Mt. San Jacinto College
Integrated Course Outline of Record

Form B

Submitted by: Joshua Hartman **Date:** 12/17/2020

Department	Subject	Course Number	Title
Chemistry	Chemistry CHEM	101	General Chemistry I

Units/Hours

Each lecture unit requires 1 hour per week of class time, and 2 hours per week of study outside of class.
Each laboratory unit requires 3 hours per week of class time.
Each activity unit requires 2 hours per week of class time and 1 hour per week of study outside of class.

Lecture Units	Lab Units	Total Units
3.00	2.00	5.00
Lecture Contact Hours	**Lab Contact Hours**	**Total Contact Hours**
48.00 - 54.00	96.00 - 108.00	144.00 - 162.00
Lecture Homework Hours	**Lab Homework Hours**	
96.00 - 108.00	0	

Stand Alone:

Program Applicable

AA/AS Degree General Ed Breadth Area(s):

A NATURAL AND PHYSICAL SCIENCES

General Education Justification:

Chemistry 101 supports area A because it is a natural science that studies the physical science of matter. The course introduces the study of atomic structures and geometry of molecules. The course uses college-level mathematics to explain chemistry concepts in quantitative terms (GELO4). The course provides students with the knowledge and skills required to analyze and interpret evidence (GELO3), formulate hypotheses, and test solutions (GELO2).

Maximum Enrollment: 25

Maximum Enrollment Justification:

Course has safety or compliance factors which influence the enrollment cap â€“ check all that apply:

*** Course has safety or health reasons that the class should have a non-standard enrollment cap.**

*** Course has specific standards outside of the college**

calling for a specific or capped class size.

Justification: CHEM101 is a combined lecture and laboratory course offered over a single-semester. Students perform laboratory experiments with a number of chemicals and reagents that are toxic, corrosive and/or irritants to the skin, eyes, and respiratory system. During each laboratory session, students are transporting these chemicals and reagents as well as glassware and other equipment from a dispensing area across the lab to their bench where they carry out procedures. Many labs also require the use of Bunsen burners with open flames. American Chemical Society (ACS) has recommended guidelines of 50 sq ft per student to ensure safety in the learning environment of a student chemistry laboratory. More than 25 students in the laboratory would constitute a safety hazard.

Grading Method: Letter Grade or P/NP

TOP code: 1905.00

Can be Taken 1 **time(s) for credit** (max 4)

- Visual or Performing Arts course that is required to meet major requirements for UC/CSU
- Intercollegiate athletics course
- Academic/vocational competition course

Catalog Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course). (**75 words** or less in gray box below).

This course covers principles of chemistry with special emphasis on atomic structure, stoichiometry, chemistry of aqueous solutions, balancing reactions, thermochemistry, periodic relationships among the elements, chemical bonding, geometry of molecules, hybridization and molecular orbital theory.

Schedule Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course). (**25 words** or less in gray box below).

This course provides basic knowledge of general chemistry principles. This course emphasizes atomic structure, stoichiometry, energy relationships, chemical bonding and periodic properties.

Need for the course:

This course is the first sequence in the major's general chemistry sequence. Chemistry 101 a natural science that studies the physical science of matter. The course introduces the study of atomic structures and geometry of molecules. The course uses college level mathematics to explain chemistry concepts in quantitative terms. The course provides students with knowledge and skills to explain the science of chemistry. Chemistry 101 covers GELO4. Chemistry 101 is also a requisite for Organic Chemistry. Chemistry 101 can be used for: 1. BIOL - A.S.-T in Biology for Transfer - Associate in Science 2. CHEM - A.S.-T in Chemistry for Transfer - Associate in Science 3. ENVS - A.S.-T in Environmental Science for Transfer - Associate in Science 4. ENVS - Environmental Studies - Associate in Science 5. ENVS - Environmental Studies: Water and Soil Technologies/Environmental Engineering Emphasis - Associate in Science 6. GEOL - A.S.-T. in Geology for Transfer Degree

