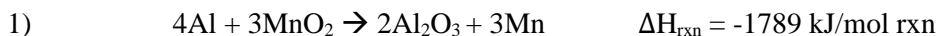


## Chemistry 232 Final Review Sheet

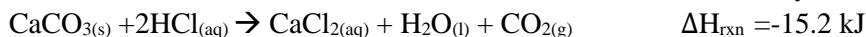
### Thermochemistry



a) According to the reaction, Determine the energy released if 17g of Al are used.

b) What mass of Mn forms when 1250 kJ is detected?

2) How much heat is released if excess calcium carbonate reacts with 48.9 mL of 0.668 M hydrochloric acid?



3) An Initial 25 gram sample of gold is at 27°C. What is the final temperature of the gold after absorbing 2.35 kJ of heat? Heat capacity of gold is 0.128 J/g°C.

4) Consider a reaction producing  $\text{NF}_3$  at 298K. Approximate the average bond enthalpy of a F – F bond if the reaction takes place with  $\Delta H_{\text{rxn}} = -211 \text{ kJ/mol}$

Bond	Average Bond Enthalpy (kJ mol <sup>-1</sup> )
N≡N	946
N–F	272
F–F	?

5) James wants to find the enthalpy of solution,  $\Delta H_{\text{soln}}$ , for the alkali metal halides lithium chloride and sodium chloride. To do this, James measures 100.0 grams of water at initially 15.0 degrees Celsius 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 temperature and records a maximum 35.6 degrees Celsius.

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  $\Delta H_{\text{soln}}$  for lithium chloride in kJ/mol<sub>rxn</sub>

6) Calculate the thermal equilibrium when a 12 gram sample of iron at 50 °C is put into a container of 4.44 moles of water at 12°C

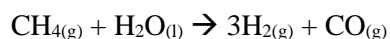
## Chemistry 232 Final Review Sheet

### Ideal Gasses

1) A gas sample is heated from 253 K to 330 K while the volume increases from 2.00 L to 4.50 L. If the initial pressure is 0.140 atm, what is the final pressure?

2) A gaseous mixture containing 1.5 mol Argon and 3.5 mol CO<sub>2</sub> has a total pressure of 7.3 atm. What is the partial pressure of CO<sub>2</sub>?

3) Methane reacts with water to form hydrogen gas and carbon monoxide. What volume of methane is required to produce 50.0 g of H<sub>2(g)</sub> at 298 K and 0.950 atm?



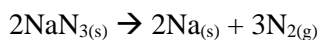
4) A 2.00-L flask containing H<sub>2</sub> gas at 475 torr is connected to a 1.00-L flask containing N<sub>2</sub> gas at 0.200 atm. After the valve between the flasks has been opened: V<sub>final</sub> = 3.00 L

What is the final partial pressure of H<sub>2</sub>?

What is the total pressure?

5) When water vapor decomposes, H<sub>2</sub> and O<sub>2</sub> form. What mass of H<sub>2</sub>O is required to form 1.4 L of O<sub>2</sub> at a temperature of 315 K and pressure of 0.957 atm?

6) Mark is driving and gets distracted from a text from Naomi. He crashes James against a brick wall and sodium azide in Mark's airbag quickly decomposes to sodium and nitrogen gas upon impact to inflate. Because of this, James dies but Mark lives. If 11.8 L was inflated, how much sodium azide, in grams, was in Mark's airbag? Assume STP conditions.



7) Determine the density (g/L) of C<sub>2</sub>H<sub>2</sub> when stored at 180 K and 0.680 atm.

**Intermolecular Forces and Phases**

1) Calculate the heat added to 4.44 g of benzene from 0.0°C to 60.0 °C

$$C_{\text{benzene(s)}} = 32.6 \text{ J/g } ^\circ\text{C}$$

$$\Delta H_{\text{fus}} = 99.0 \text{ J/mol}$$

$$\text{melting point} = 5.0 \text{ } ^\circ\text{C}$$

$$C_{\text{benzene(l)}} = 134.8 \text{ J/g } ^\circ\text{C}$$

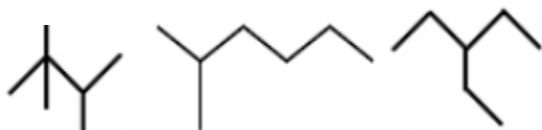
$$\Delta H_{\text{vap}} = 339 \text{ J/mol}$$

$$\text{boiling point} = 80.1 \text{ } ^\circ\text{C}$$

2) Salt and sugar dissolved in water will have a larger boiling point than pure water. Why?

