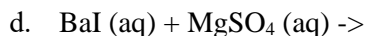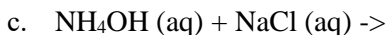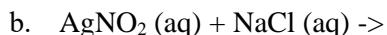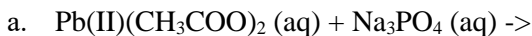Chapters 2 & 3: Atoms, Elements, Compounds, Mole

1. How many moles of oxygen atoms are present in one mole of aluminum sulfate, $Al_2(SO_4)_3$?

      A) 4
      B) 8
      C) 12
      D) 7.23×10^{24}
      E) 4.82×10^{24}

2. How many protons, neutrons, and electrons are in one ion of $^{36}S^{2-}$?

      A) 16 protons, 20 neutrons, and 18 electrons.
      B) 20 protons, 16 neutrons, and 16 electrons.
      C) 16 protons, 20 neutrons, and 14 electrons.
      D) 16 protons, 20 neutrons, and 16 electrons.
      E) 0 protons, 36 neutrons, and 18 electrons.

3. Which two elements are likely to form an ionic compound with the formula M_3X?

      A) Li and I
      B) Na and N
      C) Al and Br
      D) Ca and P
      E) K and O

4. Which compound is named *correctly*?

      A) CaO – Calcium (II) monoxide
      B) P_2O_5 – Diphosphorus pentoxide
      C) Al_2S_3 – Dialuminum trusulfide
      D) PbI_4 – Lead iodide
      E) H_2S – Sulfuric Acid

5. Determine the molecular formula of a compound that has a molecular weight of 183 g/mol and an empirical formula of $C_2H_5O_2$.

      A) $C_3H_7O_3$
      B) $C_6H_{15}O_6$
      C) $C_4H_{10}O_4$
   D) $C_2H_5O_2$
      E) $C_8H_{20}O_8$

CHEM 1310 Review: **Reactions, Solutions, & Stoichiometry**

1. Predict the products of the following reactions. Include the phase of each product. If there is no driving force for the reaction, write NR.

    a. $Pb(II)(CH_3COO)_2$ (aq) + Na_3PO_4 (aq) ->

    b. $AgNO_2$ (aq) + NaCl (aq) ->

    c. NH_4OH (aq) + NaCl (aq) ->

    d.   BaI (aq) + $MgSO_4$ (aq) ->

2. Calcium hydroxide is formed from the reaction of calcium oxide with water. What mass of calcium hydroxide can be produced from a mixture of 25.0 g of calcium oxide and 12.0 g of water? Identify limiting and excess reagents, calculate the mass (in grams) of excess reagent remaining.

3. 92 g of sulfur hexafloride is produced from the reaction of sulfur in excess fluorine. If this corresponds to an 18% yield, what mass of sulfur was used for the reaction? Hint: Determine the theoretical yield of sulfur hexafloride.

$$S \text{ (s)} + 3\ F_2 \text{ (g)} \text{ -> } SF_6 \text{ (g)}$$
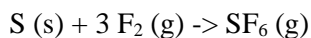
4. What is the minimum volume of 1.1 M NaOH that must be reacted with excess chorine gas to yield 2.2 grams of sodium hypochorite?
$$NaOH \text{ (aq)} + Cl_2 \text{ (g)} \text{ -> } NaClO \text{ (aq)} + NaCl \text{ (aq)} + H_2O \text{ (l)}$$

5. Calcium chloride is reacted with silver nitrate.

    a. Write the balanced reaction, and net ionic equations. Include the phase of each product.

    b. If exactly 1.4 g of solid is formed, what mass of each reactant was used?

    c. If 2.0 mL of each reactant was used, what are the molarities of the calcium chloride and silver nitrate solutions?

    d. If 2.0 mL of 1.2 M silver nitrate is reacted with excess calcium chloride, what is the theoretical yield of the solid product?

6. What is the difference between a strong, a weak, and a nonelectrolyte? Give an example of each.

7. If 100.0 mL of acetic acid is titrated to equilibrium with 10.0 mL of 1 M KOH, what is the concentration (in units of molarity) of the acetic acid solution?