- Associate in Science 7. HS - A.S.-T in Public Health Science for Transfer - Associate in Science 8. IDS - Liberal Arts: Mathematics & Science Emphasis - Associate in Arts 9. IDS - Science - Associate in Science 10. KINE - A.A.-T in Kinesiology for Transfer - Associate in Science 11. NUTR - A.S.-T. in Nutrition and Dietetics for Transfer - Associate in Science

Prerequisite(s):

Prerequisites go through a separate approval process. See Forms E1-E6 for details.
(For further clarification, contact the Prerequisite Subcommittee)

- MATH 105 with a Grade of C or better. OR completion with a C or better of MATH-110, MATH-135, MATH-211, MATH-213, MATH-215, or MATH-218 meets the prerequisite OR placement into MATH-211 or higher meets the prerequisite. and
- CHEM 100 with a Grade of C or better. or
- One year of high school chemistry

Corequisite(s):

Corequisites go through a separate approval process. See Forms E1-E6 for details.

-none-

Recommend Preparation:

Recommended Preparation goes through a separate approval process. See Forms E1-E6 for details.

- Earn a mastery score of at least 95% on the ALEKS Preparatory Chemistry Course.

Other Enrollment Criteria:

-none-

Learning Objectives:

(please number each objective and express in behavioral terms)
Upon the completion of the course the student will be able to do the following:

1. Convert from one system of units to another using dimensional analysis.
2. Distinguish the components of the atom using the Modern, Bohr and Quantum Mechanical views of atomic structure.
3. Interpret properties of elements using the periodic table.
4. Propose the name of a compound given the chemical formula.
5. Derive the theoretical yield and percentage yield of a reaction.
6. Calculate pressures,partial pressures, volumes, temperatures, and moles of gases using the principles of Charlesâ€™ Law, Avogadroâ€™s Law, Boyles Law, the ideal gas equation, and the real gas equation.
7. Calculate enthalpy using Hessâ€™ law, standard enthalpy of formation tables, calorimetric data and bond energies.
8. Predict electron configuration and orbital diagrams for various elements.
9. Deduce Lewis geometries and hybridization for various atoms, molecules, monatomic and polyatomic ions using periodic properties.
10. Derive the bond order, bond length, and magnetic character of diatomic compounds.
11. Analyze phase diagrams to identify stable phases at given temperatures and pressures, and describe phase transitions resulting form changes in these properties.
12. Compare and contrast physical properties of molecules and ionic compounds based upon analyses of intermolecular forces.

Laboratory

1. Maintain a safe laboratory environment through proper manipulation of equipment and careful observation of experiments
2. Employ standard laboratory techniques such as titration
3. Deduce solute molecular weights when given appropriate colligative property data and describe the effect of solute concentration on various solution properties (vapor pressure, boiling point, freezing point, and osmotic pressure).

Course Content:

(please number the outline of main topics and subtopics)

1. Chemical Foundations
    1. the scientific method
    2. units of measurement
    3. uncertainty in measurement
    4. significant figures in calculations
    5. dimensional analysis
    6. temperature and density
    7. classification of matter
2. Atoms, Molecules, and Ions
    1. Dalton's atomic theory
    2. the modern view of atomic structure
    3. molecules and ions
    4. an introduction to the periodic table
    5. naming inorganic compounds
    6. isotopes
3. Stoichiometry
    1. atomic masses
    2. the mole
    3. molar mass
    4. percent composition of compounds
    5. determining the formula of a compound
    6. balancing chemical equations
    7. stoichiometric calculations
    8. theoretical yield calculations
    9. percentage yield calculations
4. Types of Chemical Reactions and Solution Stoichiometry
    1. aqueous solutions: strong and weak electrolytes
    2. the composition of solutions
    3. types of chemical reactions : precipitation, acid-base and oxidation-reduction reactions
    4. stoichiometry of precipitation reactions
    5. titration
    6. balancing oxidation-reduction reactions
5. Gases
    1. pressure
    2. the gas laws of Boyle, Charles, and Avogadro
    3. the Ideal gas law
    4. gas stoichiometry
    5. Dalton's law of partial pressure
    6. the kinetic molecular theory
    7. effusion and diffusion
    8. real gases
6. Thermochemistry
    1. energy, enthalpy and calorimetry
    2. Hess's law
    3. standard enthalpies of formation
7. Atomic Structure and Periodicity
    1. electromagnetic radiation
    2. atomic spectra
    3. the Bohr model of the atom
    4. the quantum mechanical model of the atom
    5. quantum numbers

