DEVELOPMENT OF PHYSICAL CHEMICAL TEACHING MATERIALS USING TASK BASED LEARNING MODEL

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Abstrak

Physical Chemistry Teaching Materials are generally delivered using a one-way learning model, from lecturers to students. This causes student learning activities to be low so that student learning outcomes are not optimal. To maximize learning outcomes it is necessary to improve the quality of learning, by changing learning models into task-based learning. Changing the learning model requires changing the components of teaching materials according to the learning model that has been changed. Teaching material for Physical Chemistry in Chemistry Education Program PMIPA FKIP Sriwijaya University developed contains a collection of task assignments that must be carried out by students, both individuals and groups, in such a way that the series of physical chemistry learning is in the form of a series of work assignments that follow the cycle of independent work tasks, group work and group presentations, and so on. The development of the Physics Chemistry teaching material follows the ADDIE model.

Keywords: Teaching Materials of Physical Chemistry, Sriwijaya University, Task Based Learning Model

INTRODUCTION

Physics Chemistry is the name of a group of subjects in the Chemistry Education Department of the Mathematics and Natural Sciences Department of the Teaching and Education Faculty of Sriwijaya University (Compiler, 2017). Physics Chemistry consists of courses in Physical Chemistry, Solution Physics Chemistry, and Kinetics of Physical Chemistry. Physics Chemistry teaching materials have been using Physical Chemistry course material from Textbook. Some of the textbooks used include those compiled by Alberty, Atkins, Dogra, Sukardjo and other authors. Physics Chemistry lecture material contained in the textbook is mostly in the form of descriptions which are equipped with pictures, graphs and tables; which is interspersed with several examples of questions and ends with some final questions. Material description Physical chemistry explains about chemical cases in foreign countries, so that the physics chemistry course feels foreign, it feels that courses from abroad. In order for the courses to be closer to students, the courses should take advantage of things that are found in the country, even those around students. For example for students in South Sumatra in the discussion of Thermochemistry, discussing coal combustion. Coal is a very abundant material in South Sumatra.

In addition to the foregoing, the subject of physical chemistry is a subject that has very many theories, starting with the kinetic theory of gas, the mechanism of the reaction, and the decrease in formulas. Such material resulted in courses in Physical Chemistry including groups of courses that were difficult to digest, so most students said that the course in Physics Chemistry was a subject that was difficult to master.

In the study of physics chemistry courses, remembering is a subject that has very many theories, so it is generally delivered using a one-way learning model, from lecturers to students. Students listen to lecturers' explanations, material descriptions from lecturers, decrease in formulas from lecturers, and the like. This causes student learning activities to be low. Students are passive in college, so student learning outcomes are not optimal. This condition is no longer appropriate when considering the latest curriculum guidelines, namely the 2017 curriculum, which has the characteristics of student-centered learning.

Student-centered learning is learning that involves students fully in learning. In the initial activities, the core activities, until the final activities of students are functioned not as recipients of learning material, but functioned as individuals who need subject matter. Changing the function of students in this learning will result in a change in the whole component of learning. To maximize learning outcomes it is necessary to improve the quality of learning, by changing learning models into task-based learning. Changing the learning model requires changing the components of teaching materials used in physics chemistry courses according to the modified learning model. Thus to overcome the above obstacles, it is necessary to develop Physical Chemistry teaching materials.

Teaching material for Chemistry of Physics Chemistry Education Program PMIPA FKIP Sriwijaya University developed contains a collection of task assignments that must be carried out by students, both individuals and groups, in such a way that the series of physical chemistry learning is in the form of a series of work assignments that follow the cycle of independent work tasks, group work and group presentations, and so on.

Physics Chemistry teaching materials developed are teaching materials that have been given in lectures. The development of teaching materials is done by changing the way students get knowledge, understanding, ability to apply, analytical and synthesis skills, and creative abilities. If all this time learning has centered on the lecturer, so students accept it; then with student-centered learning, learning changes from accepting to looking for material by carrying out tasks given by lecturers.

