9th Chemistry Unit 5 - Energetics
Complete Corrections and Improvements

Descriptive Questions

Q.1 (Ex. Q.4 (i)) Find out the enthalpy change of the following reaction using the given data.

$N_2 + O_2 \rightarrow 2NO$

Data:

- 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

Ans.

Total amount of energy absorbed = 958.38 + 498 = **1456.38 kJ/mol**

Total amount of energy released = 2 × (-626) = **-1252 kJ/mol**

Enthalpy change = 1456.38 - 1252 = 204.38 kJ/mol

Q.2 (Ex. Q.4 (ii)) Explain the difference between the terms heat and enthalpy.

Ans.

Heat	**Enthalpy**
Definition: This form of energy is released when a bond is formed and absorbed when a bond is broken.	**Definition:** Enthalpy (H) or heat content, is defined as the total amount of thermal energy stored in a compound.
System: It is not an essential part of the system.	**System:** It is an essential part of the system.
Process: Heat just enters and leaves the object.	**Process:** Enthalpy change is equal to heat evolved or absorbed, at constant pressure.
Measurement: It is the measurement of thermal energy transferred between two objects at different temperatures.	**Measurement:** It is the measurement of energy in a thermodynamic system.
Representation: It is represented by **'q'**.	**Representation:** It is represented by **'H'**.
Unit: Its unit is **Joule (J)**.	**Unit:** Its unit is **kJ/mol**.

Q.3 (Ex. Q.4 (iii)) Explain why formation of a bond is always an exothermic process.

Ans. Bond formation always takes place with the evolution of heat. If a reaction is accompanied with the evolution of heat, it is called an **exothermic reaction**.

For Example:

Total energy evolved in the formation of 4 O—H bonds:

$2O(g) + 4H(g) \rightarrow 2H_2O(g)$ ΔH = -1936 kJ/mol

This is the energy evolved when two moles of water are formed from 4 moles of hydrogen atoms and 2 moles of oxygen atoms. Thus for the formation of one mole of water, the energy evolved will be **968 kJ/mol**.

Q.4 (Ex. Q.4 (iv)) Explain the role of lipids in our body.

Ans.

Role of Lipids in our Body:

(i) Organic Compound: Lipids are a group of organic compounds which include fats, waxes, sterols, etc.

(ii) Energy Source: Lipids serve as an energy reserve within our body. About half of the fuel our body needs comes from lipids.

(iii) Energy Bank in Animal Body: If you eat more food than you need in a day, excess food is stored as lipid in adipose tissue. In between meals and during exercise, our body relies on this resource to provide energy.

(iv) Waterproofing: Lipids such as waxes provide waterproofing for skin, hair and feathers in humans and animals.

(v) Absorption of Fat-Soluble Vitamins: Lipids are necessary for the absorption of fat-soluble vitamins (A, D, E and K) in the intestine.

Q.5 (Ex. Q.4 (v)) Explain the following terms.

Ans.

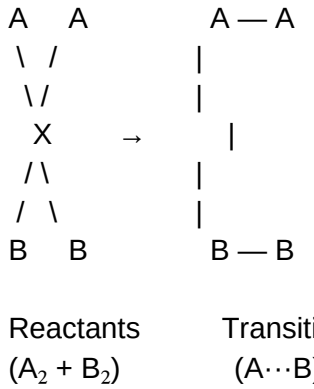
Activation Energy:

Energy absorbed by reactant or product molecule in order to be converted into transition state is called **activation energy**. It is represented by **(E_a)**.

Transition State:

When the two reactant molecules are mixed together, all these molecules start colliding with each other. The collisions which result from colliding molecules having average or less than average kinetic energies may not be able to produce any result. But when the two excited molecules from both the reactants collide with each other, they may be able to produce the **transition state**.

text



Reactants ($A_2 + B_2$) Transition State (A···B) Products (AB + AB)

After a very short period of time, the transition state either returns to the reactants or to the products. The progress of the reaction can be shown in the form of an **energy profile diagram**.

Aerobic Respiration:

Definition:

The process of respiration in human beings is a continuous process. During this process, we breathe in oxygen and breathe out carbon dioxide. Respiration also carries out complex chemical reactions inside the human body. This process that occurs in the presence of oxygen is called **aerobic respiration**.

Process:

Aerobic respiration is an exothermic process and involves the following reactions:

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

text

Glucose ($C_6H_{12}O_6$) → 2 Pyruvate ($C_3H_3O_3$) → $6CO_2 + 6H_2O$ + Energy
(Cytoplasm) (Mitochondria)

Investigative Questions

Q.1 (Ex. Q.5 (i)) Why is it essential to cook some of the food items while others we can eat without cooking?

