CH 101 Fall 2018
Discussion #8
Chapter 6

Your name: ________________ TF's name:________________ Discussion Day/Time: ________________

Things you should know when you leave Discussion today:

- Precipitation Reaction & Solubility Solubility of Ionic compounds Mahaffy, 2e section 6.5
- Acid Base Reactions, Mahaffy, 2e section 6.7
- Memorize common Acids and Bases Mahaffy, 2e Table 6.13 on page 194
- Oxidation Reduction Reactions
  - Oxidation is <u>loss</u> of electrons (acts as a reducing agent)
  - Reduction is <u>gain</u> of electrons (acts as an oxidizing agent)

1. You have two containers with the following solutions that are made by dissolving: (*i*) 0.10 moles of NaF(*s*) fully dissolved in 200. mL of water, and (*ii*) 0.20 moles of $CaCl_2$(*s*) fully dissolved in 300. mL of water. These two solutions are combined in a single container.

   a. Write net ionic reaction.

   b. Calculate the molarity of Na^+ in the final solution.

   c. Calculate the total number of moles of positive charge.

2. If you take 35.0 g AgCl and add it to one liter of water and if we then take a cubical sample of 1000 water molecules of that solution, how many ions of silver will be in that cube? How many chloride ions?

3. Balance and Answer the following about the oxidation reduction reaction given below

$$Zn(s) + Cu^{+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

   a. Half Reaction:

      - Identify if in your half reaction *oxidation* or *reduction* takes place:

   b. Half Reaction:

      - Identify if in your half reaction *oxidation* or *reduction* takes place:

   c. Oxidized Reactant: Reduced Reactant:

   d. Oxidizing Agent: Reducing Agent:

   e. How many moles of the electrons are transferred per mole of reaction?

4. Complete the following reaction:

$$3Cu(s) + 2Fe^{??} \rightarrow 2Fe(s) + ??\ Cu^{2+}$$

   a. How many moles of the electrons are transferred per mole of reaction?

5. Give a definition and an example for **Brønsted-Lowry** acid and an example:

6. Give a definition and an example for **Lewis base** and an example**:**

7. Ammonia, NH_3, is a useful household cleaner, fertilizer, and antimicrobial compound.

   a. If NH_3 acts as an acid in water, write the balanced chemical equation. Label the Brønsted-Lowry acid and its conjugates.

   b. If NH_3 acts as a base in water, write the balanced chemical equation. Label the Brønsted-Lowry acid and its conjugates.

   c. A small amount of aluminum nitrate is added to the products of the acid/base reaction in (b) and a precipitate forms. Write the balanced, net-ionic equation for the precipitation.

   d. Ammonia is the conjugate acid in the reaction of the strong base amide, NH_2^- with water. Write the acid/base reaction of amide, NH_2^-, with water and label the Brønsted-Lowry acid reactant in this reaction.

8. Consider the three acid/base reactions below.

   a. In the reaction $NH_3(aq) + H_2CO_3(aq) \rightarrow NH_4^+(aq) + HCO_3^-(aq)$, the conjugate base is __________ .

   b. In the reaction $CH_3COO^-(aq) + H_2O(l) \rightarrow CH_3COOH(aq) + OH^-(aq)$, the conjugate acid is __________ .

   c. In the reaction $Fe^{2+}(aq) + 6\ H_2O(l) \rightarrow [Fe(H_2O)_6]^{2+}(aq)$, the Lewis acid is __________ .

      the Lewis base is___________ .

9. List all strong acids you know. Why do we call them strong?

10. Give an example of neutralization reaction:

11. How many hydronium ions are in 1.5L of 0.20M solution of HCl?

12. The 0.10 mole of sulfuric acid in 50.0 mL of water produces the concentration of the hydronium ion to be 2.5 M. If you know that sulfuric acid is a strong acid and consider that acids always donate one proton at a time according to the following reactions:

$$H_2SO_4\,(aq) + H_2O(l) \rightarrow \quad H_3O^+(aq) \ + \ HSO_4^- \ (aq)$$
$$HSO_4^-\,(aq) + H_2O(l) \rightarrow \quad H_3O^+(aq) \ + \ SO_4^{2-}\,(aq)$$

   a. Is HSO_4^- acting as a strong acid or a weak acid? Prove your answer.

   b. What percentage of HSO_4^- actually reacted?

