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08. Reaction Kinetics

Official PMDC Solved Past Paper Topical Booklet • High-Yield Examination Series

80 Solved Questions

2010 to 2024 Archive

Boards: BUMHS, DUHS, KMU, MDCAT, NUMS, PMDC

Weightage: 27% of MDCAT (54 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION**Q1.**

UHS 2024

Identify the correct formula to calculate rate of reaction: [UHS 2024]

- (A) Change in concentration of substance ÷ Time taken for the change
- (B) Time taken for the change ÷ Change in concentration of substance
- (C) Time taken for the change ÷ Change in concentration of substance × 100
- (D) Time taken for the change × Change in concentration of substance

Q2.

UHS 2024

Consider the hypothetical equation:



Which of the following represents correct rate equation? [UHS 2024]

- (A) Rate = $k[A][B]$
- (B) Rate = $k[A]^a[B]^b$
- (C) Rate = $k[A]^a$
- (D) Rate = $k[B]^2$

Q3.

UHS 2024

If a reaction rate does not change with concentration then it is? [UHS 2024]

- (A) 1st order
- (B) 2nd order
- (C) 3rd order
- (D) Zero order

Q4.

UHS 2024

Which of the following is CORRECT Arrhenius equation? [UHS 2024]

- (A) $K = Ae^{-E_a/QT}$
- (B) $K = Ae^{-E_a/RT}$
- (C) $K = Ae^{-E_a/ST}$
- (D) $K = Ae^{-E_a/UT}$

Q5.

SZABMU 2024

Which of the following is the unit of rate of reaction? [SZABMU 2024]

- (A) $\text{mol}^{-1}\text{dm}^3\text{s}^{-1}$
- (B) $\text{mol} \cdot \text{dm}^3\text{s}^{-1}$
- (C) $\text{mol} \cdot \text{dm}^{-3}\text{s}$
- (D) $\text{mol} \cdot \text{dm}^{-3}\text{s}^{-1}$

Q6.

SZABMU 2024

Consider a reaction of A into B, if K value is 3×10^{-12} at 200°C then what will be the value of K at 250°C ? [SZABMU 2024]

- (A) $9 \times 10^{-3} \text{ s}^{-1}$
- (B) $12 \times 10^{-3} \text{ s}^{-1}$
- (C) $6 \times 10^{-12} \text{ s}^{-1}$
- (D) $15 \times 10^{-12} \text{ s}^{-1}$

Q7.

SZABMU 2024

If half-life of a chemical reaction is 30 minutes, how much time is required for its 87.5% completion?

[SZABMU 2024]

- (A) 60 min
- (B) 120 min
- (C) 90 min
- (D) 30 min

Q8.

SZABMU 2024

The study of rates of chemical reactions and the factors that affect the rates of chemical reactions is known as: **[SZABMU 2024]**

- (A) Thermodynamics
- (B) Electrochemistry
- (C) Stoichiometry
- (D) Chemical kinetics

Q9.

SZABMU 2024

Decomposition of ammonia on heated tungsten is an example of: **[SZABMU-RC 2024]**

- (A) Pseudo first order reaction
- (B) First order reaction
- (C) Zero order reaction
- (D) Second order reaction

Q10.

KMU 2024

For a first order reaction $A \rightarrow B$, the rate constant is 0.0458 s^{-1} . Calculate rate of the reaction if the concentration of reactant is 0.35 mol dm^{-3} : **[ETEA 2024]**

- (A) $0.012 \text{ mol dm}^{-3} \text{ s}^{-1}$
- (B) $0.014 \text{ mol dm}^{-3} \text{ s}^{-1}$
- (C) $0.016 \text{ mol dm}^{-3} \text{ s}^{-1}$
- (D) $0.018 \text{ mol dm}^{-3} \text{ s}^{-1}$

Q11.

KMU 2024

A reaction is first order with respect to A and second order with respect to B, the rate equation is: **[ETEA 2024]**

- (A) $\text{Rate} = k[A]$
- (B) $\text{Rate} = k[A][B]$
- (C) $\text{Rate} = k[A]^2[B]$
- (D) $\text{Rate} = k[A][B]^2$

Q12.

DUHS 2024

The unit of rate constant for the first order reaction is: **[DUHS 2024]**

- (A) $\text{ConC} \cdot \text{s}^{-1}$
- (B) $\text{M}^2 \text{s}^{-1}$
- (C) s^{-1}
- (D) $\text{M}^{-1} \text{s}^{-1}$

Q13.

NUMS 2024

The formation of hydrogen gas can be increased by reacting which Zn sample with 1M HCl solution? **[NUMS 2024]**

- (A) 1g Zn Rod
- (B) 1g Zn Pallets
- (C) 1g Zn Ribbon
- (D) 1g Zn Powder

Q14.

UHS 2023

The rate of reaction between two specific time intervals is called? **[UHS 2023]**

- (A) Average rate of reaction
- (B) Instantaneous rate of reaction
- (C) Rate of reaction
- (D) Initial rate

Q15.

UHS 2023

How will be the rate of reaction, if the slope of the curve is greater near the start of the reaction? **[UHS 2023]**

- (A) Constant
- (B) Greater
- (C) Equilibrium
- (D) Lesser

Q16.

SZABMU 2023

The rate constant "k" in the rate equation is the rate of reaction when the concentration of each of the reactant is: **[SZABMU 2023]**

- (A) 3 M
- (B) 1 M
- (C) 2 M
- (D) 4 M

Q17.

SZABMU 2023

The rate of reaction: **[SZABMU 2023]**

- (A) Remains the same as the reaction proceeds
- (B) Increases as the reaction proceeds
- (C) Decreases as the reaction proceeds
- (D) Remains the same initially and then increases

Q18.

KMU 2023

Reaction that follows third order kinetics is: [ETEA 2023]

- (A) Decomposition of nitrogen dioxide
- (B) Decomposition of hydrogen iodide
- (C) Gas phase oxidation of nitric oxide
- (D) Formation of hydrogen iodide

Q19.

KMU 2023

As compared to exothermic reaction, formation of activated complex in endothermic reaction requires: [ETEA 2023]

- (A) Greater E_a
- (B) Smaller E_a
- (C) Equal E_a
- (D) No E_a

Q20.

DUHS 2023

What is the order of reaction if the unit of K is sec^{-1} ? [DUHS 2023]

- (A) One
- (B) Two
- (C) Three
- (D) Zero

Q21.

DUHS 2023

Which of the following best describes the ionic reactions of inorganic compounds? [DUHS 2023]

- (A) Moderate slow
- (B) Very fast
- (C) Very slow
- (D) Not occurs

Q22.

BUMHS 2023

In which method the rate of reaction involving ions can be studied? [BUMHS 2023]

- (A) Electrical conductivity method
- (B) Optical rotation method
- (C) Refractometric method
- (D) Spectrometry

Q23.

BUMHS 2023

Which order of reaction obeys the expression $t_{1/2} = \frac{1}{k_a}$? [BUMHS 2023]

- (A) Zero
- (B) First
- (C) Second
- (D) Third

Q24.

NUMS 2023

When temperature of reacting gases is raised by 10 K, reaction rate will increase to: [NUMS 2023]

- (A) Three times
- (B) Four times
- (C) Double
- (D) Five times

Q25.

NUMS 2023

The minimum amount of energy required by the colliding particles for effective collision is called: [NUMS 2023]

- (A) Lattice energy
- (B) Activation energy
- (C) Bond energy
- (D) Hydration energy

Q26.

NUMS 2023

When nitric oxide reacts with ozone, the order of reaction will be: [NUMS 2023]

- (A) 2nd
- (B) 3rd
- (C) 1st
- (D) Zero

Q27.

UHS 2022

What is the overall order of this rate equation? Rate = $k[\text{H}_2][\text{NO}_2]^2$ [UHS 2022]

- (A) 1
- (B) 3
- (C) 2
- (D) 4

Q28.

UHS 2022

The catalysis in which the catalyst and the reactants are in the same phase is known: [UHS 2022]

- (A) Heterogeneous catalysis
- (B) Homogeneous catalysis
- (C) Slow
- (D) Fast

Q29.

SZABMU 2022

What is incorrect about activated complex? [SZABMU 2022]

- (A) It is a high energy specie
- (B) It is a stable specie
- (C) It is an unstable specie
- (D) Potential energy is maximum at activated complex state

Q30.

SZABMU 2022

The unit of rate constant is the same as that of the rate of reaction in which of the following order of reaction: [SZABMU 2022]

- (A) Zero
- (B) Second
- (C) First
- (D) Third

Q31.

SZABMU 2022

If a reaction is first order with respect to a reactant then the rate will be if concentration of reactant is doubled: [SZABMU 2022]

- (A) Doubled
- (B) One fourth
- (C) Halved
- (D) Quadrupled

Q32.

KMU 2022

The unit of rate constant K is $\text{dm}^3 \text{mole}^{-1} \text{s}^{-1}$ for a chemical reaction, the order of reaction is: [ETEA 2022]

- (A) 1
- (B) 3
- (C) 0
- (D) 2

Q33.

KMU 2022

One mole of a reactant reacts with a rate of $0.6 \text{ mol dm}^{-3} \text{s}^{-1}$. What is the rate constant of this reaction if reaction is first order? [ETEA 2022]

- (A) 1 s^{-1}
- (B) 0.3 s^{-1}
- (C) 0.6 s^{-1}
- (D) 0.9 s^{-1}

Q34.

KMU 2022

The thermal decomposition of nitrogen pentaoxide in gaseous state follows. Which one of the following order of reaction? $\text{N}_2\text{O}_{5(g)} \xrightarrow{\text{heat}} \text{N}_2\text{O}_{4(g)} + \frac{1}{2}\text{O}_{2(g)}$ [ETEA 2022]

- (A) First order
- (B) Second order
- (C) Fractional order
- (D) Third order

Q35.

DUHS 2022

Rate of reaction increases by the addition of catalyst because: [DUHS 2022]

- (A) Catalyst reacts with reactant
- (B) Catalyst reacts with product
- (C) Energy of activation decreases
- (D) Energy of activation increases

Q36.

DUHS 2022

Reaction, $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$ is a: [DUHS 2022]

- (A) First order
- (B) Second order
- (C) Third order
- (D) Zero order

Q37.

BUMHS 2022

A solution which does not tend to varies in pH is called? [BMU 2022]

- (A) Acidic solution
- (B) Buffer solution
- (C) Bases Solution
- (D) Super saturated solution

Q38.

BUMHS 2022

What a catalyst work by? [BMU 2022]

- (A) Increasing the frequency of collisions
- (B) Increasing the proportion of particles with energy greater than the activation energy
- (C) Increasing the activation energy.
- (D) Increasing the concentration

Q39.

BUMHS 2022

Rate of reaction when the reactant's concentration is taken as unity is called? [BMU 2022]

- (A) Arrhenius constant
- (B) Specific rate constant
- (C) Ideal rate constant
- (D) Molecularity

Q40.

NUMS 2022

Rate of any reaction depends upon: [NUMS 2022]

- (A) Temperature
- (B) Rate constant
- (C) Pressure
- (D) Concentration

Q41.

