

Chemical Principles 115
Department of Chemistry
Rutgers, The State University of New Jersey- Camden

EXAM 2 - A
November 4, 2015

Name: _____
Last Key First Initial

RU Number: _____

Name: _____

SECTION I

MULTIPLE CHOICE: Choose the option that best completes the statement or answers the question. Each question is worth 2.0 points unless indicated otherwise.

1. A solute is

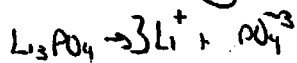
- a. a solid substance which does not dissolve in water.
- b. a solid substance that does not dissolve at a given temperature.
- c. a substance containing a solid, liquid, or gas.
- d. a substance which dissolves in a solvent.
- e. a liquid that does not dissolve in another liquid.

2. Which is a nonelectrolyte?

- a. barium nitrate, $\text{Ba}(\text{NO}_3)_2$
- b. calcium chloride, CaCl_2
- c. sodium chloride, NaCl
- d. methyl alcohol, CH_3OH
- e. potassium sulfate, K_2SO_4

3. Which compound produces four ions per formula unit by dissociation when dissolved in water?

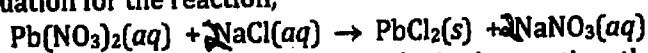
- a. $(\text{NH}_4)_2\text{SO}_4$ 3
- b. Hg_2Cl_2 3
- c. $\text{Ca}(\text{NO}_3)_2$ 3
- d. Li_3PO_4 4
- e. $(\text{NH}_4)_4\text{Fe}(\text{CN})_6$



4. Which substance does not produce ions when dissolved in water?

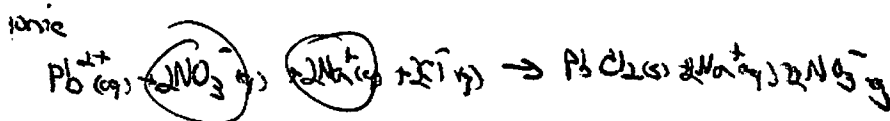
- a. CH_2O
- b. KClO
- c. manganese(II) nitrate
- d. CsCN
- e. NaHS

5. The equation for the reaction,



can be written as an ionic equation. In the ionic equation, the spectator ions are

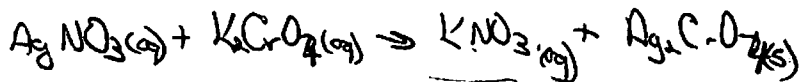
- a. Na^+ and Pb^{2+}
- b. Na^+ and Cl^-
- c. Pb^{2+} and Cl^-
- d. Pb^{2+} and NO_3^-
- e. Na^+ and NO_3^-



Name: _____

6. In the reaction between aqueous silver nitrate and aqueous potassium chromate, what is the identity of the soluble substance that is formed?

- a. silver chromate
 b. silver nitrate
 c. potassium chromate
 d. potassium nitrate
 e. A soluble substance is not formed.



7. Which is not acidic?

- a. grapefruit juice
 b. household ammonia
 c. carbonated water
 d. vinegar
 e. lemon juice

8. When an strong acid reacts with water, the products are:

- a. hydroxide and water
 b. hydronium and anion
 c. salt and hydroxide
 d. hydronium and cation
 e. hydroxide and anion

9. An acid-base neutralization is the reaction of

- a. $H_2(g)$ with $O_2(g)$ to form $H_2O(l)$
 b. $H_2(aq)$ with $OH^-(aq)$ to form $H_2O(l)$
 c. $H^+(aq)$ with $O_2(g)$ to form $H_2O(l)$
 d. $H^+(aq)$ with $OH^-(aq)$ to form $H_2O(l)$
 e. $Na^+(aq)$ with $OH^-(aq)$ to form $NaOH(aq)$

produce H_2O

10. Which is the net ionic equation for the reaction which takes place when $HC_2H_3O_2(aq)$ is added to $NH_3(aq)$?

- a. $HC_2H_3O_2(aq) + NH_3(aq) \rightarrow NH_4^+(aq) + C_2H_3O_2^-(aq)$
 b. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
 c. $HC_2H_3O_2(aq) + OH^-(aq) \rightarrow C_2H_3O_2^-(aq) + H_2O(l)$
 d. $H^+(aq) + NH_4OH(aq) \rightarrow NH_4^+(aq) + H_2O(l)$
 e. $HC_2H_3O_2(aq) + NH_4OH(aq) \rightarrow H_2O(l) + NH_4ClO_4(aq)$