13. I add 5.00 moles of solid $NaNO_3$ to 500. mL of a 1.00 M $Pb(NO_3)_2$ solution, which does not change the volume. I then pour in 500. mL of hydrochloric acid that is 0.500 M. I let the solution come to equilibrium. *Hint: Remember that nitric acid and hydrochloric acid are both strong acids.*

   a. What is the final molar concentration of H_3O^+ ion in solution?

   b. What is final molar concentration of Cl^- ion?

   c. What is final molar concentration of Pb^{2+} ion?

   d. What is the final molar concentration of the nitrate ion?

14. A 0.3mol sample of an acid HA is added to 500. mL of water and only 0.01% of the acid reacts. How many moles of HA, A^-, H_3O^+, and H_2O are present at the end of the reaction?

15. When the two compounds below are mixed, circle the one that behaves as a Lewis base

a. H_2O:	NH_4^+
b. :NH_3	H_2O
c. CO_3^{2-}	H_2O
d. BF_3	:NH_3

16. You are given 2 L of a 0.05 M HCl solution. You are also given a 0.5 M solution of barium hydroxide. What volume (in L) of the $Ba(OH)_2$(*aq*) solution is required to completely react with the HCl solution, with no HCl or $Ba(OH)_2$ remaining in solution?

17. If 1L of 0.35 M solution of the unknown acid HA produces 0.035 M concentration of the hydronium ion what is the percent of the acid reacted? Is the unknown acid a strong or weak electrolyte?

18. How many grams of $Ba(OH)_2$ is needed to be mixed with 220 ml of water to produce 0.045M solution of hydroxide?

19. Sea water contains 35 g NaCl per liter. If we have cubical sample of 1000 molecules of sea water, how many sodium ions will be in that cube? How many chloride ions? *Hint: Treat sea water as pure water.*

20. Calculate the sodium ion concentration when 70. mL of 3.0 M sodium carbonate is added to 30. mL of 1.0 M sodium nitrate.
    a. To the sodium carbonate and sodium nitrate solution, you add 0.20 moles of solid $BaCl_2$. What is the final concentration of each of the ions in the solution? Assume the solid $BaCl_2$ does not change the volume.

Numerical Answers:

1.
   a. $Ca^{2+}(aq) + 2F^-(aq) \rightarrow CaF_2(s)$
   b. 0.20M
   c. 0.40mol
2. 0 for both, both are insoluble
3.
   a. $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$
   b. $2Cu^+(aq) + 2e^- \rightarrow 2Cu(s)$
   c. Zn(s); $Cu^+(aq)$
   d. $Cu^+(aq)$; Zn(s)
   e. 2 moles of e^- per mole reaction
4. $3Cu(s) + 2Fe^{3+}(aq) \rightarrow 2Fe(s) + 3Cu^{2+}(aq)$
   a. 6 moles of e^-/mole rxn
5. NH_4^+
6. NH_3
7.
   a. $NH_3(aq) + H_2O(l) \rightarrow NH_2^-(aq) + H_3O^+(aq)$
   b. $NH_3(aq) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$
   c. $Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s)$
   d. $NH_2^-(aq) + H_2O(l) \rightarrow NH_3(aq) + OH^-(aq)$
8.
   a. $HCO_3^-(aq)$
   b. CH_3COOH
   c. $Fe^{2+}(aq)$—acid; $H_2O(l)$—base
9. HCl, HBr, HI, HNO_3, H_2SO_4, $HClO_4$, $HClO_3$; They ionize 100%
10. $NH_2^-(aq) + HCl(l) \rightarrow NH_3(aq) + H_2O(l)$
11. 1.8×10^{23} H_3O^+ ions
12.
   a. weak acid
   b. 25% of HSO_4^- reacted
13.
   a. 0.250 M H_3O^+
   b. 0.00 M Cl^-
   c. 0.375 M Pb^{2+}
   d. 6.00 M NO_3^-
14.
   HA = 0.3 mol
   A^- = 3×10^{-5} mol
   H_3O^+ = 3×10^{-5} mol
   H_2O = 30 mol

15.
   a. H_2O
   b. NH_3
   c. CO_3^{2-}
   d. NH_3

16. 0.10 L $Ba(OH)_2$
17. 10% reacted
18. 0.85 g $Ba(OH)_2$
19. 10.9 ions for each Na^+ and Cl^-
20. 4.5 M Na^+
    a. 0.0 M Ba^{2+}, 0.1 M CO_3^{2-}, 4.5 M Na^+, 0.3 M NO_3^-

In preparation for next week (NOT part of exam 2)
Mahaffy, 2e Chapter 7

Diagrams vs. Graphs

Both diagrams and graphs are used in chemistry to help represent physical phenomena. The most common graphs show the relationship of two variables, such as distance and time, or frequency and wavelength. Diagrams, however, are a bit trickier. Diagrams can come in a number of different structures and can be used to show information about one thing, or about a lot of different reationships at once.

