Class: 9th

Subject: Chemistry

Chapter 5: Energetics

Exercise MCQs:

(i) From where does the energy come to break the bonds of H_2 and Cl_2?

(a) By collisions between the molecules ✅

(b) From sunlight

(c) From the surrounding

(d) By collisions of the molecules with the walls of the container

(ii) Which of the following reactions has the least value of activation energy?

(a) $H_2(g) + O_2(g) \Rightarrow H_2O(g)$

(b) $C(s) + O_2(g) \Rightarrow CO_2(g)$

(c) $NaCl(aq) + AgNO_3(aq) \Rightarrow AgCl(s) + NaNO_3(aq)$ ✅

(d) $H_2(g) + I_2(s) \Rightarrow 2HI(g)$

(iii) Formation of which hydrogen halide from the elements is an endothermic reaction?

(a) HCl

(b) HF ✅

(c) HBr

(d) HI

(iv) What are the products of anaerobic respiration?

(a) ATP + CO_2 + H_2O

(b) ATP + Ethanol + CO_2 ✅

(c) CO_2 + H_2O

(d) Ethanol + H_2O

(v) What does it show when a chemical reaction is exothermic?

(a) It shows the bonds which break are weaker than those are formed. ✅

(b) It shows the bond which break are stronger than those are formed.

(c) Exothermic nature of the reaction is not concerned with bond formation or bond breakage.

(d) It shows that the reactants are more stable than the products.

(vi) When NaOH and HCl are mixed the temperature increases. The reaction is:

(a) endothermic with a positive enthalpy change.

(b) endothermic with a negative enthalpy change.

(c) exothermic with a positive enthalpy change.

(**d**) exothermic with a negative enthalpy change. ✅

(vii) The average bond dissociation energy for the C-H bond is 412 kJ mol^{-1}. Which of the following processes will have enthalpy change close to 412 kJ mol^{-1}?

(a) $CH_4(g) \Rightarrow C(g) + 2H_2(g)$

(b) $CH_4(g) \Rightarrow C(g) + 2H_2(g)$

(c) $CH_4(g) \Rightarrow C(g) + 4H(g)$ ✅

(d) $CH_4(g) \Rightarrow CH_3(g) + H(g)$

(Viii) The average bond energies for O–O and O=O are 146 and 496 kJ mol^{-1} respectively. Find the enthalpy (ΔH) in kJ for the reaction:

H–O–O–H ⇒ H–O–H + 1/2 O=O

(a) -102 kJ

(b) +102 kJ ✅

(c) +350 kJ

(d) +394 kJ

(ix) Why does the following exothermic reaction not occur?

C (Diamond) ⇒ C (Graphite), ΔH = -3 kJ/mol

(a) Structure of diamond is more stable than that of graphite.

(b) Diamond has stronger covalent bonds than graphite.

(c) The change from diamond to graphite has high activation energy. ✅

(d) Density of graphite is less than that of diamond.

Important MCQs:

