ENERGY CHANGES DURING CHEMICAL REACTIONS DETAILED NOTES AND SAMPLE QUESTIONS

(I regret for any mistake if noted)

S4 TERM TWO TOPIC 2

NEW LOWER SECONDARY CURRICULUM

(CHEMISTRY)

BY

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DEDICATED TO YOU

The attached questions are almost enough for a student to have a general idea/concept about this region(**content/subtopic**) in chemistry, however, I advise a student to search for more related questions about this content area for **better results**.

CONTENT:

1. **Energy changes during chemical reactions.**
2. **Some sample questions on the above topic**
3. ***Try so hard to answer the sample questions and look for more qns.***

Don't say tomorrow, it will be too late for chemistry revision, and yesterday is gone forever, you have got today to revise your chemistry!
"Revise as if tomorrow is not there"
May god bless you

Energy changes during chemical reactions.

Chemical energy.

All chemical substances posse's chemical energy stored in bonds that connect atoms in a compound.

Energy change.

Energy change in a reaction is the energy given out or taken in by a substance during a reaction.

The reaction in which heat is given out or liberated is called exothermic reaction while the one in which heat is taken in is called endothermic reactions.

Examples of processes/reactions of energy changes in our daily life in which heat is given out or taken in.

Reaction	**Energy change (energy given out or taken in)**
Respiration	Exothermic reaction
Dissolving salt in water	Endothermic reaction
Dissolving sugar	Endothermic reaction
Burning	Exothermic reaction
Sweating	Exothermic reaction
Fermentation	Exothermic reaction
Photosynthesis	Endothermic reaction
Other examples of energy changes	
Evaporating liquid water	Endothermic reaction
Sublimation of carbon dioxide	Endothermic reaction
Cracking of alkanes	Endothermic reaction
Thermal decomposition	Endothermic reaction
Melting of ice	Endothermic reaction
Rusting of iron	Exothermic reaction
Making of ice cubes	Exothermic reaction
Reaction of a strong acid and water	Exothermic reaction
Cold packs to heal an injury	Exothermic reaction
Laundry detergent	Exothermic reaction
Neutralization reaction	Exothermic reaction

Heat (enthalpy) change

Many reactions are accompanied by marked heat changes.

There are basically two types of heat changes or enthalpy changes.

Namely;

- Exothermic reaction
- Endothermic reaction

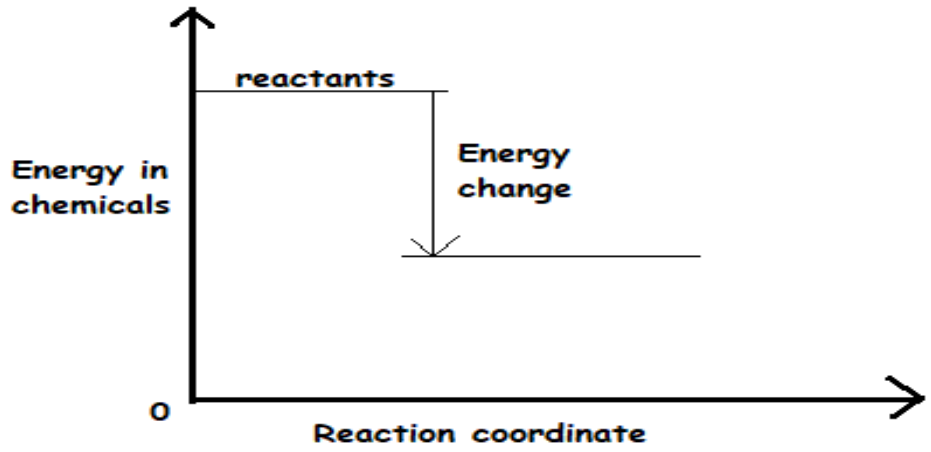
Exothermic reaction.

Is a reaction in which heat is liberated to the surrounding.

It is indicated by rise in temperature. In such reactions, the products have less energy content than the reactants.

Examples are discussed in the notes above.