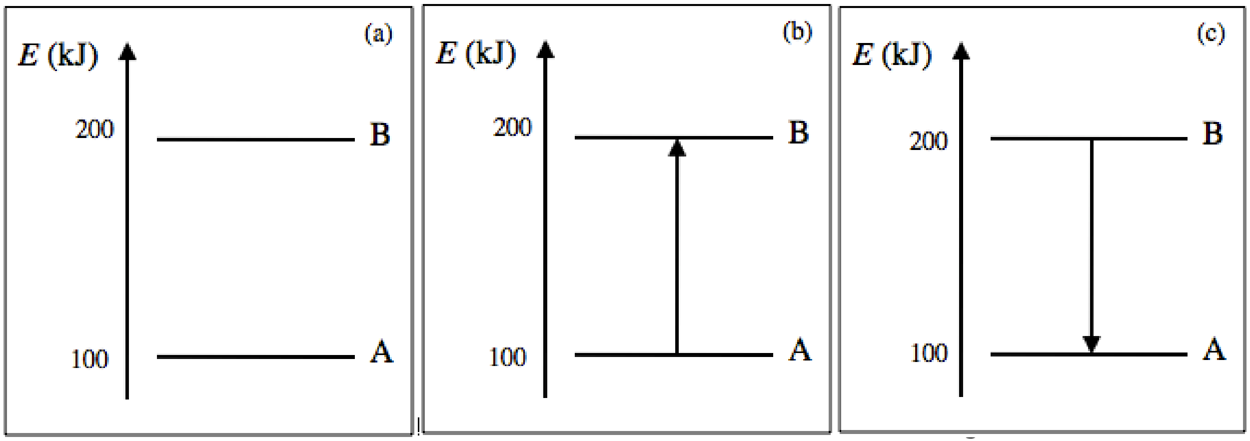
One of the simplist diagrams you will see in chemistry is a one dimentional scale, showing values of only one variable. An example of this type of diagram is one you have seen on your computer – a volume scale. This diagram shows you the relative level of volume on your computer. While there are no values shown on this diagram, you know that the higher the ticker is, the greater the volume and visa versa. In chemistry, we use a similar diagram structure when we talk about energy and different chemical reations. These are called: *Energy Diagrams*. Interactions in chemistry is a change between energy values. Therefore, the arrows on the diagram shows this change between a range of two energy values.

In chemistry, we use a vertical scale to show energy values. In the figures below, you'll notice that the arrow for our energy scale is pointing upwards, indicating that the scale can increase infinitely upwards if necessary. Next to that scale, we use horizontal lines and arrows to show either a particular value of energy, or a change in energy. The size of the horizontal lines do not matter, only their vertical location along the scale. The size of the vertical arrows, however, show a specific range on the energy scale and represents the *change in energy* associated with the process on the diagram.

For example, image (a) below shows two different states, A and B, with their associated energies, 100 kJ and 200 kJ, respectively. The states are drawn as horizontal lines, or platforms, so that we can use them to draw different changes in energy. Here we can see that B has greater energy than A. In the middle diagram (b), we have drawn an arrow pointing from the lower energy level to the higher one. This means that with some sort of physical phenomenon, like a chemical reaction, during which state "A" is transformed into state "B" (the reaction would be written as A→B). During that process, is the energy increased from 100 kJ to 200 kJ. The change in energy, ΔE, is calculated as the different between the final energy and intial energy:

$$\Delta E = E_{\mathrm{A \to B}} = E_{\mathrm{final}} - E_{\mathrm{initial}} = 200\ \mathrm{kJ} - 100\ \mathrm{kJ} = 100\ \mathrm{kJ}$$

The diagram on the right (c) shows the reverse of this phenomenon (where B is the initial state and A is the final state), where the energy decreases from 200 kJ to 100 kJ ($E_{B \to A} = -100$ kJ).