6. orbital shapes and energies
7. electron spin and the Pauli principle
8. the aufbau principle
9. electron configurations of atoms
10. periodic trends in atomic properties

8. Bonding: General Concepts
    1. types of chemical bonds
    2. electronegativity
    3. bond polarity and dipole moments
    4. electron configurations of ions
    5. covalent bonds and covalent bond energies in chemical reactions
    6. Lewis structures
    7. resonance
    8. molecular structure and VSEPR theory
    9. formal charge
9. Covalent Bonding: Orbitals
    1. hybridization
    2. molecular orbital theory, bond order and magnetism
10. States of Matter
    1. Intermolecular forces
    2. Properties of liquids
    3. Phase diagrams
    4. Structure and properties of solids
11. Physical Properties of Solutions
    1. A molecular view of the solutions process
    2. Solution compositions and concentration units
    3. Energies of solution formation
    4. Factors affecting solubility
    5. Colligative properties of electrolytic and non-electrolytic solutions

Lab Content:

(please number the outline of main topics and subtopics)

1. Chemical Foundations
    1. units of measurement
    2. uncertainty in measurement
    3. significant figures in calculations
    4. dimensional analysis
    5. properties of matter
2. Stoichiometry
    1. atomic masses
    2. the mole
    3. molar mass
    4. percent composition of compounds
    5. determining the formula of a compound
    6. balancing chemical equations
    7. stoichiometric calculations
    8. theoretical yield calculations
    9. percentage yield calculations
3. Types of Chemical Reactions and Solution Stoichiometry
    1. aqueous solutions: strong and weak electrolytes
    2. the composition of solutions
    3. types of chemical reactions : precipitation, acid-base and oxidation-reduction reactions
    4. stoichiometry of precipitation reactions

5. standardization and titration
6. balancing oxidation-reduction reactions

4. Gases
    1. pressure
    2. the gas laws of Boyle, Charles, and Avogadro
    3. the Ideal gas law
    4. gas stoichiometry
    5. Dalton's law of partial pressure
5. Thermochemistry
    1. energy, enthalpy and calorimetry
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    1. electromagnetic radiation
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    1. types of chemical bonds
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    3. bond polarity and dipole moments
    4. electron configurations of ions
    5. covalent bonds and covalent bond energies in chemical reactions
    6. Lewis structures
    7. resonance
    8. molecular structure and VSEPR theory
    9. formal charge
8. Covalent Bonding: Orbitals
    1. hybridization
    2. molecular orbital theory, bond order and magnetism
9. Safety
    1. Safety Equipment
    2. General Rules of Conduct
    3. Dress Code
    4. Personal Protective Equipment
    5. Chemical Hygeine
    6. Hazardous Materials
    7. Waste and Disposal
    8. Chemical Spills
    9. Glassware and Sharps
    10. Bunsen Burners
    11. Accidents

Methods of Instruction:

Methods of instruction may include, but are not limited to the following:

- **Method:** Lecture
  Integration: Use of presentation software (powerpoint, WebMO, document visualizer, etc) and whiteboard will be used to demonstrate chemical reactions, calculations, conversions, Lewis structures, VSEPR, and other bonding theories.
- **Method:** Lab Activities
  Integration: Conduct experiments that include wet, dry, and computer assisted learning activities. Students will; (1) collect scientific data while performing lab experiments, (2) Format and write lab reports using scientific methods including an organized presentation of data and results, and (3) demonstrate application of knowledge through post-laboratory analysis. Example laboratory activities designed to reinforce key content areas include;

(1) the determination of theoretical yield and percentage yield of a reaction, (2) calorimetry and energy transfer, (3) thermodynamics, and (4) atomic and molecular structure. All laboratory activities will focus on laboratory skills, experimental techniques, proper use of equipment, safe lab practices and chemical hygiene, waste disposal, and quality of data/results.

- **Method:** Film/video Viewing and Discussion
  Integration: Videos, animations, and molecular modeling software can be used to assist the visual analysis of molecular structure, electronic structure, chemical bonding, and intermolecular forces in both lecture, laboratory and as pre-lab activities.
- **Method:** Observation and Demonstration
  Integration: Demonstrations of reactions, molecular modeling, and calculations can be used in the lecture and laboratory components to enhance qualitative and quantitative interpretations associated with dimensional analysis, stoichiometry, concentrations, mass, moles, thermochemical properties, structure/function relationships of compounds, and gas laws.
- **Method:** Discussion
  Integration: In class group discussions and assignments that involve students in peer-interactions, critical thinking, and active learning.
- **Method:** Activity
  Integration: Assignments include homework problem solving and audio-visual experiential learning activities.

Methods of Evaluation:

A student's grade shall be determined by the instructor using multiple measures of performance related to the course objectives. Methods of evaluation may include but are not limited to the following:

- **Method:** Homework
  Integration: Homework assignments evaluate for example, how the students are learning the concept of converting from one system of units to another using dimensional analysis. Homework should constitute no more than 0 to 15% of the course grade.
- **Method:** Other
  Integration: Laboratory exercises assess how the students are learning practical application of chemistry concepts in a laboratory setting, and proper use of glassware, equipment, and chemical supplies throughout every lab. Also assessed during lab are derivations of theoretical and percentage yield of a reaction, calculated with accurate data and proper use of significant figures. Laboratory exercises should constitute no more than 30 to 40% of the course grade.
- **Method:** Exams/Tests
  Integration: Written, oral, and practicum exams, informal assessments, and prelab/postlab assignments can be used to evaluate student progress, application of metacognitive and practical skills, and content knowledge associated with bond order, bond length, and magnetic characteristics of diatomic molecules and other compounds in both lecture and lab components of the course. Midterm Exams and Lab Practicums should constitute no more than 35% to 50% of the course grade. Final Exams should constitute no more than 20-30% of the course grade. The general chemistry ACS exam may be used for the final exam.
- **Method:** Papers
  Integration: Written laboratory reports that include an objective, procedure, data and results, data tables, discussion, conclusion, references, and when applicable, calculations, figures, and graphs. Reports should constitute approximately 20% of the total lab points.
- **Method:** Quizzes
  Integration: Quizzes evaluate student safety training, safe laboratory and chemical hygiene practices and student knowledge of personal protective equipment, injury prevention, chemical spills, and minor first aid.
- **Method:** Other
  Integration: Laboratory exercises can be used to evaluate safe and effective use of equipment, chemicals, and supplies while monitoring preparedness, organizational skills, and data analysis.

Examples of Assignments:

Students will be expected to understand and critique college level texts or the equivalent. Reading and writing, as well as out of class

assignments are required. These assignments may include but are not limited to the following:

Typical questions are given for each section of the course content and are intended to indicate the level of difficulty for homework problems and test questions for the General Chemistry level. Many of the questions were taken from Zumdahl, Chemistry, 6th ed. and Kotz and Treichel, Chemistry and Chemical Reactivity, 3rd Ed.