METHODS

Development of Physical Chemistry teaching materials follows the ADDIE development model. The ADDIE model is a development model consisting of a series of stages A → D → D → I → E, where A (= Analysis), D (= Design), D (= Development), I (= Implementation), and E (= Evaluation) Analysis Phase (A); material analysis of lecture topics. Each topic is determined by the core of the material and analyzed what core material can be changed into what tasks, and tasks can be given according to the topic. Every minimal topic can be changed into one assignment title. All teaching material then changes to a number of Task titles. At this stage of the analysis, it is also possible to analyze the possibility of the title of a task title that can be merged. The number of assignments given by considering the suitability of the lecture time and the workload.

Design Stage (D); the preparation of tasks that have been set for each topic. The task for students is designed to be individual and group assignments. In each assignment students carry out the task of collecting data, processing data, or communicating data obtained in the assignment. Considering the number of meetings 16 times, with the details of the first meeting orientation lectures, the 8th meeting of the midterm exam, and the

16th meeting of the final exams, the task-based physics teaching materials were arranged for 13 meetings.

Development Stage (D); The results of the next design phase are developed into a complete description of the task, which includes the title, objectives, tools and materials, procedures, form of work data, form of data analysis, and conclusions of the results of the task. In this Development phase the teaching material that was previously in the form of textbooks turned into a collection of tasks. The results of the implementation of the task can be in the form of formulas, laws or theories about Physical Chemistry. At the end of this development phase the task that has been compiled is tried by the drafting team. Implementation Stage (I); the application of tasks that have been developed in learning with a limited number of students, approximately 6 people. The limited number of students considers the ease of providing supporting facilities for carrying out tasks, observing, and facilitating anticipation of possible obstacles. Students involved in the implementation phase are students who have attended physics chemistry courses that use textbooks. In this application identified things that need to be improved. and Evaluation Stage (E); at this stage an evaluation of lecture material has been changed in the form of assignments. The evaluation is carried out aimed at assessing the perfection of the teaching material that has been made. If the evaluation results show things that are not good, then it will be improved.

RESULTS AND DISCUSSION

Teaching material from the topic of Gas situation equality can be made into 15 tasks. Thermodynamic Law I can be made 7 tasks, Thermochemistry 7 tasks, Law II and III Thermodynamics into 21 tasks, 11 Chemical Equilibrium tasks, and 16 phase balance equilibrium material. The results of the analysis of Chemical Physics teaching materials as shown in Table 1.

Table 1. Project Title in Physical Chemistry Teaching material

No.	Topic	Task	Title Task	ClassInto
1	Gas State Equation	1	Discussion Difference between Real and the Ideal Gas Gas	2; 3
		2	Preparation of Equation situation Ideal Gas	
		3	Pricing Constants Gas R	
		4	Determining Relationships Gas Pressure And Total Mol	
		5	Isobars, isotherms, and Isometric Ideal Gas	
		6	Discussion About Factors Compressibility Z	
		7	Preparation of Equation Circumstance Van Der Waals Gas	
		8	Discussion About Equations Gas Real	
		9	Discussion of Real Gas Isotherms And Van Der Waals Gas	
		10	Formulation of Van Der Waals Gas Critical Condition	
		11	Decreasing Legal Formulas for the State of Interest	
		12	Compressibility Factors As Reduced Pressure Function	
		13	Boyle Temperature Formulation	
		14	Use of Real Gas Situations for Determining the Mass of Real Gas Relative Molecules	
		15	Coefficient of thermal expansion and compressibility	
2	Laws of thermodynamics 1	16	Discussion of systems and environment, equality of conditions, state of functioning, changing circumstances, heat, work, one-step expansion work, two-step expansion work, reversible expansion, compression work,	4; 5
		17	Discussion concerning inner energy and the first law of thermodynamics	