$HC_2H_3O_2$ is a weak acid
 so it does not completely
 dissociate

11. A solution is made by taking 54.62 grams of K_2CrO_4 in enough water to make 250.0 mL of solution. The molarity of the solution is therefore

- a. 0.0002813 M
 b. 0.001125 M
 c. 0.2813 M
 d. 1.125 M
 e. 1.409 M

$$K_2CrO_4 \quad 194.19 \text{ g/mol}$$

$$54.62 \text{ g } K_2CrO_4 \left(\frac{1 \text{ mol}}{194.19 \text{ g } K_2CrO_4} \right) \left(\frac{1}{0.250 \text{ L}} \right) = \boxed{1.125 \text{ M}}$$

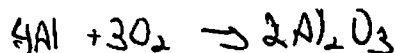
Name: _____

18. Which reaction below *does not occur spontaneously* upon mixing the reagents shown?

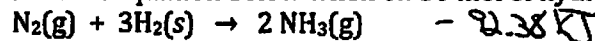
- a. $\text{Cd}(s) + \text{Al}^{3+}(aq) \rightarrow \text{Cd}^{2+}(aq) + \text{Al}(s)$
 b. $\text{Cd}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Cd}^{2+}(aq) + \text{Cu}(s)$
 c. $\text{Zn}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Cu}(s)$
 d. $\text{Al}(s) + \text{Ag}^{+}(aq) \rightarrow \text{Al}^{3+}(aq) + \text{Ag}(s)$
 e. $\text{Cu}(s) + \text{Au}^{3+}(aq) \rightarrow \text{Cu}^{2+}(aq) + \text{Au}(s)$

19. The oxidation of aluminum occurs slowly due to the formation of which substance on the surface of the metal?

- a. $\text{AlCl}_3(s)$
 b. $\text{Al}_2(\text{SO}_4)_3(s)$
 c. $\text{Al}(\text{NO}_3)_3(s)$
 d. $\text{Al}_2\text{O}_3(s)$
 e. $\text{Al}(\text{OH})_3(s)$



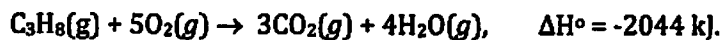
20. When nitrogen gas reacts with hydrogen gas to form ammonia, 92.38 kJ of heat are given off for each mole of nitrogen gas consumed, under constant pressure and standard conditions. What is the correct value for the standard enthalpy of reaction in the thermochemical equation below when 0.750 mol of hydrogen reacts?



- a. +34.5 kJ
 b. -98.3 kJ
 c. +59.2 kJ
 d. -59.2 kJ
 e. 23.1 kJ

$$0.750 \text{ mol H}_2 \left(\frac{-92.38 \text{ kJ}}{3 \text{ mol H}_2} \right) = -23.1 \text{ kJ}$$

21. Propane is often used to heat homes. The combustion of propane follows the following reaction:



How many grams of propane must be reacted by this reaction to release 7563 kJ of heat?

