature and pressure at which a certain liquid mixture transforms into more than one solid phases. Which of the following is false?**

a) There are three triple points
b) There are six phases within these alloys
c) There are eight phase boundaries
d) Silver has a lower melting temperature than copper
e) Decrease in temperature from the eutectic point will transition to the $\alpha + \beta$ phase

**7) How many moles of calcium are needed to be dissolved in water to produce 500.0 mL of a 0.200M solution from 10.0 grams of CaCO$_3$?**

a) $6.022 \times 10^{20}$
b) $2.408 \times 10^{22}$
c) $1.506 \times 10^{23}$
d) $6.022 \times 10^{23}$
e) $1.506 \times 10^{24}$

**8) Consider a mixture of equal grams of gaseous NO$_2$ and C$_2$H$_5$OH under the same conditions within an expandable container. Which of the following are true? (There may be more than one)**

a) NO$_2$ will have the same partial pressure as C$_2$H$_5$OH
b) NO$_2$ will occupy less volume than C$_2$H$_5$OH
c) NO$_2$ will have the same velocity as C$_2$H$_5$OH
d) NO$_2$ will have the same kinetic energy as C$_2$H$_5$OH
e) If the temperature of the container increases, the final volume of NO$_2$ will be greater than that of C$_2$H$_5$OH
f) It will take less energy for NO$_2$ to condense from gas to liquid than for C$_2$H$_5$OH to condense from gas to liquid.
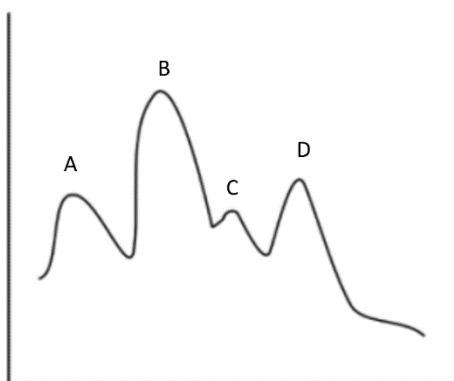
probability

speed

I

II

III
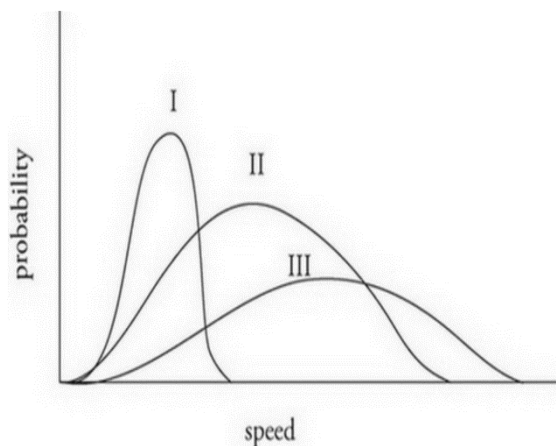
9) Identify the three gases represented on the Maxwell-Boltzmann diagram. Assume all gases are at the same temperature.

|     | I     | II    | III   |
|-----|-------|-------|-------|
| A.  | $H_2$ | $N_2$ | $F_2$ |
| B.  | $H_2$ | $F_2$ | $N_2$ |
| C.  | $F_2$ | $N_2$ | $H_2$ |
| D.  | $N_2$ | $F_2$ | $H_2$ |

10) A steel gas cylinder contains argon gas at STP. What is the final pressure if the temperature is changed to 145°C?

a) 0.653 atm
b) 0.713 atm
c) 1.40 atm
d) 1.53 atm
e) 5.80 atm



11) The potential energy vs reaction progress graph is depicted to the left. Which of the following is not true? (select all)

a) The reaction is overall exothermic
b) Step A is the rate determining step
c) Step B has the largest rate constant
d) There are 3 intermediates
e) Step C is the fast step
f) For the reverse reaction, step D is rate limiting

12) You are climbing the ice caps along the summit of the Icelandic volcano Eyjafjallajökull. You need to melt 2.00 kg of ice at 0 °C for drinking water. You have small cylinders capable of providing 155 kJ each. How many cylinders will you need to melt all the ice?

a) 1
b) 3
c) 5
d) 7
e) 9

13)



Nonane

2,3,4-trifluoropentane
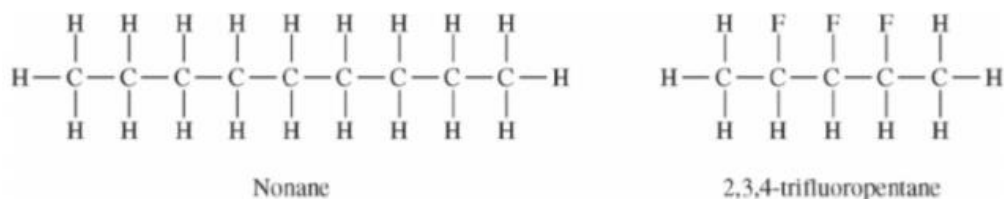
Consider the molecules represented above and the data in the table below.

| Compound | Molecular Formula | Molar Mass (g/mol) | Boiling Point (°C) |
|---|---|---|---|
| Nonane | $C_9H_{20}$ | 128 | 151 |
| 2,3,4-trifluoropentane | $C_5H_9F_3$ | 126 | 89 |

Nonane and 2,3,4-trifluoropentane have almost identical molar masses, but nonane has a significantly higher boiling point. Which of the following statements best helps explain this observation?

