SYLLABUS

Name of Course : Physical Chem II (*Chemical Kinetics)*
Code Number : *KI C–319*
Credit : *3 credits per semester*
Semester : *IV / V*
Study Program : *Chemistry Ed. / Chemistry*

LECTURER:

Drs. Jaslin Ikhsan, M.App.Sc, Ph.D.
The Department of Chemistry Education,
The Faculty of Mathematics and Natural Sciences
Yogyakarta State University

2013

KIC 319, Physical Chemistry II (Chemical Kinetics: CheKin, 3 sks, semester IV and V)

This course studies Chemical kinetics with **learning materials** of (1) Kinetic Theory of Gas, (2) Chemical Rate, and (Transporting Molecules). The **chosen methods** for student learning and teaching are *reasoning* and *problem solving*, *cooperation*, and *experimentation*. The **interaction** will be the important part of learning that is most emerged in most 16 times of face-to-face lectures.

Delivery system in this course is a kind of ***hybrid learning***, e.i a mixture between face-to-face lecture and online lecture using learning management system (LMS) of edmodo.com. edmodo.com will be most the media of online interaction in which the materials are uploaded, the assignments are given, the online discussions are carried out, the online observations from students' parents can be conducted, and the results/achievements of students are saved and displayed. Online discussion (conference) is sometimes carried out using skype or fb-video-chat when it is expected by students.

References that are used in this lecture mainly are Physical Chemistry textbooks and their translation such as the book written by Atkins, as well as chemical kinetics textbook such as the one written by Laidler.

1. Identity of Course

- Name of Course : Chemical Kinetics
- Code Number : KI C–319
- Credit : 3 credits per semester
- Semester : IV / V
- Course Group : Physical Chemistry
- Study Program : Chemistry Ed. / Chemistry
- Course Status : Compulsory
- Pre-requisite Course : Physical Chemistry I (Thermodynamic)

2. Objectives

The objective of this lecture is to develop chemistry skills of students, especially dealing with Chemical Kinetics. By learning Chemical Kinetics, students will implement the concepts of those kinetics to daily life phenomena and industrial processes purposes.

3. Content Description

This course is part of physical chemistry discussing chemical kinetics or dynamics. Chemical dynamic or kinetics is due to the movement of molecules both gas and solute with certain reaction mechanisms. This course includes: kinetic theory of gas, chemical kinetics, and transport of gas and solute.

The kinetic theory will discuss:

- the Gas Pressure,
- Translational Kinetic Energy,
- Root Mean Square Speed, Average Speed, Most probable Speed,

- Maxwell Boltzmann Distribution,
- Collision Frequency (number of collisions per molecule),
- Collision rate (total number of collisions),
- Mean Free Path (distance traveled between collisions).

Chemical Rate includes:

- Rate,
- Order,
- Rate law,
- Rate constant,
- Half-life,
- Temperature Dependence,
- Molecularity,
- Elementary (Elementary Consecutive Reactions, Rate Determining Steps, Pre-equilibrium Reaction),
- Reaction Mechanisms,
- Steady-state Approximation,
- Mechanism of Enzyme Reaction (Michaelis-Menten Mechanisms,
- Unimoleculer Reactions (Lindemann-Hinshelwood Mechanisms).

Transporting molecules will discuss mainly on:

- Conductivity of electrolyte solutions (Strong and weak electrolyte),
- Ion Mobility (Ion mobility, Conductivity, Transport number),
- Transport numbers,
- Diffusion.

4. Learning Strategy

- Methods : reasoning and problem solving, cooperative, independent assignment
- Assignment : independent through online with LMS for enrichments
- Media : infocus, materials resources (ppt/pdf, video, digibook, LMS edmodo, online video chat, website).

5. Evaluation

- Independent and group assignment
- Face-to-face and online activities
- Mid-term test
- Post-test (final exam)

6. Learning material for each meeting of lecture

Meeting		Learning Materials
1	:	Introduction/Orientation
2	:	Gas Pressure, root mean square speed, , average speed, most possible speed,
3	:	Maxwell Distribution (M-B) of Molecule speed
4	:	M-B to derive the equations of the speeds
5	:	Collision parameters, and collision number
6	:	Collision frequency and mean free path

