***Final Exam Review-Honors*** Name _____
Period _____

**This is not a fully comprehensive review packet. This packet is especially lacking practice of "explanation" type questions!!! You should study all previous review sheets and tests. Blanks may be downloaded from my website.**

## Unit 9: Types of Reactions

1) For each reaction below, determine the type of reaction (synthesis, decomposition, single replacement, double replacement or combustion). Then, predict the products and balance the equations. For all double replacement reactions, specify (s) or (aq).

Reaction Type

a) ____ $Ag_2SO_4$ (aq) + ____ KCl (aq) → _____

b) ____ $C_5H_{12}$ (*l*) + ____ $O_2$ (g) → _____

c) ____ K (s) + ____ $N_2$ (g) → _____

d) ____ $OF_2$ (s) $\xrightarrow{\Delta}$ _____

e) ____ Li (s) + ____ $Pb(NO_3)_2$ → _____

f) ____ $Na_3PO_4$ (aq) + ____ $NiCl_4$ (aq) → _____

g) ____ $Cl_2$ (g) + ____ KBr (aq) → _____

h) Aqueous lead(II) nitrate is mixed with aqueous sodium phosphate. _____

i) Solid mercury(II) oxide is heated. _____

j) Liquid butanol ($C_4H_9OH$) is burned in oxygen. _____

k) Hot liquid sodium reacts with liquid bromine. _____

Note: Although we first covered single-replacement reactions in this unit, they have been reviewed during Unit 16, Electrochemistry.

For the following equations, determine the correct product formulas & states, then balance. Then write complete ionic and net ionic equations.

2) ___ $BaCl_2$ (aq) + ___ $K_2SO_4$ (aq) →

3) Silver chlorate solution reacts with iron(III) bromide solution.

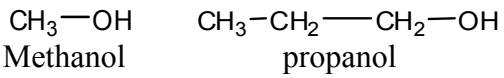
**Unit 10: Intermolecular Forces & Polarity**

4) Complete this chart as asked.

| **Chemical Formula** | **Structure**<br>• For all covalent molecules, draw Lewis Dot and 3D structures. Show any permanent partial charges.<br>• For all metallics, draw the particles that make it up.<br>• For all ionics, show charges on each ion in the substance and draw a full Lewis Dot structure for any polyatomic ion. | **type of substance**<br>NPC molecular, PC Molecular, Ionic, Metallic, Network Covalent. | **Strongest attractive force**<br>(the attraction that must break if boiled) |
|---|---|---|---|
| a) $C_2H_2$ | | | |
| b) $N_2H_2$ | | | |
| c) Mg | | | |
| d) $Al(NO_3)_3$ | | | |
| e) $CCl_4$ | | | |
| f) $AsBr_3$ | | | |
| g) $SeO_2$ | | | |

5) Why do $H_2O$, $NH_3$, and HF have significantly higher boiling points than $CH_4$ even though all four molecules have the same number of electrons and so have similar dispersion forces.

6) Methanol's boiling point is 65°C and propanol's boiling point is 97°C. Use the structures below to help explain why there is this difference in boiling points.




Methanol propanol

7) Acetone is soluble in non-polar, slightly polar and very polar substances. Thus, the polarity of acetone must be _____.

8) **T or F**? Nonpolar substances are generally soluble in polar substances.

9) Electrons are shared between atoms in **(a covalent, an ionic)** substance.

10) Electrons are transferred between atoms in **(a covalent, an ionic)** substance.

11) Would $C_6H_{12}$ (*l*) dissolve in water? _____ Would $C_2H_5OH$ (*l*)? _____ Explain choices.

**Unit 11: Gases**

12) The volume of the gas inside a syringe is 50.0 mL when 0.75 atm of pressure is exerted on the plunger. When 2.5 atm of pressure is exerted on the plunger, what is the volume of the gas inside the syringe?

13) A balloon has a volume of 3.0 L at 0.0°C. What is the volume of the balloon at 50.0°C?

14) Use the collision theory to explain why the volume of a balloon increases with increased temperature.