Ans. Some fruits and vegetables are usually safe to eat if they are not contaminated. However, many raw foods like meat and eggs may have harmful bacteria or parasites. Cooking kills these micro-organisms, making the food safe to eat. Cooking also makes food easier to digest and enhances the flavor and texture, making it more enjoyable to eat. For example, meat and poultry need to be cooked thoroughly to avoid foodborne illnesses, while some fruits and nuts are safe to eat raw because they don't carry the same risks. So cooking is important for safety, digestibility, and taste.

Q.2 (Ex. Q.5 (ii)) Why does fireworks look spectacular? What type of chemical compounds undergo chemical reactions during this activity?

Ans. Fireworks look spectacular because people enjoy bright colors lighting up the sky. Fireworks are the result of combustion reactions that yield heat, light and sound. Different metal powders along with oxidizing agents produce a variety of colors when burnt. For example:

- **Copper (Cu)** produces blue color
- **Strontium (Sr)** produces red color
- **Barium (Ba)** produces green color
- **Sodium (Na)** produces yellow color

SLO Based Additional Long Questions

Q.1 Explain the Exothermic and Endothermic Reactions.

Ans.

Definitions:

- Chemical reactions in which heat energy is evolved are called **exothermic reactions**.
- Those reactions in which heat energy is absorbed are called **endothermic reactions**.

Explanation:

A physical or a chemical change is almost always accompanied with either absorption or evolution of heat. Heat, which is evolved or absorbed during a chemical reaction, is called the **heat of that reaction**.

Example of Exothermic Reactions:

(i) Hydrogen gas and oxygen gas react to give liquid water is an exothermic reaction:

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

571.6 kJ heat energy is evolved during this reaction. If the energy evolved is shown separately, it is expressed as **$\Delta H = -571.6$ kJ/mol**. The same amount of energy will be absorbed when the reaction will move in the backward direction i.e., water will decompose to give hydrogen and oxygen back.

(ii) Carbon dioxide gas is produced when solid carbon burns in oxygen gas:

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

It is also an exothermic reaction and 393.5 kJ heat energy is evolved during this reaction. When this reaction moves in the backward direction, the same amount of energy i.e. 393.5 kJ will be absorbed.

Example of Endothermic Reactions:

(i) The following reaction represents an endothermic change:

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

The enthalpy change for the reaction is **$\Delta H = +53.08$ kJ/mol**. Hydrogen gas reacts with solid iodine only at high temperature and 53.08 kJ of heat energy is absorbed.

(ii) Formation of NO in air due to lightning in the clouds:
$N_2(g) + O_2(g) \rightarrow 2NO(g)$ $\Delta H = +180.6$ kJ/mol
The enthalpy change for the reaction is **$\Delta H = +180.6$ kJ/mol**.

Q.2 Give the Importance of Exothermic and Endothermic reactions in daily life.
Ans. Our present-day living conditions depend heavily on energy in its various forms. Exothermic chemical reactions are extensively used to fulfill this requirement. In such reactions, chemical energy is converted into heat energy.
Combustion: We burn fuels like gas, oil and coal to cook food and for other heating purposes in our homes and industry. During this burning process called combustion, compounds present in fuels react with oxygen of the air to produce a large amount of heat.
Metabolism: Foods such as fats and carbohydrates are important biological fuels. During metabolism, the chemical energy present in this food is converted to heat to keep us warm.
Power Stations: A large portion of electricity is produced at power stations by burning fuels such as natural gas and coal. The heat which comes out from their combustion is used to produce steam at high pressure. This high pressure steam is then used to turn turbines, which in turn generate electricity.
Vehicles: While driving a vehicle, it is the combustion of petrol or diesel that gives off energy and drives it forward.
Fireworks: The one example of exothermic reactions people seem to enjoy the most is that of fireworks. Fireworks are the result of combustion reactions that yield heat, light and sound. Different metal powders along with oxidizing agents produce a variety of colors when burnt.

Q.3 Why are chemical reactions either exothermic or endothermic? Explain with examples.

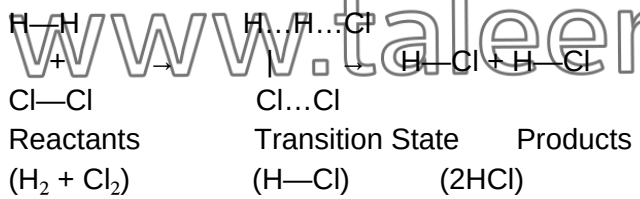
Ans. A chemical reaction mainly involves the processes which involve bond breaking and bond formation.
In the following reaction, the chemical bonds between the atoms present in the molecules of H_2 and O_2 first break to give their atoms:
$2H_2(g) \rightarrow 4H(g)$ (Endothermic - absorbs energy)
$O_2(g) \rightarrow 2O(g)$ (Endothermic - absorbs energy)
These atoms of hydrogen then form bonds with oxygen atoms to form two molecules of gaseous H_2O:
$4H(g) + 2O(g) \rightarrow 2H_2O(g)$ (Exothermic - releases energy)
Breaking of bonds of H_2 and O_2 absorb energy (endothermic process) while **making of bonds** between H and O evolve energy (exothermic process). In this reaction, weaker bonds are broken, hence less energy is absorbed in the system. While the bonds which are formed in water molecules are stronger and thus greater energy is evolved. Hence, the energy which is evolved is more than the energy which is absorbed. The overall reaction is thus **exothermic**.
$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta H = -568$ kJ/mol
The enthalpy change for the formation of two moles of gaseous water is thus **-568 kJ**. So the enthalpy change for the formation of one mole of gaseous water will be:
-568 kJ / 2 mol = -284 kJ/mol
The experimental value of formation of gaseous water is **-284 kJ/mol** which is quite close to this calculated value.