Meeting		Learning Materials
7	:	Rate, Reaction Order, Rate Law, Rate constants, Half Life
8	:	Temperature Dependence, Rate on Reaction approaching the equilibrium
9	:	Rate on Elementary Reactions: Elementary Consecutive Reactions, RDS, Pre-equilibrium
10	:	Steady-state Approximation
11	:	Reaction Mechanism: Michaelis Mentan, Lindemann-Hinshelwood
12	:	Transport of Gas: Diffusion, and Thermal Conductivity,
13	:	Transport of Gas: viscosity and exercise
14	:	Transport of Ion: Conductivity of electrolyte solutions (strong and weak electrolyte)
15	:	Ion Mobility: Ion mobility and conductivity, Transport number
16	:	Conductivity, Transport numbers, Diffusion

7. References

- P.W. Atkins, Physical Chemistry, Oxford University Press
- P.W. Atkins, Kimia Fisika, Jilid 2 (terjemahan), Erlangga, Jakarta.
- Ira N. Levine, Physical Chemistry, McGraw-Hill.
- Keith J. Laidler, Chemical Kinetics, HarperCollins Publishers.

LEARNING MATERIALS

MEETING 1 - 16

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COLLECTION OF ASSIGNMENT QUESTIONS

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RENCANA PELAKSANAAN PEMBELAJARAN (1)

1. Fakultas/ Program Studi : MIPA/ Kimia

2. Mata Kuliah : Kimia Fisika II

3. Jumlah sks : Teori 3 sks

4. Semester dan Waktu : 5, 3 x 50 menit

5. Kompetensi Dasar :

Menurunkan rumus Distribusi Maxwell-Boltzmann dan memanfaatkannya untuk menghitung kecepatan rata, akar kuadrat kecepatan rata-rata, dan kecepatan yang paling paling mungkin.

6. Indikator Ketercapaian :

1) Mahasiswa dapat menurunkan rumus Maxwell-Boltzmann Distribution (M-B)
2) Mahasiswa dapat menghitung akar kuadrat kecepatan rata-rata kuadrat (v_{rms}) dengan M-B
3) Mahasiswa dapat menghitung kecepatan rata-rata (v_{avg}) dengan M-B
4) Mahasiswa dapat menjelaskan hubungan antara M-B dengan suhu dan kecepatan

7. Materi Pokok/Penggalan Materi : Konduktivitas Larutan Elektrolit

8. Kegiatan Perkuliahan :

Komponen Langkah	**Uraian Kegiatan**	**Estimasi Waktu**	**Metode**	**Media**	**Sumber Bahan/ Referensi**
Pendahuluan	**Apersepsi** tentang kecepatan v_{rms} dan tekana gas	10 menit	Tanya jawab	Papan Tulis	A
Penyajian (Inti)	**Penyampaian materi** tentang - distribusi maxwell-Boltzmann (M-B) - pentingnya distribusi maxwell-Boltzmann dalam	80 menit	Ceramah, diskusi informasi, Tanya jawab	LCD, labtop, papan tulis	A

	menghitung kecepatan Gas - Menurunkan persamaan distribusi maxwell-Boltzmann - Contoh soal keguanaan maxwell Botzmann dalam menentukan kecepatan - v_{rms} dg M-B - v_{avg} dg M-B **Diskusi kelompok kooperatif** **Presentasi kelompok** **Konfirmasi**				
Penutup	Kesimpulan	8 menit	Tanya jawab		A
Tindak Lanjut	Tugas PR	2 menit		Papan Tulis	A

9. Evaluasi

1) Calculate the most probable speed v_p, the mean speed v_{avg}, and the root-mean square speed v_{rms} for hydrogen molecules at 0 ^oC!
2) Using M-B, Derive the equation of M-B to calculate the mean speed of N_2 in air at 25 ^oC!
3) Using M-B, Derive the equation of M-B to calculate the root-mean square speed v_{rms} of N_2 in air at 25 ^oC!

4) Explain the effect of temperature on the distribution of the Maxwell speed that is cacuated using M-B equation!