1. Unit conversion and density.

a) Is the scientific method suitable for solving problems only in the sciences? Explain.

b) Use the following exact conversion factors to perform the stated calculations:
5 ½ yards = 1 rod, 40 rods = 1 furlong, 8 furlongs = 1 mile
The Kentucky Derby race is 1.25 miles. How long is the race in rods, furlongs, meters, and kilometers?

c) Perform the following calculations and express each result to the proper number of significant figures.
i) 4.184 X 100.62 X (25.27 - 24.16)
ii) (9.04 - 8.23 + 21 954 + 81.0) ?3.1416

d) Perform each of the following conversions:
i) 8.43 centimeters to millimeters
ii) 903.3 nanometers to micrometers
iii) 212 oF = ? K

e)The density of a diamond is 3.51 g/cm3 and 1 carat = 0.20 g. What is the volume of a 5-carat diamond?

f) Classify each of the following as a chemical or physical change.
i) Mothballs gradually vaporize in a closet.
ii) Hydrofluoric acid attacks glass.
iii) Students sometimes get holes in cotton jeans because of acid spills.

2. Molar mass and percent composition.

a) Gallium has two naturally occurring isotopes, 69Ga, and 71Ga with masses of 68.9257amu and 70.9249amu, respectively. Calculate the percent abundances of these two isotopes knowing the average atomic mass of gallium is 69.723amu.

b) Calculate the molar mass of K2SO4 and find how many moles are in 7.65 grams of K2SO4?

c) Calculate the percent composition of caffeine, C8H10N4O2

d) The action of bacteria on meat and fish produce a poisonous compound called cadaverine. As its name and origin imply, it stinks! It is 58.77% C, 13.81% H, and 27.40% N. It's molar mass is 102.2 g/mol. Determine the molecular formula of cadaverine.

e) Balance the following equation:

$$Al(OH)3 + HCl \rightarrow AlCl3 + H2O$$

f) For the combustion of propane, C3H8:

$$C3H8 + 5O2 \rightarrow 3CO2 + 4H2O$$

Calculate the theoretical yield of CO2 if 10.0 g of C3H8 react with 20.0 g of O2.

3. Chemical reaction equations

a) Write total ionic and net ionic equations for the following balanced, molecular equations.

i) $Zn(s) + 2HCl(aq) \rightarrow H2(g) + ZnCl2(aq)$

b) If 32.67 ml of HCl is used to titrate 2.095 grams of Na_2CO_3, what is the molarity of the HCl solution? The balance equation for the reaction is:

$2HCl(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

5. Gas Laws

a) Convert 2.54 atmospheres pressure to units of torr.

b) A 4.0 l balloon filled with a gas at 25oC is released and, after floating upward, comes to a temperature of 10oC. What is the final volume of the balloon?

c) A 2.5 l container has 20.0 grams N_2 gas at 22oC. What is the pressure, in units of torr, inside the container?

d) For the following combustion reaction of benzene, C_6H_6:

$2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$

If 50.0 grams of C_6H_6 react with 100 grams of O_2, how many grams of H_2O will be produced?

e) Helium, He (0.56 grams) and hydrogen, H_2, are mixed in a flask at room temperature. The partial pressure of He is 150 mmHg and that of H_2 is 25 mmHg. How many grams of H_2 are present?

f) Place the following gases in order of increasing molecular speed at 25oC.

a) Ar b) CH_4 c) N_2 and d) CH_2F_2

g) A gas whose molar mass you wish to know effuses through an opening at a rate only one third as great as the effusion rate of helium. What is the molar mass of the unknown gas?

h) You want to store 165 grams of CO_2 gas in a 12.5-liter tank at 25oC. Calculate the pressure the gas would have using :

a) the ideal gas law and b) van der Waal's equation

6. Thermochemistry

a) If 38.1 kJ is used to heat 0.31 grams of aluminum with a mass of 260 grams, what is the final temperature of the aluminum if it initial temperature is 7.0oC? The specific heat of aluminum is 0.902 J/g.oC.