1. In chemistry, the part under study is called:

(a) Atom

(b) Molecule

(c) System ✅

(d) Surrounding

2. Everything outside the system is called:

(a) Mixture

(b) Reaction

(c) Compound

(d) Surrounding ✅

3. In an exothermic reaction, heat is:

(a) Absorbed

(b) Released ✅

(c) Remains same

(d) Not involved

4. In an endothermic reaction, heat is:

(a) Released

(b) Emitted

(c) Absorbed ✅

(d) Lost

5. Which sign is used for exothermic change?

(a) +

(b) − ✅

(c) =

(d) ±

6. Which of the following is an endothermic reaction?

(a) $2H_2 + O_2 \Rightarrow 2H_2O$

(b) $C + O_2 \Rightarrow CO_2$

(c) $H_2 + I_2 \Rightarrow 2HI$ ✅

(d) $CH_4 + O_2 \Rightarrow CO_2 + H_2O$

7. Enthalpy is represented by which symbol?

(a) E

(b) H ✅

(c) Q

(d) T

8. The standard conditions for enthalpy are:

(a) 25°C and 1 atm

(b) 100°C and 760 mm

(c) 0°C and 760 mm ✅

(d) 37°C and 1 atm

9. Enthalpy is a measure of:

(a) Pressure

(b) Mass

(c) Energy ✅

(d) Volume

10. The enthalpy change of an exothermic reaction is always:

(a) Zero

(b) Positive

(c) Negative ✅

(d) Constant

11. Heat always flows from:

(a) Cold to hot

(b) Hot to cold ✅

(c) System to surroundings only

(d) Solid to gas

12. Which one is not a component of a system?

(a) Reactants

(b) Products

(c) Burner ✅

(d) Catalyst

13. Heat content of a system is also called:

(a) Kinetic energy

(b) Enthalpy ✅

(c) Temperature

(d) Work

14. In power plants, fuels are burned to produce:

(a) Electricity ✅

(b) Light

(c) Coal

(d) Chemicals

15. Which of the following is an example of an exothermic reaction?

(a) $N_2 + O_2 \Rightarrow 2NO$

(b) $H_2 + I_2 \Rightarrow 2HI$

(c) $C + O_2 \Rightarrow CO_2$ ✅

(d) Melting of ice

16. What does the symbol ΔH represent in thermochemistry?

(a) Heat capacity

(b) Change in enthalpy ✅

(c) Total energy

(d) Energy absorbed

17. Which of the following best defines enthalpy?

(a) Flow of energy between systems

(b) Total heat energy transferred

(c) Total heat content of a system ✅

(d) Amount of work done

18. What is the unit of enthalpy change commonly used in chemical reactions?

(a) Newton

(b) Joule ✅

(c) Kilogram

(d) Liter

19. Why can't total enthalpy (H) of a system be measured directly?

(a) It changes every second

(b) It is unstable

(c) It is an absolute value not measurable directly ✅

(d) It depends on pressure only

20. What is the standard enthalpy change of the reaction: $2CO + O_2 \Rightarrow 2CO_2$?

(a) +566 kJ

(b) -566 kJ ✅

(c) +393.5 kJ

(d) -393.5 kJ

21. What type of reaction absorbs heat from surroundings?

(a) Exothermic

(b) Combustion

(c) Endothermic ✅

(d) Neutralization

22. Which reaction is an example of an exothermic process?

(a) $2HI \Rightarrow H_2 + I_2$

(b) $C + O_2 \Rightarrow CO_2$ ✅

(c) $N_2 + O_2 \Rightarrow 2NO$

(d) $H_2 + I_2 \Rightarrow 2HI$

23. What is the enthalpy change when 1 mole of carbon reacts with oxygen?

(a) -180.6 kJ

(b) +180.6 kJ

(c) -393.5 kJ ✅

(d) +393.5 kJ

24. What happens in an endothermic reaction?

(a) Heat is evolved

(b) Heat is absorbed ✅

(c) Light is released

(d) Temperature of container rises

25. What type of energy transformation takes place in combustion reactions?

(a) Electrical to chemical

(b) Mechanical to thermal

(c) Chemical to heat ✅

(d) Heat to electrical

26. What causes a chemical reaction to take place?

(a) Random movement of molecules

(b) Collision of reactant molecules with sufficient

energy ✅

(c) Temperature change

(d) Presence of light

27. What is the transition state in a chemical reaction?

(a) Reactants before collision

(b) Products after reaction

(c) A high-energy intermediate state during the reaction ✅

(d) A catalyst used in the reaction

28. What does activation energy (Ea) mean?

(a) Energy released during reaction

(b) Energy required to form the transition state ✅

(c) Total energy of reactants

(d) Heat absorbed by products

29. How does a catalyst affect a chemical reaction?

(a) Increases activation energy

(b) Decreases activation energy and increases

reaction rate ✅

(c) Converts products into reactants

(d) Is consumed in the reaction

30. Which catalyst is used in hydrogenation of oil?

(a) Platinum

(b) Nickel ✅

(c) Chlorine

(d) Oxygen

31. Aerobic respiration requires:

(a) Oxygen ✅

(b) Carbon dioxide

(c) Nitrogen

(d) Hydrogen