15) Erlenmeyer flask is filled to the brim with water. A note card is carefully placed over the opening of the flask. The flask is turned upside down. Amazingly, the note card does not fall. What keeps it from falling?

16) A gas sample containing a mixture of $Br_2$ and Ne gas has a total pressure of 2.3 atm. If the partial pressure of $Br_2$ (g) is 1.9 atm, what is the partial pressure of the Ne gas?

17) At what conditions do real gases have similar behavior as ideal gases?

18) Why does water boil at room temperature in a bell jar? (Discuss vapor pressure differences.)

19) What is the molar mass of a gas with density of 5.25 g/L at 354 kPa and 35°C? Identify this diatomic element.

20) A 0.90 L sample of $Cl_2$ gas is collected at 1.5 atm and 25°C.
   a) Calculate the # moles of $Cl_2$ gas in the sample.

   b) Calculate the density of the $Cl_2$ gas sample.

   c) If a 0.90 L sample of $O_2$ gas was collected in the same conditions (1.5 atm and 25°C), how many moles of $O_2$ would there be in the sample?

   d) Which molecules are moving faster on average? **$Cl_2$ (g) or $O_2$ (g)**

   e) Which molecules have a higher average kinetic energy-- **$Cl_2$ (g) or $O_2$ (g)**?

21) A gas suspected to be either CO or $CO_2$ effuses at a rate that is only 0.301 times that of He at the same temperature. What is the molar mass of the gas? What is the identity of the gas?

22) Given this reaction: $H_2\,(g) + I_2\,(g) \rightarrow 2\ HI\,(g)$
If 3.5 g of $H_2$ are completely reacted with excess $I_2$ (g), what volume of HI (g) would be collected at 255°C and 128 kPa?

**Unit 12: Solutions**

23) You wish to make 400. ml of 2.0 M $CaCl_2$.
a) How many grams of $CaCl_2$ must you mass out?

b) Describe in detail how you would make the solution.

24) Which solution has the lowest freezing point? Why?
a) pure water b) 0.5 M $AgNO_3$(aq) c) 1.0 M $AgNO_3$ (aq) d) 1.5 M $AgNO_3$ (aq)

25) What is the theoretical yield of $MgF_2$ when 180. mL of 0.0375 M $AlF_3$ is mixed with excess $Mg(NO_3)_2$ according to the following equation (balance!)?

____ $Mg(NO_3)_2$ (aq) + ____ $AlF_3$ (aq) ⟶ ____ $MgF_2$ (s) + ____ $Al(NO_3)_3$ (aq)

26) Determine the boiling point of an aqueous solution of 63.8 g of $KNO_3$ (what is *i*?) dissolved in 175.0 g $H_2O$ ($K_b$ = 0.512°C/*m*).

**Unit 13: Energy, Spontaneity and Rates**

27) Given the following information, calculate the ΔH for the overall reaction

$Fe\ (s) + Br_2\ (l) \rightarrow FeBr_2\ (s)$ $\Delta H = -250$ kJ

$2\ FeBr_3\ (s) \rightarrow 2\ FeBr_2\ (s) + Br_2\ (l)$ $\Delta H = +9.2$ kJ

***Overall:*** $2\ Fe + 3\ Br_2\ (l) \rightarrow 2\ FeBr_3\ (s)$ $\Delta H =$

28) Using the standard enthalpies of formation listed below, calculate the enthalpy change for the following combustion reaction: $C_2H_5OH\ (l) + 3O_2\ (g) \rightarrow 2\ CO_2\ (g) + 3\ H_2O\ (l)$

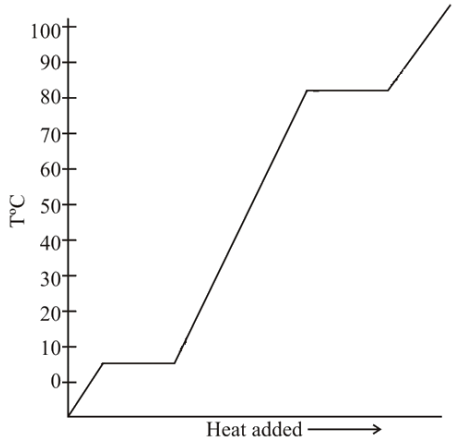
$\Delta H_f$ of $C_2H_5OH(l) = -277.7$ kJ $\Delta H_f$ of $CO_2\ (g) = -393.5$ kJ $\Delta H_f$ of $H_2O\ (l) = -285.8$ kJ