		18	The decline in the energy formula in all as a function of temperature and volume	
		19	Discussion of Enthalpi and its changes	
		20	Formulation of Enthalpi as a function of temperature and pressure	
		21	Determination of the relationship of Cp with Cv	
		22	The Aplication of Thermodynamic law 1 to an Adjunct and Reversible Process	
3	Thermochemistry	23	Preparation Thermochemical equations	6; 7
		24	Definition of Enthalpi dissolution	
		25	Definition of Enthalpy reaction formation and combustion	
		26	Compilation of Hess's Law	
		27	Relationship of inner and enthalpy energy	
		28	Definition of bond enthalpy and bonding energy	
		29	Determining enthalpy of reaction in various temperatures	
4	Laws of Thermodynamics II and III	30	Discussion Understanding the karnot circumference process	9; 10
		31	Understanding of karnot heat engine efficiency	
		32	Discussion of cooling engine, heat pump karnot	
		33	Entropy formulation	
		34	Entropy as a function of temperature and volume	
		35	Entropy as a function of temperature and pressure	
		36	Entropy changes in various reversible processes	
		37	Entropy changes in irreversible processes	
		38	Mixing Entropy Ideal Gas	
		39	Entropy in Chemical Reactions	
		40	Formulation of the Second Law of Thermodynamics	
		41	Formulation of the Third Law of Thermodynamics	
		42	Standard entropy of solids at their melting point	
		43	The formulation of the standard entropy of solids at its boiling point	
		44	Entropy as the Process Spontanieus Criteria	
		45	Helmholtz free energy and gibbs free energy.	
		46	Free energy as a variable function of the system	
		47	Equation Gibbs - Helmholtz	
		48	Calculation of free energy chemical reactions	
		49	Free energy as process spontaneity criteria	
		50	Basic equations and maxwell relationships	
5	Chemical equilibrium	51	Formulation of chemical potential	11, 12, 13
		52	Chemical equilibrium criteria with chemical potential	
		53	Chemical potential in mixtures	
		54	The concepts of equilibrium constants	
		55	Equilibrium constants Kp, Kx, and Kc.	
		56	Calculation of equilibrium constant	
		57	Effect of temperature on the equilibrium constant	
		58	Heterogeneous equilibrium	
		59	Shifting equilibrium due to isobar temperature changes and because the pressure is isothermal	
		60	Adding inert gases in isochorically and isobars	
		61	Adding reactant gases	
6	Phase Equilibrium	62	Phase, components, degrees of freedom	14, 15
		63	Phase equilibrium criterion	
		64	Rule Gibbs Phase	
		65	Clapeyron equation	
		66	Equation clausius clapeyronIdealLever	
		67	two-component system of steam vapor	
		68	Lever rule	
		69	Temperature diagram composition of two-component	
		70	A Liquid two component steam system is not ideal	
		71	Liquid two component system	

		72	System two the immobilized component in the solid is mibble in liquid	
		73	Both components form compounds with a congruent melting point	
		74	Both components form compounds with an incongruent melting point	
		75	two components form a solid solution	
		76	Both components are in the liquid phase and partially in solid phase	
		77	Three-component system	

Given the number assignment analysis results is very much compared to the number of meetings available, then the task needs to be grouped into as many meetings. The number of lecture meetings is a maximum of 13 times plus 3 other meetings, the first is discussing lecture contracts, the eighth meeting of midterm exam and the sixteenth meeting of final exam. Task grouping is carried out on assignments whose teaching material is related. The task group was named in accordance with the original sub topic of teaching material. The assignment name for each meeting is shown in table 2 below.

Table 2. The name of the task group at each Physical Chemistry lecture meeting.

No.	Meeting of	Task No.	NameTask Group
1	Second	1-6	Ideal Gas Equation situation
2	Third	7-15	Real Gas Equation situation
3	Fourth	16-18	Inner Energy
4	Fifth	19-22	Enthalpy
5	Sixth	23-26	Enthalpi reaction
6	Seventh	27 - 29	Energy ties
7	Ninth	30 -40	Laws of Thermodynamics II
8	Tenth	41 - 50	Laws of Thermodynamics III
9	Eleventh	51 - 53	Chemical Potentials
10	Twelfth	54 - 57	Constants of Equilibrium
11	Thirteenth	58 - 61	Shift in equilibrium
12	Fourteenth	62 - 69	Phase Equilibrium Criteria
13	Fifteenth	70 - 77	Two system and three component

In the second development stage, Design, the preparation of tasks in each meeting becomes individual tasks and group assignments. The form of individual tasks is the task of reading, making individual summaries and communicating summaries. The form of group assignments is a discussion of relevant issues and preparing a discussion report. Physics Chemistry teaching materials for each meeting are organized into individual reading, individual summaries, material to be discussed and group discussion reports. Thus the Physics Chemistry Teaching Materials based on the task contains 13 task titles which also become the title of teaching material, where each task becomes the teaching material for each meeting, as shown in table 3 below.