32. During glycolysis, glucose is converted into:

(a) Two molecules of ethanol

(b) Two molecules of pyruvate ✅

(c) One molecule of carbon dioxide

(d) One molecule of ATP

33. Anaerobic respiration produces energy by converting glucose into:

(a) Carbon dioxide and water

(**b**) Carbon dioxide and ethanol ✅

(c) Oxygen and ethanol

(d) Oxygen and carbon dioxide

34. Glycogen is mainly stored in:

(a) Blood

(**b**) Liver and muscles ✅

(c) Kidneys

(d) Lungs

35. Lipids serve as:

(a) Primary energy source

(b) Structural proteins

(**c**) Energy reserve ✅

(d) Enzymes for digestion

Exercise Short Questions:

i. What is the difference between enthalpy and enthalpy change?

Answer:

- Enthalpy (H) is the total heat content of a system at constant pressure.
- Enthalpy change (ΔH) is the amount of heat released or absorbed during a chemical reaction.

It is calculated as:

- $\Delta H = H(\text{products}) - H(\text{reactants})$
- If ΔH is negative, the reaction is exothermic; if positive, it is endothermic.

ii. Why is breaking of a bond an endothermic process?

Answer:

- Bond breaking requires energy to overcome the attraction between atoms.
- Since energy is absorbed from the

surroundings, the process is endothermic.

- **For example:** Breaking the H–H bond in hydrogen needs energy input.

iii. Depict the transition state for the following reaction: $H_2 + Cl_2 \Rightarrow 2HCl$

Answer:

The transition state is the high-energy unstable arrangement of atoms where old bonds are breaking and new bonds are forming.

It is represented as:

$H–H + Cl–Cl \Rightarrow [H\cdots H\cdots Cl\cdots Cl]‡ \Rightarrow 2H–Cl$

This state exists for a very short time and is shown at the peak of the energy profile curve.

iv. Draw the reaction profiles for two exothermic reactions, one of which moves faster than the other.

Answer:

- Two reaction profiles can be drawn showing:
- Same energy of reactants and products

- Different activation energies (Ea)
- The reaction with lower activation energy happens faster.
- Both reactions have $\Delta H < 0$, meaning they release heat (exothermic).
- (Attach a simple sketch with two curves: one with a smaller hump for faster reaction)

v. What is the role of glycogen in our body?

Answer:

- Glycogen is a storage form of glucose in the human body.
- It is stored in the liver and muscles.
- During physical activity or between meals, glycogen is broken down to release glucose for energy.
- It ensures a steady supply of energy to body cells when needed.

Important Short Questions:

1. Why the chemical reaction between sodium metal and water proceeds violently?

The **chemical reaction** between **sodium metal** and **water** proceeds **violently** because it is highly **exothermic**. **Sodium** reacts **rapidly** with water, producing **sodium** hydroxide (NaOH) and **hydrogen** gas (H_2). The **large amount** of heat released ignites the hydrogen gas, causing a violent reaction.

2. Is melting of ice an exothermic or endothermic change?

Melting of ice is an **endothermic** change. During melting, ice absorbs heat from its surroundings to overcome the forces holding the water molecules in solid form, thus converting into **liquid water**.

3. Can exothermic reaction be reversed?

Yes, **exothermic reactions** can be **reversed**, but the reverse reaction is usually **endothermic**. For **example**, the combustion of hydrogen to form water is **exothermic**, while the **decomposition** of

water into hydrogen and oxygen requires absorption of the same amount of heat and is endothermic.

4. Why does the chemical reaction between sodium metal and water proceed violently?

Because sodium reacts quickly with water, producing hydrogen gas and heat, which causes bubbling and sometimes sparks.

5. Is melting of ice an exothermic or endothermic change?

Melting of ice is an endothermic change because it absorbs heat to change from solid to liquid.

6. Can an exothermic reaction be reversed?

Yes, an exothermic reaction can be reversed, but the reverse reaction will be endothermic, absorbing heat.

7. Define system and give one example.

- In chemistry, the part of the universe under study is called the system.
- **Example**: Water being boiled in a beaker is the system.

8. What is meant by surroundings in a chemical process?

Everything other than the system is called the surroundings.

