	Universitas Negeri Surabaya Faculty of Mathematics and Natural Sciences Undergraduate Chemistry Study Program	Document Code

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
CHEMICAL THERMODYNAMICS	4720103187	Compulsory Study Program Subjects	T=3	P=0	ECTS=4.77	3	July 1, 2022

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
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Learning model: Case Studies

Program Learning Outcomes (PLO)

PLO study program that is charged to the course

Program Objectives (PO)

PO - 1	Understand the basic principles of thermodynamics and their applications: properties and behavior of gases; gas kinetics, energy, heat and work; internal energy and enthalpy; process direction and the concept of entropy; free energy and its relationship with system stability, chemical equilibrium, electrochemical cell thermodynamics, solution thermodynamics, phase equilibrium
PO - 2	Able to solve science and technology problems in the general field of chemistry and in a simple scope such as through the application of knowledge of the properties and behavior of gases; gas kinetics, energy, heat and work; internal energy and enthalpy; process direction and the concept of entropy; free energy and its relationship with system stability, chemical equilibrium, thermodynamics of electrochemical cells, thermodynamics of solutions, phase equilibrium, and the application of relevant technology
PO - 3	Have the ability to utilize ICT-based learning resources and learning media in understanding the concept of energetics.
PO - 4	Make decisions about the relationship between basic chemical concepts and laboratory activities, research results, and the existence of chemistry in everyday life.

PLO-PO Matrix

P.O
PO-1
PO-2
PO-3
PO-4

PO Matrix at the end of each learning stage (Sub-PO)

P.O	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PO-1																
PO-2																
PO-3																
PO-4																

Short Course Description: Brief description: Study of the properties and behavior of gases, gas kinetics, energy, heat and work, internal energy and enthalpy, process direction and the concept of free energy entropy and its relationship to system stability, chemical equilibrium, electrochemical cell thermodynamics, solution thermodynamics, phase equilibrium and laboratory activities. in accordance.

References

Main :

1. Daftar Pustaka : Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.

Supporters:

1. Levine, I.N., 2005, Physical Chemistry, 4th edition, Singapore, McGraw-Hill
2. Bahl, BS. 2002. Essential of Physical Chemistry. New Delhi: S.Chand and Company Ltd.
3. Argon Sembiring, 2000, Kimia Fisika I, Universitas Terbuka.

Supporting lecturer: Prof. Dr. Harun Nasrudin, M.S.
Dian Novita, S.T., M.Pd.
Findiyani Ernawati Asih, S.Pd., M.Pd.

Week-	Final abilities of each learning stage (Sub-PO)	Evaluation		Help Learning, Learning methods, Student Assignments, [Estimated time]		Learning materials [References]	Assessment Weight (%)
		Indicator	Criteria & Form	Offline (*offline*)	Online (*online*)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Understanding RPS	Prepare lecture materials for the next meeting	**Criteria:** Participation, assignments **Form of Assessment** : Participatory Activities	Discussion, information on lecture material for 1 semester 3 X 50		**Material:** Basic introduction to thermodynamics **References:** *Bibliography : Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.*	5%
2	Understand the properties and behavior of ideal gases and real gases	1.Apply ideal gas laws. 2.Explain compressibility. 3.Explain/Apply the van der Waals equation. 4.Interpreting ZP curves	**Criteria:** Participation, assignments **Form of Assessment** : Participatory Activities	Discussion/Presentation and practice questions 3 X 50		**Material:** properties and behavior of ideal gases and real gases **References:** *Bibliography : Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.*	5%
3	Understand the concepts of energy, heat, internal energy, enthalpy and their relationships and be able to apply them in calculations.	1.Explain the meaning of energy, heat, work. 2.Apply the mathematical relationships of the first law of thermodynamics. 3.Derive the physical meaning of internal energy, enthalpy, heat capacity	**Criteria:** Participant, task **Form of Assessment** : Participatory Activities	Discussion and practice questions 3 X 50		**Material:** concepts of energy, heat, internal energy, enthalpy and their relationships and able to apply them in calculations **. References:** *Bibliography: Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.*	5%
4	Understand the concepts of energy, heat, internal energy, enthalpy and their relationships and be able to apply them in calculations.	1.Explain the meaning of energy, heat, work. 2.Apply the mathematical relationships of the first law of thermodynamics. 3.Derive the physical meaning of internal energy, enthalpy, heat capacity	**Criteria:** Participant, task **Form of Assessment** : Participatory Activities	Discussion and practice questions 3 X 50		**Material:** concepts of energy, heat, internal energy, enthalpy and their relationships and able to apply them in calculations **. References:** *Bibliography: Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.*	5%
5	Understand the direction of the process, the concept of entropy and system stability.	1. Explain and describe the circular process using a PV diagram. 2. Calculate the work of each step of the process. 3. Explain the concept of entropy based on Carnot circle calculations. 4. Define changes in entropy. 5. Explain the formulation of the second law of thermodynamics. 6. Explain that changes in entropy are a criterion for system stability.	**Criteria:** Participation, duty **Form of Assessment** : Participatory Activities	Discussion and practice questions 3 X 50		**Material:** process direction, the concept of entropy and system stability. **References:** *Bibliography: Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.*	5%