3) At 25°C and 1 atm, F<sub>2</sub> is a gas, whereas I<sub>2</sub> is a solid. Why?

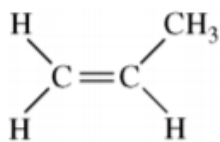
4) Which of the following constitutional isomer of heptane would have the greatest viscosity?



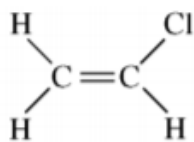
5) Consider liquid pentane, C<sub>5</sub>H<sub>12</sub> (l). Which of the following is most soluble in pentane at 1 atm?



6) Rank by increasing boiling point and explain why:

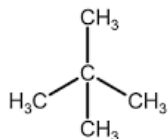


Propene

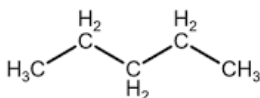


Vinyl Chloride (chloroethene)

7) Propene has a smaller boiling point than vinyl chloride. Why?



neopentane



*n*-pentane

8) Neopentane and *n*-pentane have the same molar mass. Which will have a higher boiling point? Why?

**Colligative properties and Solutions**

1) A mixture of volatile Jamesonnum and ethyl ether are in a beaker at room temperature. It is well mixed and has a vapor pressure of 430 torr. At room temperature, pure Jamesonnum and ethyl ether has a vapor pressure of 420 torr and 520 torr, respectively. What is the mole fraction of Jamesonnum in the mixture?

2) What is the freezing point of a solution made by dissolving 12.54 g of benzene,  $C_6H_6$  in 83.5 mL of chloroform?  $CHCl_3$

3) What is the freezing point of a solution comprised of 47.4 g  $CaCl_2$  dissolved in 359.5 g water?  $K_f = 1.86$  C/m

4) An unknown sample of Jamesonnum is dissolved in 125 mL of water. The resulting solution boils 103.5 deg C. Jamesonnum has a molar mass of 11.5 g/mol and a normal boiling point of 96 degrees C. How many grams of Jamesonnum was dissolved?

5) Provide the van hoff factor for:

LiOH

$CaCl_2$

KI

$Mg_3(PO_4)_2$

$Li_2SO_4$

$HC_2H_3O_2$

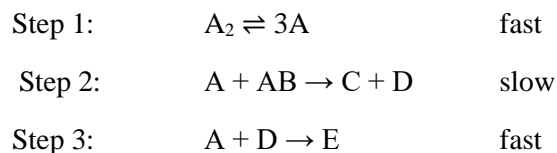
NaCl

6) 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.

7) A 0.15-g sample of a purified protein is dissolved in water to give 2.0 mL of solution. The osmotic pressure is found to be 18.6 torr at 25 °C. Calculate the protein's molar mass.

**Chemical Kinetics**

1) A proposed mechanism for an unknown exothermic reaction is shown below. Write the overall reaction, and identify the intermediates, the rate-determining step, and the rate law predicted by this mechanism.



2) Radioactive Iodine can be used in cancer treatment in the thyroids. If Iodine normally has a half-life of 8.07 days, how much time has passed if your thyroid has reduced it by 78 percent?

3) James is mass producing large quantities of Jamesonium at a rate of  $650 \text{ M s}^{-1}$  to start an empire. Due to the FBI on his tail, James decides to temporarily produce Jamesonium at a rate of  $13 \text{ M s}^{-1}$  under the table instead. James accomplishes this by lowering the temperature to 36 degrees Celsius. However, he forgets his blueprints for his original schematics, and needs to figure out the necessary temperature to restart his empire. If Jamesonium has an activation energy of 113 kJ/mol, what temperature would James need to achieve the original rate of production using constant concentrations?