CHEM 1310 Reading Day
Chapters 7 and 8: *Gases* **and** *The Quantum Model of the Atom*

1. If 4.000 grams of hydrogen peroxide are placed within a sealed 250 mL container at 500 K, what is the pressure of the oxygen gas produced in atm?

$$2H_2O_2 \rightarrow 2H_2O + O_2$$
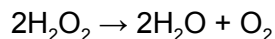
2. Calculate the number of photons having a wavelength of 10.0 µm required to produce 1.0 kJ of energy. Identify the type of electromagnetic radiation.

3. Identify the subshell in which electrons with the following quantum numbers are found:
    a. $n = 3, l = 2$
    b. $n = 1, l = 0$
    c. $n = 4, l = 3$

4. Write the noble gas electron configurations for the following atoms or ions:
    a. O^-
    b. Ti
    c. Cl^{3+}

5. Which of the following combinations of quantum numbers is not allowed?

	n	l	m_l	m_s
a.	2	2	0	+½
b.	3	0	0	-½
c.	2	1	-1	+½
d.	4	3	-2	-½
e.	4	2	0	+½

1. Consider a neutral neon atom (Ne), a sodium cation (Na⁺), and a fluorine anion (F⁻). Which atom has the largest effective nuclear charge?

2. For CH_2F_2
   a. Draw the Lewis dot structure
   b. Determine the electron geometry of the molecule.
   c. If there is a dipole, draw an arrow representing the dipole moment.

3. For each of the following molecules, indicate the electron geometry, the molecular geometry, the bond angles, and state whether or not the molecule is polar.
   a. ClO^-
   b. KrF_2
   c. XeF_3^+
   d. NH_3Cl^+

4. Based on the Lewis structure of this compound, what is the hybridization type of each carbon, oxygen, and the nitrogen? How many sigma bonds and pi bonds are there?
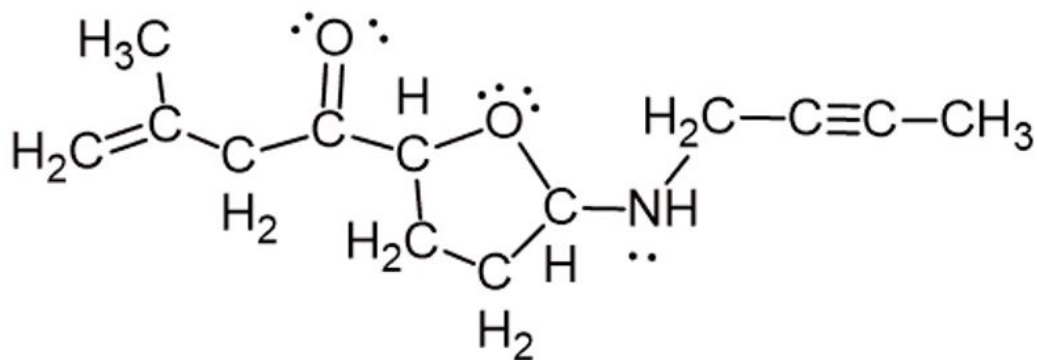
Chapters 6 and 18: Thermodynamics

1. A 50.0 mL sample of 0.100 M $AgNO_3$ and a 50.0 mL sample of 0.100 M HCl are mixed in a coffee cup calorimeter, forming AgCl(s). The initial temperature of the solutions is 24.30°C, and the final temperature is 25.10°C. Assume that the mixture's total mass is 100.0 g and that its specific heat capacity is the same as that of pure water. Assume that no heat is lost to the surroundings. Determine ΔH for the reaction in kJ/mol, and explain the sign (positive or negative) for the reaction.

2. Calculate ΔH for the reaction $P_4O_{10}(s) + 6PCl_5(g) \rightarrow 10Cl_3PO(g)$ given the information below:

$P_4(s) + 6Cl_2(g) \rightarrow 4PCl_3(g)$	ΔH = - 1225.6 kJ
$P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$	ΔH = - 2967.3 kJ
$PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$	ΔH = -84.2 kJ
$PCl_3(g) + ½ O_2(g) \rightarrow Cl_3PO(g)$	ΔH = -285.7 kJ

3. For the following chemical reactions, predict the sign of ΔS for the system. Note that this should not require any detailed calculations.
   A) $Fe(s) + 2HCl(g) \rightarrow FeCl_2(s) + H_2(g)$
   B) $3NO_2(g) + H_2O(\ell) \rightarrow 2HNO_3(\ell) + NO(g)$
   C) $2K(s) + Cl_2(g) \rightarrow 2KCl(s)$
   D) $Cl_2(g) + 2NO(g) \rightarrow 2ClNO(g)$
   E) $SiCl_4(g) \rightarrow Si(s) + 2Cl_2(g)$

4. Write a thermochemical reaction to represent the combustion of Fe(s) with oxygen gas to produce iron(III) oxide if DH for the reaction is -1652 kJ/mol.
   How much heat is released when 10.0 g Fe and 3.00 g O_2 react? You may assume that the percentage yield for the reaction is 100%.