29) Benzene (initially a solid) is heated consistently and the heating curve to the right is obtained. Use the diagram to answer the questions:

a. What is the freezing point of benzene?_____

b. At what temperature, do the liquid and gas phases exist together? _____ What energy change is occurring?

c. What energy change is occurring as T increases from 30° to 70°?




30) Given this equation: $C\ (s) + H_2O(l) \rightarrow CO\ (g) + H_2\ (g)$ $\Delta H = +549$ kJ /mole of C

a) Is this reaction favorable in terms of its enthalpy change? _____ Why?_____

b) Is this reaction favorable in terms of its entropy change? _____ Why?_____

c) If the $\Delta S = +134$ J /K mol, is this reaction spontaneous at 250°C?

d) At what temperature will this reaction become spontaneous?

31) The four major ways of increasing the rate of a reaction are listed below. Explain how each change will increase the rate. **(more collisions, harder collisions, change in the activation energy?)**

a) increase the temperature:

b) increase the concentration of a reactant:

c) increase the surface area of reactants:

d) use a catalyst:

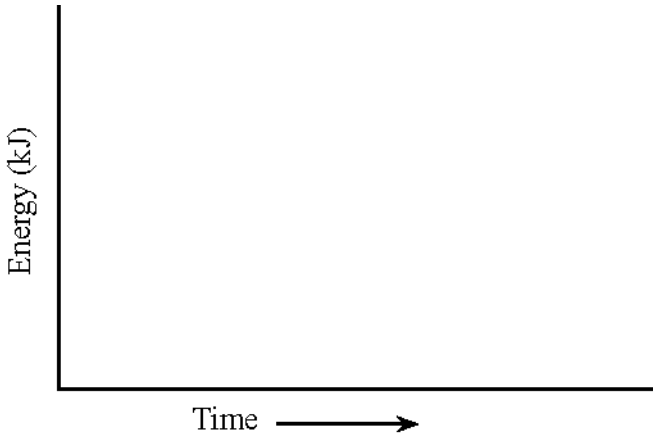
32) Which step in a mechanism is the rate determining step? **(slow or fast)? (lowest or highest $E_a$)?**

33) If the rate law for a particular reaction is Rate = $k\,[CH_3CHO]^2$ , what happens to the rate when the $CH_3CHO$ concentration triples?_____

34) **Given this equation**: $CH_3OH\ (l) + 3/2\ O_2 \rightarrow CO_2 + 2\ H_2O$

**Data**:
- $\Delta H = -730$ kJ/mole of $CH_3OH$
- Activation energy = +105 kJ.

**Directions:**
- Draw a relatively accurate energy diagram.
- Put numerical values on the vertical axis.
- Label the reactants and products
- Draw arrows to show the energy changes of the activation energy and the $\Delta H$.




## Unit 14: Equilibrium

35) Given this equilibrium equation, $2\ NOCl\ (g) \rightleftharpoons 2\ NO\ (g) + Cl_2\ (g)$ , The following equilibrium concentrations are measured: 0.0344 M NOCl, 0.0400 M NO and 0.0200 M $Cl_2$. What is the equilibrium constant for this reaction?

36) Consider the following system: $2\ H_2S\ (g) + 3\ O_2\ (g) \rightleftharpoons 2\ H_2O\ (g) + 2\ SO_2\ (g) + \text{heat}$
Predict which way the equilibrium position will shift when the system is disturbed by...

a) expanding the container at constant temperature: _____ Why?_____

b) removing $SO_2$ : _____ Why?_____

c) raising the temperature: _____ Why? _____

d) absorbing the water vapor: _____ Why? _____

37) The following two questions concern $CaF_2$ whose solubility product constant, $K_{sp} = 2.0 \times 10^{-10}$

a) Suppose a ground-water source contains $2.5 \times 10^{-3}$ g of $F^-$ ions per liter of water. Will $CaF_2$ precipitate if a liter of that ground-water is mixed with $5.0 \times 10^{-3}$ moles of $Ca^{2+}$?

b) In another situation, suppose enough $CaF_2$ solid is added to pure water to make a saturated solution. What would be the $F^-$ ion concentration in that saturated solution?