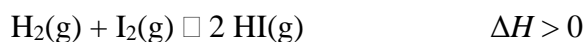
4) How would the ratio of rate change if:  $\text{rate} = k[A]^{1/2}[B]^4$

- A is tripled
- A and B are both halved
- A is half and B is doubled
- What are the units of the k constant?

5) The rate constant for the first-order decomposition of  $N_2O_5$  to  $NO_2$  and  $O_2$  (all three are gases) is  $7.48 \times 10^{-3} \text{ min}^{-1}$  at  $45^\circ\text{C}$ . If the reaction begins with only 0.100 atm of  $N_2O_5$  present in the container, how long will it take for the total pressure in the container to rise to 0.145 atm?

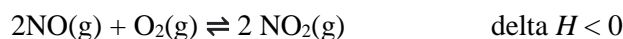
**Chemical Equilibrium**

- 1) Consider a chemical equilibrium where  $K > 1$ . Does the forward reaction or reverse reaction have a greater rate?
- 2) Consider a chemical equilibrium where  $K < 1$ . Is there a larger concentration of reactants or products at equilibrium?



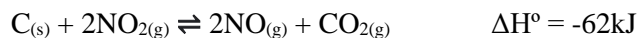
Which of the following changes to the equilibrium system represented above will increase the quantity of  $\text{HI}(\text{g})$  in the equilibrium mixture?

- I. Adding  $\text{H}_2(\text{g})$
- II. Increasing the temperature
- III. Decreasing the pressure



3) Which of the following changes alone would cause a decrease in the value of  $K_{\text{eq}}$  for the reaction represented above?

- A) Decreasing the temperature
- B) Increasing the temperature
- C) Decreasing the volume of the reaction vessel
- D) Increasing the volume of the reaction vessel
- E) Adding a catalyst

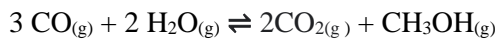


4) Predict the shift in equilibrium if:

- |  |                             |                               |
|--|-----------------------------|-------------------------------|
| 1. Some $\text{NO}_2$ added                                      | 2. Some $\text{CO}_2$ added | 3. Some $\text{CO}_2$ removed |
| 4. Some C is added   | 5. Temperature is increased | 6. Temperature is decreased   |
| 7. Pressure is increased   | 8. Pressure is decreased    | 9. $Q > K$ 10. $Q < K$        |
| 11. Increasing the pressure by adding argon gas to the reactants | 12. adding a catalyst       |                               |

## Chemistry 232 Final Review Sheet

5) Consider the following reaction where carbon monoxide and water react to form carbon dioxide and methanol.



- a) At 255 degrees C, a rigid 4.35L container hold 0.0241 moles of  $\text{H}_2\text{O}$ , 0.125 moles of  $\text{CO}_2$ , and 0.0980 moles of  $\text{CH}_3\text{OH}$ . How many moles of  $\text{CO}$  are in the container if the  $K_p$  is 169 at this temperature?

6) For a reaction  $\text{A}_{(\text{g})} + \text{B}_{(\text{g})} \rightleftharpoons 2\text{C}_{(\text{g})}$   $K_p = 0.355$  at 300 degrees C

Initial partial pressures are 300.0 torr for A and B and 500 torr for C. What will be the partial pressures at equilibrium?

7) For the following reaction,  $2\text{HI}_{(\text{g})} \rightleftharpoons \text{H}_{2(\text{g})} + \text{I}_{2(\text{g})}$

- a) find the total pressure (in atm) at equilibrium and the equilibrium constant if at 298K, there are 0.0154 mol HI, 0.00216 mol  $\text{H}_2$  and 0.00216 mol of  $\text{I}_2$ .
- b) Determine the new equilibrium concentration after 0.00100 mol  $\text{H}_2$  are added to the system.

## Chemistry 232 Final Review Sheet

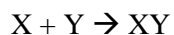
### Conceptual questions to cause headache

Circle the chemicals that would NOT have an enthalpy of formation equal to zero:

He<sub>(g)</sub>   Fe<sub>(g)</sub>   H<sub>2</sub>O<sub>(g)</sub>   O<sub>2(g)</sub>   Ag<sub>(l)</sub>

A reaction has 3 activated complexes. How many intermediates will it have?

The following reaction is observed to be second order in x and third order in y



Does this reaction occur in a single step in which the X and Y collide?