(A) The C–F bond is easier to break than the C–H bond.
(B) The C–F bond is more polar than the C–H bond.
(C) The carbon chains are longer in nonane than they are in 2,3,4-trifluoropentane.
(D) The carbon chains are farther apart in a sample of nonane than they are in 2,3,4-trifluoropentane.


14)Consider the following hypothetical reaction:

$$2A_{2\,(g)} + 4B_{(s)} \rightarrow 4AB_{(g)} \qquad \text{Endothermic}$$

Which of the following will cause a shift towards the reactants? (select all)

a) Removal of AB       b) Removal of B                 c) Decrease in volume
d) Increase in Volume       e) Decrease in Temperature   f) Increase in Temperature
g) Addition of 1 mol of gaseous compound                 h) Addition of catalyst D


15) What volume of methane is required to produce 50.0 grams of $H_{2(g)}$ at 25°C and 0.950 atm?

$$CH_{4(g)} + H_2O_{(l)} \rightarrow 3H_{2(g)} + CO_{(g)}$$
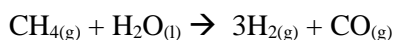
a) 192L
b) 214 L
c) 1,280 L
d) 638 L
e) 1,920 L


16) For a certain endothermic reaction, what can be said about the $K_{eq}$ once the temperature has decreased?

a) $K_{eq}$ after > $K_{eq}$ before          b) $K_{eq}$ after < $K_{eq}$ before          c) $K_{eq}$ after = $K_{eq}$ before

d) Can't be determined

**Free Response Question** (8 questions)

17) A student mixes 100.00 mL of 0.250 M $LiOH_2$ to a 125 mL solution of 0.175 M $Pb(NO_3)_4$. If 0.56 grams of precipitate is formed, what is the percent yield?

18) A student wants to find the enthalpy of solution, $\Delta Hsoln$, for lithium chloride. To do this, he measures 10.0 g of sodium hydroxide initially at 15.0°C to a calorimeter and then adds 10.0 g of the solid lithium chloride while stirring to let it dissolve. After the salt dissolves completely, he measures the temperature and records a maximum 23.6°C.

   a) Calculate the magnitude of heat absorbed by the solution during the dissolution process assuming a specific heat capacity of the solution to be 4.18 J/(g-C).

   b) Determine the value of $\Delta Hsoln$ for lithium chloride

   c) Determine the $\Delta H_{rxn}$

19) Radioactive iodine can be used in cancer treatment in the thyroids. If iodine normally has a half-life of 8.07 days, and today, your thyroid absorbed 148 microcuries (µC) during treatment, how much would remain after 39 days?

20) What is the boiling point of an aqueous solution whose vapor pressure is 20.5 torr at 25°C? Assume the solute is nonvolatile and that the vapor pressure of pure water at 25°C is 23.76 torr.
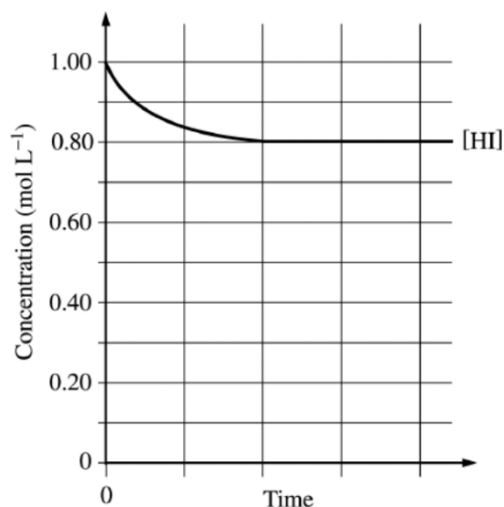
21) Hydrogen Iodide decomposes to Hydrogen and Iodine in fast equilibrium. After a 1.0 mole sample of HI(g) is placed into an evacuated 1.0 L container at 700. K, the concentration of HI(g) as a function of time is shown to the left.

(a) Determine the value of $K_c$ at equilibrium

(b) Make a sketch on the graph that shows how the concentration of Hydrogen changes as a function of time.

22)  Fill in the table below for the reaction $2A + 2B + C \rightarrow D + 2E$

The rate law is known to be:     Rate $= k[A][B]^2$

| Trial# | [A] | [B] | [C] | Initial Rate (M/min) |
|---|---|---|---|---|
| 1 | 0.10 | 0.10 | 0.20 | $2.3 \times 10^{-5}$ |
| 2 | 0.20 | | | $4.6 \times 10^{-5}$ |
| 3 | 0.10 | | | $2.1 \times 10^{-4}$ |
| 4 | | 0.20 | | $1.8 \times 10^{-5}$ |
| 5 | | | 0.60 | $2.3 \times 10^{-4}$ |

23) A cup of water at 12°C has some ice cubes added to it. The ice cubes were originally sitting at -4 deg C, and at thermal equilibrium the temperature of the water decreases to 0°C. How much, in grams, of ice cubes were added?

24) At equilibrium, there are 0.030 moles of A and 0.115 moles of B at 350K in a 3000 mL container. The volume decreased to a third of its size. Calculate the new equilibrium pressure of A.

$$A_{(g)} \rightleftharpoons 2B_{(g)}$$