Example: Beaker, burner, and air around boiling water.

9. Differentiate between system and surroundings with an example.

- The system includes substances involved in a reaction. The surroundings include everything else.
- **Example**: In boiling water, water is system; beaker and burner are surroundings.

10. What is meant by exothermic reaction? Give one example.

A reaction in which heat is released to surroundings is exothermic.

Example:

$2H_2 + O_2 \Rightarrow 2H_2O + 571.6\ kJ$

11. What is meant by endothermic reaction? Give one example.

A reaction in which heat is absorbed from surroundings is endothermic.

Example:

$H_2 + I_2 \Rightarrow 2HI - 53.08\ kJ$

12. What type of sign is used for exothermic change?

Negative sign ($-\Delta H$) is used for exothermic reactions.

13. What is the sign of ΔH in endothermic reactions?

Positive sign ($+\Delta H$) is used for endothermic reactions.

14. Define enthalpy and give its symbol.

Enthalpy is the total heat content of a system.

Symbol: H

15. What is the difference between heat and enthalpy?

Heat is energy that flows due to temperature difference, while enthalpy is the total energy in a system including heat.

16. What is standard enthalpy of reaction?

It is the heat change when reactants in standard states form products in standard states at constant pressure.

17.Write the enthalpy change for the reaction:

$2CO\ (g) + O_2\ (g) \Rightarrow 2CO_2\ (g)$

A: $\Delta H° = -566.0$ kJ (It is an exothermic reaction)

18. Write an example of an exothermic reaction used in everyday life.

Burning of fuel like gas or coal:

$CH_4 + 2O_2 \Rightarrow CO_2 + 2H_2O$ + heat

19. Why does temperature of container decrease during endothermic reaction?

Because heat is absorbed from the surroundings, lowering the container's temperature.

20. How is energy transferred in an endothermic

change?

Energy is transferred from surroundings to the system.

21. What is the role of exothermic reactions in electricity generation?

Combustion of fuels in power plants releases heat which is used to produce steam, rotating turbines to generate electricity.

22. What is enthalpy and how is it represented in a chemical system?

Enthalpy is the total heat content or energy of a thermodynamic system under standard conditions. It is represented by the symbol H. The change in enthalpy during a reaction is represented by ΔH.

23. Why is it easier to measure the change in enthalpy (ΔH) rather than total enthalpy (H)?

The total enthalpy (H) of a system cannot be measured directly because it depends on the internal energy and pressure-volume work of the system. However, the change in enthalpy (ΔH)

during a reaction can be measured easily by comparing heat changes under constant pressure.

24. What is the difference between exothermic and endothermic reactions?

Exothermic reactions release heat energy to the surroundings, causing the container to become hot. Endothermic reactions absorb heat energy from the surroundings, causing the container to become cold.

25. Give an example of an exothermic reaction and state its enthalpy change.

Combustion of carbon:

$C(s) + O_2(g) \Rightarrow CO_2(g)$

$\Delta H = -393.5$ kJ (heat is released)

26. Why do exothermic reactions play an important role in our daily life and industry?

Exothermic reactions release energy in the form of heat, which is used for cooking, heating, generating electricity, and powering vehicles, making them essential for daily living and industrial processes.

27. What is required for a chemical reaction to take

place between reactant molecules?

A reaction takes place when reactant molecules collide with enough kinetic energy to form a transition state.

28. Define the transition state in a chemical reaction.

The transition state is a high-energy, unstable state during a reaction where old bonds are breaking and new bonds are forming.

29. Why is the energy of the transition state higher than that of reactants and products?

Because bonds are being broken and rearranged, requiring energy input, so the transition state has the highest energy.

30. What is activation energy (Ea) in a chemical reaction?

Activation energy is the minimum energy needed for reactants to form the transition state and proceed to products.

31. How does a catalyst affect the activation

energy and rate of a reaction?

A catalyst lowers the activation energy, allowing more reactant molecules to convert to products faster, thus increasing the reaction rate.

32. Give an example of a catalyst used in the hydrogenation of oil.

Nickel (Ni) is used as a catalyst in the hydrogenation of oil to make banaspati ghee.