Exercise Short Questions
Q.1 What is the difference between enthalpy and enthalpy change?

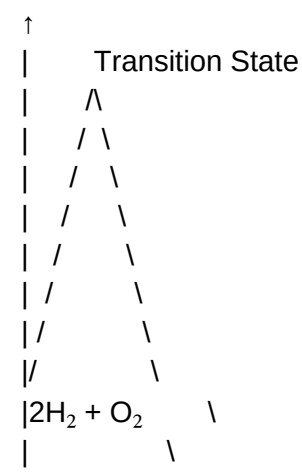
Enthalpy	Enthalpy Change
Enthalpy (H) or heat content, is defined as the total amount of thermal energy stored in a compound.	Enthalpy change (ΔH) is the amount of heat evolved or absorbed during a chemical reaction at constant pressure.
It is the total heat content of a system.	It is the difference between the enthalpy of products and reactants (ΔH = H_products - H_reactants).
It cannot be measured directly.	It can be measured experimentally.
It is represented by **'H'**.	It is represented by **'ΔH'**.
Its unit is **kJ/mol**.	Its unit is **kJ/mol**.

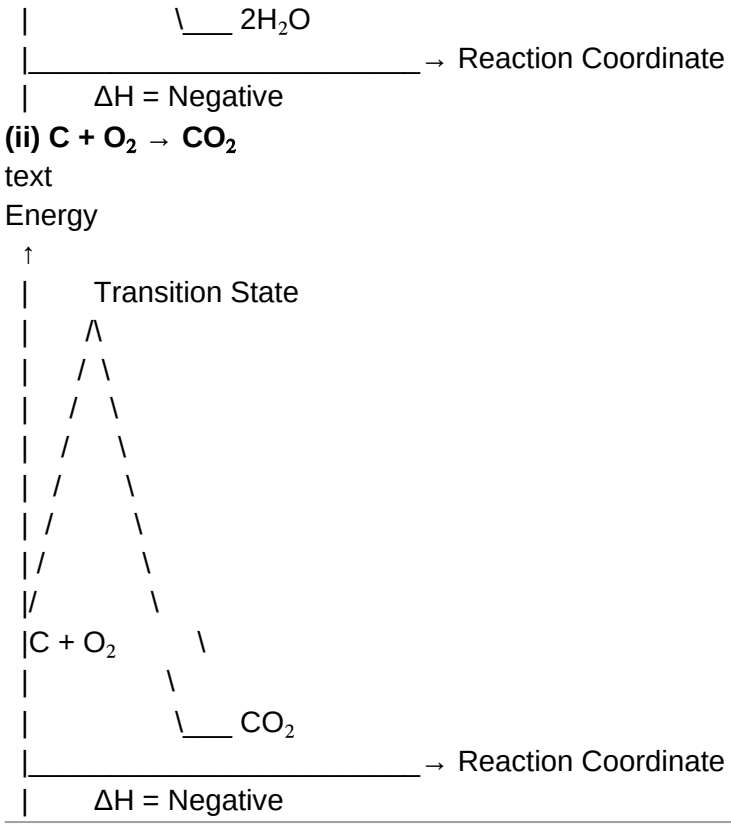
Q.2 Why is breaking of a bond an endothermic process?
Ans. Bond breaking is an endothermic process because when two atoms combine, energy is stored in them and when we break a bond, an equal amount of energy is required to break that bond. This energy is also known as **dissociation energy**. e.g., dissociation energy for hydrogen is **435 kJ/mol**.

Q.3 Depict the transition state for the following reaction: $H_2 + Cl_2 \rightarrow 2HCl$
Ans.
text



Q.4 Draw the reaction profiles for two exothermic reactions, one of which moves faster than the other.
Ans.
(i) $2H_2 + O_2 \rightarrow 2H_2O$
text





(ii) $C + O_2 \rightarrow CO_2$

Q.5 What is the role of glycogen in our body?

Ans. Glycogen is the primary storage form of glucose. It is stored in the liver and muscles. It helps to regulate blood sugar levels in our body.

Practice Exercise Questions

Q.6 Is boiling water in a beaker an endothermic or exothermic change? Which form of energy is being transferred in this system?

Ans. Boiling water in a beaker is an **endothermic** reaction. **Heat energy** is being transferred into this system.