- a. 3.70 g
 b. 44.1 g
 c. 81.6 g
 d. 243.4 g
 e. ~~163.2~~ g

$$-7563 \text{ kJ} \left(\frac{1 \text{ mol C}_3\text{H}_8}{-2044 \text{ kJ}} \right) \left(\frac{44.09 \text{ g C}_3\text{H}_8}{1 \text{ mol}} \right) = 163.2$$

Name: _____

SECTION II

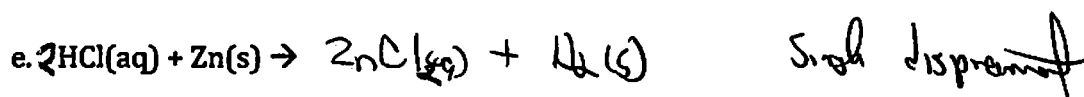
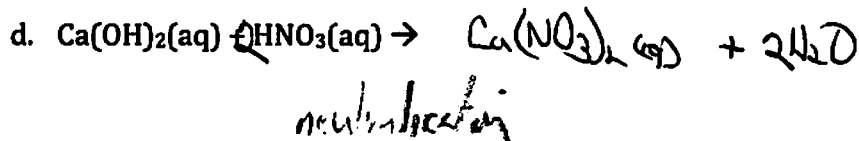
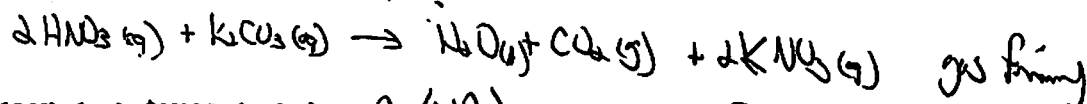
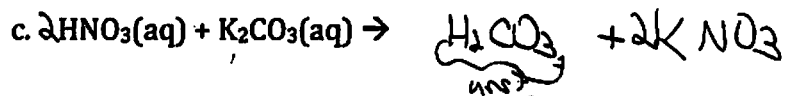
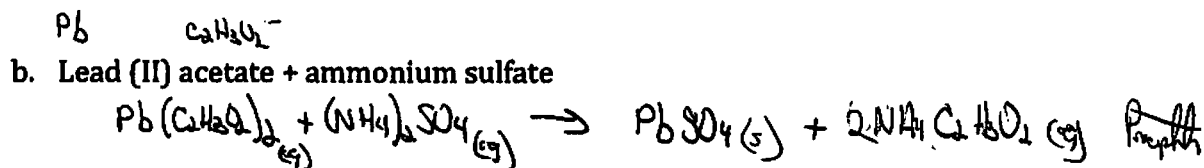
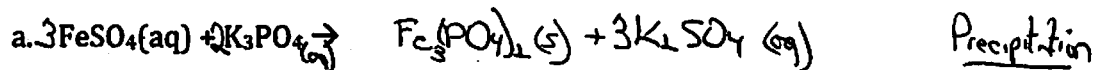
Complete each of the following.

Show all work. No Credit will be given for answer only.

1. (10 Points) Match the name with the correct formula.

Name	Chemical Formula Name	Potential Chemical Name
6 hydrocyanic acid	HCN	1. Nitric Acid
7 chlorous acid	HClO ₂	2. Nitrous Acid
5 carbonic acid	H ₂ CO ₃	3. Sulfurous Acid
4 chloric acid	HClO ₃	4. Chloric Acid
1 nitric acid	HCN HNO ₃	5. Carbonic Acid
		6. Hydrocyanic acid
		7. Chlorous Acid

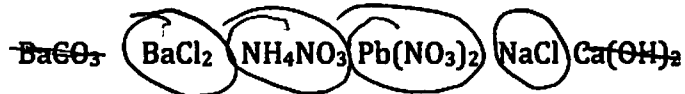
2. (15 Points) Complete and balance the overall chemical reactions and select the type of equation: Precipitation, Neutralization, Gas Forming and Single Displacement.



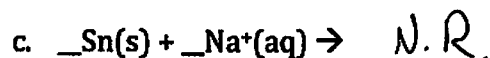
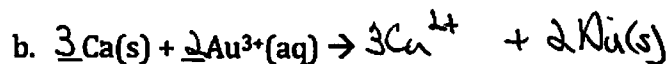
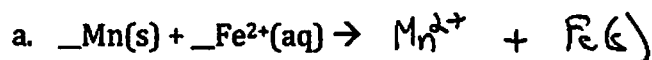
3. (6 Points) Circle which of the compounds are soluble in water?