Energy profile for exothermic reactions



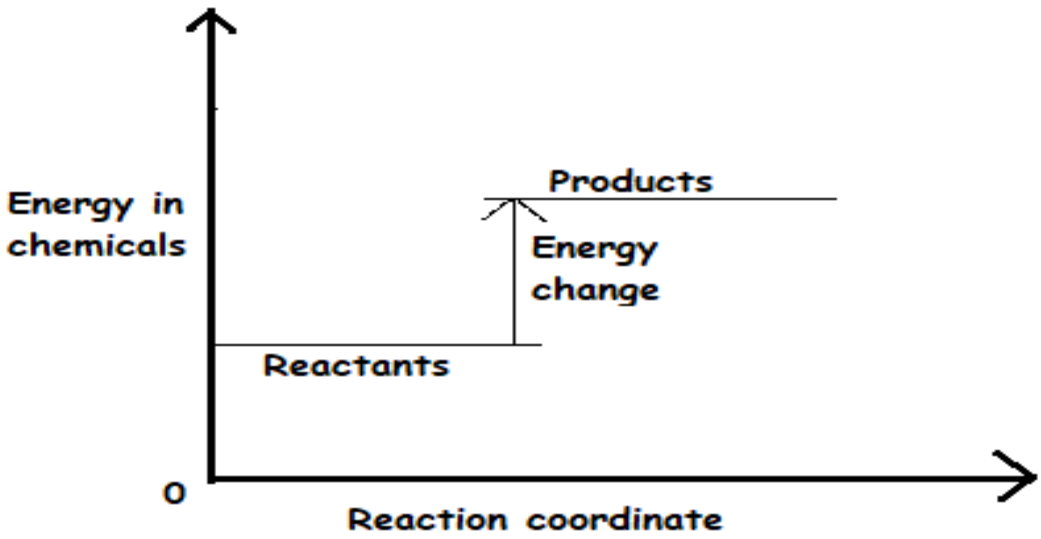
Endothermic reaction

Is a reaction in which heat is absorbed from the surrounding.

In this reaction, the products are richer in energy than the reactants.

Examples are discussed in the above notes

Energy profile for endothermic reactions.



Temperature changes in dissolving substances in water

Previously, we found out that energy is gained or given out.

Energy can neither be created nor destroyed, rather, it can be transformed from one form to another. *This is referred to as the law of conservation of energy.*

Energy changes occur in chemical reactions and some physical processes like dissolving solid substances in water.

Investigating changes in temperature as different substances are dissolved in water.

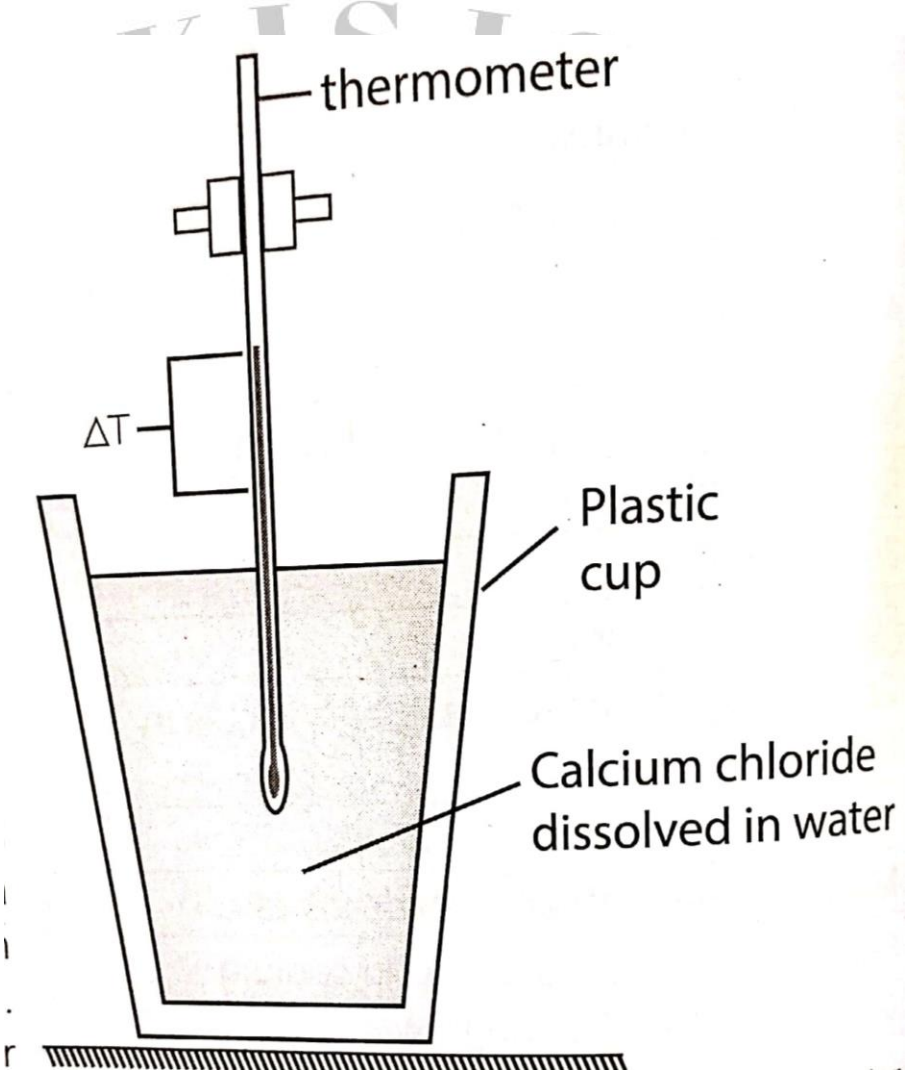
What you need/requirements

- Potassium chloride
- Sodium hydroxide
- Calcium chloride
- Sodium hydrogen carbonate
- Ammonium nitrate
- Sodium carbonate
- Water
- 5 beakers
- Permanent marker/masking tape/pen.
- Graduated cylinder
- Thermometer
- Chemical balance.