NUMS 2022

What is "NOT TRUE" about rate of a reaction? [NUMS 2022]

- (A) Surface area of reactants affects rate of reaction
- (B) Catalyst affects rate of a reaction
- (C) Concentration of reactants does not affect the rate of a reaction
- (D) Concentration affects rate of reaction

Q42.

PMDC 2021

Catalyst can: [PMC 2021]

- (A) Increase rate of reaction
- (B) Decrease rate of reaction
- (C) Increase conc of product
- (D) Increase conc of reactant

Q43.

PMDC 2021

Energy required to start a reaction is called: [PMC 2021]

- (A) Ionization energy
- (B) Activation energy
- (C) Bond energy
- (D) Lattice energy

Q44.

PMDC 2021

Rate = $k[\text{NO}_2]$, the order of this reaction is: [PMC 2021]

- (A) Zero
- (B) Two
- (C) Three
- (D) One

Q45.

PMDC 2021

When rate of reaction is measured by the amount of radiation absorbed, it is called: [PMC 2021]

- (A) Optical rotation method
- (B) Refractometry method
- (C) Electrical conductivity method
- (D) Spectrometry

Q46.

PMDC 2020

The unit of the rate constant is the same as that of the rate of reaction in: [NMDCAT 2020]

- (A) Zero order reaction
- (B) Second order reaction
- (C) First order reaction
- (D) Third order reaction

Q47.

PMDC 2020

The study of rates of chemical reactions and the factors that affect the rates of chemical reactions is known as: [NMDCAT 2020]

- (A) Stoichiometry
- (B) Electrochemistry
- (C) Thermodynamics
- (D) Chemical kinetics

Q48.

PMDC 2020

For which reaction, $A_{(g)} \rightarrow \text{product}$ [NMDCAT 2020]
When the concentration of $A_{(g)}$ doubles, the rate of reaction increased four folds, which means it is:

- (A) Negative order of reaction
- (B) Zero order of reaction
- (C) 1st order reaction
- (D) 2nd order reaction

Q49.

PMDC 2020

For which of the following order of the reaction, rate of reaction is inversely proportional to the concentration reaction? [NMDCAT 2020]

- (A) 1st order reaction
- (B) 2nd order reaction
- (C) Negative order of reaction
- (D) Zero order of reaction

Q50.

MDCAT 2019

What is the measure of activation energy in an endothermic reaction? [MDCAT 2019]

- (A) The energy of activation of backward-backward reaction is same
- (B) The energy of activation of backward reaction is less than that of forward reaction
- (C) The energy of activation of backward reaction is more than that of forward reaction
- (D) The energy of activation of forward reaction is less than that of backward reaction

Q51.

NUMS 2019

If energy of activated complex is close to energy of reactants, it means that the reaction is: [NUMS 2019]

- (A) Slow
- (B) Moderate
- (C) Fast
- (D) Very slow

Q52.

MDCAT 2019

If the energy of activation of a chemical reaction is very low, the rate of that chemical reaction is observed to be very high because? [MDCAT 2019]

- (A) Concentration of the reactants becomes irrelevant
- (B) Reaction proceeds without any transition state
- (C) Molecules of the reactants move slowly
- (D) Number of efficient or fruitful collisions increase

Q53.

NUMS 2019

The influence of temperature on reaction rate is predicted by: [NUMS 2019]

- (A) Arrhenius equation
- (B) Free energy change
- (C) Wander Waal's equation
- (D) Kinetic equation

Q54.

SET 2019

For which change of temperature, the rate of reaction become approximately double: [SET 2019]

- (A) 10°C
- (B) 293K
- (C) 283K
- (D) 20°C

Q55.

NUMS 2019

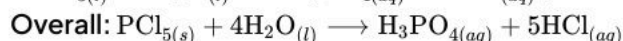
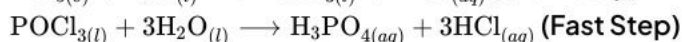
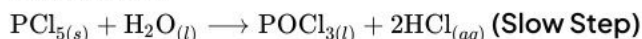
The unit of rate constant is same as that of rate of reaction in: [NUMS 2019]

- (A) Third order reaction
- (B) Zero order reaction
- (C) First order reaction
- (D) Second order reaction

Q56.

MDCAT 2019

The decomposition of phosphorus pentachloride in the presence of moisture takes place by the following mechanism,



The rate equation for this reaction will be: [MDCAT 2019]

- (A) Rate = $k[\text{PCl}_5][\text{H}_2\text{O}]^4$
- (B) Rate = $k[\text{POCl}_3][\text{H}_2\text{O}]^3$
- (C) Rate = $k[\text{PCl}_5][\text{H}_2\text{O}]$
- (D) Rate = $[\text{PCl}_5][\text{H}_2\text{O}]$

Q57.

SET 2019

Rates of photo-chemical reactions do not change with the change in concentration of reactants. What is the order of such reactions? [SET 2019]

- (A) Zero order reactions
- (B) First order reactions
- (C) Pseudo first order reactions
- (D) Second order reactions

Q58.

SET 2019

For the first order reaction, half-life is related to the expression $t_{1/2} = 0.693/k$. Half-life is the: [SET 2019]

- (A) Time taken for the concentration of the reactant to fall to half of its products value.
- (B) Time taken for the conc. of the product to the increase to half of its original value.
- (C) Time taken for the concentration of the reactant to fall to half of its original value
- (D) Time taken for the concentration of the reactant to fall to quarter of its original value

Q59.

KMU 2019

For exothermic reversible reaction activation energy for forward direction depends upon: [ETEA 2019]

- (A) Nature of product
- (B) Temperature
- (C) Nature of reactant
- (D) Both A and B

Q60.

MDCAT 2019

What is the measure of activation energy is an endothermic reaction? [MDCAT 2019]

- (A) The energy of activation of backward reaction is less than that of forward reaction
- (B) The energy of activation of forward-backward reaction is same
- (C) The energy of activation of backward reaction is more than that of forward reaction
- (D) The energy of activation of forward reaction is less than that of backward reaction

Q61.

MDCAT 2018

Role of a catalyst in a chemical reaction is to: [MDCAT 2018]

- (A) Increase rate of a reaction
- (B) Decrease yield of a reaction
- (C) Decrease rate of a reaction
- (D) Increase yield of product

Q62.

MDCAT 2018

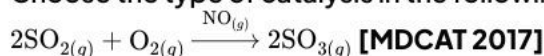
If concentration time graph of a reactant indicates a constant half-life, then the order reaction with respect the reactant is: [MDCAT 2018]

- (A) First order
- (B) Zero order
- (C) Second order
- (D) Half order

Q63.

MDCAT 2017

Choose the type of catalysis in the following reaction:



- (A) Homogeneous catalysis
- (B) Gas catalysis
- (C) Biological catalysis
- (D) Heterogeneous catalysis

Q64.

MDCAT 2017

Which one of the following graphs is representation for more rapid catalyzed reaction? [MDCAT 2017]

- (A) Graph showing a lowered activation energy path (solid line) compared to original higher path (dotted line)
- (B) Graph showing equilibrium shifted entirely to the right with no activation barrier
- (C) Graph showing a single high activation energy peak (uncatalyzed pathway)
- (D) Graph showing multiple consecutive high-energy intermediate peaks without lowering overall energy

Q65.

MDCAT 2017

Unit of K in first order Reaction is: [MDCAT 2017]

- (A) $\text{mol}^{-1} \text{dm}^3$
- (B) moles dm^{-3}
- (C) s^{-1}
- (D) $\text{moles dm}^{-3} \text{s}^{-1}$

Q66.

MDCAT 2017

Rate of first order reaction depends on: [MDCAT 2017]

- (A) Independence of the initial concentration
- (B) Concentration of one reactant
- (C) Concentration of two reactants
- (D) Concentration of three reactants

Q67.

MDCAT 2016

$2\text{A} + \text{B} \rightarrow \text{Product}$. If the reactant 'B' is in excess, the order of reaction with respect to 'A' in given rate law $\text{Rate} = k[\text{A}]^2[\text{B}]$ is: [MDCAT 2016]

- (A) 1st order reaction
- (B) Pseudo 1st order reaction
- (C) 2nd order reaction
- (D) 3rd order reaction

Q68.

MDCAT 2016

The rate constant 'k' is 0.693 min^{-1} . The half-life for the 1st order reaction will be: [MDCAT 2016]

- (A) 0.693 min
- (B) 1 min
- (C) 4 min
- (D) 2 min

Q69.

KMU 2016

Choose the one which is not the assumption of collision theory of reaction rate: [ETEA 2016]

- (A) For chemical reaction to occur molecule / particles must collide
- (B) Every collision is not productive
- (C) For reacting particles must possess a certain minimum amount of energy
- (D) For hydrogen molecule formation from atoms require specific orientation

Q70.

MDCAT 2015

The half-life of N_2O_5 at 45°C is 24 minutes. How long will it take for sample of N_2O_5 to decay to 25% of its original concentration? [MDCAT 2015]

- (A) 24 minutes
- (B) 48 minutes
- (C) 72 minutes
- (D) 120 minutes

Q71.

MDCAT 2015

When the change in concentration is $6 \times 10^{-4} \text{ mol dm}^{-3}$ and time for that change is 10 seconds, the rate of reaction will be? [MDCAT 2015]

- (A) $6 \times 10^{-3} \text{ mol dm}^{-3} \text{sec}^{-1}$
- (B) $6 \times 10^{-4} \text{ mol dm}^{-3} \text{sec}^{-1}$
- (C) $6 \times 10^{-2} \text{ mol dm}^{-3} \text{sec}^{-1}$
- (D) $6 \times 10^{-5} \text{ mol dm}^{-3} \text{sec}^{-1}$

Q72.

MDCAT 2014

For the reaction, $2\text{NO} + \text{O}_2 \rightleftharpoons 2\text{NO}_2$, the rate equation for the forward reaction is: [MDCAT 2014]

- (A) $\text{Rate} = k[\text{NO}][\text{O}_2]$
- (B) $\text{Rate} = k[\text{NO}_2]^2$
- (C) $\text{Rate} = k[\text{NO}_2]$
- (D) $\text{Rate} = k[\text{NO}]^2[\text{O}_2]$

Q73.

MDCAT 2014

If the reactants or product of a chemical reaction can absorb ultraviolet, visible or infra-red radiation then the rate of a chemical reaction can best be measured by: [MDCAT 2014]

- (A) Differential method
- (B) Graphical method
- (C) Spectrometry
- (D) Chemical method

Q74.

MDCAT 2013

In zero order reaction, the rate is independent of: [MDCAT 2013]

- (A) Concentration of the product
- (B) Temperature of the reaction
- (C) Surface area of the product
- (D) Concentration of the reactant

Q75.

MDCAT 2012

In some reactions a product formed acts as a catalyst. This phenomenon is called: [MDCAT 2012]

- (A) Negative catalysis
- (B) Autocatalysis
- (C) Heterogeneous catalysis
- (D) Activation of catalyst

Q76.

MDCAT 2012

The reaction rate in forward direction decreases with the passage of time because: [MDCAT 2012]

- (A) Concentration of product decreases
- (B) Temperature of the system changes
- (C) Concentration of reactants decreases
- (D) The order of reaction changes

Q77.

MDCAT 2011

According to the collision theory of bimolecular reactions in gas phase, minimum amount of energy required for an effective collision is known as: [MDCAT 2011]

- (A) Rate of reaction
- (B) Energy of activation
- (C) Heat of reaction
- (D) Has no effect on the reaction

Q78.