Q.7 Can energy be transferred in a form other than heat during a chemical reaction?

Ans. Yes, energy can be transferred in forms other than heat like **light**, **sound**, **electrical energy**, etc.

Q.8 Why is it not possible to calculate the absolute enthalpy of a system?

Ans. It is not possible to calculate the absolute enthalpy of a system because enthalpy (H) is a state function that depends on the internal energy (E), pressure (P) and volume (V) of a system. We cannot determine the absolute values of these quantities for a system in isolation. Instead, we calculate the **change in enthalpy (ΔH)**.

Q.9 Why does the chemical reaction between sodium metal and water proceed violently?

Ans. The reaction between sodium and water is highly **exothermic**. That's why sodium reacts violently with water, producing hydrogen gas and heat.

$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) + Heat$

Q.10 Is melting of ice an exothermic or endothermic change?
Ans. Melting of ice is an **endothermic** change because it absorbs heat from the surroundings.
$H_2O(s) + Heat \rightarrow H_2O(l)$

Q.11 Can an exothermic reaction be reversed?
Ans. Yes, exothermic reactions can be reversed. Hydrogen gas and oxygen gas react to give liquid water in an exothermic reaction:
$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H = -571.6$ kJ/mol
571.6 kJ heat energy is evolved during this reaction. The same amount of energy will be absorbed when the reaction moves in the backward direction i.e., water will decompose to give hydrogen and oxygen gases back:
$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$ $\Delta H = +571.6$ kJ/mol

---

Q.12 Calculate the enthalpy change for the formation of one mole of liquid water.
Ans. Enthalpy change for the formation of two moles of liquid water is:
$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H = -571.6$ kJ/mol
For formation of one mole:
$\Delta H = -571.6 / 2 = -284.6$ kJ/mol
The enthalpy of elements in standard states H_2 and O_2 is zero. The enthalpy of liquid water is **-284.6 kJ/mol** under standard conditions.

Q.13 Are energy diagrams useful?
Ans. Energy diagrams are useful because they give us immediate information about the energy changes happening in a reaction, such as activation energy, enthalpy change, and the stability of reactants and products.

Q.14 Draw an energy profile diagram for a hypothetical reaction which does not evolve or absorb heat.
Ans.
text
Energy
↑
| Transition State
| /\
| / \
| / \
| / \
| / \
| / \
| / \
| / \
|/ \
|Reactants Products (Same Energy Level)
|_____→ Reaction Coordinate
| ΔH = 0

Q.15 Define thermodynamics.

Ans. Thermodynamics deals with how the energy changes during chemical reactions affect the properties of a chemical system.

Q.16 Who used the word "energy" for the first time?
Ans. Thomas Young was the first to use the word **'energy'** in the field of physics in **1802**.

Q.17 What is the difference between Chemical and Heat energy?

Chemical Energy	Heat Energy
This energy is stored in a molecule in which atoms are bonded to each other.	This form of energy is released when a bond is formed and absorbed when it is broken.
It is potential energy stored in chemical bonds.	It is kinetic energy associated with the motion of particles.
Example: Energy stored in food, fuel, etc.	Example: Energy released during combustion.

System and Surrounding
Q.18 Can we use energy evolved during a chemical reaction?
Ans. Energy evolved during a chemical reaction is used in everyday life for cooking, heating, lighting, transportation, communication, entertainment and much more.

Q.19 Differentiate between system and surrounding.

System	Surrounding
(i) Any physical or chemical change under study may also be called a **system**.	(i) Everything else which does not fall in the system is called the **surrounding**.
(ii) It includes reactants, products, catalyst, solvent, and anything else which is important to study a particular reaction.	(ii) It includes all other things such as beaker, burner, test tube, etc.

Enthalpy
Q.20 What is the importance of enthalpy?
Ans. Enthalpy is important because it tells us how much heat is present in a system. Heat is important because we can extract useful work from it.

Q.21 What is the difference between ΔE and ΔH?

ΔE (Change in Internal Energy)	ΔH (Enthalpy Change)
ΔE is the change in internal energy.	ΔH is the enthalpy change.
It is equal to heat absorbed by the system at constant volume.	It is equal to the heat of reaction at constant pressure.
$\Delta E = q_v$	$\Delta H = q_p$

ΔE (Change in Internal Energy)	**ΔH (Enthalpy Change)**
It is equal to the sum of heat and work.	It is equal to the sum of internal energy and product of pressure-volume work.
ΔE = q + w	**ΔH = ΔE + PΔV**

Q.22 Define standard enthalpy of reaction.
Ans.
(i) Standard enthalpy of reaction (ΔH°) is the amount of heat evolved or absorbed when one mole of reactants are converted into products under **standard conditions (25°C and 1 atm)** in a chemical reaction.
(ii) It is represented by **(ΔH°)**.
(iii) Its sign is **positive** for endothermic reactions and **negative** for exothermic reactions. Reactants and products should be taken in standard physical state.
Examples:

