# Science 2 (Chemistry)

| Basic Course Information | | | |
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| **Course Code** | SCIENCE | **Subject Division** | Science (Chemistry) |
| **Class Format** | Lecture | **Credit Type and Number** | Elective |
| **Credit Hours** | 2 credits (2 hours/week) | **Course Level** | 100 |
| **Course Language** | Korean | **Grading Type** | Letter |
| **Prerequisite** | Chemistry I | **Course Type** | Lecture |
| **Required Materials** | 1. Brown et al.(Brown) M. (2017). Introductory Chemistry (4th edition) NEXT APPROACH. McGraw-Hill Education.<br>2. Zhang Q. Teaching. J. (2018). Chemistry I (10th ed.). McGraw-Hill Education. | | |
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## Course Description

Prerequisite: Chemistry I

Rationale 2: Chemistry allows molecules to descend to the fundamental elements of chemistry, with a specific focus on phase changes and phase diagrams, liquids and solids, equilibrium chemistry, and chemical energetics. By the end of the course, students will have a comprehensive understanding of the role of chemistry in engineering, and they will be able to apply the knowledge to solve technical engineering problems.

Moreover this course will help students develop critical thinking, exploration, discussion, and collaboration skills that are essential for global engineers to understand and solve complex problems. Throughout the course, safe and group assignments will be given to help students build these competencies.

Specifically, students will learn about phase changes and phase diagrams which are important in many industrial processes and engineering applications. Students will also learn about liquids and solids, equilibrium chemistry, and chemical energetics which is important to know and apply in our surroundings. Additionally, industrial engineers will be involved in fields including nanotechnology, thermodynamics and chemical equilibrium.

By the end of the course, students will have a strong appreciation of the fundamental laws and principles of chemistry and their practical applications in engineering. Further, students will be able to apply the knowledge learned in order to make and explore solutions and make informed decisions in their future careers as engineers.

## Outcomes/Goals

| Outcomes/Goals | Minimum Achievement Criteria Goals | Expected Level of Achievement Criteria | Unacceptable Level of Achievement Criteria |
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| Understand the concepts and understanding of the following contents:<br>1. Phase changes and Phase diagrams<br>2. Liquids and solids<br>3. Equilibrium chemistry<br>4. Chemical energetics | Theoretically understand and apply the knowledge, and identify non-trivial, the complex, and the complex | Only understanding of the major terms and concepts | Cannot the appropriate knowledge and understanding |

## Instructional Learning Outcomes

**SLO 1(Knowledge) Understanding of the fundamental laws and principles of chemistry and their practical applications in engineering.**

**SLO 2(Skills) Develop critical thinking, exploration, discussion, and collaboration skills to solve problems in the course.**

**SLO 3(Attitude) Develop a positive attitude toward the chemistry and engineering.**

**SLO 4(Attitude) Develop a positive attitude toward the chemistry and engineering.**

**SLO 5(Attitude) Develop a positive attitude toward the chemistry and engineering.**

## Instructional Methods

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| **Class Format** | Lecture (Face to Face), Discussion, Group Work, Presentation, Student Presentation |
| **Class Time** | 2 hours/week |
| **Class Rules** | Attendance, Assignment, Quiz, Mid-term exam, Final exam, Participation, Attitude |