5. A 95.0 g sample of H_2O at 22°C is added to a 55.0°C sample of water. If the final temperature of the resulting water sample is 37°C, then what mass of hot water was added?

1.

If the rate of formation of NH_3 under a given set of conditions is 0.35 M/s, then what is the rate of disappearance of H_2 under the same conditions?

$$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$$
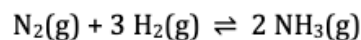
A) 0.23 M/s
B) 0.35 M/s
C) 0.53 M/s
D) 0.70 M/s
E) 1.1 M/s

2.

A first-order reaction is 38.5% complete in 520 s. What is the value of the rate constant?

A) $1.83 \times 10^{-3}\ s^{-1}$

B) $9.35 \times 10^{-4}\ s^{-1}$

C) $3.07 \times 10^{-3}\ s^{-1}$

D) $1.18 \times 10^{-3}\ s^{-1}$

E) $1.20 \times 10^{-3}\ s^{-1}$

3.

1. Data collected in a laboratory experiment was used to create a graph of ln k versus 1/T (T in Kelvin). The slope of the resulting line is m. Which answer option represents the activation energy for the reaction used to collect the data?

A) E_a/R
B) $-E_a/R$
C) mR
D) $-mR$
E) ln A

4.

Phosgene, $COCl_2$, was used as a chemical weapon during World War I and is currently used as a starting material for the synthesis of other chemical compounds. Phosgene decomposes into carbon monoxide and chlorine gas.
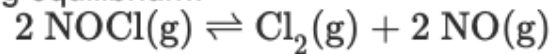
$$COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$$
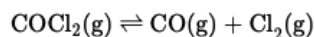
Suppose that 0.250 mol $COCl_2$ decomposes in a sealed 1.00 L container at 1000 K to give 0.0294 mol CO at equilibrium.

a. Determine the equilibrium constant for the decomposition of phosgene at 1000 K.

5.

Consider the following equilibrium:

$$2\,NOCl(g) \rightleftharpoons Cl_2(g) + 2\,NO(g)$$

Determine the relative values of Q and K when the following changes are made to the system, and determine the direction in which the reaction shifts after these changes are made:

a. Increasing the concentration of Cl_2
b. Decreasing the concentration of NO
c. Removing NOCl from the system

CHEM 1310 Review Session
Chapters 16 and 19 – Acid/Base and Electrochemistry

Chapter 16

1. Determine the $[H_3O^+]$ and pH of a 0.100M solution of benzoic acid. K_a of benzoic acid = 6.5 x 10^{-5}

2. A 0.485M solution of a weak acid (HA) has a pH of 3.21. Calculate the K_a.

3. What volume of 0.655M KOH solution do you need to make 4.5 L solution with pH = 11.30

Chapter 19

4. Balance each of the following redox reactions in acidic solution
   a. SO_3^{2-} (aq) + MnO_4^- (aq) → SO_4^{2-} (aq) + Mn^{2+} (aq)
   b. I^- (aq) + NO_2^- (aq) → I_2 (s) + NO (g)
   c. Now, balance this redox reaction in basic solution:
      Al (s) + MnO_4^- (aq) → MnO_2 (s) + $Al(OH)_4^-$ (aq)

5. Calculate the E°cell for the following reaction and determine if it is spontaneous or non-spontaneous
   a. MnO_2 (s) + 4 H^+(aq) + Zn (s) → Mn^{2+} (aq) + 2 H_2O (l) + 2 Zn^{2+} (aq)
   b. Br_2 (l) + 2 I^- (aq) → I_2 (s) + 2 Br^- (aq)
   c. O_2 (g) + 2 H_2O (l) + 4 Ag (s) → 4 OH^-(aq) + 4 Ag^+ (aq)

