

# Virtual University of Pakistan

## Che201

### Physical chemistry

#### Final past papers

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Che201 final term past papers:

MCQs

1. **Thermodynamics** is the study of heat.
2. Two systems in thermal equilibrium with each other have the **same temperature**.

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3. Two systems that are each found to be in thermal equilibrium with a third system will be found to be in thermal equilibrium with each other. is called **Zerth law of thermodynamics**
4. The quantitative study and measurement of heat and enthalpy changes is known as **thermochemistry**.
5. The measurement of  $q$  or  $\Delta H$  is generally known as **Calorimetry**
6. Example of a irreversible process is **Heat transfer**
7. The oxidation of gold is **Nonspontaneous Processes**
8. **The reaction quotient Q** is a measure of the relative amounts of products and reactants present in a reaction at a given time.
9. **Gibbs Helmholtz** demonstrate that the free energy, not heat production, was the driver of spontaneous change in isothermal chemical reactions.
10. The **molarity (M)** of a solution is used to represent the amount of moles of solute per liter of the solution.
11. **Foams** are liquids or solids with a gas dispersed into them.
12. The interactions between the solute particles and the solvent molecules is called **solvation**
13. **Dissolution**, the solute separates into ions or molecules, and each ion or molecule is surrounded by molecules of solvent.
14. Chemical kinetics is the measurement **of how quickly reactions occur**.
15. The fractionating column is packed with glass beads (or something similar) to give the **maximum possible surface area** for vapor to condense on.
16. The continuous flow assay offers a high degree of accuracy by allowing what amounts to a large number of readings **at each time point**,
17. **The initial rate of reaction** is the rate at which the reagents are first brought together
18. Relaxation method: Many chemical reactions are complete in less than a few seconds, which makes the rate of reaction difficult to determine. In these cases, the relaxation methods can be used to determine the **rate of the reaction**
19. Although a balanced chemical equation for a reaction describes the **quantitative** relationships between the amounts of reactants present and the amounts of products that can be formed,
20. A first-order reaction is a reaction that proceeds at a rate that depends linearly on only one **reactant concentration**
21. In **Third Order Reaction**, the minimum number of molecules necessary for the reaction to take place is three.
22. Third order reaction does not depend on **Product concentration**.
23. The activation energy is the threshold energy that the reactant(s) **must acquire before reaching the transition state**
24. The kinetic energy of a molecule is proportional to the **velocity of the molecule**.
25. Once started, chain reactions continue until the **reactants are exhausted**
26. A mixture of hydrogen and chlorine will not react at all **in the dark**
27. the **concentrations of the different reactants** will generally fall at different rates, depending on the stoichiometry.

28. Chain reactions usually consist of many repeating **elementary steps**, each of which has a chain carrier.
29. Whether you use the differential rate laws or the integrated laws, you have to **evaluate the order first**.
30. The classical examples of such reactions are two of the fastest ones ever observed, the **dissociation of water**

### Short Questions:

1. Effect of the catalyst on the energy of activation 2 (Topic 101,115)
2. Pseudo first order reaction 2 (Topic 105)
3. Define solubility 2 (Topic 77)
4. Elementary steps for the reaction mechanism 3 (Topic 126-127)
5. Properties of colloids 3 (Topic 76)
6. Mechanism of stopped flow 3 (Topic 145)

### Long Questions:

- Azeotropes 5 (Topic 83)
- What are the limitations of thermodynamics 5 (Topic 134-135)
- Define the half-life of reaction,
- Discuss half-life of 0, 1st and 2nd order reactions 10 (Topic 109-110-111-112)
- Factors that affect the reaction rate 10 (Topic 100-101)

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### Che201

Very easy tha.

- 1)effect of catalyst
- 2)pseudo first order reaction
- 3)properties of colloids
- 4)stopped flow method
- 5)elementary steps for reaction mechanism.
- 6)le chateliers principle
- 7)azeotrops

- 8) open, closed and isolated system  
9) half life reaction, zero, 1st and second order reaction.

### **che201**

- Define chemical system.  
Pseudo first order reaction.  
Effect of catalyst on activation energy.  
Limitations of thermodynamic reaction.  
What is half life? half life of zero first second order of reaction.  
Define closed isolated and open system.  
Colloid define.  
Azeotropes .  
Flow mechanism reaction.  
Le chateliers principal effect on temperature and pressure.

### **Che201**

- Gibbs free energy (2)  
Effect of catalyst on energy of activation (2)  
Pseudo first order reaction (2)  
Properties of colloids (3)  
Open, closed and isolated systems (3)  
Stopped flow method (3)  
Elementary steps for reaction mechanism (3)  
Limitations of thermodynamics (5)  
Le Châtelier's principle with effect of concentration, temperature and pressure (5) Azeotropes (5)  
Define half life and also discuss half lives of zero, first and second ordered reactions (10)

## **CHE201 Solved subjective for final terms by Nimra Imtiaz.**

### **Short Questions:**

1. Effect of the catalyst on the energy of activation 2 (Topic 101,115)

#### **Catalyst Effect**

#### **ANSWER.**

- A catalyst is a substance that participates in a chemical reaction and increases the reaction.