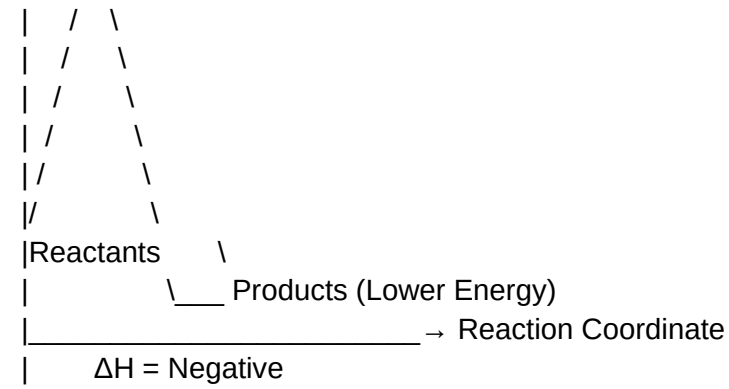
- **$C(s) + O_2(g) \rightarrow CO_2(g)$ ΔH° = -393.5 kJ** (Exothermic)
- **$H_2(g) + I_2(s) \rightarrow 2HI(g)$ ΔH° = +53.8 kJ** (Endothermic)

Q.23 Define enthalpy of a chemical reaction.
Ans. The amount of heat or thermal energy evolved or absorbed in a chemical reaction is called **enthalpy of reaction**.
Sign: Its sign is **negative** for exothermic and **positive** for endothermic reactions.

Standard enthalpy change: Enthalpy of reaction measured at **25°C (or 298 K)** and one atmospheric pressure is known as **standard enthalpy change**.
Representation: It is denoted by **ΔH°**.
Examples:
(i) $C(s) + O_2(g) \rightarrow CO_2(g)$ ΔH° = -393.5 kJ
(ii) $H_2(g) + I_2(s) \rightarrow 2HI(g)$ ΔH° = +53.8 kJ

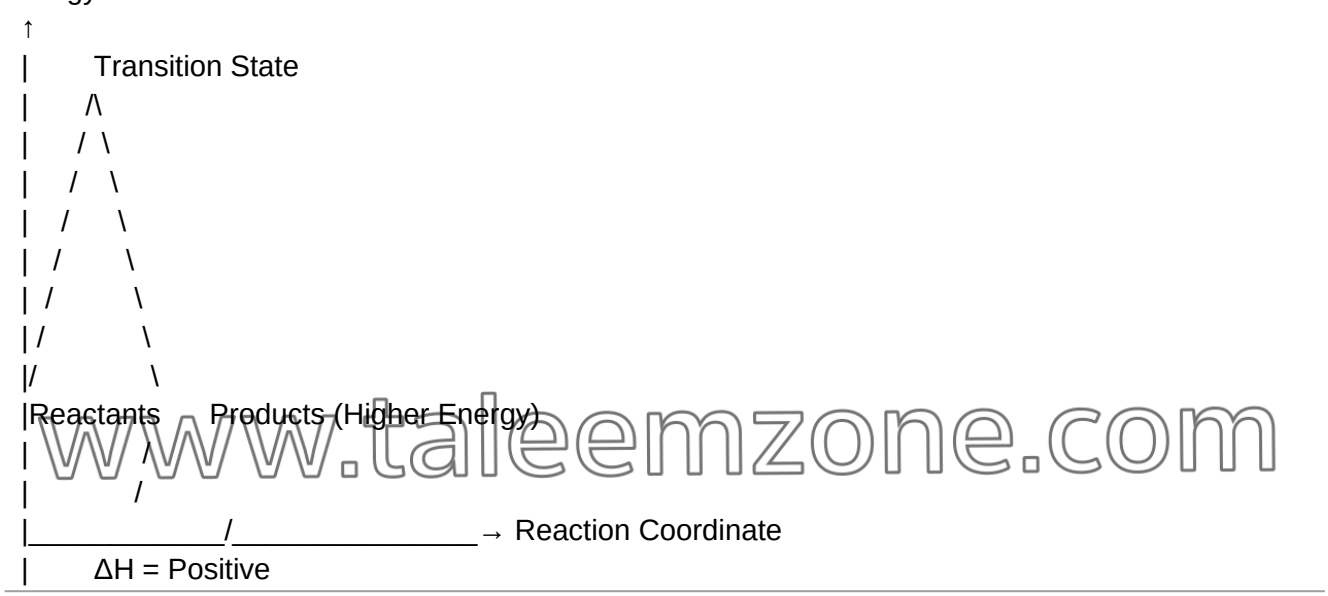
Exothermic or Endothermic Reactions
Q.24 How can atmospheric N_2 and O_2 react with each other?
Ans. Nitrogen of the atmosphere reacts with oxygen to produce nitrogen oxide (NO) only in the presence of lightning. This is because the reaction is highly **endothermic**, so only lightning can provide enough energy for this reaction to take place.
$N_2(g) + O_2(g) \rightarrow 2NO(g)$ ΔH = +180.6 kJ/mol

Q.25 Give energy diagrams for endothermic and exothermic reactions.
Ans.
(i) Exothermic Reaction:
text
Energy
↑
| Transition State
| /\
| / \



(ii) Endothermic Reaction:

text



Q.26 Define exothermic and endothermic reactions.