Name: _____

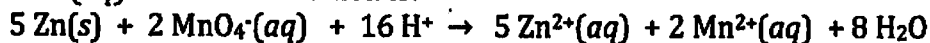
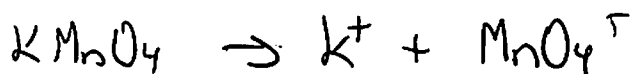
3. (6 Points) Circle which of the compounds are soluble in water?



4. (6 Points) Use the activity table to predict the outcome of the following reactions. If no reaction occurs, write N.R. If a reaction occurs, write a balance chemical equation for it.



5. (7 Points) Zinc reacts with permanganate ion to form
- $\text{Zn}^{2+}(\text{aq})$
- ions and
- $\text{Mn}^{2+}(\text{aq})$
- ions. The reaction is:

How many grams of zinc are required to completely react with 100.0 mL of a 0.0150 M solution of $\text{KMnO}_4(\text{aq})$?

$$100 \text{ mL} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.0150 \text{ mol KMnO}_4}{1 \text{ L}} \right) \left(\frac{1 \text{ mol MnO}_4^-}{1 \text{ mol KMnO}_4} \right) \left(\frac{5 \text{ mol Zn}}{2 \text{ mol MnO}_4^-} \right) \left(\frac{65.37 \text{ g Zn}}{1 \text{ mol}} \right)$$

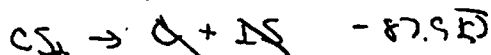
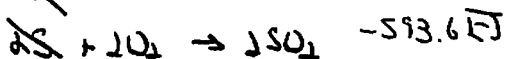
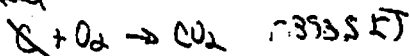
$$= 0.245 \text{ g Zn}$$

Name: _____

6. (7 Points) Determine the enthalpy change, ΔH , for the reaction, $\text{CS}_2(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{SO}_2(\text{g})$, given the following thermochemical equations:



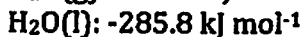
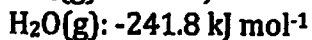
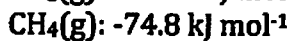
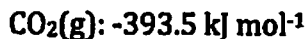
Cancel



$$\Delta H = -1075 \text{ kJ}$$

exothermic

7. (7 Points) Given the equation for the reaction, $\text{CO}_2(\text{g}) + 4\text{H}_2(\text{g}) \rightarrow \text{CH}_4(\text{g}) + 2\text{H}_2\text{O}(\text{g})$, and the following standard enthalpies of formation, ΔH_f° :



What is the standard enthalpy of reaction, in kJ for the reaction shown?

$$\Delta H_{\text{rxn}}^\circ = (1 \times -74.8 \text{ kJ} + 2 \times -241.8 \text{ kJ}) - (1 \times -393.5 \text{ kJ})$$

$$= -164.58 \text{ kJ}$$

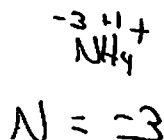
Name: _____

SECTION III: BONUS POINTS

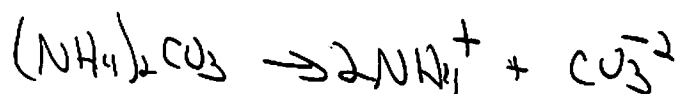
Complete each of the following showing mathematical procedures if necessary.

Show all work. No Credit will be given for answer only.

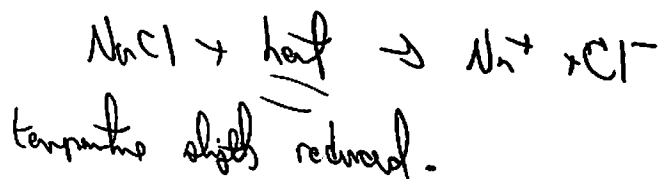
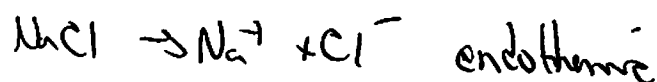
1. (2 Points) What is the oxidation number of nitrogen in
- $(\text{NH}_4)_2\text{SO}_4$
- ?



