

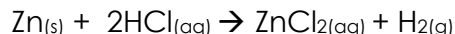
Chemistry 12

Reaction Kinetics Review Package

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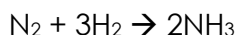
I. Multiple Choice

1. Which of the following properties could be used to measure the rate of the following reaction taking place in an open container?



- A. mass of Zn
B. solubility of HCl
C. concentration of Cl⁻ ions
D. colour of the solution

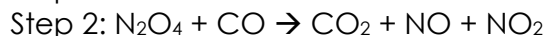
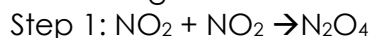
2. Consider the following reaction where all reactants and products are gases:



The rate of formation of NH₃ is 3.0 mL/min at STP. The rate of consumption of H₂ is

- A. 1.5 mL/min
B. 2.0 mL/min
C. 4.5 mL/min
D. 9.0 mL/min

3. Consider the following reaction mechanism:



In the overall reaction, N₂O₄ is a:

- A. product.
B. catalyst.
C. reactant.
D. reaction intermediate.

4. The minimum amount of energy needed to start a reaction is called the:

- A. activation energy.
B. energy of reaction.
C. entropy of reaction.
D. reaction mechanism energy.

5. An 8.00 g piece of magnesium was placed into 6.0 M HCl. After 25 s, 3.50 g of unreacted magnesium remained. The average rate at which magnesium was consumed is

- A. 0.14 g/s
B. 0.18 g/s
C. 0.32 g/s
D. 4.50 g/s

6. In general, reaction rates double when the temperature is increased by 10°C. The temperature of a reaction is increased by 40°C. The rate of the reaction will increase by a factor of:

- A. 2
B. 4
C. 8
D. 16

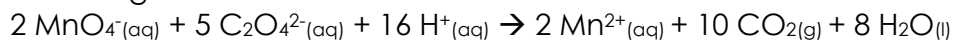
7. Consider the following factors:

- I. reactant particles collide
II. sufficient kinetic energy is present
III. a favourable geometry exists
IV. catalysts are present

Which combination of the above factors is required for all successful collisions?

- A. I only
B. II and III only
C. I, II and III only
D. I, II, III and IV

8. Consider the following reaction:



The rate of decomposition of the oxalate ion ($\text{C}_2\text{O}_4^{2-}$) is increased by

- A. adding NaOH.
- B. removing CO_2 .
- C. adding a catalyst.
- D. decreasing the pressure

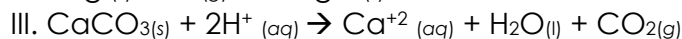
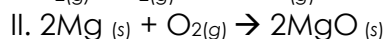
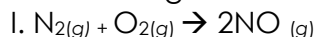
9. Consider the following reaction:



Under certain conditions, the rate of decomposition of NO_2 is 3.2×10^{-3} mol/s. The rate of formation of O_2 is:

- A. 1.6×10^{-3} mol/s
- B. 3.2×10^{-3} mol/s
- C. 4.8×10^{-3} mol/s
- D. 6.4×10^{-3} mol/s

10. Consider the following reactions:



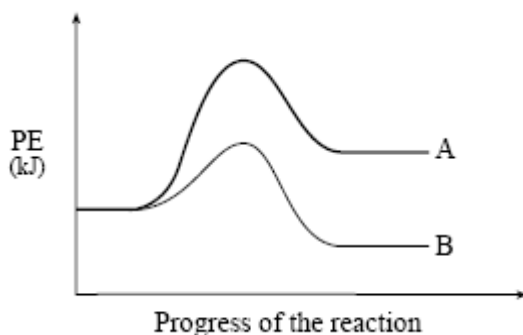
Increasing the surface area will increase the reaction rate in

- A. II only
- B. I and III only
- C. II and III only
- D. I, II and III

11. A catalyst increases the rate of a reaction by:

- A. increasing the concentration of the reactant(s).
- B. decreasing the concentration of the reactant(s).
- C. increasing the activation energy of the overall reaction.
- D. decreasing the activation energy of the overall reaction.

12. Consider the following potential energy diagram that represents two different reactions.



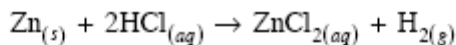
Which of the following statements is correct?

- A. Reactions A and B are both exothermic.
- B. Reactions A and B are both endothermic.
- C. Reaction A is exothermic and reaction B is endothermic.
- D. Reaction A is endothermic and reaction B is exothermic.

18. Which of the following is most likely to have the **greatest** reaction rate at room temperature?

- A. $2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{l})$
- B. $2 \text{Ag}^+(\text{aq}) + \text{CrO}_4^{2-}(\text{aq}) \rightarrow \text{Ag}_2\text{CrO}_4(\text{s})$
- C. $\text{Pb}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{PbCl}_2(\text{aq}) + \text{H}_2(\text{g})$
- D. $\text{CH}_4(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$

19. Consider the following reaction involving 10.0 g of powdered zinc:

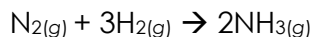


Trial	Temperature (°C)	Concentration of HCl
1	40	3.0
2	20	3.0
3	40	6.0

The rates, in order of fastest to slowest, are

- A. 1, 2, 3
- B. 2, 1, 3
- C. 3, 1, 2
- D. 3, 2, 1

20. Consider the following reaction:



If the rate of formation of NH_3 is 4.0×10^{-4} mol/s, then the rate of consumption of H_2 is

- A. 2.0×10^{-4} mol/s
- B. 4.0×10^{-4} mol/s
- C. 6.0×10^{-4} mol/s
- D. 1.2×10^{-3} mol/s

21. Consider the following reaction:



Which of the following could be used to monitor the reaction rate in an **open** system?