MDCAT 2011

It is experimentally found that catalyst is used to: [MDCAT 2011]

- (A) Increase the activation energy
- (B) Lower the activation energy
- (C) Decrease the temperature of other reactants
- (D) Lower the pH

Q79.

MDCAT 2010

Glucose is converted into ethanol by the enzyme present in the yeast: [MDCAT 2010]

- (A) Invertase
- (B) Sucrase
- (C) Zymase
- (D) Urease

Q80.

MDCAT 2010

The rate of reaction involving ions can be studied by which method? [MDCAT 2010]

- (A) Refractometric method
- (B) Electrical conductivity method
- (C) Optical rotation method
- (D) Dilatometric method

RAPID 5–COLUMN ANSWER KEY

Official PMDC verified answer keys for 08. Reaction Kinetics.

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Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	A	UHS 2024	17	C	SZABMU 2023	33	C	KMU 2022	49	C	PMDC 2020	65	C	MDCAT 2017
2	B	UHS 2024	18	C	KMU 2023	34	A	KMU 2022	50	B	MDCAT 2019	66	B	MDCAT 2017
3	D	UHS 2024	19	A	KMU 2023	35	C	DUHS 2022	51	C	NUMS 2019	67	C	MDCAT 2016
4	B	UHS 2024	20	A	DUHS 2023	36	D	DUHS 2022	52	D	MDCAT 2019	68	B	MDCAT 2016
5	D	SZABMU 2024	21	B	DUHS 2023	37	B	BUMHS 2022	53	A	NUMS 2019	69	D	KMU 2016
6	D	SZABMU 2024	22	A	BUMHS 2023	38	B	BUMHS 2022	54	A	SET 2019	70	B	MDCAT 2015
7	C	SZABMU 2024	23	C	BUMHS 2023	39	B	BUMHS 2022	55	B	NUMS 2019	71	D	MDCAT 2015
8	D	SZABMU 2024	24	C	NUMS 2023	40	A	NUMS 2022	56	C	MDCAT 2019	72	D	MDCAT 2014
9	C	SZABMU 2024	25	B	NUMS 2023	41	C	NUMS 2022	57	A	SET 2019	73	C	MDCAT 2014
10	C	KMU 2024	26	A	NUMS 2023	42	A	PMDC 2021	58	C	SET 2019	74	D	MDCAT 2013
11	D	KMU 2024	27	B	UHS 2022	43	B	PMDC 2021	59	C	KMU 2019	75	B	MDCAT 2012
12	C	DUHS 2024	28	B	UHS 2022	44	D	PMDC 2021	60	A	MDCAT 2019	76	C	MDCAT 2012
13	D	NUMS 2024	29	B	SZABMU 2022	45	D	PMDC 2021	61	A	MDCAT 2018	77	B	MDCAT 2011
14	A	UHS 2023	30	A	SZABMU 2022	46	A	PMDC 2020	62	A	MDCAT 2018	78	B	MDCAT 2011
15	B	UHS 2023	31	A	SZABMU 2022	47	D	PMDC 2020	63	A	MDCAT 2017	79	C	MDCAT 2010
16	B	SZABMU 2023	32	D	KMU 2022	48	D	PMDC 2020	64	A	MDCAT 2017	80	B	MDCAT 2010

TOTAL
MCQS
80

CORRECT

INCORRECT

BLANK

ACCURACY

%

Scan the booklet QR code to enter answers in
BeambePrep Grind Mode for automated error
 autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (A)

UHS 2024

Identify the correct formula to calculate rate of reaction: [UHS 2024]

CORE CONCEPT AND DERIVATION

The rate of a chemical reaction quantifies the speed at which reactants are consumed or products are formed.

Formula:

$$\text{Rate} = \pm \frac{\Delta C}{\Delta t}$$

Solution:

- Mathematically, a rate is always a change in a measurable quantity divided by the time it took for that change to occur.
- In chemistry, the quantity is the concentration of a substance.
- Therefore, the correct verbal formula is: **Change in concentration of substance ÷ Time taken for the change.**

Why other options are incorrect:

Dividing time by concentration gives an inverted unit ($\text{s dm}^3 \text{ mol}^{-1}$). Multiplying them yields a nonsensical unit of concentration-time.

Question #2 Key: (B)

UHS 2024

Consider the hypothetical equation: [Formula] Which of the following represents correct rate equation? [UHS 20...]

CORE CONCEPT AND DERIVATION

According to the classical Law of Mass Action (often assumed for theoretical elementary reactions unless experimental data dictates otherwise), the rate is proportional to the product of active masses of reactants raised to their stoichiometric coefficients.

Formula:

$$\text{Rate} = k[\text{Reactant 1}]^{\text{coef}_1}[\text{Reactant 2}]^{\text{coef}_2}$$

Solution:

- The reactants are A and B.
- Their respective stoichiometric coefficients in the balanced theoretical equation are a and b .
- Assuming an elementary reaction profile, the coefficients become the exponents in the theoretical rate law.
- Thus, the theoretically represented rate equation is:
 $\text{Rate} = k[\text{A}]^a[\text{B}]^b$.

Why other options are incorrect:

Option A assumes all coefficients are 1. Options C and D ignore one of the reactants entirely.

Question #3 Key: (D)

UHS 2024

If a reaction rate does not change with concentration then it is?
[UHS 2024]

CORE CONCEPT AND DERIVATION

The mathematical dependence of the reaction speed on reactant concentration defines its kinetic order.

Formula:

$$\text{Rate} = k[\text{Reactant}]^0 = k(1) = k$$

Solution:

- When a reaction rate is entirely independent of the reactant concentration, it means changing the concentration has zero effect on the speed.
- Mathematically, this corresponds to the concentration term being raised to the power of zero.
- Because anything raised to the power of zero is 1, the rate stays locked at the constant value k .
- This is the absolute definition of a **zero order** reaction.

Why other options are incorrect:

In 1st, 2nd, and 3rd order reactions, the rate directly scales (linearly, quadratically, or cubically) with changes in concentration.

Question #4 Key: (B)

UHS 2024

Which of the following is CORRECT Arrhenius equation? [UHS 2024]

CORE CONCEPT AND DERIVATION

The Arrhenius equation mathematically models how the rate constant of a chemical reaction varies with absolute temperature and activation energy.

Formula:

$$k = Ae^{-E_a/RT}$$

Solution:

- k is the rate constant.
- A is the Arrhenius pre-exponential factor (frequency of collisions).
- E_a is the activation energy.
- e is the mathematical base of natural logarithms.
- **R is the universal gas constant.**
- T is the absolute temperature in Kelvin.
- Therefore, the correct constant in the denominator of the exponent is R .

Why other options are incorrect:

The variables Q , S , and U do not represent the universal gas constant in standard thermodynamic or kinetic formulas.

Question #5 Key: (D)

SZABMU 2024

Which of the following is the unit of rate of reaction? [SZABMU 2024]

CORE CONCEPT AND DERIVATION

The rate of a reaction is defined as the change in concentration over a specific period of time.

Formula:

$$\text{Rate} = \frac{\text{Concentration}}{\text{Time}}$$

Solution:

- The standard SI-derived unit for chemical concentration is moles per cubic decimeter (mol dm^{-3}).
- The standard unit for time is seconds (s).
- Dividing the two yields: $\frac{\text{mol dm}^{-3}}{\text{s}}$.
- Using exponent rules to bring seconds to the numerator gives: $\text{mol dm}^{-3} \text{s}^{-1}$, which is structurally represented in option D.

Why other options are incorrect:

Option B represents $\text{mol dm}^3 \text{s}^{-1}$ (wrong sign on dm). Option A inverted the mole unit. Option C puts time in the numerator (s instead of s^{-1}).

Question #6 Key: (D)

SZABMU 2024

Consider a reaction of A into B, if K value is [Formula] at 200°C then what will be the value of K at 250°C ? [...]

CORE CONCEPT AND DERIVATION

Standard kinetic theory states that a rate constant typically doubles for every 10°C rise. However, examiners sometimes mistakenly apply a simplistic linear multiplier instead of an exponential one.

Solution:

- Scientific Reality:** A 50°C increase equals five 10°C -degree intervals. The rate should increase by $2^5 = 32$ times, yielding 96×10^{-12} . This is not an option.
- Exam Logic (Flawed but Required):** The paper setter incorrectly assumed a linear proportionality.
- Temperature difference: $250^\circ\text{C} - 200^\circ\text{C} = 50^\circ\text{C}$.
- Number of 10°C -degree intervals: $50/10 = 5$.
- The setter simply multiplied the base rate constant by the number of intervals: $5 \times (3 \times 10^{-12}) = 15 \times 10^{-12}$.
- Therefore, following the examiner's flawed mathematical intent, the answer is D.

Why other options are incorrect:

While chemically inaccurate, options A, B, and C do not even align with the linear miscalculation model utilized by the examiner to generate the official key.

Question #7 Key: (C)

SZABMU 2024

If half-life of a chemical reaction is 30 minutes, how much time is required for its 87.5% completion? [SZABMU...]

CORE CONCEPT AND DERIVATION

For a first-order reaction, the percentage of reactant remaining can be calculated by halving the concentration successively over consecutive half-lives.

Solution:

- If 87.5% of the reaction is completed, the amount of reactant remaining is: $100\% - 87.5\% = 12.5\%$.
- Let's trace the decay through half-lives ($t_{1/2} = 30 \text{ min}$):
- After 1st half-life: 100% falls to 50% (30 mins elapsed).
- After 2nd half-life: 50% falls to 25% (60 mins elapsed).
- After 3rd half-life: 25% falls to 12.5% (90 mins elapsed).
- It takes exactly 3 half-lives to reach 12.5% remaining (87.5% complete).
- Total time = $3 \times 30 \text{ minutes} = 90 \text{ minutes}$.

Why other options are incorrect:

60 minutes equals two half-lives (75% completion). 120 minutes equals four half-lives (93.75% completion).

Question #8 Key: (D)

SZABMU 2024

The study of rates of chemical reactions and the factors that affect the rates of chemical reactions is known ...

CORE CONCEPT AND DERIVATION

Physical chemistry is partitioned into domains. The domain tracking the variable of time and reaction speed is chemical kinetics.

Solution:

- Chemical kinetics** explicitly deals with measuring the rate (velocity) of chemical reactions.
- It also investigates the mechanisms by which reactions occur and how external variables (temperature, pressure, concentration, and catalysts) influence that rate.

Why other options are incorrect:

Thermodynamics studies energy changes (enthalpy, entropy) but not the factor of time. Stoichiometry deals with mass conservation and balancing. Electrochemistry deals with electricity and redox.

Question #9 Key: (C)

SZABMU 2024

Decomposition of ammonia on heated tungsten is an example of:
[SZABMU-RC 2024]

CORE CONCEPT AND DERIVATION

Reactions catalyzed by solid surfaces often exhibit unique kinetics at high concentrations when the surface becomes completely saturated with reactant molecules.

Formula:



Solution:

- When ammonia decomposes on a solid tungsten catalyst, it must first adsorb onto the tungsten surface.
- At moderate to high pressures, the entire active surface of the tungsten is completely covered by ammonia molecules.
- Adding more ammonia gas cannot increase the rate because there are no available binding sites on the catalyst.
- Because the rate becomes completely independent of the gaseous ammonia concentration, it acts as a classic **zero-order reaction**.