Table 3. Arrangement of Physics Chemistry based teaching materials

Meeting to	Title teaching materials	Activity Forms
Second	Ideal Gas State Equations	Individual Reading: Differences in Real Gas and Ideal Gas, Ideal Gas State Equations, R Gas Constants, Gas Pressure Relations and Mol Amount, Isobar , isotherms, and Isometric Gas Ideal, compressibility factor Z. individual Summary: Different Gas Real and the Ideal Gas, Gas formula Ideal situation, constant R, formula P to n, charts isobars, isotherms, and Isometric Gas Ideal,formula Z. discussion material: Ideal Gas State Equations, graphs of Isobar, Isotherm, and

		Ideal Gas Isometric, Compressibility Factor Z. Group discussion report: about Ideal Gas State Equations, graphs of Isobar, Isotherm, and Ideal Gas Isometric, Compressibility Factor Z.
Third	Real Gas State Equations	Individual reading: State of Real Gas and Real Gas Vanity Equations, Van Der Waals Real and Gas Gas Isoterm, Van Der Waals Gas Critical Condition, Law of Relation, Compressibility Factor The Reduced Pressure Function, Boyle Temperature, Real Gas Equation For Determining Real Gas Relative Molecular Mass, Coefficient of thermal expansion and compressibility. Individual summary: Formula of Real Gas Equation, Gas Isoterm, Van Der Waals Gas Critical State, Related State Formula, Z Vs Pr, Tb, Mr vs. Real Gas Function, Alpha and Bheta Formula. Discussion material: Difference between real gas conditions, VD Waals gas, and ideal gas. Determination of mass relative gas with the equation of the gas state. Coefficient of expansion and compressibility. Group discussion reports: characteristics of real gas, vd waals, and ideal gas. The determination of Mr.
Fourth	Inner Energy	Individual Reading: Understanding System and Environment, equality of circumstances, state function, changing circumstances, heat, work, one-step expansion work, two-step expansion work, reversible expansion, compression work, Understanding of energy and first law of thermodynamics. Decreasing the energy formula in as a function of temperature and volume. Discussion of Enthalpi and its changes Individual Summaries: definition of system and environment, equality of conditions, function of state, changing circumstances, heat, work, one-step expansion work, two-step expansion work, reversible expansion, compression work, inner energy formula. energy formula in as a function of temperature and volume. Enthalpi formula. Discussion material: the first law of thermodynamics, energy in as a function of temperature and volume, Enthalpi and its changes Group discussion report: The first legal definition of thermodynamics, the energy formula as a function of temperature and volume, Enthalpi formula and its change.
Fifth	Enthalpi	Individual Reading : Understanding the thermochemical equation, the enthalpy of dissolution, formation and combustion reaction enthalpy Individual Summary: Equations thermochemical, Definition enthalpy of dissolution, the reaction enthalpy formation and combustion Materials Discussion: Application of thermochemical equation. Enthalpi dissolution calculation, Enthalpy reaction formation and combustion Group discussion report: thermochemical equation, Enthalpi,
Sixth	Reaction Enthalpi	Individual Reading: Hess's Law Compilation, Relationship between inner energy and enthalpy, Definition of bond enthalpy and bond energy, Individual Summary: Hess's law, Energy formula inner and enthalpy, Definition of bond enthalpy and bond energy, Determine the enthalpy of reaction at various temperatures. Discussion material: Hess's Law Preparation, Determine the enthalpy of reactions at various temperatures. Group discussion reports: Hess's law, enthalpy of reactions at various temperatures.
Seventh	Bonds Energy	Individual Reading: The relationship between inner and enthalpy energy, the definition of bond enthalpy and bonding energy. Determining the enthalpy of reaction in various temperatures. Individual Summaries: Relationship of inner and enthalpy energy. bond energy, enthalpy reaction at various temperatures Discussion Material: Relationship of inner and enthalpy energy, Definition of bond enthalpy and bonding energy, Determining the enthalpy of reaction at various temperatures Group discussion report: Relationship of inner and enthalpy energy, Definition of bond enthalpy and bonding energy, Determining the enthalpy of reaction in various temperature of the
Ninth	Laws Thermodynamics II	Individual reading: Understanding the karnot circumference process, Understanding the efficiency of the karnot heat engine, cooling engine, karnot heat pump, entropy formulation, Entropy as a function of temperature and volume, Entropy as a function of temperature and pressure, Entropy changes in various reversible processes , Entropy Mixing Ideal Gas, Entropy In Chemical