- I. Balance*
- II. Pressure gauge*
- III. pH Meter*

- A. I and II only.
- B. I and III only
- C. II and III only.
- D. I, II, and III

22. Which of the following changes occur when the temperature of a reaction is increased?

- I. ΔH of the reaction increases*
- II. Frequency of the collisions increases*
- III. Kinetic energy of the reactants increases*

- A. I and II only.
- B. I and III only.
- C. II and III only.
- D. I, II and III.

23. Which of the following is true for an activated complex?

- A. stable and has low PE
- B. stable and has high PE
- C. unstable and has low PE
- D. unstable and has high PE

24. As you increase the temperature of a reaction, the:

- A. rate increases and the time required for the reaction increases.
- B. rate increases and the time required for the reaction decreases.
- C. rate decreases and the time required for the reaction increases.
- D. rate decreases and the time required for the reaction decreases.

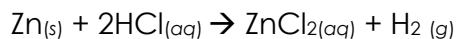
25. Consider the following reactions in open systems:

- I. $2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{g})$
- II. $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
- III. $\text{CaO}(\text{s}) + \text{SiO}_2(\text{s}) \rightarrow \text{CaSiO}_3(\text{s})$
- IV. $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{AgCl}(\text{s})$

In which of the above could reaction rate be determined by a change in mass?

- A. I
- B. II
- C. III
- D. IV

26. Consider the following reaction:



Which of the following would increase the reaction rate?

- A. an increase in pressure
- B. an increase in temperature
- C. an increase in the concentration of H_2
- D. an increase in the concentration of ZnCl_2

II. Short Answers:

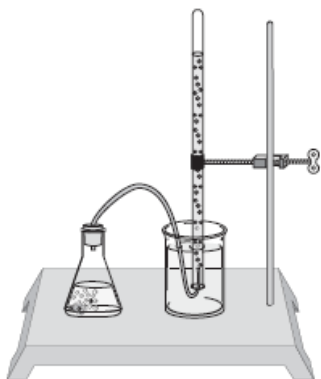
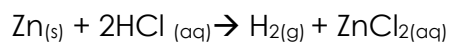
1) When solid sodium is placed in water at room temperature, an immediate, violent reaction occurs:



a) Describe two methods that could be used to experimentally determine the rate of reaction.

b) Would you expect the activation energy of this reaction to be high or low? Explain, using collision theory.

2) An experiment is performed by displacement of water to determine the rate of the following reaction:



The following data is collected:

Time (s)	Volume of H ₂ (mL)
0.0	0.0
10.0	21.1
20.0	40.9
30.0	60.0
40.0	77.6

a) Calculate the average rate of formation of H₂ in mL s for the time interval between 20 and 40 seconds.

b) How does the rate of this reaction change as the reaction proceeds? Explain why.

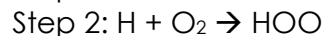
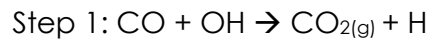
3) The combustion of coal, C, produces carbon dioxide gas according to the following equation:



- a) What is the value of ΔH for this reaction? Is this reaction endothermic or exothermic?

 - b) Using collision theory, explain why a lump of coal does not react with oxygen at room temperature and pressure.

 - c) Many coal mine disasters have resulted when a spark ignites coal dust in the air. Explain, using collision theory.
- 4) One of the reactions in the production of smog involves the oxidation of nitrogen monoxide. A possible mechanism for this reaction is:



- a) Write the balanced equation for the overall reaction.

- b) Identify all reaction intermediates.

- c) Identify the catalyst.

Answers:

I. Multiple Choice:

- | | | | | | |
|------|-------|-------|-------|-------|-------|
| 1) A | 6) D | 11) D | 16) A | 21) B | 26) B |
| 2) C | 7) C | 12) D | 17) B | 22) C | |
| 3) D | 8) C | 13) C | 18) B | 23) D | |
| 4) A | 9) A | 14) A | 19) C | 24) B | |
| 5) B | 10) C | 15) A | 20) C | 25) D | |

II. Short Answers:

- a) Change of mass of Na, change of pressure, change of volume of H₂, change of temperature, change of pH.

b) E_a of this reaction would be low because reaction is so exothermic, meaning very spontaneous.
- a) 1.84mL/s

b) Rate of reaction would decrease over time as [HCl] decreases over time.
- a) -394kJ/mol; exothermic

b) Most likely due to the fact that the reaction requires a high E_a.

c) The spark provides the necessary E_a for the reaction to begin, and once it begins, the reaction is very exothermic, thus explosive.
- a) $\text{NO} + \text{CO} + \text{O}_2 \rightarrow \text{NO}_2 + \text{CO}_2$

b) H and HOO

c) OH