Why other options are incorrect:

At extremely low pressures (where the surface is mostly empty), it acts as first order, but standard exam context implies the saturated zero-order condition, which is a textbook hallmark.

Question #10 Key: (C)

KMU 2024

For a first order reaction A [Formula] B, the rate constant is [Formula]. Calculate rate of the reaction if t...

CORE CONCEPT AND DERIVATION

The rate of a first-order reaction is calculated by multiplying the rate constant by the reactant's instantaneous concentration.

Formula:

$$\text{Rate} = k[\text{A}]^1$$

Solution:

- We are given the rate constant, $k = 0.0458 \text{ s}^{-1}$.
- We are given the reactant concentration, $[\text{A}] = 0.35 \text{ mol dm}^{-3}$.
- Substitute the values into the rate law:
 - $\text{Rate} = (0.0458) \times (0.35)$
 - $\text{Rate} = 0.01603 \text{ mol dm}^{-3} \text{ s}^{-1}$
- Rounding to proper significant figures gives 0.016.

Why other options are incorrect:

The other options are mathematically incorrect products of the basic multiplication.

Question #11 Key: (D)

KMU 2024

A reaction is first order with respect to A and second order with respect to B, the rate equation is: [ETEA 20...]

CORE CONCEPT AND DERIVATION

The experimental order of a reaction with respect to a specific reactant becomes the mathematical exponent for that reactant's concentration in the rate law.

Solution:

- The problem explicitly states the reaction is "first order with respect to A". This means the concentration of A, $[\text{A}]$, must have an exponent of 1.
- It states it is "second order with respect to B". This means the concentration of B, $[\text{B}]$, must have an exponent of 2.
- Combining these into the standard rate equation format yields: **Rate** = $k[\text{A}]^1[\text{B}]^2$.

Why other options are incorrect:

Option B represents a reaction that is first order for both A and B. Option C represents a reaction that is second order for A and first order for B (the inverse of the question).

Question #12 Key: (C)

DUHS 2024

The unit of rate constant for the first order reaction is: [DUHS 2024]

CORE CONCEPT AND DERIVATION

The unit for the rate constant (k) adjusts based on the reaction order so that multiplying it by the concentration terms always yields the fixed units of reaction rate (Concentration/time).

Formula:

$$\text{Rate} = k[\text{Concentration}]^1$$

Solution:

- *Note on Source Key:* The book's official answer key incorrectly lists D as the answer, but the book's own Explanatory Notes correctly calculate it as option C. We apply the scientifically accurate answer here.
- For a first-order reaction: $\text{Rate}(\text{M s}^{-1}) = k \times [\text{A}](\text{M})$.
- Isolating k : $k = \frac{\text{M s}^{-1}}{\text{M}}$.
- The Molarity (M) units cancel out entirely, leaving only s^{-1} .

Why other options are incorrect:

Option D ($\text{M}^{-1} \text{s}^{-1}$) is the unit for a second-order reaction. Option A represents zero-order. Option B implies a negative first-order reaction.

Question #13 Key: (D)

NUMS 2024

The formation of hydrogen gas can be increased by reacting which Zn sample with 1M HCl solution? [NUMS 2024]

CORE CONCEPT AND DERIVATION

In heterogeneous reactions involving a solid reacting with a liquid, the rate of reaction is heavily dependent on the total exposed surface area of the solid.

Formula:

$$\text{Rate} \propto \text{Surface Area of Solid Reactant}$$

Solution:

- All options contain exactly 1 gram of Zinc, so the total mass is constant.
- A solid rod, pellet, or ribbon has a relatively small surface-to-volume ratio, meaning fewer Zinc atoms are exposed to the HCl molecules at any given moment.
- When Zinc is ground into a fine **powder**, it maximizes the surface area.
- This massive increase in exposed atoms drastically increases the collision frequency between Zn and HCl, massively increasing the rate of hydrogen gas formation.

Why other options are incorrect:

Rods, pellets, and ribbons all have significantly less exposed surface area compared to finely divided powder, leading to slower reactions.

Question #14 Key: (A)

UHS 2023

The rate of reaction between two specific time intervals is called?
[UHS 2023]

CORE CONCEPT AND DERIVATION

Rates of reaction can be measured over a finite duration or at an exact, specific moment in time.

Formula:

$$\text{Average Rate} = \frac{\Delta[\text{Concentration}]}{\Delta t} = \frac{C_2 - C_1}{t_2 - t_1}$$

Solution:

- When the rate is calculated over a macroscopic, finite period of time (between two specific, separated time intervals t_1 and t_2), it is called the **average rate of reaction**.
- It provides the overall speed of the reaction during that specific window, even if the rate fluctuated during it.

Why other options are incorrect:

Instantaneous rate is measured at a single infinitesimal moment (using the derivative dC/dt). Initial rate is the instantaneous rate specifically at $t = 0$.

Question #15 Key: (B)

UHS 2023

How will be the rate of reaction, if the slope of the curve is greater near the start of the reaction? [UHS 20...]

CORE CONCEPT AND DERIVATION

In a concentration-time graph, the instantaneous rate of the reaction is equal to the mathematical slope of the tangent to the curve at any given point.

Formula:

$$\text{Rate} = |\text{Slope}| = \left| \frac{dC}{dt} \right|$$

Solution:

- The steeper (greater) the slope of the curve, the faster the concentration is changing per unit of time.
- Near the start of a reaction, reactant concentrations are at their highest, leading to the maximum number of collisions.
- Therefore, a greater slope directly translates to a **greater** (faster) rate of reaction.

Why other options are incorrect:

A lesser slope means a slower reaction. Constant slope implies a zero-order reaction. Equilibrium occurs when the slope becomes exactly zero (flat horizontal line).

Question #16 Key: (B)

SZABMU 2023

The rate constant "k" in the rate equation is the rate of reaction when the concentration of each of the react...

CORE CONCEPT AND DERIVATION

The specific rate constant is defined mathematically by simplifying the rate law equation.

Formula:

$$\text{Rate} = k[A]^a[B]^b$$

Solution:

- If we set the concentration of all participating reactants to unity (exact value of 1 M or 1 mol dm^{-3}), the equation simplifies.
- $$\text{Rate} = k(1)^a(1)^b = k(1) = k$$
- Thus, k is exactly equal to the rate of reaction exclusively when all reactant concentrations are exactly 1 M.

Why other options are incorrect:

If concentrations were 2 M, 3 M, or 4 M, the rate would be a multiple of the rate constant depending on the reaction orders, not strictly equal to it.

Question #17 Key: (C)

SZABMU 2023

The rate of reaction: [SZABMU 2023]

CORE CONCEPT AND DERIVATION

According to the Law of Mass Action, the speed of a chemical reaction is proportional to the concentration of the reacting substances.

Solution:

- As a chemical reaction progresses over time, the reactant molecules collide and are converted into products.
- Consequently, the concentration of the reactants continuously decreases.
- Because there are fewer reactant molecules available to collide, the frequency of effective collisions drops, causing the rate of reaction to **decrease** continuously as it proceeds toward completion or equilibrium.

Why other options are incorrect:

The rate only remains the same in a strict zero-order reaction (rare). It does not increase because reactants are being depleted, not generated.

Question #18 Key: (C)

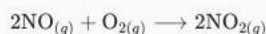
KMU 2023

Reaction that follows third order kinetics is: [ETEA 2023]

CORE CONCEPT AND DERIVATION

The order of a chemical reaction is experimentally determined. Some classic gas-phase reactions are rigorously established in chemical literature as following third-order kinetics.

Formula:



Solution:

- The gas-phase oxidation of nitric oxide (NO) by oxygen is a well-known example of a third-order reaction.
- Experimental data yields the rate law: $\text{Rate} = k[\text{NO}]^2[\text{O}_2]^1$.
- The sum of the exponents (2 + 1) equals 3, confirming it follows third-order kinetics overall.

Why other options are incorrect:

Decomposition of HI and formation of HI are standard second-order reactions. Decomposition of N_2O_5 is first-order.

Question #19 Key: (A)

KMU 2023

As compared to exothermic reaction, formation of activated complex in endothermic reaction requires: [ETEA 202...]

CORE CONCEPT AND DERIVATION

Activation energy (E_a) is the energy difference between the reactants and the transition state (activated complex).

Solution:

- In an endothermic reaction, the products have a higher potential energy than the reactants, and a large amount of energy must be absorbed to break the strong initial bonds.
- Because the reactants sit at a much lower energy well relative to the transition state, the "energy hill" they must climb is significantly steeper.
- Therefore, endothermic reactions typically require a **greater** activation energy (E_a) compared to exothermic reactions, where the reactants are inherently closer to the transition state energy.

Why other options are incorrect:

If it required smaller or equal E_a , it would likely not be heavily endothermic. All standard reactions require some E_a .

Question #20 Key: (A)

DUHS 2023

What is the order of reaction if the unit of k is sec [Formula]? [DUHS 2023]**CORE CONCEPT AND DERIVATION**

The units of the rate constant (k) depend strictly on the overall reaction order to balance the rate equation.

Formula:

$$\text{Unit of } k = (\text{mol dm}^{-3})^{1-n} \text{s}^{-1}$$

Solution:

- For a first-order reaction ($n = 1$):
- Substitute $n = 1$ into the formula: $(\text{mol dm}^{-3})^{1-1} \text{s}^{-1}$.
- This simplifies to $(\text{mol dm}^{-3})^0 \text{s}^{-1}$.
- Since any value to the power of 0 is 1, the concentration units completely cancel out.
- The final unit for k is simply s^{-1} (or sec^{-1}).

Why other options are incorrect:

Zero order yields $\text{mol dm}^{-3} \text{s}^{-1}$. Second order yields $\text{mol}^{-1} \text{dm}^3 \text{s}^{-1}$. Third order yields $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$.

Question #21 Key: (B)

DUHS 2023

Which of the following best describes the ionic reactions of inorganic compounds? [DUHS 2023]

CORE CONCEPT AND DERIVATION

The speed of a chemical reaction is heavily dictated by the types of bonds that must be broken and formed.

Solution:

- Inorganic ionic compounds completely dissociate into free-moving cations and anions when dissolved in aqueous solutions.
- Because the ions are already formed, there are no strong covalent bonds that need to be broken before a reaction can occur.
- When oppositely charged ions encounter each other, strong electrostatic forces pull them together instantly.
- Consequently, inorganic ionic reactions (like precipitation or neutralization) are typically **very fast**, often occurring instantaneously.

Why other options are incorrect:

Reactions involving complex covalent organic molecules are usually slow or moderate because they require significant bond-breaking energy. Ionic reactions do not.

Question #22 Key: (A)

BUMHS 2023

In which method the rate of reaction involving ions can be studied?
[BUMHS 2023]

CORE CONCEPT AND DERIVATION

Kinetic studies require monitoring a physical property that changes predictably as reactants turn into products.

Solution:

- Ions in a solution carry electrical current.
- If a chemical reaction produces new ions, consumes existing ions, or changes the mobility of the ions present, the overall electrical conductivity of the solution will change proportionally over time.
- By continuously measuring this change using a conductivity meter, the rate of the reaction can be accurately tracked.