33. What is aerobic respiration and where does it occur in the cell?

Aerobic respiration is the process of producing energy in the presence of oxygen, mainly occurring in the mitochondria.

34. What happens during glycolysis in aerobic respiration?

One molecule of glucose is broken into two molecules of pyruvate, producing a net gain of 2 ATP molecules.

35. How does anaerobic respiration differ from aerobic respiration?

Anaerobic respiration occurs without oxygen, producing ethanol and carbon dioxide along with energy, while aerobic respiration uses oxygen and produces carbon dioxide and water.

36. What role do lipids play in the human body regarding energy?

Lipids serve as a long-term energy reserve, storing excess food energy in adipose cells for use between meals and during exercise.

Important Long Questions:

Q1: Define system and surrounding with suitable examples. Explain their importance in the study of physical and chemical changes.

Answer:

In chemistry, any physical or chemical process under study is termed as a system, and everything else around it is referred to as the surrounding.

System:

A system includes all the reactants, products, catalysts, solvents, and anything else that is directly involved in the reaction or process being studied.

Example:

If water is being boiled in a beaker, then the water molecules undergoing the change are considered the system.

Surrounding:

The surrounding refers to everything that is outside the system and not directly involved in the process but may interact with it.

Example:

In the same boiling water experiment, the beaker, burner, air, and table are all part of the surrounding.

Importance in Physical and Chemical Changes:

1. Energy Transfer Understanding:

Understanding the system and surrounding helps us analyze how energy is transferred during a

reaction—whether it is absorbed from or released into the surroundings.

2. Classification of Reactions:

This concept helps classify reactions into endothermic (energy absorbed, system gains energy) or exothermic (energy released, system loses energy).

3. Experimental Control:

Defining the system helps chemists control the variables and conditions that affect the outcome of the experiment or reaction.

4. Thermodynamic Studies:

It is essential in thermodynamics to measure changes in energy, enthalpy, and entropy by focusing only on the system.

Q2: Define enthalpy. How is it different from heat? Explain with examples.

Answer:

Enthalpy:

Enthalpy is the total amount of heat energy present in a system under standard conditions (0°C temperature and 760 mmHg pressure). It is also called the heat content of a system. It is represented by the symbol H.

Since we cannot measure the total enthalpy (H) of a system directly, we usually measure the change in enthalpy (ΔH) during a physical or chemical process. Enthalpy depends on the number of molecules, their structure, and chemical composition.

> **Example**:

In the reaction:

$2CO(g) + O_2(g) \Rightarrow 2CO_2(g)$

$\Delta H° = -566$ kJ

This means 566 kJ of energy is released (exothermic reaction) and given to the surroundings.

Heat:

Heat is a form of energy that flows from a hot body to a cold body due to a difference in temperature. It

is not stored in a system but is only transferred. Heat is measured in joules (J) or kilojoules (kJ).

Q3: Define exothermic and endothermic reactions with suitable chemical equations.

Answer:

A chemical reaction is always accompanied by an energy change, either in the form of heat absorption or heat release. Based on this, reactions are classified as:

1. Exothermic Reactions:

These are the reactions in which heat energy is evolved or released to the surroundings. As a result, the temperature of the container increases. These reactions have a negative enthalpy change (ΔH < 0).

Example 1:

Formation of water from hydrogen and oxygen:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l) + 571.6\,kJ \quad (\Delta H = -571.6\,kJ)$$

Example 2:

Combustion of carbon:

$$C(s) + O_2(g) \rightarrow CO_2(g) + 393.5\,kJ \quad (\Delta H = -393.5\,kJ)$$

2. Endothermic Reactions:

These are the reactions in which heat energy is absorbed from the surroundings. As a result, the temperature of the container decreases. These reactions have a positive enthalpy change (ΔH > 0).

Example 1:

Formation of hydrogen iodide (HI):

$$H_2(g) + I_2(s) \rightarrow 2HI(g) \quad (\Delta H = +53.08\,kJ)$$

Example 2:

Formation of nitric oxide (NO):

$$N_2(g) + O_2(g) \rightarrow 2NO(g) \quad (\Delta H = +180.6\,kJ)$$

Q4: Explain the importance of exothermic reactions in our daily life. Give at least three practical examples with explanation.