At a temperature of 250K, the molecules of unknown gas Z, have an average velocity equal to that of HI at 500K. What is the identity of the gas?

SO<sub>2</sub>   O<sub>2</sub>   N<sub>2</sub>   CO<sub>2</sub>   NO<sub>2</sub>

Largest volume occupied: O<sub>2</sub> or Cl<sub>2</sub> where there is twice the amount of Cl<sub>2</sub> than O<sub>2</sub> and Cl<sub>2</sub> is at 350K and O<sub>2</sub> is at 300K

Largest final temperature: higher amount of substance A with more energy added and a lower specific heat capacity compared to substance B with lesser energy added, higher specific heat, and lower amount

Largest volume occupied: C or O<sub>2</sub> where there is 10 grams of C, 30 grams of O<sub>2</sub> at the same temperature and pressure.

Smallest velocity: NO<sub>2</sub> or O<sub>2</sub> with the same kinetic energy

Largest volume occupied: equal amounts Carbon vs Fluorine where the temperature of Carbon is larger than that of Fluorine

Largest volume occupied: Neon or Krypton where there is a larger amount of Krypton present.

Identify as either exothermic (EXO) or endothermic (ENDO)

melting gold	boiling water	copper cooling down	crushing a pill
evaporation	lighting a match	iron rusting	energy being released
cold packs	Water freezing	heat transferred from surrounding to system	
heat transferred from system to surroundings		a container feels cold	a container feels hot

P-type or N-type indicator?

Silicon doped with Gallium	Germanium doped with antimony	Tin Doped with Arsenic
Antimony doped with Tin	Germanium doped with Phosphorous	Silicon doped with Aluminum

Consider Jamesonium metal, which has 8 X corner atoms, 2 Y center atoms, 4 Z face atoms, and 12 D edge atoms. What is the formula of this metal?



# Chemistry 232 Final Review Sheet

Rank by largest band gap: N, P, As, Sb

Rank by largest atomic radii, B, N, Al, F

Rank by largest effective nuclear charge: B, N, Be, Mg      Rank by increasing BP:  $\text{NH}_3$ ,  $\text{CF}_4$ ,  $\text{PH}_3$ ,  $\text{CaCl}_2$ ,  $\text{O}_2$

Rank by increasing average velocity: Kr,  $\text{NO}_2$ ,  $\text{Cl}_2$

Rank by increasing conductivity: N, P, As, Sb

Rank the following by lowest boiling point:

0.10 m KI

0.05 m  $\text{MgCl}_2$

0.25 m  $\text{C}_6\text{H}_{12}\text{O}_6$

0.5m HCl

Assuming sufficient energy, will the following interactions form a bond to start the reaction involving nitrosyl chloride?  
 $\text{NOCl(g)} + \text{NOCl(g)} \rightarrow 2\text{NO(g)} + \text{Cl}_2\text{(g)}$

Cl-N-O - - - O-N-Cl

Cl-N-O - - -Cl-N-O

O-N-Cl - - - Cl-N-O

A proposed mechanism for an unknown exothermic reaction is shown below. Write the overall reaction, and identify the intermediates, the rate-determining step, and the rate law predicted by this mechanism.

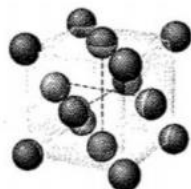
Step 1:  $\text{A}_2 \rightleftharpoons 3\text{A}$  fast

Step 2:  $\text{A} + \text{AB} \rightarrow \text{C} + \text{D}$  slow

Step 3:  $2\text{A} + \text{D} \rightarrow \text{E}$  fast

From the list below, assuming everything is at STP, which molecule(s) would be most likely to exhibit non-ideal behavior?  $\text{SO}_2$   $\text{O}_2$   $\text{N}_2$   $\text{CO}_2$   $\text{NO}_2$

Atoms per unit cell?



What happens to volume if temperature decreases and pressure is constant?

Which is not a state function? Heat, temperature, entropy, enthalpy, volume, work, internal energy

Write down the equation for  $\Delta H$  using standard enthalpies of formation

Write the equation for a real gas that corrects the non-ideal assumptions of an ideal gas