b) Calculate the enthalpy change for the reaction :

$BrCl(g) \rightarrow Br(g) + Cl(g)$ $\Delta H = ?$

by using the following data:

$Br_2(l) \rightarrow Br_2(g)$ $\Delta H = +30.91$ kJ

$Br_2(g) \rightarrow 2\,Br(g)$ $\Delta H = +192.9$ kJ

$Cl_2(g) \rightarrow 2\,Cl(g)$ $\Delta H = +243.4$ kJ

$Br_2(l) + Cl_2(g) \rightarrow 2\,BrCl(g)$ $\Delta H = +29.2$ kJ

c) A 0.6250 gram sample of gasoline is burned in a bomb calorimeter with a heat capacity of 9.89 kJ/oC. The temperature in the calorimeter rises from 21.35 to 25.26 oC. Calculate the heat of combustion of the gasoline, in kilojoules per gram of gasoline?

d) Using a standard enthalpy of formation table, calculate the standard enthalpy change for ther following reactions:

i) $Al_2O_3(s) + 3H_2O(l) \rightarrow 2\,Al(OH)_3(s)$

ii) $C_2N_2(g) + 2\,O_2(g) \rightarrow 2\,CO_2(g) + N_2(g)$

e) Using a table of average bond energies, calculate the enthalpy of reaction for the following:

i) $CH_4(g) + 2Cl_2(g) + 2F_2(g) \rightarrow CF_2Cl_2(g) + 2HF(g) + 2HCl(g)$

7. Quantum Model of the Atom

a) List the three characteristic components of a wave.

b) Which color in the visible spectrum has the highest frequency?

c) What is the Aufbau principle?

d) Calculate the wavelength of light that is emitted when an electron makes the transition from principle energy level 4 to principle energy level 3. What part of the electromagnetic spectrum is this wavelength associated?

e) Write the four quantum numbers (n, l, ml, ms) for each electron in the neutral oxygen atom.

f) Arrange the atoms in order of increasing ionization energy:
i) F, O, and S ii) Se, Cl, and Br

g) Compare the elements B, Al, C, and Si.
i) Which has the largest atomic radius?
ii) Which has the most negative electron affinity?
iii) Which has the most metallic character?

h) Write complete electron configurations for the following atoms.
i) Mn ii) Cr iii) Br iv) Cu

8. Electronic Structure

a) Using a periodic table, arrange the following elements in order of increasing electronegativity.
i) P,O,N ii) K, Br, Ca iii) Cl, Al, In

b) Using a periodic table, arrange the following elements in order of increasing bond polarity.
i) Na–F ii) K–F iii) N–O iv) Al–N

c) Draw the Lewis structures for CO_2 showing all possible resonance structures.

d) Write Lewis structures and give geometries for the following:
i) CO ii) PBr_3 iii) CN^{-1} iv) XeF_5^+

e) Write electron configurations for the following atoms:
i) Fe ii) Cr iii) Cu iv) Kr

f) Calculate the formal charge for each atom in the following ion and compound:
i) XeF_2 ii) NO_2^{-1}

g) Using the bond energy tables provided, estimate the ?H for the following reaction:

$$H_2(g) + O_2(g) \rightarrow H_2O_2(g)$$

9. Advanced bonding theories

a) What is the hybridization for the central atom in each of the following:
i) SF_2 ii) BrO_3^{-1} iii) CO_3^{-2}

b) Using molecular orbital theory, find the bond order, and indicate whether the molecule or ion is paramagnetic or diamagnetic.
i) O_2^{-1} ii) C_2^+ iii) Ne_2

Example of a LABORATORY ASSIGNMENT

The following sample laboratory assignment is intended to indicate the level of difficulty for a laboratory assignment at the General Chemistry level :

Hydrated Salts

Purpose

1. To become familiar with hydrated salts.
2. To determine the formulas of hydrated salts.

Discussion

Many pure substances combine with water to form hydrates. In their nonhydrated form, these substances are said to be anhydrous, which means without water. Unlike substances that absorb indefinite amounts of moisture, hydrates have a definite percentage of water. This definite composition results from a fixed number of moles of water for each mole of the anhydrous substance. An example of a hydrated salt is calcium sulfate dihydrate, CaSO4?2H2O.