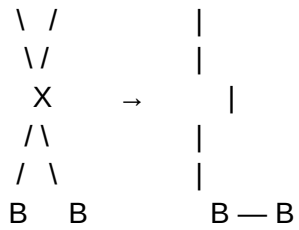
Exothermic Reactions	**Endothermic Reactions**
A chemical reaction that proceeds with the evolution of heat is called an **exothermic reaction**.	A chemical reaction that proceeds with the absorption of heat is called an **endothermic reaction**.
(i) $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H° = -393.5$ kJ	(i) $H_2(g) + I_2(s) \rightarrow 2HI(g)$ $\Delta H° = +53.8$ kJ
(ii) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H° = -571.6$ kJ	(ii) $N_2(g) + O_2(g) \rightarrow 2NO(g)$ $\Delta H° = +180.6$ kJ

How does a Reaction take place?

Q.27 Give the collision theory of reactions.

Ans. When two reactant molecules are mixed together, all these molecules start colliding with each other. The collisions which result from colliding molecules having average or less than average kinetic energies may not be able to produce any result. But when the two excited molecules from both the reactants collide with each other, they may be able to produce the **transition state**.

text



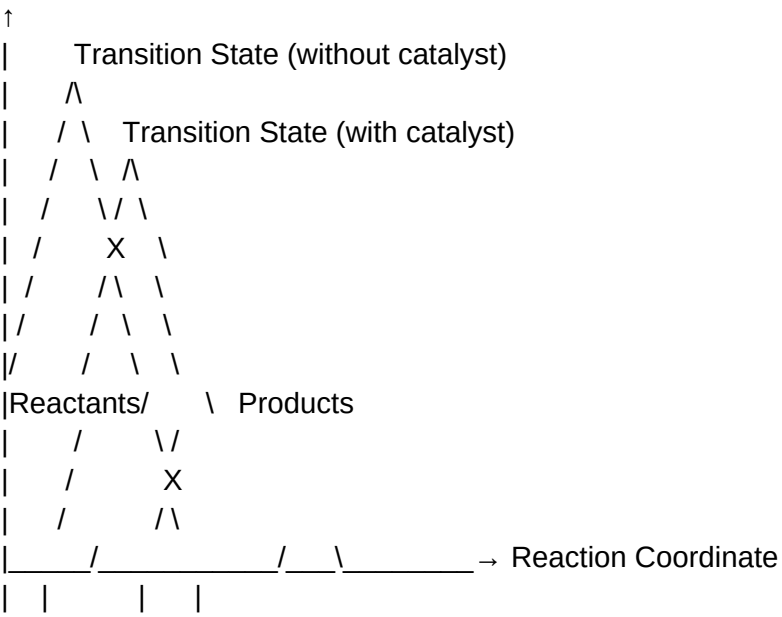
Reactants	Transition State	Products
($A_2 + B_2$)	(A···B)	(AB + AB)

Q.28 Why is the energy of the transition state higher than that of reactants or products?
Ans. The energy of the transition state is higher than that of reactants or products because the bonds between the reactant or product molecules are being **cleaved** or **stressed** progressively.

Q.29 How does a catalyst increase the rate of reaction?
Ans. The addition of a catalyst in a reaction increases the rate of reaction because it changes the path adopted by the reactants whereby the **activation energy** value of the reaction is substantially decreased. As a result, more reactants are now able to be converted into product molecules and hence the rate of reaction will increase.

Q.30 Define Catalyst with an example.
Ans. A substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change is called a **catalyst**.
Examples:

(i) Nickel (Ni) acts as a catalyst in the hydrogenation of oil to give vanaspati ghee.
(ii) Platinum (Pt) acts as a catalyst in the production of H_2SO_4.
(iii) Chlorine (Cl_2) acts as a catalyst promoting the breakdown of ozone.

Q.31 Draw energy diagrams for the absence and presence of catalyst.
Ans.
text


| Ea (without) Ea (with catalyst) - Lower
| | |
| | Catalyst decreases activation energy

Aerobic and Anaerobic Respiration

Q.32 Differentiate between Aerobic and Anaerobic respiration.

Aerobic Respiration	**Anaerobic Respiration**
(i) It occurs in the **presence** of oxygen.	(i) It occurs in the **absence** of oxygen.
(ii) It occurs in higher animals like human body.	(ii) It occurs in bacteria, yeast, and algae.
(iii) The products of this reaction are CO_2 and H_2O.	(iii) The products of this reaction are alcohol and CO_2 (in yeast) or lactic acid (in muscles).
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O +$ Energy	**$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ + Energy** (in yeast)
(iv) Releases more energy (38 ATP).	(iv) Releases less energy (2 ATP).