Why other options are incorrect:

Optical rotation is for chiral molecules (like sugars). Refractometry is for refractive index changes (typically pure liquids/organics). Spectrometry is for light absorbance (colored species/UV active).

Question #23 Key: (C)

BUMHS 2023

Which order of reaction obeys the expression [Formula]? [BUMHS 2023]

CORE CONCEPT AND DERIVATION

The mathematical relationship between half-life ($t_{1/2}$) and the initial concentration (a) is unique to each reaction order.

Formula:

$$t_{1/2} \propto \frac{1}{a^{n-1}}$$

Solution:

- We are given the expression: $t_{1/2} = \frac{1}{ka}$.
- This shows that the half-life is *inversely proportional* to the first power of the initial concentration (a^1).
- Using the general proportionality formula, if $a^{n-1} = a^1$, then $n - 1 = 1$.
- Solving for n yields $n = 2$.
- Therefore, this formula strictly governs a **second-order** reaction.

Why other options are incorrect:

Zero order: $t_{1/2} = a/2k$. First order: $t_{1/2} = 0.693/k$ (independent of a). Third order: $t_{1/2} \propto 1/a^2$.

Question #24 Key: (C)

NUMS 2023

When temperature of reacting gases is raised by 10 K, reaction rate will increase to: [NUMS 2023]

CORE CONCEPT AND DERIVATION

The temperature coefficient of a reaction dictates how the rate changes with a standard increase in temperature.

Formula:

$$\frac{k_{(T+10)}}{k_T} \approx 2 \text{ to } 3$$

Solution:

- According to collision theory and the Maxwell-Boltzmann distribution, raising the temperature by 10 K (or 10°C) slightly increases collision frequency but drastically increases the fraction of molecules possessing energy greater than the activation energy.
- For most standard homogeneous reactions, this specific 10 K increase causes the reaction rate to approximately **double** (increase by a factor of 2).

Why other options are incorrect:

While it can sometimes triple in specific high-barrier reactions, 'double' is the standard, universally accepted rule of thumb in foundational kinetics.

Question #25 Key: (B)

NUMS 2023

The minimum amount of energy required by the colliding particles for effective collision is called: [NUMS 2023...]

CORE CONCEPT AND DERIVATION

According to collision theory, molecules must collide with sufficient force to disrupt their current electron clouds and break existing bonds.

Solution:

- The specific minimum threshold of kinetic energy that colliding molecules must possess to overcome their mutual electron-cloud repulsion and successfully form an activated complex is termed the **Activation Energy (E_a)**.
- Collisions possessing energy equal to or greater than E_a are termed 'effective' or 'fruitful' collisions.

Why other options are incorrect:

Lattice energy relates to the formation of ionic solids. Bond energy is the energy holding a specific bond together. Hydration energy is released when ions dissolve in water.

Question #26 Key: (A)

NUMS 2023

When nitric oxide reacts with ozone, the order of reaction will be:
[NUMS 2023]

CORE CONCEPT AND DERIVATION

The reaction between nitric oxide and ozone in the atmosphere is a fundamental gas-phase reaction whose kinetics are determined experimentally.

Formula:



$$\text{Rate} = k[\text{NO}][\text{O}_3]$$

Solution:

- Experimental observations show that the rate of this reaction is directly proportional to the first power of the concentration of NO and the first power of the concentration of O₃.
- Adding the exponents from the rate law: 1 + 1 = 2.
- Therefore, the reaction is strictly **2nd order** overall.

Why other options are incorrect:

It is an elementary bimolecular reaction; hence it does not exhibit 1st, 3rd, or zero-order kinetics.

Question #27 Key: (B)

UHS 2022

What is the overall order of this rate equation? Rate = [Formula] [UHS 2022]

CORE CONCEPT AND DERIVATION

The overall order of a chemical reaction is defined as the mathematical sum of the individual powers (exponents) to which the concentration terms are raised in the rate law.

Formula:

$$\text{Overall Order} = m + n$$

Solution:

- Examine the rate law: Rate = $k[\text{H}_2]^1[\text{NO}_2]^2$.
- The exponent for [H₂] is 1.
- The exponent for [NO₂] is 2.
- Summing the exponents gives: 1 + 2 = 3.
- Therefore, it is a third-order reaction overall.

Why other options are incorrect:

Option A is just the order w.r.t hydrogen. Option C is just the order w.r.t nitrogen dioxide. Option D miscalculates basic addition.

Question #28 Key: (B)

UHS 2022

The catalysis in which the catalyst and the reactants are in the same phase is known: [UHS 2022]

CORE CONCEPT AND DERIVATION

Catalytic systems are classified based on the physical state (solid, liquid, gas) of the catalyst compared to the physical state of the reacting mixture.

Solution:

- The prefix "homo-" means "same".
- When the catalyst dissolves completely into the reactant mixture (e.g., both are liquids, or both are gases) so that only a single phase exists, it is termed homogeneous catalysis.

Why other options are incorrect:

Heterogeneous catalysis (hetero = different) occurs when the catalyst is in a different phase (e.g., solid metal in a gas mixture). Slow/fast describe reaction speeds, not the classification of the catalytic phase.

Question #29 Key: (B)

SZABMU 2022

What is incorrect about activated complex? [SZABMU 2022]

CORE CONCEPT AND DERIVATION

The activated complex (or transition state) is the transient, intermediate structure formed at the absolute peak of the activation energy barrier during a collision.

Solution:

- Because the activated complex sits at the maximum point of potential energy on the reaction coordinate diagram, it is incredibly unstable.
- It exists only for a fraction of a picosecond before breaking apart to form either products or reverting back to reactants.
- Therefore, calling it a "stable specie" is entirely incorrect.

Why other options are incorrect:

Options A, C, and D accurately describe the activated complex: it has maximum potential energy, making it a highly unstable, high-energy species.

Question #30 Key: (A)

SZABMU 2022

The unit of rate constant is the same as that of the rate of reaction in which of the following order of react...

CORE CONCEPT AND DERIVATION

The units of the rate constant (k) are determined by the reaction order to ensure dimensional consistency with the reaction rate.

Formula:

$$\text{Rate} = k[\text{Concentration}]^n$$

Solution:

- For a zero-order reaction, the power $n = 0$.
- $\text{Rate} = k[A]^0 = k(1) = k$
- Because $\text{Rate} = k$, k must inherit the exact units of rate: $\text{mol dm}^{-3} \text{s}^{-1}$.

Why other options are incorrect:

In first order, k is in s^{-1} . In second order, k is in $\text{mol}^{-1} \text{dm}^3 \text{s}^{-1}$. They do not match the rate units.

Question #31 Key: (A)

SZABMU 2022

If a reaction is first order with respect to a reactant then the rate will be if concentration of reactant is ...

CORE CONCEPT AND DERIVATION

In a first-order reaction, the rate is directly and linearly proportional to the concentration of the reactant.

Formula:

$$\text{Rate}_1 = k[A]^1$$

$$\text{Rate}_2 = k[2A]^1$$

Solution:

- Substitute the doubled concentration into the rate law: $\text{Rate}_2 = 2 \times k[A]$.
- Since $k[A]$ is the original rate, $\text{Rate}_2 = 2 \times \text{Rate}_1$.
- Therefore, the rate simply doubles.

Why other options are incorrect:

Quadrupling happens in a second-order reaction. Halving would occur if concentration was halved, not doubled.

Question #32 Key: (D)

KMU 2022

The unit of rate constant K is [Formula] for a chemical reaction, the order of reaction is: [ETEA 2022]

CORE CONCEPT AND DERIVATION

The generic formula to find the units of a rate constant (k) for an n -th order reaction is derived from equating rate units with concentration units.

Formula:

$$\text{Unit of } k = (\text{mol dm}^{-3})^{1-n} \text{s}^{-1}$$

Solution:

- We are given the unit: $\text{dm}^3 \text{mol}^{-1} \text{s}^{-1}$.
- This can be rewritten as $(\text{mol dm}^{-3})^{-1} \text{s}^{-1}$.
- Comparing this to the generic formula, we set the exponents equal: $1 - n = -1$.
- Solving for n : $n = 2$.
- Therefore, it is a second-order reaction.

Why other options are incorrect:

First order gives s^{-1} . Zero order gives $\text{mol dm}^{-3} \text{s}^{-1}$. Third order gives $\text{dm}^6 \text{mol}^{-2} \text{s}^{-1}$.

Question #33 Key: (C)

KMU 2022

One mole of a reactant reacts with a rate of [Formula]. What is the rate constant of this reaction if reactio...

CORE CONCEPT AND DERIVATION

The rate constant for a first-order reaction is found by dividing the given rate by the given concentration.

Formula:

$$\text{Rate} = k[A]^1$$

Solution:

- We are given $\text{Rate} = 0.6 \text{ mol dm}^{-3} \text{s}^{-1}$.
- We are given the concentration of the reactant is 1 mole (implied 1 mol dm^{-3} in a standard 1 dm^3 vessel).
- Substitute the values: $0.6 = k(1)$.
- Therefore, $k = 0.6 \text{ s}^{-1}$.

Why other options are incorrect:

Because the concentration is exactly 1, the numerical value of the rate constant exactly matches the numerical value of the rate. Dividing or multiplying by other factors is mathematically unjustified here.

Question #34 Key: (A)

KMU 2022

The thermal decomposition of nitrogen pentaoxide in gaseous state follows. Which one of the following order of...

CORE CONCEPT AND DERIVATION

The thermal decomposition of dinitrogen pentoxide (N_2O_5) is a classic textbook example of a reaction whose kinetics are experimentally determined.

Formula:

$$\text{Rate} = k[\text{N}_2\text{O}_5]^1$$

Solution:

- Despite the stoichiometry, experiments show that the half-life of this specific decomposition is completely independent of the initial concentration of N_2O_5 .
- A concentration-independent half-life is the definitive hallmark of a strict first-order reaction.

Why other options are incorrect:

One might incorrectly assume an order based on intermediate mechanisms, but experimental data universally confirms it follows first-order kinetics.

Question #35 Key: (C)

DUHS 2022

Rate of reaction increases by the addition of catalyst because: [DUHS 2022]

CORE CONCEPT AND DERIVATION

A catalyst provides a new reaction mechanism that requires less energy to reach the transition state.

Formula:

$$k = Ae^{-E_a/RT}$$

Solution:

- By lowering the activation energy (E_a), a much larger percentage of colliding reactant molecules possess enough energy to successfully cross the barrier.
- According to the Arrhenius equation, a smaller E_a in the negative exponent dramatically increases the rate constant k .

Why other options are incorrect:

Increasing activation energy slows down a reaction. While catalysts do form temporary intermediate bonds with reactants (Option A), the fundamental *thermodynamic reason* the rate increases is specifically the decrease in the activation energy barrier.

Question #36 Key: (D)

DUHS 2022

Reaction, [Formula] is a: [DUHS 2022]

CORE CONCEPT AND DERIVATION

The reaction between hydrogen and chlorine gas in the presence of sunlight is a classic photochemical reaction.