Answer:

Exothermic reactions are extremely important in our daily life because they release energy that is used for various practical purposes. Here are three major examples:

1. Combustion of Fuels (Gas, Oil, Coal):

When fuels like natural gas, petrol, diesel, and coal are burned, they undergo combustion, which is an exothermic process.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{heat}$$

- Cooking food at homes.
- Heating homes and industrial boilers.
- Running engines in vehicles.

2. Metabolism of Food in Human Body:

Foods like carbohydrates and fats undergo metabolic reactions in the body. These reactions release heat energy, which:

- Maintains body temperature.
- Provides energy for physical activities.
- Powers internal functions like heartbeat and breathing.

3. Production of Electricity in Power Stations:

- In thermal power plants, fuels like coal or natural gas are burned to produce heat.
- This heat is used to boil water and produce high-pressure steam.
- The steam rotates turbines, which generate electricity.

4. Descriptive Questions

i. Find out the enthalpy change (ΔH) of the following reaction:

$$N_2 + O_2 \rightarrow 2NO$$

Given:

- Bond dissociation energy of N_2 = 958.38 kJ/mol
- Bond dissociation energy of O_2 = 498 kJ/mol
- Bond formation energy of NO = 626 kJ/mol (per mole)

Solution:

Step 1: Calculate Total Energy Absorbed (Bond Breaking):

- 1 mole of N≡N bond = 958.38 kJ
- 1 mole of O=O bond = 498 kJ
- Total energy absorbed = 958.38 + 498 = 1456.38 kJ

Step 2: Calculate Total Energy Released (Bond Formation):

2 moles of NO formed = 2 × 626 = 1252 kJ

Step 3: Enthalpy Change (ΔH):

$$\Delta H = \text{Energy Absorbed} - \text{Energy Released}$$

$$\Delta H = 1456.38 - 1252 = \boxed{+204.38\ \text{kJ/mol}}$$

Conclusion: The reaction is endothermic as energy is absorbed.

ii. Explain the difference between the terms heat and enthalpy.

Answer:

Heat is the energy transferred between a system and its surroundings due to a temperature difference. It is not a property of the system but a form of energy in transit.

Enthalpy (H) is the total heat content of a system at

constant pressure. It is a state function, meaning it depends on the current state of the system, not how it got there.

Key Difference:

- Heat can flow in or out of a system.
- Enthalpy is a measure of energy stored within the system.
- **Example**: If water is heated from 25°C to 50°C, the heat added increases its enthalpy.

iii. Explain why formation of a bond is always an exothermic process.

Answer:

- When a **chemical bond** is formed, atoms come closer and release energy because a stable configuration is achieved.
- **Energy** is not **needed** to hold them together; instead, energy is released as they move to a

lower energy state.

- **Since energy** is released to the surroundings, the process is exothermic, and the enthalpy change (ΔH) is negative.

Example: Formation of water:

$$2H_2 + O_2 \rightarrow 2H_2O \quad \Delta H = -571.6\,kJ$$

iv. Explain the role of lipids in our body.

Answer:

Lipids (fats and oils) play many important roles in the human body:

1. Energy Storage:

Lipids provide long-term energy. 1 gram of fat gives about 9 kcal, which is more than carbohydrates or proteins.

2. Insulation and Protection:

Lipids form a protective layer under the skin to reduce heat loss and cushion internal organs.

3. Cell Structure:

Lipids are the main components of cell membranes (phospholipids).

4. Vitamin Absorption:

Lipids help in the absorption of fat-soluble vitamins (A, D, E, K).

v. Explain the following terms:

a. Activation Energy:

The minimum energy required to start a chemical reaction by breaking the reactant bonds. Without this energy, the reaction won't proceed.

b. Transition State:

A temporary unstable state during a reaction when bonds are partially broken and new bonds are partially formed. It has the highest energy in the reaction pathway.

c. Aerobic Respiration:

A process in which glucose is broken down in the presence of oxygen to release energy (ATP), carbon

dioxide, and water.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$$

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further

exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

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Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

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