Q.33 Define Glycolysis.

Ans. During glycolysis, one molecule of glucose is split into two molecules of pyruvate. This process involves a series of reactions catalyzed by enzymes, with a net production of **2 ATP** (Adenosine Triphosphate). When cells of our body require energy for performing metabolic activities, they use this ATP and break it down to get the required energy.

$C_6H_{12}O_6 \rightarrow 2C_3H_3O_3 + 2ATP$

Q.34 How is energy produced from food?

Ans. The food we eat undergoes digestion in our body and the digested food molecules that are absorbed by the cells undergo **oxidation** to produce energy. This energy is stored in the form of **ATP** (Adenosine Triphosphate), which is used by cells for various metabolic activities.

Constructed Response Questions

Q.1 (Ex. Q.3 (i)) Physical changes which usually occur around us are given in the table. Write down whether they are exothermic or endothermic.

Physical Change	**Exothermic or Endothermic**
Conversion of hydrated salt into anhydrous salt	**Endothermic**
Conduction of electricity by metals	Neither Endothermic nor Exothermic
Burning paper	**Exothermic**
Dissolving ammonium chloride in water	**Endothermic**

Physical Change	Exothermic or Endothermic
Vaporizing liquid nitrogen	**Endothermic**
Formation of rain from clouds	**Exothermic**
Evaporation of dry ice	**Endothermic**
Dissolving sodium carbonate in water	**Exothermic** *(Corrected from original)*

Q.2 (Ex. Q.3 (ii)) Explain why the reaction between atmospheric gases oxygen and nitrogen does not take place under normal conditions? But in the presence of lightning, these gases react to give NO. The reaction stops as soon as the lightning stops.
Ans. Nitrogen and oxygen do not react under normal conditions because it is a highly **endothermic** reaction. Nitrogen molecule has a **triple covalent bond** (N≡N) which requires very high energy to break. That energy is supplied by lightning. So as long as lightning continues, the reaction will continue.
$N_2(g) + O_2(g) \rightarrow 2NO(g)$ $\Delta H = +180.6$ kJ/mol
Once the lightning stops, the energy source is removed and the reaction stops immediately because it cannot proceed without the continuous supply of energy.

Q.3 (Ex. Q.3 (iii)) A reaction between natural gas (CH_4) and atmospheric oxygen does not take place when you mix them. As soon as you show a flame, it starts immediately and then it continues until one or both of the reactants is/are used up. Explain.

Ans. The activation energy of methane is very high which is supplied by the burning match stick (flame). Once the reactants break and combine to form new products, the reaction becomes **exothermic** and releases enough heat to sustain itself. This is why the reaction continues on its own once initiated.
$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ $\Delta H = -890$ kJ/mol
The reaction continues until one or both reactants get consumed completely.

Multiple Choice Questions (with Corrections)
1. The following reaction is an exothermic reaction: $H_2 + Cl_2 \rightarrow 2HCl$. 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

2. Which of the following reactions has the least value of activation energy?
- (a) $H_2(g) + ½O_2(g) \rightarrow H_2O(g)$
- (b) $C(s) + O_2(g) \rightarrow CO_2(g)$
- **(c) $NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + NaNO_3(aq)$** ✓ *(Precipitation reactions have very low activation energy)*
- (d) $H_2(g) + I_2(s) \rightarrow 2HI(g)$

3. Formation of which hydrogen halide from the elements is an endothermic reaction?
- (a) HCl

- (b) HF
- (c) HBr
- **(d) HI** ✓ *(HI formation is endothermic)*

4. What are the products of anaerobic respiration?

- (a) ATP + CO_2 + H_2O
- (b) CO_2 + H_2O
- **(c) ATP + Ethanol + CO_2** ✓
- (d) Ethanol + CO_2 + energy

5. Which reaction do you expect to be a reversible reaction?

(From the energy profile diagrams, the one with similar energy levels for reactants and products)

- **(b)** ✓

6. What does it show when a chemical reaction is exothermic?

- **(a) It shows the bonds which break are weaker than those which are formed.** ✓
- (b) It shows the bonds which break are stronger than those which 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.

7. 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.** ✓

8. The average bond dissociation energy for the C—H bond is 412 kJ/mol. Which of the following processes will have enthalpy change close to 412 kJ/mol?

- (a) $CH_4(g) \rightarrow C(s) + 2H_2(g)$
- (b) $CH_4(g) \rightarrow C(g) + H_2(g)$
- (c) $CH_4(g) \rightarrow C(g) + 4H(g)$
- **(d) $CH_4(g) \rightarrow CH_3(g) + H(g)$** ✓ *(Breaking one C—H bond)*

9. The average bond energies for O—O and O=O are 146 and 496 kJ/mol respectively. Find the enthalpy in kJ for the following reaction:

(Note: The reaction needs to be clearly specified. Based on the options, it's likely H_2O_2 decomposition)

- **(a) -102 kJ** ✓

10. 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.