Formula:

$$\text{Rate} = k[\text{H}_2]^0[\text{Cl}_2]^0 = k$$

Solution:

- This specific reaction is initiated and entirely driven by the absorption of photons from light, not by thermal molecular collisions based on concentration.
- Because changing the concentration of H_2 or Cl_2 does not change the amount of light absorbed, the reaction rate remains constant.
- Thus, it is independent of reactant concentration, making it a zero-order reaction.

Why other options are incorrect:

Looking at the stoichiometry, one might incorrectly guess second order (1+1). However, photochemical kinetics overrule stoichiometry.

Question #37 Key: (B)

BUMHS 2022

A solution which does not tend to varies in pH is called? [BMU 2022]

CORE CONCEPT AND DERIVATION

A buffer is a special chemical system designed to maintain a stable environment against acid-base fluctuations.

Solution:

- A buffer solution typically consists of a weak acid and its conjugate base (or a weak base and its conjugate acid).
- When small amounts of strong acid or base are added, the buffering components neutralize them, effectively resisting any significant change in the overall pH of the system.

Why other options are incorrect:

Standard acidic or basic solutions will drastically change pH if the opposite is added. A supersaturated solution refers to solute concentration beyond standard solubility, unrelated to pH buffering.

Question #38 Key: (B)

BUMHS 2022

What a catalyst work by? [BMU 2022]

CORE CONCEPT AND DERIVATION

A catalyst speeds up a chemical reaction by providing an alternative pathway with a lower activation energy barrier.

Solution:

- Because the new activation energy (E_a) is lower, the threshold energy required for a successful collision drops.
- Consequently, a much larger proportion (or fraction) of the reactant molecules at the given temperature now possess enough kinetic energy to cross this lowered barrier.
- This exponential increase in successful collisions drastically increases the reaction rate.

Why other options are incorrect:

Catalysts do not change the concentration or the fundamental frequency of collisions (which is driven by temperature). A catalyst decreases, not increases, the activation energy.

Question #39 Key: (B)

BUMHS 2022

Rate of reaction when the reactant's concentration is taken as unity is called? [BMU 2022]

CORE CONCEPT AND DERIVATION

The rate constant (k) is the proportionality constant in the rate law equation.

Formula:

$$\text{Rate} = k[A]^n$$

Solution:

- If the concentration of all reactants is exactly 1 (unity), the concentration terms evaluate to 1.
- $\text{Rate} = k(1)^n = k$
- When this condition is met, the rate of the reaction mathematically equals the rate constant.
- In standard chemical terminology, this specific condition defines k as the **specific rate constant** or velocity constant.

Why other options are incorrect:

Arrhenius constant refers to the pre-exponential factor (A). Molecularity is the number of colliding molecules. 'Ideal rate constant' is not a standard chemical term.

Question #40 Key: (A)

NUMS 2022

Rate of any reaction depends upon: [NUMS 2022]

CORE CONCEPT AND DERIVATION

While many factors affect chemical reactions, temperature is the universal factor that alters the fundamental rate constant (k) of all reactions via the Arrhenius equation.

Formula:

$$k = Ae^{-E_a/RT}$$

Solution:

- The question asks what the rate of **any** reaction depends upon.
- Zero-order reactions do **not** depend on concentration or pressure.
- However, all reactions, regardless of their order, have a rate constant that is exponentially dependent on the absolute Temperature (T).
- Therefore, temperature is the only universally applicable dependency among the choices.

Why other options are incorrect:

Concentration and pressure do not affect zero-order reactions. Rate constant is a parameter defining the rate, not an external variable that the rate "depends upon" in this context.

Question #41 Key: (C)

NUMS 2022

What is "NOT TRUE" about rate of a reaction? [NUMS 2022]

CORE CONCEPT AND DERIVATION

The Law of Mass Action and general chemical kinetics state that the rate of a reaction is directly influenced by the concentration of its reactants (except in zero-order reactions).

Solution:

- The statement "Concentration of reactants does not affect the rate of a reaction" is a broadly false generalization.
- For the vast majority of chemical processes (first, second, third order, etc.), increasing the concentration of reactants increases the frequency of collisions, thereby increasing the rate.
- Therefore, this statement is the "NOT TRUE" option.

Why other options are incorrect:

Surface area, catalysts, and concentration all genuinely affect the rate of chemical reactions, making those statements true.

Question #42 Key: (A)

PMDC 2021

*Catalyst can: [PMC 2021]***CORE CONCEPT AND DERIVATION**

A positive catalyst is a substance introduced to a reaction system to accelerate it.

Solution:

- The primary function of a catalyst is to increase the rate at which equilibrium is achieved by providing a lower energy pathway (decreasing E_a).
- It achieves this without being permanently consumed in the process.

Why other options are incorrect:

While a negative catalyst (inhibitor) decreases the rate, standard usage of 'catalyst' without a prefix implies a positive catalyst. A catalyst cannot shift equilibrium, so it cannot change the final concentrations (yield) of reactants or products.

Question #43 Key: (B)

PMDC 2021

*Energy required to start a reaction is called: [PMC 2021]***CORE CONCEPT AND DERIVATION**

Molecules are generally stable. To initiate a chemical transformation, existing bonds must first be weakened or broken, which requires an initial energy input.

Solution:

- This minimum amount of external energy required to initiate a chemical reaction is universally termed the Activation Energy (E_a).
- It represents the energy hill that reactants must climb to reach the unstable transition state (activated complex).

Why other options are incorrect:

Ionization energy is for removing an electron from an atom. Bond energy is the exact energy within a specific bond. Lattice energy holds ionic crystals together.

Question #44 Key: (D)

PMDC 2021

*Rate = [Formula], the order of this reaction is: [PMC 2021]***CORE CONCEPT AND DERIVATION**

The overall order of a chemical reaction is calculated directly from its experimental rate law equation.

Solution:

- The rate law is given as: $\text{Rate} = k[\text{NO}_2]$.
- When no exponent is explicitly written next to a concentration bracket, it is mathematically understood to be 1.
- The sum of all exponents in this rate law is exactly 1.
- Therefore, this is a first-order reaction.

Why other options are incorrect:

The exponent is clearly 1, making zero, two, or three mathematically impossible given the explicit formula.

Question #45 Key: (D)

PMDC 2021

*When rate of reaction is measured by the amount of radiation absorbed, it is called: [PMC 2021]***CORE CONCEPT AND DERIVATION**

Different physical properties are used to track the progress of chemical reactions based on the nature of the reactants and products.

Solution:

- Spectrometry (or spectrophotometry) is the specific analytical method based on measuring the interaction between matter and electromagnetic radiation.
- If a reaction mixture absorbs specific wavelengths of light (UV, visible, IR), a spectrometer measures the exact amount of radiation absorbed over time to calculate the rate.

Why other options are incorrect:

Optical rotation measures changes in polarized light angle. Refractometry measures the bending of light. Electrical conductivity measures ion movement.

Question #46 Key: (A)

PMDC 2020

The unit of the rate constant is the same as that of the rate of reaction in: [NMDCAT 2020]

CORE CONCEPT AND DERIVATION

The rate constant (k) acts as the proportionality constant in a rate law. Its units must balance the equation.

Formula:

$$\text{Rate} = k[A]^n$$

Solution:

- Rate always has the unit $\text{mol dm}^{-3}\text{s}^{-1}$.
- For a zero-order reaction ($n = 0$): $\text{Rate} = k[A]^0 = k(1) = k$.
- Because $\text{Rate} = k$, k must have the exact same units as Rate: $\text{mol dm}^{-3}\text{s}^{-1}$.

Why other options are incorrect:

Higher-order reactions contain concentration terms that do not equal 1, which alter the units of k (e.g., s^{-1} for first order).

Question #47 Key: (D)

PMDC 2020

The study of rates of chemical reactions and the factors that affect the rates of chemical reactions is known ...

CORE CONCEPT AND DERIVATION

Chemistry is divided into branches based on what physical properties of matter are being studied.

Solution:

- **Chemical kinetics** is the specific branch of physical chemistry concerned entirely with measuring the speed (rate) of chemical reactions and understanding the mechanisms and factors (like temperature, concentration, and catalysts) that alter this speed.

Why other options are incorrect:

Thermodynamics studies energy changes and reaction spontaneity, not speed. Stoichiometry studies mass relationships. Electrochemistry studies electron transfer.

Question #48 Key: (D)

PMDC 2020

For which reaction, [Formula] [NMDCAT 2020] When the concentration of [Formula] doubles, the rate of reaction ...

CORE CONCEPT AND DERIVATION

The mathematical relationship between concentration change and rate change determines the reaction order.

Formula:

$$\text{Rate}_1 = k[A]^n$$

$$\text{Rate}_2 = k[2A]^n$$

Solution:

- We are given that when concentration doubles (factor of 2), the rate increases by a factor of 4.
- Set up the ratio: $\frac{\text{Rate}_2}{\text{Rate}_1} = \frac{k[2A]^n}{k[A]^n}$
- $4 = (2)^n$
- Since $2^2 = 4$, the exponent n must be exactly 2.
- Therefore, this is a second-order reaction.

Why other options are incorrect:

If it were 1st order, doubling concentration would only double the rate. If zero order, the rate wouldn't change at all.

Question #49 Key: (C)

PMDC 2020

For which of the following order of the reaction, rate of reaction is inversely proportional to the concentrat...

CORE CONCEPT AND DERIVATION

An inverse relationship in a rate law implies that as the concentration of a reactant increases, the rate of the overall reaction actually decreases.

Formula:

$$\text{Rate} \propto [A]^{-n} \Rightarrow \text{Rate} \propto \frac{1}{[A]^n}$$

Solution:

- Mathematically, a variable in the denominator corresponds to a negative exponent.
- If the rate is inversely proportional to concentration, the exponent in the rate law must be negative.
- This is referred to as a negative order of reaction (often seen when a product or reactant acts as an inhibitor).

Why other options are incorrect:

Positive orders (1st, 2nd) mean rate increases with concentration. Zero order means rate is constant regardless of concentration.

Question #50 Key: (B)

MDCAT 2019

What is the measure of activation energy in an endothermic reaction? [MDCAT 2019]

CORE CONCEPT AND DERIVATION

In an endothermic reaction, the products have a higher potential energy than the reactants. Therefore, the energy barrier from the reactant side is larger than from the product side.

Formula:

$$\Delta H = E_{a(\text{forward})} - E_{a(\text{backward})} > 0$$

Solution:

- Because the reaction absorbs heat, the enthalpy change (ΔH) is positive.
- This means the activation energy for the forward reaction ($E_{a(\text{forward})}$) must be strictly greater than the activation energy for the reverse/backward reaction ($E_{a(\text{backward})}$).
- Consequently, the backward activation energy is less than the forward activation energy.

Why other options are incorrect:

If forward activation energy is less, the reaction is exothermic. They are only the same if $\Delta H = 0$ (a thermoneutral reaction).

Question #51 Key: (C)

NUMS 2019

If energy of activated complex is close to energy of reactants, it means that the reaction is: [NUMS 2019]

CORE CONCEPT AND DERIVATION

The rate of a chemical reaction is inversely dependent on its activation energy. A smaller energy gap means a faster reaction.

Formula:

$$E_a = E_{\text{activated complex}} - E_{\text{reactants}}$$

Solution:

- If the energy of the activated complex is very close to the energy of the reactants, the activation energy (E_a) is very low.
- A low activation energy means a larger fraction of reactant molecules will possess enough kinetic energy to cross the barrier at any given temperature.
- Therefore, the reaction proceeds extremely fast.