| Course Plan Semester 1 | Contents and Method of Course | Goals | Actual LSM |
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| 1st week | **1. Phase changes and Phase diagrams**<br>1.1 Introduction to Phase | 1.1 Describe the distinguishing characteristics of solids, liquids, and gases.<br>1.2 Identify the six phase changes and describe the process of each phase change in terms of energy, arrangement and motion. | 0:0 + 0 |
| 2nd week | 1.2 Energy and phase change | 1.3 Describe changes of state in terms of melting, freezing, condensation, vaporization, and sublimation in terms of kinetic particle theory.<br>1.4 Calculate heat and energy changes related to phase changes and heating curves and phase changes. | 0:0 + 10 |
| 3rd week | 1.3 Phase diagram | 1.5 Define critical pressure, critical temperature, normal melting point, normal freezing point, triple point, critical point and boiling point.<br>1.6 Read Phase Diagrams.<br>1.7 Describe Region, Line, Triple Region, Critical point, Solid-Liquid, Liquid-Gas and Solid-Gas. | 0:0 + 0 |
| 4th week | **2. Liquids and solids**<br>2.1 Intermolecular forces and properties<br>2.2 Crystal structure, Nanoparticle,fullerene | 2.1 Explain the concepts of capillary surface tension and viscosity.<br>2.2 Define the vapor pressure of liquid and solid.<br>2.3 Interpret what the volatility is and how.<br>2.4 Describe the differences between crystalline and amorphous solids.<br>2.5 Classify solids based on the kind of bonds and describe their properties.<br>2.6 Describe the differences between metallic and covalent solids.<br>2.7 Define and describe the concepts of electrical conductivity and thermal conductivity.<br>2.8 Classify solids based on the kind of bonds and describe their properties.<br>2.9 Describe the differences between metallic and covalent solids.<br>2.10 Describe the differences between metallic and covalent solids. | 0:0 + 0 |
| 5th~7th week | 2.3 Solid-liquid phase<br>2.4 Liquid-gas phase<br>2.5 Solid-gas phase | | 0:0 + 20<br>0:0 + 20<br>0:0 + 20 |
| 8th | Wrap-up of first half of semester | Consolidate and summarize the knowledge and skills taught/learned in the first half of the semester. | |
| 9th week | Midterm Examination | Calculation of students' information | |
| 10th week | Return of examination script and reflection | Review students' results and the mid-term exam | |
| 11th week | **3. Equilibrium chemistry**<br>3.1 Introduction | 3.1 Define the unified theory of acids and bases and describe the concept of pattern 12 atom.<br>3.2 Define the conjugate pairs, Ka, relative strength of acids and bases, pH, pOH, Kb, and relative strength of acids and bases, the unified theory of acids and bases.<br>3.3 Describe the molecular structure of acids and bases and explain the relationship between molecular structure and acid-base properties, e.g. polarity, ionic bonding, and the strength of the oxygen-containing acids.<br>3.4 Describe the concepts of equilibrium in solution, calculate the concentration of ions, calculate the pH, calculate the number of particles, calculate the pH of polyprotic compounds, calculate the pH of salts, calculate the pH of common acids, calculate the pH of common bases, and understand the concepts of buffer and buffering ability. | 0:0 + 30<br>0:0 + 30<br>0:0 + 30<br>0:0 + 30 |
| 12th week | 3.2 Percent composition and empirical formula | 3.5 State the formulas of the species that are contained in the solution.<br>3.6 Define the molecular formula, the empirical formula, the number and types of atoms in the molecular formula.<br>3.7 Define the percentage composition by mass given the molecular formula.<br>3.8 Define the empirical formula, the molecular formula, the standard molar number of atoms in a molecule, and of ions in a compound.<br>3.9 Calculate the empirical formula, the molecular formula, using given data. | 0:0 + 30<br>0:0 + 30 |
| 13th week | 3.3 Chemical equation and reaction<br>3.4 Limiting reagent and yield | 3.10 Construct balanced equations and predict the products of the following reactions: combustion, synthesis, decomposition, single replacement, double replacement, and acid-base neutralization.<br>3.11 Calculate yields.<br>3.12 Define the optimal conditions for a reaction to occur in a chemical reaction.<br>3.13 Calculate the number of moles and coordination number of a complex, and the molarity.<br>3.14 Calculate the mass of a salt and water required by given experimental data. | 0:0 + 30<br>0:0 + 0<br>0:0 + 0<br>0:0 + 0 |
| 14th week | **4. Chemical energetics**<br>4.1 Introduction | 4.1 State that the transfer of thermal energy during a chemical reaction is called enthalpy change, $\Delta H$, and that it is positive for endothermic reactions and negative for exothermic reactions.<br>4.2 Describe the relationship between the enthalpy change, $\Delta H$, and the internal energy, $\Delta U$, and the work done, $\Delta W$, in a chemical reaction.<br>4.3 Calculate the enthalpy change of the reaction, $\Delta H$, using the equation energy $\Delta H = \Delta U + \Delta W$ and the work done, $\Delta W$, calculated from the pressure and the volume change of a chemical reaction. Describe the meaning of standard state. | |
| | 4.2 Bond enthalpy and Heat $\Delta H_{rxn}$ | 4.4 Calculate the enthalpy change of a reaction using standard enthalpy of formation, $\Delta H_f$.<br>4.5 Apply Hess' $\Delta H_{rxn}$ to calculate the enthalpy change of a reaction.<br>4.6 Calculate sub-stations using ordered/unordered arrangements of particles, the Gibbs free energy change, $\Delta G$, and the entropy change, $\Delta S$, by using the Gibbs' equation $\Delta G = \Delta H - T\Delta S$. | |
| | | 4.7 Explain and apply the | |

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| | 4.5Gibbs free energy, entropy, and spontaneous reaction | 1.1 Ionized and spot the ionized Gibbs free energy and entropy<br>1.2 Define entropy and state the second law of thermodynamics.<br>1.3 Calculate the free energy of reaction to predict the spontaneity of a chemical reaction.<br>1.4 Calculate the effect of temperature on spontaneity of reaction (in Gibbs and entropy) | |
| 15th ~ 16th week | **6. Gases and gas laws**<br>Chapter 10 | 1.1 Explain the relationship between P, V, and T<br>1.2 Explain the relationship between P, V, and n<br>1.3 Explain the relationship between P, V, and T<br>1.4 Use the gas laws to find unknown quantities of pressure, volume, and moles of gas | 0 in ~ 1.5 |
| | 5.2 Ideal gas laws | 1.1 Understand that ideal gas behavior is based on kinetic theory<br>1.2 Calculate the volume of a gas using<br>PV=nRT, P1V1/n1T1=P2V2/n2T2 (Apply the ideal gas equation to calculate the volume, pressure, moles to the ideal gas law and Dalton's law of partial pressure)<br>1.3 Calculate the volume gas produced in a given amount in a chemical reaction | 0 in ~ 1.5<br>0 in ~ 1.5<br>0 in ~ 1.5 |
| | 5.3 Dalton's a law of partial pressure | 1.1 Calculate the total pressure of a gas mixture using the law of partial pressure (Dalton's law)<br>1.2 Calculate the partial pressure of a gas in a mixture using the partial pressure law | 0 in ~ 1.5 |
| 17th ~ 18th week | 5.4Diffusion and Effusion (Graham's a law of diffusion) | 1.1 Describe the kinetic molecular theory of gases<br>1.2 Calculate the effect of pressure and temperature on the rate of diffusion and the rate of effusion and compare<br>1.3 Determine and explain the relationship between the rate of diffusion of gases | |
| | 5.5 Deviation from ideal behavior | 1.1 Explain why real molecular and ionic gases deviate from ideal behavior<br>1.2 Explain the effect of high pressure or low temperature. | |
| 19th week | Final Examination | Calculation of students' overall information | |
| 20th week | Return of examination sector and reflection | Review students' results and the final exam | |

Sign and

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| Prepared by: | | | | Date | Signature |
| Approved by: | | | | | |
| Approved by Academic Dean: | | | | | |

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| Received academic first coordinator | Date | Received academic second coordinator | Date | Signature |
| | NOV | NOV | 1 Dec Saturday | |