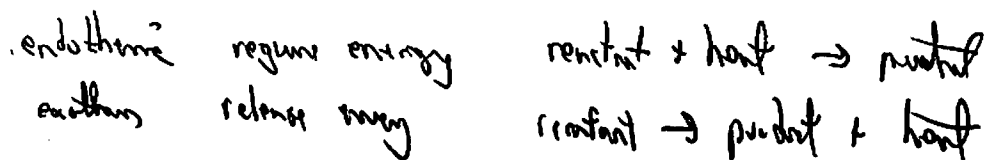
2. (2 Points) Write the dissociation reaction for
- $(\text{NH}_4)_2\text{CO}_3$



3. (2 Points) What happens to the temperature when you mix NaCl and water?



4. (2 Points) Define endothermic and exothermic reactions.



Name: _____

Periodic Table of the Elements

1A												2A												8A			
1	H 1.008											4	Be 9.012											2	He 4.003		
3	Li 6.939											12	Mg 24.31											10	Ne 20.18		
11	Na 22.99											20	Ca 40.08											18	Ar 39.95		
19	K 39.10											28	Sc 44.96											36	Kr 83.80		
37	Rb 85.47											38	Y 88.91											54	Xe 131.3		
55	Cs 132.9											57	La 138.9											86	Rn [222]		
87	Fr [223]											88	Ra [226]											88	Rn [222]		
Lanthanum series																											
Actinium series																											
58	Ce 140.1	59	Pr 140.9	60	Nd 144.2	61	Pm (145)	62	Sm 150.4	63	Eu 152.0	64	Gd 157.3	65	Tb 158.9	66	Dy 162.5	67	Ho 164.9	68	Er 167.3	69	Tm 168.9	70	Yb 173.0	71	Lu 175
90	Th 231	91	Pa 231	92	U 238.0	93	Np (237)	94	Pu (242)	95	Am (243)	96	Cm (247)	97	Bk (247)	98	Cf (249)	99	Es (254)	100	Fm (253)	101	Md (256)	102	No (256)	103	Lr (257)

Name: _____

	$C_2H_3O_2^-$	AsO_4^{3-}	Br^-	CO_3^{2-}	Cl^-	CrO_4^{2-}	OH^-	I^-	NO_3^-	$C_2O_4^{2-}$	O^{2-}	PO_4^{3-}	SO_4^{2-}	S^{2-}	SO_3^{2-}
Al^{3+}	s	l	s	-	s	-	l	s	s	-	l	l	s	d	-
NH_4^+	s	s	s	s	s	s	s	s	s	s	-	s	s	s	s
Ba^{2+}	s	l	s	l	s	l	a	s	s	l	a	l	l	d	l
Ba^{2+}	-	a	d	l	d	-	l	l	d	l	l	s	d	l	-
Ca^{2+}	s	l	s	l	s	s	l	s	s	l	l	l	l	d	l
Co^{2+}	s	l	s	l	s	l	l	s	s	l	l	l	s	l	l
Cu^{2+}	s	l	s	l	s	l	l	-	s	l	l	l	s	l	-
Fe^{2+}	s	l	s	a	s	-	l	s	s	l	l	l	s	l	s
Fe^{3+}	l	l	s	l	s	-	l	-	s	s	l	l	s	l	-
Pb^{2+}	s	l	l	l	l	l	l	l	s	l	l	l	l	l	l
Mg^{2+}	s	d	s	l	s	s	l	s	s	l	l	l	s	d	s
Hg^{2+}	s	l	l	l	s	a	l	l	s	l	l	l	d	l	-
K^+	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s
Ag^+	a	l	l	l	l	l	-	l	s	l	l	l	l	l	l
Na^+	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s
Zn^{2+}	s	l	s	l	s	l	l	s	s	l	l	l	s	l	l