Yogyakarta, 22 Maret 2012

Dosen,

Dr. Jaslin Ikhsan

NIP. 19680629 1903 03 1 001

RENCANA PELAKSANAAN PEMBELAJARAN (2)

1. Fakultas/ Program Studi : MIPA/ Kimia

2. Mata Kuliah : Kimia Fisika II

3. Jumlah sks : Teori 3 sks

4. Semester dan Waktu : 5, 2 x 50 menit

5. Kompetensi Dasar :

Menentukan tahap penentu laju dan laju reaksi dari persamaan reaksi dasar konsekutif menggunakan pendekatan tunak

6. Indikator Ketercapaian :

Mahasiswa dapat menjelaskan pengertian mobilitas ion

Mahasiswa dapat menghitung radius hidrodinamik berdasarkan nilai mobilitas ion

Mahasiswa dapat menjelaskan konduktivitas molar ion

Mahasiswa dapat menentukan konduktivitas molar pembatas berdasarkan nilai radius hidrodinamik

7. Materi Pokok/Penggalan Materi : Mobilitas Ion

8. Kegiatan Perkuliahan :

Komponen Langkah	**Uraian Kegiatan**	**Estimasi Waktu**	**Metode**	**Media**	**Sumber Bahan/Referensi**
Pendahuluan	**Apersepsi** laju reaksi dan mekanisme reaksi	10 menit	Tanya jawab	Papan Tulis	A
Penyajian (Inti)	**Penyampaian materi** tentang -Reaksi Dasar - Tahap Penentu Laju	80 menit	Ceramah, diskusi informasi, Tanya jawab	LCD, labtop, papan tulis	A

	- Pendekatan Keadaan Tunak **Diskusi kelompok kooperatif** **Presentasi kelompok** **Konfirmasi**				
Penutup	Kesimpulan	8 menit	Tanya jawab		A
Tindak Lanjut	Tugas PR	2 menit		Papan Tulis	A

9. Evaluasi

1)

Consider the reaction mechanism

$$A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} X + B$$

$$X \xrightarrow{k_2} C + D$$

(a) Write chemical rate equations for [A] and [X].

(b) Employing the steady-state approximation, show that an effective rate equation for [A] is

$$\frac{d[A]}{dt} = -k_{eff}[A][B].$$

(c) Give an expression for k_{eff} in terms of k_1, k_{-1}, k_2, and [B].

$$A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} X + B$$

$$X \xrightarrow{k_2} C + D$$

The mechanism for the decomposition of ozone into oxygen,

$$2\,O_3 = 3\,O_2$$

is stated to be as follows:

Step 1. $O_3 \rightarrow O_2 + O$, rate constant, k_1

Step 2. $O + O_2 \rightarrow O_3$, rate constant, k_2

Step 3. $O + O_3 \rightarrow 2\,O_2$, rate constant, k_3

The activation energies, in kilojoules per mole, for each of the steps are as follows:

Step 1, $E_{act} = 103$ kJ/mole

Step 2, $E_{act} = 0$

Step 3, $E_{act} = 21$ kJ/mole

(a) Obtain the differential equation for the steady state rate of decomposition of ozone, $-d[O_3]/dt$, in terms of the constants, k_1, k_2 and k_3, the concentration of ozone, $[O_3]$, and the concentration of oxygen, $[O_2]$.

(b) On the basis of the values of E_{act} given above, simplify the expression for $-d[O_3]/dt$ obtained in (a) by eliminating any terms which can become negligible. State clearly the basis for the simplification.

(c) Calculate the energy of activation for the overall reaction.

$$2\,O_3 \longrightarrow 3\,O_2$$

slow $O_3 \xrightarrow{k_1} O_2 + O$ $E_1 = 103$ kJ/mole

fast $O + O_2 \xrightarrow{k_2} O_3$ $E_2 = 0$

fast $O + O_3 \xrightarrow{k_3} 2\,O_2$ $E_3 = 21$ kJ/mole

Yogyakarta, 22 Maret 2012

Dosen,

Dr. Jasin Ikhsan

NIP. 196806291993031001

BAHAN DISKUSI KELOMPOK PEMBELAJARAN siklus 1

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3) Using M-B, Derive the equation of M-B to calculate the root-mean square speed v_{rms} of N_2 in air at 25 ^oC!
4) Explain the effect of temperature on the distribution of the Maxwell speed that is cacuated using M-B equation!

BAHAN DISKUSI KELOMPOK PEMBELAJARAN siklus 2

Consider the reaction mechanism

$$A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} X + B$$

$$X \xrightarrow{k_2} C + D$$

(a) Write chemical rate equations for [A] and [X].

(b) Employing the steady-state approximation, show that an effective rate equation for [A] is

$$\frac{d[A]}{dt} = -k_{eff}[A][B].$$

(c) Give an expression for k_{eff} in terms of k_1, k_{-1}, k_2, and [B].

$$A + B \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} X + B$$

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