A catalyst provides a route by lowering the activation energy.

Suppose catalyzed activation energy is 25 KJ/mol.

The reaction is conducted at 293K

$$e^{-\frac{E_A}{RT}} = e^{-\frac{25000}{8.31 \times 293}}$$
$$= 3.47 \times 10^{-5}$$

2. Pseudo first order reaction 2 (Topic 105) Answer.

To avoid more complicated, expensive experiments and calculations, we can use the pseudo first order reaction, which involves treating a second order reaction like a first order reaction.

The functional form of the decay kinetics is similar to the first order kinetics and the system is said to operate under pseudo first order kinetics.

3. Define solubility 2 (Topic 77) Answer.

- The solubility of a solution is a measure of how much of the solute can be dissolved into the solvent.  
Each solvent and solute pair has a characteristic solubility at a given temperature. Usually as you increase the temperature, an increased amount of solute will be able to dissolve.

4. Elementary steps for the reaction mechanism 3 (Topic 126-127)  
Answer.

A mechanism for a reaction is a collection of elementary processes (also called elementary steps or elementary reactions) that explains how the overall reaction proceeds.

**Elementary Processes or Steps:**

- An elementary process is also called an elementary step or elementary reaction.
- It expresses how molecules or ions actually react with each other.
- The equation in an elementary step represents the reaction at the molecular level, not the overall reaction.
- Based on numbers of molecules involved in the elementary step, there are three kinds of elementary steps:
- Unimolecular step (or process),
- Bimolecular step, • Trimolecular step.

**1. Unimolecular Step**

- When a molecule or ion decomposes by itself, such an elementary step is called a unimolecular step (or process).
- A unimolecular step is always a first order reaction.
- $O_3 \rightarrow O_2 + O$ , Rate =  $k[O_3]$

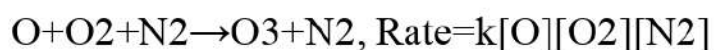
**2. Bimolecular Step (process):**

- A bimolecular process involves two reacting molecules or ions.

- The rates for these steps are 2nd order, and some examples are given to illustrate how you should give the rate expression.
- The simulation illustrates a bimolecular process.
- Examples:
- $\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$ ,  $\text{Rate} = k[\text{NO}][\text{O}_3]$

### 3. Trimolecular Step (process):

- A trimolecular process involves the collision of three molecules.  
For example:



### 5. Properties of colloids 3 (Topic 76)

#### ANSWER

- The particles of dispersant are the between about 500 nm to 1 nm in diameter.
- The mixture does not separate on standing in a standard gravity condition. (One 'g.')
- The mixture does not separate by common fiber filter, but might be filterable by materials with a smaller mesh.
- The mixture is not necessarily completely homogeneous, but usually close to being so.
- The mixture may appear cloudy or almost totally transparent, but if you shine a light beam through it, the pathway of the light is visible from any angle. This scattering of light is called the Tyndall effect

- There usually is not a definite, sharp saturation point at which no more dispersant can be taken by the dispersing agent.
- The dispersant can be coagulated, or separated by clumping the dispersant particles with heat or an increase in the concentration of ionic particles in solution into the mixture.
- There is usually only small effect of any of the colligative properties due to the dispersant.

#### 6. Mechanism of stopped flow 3 (Topic 145)

- In some cases, it is often practical to quench (stop) the reaction after a desired interval by adding an appropriate quenching agent.

The mechanism used is known as stopped flow mechanism.

The basic stopped flow apparatus consists of two or more coupled syringes that rapidly inject the reactants into a small mixing chamber and then through an observation cell that can be coupled to instruments that measure absorption, fluorescence, light scattering, or other optical or electrical properties of the solution.

#### Long Questions:

Azeotropes 5 (Topic 83)

ANSWER.

#### **Azeotropes:**

- An azeotrope is a mixture that exhibits the same concentration in the vapor phase and the liquid phase.

- This is in contrast to ideal solutions with one component typically more volatile than the other; this is the reason we use distillation to separate materials.
- If the mixture forms an azeotrope, the vapor and the liquid concentrations are the same, which preventing separation via this approach.
- Azeotropes are a mixture of at least two different liquids.
- Their mixture can either have a higher boiling point than either of the components or they can have a lower boiling point.
- Azeotropes occur when fraction of the liquids cannot be altered by distillation.
- Typically when dealing with mixtures, components can be extracted out of solutions by means of Fractional Distillation, or essentially repeated distillation in stages (hence the idea of 'fractional').
- The more volatile component tends to vaporize and is collected separately while the least volatile component remains in the distillation container and ultimately, the result is two pure, separate solutions.