SLO Based Introduction

11. When old bonds are broken, the energy is:

- **(a) Consumed** ✓ *(Energy is absorbed when bonds break)*
- (b) Released
- (c) Energy changes
- (d) All of these

12. When new bonds are formed, the energy is:

- **(b) Released** ✓ *(Bond formation releases energy - exothermic)*

13. All chemical reactions involve:

- (a) Catalysts.
- (b) Enzymes
- **(c) Energy changes** ✓
- (d) All of these

14. Who used the word "energy" for the first time?

- **(a) Thomas Young** ✓
- (b) Bohr
- (c) Rutherford
- (d) None of these

15. The word "energy" was used in physics for the first time in:

- **(a) 1802** ✓
- (b) 1805
- (c) 1858
- (d) 1902

System and Surrounding

16. The part of the universe that we want to focus our attention on is called:

- **(a) System** ✓
- (b) Surrounding
- (c) Energy
- (d) Both a & b

Enthalpy

17. The enthalpy of reaction $C + O_2 \rightarrow CO_2$ is:

- (a) -571.6 kJ
- (b) -110.5 kJ
- **(c) -393.5 kJ** ✓
- (d) +53.8 kJ

18. The enthalpy of reaction $2H_2 + O_2 \rightarrow 2H_2O$ is:

- **(a) -571.6 kJ** ✓
- (b) -110.5 kJ
- (c) -393.5 kJ
- (d) +53.8 kJ

19. The enthalpy of reaction $C + ½O_2 \rightarrow CO$ is:

- (a) -571.6 kJ
- **(b) -110.5 kJ** ✓
- (c) -393.5 kJ
- (d) +53.8 kJ

20. The enthalpy of reaction $H_2 + I_2 \rightarrow 2HI$ is:

- (a) -571.6 kJ
- (b) -110.5 kJ
- (c) -393.5 kJ
- **(d) +53.8 kJ** ✓

Exothermic and Endothermic Reactions

21. If the ΔH value is negative, the reaction will be:

- **(a) Exothermic** ✓
- (b) Endothermic
- (c) May or may not be Exothermic or Endothermic
- (d) None of these

22. If ΔH° is positive, then the reaction will be:

- (a) Exothermic
- **(b) Endothermic** ✓
- (c) Both a & b
- (d) None of these

23. Bond formation energy of one O—H bond is:

- **(a) 484 kJ/mol** ✓
- (b) 486 kJ/mol
- (c) 488 kJ/mol
- (d) None

24. Bond dissociation energy for H_2 is:

- (a) 430 kJ/mol
- **(b) 435 kJ/mol** ✓
- (c) 440 kJ/mol
- (d) 445 kJ/mol

25. Bond dissociation energy for O_2 is:

- **(a) 498 kJ/mol** ✓
- (b) 505 kJ/mol
- (c) 605 kJ/mol
- (d) 705 kJ/mol

26. Formation of NO is:

- **(a) Endothermic** ✓
- (b) Exothermic
- (c) No heat change
- (d) None of These

How does a Reaction take place?

27. Activation energy of a chemical reaction must be _____ than the average kinetic energy of reacting molecules.

- (a) Lower than
- **(b) Greater than** ✓
- (c) Equal to
- (d) None of these

28. No reaction occurs if the energy of reacting particles is _____ than activation energy.

- (a) Greater than
- **(b) Lower than** ✓
- (c) Equal to
- (d) Nearest to

29. Washing clothes at 140°F uses almost _____ the energy as at 140°F wash?

- **(a) Half** ✓

30. _____ of the energy used by a traditional electric bulb is wasted in producing heat.

- (a) 60%
- (b) 70%

- **(c) 80%** ✓
- (d) 90%

Aerobic and Anaerobic Respiration

31. Which is not produced in anaerobic respiration?

- (a) Carbon dioxide
- **(b) Water** ✓
- (c) Energy
- (d) Lactic acid

32. _____ acts as reserve energy sources.

- (a) Vitamins
- (b) Proteins
- **(c) Lipids** ✓
- (d) Enzyme

33. Which is released in anaerobic respiration?

- (a) Amino acid
- (b) Stearic acid
- (c) Citric acid
- **(d) Lactic acid** ✓

34. Aerobic respiration releases _____ energy than anaerobic respiration.

- (a) Equal
- (b) Less
- **(c) More** ✓
- (d) None of these

35. _____ acts as a catalyst promoting the breakdown of ozone.

- **(a) Cl_2** ✓
- (b) Br_2
- (c) I_2
- (d) None

36. During glycolysis, the net ATP produced are:

- **(a) 2** ✓
- (b) 4
- (c) 6
- (d) 8