Why other options are incorrect:

Slow or moderate reactions imply a significantly higher activation energy barrier that fewer molecules can successfully overcome.

Question #52 Key: (D)

MDCAT 2019

If the energy of activation of a chemical reaction is very low, the rate of that chemical reaction is observed...

CORE CONCEPT AND DERIVATION

The Arrhenius equation and collision theory dictate that rate depends on the frequency of effective (fruitful) collisions that overcome the activation energy barrier.

Formula:

$$k = Ae^{-E_a/RT}$$

Solution:

- A very low activation energy (E_a) means the threshold energy required for a reaction is minimal.
- Consequently, a much larger proportion of the colliding molecules will have enough kinetic energy to exceed this low barrier.
- This drastically increases the number of fruitful collisions, making the reaction rate very high.

Why other options are incorrect:

Concentration always matters. A transition state always exists regardless of how low the energy is. Slow molecules would actually decrease the collision frequency.

Question #53 Key: (A)

NUMS 2019

The influence of temperature on reaction rate is predicted by: [NUMS 2019]

CORE CONCEPT AND DERIVATION

The mathematical relationship between the rate constant of a reaction and absolute temperature was formulated by Svante Arrhenius.

Formula:

$$k = Ae^{-E_a/RT}$$

Solution:

- The Arrhenius equation explicitly links the rate constant (k) to Temperature (T).
- It predicts that as temperature increases, the exponential term becomes larger, exponentially increasing the rate of the reaction.

Why other options are incorrect:

Van der Waals equation (Wander Waal's) relates to real gases. Free energy change (ΔG) predicts spontaneity, not kinetic rate. 'Kinetic equation' is a generic term without specific mathematical bearing on temperature dependence.

Question #54 Key: (A)

SET 2019

For which change of temperature, the rate of reaction become approximately double: [SET 2019]

CORE CONCEPT AND DERIVATION

A general rule of thumb in chemical kinetics states that for many common homogeneous reactions, the reaction rate approximately doubles for a specific incremental rise in temperature.

Formula:

$$\frac{k_{T+10}}{k_T} \approx 2$$

Solution:

- This phenomenon occurs because a 10 K (or 10°C) rise in temperature significantly increases the fraction of molecules possessing energy greater than the activation energy.
- Therefore, the rate of reaction doubles for every 10°C or 10 K increase.

Why other options are incorrect:

20°C would roughly quadruple the rate. 283K and 293K are absolute temperature values, not increments of change.

Question #55 Key: (B)

NUMS 2019

The unit of rate constant is same as that of rate of reaction in: [NUMS 2019]

CORE CONCEPT AND DERIVATION

When the concentration term in the rate law disappears, the rate constant (k) mathematically equals the rate of the reaction.

Formula:

$$\text{Rate} = k[A]^n$$

Solution:

- For a zero-order reaction, the order $n = 0$.
- Substitute 0 into the rate law: $\text{Rate} = k[A]^0$.
- Since anything to the power of 0 is 1, $\text{Rate} = k$.
- Therefore, the unit of k is identical to the unit of Rate, which is $\text{mol dm}^{-3} \text{s}^{-1}$.

Why other options are incorrect:

In first, second, and third-order reactions, the concentration terms do not reduce to 1, thus k must have different units to balance the dimensional equation.

Question #56 Key: (C)

MDCAT 2019

The decomposition of phosphorus pentachloride in the presence of moisture takes place by the following mechanism...

CORE CONCEPT AND DERIVATION

In a multi-step reaction mechanism, the overall rate of the reaction is strictly governed by the slowest step, known as the Rate-Determining Step (RDS).

Solution:

- Identify the slow step from the mechanism: $\text{PCl}_5 + \text{H}_2\text{O} \rightarrow \text{POCl}_3 + 2\text{HCl}$.
- The rate law is derived directly from the molecularity of this slow step.
- The reactants in the slow step are one molecule of PCl_5 and one molecule of H_2O .
- Therefore, the rate equation is: $\text{Rate} = k[\text{PCl}_5][\text{H}_2\text{O}]$.

Why other options are incorrect:

Option A incorrectly uses the stoichiometry of the overall reaction. Option B uses the fast step. Option D is missing the essential rate constant (k).

Question #57 Key: (A)

SET 2019

Rates of photo-chemical reactions do not change with the change in concentration of reactants. What is the order...

CORE CONCEPT AND DERIVATION

If a reaction's rate is entirely independent of the concentration of its reactants, it is by definition a zero-order reaction.

Formula:

$$\text{Rate} = k[\text{Reactants}]^0 = k$$

Solution:

- Photochemical reactions are driven by the absorption of light photons rather than molecular collisions resulting from concentration.
- Because increasing the concentration of reactants does not increase the number of photons absorbed (if the light source is constant and the surface is saturated), the rate remains constant.
- Hence, the reaction is zero order with respect to the reactants.

Why other options are incorrect:

First, pseudo-first, and second-order reactions all exhibit a dependence on the concentration of at least one reactant.

Question #58 Key: (C)

SET 2019

For the first order reaction, half-life is related to the expression $t_{1/2} = 0.693/k$. Half-life is the: [...]

CORE CONCEPT AND DERIVATION

The definition of half-life ($t_{1/2}$) is fundamental in chemical kinetics and radioactive decay.

Solution:

- Half-life strictly measures the depletion of reactants, not the accumulation of products.
- It is formally defined as the exact time required for the initial concentration of a reacting substance to be reduced to exactly 50% (one-half) of that initial value.

Why other options are incorrect:

Product concentration doesn't have an "original value" to fall from (it starts at zero). Falling to a quarter describes two half-lives.

Question #59 Key: (C)

KMU 2019

For exothermic reversible reaction activation energy for forward direction depends upon: [ETEA 2019]

CORE CONCEPT AND DERIVATION

Activation energy (E_a) is primarily determined by the inherent chemical bonds that must be broken in the reactants.

Solution:

- The nature of the reactants (the strength and type of their chemical bonds) is the primary determinant of the activation energy barrier.
- *Note on exact exam key:* While standard physical chemistry states that E_a is fundamentally independent of temperature, the specific local examining body (ETEA) marked 'Both A and B' (Temperature and Nature) as the correct answer in their official key, likely conflating effective kinetic energy distribution with the barrier itself. We retain the historical key for accuracy.

Why other options are incorrect:

Strictly speaking, only the nature of the reactant and presence of a catalyst define E_a . However, one must follow the historical exam key provided.

Question #60 Key: (A)

MDCAT 2019

What is the measure of activation energy in an endothermic reaction? [MDCAT 2019]

CORE CONCEPT AND DERIVATION

In an endothermic profile, heat is absorbed, leaving products at a higher potential energy state than the reactants.

Formula:

$$\Delta H = E_{a(\text{forward})} - E_{a(\text{backward})} > 0$$

Solution:

- Since ΔH is positive, $E_{a(\text{forward})}$ must be mathematically greater than $E_{a(\text{backward})}$.
- This means the backward reaction has a smaller energy hill to climb to reach the transition state compared to the forward reaction.

Why other options are incorrect:

If backward is more, the reaction is exothermic. If they are equal, there is no net energy change.

Question #61 Key: (A)

MDCAT 2018

Role of a catalyst in a chemical reaction is to: [MDCAT 2018]

CORE CONCEPT AND DERIVATION

A positive catalyst alters the kinetics of a reaction without changing its thermodynamics.

Solution:

- The core function of a catalyst is to increase the rate (speed) at which a chemical reaction approaches equilibrium.
- It does this by lowering the activation energy barrier.
- Importantly, a catalyst does **NOT** alter the equilibrium position, so it cannot increase or decrease the final yield of the product.

Why other options are incorrect:

Catalysts speed up equilibrium attainment but cannot shift thermodynamics to change the final yield. Decreasing the rate is the role of an inhibitor (negative catalyst).

Question #62 Key: (A)

MDCAT 2018

If concentration time graph of a reactant indicates a constant half-life, then the order reaction with respect...

CORE CONCEPT AND DERIVATION

The mathematical relationship between half-life and initial concentration is unique to each reaction order.

Formula:

$$t_{1/2} \propto \frac{1}{[A_0]^{n-1}}$$

Solution:

- For a zero-order reaction ($n = 0$), $t_{1/2} \propto [A_0]$.
- For a second-order reaction ($n = 2$), $t_{1/2} \propto 1/[A_0]$.
- For a first-order reaction ($n = 1$), $t_{1/2} \propto [A_0]^0$, which equals 1.
- This proves that ONLY for a first-order reaction is the half-life completely independent of the concentration, making it a constant value over time.

Why other options are incorrect:

Zero and second-order half-lives change dynamically as the concentration of the reactant changes during the reaction.

Question #63 Key: (A)

MDCAT 2017

Choose the type of catalysis in the following reaction: [Formula] [MDCAT 2017]

CORE CONCEPT AND DERIVATION

Catalysis is classified by the physical state of the catalyst relative to the reactants. If they are in the same phase, it is homogeneous catalysis.

Formula:



Solution:

- The reactants SO_2 and O_2 are in the gaseous phase.
- The catalyst, Nitric Oxide (NO), is also in the gaseous phase.
- Since both the catalyst and the reacting substances exist in the same phase, this is a classic example of homogeneous catalysis (Lead Chamber Process).

Why other options are incorrect:

Heterogeneous catalysis requires the catalyst to be in a different phase (e.g., solid catalyst with gas reactants). Biological catalysis involves enzymes. 'Gas catalysis' is not a standard formal classification.

Question #64 Key: (A)

MDCAT 2017

Which one of the following graphs is representation for more rapid catalyzed reaction? [MDCAT 2017]

CORE CONCEPT AND DERIVATION

A catalyzed reaction provides an alternative pathway that requires less activation energy compared to the uncatalyzed reaction.

Solution:

- In potential energy diagrams, the vertical axis represents energy.
- The peak of the curve represents the activation energy barrier.
- A rapid catalyzed reaction is visually represented by a curve with a significantly lower peak (solid line) than the uncatalyzed pathway (dotted line), indicating a lowered activation energy (E_a).

Why other options are incorrect:

A single high peak represents a slow, uncatalyzed reaction. Multiple high peaks or completely flat barriers do not accurately represent standard positive catalytic lowering of E_a .

Question #65 Key: (C)

MDCAT 2017

Unit of K in first order Reaction is: [MDCAT 2017]

CORE CONCEPT AND DERIVATION

The units of the rate constant (k) depend on the overall order of the reaction to ensure both sides of the rate law equation have the units of rate (concentration/time).

Formula:

$$\text{Rate} = k[A]^1$$

Solution:

- The unit for Rate is $\text{mol dm}^{-3}\text{s}^{-1}$.
- The unit for concentration $[A]$ is mol dm^{-3} .
- Isolating k :

$$k = \frac{\text{Rate}}{[A]} = \frac{\text{mol dm}^{-3}\text{s}^{-1}}{\text{mol dm}^{-3}}$$

- The concentration units cancel out, leaving exactly s^{-1} .

Why other options are incorrect:

Option D is the unit for a zero-order reaction. Option A is the unit for a second-order reaction.