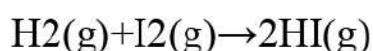
What are the limitations of thermodynamics 5 (Topic 134-135)

ANSWER.

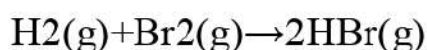
- Three reactions that look alike, but are different:

Consider, for example, the gas-phase formation reactions of the hydrogen halides from the elements.

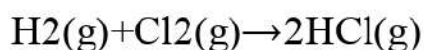
The thermodynamics of these reactions are all similar (they are all highly exothermic), but their dynamics (their kinetics and mechanisms) could not be more different.



Careful experiments, carried out over many years, are consistent with the simplest imaginable mechanism: a collision between the two reactant molecules results in a rearrangement of the bonds.



- One might be tempted to suppose that this would proceed in a similar way, but experiments reveal that the mechanism of this reaction is far more complex.
- The reaction takes place in a succession of steps, some of which involve atomic H and Br.



- The mechanism of this reaction is different again.
- Although the first two reactions reach equilibrium in minutes to an hour or so at temperatures of 300 to 600 K, a mixture of hydrogen and chlorine will not react at all in the dark, but if you shine a light on the mixture, it goes off with a bang as the instantaneous reaction releases heat and expands the gas explosively.

- What is particularly noteworthy is that these striking differences cannot be reliably predicted from theory; they were revealed only by experimentation.
- 

- It is worth noting that the concept of "time" plays no role whatsoever in thermodynamics. But kinetics is all about time.
- The "speed" of a reaction (how long it takes to reach equilibrium) bears no relation at all to how spontaneous it is (as given by the sign and value of  $\Delta G^\circ$ ) or whether it is exothermic or endothermic (given by the sign of  $\Delta H^\circ$ ).
- Moreover, there is no way that reaction rates can be predicted in advance; each reaction must be studied individually.

The stoichiometric equation for the reaction says nothing about its mechanism:

- The term "mechanism" refers to, "who does what to whom". •
- 

Define the half life of reaction, Discuss half life of 0, 1st and 2nd order reactions 10 (Topic 109-110-111-112)

ANSWER.

### **Half lives of Reactions:**

- The half life of a reaction,  $t_{1/2}$ , is the amount of time needed for a reactant concentration to decrease by half compared to its initial concentration.

- The half-life ( $t_{1/2}$ ) is a timescale on which the initial population is decreased by half of its original value.

### **Half Life of zero Order Reactions:**

- In zero order reactions/kinetics, the rate of a reaction does not depend on the substrate concentration.
- In other words, saturating the amount of substrate does not speed up the rate of the reaction.
- Below is a graph of time (t) vs. concentration [A] in a zero order reaction, several observation can be made: the slope of this plot is a straight line with negative slope equal negative k, the half life of zero order reaction decrease as the concentration decrease.
- We learn that the zero order kinetic rate law is as followed, where [A] is the current concentration,  $[A]_0$  is the initial concentration, and k is the reaction constant and t is time:

$$[A] = [A]_0 - kt$$

- In order to find the half life we need to isolate  $t$  on its own, and divide it by 2.
- We would end up with a formula as such depict how long it takes for the initial concentration to dwindle by half:

$$t_{1/2} = \frac{[A]_0}{2k}$$

- The  $t_{1/2}$  formula for a zero order reaction suggests the half life depends on the amount of initial concentration and rate constant.

### Half Life of First Order Reactions:

In First order reactions, the graph represents the half life is different from zero order reaction in a way that the slope continually decreases as time progresses until it reaches zero.

- We can also easily see that the length of half life will be constant, independent of concentration.
- For example, it takes the same amount of time for the concentration to decrease from one point to another point.

- In order to solve the half life of first order reactions, we recall that the rate law of a first order reaction was:

$$[A] = [A_0]e^{-kt}$$

- To find the half life we need to isolate t and substitute [A] with  $[A]_0/2$ , we end up with an equation looking like this:

$$t_{1/2} = \frac{\ln 2}{k} \approx \frac{0.693}{k}$$

#### **Half Life of second Order Reactions:**

- Half life of second order reactions shows concentration [A] vs. time (t), which is similar to first order plots in that their slopes decrease to zero with time.
- However, second order reactions decrease at a much faster rate as the graph shows.
- We can also note that the length of half life increase while the concentration of substrate constantly decreases, unlike zero and first order reaction.

- In order to solve for half life of second order reactions we need to remember that the rate law of a second order reaction is:

$$\frac{1}{[A]} = \frac{1}{[A]_0} + kt$$

As in zero and first order reactions, we need to isolate T on its own:

Factors that affect the reaction rate 10

ANSWER.

### **Factors That Affect Reaction Rates 1:**

- Reactant concentrations, temperature, physical states and surface areas of reactants, and solvent and catalyst properties if either are present.

### **Concentration Effects:**

- Two substances cannot possibly react with each other unless their constituent particles (molecules, atoms, or ions) come into contact.
- If there is no contact, the reaction rate will be zero.