Draw energy diagrams for each of the following situations:

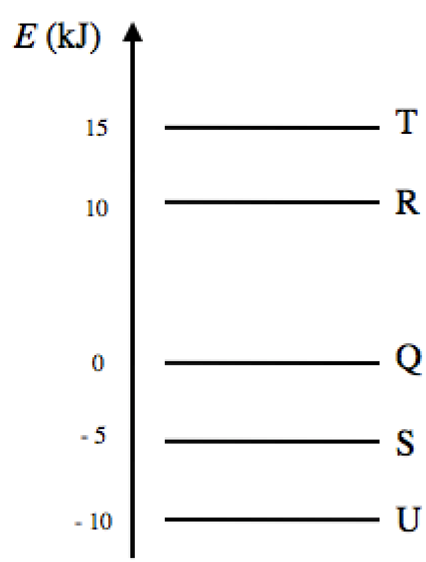
1. The energy of "B" is 10 kJ greater than the energy of "A". "A" is 30 kJ ($E_A = 30$ kJ).
   a. Draw in the energy levels of A and B on the diagram.
   b. Write the "reaction" for the process of A becoming B.
   c. On your diagram, draw the arrow corresponding to $E_{A \to B}$. Is this process endothermic or exothermic?

2. The energy of "C" is 25 kJ greater than the energy of "D". "D" is 0 kJ ($E_D = 0$ kJ).
   a. Draw in the energy levels of C and D on the diagram.
   b. Write the "reaction" for the process of C becoming D.
   c. On your diagram, draw the arrow corresponding to $E_{C \to D}$. Is this process endothermic or exothermic?

3. Below are energy transitions between energy levels F, G, H and I. Using these transitions, draw one diagram that shows all four energy levels in the appropriate order and with the appropriate energy values.
   a. $E_F = 10$ kJ
   b. $E_{I \to F} = 10$ kJ
   c. $E_{I \to H} = 20$ kJ
   d. $E_{F \to G} = 5$ kJ
   e. $E_{G \to I} = 15$ kJ

Reading Energy Diagrams: From the diagram given on the right, answer the following questions:

1. What is the change in energy from Q and S? ($E_{Q \to S}$).
2. What is the change in energy from R and T? ($E_{R \to T}$)
3. What transitions result in -20 kJ? Write the "reactions" for each.
4. What transitions result in 15 kJ?

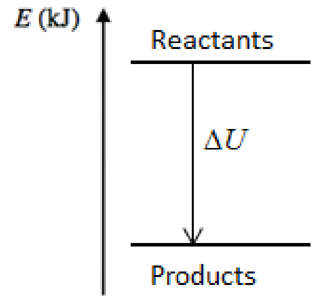


Make your own diagram

1. Burning one mole of carbon, C(*s*), in oxygen, $O_2(g)$, to form carbon dioxide, $CO_2(g)$, releases 400 kJ of energy. Draw an energy level diagram to depict this transformation. What is the "initial state"? What is the "final state"? Is the process endothermic or exothermic?

Energy Diagrams: Endothermic and Exothermic Reactions

Chemical Reactions



Chemical reactions are always accompanied by a change in internal energy, ΔU, which is the difference between the internal energy of the reactants ($U_{initial}$) and the internal energy of the products ΔU_{final}):

$$\Delta U = U_{final} - U_{initial} \qquad (1)$$

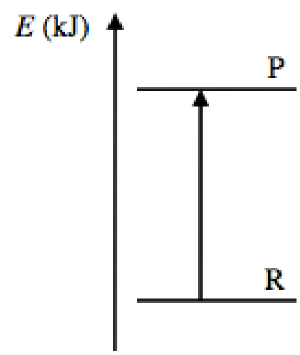
In some cases, the chemical reaction (the 'system') releases energy to the surroundings – this is called an *exothermic* reaction. In this case, the energy of the products is lower than that of the reactants, as can be seen in the diagram on the right.

Other than using the diagram, there are a few other ways of indicating that a reaction is exothermic. "Energy is released (from system to surroundings)", $\Delta U < 0$, and "heat is a product" are all ways of indicating that a process is exothermic. Some people also write a chemical reaction including energy/heat:

A + B → C + heat/energy

Though writing a reaction like this is not rigororously correct, as heat/energy are not chemical species and therefore cannot be reactants or products, this can help you visualize whether heat is released by a reaction (exothermic) or absorbed by a reaction (endothermic).

In an *endothermic* reaction, the reverse occurs and energy is absorbed by the system. In this case, the overall energy of the system increases throughout the reaction and the resulting energy of the products is greater than that of the reactants.



1. Draw the diagram, like the one above, for an endothermic reaction.

2. Write a chemical reaction equation, like the one above, for an endothermic reaction.

3. In the discussion above, we listed four other ways of indicating the flow of energy in reactions in addition to drawing diagrams. Write this list for an endothermic reaction.

4. Did the overall energy of the reaction on the right increase or decrease? What kind of a reaction does