CHEM 1310 Reading Day
Chapters 12 and 13: *Liquids and Solids* and *Solutions*

1. Arrange each of the following sets of compounds in order of increasing boiling temperature:
   a. HCl, H_2O, SiH_4
   b. F_2, Cl_2, Br_2
   c. CH_4, C_3H_8, C_2H_6

2. What phase changes will take place when water is subjected to varying pressure at a constant temperature of:
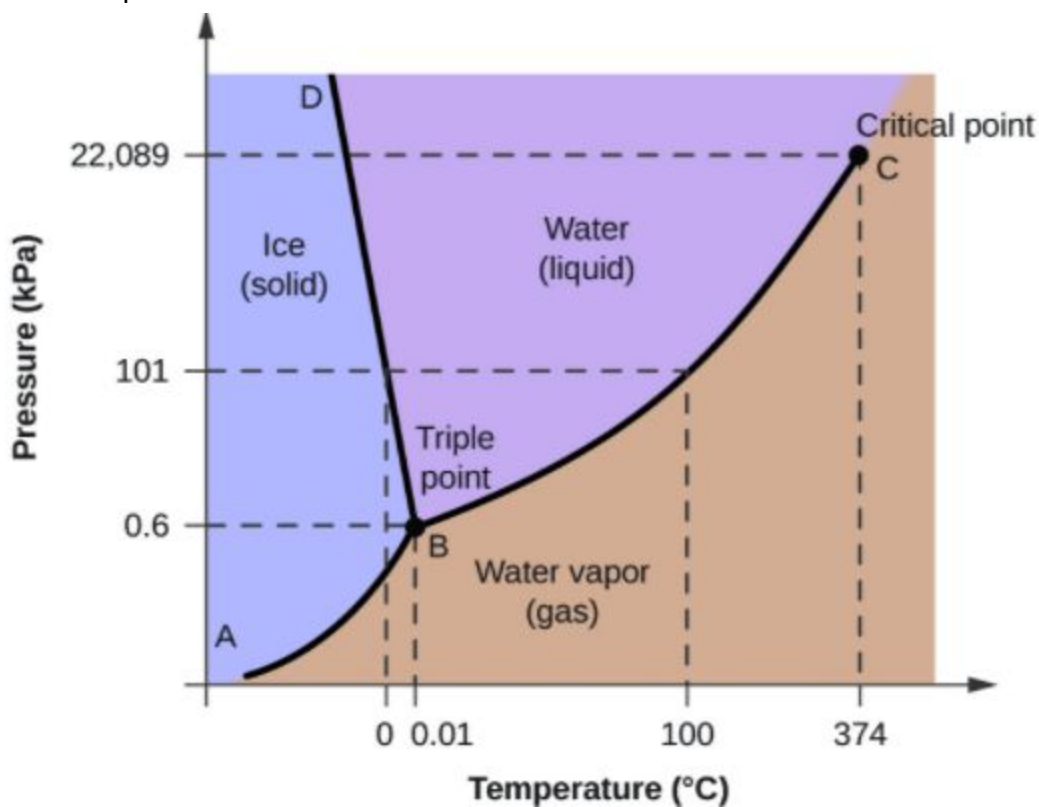
   a. 0.005 °C
   b. 40 °C
   c. -40 °C

3. Calculate the total amount of heat absorbed in kJ when a 2.00 mol of ice at -30.0°C is converted to steam at 140.0°C. The specific heats and enthalpies are:

   $C_{p, ice}$ = 2.06 J/g°C
   $C_{p, water}$ = 4.18 J/g°C
   $C_{p, steam}$ = 1.87 J/g°C
   ΔH_{fus} = 6.01 kJ/mol
   ΔH_{vap} = 40.7 kJ/mol

4. In an experiment, 100 mL of water is placed in a polystyrene foam cup and the initial temperature of water is recorded. 5.05 g of potassium nitrate is added to the water while stirring until it is fully dissolved. The temperature of the solution falls and the minimum temperature achieved is recorded as the final temperature. The results of the experiment are shown below:

Volume of water	100 mL
Mass of $KNO_3(s)$	5.05 g
$T_{initial}$	25°C
T_{final}	21.7°C

Determine the value of the molar heat of solution of potassium nitrate in kJ/mol. Keep in mind that the density of water is 1.00 g/mL and the specific heat capacity of water is 4.18 J/g°C.