Chemical Kinetics

Fill in the blanks

1. Molecularity is the number of reacting species taking part in an _____ reaction.
   Answer: elementary
2. A reaction involving only one reacting species is called a _____ reaction.
   Answer: unimolecular
3. In the reaction $NH_4NO_2 \rightarrow N_2 + 2H_2O$, the molecularity is _____.
   Answer: one
4. A reaction involving collision between two reacting species is called a _____ reaction.
   Answer: bimolecular
5. In the reaction $2HI \rightarrow H_2 + I_2$, the molecularity is _____.
   Answer: two
6. Reactions involving simultaneous collision of three reacting species are called _____ reactions.
   Answer: trimolecular
7. The reaction $2NO + O_2 \rightarrow 2NO_2$ is an example of a _____ reaction.
   Answer: termolecular
8. Molecularity can never be zero or _____.
   Answer: fractional
9. Complex reactions occur in several elementary _____.
   Answer: steps

10. The slowest step in a reaction mechanism is called the rate _____ step.
Answer: determining
11. Species formed during reaction but absent in the overall balanced equation are called _____.
Answer: intermediates
12. In the decomposition of hydrogen peroxide, IO^- acts as an _____.
Answer: intermediate
13. Order of a reaction is an _____ quantity.
Answer: experimental
14. Molecularity is applicable only for _____ reactions.
Answer: elementary
15. For complex reactions, the overall rate depends on the _____ step.
Answer: slowest
16. Molecularity is always a positive _____ number.
Answer: whole
17. The decomposition of hydrogen peroxide in alkaline medium is catalysed by _____ ion.
Answer: iodide
18. The rate determining step controls the overall _____ of reaction.
Answer: rate
19. Simultaneous collision of more than three molecules is highly

_____.
Answer: improbable

20. For complex reactions, molecularity of the slowest step is equal to the _____ of the overall reaction.
Answer: order

Short QAs

1. **What is molecularity of a reaction?**
Molecularity is the number of reacting species that collide simultaneously in an elementary reaction.

2. **What is a unimolecular reaction?**
A unimolecular reaction involves only one reacting species.

3. **Give an example of a unimolecular reaction.**
$NH_4NO_2 \rightarrow N_2+2H_2O$

4. **What is a bimolecular reaction?**
A bimolecular reaction involves simultaneous collision between two reacting species.

5. **Give an example of a bimolecular reaction.**
$2HI \rightarrow H_2+I_2$

6. **Why are termolecular reactions rare?**
Termolecular reactions are rare

because simultaneous collision of three molecules is highly improbable.

7. **What is a rate determining step?**
   The slowest step in a reaction mechanism that controls the overall rate of reaction is called the rate determining step.

8. **What is an intermediate in a reaction?**
   An intermediate is a species formed during the reaction but absent in the overall balanced equation.

9. **How does molecularity differ from order of reaction?**
   Molecularity is always a whole number and applies only to elementary reactions, whereas order may be zero or fractional and is determined experimentally.

10. **What controls the rate of a complex reaction?**
    The slowest step, called the rate determining step, controls the rate of a complex reaction.

MCQs

1. **Molecularity of a reaction refers to the number of:**
   A) Products formed
   B) Molecules present in vessel
   C) Reacting species colliding

simultaneously
D) Catalysts used

Answer: C) Reacting species colliding simultaneously

Explanation: Molecularity is the number of atoms, ions, or molecules colliding together in an elementary reaction.

2. **Molecularity is applicable only to:**
   A) Complex reactions
   B) Elementary reactions
   C) Reversible reactions
   D) Nuclear reactions

Answer: B) Elementary reactions

Explanation: Molecularity is defined only for elementary reactions occurring in a single step.

3. **The decomposition of ammonium nitrite is a:**
   $NH_4NO_2 \rightarrow N_2 + 2H_2O$

A) Bimolecular reaction
B) Trimolecular reaction
C) Unimolecular reaction
D) Complex reaction

Answer: C) Unimolecular reaction

Explanation: Only one reacting species participates in the reaction.

4. **A bimolecular reaction involves collision between:**
   A) One species
   B) Two species
   C) Three species
   D) Four species

Answer: B) Two species

Explanation: Two reacting particles collide simultaneously in a bimolecular reaction.