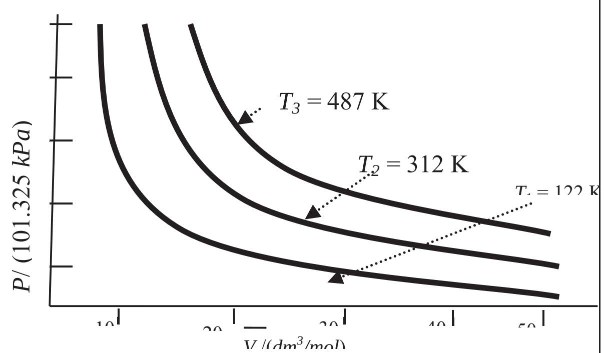
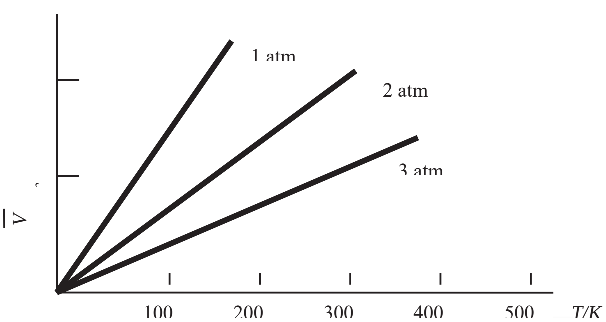
		Reactions, Formulation of Second Law of Thermodynamics Individual Summary: Definition of karnot circumference process, Understanding the efficiency of karnot heat engine, cooling engine, karnot heat pump, entropy formula, Entropy function of temperature and volume, Entropy function of temperature and pressure, Entropy in various reversible processes, Ideal Gas Mixing Entropy, Entropy in Chemical Reactions, Thermodynamic Second Law Discussion Material: Thermodynamic Second Law Formulation, Discussion Understanding the karnot circumference process, Discussion of cooling machines, entropy formulation, Group discussion report: Second Law of Thermodynamics, circumference process karnot, cooling machine, entropy,
Tenth	Laws of Thermodynamics III	Individual reading: Formulation of the Third Law of Thermodynamics, standard entropy of solids at their melting point, Standard entropy formulation of solids at their boiling point, Entropy as the process's spontaneous criteria, Helmholtz free energy and free energy of gibbs , Free energy as a function of variable system, Equation Gibbs - Helmholtz, Calculation of free energy chemical reactions, free energy as criteria for spontaneity of processes, Basic equations and Maxwell relationships, Individual summary: Third Law of Thermodynamics, Standard entropy of solids at their melting point, standard entropy of solids at their boiling point, Entropy as criteria for Freedom of Process, Helmholtz free energy and free energy of gibbs, Free energy as a variable system function, Equation of Gibbs - Helmholtz, free energy of chemical reactions, free energy as criteria for spontaneity of processes, Basic equations and Maxwell relations, Discussion material: Third Law of Thermodynamics, Helmholtz free energy and gibbs free energy, free energy as a variable system function Group discussion report: Third Law of Thermodynamics, Helmholtz free energy and free energy gibbs, Free energy as a variable system function
Eleventh	Chemical Potential	Individual reading: Chemical Potential Formulation, Chemical equilibrium criteria with chemical potential, chemical potential in the mixtures Individual summary: Chemical potential, Chemical equilibrium criteria with chemical potential, Chemical potential in mixtures Discussion material: Formulation of chemical potential, Chemical equilibrium criteria with chemical potential, Chemical potential in mixtures Group discussion report: Chemical potential formula, Chemical equilibrium criteria with chemical potential, Chemical potential in mixtures
Twelfth	Equilibrium Constant	Individual Readings: equilibrium constant concepts, Equilibrium Constants Kp, Kx, and Kc., Calculation of equilibrium constants, Effect of temperature on equilibrium constants. Individual Summary: Equilibrium constant, Kp, Kx, and Kc., Effect of temperature on equilibrium constants. Discussion material: Calculation of equilibrium constants, effect of temperature on equilibrium constants. Group discussion report: Calculation of equilibrium constants, effect of temperature on equilibrium constants.
Thirteenth	Shifting Equilibrium	Individual Readings: Heterogeneous Equilibrium, Shifting Equilibrium due to isobar temperature changes and because of isothermal pressure, Ischore and isobaric addition of inert gases, Addition of reactant gases Individual Summary: Heterogeneous Equilibrium, Shifting Equilibrium due to isobar temperature changes and arenas pressure isothermal, the addition of isocratic and isobar inert gases, Addition of reactant gas Discussion material: Shifting equilibrium due to isobar temperature changes and because of pressure isothermal, the addition of isocratic and isobar inert gas, Addition of reactant gas Group discussion report: Shifting Equilibrium due to changes and because the isobars temperature in isothermal pressure, the addition of isocratic and isobar inert gas, addition of reactant gas.
Fourteenth	Phase Equilibrium Criteria	Individual Readings: phase, components, degrees of freedom, Phase equilibrium criterion, Gibbs phase rule, clapeyron equation, equation of clausius clapeyron, ideal two-component liquid steam system, lever rule, temperature diagram of two-component system composition. Individual Summary: Phase, component, degree of freedom, Phase equilibrium criterion, Gibbs Phase rule, clapeyron equation, equation of clausius clapeyron,