We often refer to the water in a hydrate as the water of hydration. In this experiment, you will heat a sample of hydrated barium chloride to drive off the water. By weighing the hydrated salt before and after heating, you will be able to determine the ratio of moles of water to moles of barium chloride. From this ratio, you will be able to write the formula of the hydrated salt.

Let us consider an experiment in which 3.00 g of hydrated copper(II) sulfate is heated to drive off the water. At the end of the experiment, the sample is reweighed and the mass of anhydrous salt that remains is found to be 1.92 g. To determine the ratio of moles of water to copper(II) sulfate, we will first calculate the actual number of moles of each substance that was present in the heated sample. The mass lost during the heating period represents the water present in the hydrated salt. The residue that remains is anhydrous copper(II) sulfate. We may calculate the moles of each as follows:

? g H2O = 3.00 g – 1.92 g = 1.08 g H2O

? mol H2O = 1.08 g H2O = 0.0600 mol H2O

? mol CuSO4 = 1.92 g CuSO4 = 0.0120 mol CuSO4

The formula of the hydrate is CuSO4 5 H2O. Notice the similarity between this calculation and those used for determining empirical formulas.

The percentage of water in a hydrated salt also is a useful quantity for identification of the salt. The percentage of water in the hydrated copper(II) sulfate may be obtained by expressing the mass of water driven off as a percentage of the entire sample that was heated:

% water = x 100% = x 100% = 36.0%

Experimental

Materials

Copper(II) sulfate pentahydrate, CuSO4 5 H2O
Hydrated barium chloride, BaCl2 X H2O (formula to be determined)
Anhydrous calcium chloride
Test tubes

Crucible with cover
Clay triangle
Crucible tongs
Ring stand and iron ring
Bunsen burner

Laboratory Notes

If excessive spattering occurs in part II, the initial phases of heating should be carried out with the crucible cover completely covering the crucible. After heating for several minutes, use your crucible tong to set the crucible cover slightly ajar so that the water vapor can escape completely.

Procedure

I. Hydrated Copper(II) Sulfate

1. Place a few crystals of copper(II) sulfate pentahydrate, $CuSO_4 \cdot 5H_2O$, in a test tube. Hold the test tube in a horizontal position, and gently heat the bottom of the tube with your Bunsen burner. Note all of the changes you observe.

2. Anhydrous calcium chloride, $CaCl_2$ will absorb water vapor from the air. Place about 1 g of anhydrous calcium chloride in a clean test tube, and tap the test tube gently to shake the solid to the bottom. Heat the test tube gently to drive off any moisture that might be present. Allow the test tube to cool before you continue.

3. Do not use the same sample of $CuSO_4$ used in step 1, for this next part, get a new sample of $CuSO_4$. Carefully incline the cool test tube to a horizontal position, and place a few fresh (not the crystals you used in step 1) crystals of copper(II) sulfate pentahydrate, $CuSO_4 \cdot 5H_2O$, near the open end. Move crystals to about an inch away from the $CaCl_2$ using your stirring rod to place the crystals into position. Be careful to keep the copper(II) sulfate pentahydrate crystals separated from the calcium chloride. Record the color of the copper crystals.