6	Understand the direction of the process, the concept of entropy and system stability.	1. Calculate changes in entropy as a function of volume and temperature and entropy as a function of pressure and temperature. 2. Calculate the change in entropy during phase changes. 3. Calculate absolute entropy.	**Criteria:** Participation, assignments **Form of Assessment** : Participatory Activities, Practical Assessment	Discussion and practice questions 3 X 50		**Material:** process direction, the concept of entropy and system stability. **References:** *Bibliography: Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.*	10%
7	Understand the free energy function and its relationship with other state functions and apply it in solving problems.	Define and explain the physical meaning of Helmholtz free energy Define and explain the physical meaning of Gibbs free energy Write down the fundamental equations and Maxwell's relationships and apply them in calculations.	**Criteria:** Participant, task **Form of Assessment** : Participatory Activities	Discussion and practice questions 3 X 50		**Matter:** free energy function and its relationship to other state functions **References:** *Bibliography : Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.*	5%
8	Covers meetings 1-7	Covers meetings 1-7	**Criteria:** UTS test **Form of Assessment** : Test	Written test 3 X 50			10%
9	Understand the concept of chemical equilibrium related to the free energy function.	1. Write down the equilibrium conditions. 2. Write down the Clapeyron equation and apply it.	**Criteria:** participation, tasks **Form of Assessment** : Participatory Activities	Discussion and practice questions, and 5 X 50 practice		**Material:** equilibrium conditions and Clausius Clapeyron equations **References:** *Bibliography : Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.*	5%
10	Understand the concept of chemical equilibrium related to the free energy function.	1. Explain the form of the equilibrium constant. 2. Explain the effect of temperature on the equilibrium constant. 3. Calculate the equilibrium constant.	**Criteria:** Participation, assignments **Form of Assessment** : Practical Assessment	Discussion and practice questions, 5 X 50 practical			5%
11	Understand the concept of properties of non-electrolyte solutions related to free energy.	Explain: partial molar quantities, ideal solutions, thermodynamics of mixing ideal solutions.	**Criteria:** Participation, assignments **Form of Assessment** : Participatory Activities	Discussion and practice questions 3 X 50			5%
12	Understanding Gibbs energy in electrochemical cells.	Explain Gibbs energy, Nernst equation and cell potential temperature coefficient.	**Criteria:** Participation, assignments **Form of Assessment** : Participatory Activities	Discussion 3 X 50			10%
13	Understand the concept of 1, 2 and 3 component phase equilibrium	Explain: phase equilibrium criteria, Gibbs phase rule, Clapeyron equation, Clasius Clapeyron equation, water phase diagram, CO_2 phase diagram, two component and three component systems.	**Criteria:** Participation, assignments **Form of Assessment** : Practical Assessment	Discussion and practice 3 X 50			5%

14	Understand the concept of 1, 2 and 3 component phase equilibrium	Explain: phase equilibrium criteria, Gibbs phase rule, Clapeyron equation, Clasius Clapeyron equation, water phase diagram, CO2 phase diagram, two component and three component systems.	**Criteria:** participation, tasks **Form of Assessment** : Participatory Activities, Practical Assessment	Discussion and practice, and 5 X 50 practicum			5%
15	Understand the concept of 1, 2 and 3 component phase equilibrium	Explain: phase equilibrium criteria, Gibbs phase rule, Clapeyron equation, Clasius Clapeyron equation, water phase diagram, CO2 phase diagram, two component and three component systems.	**Criteria:** Participation, assignments **Form of Assessment** : Participatory Activities	Discussion and practice 3 X 50		**Material:** phase equilibrium criteria, Gibbs phase rule, Clapeyron equation, Clasius Clapeyron equation, water phase diagram, CO2 phase diagram, two component and three component systems **References:** *Bibliography : Atkins, PW. 1996. Physical Chemistry. Oxford: ELBS Oxford University Press.*	10%
16	Covers meetings 9-15	Covers meetings 9-15	**Criteria:** Test **Form of Assessment** : Test	Written test 3 X 50			10%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	67.5%
2.	Practical Assessment	17.5%
3.	Test	20%
		100%

Notes

1. **Learning Outcomes of Study Program Graduates (PLO - Study Program)** are the abilities possessed by each Study Program graduate which are the internalization of attitudes, mastery of knowledge and skills according to the level of their study program obtained through the learning process.
2. **The PLO imposed on courses** are several learning outcomes of study program graduates (CPL-Study Program) which are used for the formation/development of a course consisting of aspects of attitude, general skills, special skills and knowledge.
3. **Program Objectives (PO)** are abilities that are specifically described from the PLO assigned to a course, and are specific to the study material or learning materials for that course.
4. **Subject Sub-PO (Sub-PO)** is a capability that is specifically described from the PO that can be measured or observed and is the final ability that is planned at each learning stage, and is specific to the learning material of the course.
5. **Indicators for assessing** ability in the process and student learning outcomes are specific and measurable statements that identify the ability or performance of student learning outcomes accompanied by evidence.
6. **Assessment Criteria** are benchmarks used as a measure or measure of learning achievement in assessments based on predetermined indicators. Assessment criteria are guidelines for assessors so that assessments are consistent and unbiased. Criteria can be quantitative or qualitative.
7. **Forms of assessment:** test and non-test.
8. **Forms of learning:** Lecture, Response, Tutorial, Seminar or equivalent, Practicum, Studio Practice, Workshop Practice, Field Practice, Research, Community Service and/or other equivalent forms of learning.
9. **Learning Methods:** Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
10. **Learning materials** are details or descriptions of study materials which can be presented in the form of several main points and sub-topics.
11. **The assessment weight** is the percentage of assessment of each sub-PO achievement whose size is proportional to the level of difficulty of achieving that sub-PO, and the total is 100%.
12. TM=Face to face, PT=Structured assignments, BM=Independent study.