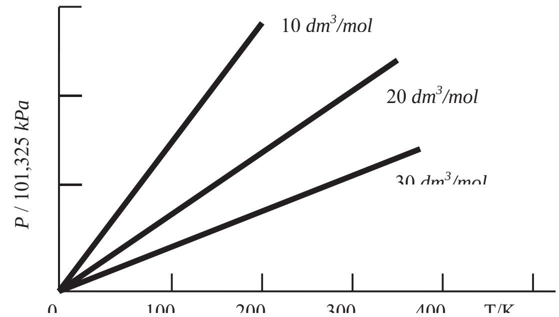
		ideal two-component liquid steam system, lever rule, temperature diagram of two-component system composition. Discussion material: Clapeyron equation, the clausius clapeyron equation, ideal two-component liquid steam system, the lever rule, temperature diagram of two-component system composition. Group discussion report: Clapeyron equation, the clausius clapeyron equation, ideal two-component liquid steam system, lever rule, temperature diagram of two-component system composition.
Fifteenth	Two And Three Compone nts Systems	Individual reading: The two-component liquid vapor system is not, liquid two-component liquid system, the two miscible component systems in solid are miscible in liquid, Both components form compounds with a congruent melting point, the two components form compounds with points incongruent melting, Both components form a solid solution. The two components are in the liquid phase and the partial in solid phase, three-component system Individual summary: The two-component liquid vapor system is not ideal, liquid two-component liquid system, the two miscible component systems in solid are miscible in liquid, Both components form compounds with a congruent melting point, the two components form compounds with an incongruent melting point, the two components form a solid solution, the two components are in the liquid phase and the partial in solid phase, three-component system Discussion material: liquid two-component steam system not ideal, a liquid two-component liquid system, the two miscible component systems in solid are miscible in liquid, Both components form compounds with a congruent melting point, the two components form compounds with an incongruent melting point, the two components form a solid solution, the two components are in the liquid phase and partially in solid phase, three-component system Group discussion reports: The two-component liquid vapor system is not ideal, the liquid two-component system is liquid, , the two miscible component systems in solid are miscible in liquid, both components form compounds with a congruent melting point, the two components form compounds with an incongruent melting point, the two components form a solid solution, the two components in the liquid phase and partially in the solid phase, three-component system