5. **The reaction $2HI \rightarrow H_2 + I_2$ is:**

A) Unimolecular
B) Bimolecular
C) Trimolecular
D) Photochemical
Answer: B) Bimolecular
Explanation: Two HI molecules participate in the elementary step.

6. **Trimolecular reactions involve simultaneous collision of:**
   A) One species
   B) Two species
   C) Three species
   D) Four species

Answer: C) Three species
Explanation: Three reacting species collide together in a trimolecular reaction.

7. **Which reaction is termolecular?**

A) $NH_4NO_2 \rightarrow N_2 + 2H_2O$
B) $2HI \rightarrow H_2 + I_2$
C) $2NO + O_2 \rightarrow 2NO_2$
D) $H_2 + Cl_2 \rightarrow 2HCl$
Answer: C) $2NO + O_2 \rightarrow 2NO_2$
Explanation: Three reacting species participate simultaneously.

8. **Reactions with molecularity three are generally:**
   A) Very fast
   B) Very common
   C) Rare and slow
   D) Instantaneous

Answer: C) Rare and slow
Explanation: Simultaneous collision of three molecules is highly improbable.

9. **Molecularity can never be:**
   A) Positive
   B) Whole number
   C) Fractional
   D) Integer

Answer: C) Fractional
Explanation: Molecularity is always a positive whole number.

10. **Complex reactions occur in:**
   A) One step only
   B) Several elementary steps
   C) Nuclear steps
   D) No steps

Answer: B) Several elementary steps
Explanation: Complex reactions proceed through multiple elementary reactions.

11. **The slowest step in a reaction mechanism is called:**
   A) Fast step
   B) Intermediate step
   C) Rate determining step
   D) Reversible step

Answer: C) Rate determining step
Explanation: The slowest step controls the overall reaction rate.

12. **The overall rate of a complex reaction depends on:**
   A) Fastest step
   B) Product concentration
   C) Slowest step
   D) Catalyst only

Answer: C) Slowest step
Explanation: The rate determining step decides the overall speed.

13. **Species formed during reaction but absent in overall equation are called:**

A) Catalysts
B) Intermediates
C) Products
D) Inhibitors

Answer: B) Intermediates
Explanation: Intermediates are produced in one step and consumed in another.

14. **In decomposition of H_2O_2, IO^- acts as:**

$$H_2O_2 + I^- \rightarrow H_2O + IO^-$$

A) Catalyst
B) Product
C) Intermediate
D) Reactant

Answer: C) Intermediate
Explanation: IO^- is formed during reaction but absent in the final equation.
Hydrogen peroxide (H_2O_2) acts as an oxidizing agent.
Iodide ion (I^-) is oxidized to hypoiodite ion (IO^-).
Hydrogen peroxide is reduced to water.
Oxidation States
In I^-, iodine has oxidation number -1.
In IO^-, iodine has oxidation number +1.
Since the **oxidation number of iodine increases from −1 to +1,** iodide is oxidized.

15. **Order of a reaction is:**

A) Always whole number
B) Always positive integer

C) Experimental quantity
D) Same as molecularity always

Answer: C) Experimental quantity
Explanation: Order is determined experimentally and may be fractional or zero.

16. **Which statement about molecularity is correct?**
A) It can be zero
B) It can be fractional
C) It is always a whole number
D) It is always negative

Answer: C) It is always a whole number
Explanation: Molecularity cannot be fractional or zero.

17. **For complex reactions, molecularity has:**
A) Great importance
B) No meaning
C) Fractional value
D) Negative value

Answer: B) No meaning
Explanation: Molecularity is defined only for elementary reactions.

18. **In complex reactions, overall order is determined by:**
A) Fastest step
B) Number of products
C) Slowest step
D) Catalyst concentration

Answer: C) Slowest step
Explanation: The rate determining step governs the order and rate.

19. **The decomposition of hydrogen peroxide in alkaline medium is catalysed by:**

A) Chloride ion
B) Sulphate ion
C) Iodide ion
D) Nitrate ion

Answer: C) Iodide ion
Explanation: Iodide ion catalyses decomposition of H_2O_2.

20. **For the rate law:**

$$r = k[A]^{1/2}[B]^2$$

What is the overall order of the reaction?

A) 1
B) 2
C) 5/2
D) 3

Answer: C) 5/2
Explanation: Overall order equals sum of powers of concentration terms.