**Unit 15: Acids and Bases**

38) *$Ba(OH)_2$ (aq) and KOH (aq) are good conductors of electricity.*
*$CH_3CH_2NH_2$ (aq) conducts electricity and has a pH of 11.5.*
*HF(aq) conducts electricity slightly.*

a) Use the data above to label each of the compounds with one of the following labels:
***strong acid, weak acid, strong base, weak base.***

***$Ba(OH)_2$*** _____ ***$CH_3CH_2NH_2$*** _____
***HF*** _____ ***KOH*** _____

b) Explain why $Ba(OH)_2$ conducts electricity when dissolved in water but not as a solid.

c) Explain what happens when pure HF(g) is added to water. Include why HF(aq) only conducts slightly.

39) The $NO_2^-$ ion is a weak base. Suppose a 0.500 M solution of $NaNO_2$ (aq) is made. The pH of the resulting solution is 8.50. What is the $K_b$ of $NO_2^-$ ion?

**Rxn**: $NO_2^-$ + →
**I:**
**C:** _____
**E:**

40) 25.3 mL of an NaOH solution is needed to exactly titrate 30.0 ml of 2.0 M $H_3PO_4$.
**What is the molarity of the NaOH solution?**
*Hint: Complete the balanced reaction first: $H_3PO_4$ (aq) + NaOH (aq) →*

41) Solution A has $[OH^-] = 1.6 \times 10^{-5}$ M and solution B has $[OH^-] = 2.0 \times 10^{-11}$ M. Calculate the pH of each solution. Which solution is the most acidic?

**Unit 16: Electrochemistry**

42) For the following reactions put in all charges and indicate what is being oxidized and what is being reduced.

a) $Cl_2$ (g) + 2 NaBr (aq) → 2 NaCl (aq) + $Br_2$ (l)

b) $MnO_2$ (s) + $FeSO_4$ (aq) + $H_2SO_4$ (aq) → $MnSO_4$ + $Fe_2(SO_4)_3$ (aq) + $H_2O$

43) Determine if these reactions are spontaneous in the **forward** direction or in the **reverse** direction. *(Look at your reference chart, but you do NOT need to calculate $E^\circ_{net}$)*

_____a) $Pb^{2+}$ (aq) + 2 $Br^-$ (aq) $\underset{?}{\overset{?}{\rightleftharpoons}}$ Pb (s) + $Br_2$ (l)

_____b) $Ca^{2+}$ (aq) + Sn (s) $\underset{?}{\overset{?}{\rightleftharpoons}}$ Ca (s) + $Sn^{2+}$ (aq)

44) This reaction is <u>non-spontaneous</u> in the forward direction. *(Thus, it is spontaneous in the reverse direction)* Which metal is more easily oxidized? **Cd or Fe** (Reference charts will NOT help you for this one.)

Cd (s) + $Fe^{2+}$ (aq) $\not\rightleftharpoons$ $Cd^{2+}$ (aq) + Fe (s)

45) Given enough time, what will happen if tomato sauce (acidic-- contains $H^+$) is covered with aluminum foil? To answer, complete these half reactions: *(HINT: use reference chart to determine this Rxn.)*

Ox: Al (s) $E^\circ_{ox}$ =

<u>Red:</u> $H^+$ (aq) $E^\circ_{red}$ = _____

Overall: $E^\circ_{net}$ =

46) Given this reaction, $F_2$ (g) + Cu (s) → $CuF_2$ (s)
Write the two half reactions (balanced), determine the $E^\circ_{net}$, and determine if the reaction is spontaneous.