II. Determining the Formula of a Hydrate

1. Place a freshly cleaned crucible with its cover on a clay triangle, supported by an iron ring on a ring stand. The crucible cover should be left ajar so that water vapor may escape. Heat the partially covered crucible assembly for about 2 minutes to dry it. Allow the crucible to cool, and weigh it (without the cover) to the nearest 0.01 g. Record the mass. Do not weigh the crucible cover.

2. Add approximately 1.5 g hydrated barium chloride to the crucible. Reweigh the filled crucible (without the cover) to the nearest 0.01 g. Record the mass.

3. Put the crucible back on the clay triangle, and set the cover so that it is just slightly ajar. Heat the crucible gently at first to avoid spattering. Gradually increase the intensity of the heat until the bottom of the crucible is a dull red color and no water vapor appears to be given off. Continue heating for an additional 10 minutes.

4. Allow the crucible to return to room temperature, and then weigh it (without the cover).

5. Reheat the crucible and its contents (without the cover) for 10 minutes, cool, and reweigh. If no significant decreases in mass has occurred (less than 0.05 g) since the previous weighing, the remaining salt is anhydrous. If not, continue heating until a constant mass is obtained.

6. Calculate the percentage of water in your sample. Calculate the number of moles of water lost and the number of moles of anhydrous barium chloride, $BaCl_2$, remaining. Determine the ratio of moles of water to the moles of barium chloride. Write the formula for the hydrated salt.

Cleaning Up
Dispose of your barium chloride wasted and your unknown compounds into the waste container provided.

Prelab questions are to be completed as homework after reading the corresponding experiment in the laboratory manual.

Lab 11 Prelab Questions Name_____

1. What is the percentage of water in MgSO4 7 H2O?

2. A hydrate of cobalt(II) chloride, CoCl2, is weighed out and dehydrated to determine the formula of the hydrate. Use the following data to calculate the formula:
Mass of crucible: 12.635 g
Mass of crucible plus hydrate: 14.435 g
Mass of crucible plus anhydrous salt after heating: 14.044 g
Determine each of the following:

a mass of anhydrous salt
b mass of water
c moles of anhydrous salt =
d moles of water =
e ratio of moles of water to moles of anhydrous salt chemical formula of the hydrated salt

Report Sheet

Name_____

Hydrated Salts

I. Hydrated Copper(II) Sulfate

A. Color of hydrate:_____

B. Color of sample after heating with Bunsen burner:_____

C. Color of sample after exposure to calcium chloride:_____

II. Hydrated Barium Chloride

A. Mass of crucible:_____

B. Mass of crucible plus hydrated barium chloride:_____

C. Mass of crucible plus anhydrous barium chloride after first heating:_____

D. Mass of crucible plus anhydrous barium chloride after second heating:_____

Calculations Part II(Show set-ups and answers)
E. Mass of hydrate:
F. Mass of water:
G. Mass of anhydrous barium chloride:
H. Percentage of water in hydrate:
I. Moles of water:
J. Moles of anhydrous barium chloride.
K. Ratio of moles H2O to moles BaCl2:
L. Formula of hydrated barium chloride:

Textbooks:

- Tro, Nivaldo (2020). *Chemistry: A Molecular Approach. 5th edition* Pearson. ISBN: 9780136874201
- Beran (2014). *Laboratory Manual for Principles of General Chemistry, 10th edition* Wiley. ISBN: 1118621516
- Zumdahl, S. S., Zumdahl, S. A. Donald, J. D. (2018). *Chemistry, 10th edition* Cengage. ISBN: 1305957404
- Tro, N. T., Norton, D. (2017). *Laboratory Manual for Chemistry: Structure and Properties* Pearson. ISBN: 978-0134293936
- Brown, B., E. Eugene, L., Bruce B., B. Murphy, C., Woodward, P. (2018). *Chemistry the Central Science 14th edition* Pearson. ISBN: 978-0134414232

Other Resources:

- MSJC. General Chemistry I lab manual . MSJC , 01-01-2020.

Minimum Qualification

- Chemistry (Masters Required)