Key: s = Soluble in water

l = Insoluble in water (less than 1 g/100 g H₂O)

a = Slightly soluble in water

d = Decomposes in water

ing activity ↑

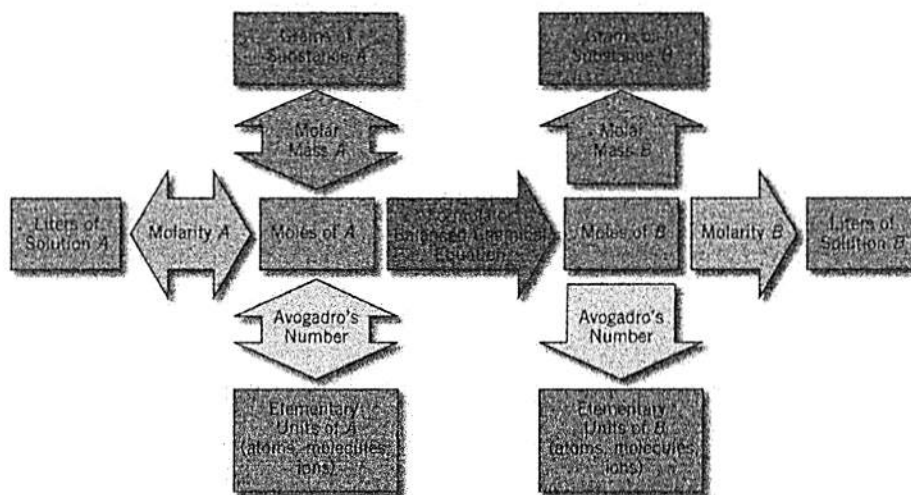
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USEFUL INFORMATION

TABLE 5.3 Activity Series for Some Metals (and Hydrogen)

	Element	Ion
Least Active	Gold	Au ³⁺
	Mercury	Hg ²⁺
	Silver	Ag ⁺
	Copper	Cu ²⁺
	HYDROGEN	H ⁺
	Lead	Pb ²⁺
	Tin	Sn ²⁺
	Cobalt	Co ²⁺
	Cadmium	Cd ²⁺
	Iron	Fe ²⁺
	Chromium	Cr ³⁺
	Zinc	Zn ²⁺
	Manganese	Mn ²⁺
	Aluminum	Al ³⁺
	Magnesium	Mg ²⁺
	Sodium	Na ⁺
	Calcium	Ca ²⁺
	Strontium	Sr ²⁺
	Barium	Ba ²⁺
	Cesium	Cs ⁺
	Potassium	K ⁺
Most Active	Rubidium	Rb ⁺

Annotations:
 - Left side: "Do not react with nonoxidizing acids" (top) and "React with water to form hydrogen" (bottom).
 - Middle: "React with nonoxidizing acids to produce hydrogen" (left side).
 - Right side: "Increasing ease of oxidation of the metal" (downward arrow) and "Increasing ease of reduction of the ion" (upward arrow).



$$\% \text{Yield} = \frac{\text{actual}}{\text{theoretical}} * 100$$

$$V_{\text{final}} \cdot C_{\text{final}} = V_{\text{initial}} \cdot C_{\text{initial}}$$

$$T_C = (T_F - 32^\circ\text{F}) * \frac{5^\circ\text{C}}{9^\circ\text{F}}$$

$$N = \frac{\text{sample mass}}{\text{atom mass}}$$

$$\text{Mass}\%_{\text{element}} = \frac{\text{mass}_{\text{element}}}{\text{mass}_{\text{total-sample}}} * 100\%$$

$$M = m_{\text{atom}} N_A$$

$$N = n N_A$$

$$c = \frac{n}{V}$$

$$m = nM$$

$$\Delta H^\circ = \sum n \Delta H_f^\circ(\text{products}) - \sum n \Delta H_f^\circ(\text{reactants})$$

$$V_{\text{final}} \cdot C_{\text{final}} = V_{\text{initial}} \cdot C_{\text{initial}}$$