Ox: $E^\circ_{ox}$ =

<u>Red:</u> $E^\circ_{red}$ = _____

$E^\circ_{net}$ =

47) Look at the diagram of the voltaic cell (spontaneous reaction). Determine which metal is more easily oxidized, write balanced half reactions, determine the overall reaction (balanced), determine the $E^\circ_{net}$. Label the **anode and cathode**, show the **flow of electrons** and **flow of ions** in the salt bridge.

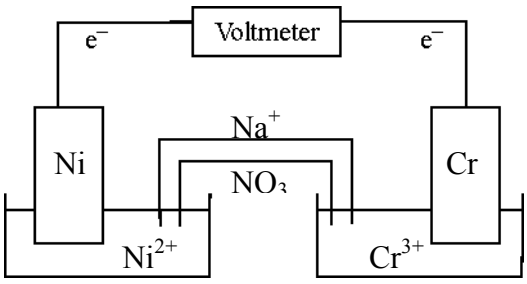
Ox: $E^\circ_{ox}$ =

<u>Red:</u> $E^\circ_{red}$ = _____

**Overall:** $E^\circ_{net}$ =

a) Which electrode will gain mass? _____ Why?

b) Which electrode will lose mass? _____ Why?




48) Sodium metal (Na) and $Cl_2$ gas can be produced by electrolysis (a battery is used). To do this, one sends an electrical current through molten NaCl. The overall reaction is as follows:

2 NaCl (*l*) → 2 Na (s) + $Cl_2$ (g)

a) Write the two half reactions, and determine the $E_{net}$.

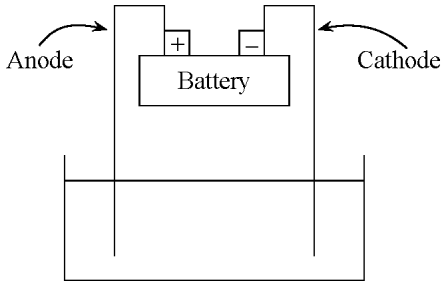
Ox: $E^\circ_{ox}$ =

<u>Red:</u> $E^\circ_{red}$ = _____

$E^\circ_{net}$ =

b) In diagram**,** label where the **solid** and the **gas** are produced.

c) What does the sign of $E^\circ_{net}$ tell you about the reaction?



49) For the following situations below, complete the chemical equations assuming each reaction takes place. Then, determine if the reaction is spontaneous. Based on this decision, predict what would be observed in each case.

*(HINT: Both reactions are just simple single replacement reactions.)*

a) A strip of silver metal (Ag) is placed into an aqueous solution of $MgSO_4$.

$Ag\ (s) \ + \ MgSO_4\ (aq) \rightarrow$

Spontaneous reaction? _____ Observations? _____

b) A strip of magnesium metal is placed into an aqueous solution of $AgNO_3$ .

$Mg\ (s) \ + \ AgNO_3\ (aq) \rightarrow$

Spontaneous reaction? _____ Observations? _____

c) Neither one of these situations as described above produces electricity. Why not?

Answers: 11) $V_2$ = 15.0 mL; 12) $V_2$ = 3.5 L; 15) $P_{Ne}$ = 0.4 atm; 18) MM = 38.0 g/mol; 19a) n = 0.055 mol; 19b) D = 4.3 g/L; 19c) same; 20) MM = 44.2 g/mol; 21) V = 120 L; 22) m = 89 g $CaCl_2$; 24) m = 0.631 g $MgF_2$; 25) $T_b$ = 103.69°C; 26) $\Delta H = -509$ kJ; 27) $\Delta H = -1366.7$ kJ; 30c) $\Delta G = +483$ kJ/mol; 30d) $T = 4.10\times10^3$ K; 35) $K_{eq} = 0.270$; 37a) $Q = 8.5\times10^{-11}$; 37b) $[F^-] = 7.4\times10^{-4}$ M; 39) $K_b = 2.1\times10^{-11}$; 40) [NaOH] = 7.1 M; 41) $pH_A = 9.20$; $pH_B = 3.30$; 45) +2.53 V; 47) +0.49 V; 48) −4.07 V