In the Third Development stage, Development, the new design results in the form of a title are developed by adding material description. As an example of the results of material development, the material developed for the second meeting, as shown in table 4 below. In Table 4, the student is initially shown reading assignments. Teaching materials which were originally used as lecturers' teaching materials were changed to student reading material. Students then get the task of summarizing the results of readings that have been read. The task of reading and summarizing this is an individual task carried out before the lecture meeting. During college students get the task of carrying out discussions.

Table 4. Results of Development of material for the meeting of both courses Physical Chemistry

Task Group	Material Task	Description Material Task
Individual reading:	Difference between Real Gas and Ideal Gas,	Read Description of Gas, description of ideal gas characteristics of real gas, description of differences ideal gas with real gas.
	Ideal Gas State Equations	Read the description of the factors that affect the ideal Gas state, and a description of how the ideal gas state equation is formulated.
	Gas R Constants	Read the description of the formulation of a gas constant R
	Relation of Gas Pressure and Number of Moles	Study the formula drop from the equation of the gas state equation to the relationship formula of Gas Pressure and Number of Moles of
	Isobar, Isotherm,	Read the description and note the description of the Isobar chart,

	and Ideal Gas Isometric,	isotherm , and isometric
	Compressibility Factor Z.	Study the description of compressibility factors
Individual summary:	Real gas and Ideal Gas Differences,	Real gas properties and ideal gas properties: Ideal gas not gas encountered in everyday life, while real gas is gas found in everyday life. The ideal gas is assumed to have properties: Gas molecules have no volume, and between the gas molecules there is no interaction, both attractive and resisting.
	Ideal Gas state formula,	the formula Ideal Gas state PV = nRT
	Constant R,	Large and unit R $\lim_{P \to 0} \frac{PV}{nT} = R$ constant (R) of 0.08205 L atm mol-1 K -1. In international units (SI) theconstant R is 8.314 m3 Pa mol-1 K-1 .
	Formula P to n,	Formula $\frac{\rho}{P} = \frac{M}{RT} - \frac{Mb}{(RT)^2} P$
	graphs of Isobar, Isotherm, and Ideal Gas Isometric,	 Isotherm of ideal gas  Graph of the Ideal Gas Isobar

		 Graph of the Ideal Gas Isochore
material:	Ideal Gas State Equation	Discuss how the process of finding ideal gas equation
	graphs Isobar, Isoterm, and Ideal Gas Isometric	Discuss graph isobar, isotherm and isochor of ideal gas
	Compressibility Factor Z	Determine the process of finding compressibility factor Z
Group discussion report:	Ideal Gas State Equation,,	Concluded ideal gas state equation
	graphs of Isobar, Isotherm, and Ideal Gas Isometric	Concluded of isobar, isotherm, and isometric
	Compressibility factors Z .	Concluded compressibility factors Z

Furtherat this stage of development of teaching material to four, Implementation,teaching materials have been developed to try to students in limited quantities, as many as six people.

The last development phase was evaluated. Teaching materials that have been used are seen, assessed the level of effectiveness. The effectiveness level is concluded from (1) the value of student learning outcomes, (2) learning observations by observers, and (3) satisfaction questionnaires that have been filled by students using developed teaching materials.

CONCLUSIONS AND SUGGESTIONS

Based on the results and discussion above, it can be concluded that the development of Physics Chemistry teaching materials that originally used a learning approach centered on the lecturer into teaching materials that use a student-centered learning approach.

Based on the conclusions above it is recommended to change the teaching material of other subjects into lecture material that allows student-centered learning, for example by changing the lecture material in the form of textbooks into lecture material in the form of assignments.

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