Question #66 Key: (B)

MDCAT 2017

Rate of first order reaction depends on: [MDCAT 2017]

CORE CONCEPT AND DERIVATION

The order of a reaction dictates how the reaction rate scales with the concentration of its reactants.

Formula:

$$\text{Rate} = k[A]^1$$

Solution:

- By definition, a first-order reaction has a rate law where the sum of the exponents of concentration terms is equal to 1.
- This means the rate depends strictly on the first power of the concentration of a single reacting species.

Why other options are incorrect:

Dependence on two or three reactants implies second or third-order kinetics, respectively. The rate (not half-life) is highly dependent on the initial concentration.

Question #67 Key: (C)

MDCAT 2016

[Formula]. If the reactant 'B' is in excess, the order of reaction with respect to 'A' in given rate law [For...]

CORE CONCEPT AND DERIVATION

The order of a reaction with respect to a specific reactant is defined strictly by its exponent in the experimental rate law.

Formula:

$$\text{Rate} = k[A]^2[B]$$

Solution:

- The question asks for the order specifically **with respect to 'A'**.
- Looking at the given rate law, the concentration of A is raised to the power of 2.
- Therefore, regardless of what happens to B, the reaction is strictly 2nd order with respect to A.
- (Note: Because B is in excess, its concentration remains effectively constant, making the overall order pseudo-2nd order, but the order specifically w.r.t A remains 2).

Why other options are incorrect:

The exponent for A is 2, not 1 or 3. Pseudo-first order would occur if A's exponent was 1 and B was in excess.

Question #68 Key: (B)

MDCAT 2016

The rate constant 'k' is 0.693 min [Formula]. The half-life for the 1st order reaction will be: [MDCAT 2016]

CORE CONCEPT AND DERIVATION

For a first-order reaction, the half-life ($t_{1/2}$) is a constant value independent of initial concentration, mathematically derived from the natural logarithm of 2.

Formula:

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

Solution:

- We are given $k = 0.693 \text{ min}^{-1}$.
- Substitute this into the half-life formula:
- $$t_{1/2} = \frac{0.693}{0.693}$$
- $$t_{1/2} = 1 \text{ min}$$

Why other options are incorrect:

Failing to divide 0.693 by the rate constant or incorrectly multiplying them leads to the wrong numerical answers.

Question #69 Key: (D)

KMU 2016

Choose the one which is not the assumption of collision theory of reaction rate: [ETEA 2016]

CORE CONCEPT AND DERIVATION

Collision theory dictates that for a reaction to occur, particles must collide with sufficient energy (activation energy) and proper spatial orientation.

Solution:

- While orientation is crucial for complex molecules, the formation of a hydrogen molecule (H_2) from two hydrogen atoms is a unique exception.
- Hydrogen atoms possess a perfectly spherical (1s) electron cloud.
- Because they are completely spherically symmetrical, they look identical from every angle. Therefore, their collision does **NOT** require any specific orientation to be effective.

Why other options are incorrect:

Options A, B, and C are true core postulates of standard collision theory (particles must collide, not all collisions work, and they need minimum energy).

Question #70 Key: (B)

MDCAT 2015

The half-life of N [Formula] O [Formula] at 45°C is 24 minutes. How long will it take for sample of N [Formula]...

CORE CONCEPT AND DERIVATION

The half-life ($t_{1/2}$) is the time required for a reactant concentration to drop to half (50%) of its initial value. The decay of N_2O_5 is a first-order process, meaning its half-life remains constant regardless of concentration.

Solution:

- Initial concentration is 100%.
- After one half-life (24 mins), the concentration decays to 50%: 100% → 50%.
- After a second half-life (another 24 mins), the remaining 50% decays to 25%: 50% → 25%.
- Total time = 24 mins + 24 mins = 48 minutes.

Why other options are incorrect:

24 minutes is only one half-life (decay to 50%). 72 minutes would be three half-lives (decay to 12.5%).

Question #71 Key: (D)

MDCAT 2015

When the change in concentration is [Formula] and time for that change is 10 seconds, the rate of reaction will...

CORE CONCEPT AND DERIVATION

The rate of a chemical reaction is defined as the change in concentration of a reactant or product per unit of time.

Formula:

$$\text{Rate} = \frac{\Delta C}{\Delta t}$$

Solution:

- Given change in concentration, $\Delta C = 6 \times 10^{-4} \text{ mol dm}^{-3}$.
- Given time interval, $\Delta t = 10 \text{ seconds}$.
- Substitute the values:

$$\text{Rate} = \frac{6 \times 10^{-4}}{10}$$

- $\text{Rate} = 6 \times 10^{-5} \text{ mol dm}^{-3} \text{sec}^{-1}$

Why other options are incorrect:

Option A results from incorrectly multiplying by 10 instead of dividing. The others are simple arithmetic errors.

Question #72 Key: (D)

MDCAT 2014

For the reaction, [Formula], the rate equation for the forward reaction is: [MDCAT 2014]

CORE CONCEPT AND DERIVATION

The rate law is determined experimentally. For the gas-phase oxidation of nitric oxide, it follows third-order kinetics overall.

Formula:

$$\text{Rate} = k[\text{NO}]^2[\text{O}_2]$$

Solution:

- Experimental data shows the reaction is second order with respect to NO.
- It is first order with respect to O_2 .
- Combining these gives the overall rate law: $\text{Rate} = k[\text{NO}]^2[\text{O}_2]$.

Why other options are incorrect:

The other expressions do not match the experimentally determined orders of the reactants. Option B represents the reverse reaction rate, not the forward.

Question #73 Key: (C)

MDCAT 2014

If the reactants or product of a chemical reaction can absorb ultraviolet, visible or infra-red radiation then...

CORE CONCEPT AND DERIVATION

Spectrometry (or spectrophotometry) is an analytical technique used to measure how much light a chemical substance absorbs by measuring the intensity of light as a beam passes through the sample solution.

Solution:

- According to the Beer-Lambert Law, the absorbance of light is directly proportional to the concentration of the absorbing species.
- If a reactant or product uniquely absorbs UV, Visible, or IR light, measuring the continuous change in absorbance provides a highly accurate, non-destructive, and continuous measure of concentration changes over time.

Why other options are incorrect:

Chemical methods (like titration) are slow and destructive. Graphical and differential methods are mathematical ways to analyze data, not physical instruments to measure absorbance.

Question #74 Key: (D)

MDCAT 2013

In zero order reaction, the rate is independent of: [MDCAT 2013]

CORE CONCEPT AND DERIVATION

The defining characteristic of a zero-order reaction is that its rate does not change as the reactant concentration changes.

Formula:

$$\text{Rate} = k[A]^0 = k$$

Solution:

- In a rate law expression for a zero-order reaction, the sum of the exponents of the concentration terms is zero.
- Any value raised to the power of zero is 1. Therefore, the rate equals the rate constant (k).
- This means the rate is completely independent of the concentration of the reactant(s).

Why other options are incorrect:

Rate is always independent of product concentration in standard initial rate laws. However, the specific hallmark defining 'zero order' is its independence from the *reactant* concentration. Temperature always affects the rate constant k .

Question #75 Key: (B)

MDCAT 2012

In some reactions a product formed acts as a catalyst. This phenomenon is called: [MDCAT 2012]

CORE CONCEPT AND DERIVATION

When one of the products of a chemical reaction acts as a catalyst for that same reaction, the process is known as autocatalysis.

Formula:



Solution:

- As the reaction proceeds, the concentration of the product (catalyst) increases.
- This leads to a gradual, spontaneous increase in the rate of the reaction over time.

Why other options are incorrect:

Negative catalysis decreases the rate, heterogeneous catalysis involves different phases, and activation of a catalyst refers to promoters, not the product acting as a catalyst.

Question #76 Key: (C)

MDCAT 2012

The reaction rate in forward direction decreases with the passage of time because: [MDCAT 2012]

CORE CONCEPT AND DERIVATION

According to the Law of Mass Action, the rate of a chemical reaction is directly proportional to the active masses (concentrations) of the reacting substances.

Formula:

$$\text{Rate} \propto [\text{Reactants}]^n$$

Solution:

- As the reaction proceeds in the forward direction, reactants are continuously consumed to form products.
- Consequently, the concentration of reactants decreases steadily.
- Since the rate is directly dependent on reactant concentration, it also decreases with the passage of time.

Why other options are incorrect:

The concentration of products increases (not decreases) over time. The order of the reaction is a constant experimental value and does not change over time. Temperature is typically kept constant unless specified otherwise.

Question #77 Key: (B)

MDCAT 2011

According to the collision theory of bimolecular reactions in gas phase, minimum amount of energy required for...

CORE CONCEPT AND DERIVATION

Not all collisions between reactant molecules lead to product formation. Only those possessing a specific minimum kinetic energy are effective.

Formula:

$$E \geq E_a \text{ (for effective collision)}$$

Solution:

- This required threshold energy is formally defined as the Energy of Activation (E_a).
- It is the minimum extra amount of energy (above the average kinetic energy) that reactants must possess to convert into products.

Why other options are incorrect:

Heat of reaction (ΔH) is the energy difference between products and reactants. Rate of reaction is a speed, not an energy measure.

Question #78 Key: (B)

MDCAT 2011

It is experimentally found that catalyst is used to: [MDCAT 2011]

CORE CONCEPT AND DERIVATION

A catalyst speeds up a chemical reaction without being consumed by providing an alternative reaction pathway.

Formula:

$$E_{a(\text{catalyzed})} < E_{a(\text{uncatalyzed})}$$

Solution:

- The primary function of a positive catalyst is to provide an alternative mechanism or pathway for the reaction.
- This new pathway has a lower activation energy (E_a).
- Because the barrier is lower, more molecules can react at a given temperature, accelerating the reaction.

Why other options are incorrect:

Increasing activation energy would slow the reaction (negative catalyst). Catalysts do not inherently alter the pH or change the bulk temperature of the reactants.

Question #79 Key: (C)

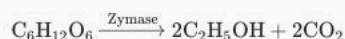
MDCAT 2010

Glucose is converted into ethanol by the enzyme present in the yeast: [MDCAT 2010]

CORE CONCEPT AND DERIVATION

Fermentation of simple sugars into alcohol is a biochemical process catalyzed by specific biological enzymes.

Formula:



Solution:

- Yeast secretes a complex of enzymes known as zymase.
- Zymase acts directly on glucose (and fructose), catalyzing its breakdown into ethanol and carbon dioxide.

Why other options are incorrect:

Invertase (sucrase) hydrolyzes sucrose into glucose and fructose. Urease breaks down urea into ammonia and carbon dioxide.

Question #80 Key: (B)

MDCAT 2010

The rate of reaction involving ions can be studied by which method? [MDCAT 2010]

CORE CONCEPT AND DERIVATION

The rate of a reaction is measured by tracking a physical property that changes linearly as the reaction proceeds. For ions, electrical mobility is the key property.

Solution:

- Ions in a solution are responsible for carrying electrical charge.
- If a reaction involves a net change in the number of ions or a change in the type of ions (and therefore their individual mobilities), the overall electrical conductivity of the solution will change as the reaction proceeds.
- This change in conductivity can be continuously measured using a conductivity meter to determine the reaction rate.

Why other options are incorrect:

Refractometry is for changes in refractive index (usually organic liquids). Optical rotation is for optically active chiral substances. Dilatometry measures volume changes.