What to do/steps taken/procedure.

1. Label the beakers with "calcium chloride, potassium chloride, sodium hydroxide, sodium hydrogen carbonate, sodium carbonate and ammonium nitrate"
2. Add 100ml of water into the beaker labelled calcium chloride and measure its temperature using a temperature using a thermometer. Record the temperature in the table as the initial temperature.
3. Weigh 2 grams of calcium chloride and add it to the beaker in step 2 above, stir the mixture until the temperature stops changing and record the final temperature.
4. Repeat 2 and 3 using the beakers labelled "potassium chloride, sodium hydroxide, sodium hydrogen carbonate, sodium carbonate and ammonium nitrate"

Set up of apparatus



Observation and conclusion

Experiment number	solid	Initial temperature (^{0}c)	Final temperature (^{0}c)	Temperature change	Conclusion (Is it exothermic/ endothermic)
1	Calcium chloride	25	35		Highly exothermic
2	Potassium chloride	25	20		endothermic
3	Sodium hydrogen carbonate	25	32		Exothermic
4	Sodium carbonate	25	31		Exothermic
5	Ammonium nitrate	25	21		Endothermic
6	Sodium hydroxide				Exothermic

Characteristics of endothermic reactions

- They absorb thermal energy from their surroundings when they proceed
- The enthalpy of the products is always more than that of the reactants.
- The change in enthalpy is always positive.

Characteristics of exothermic reactions.

- They release thermal energy to their surrounding as the reactions proceed
- The enthalpy of the products is always less than that of the reactants.
- The change in enthalpy is always negative

Importances (or applications) of endothermic and exothermic reactions

Process/reactions	Nature (Exothermic or endothermic)	Importance/applications
Burning of petrol	Exothermic	Provides energy to run vehicles.
Cracking of alkanes	Endothermic	Production of lower alkanes
Adding lime to soil	Endothermic	Controlling soil pH
Respiration	Exothermic	Production of energy to run life processes.

Photosynthesis	Exothermic	Production of food in green plants.
Evaporation	Endothermic	Cooling Rainfall formation
Decomposition	Exothermic	Recycling
Condensation of water vapour	Exothermic	Rain formation Cooling
crystallisation	Exothermic	Separation of mixtures

Explain how the endothermic and exothermic reactions occur.

Refer to your notes of mixtures and other parts of senior one work.

Burning of fuels

Energy can be released in chemical reactions as light, sound or electrical but is most often released as heat.

Measuring heat transfers or changes is called **calorimetry**.

The calorimetry experiment can be used to measure the heat energy released from burning fuel.

Finding out energy released by burning ethanol.

What is needed/requirements

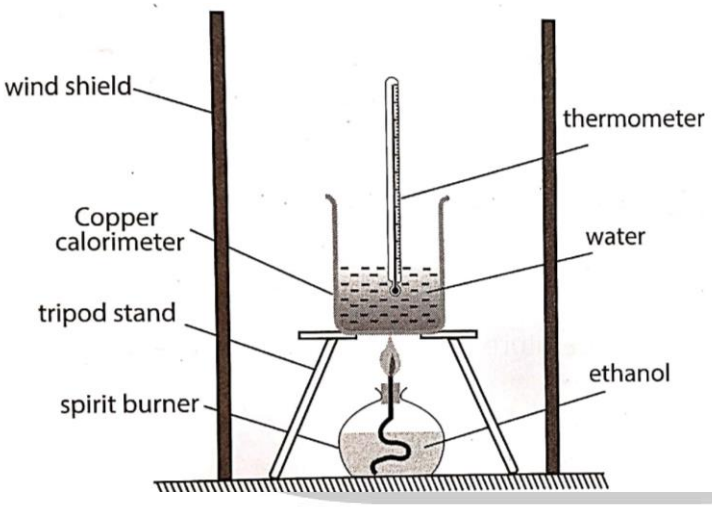
- Spirit burner
- Beakers
- Thermometer
- Wind shield
- Copper calorimeter
- Tripod stand
- Water
- Ethanol
- Peanut
- Oil
- Paper
- Wood

What to do/steps taken/ procedure

1. Measure 200ml of water using a measuring cylinder and pour into a thin copper calorimeter.

2. Measure the initial temperature of water in the calorimeter using a thermometer and record it as T_1 (^0C).
3. Add ethanol to the spirit burner, weigh it and record its mass as m_1 g
4. Light the spirit burner and let its flame heat the water directly and record the final temperature as T_2 (^0C).
5. Weigh the mass of the spirit burner with its contents after the experiment and record it as m_2 g

Set up of apparatus



Treatment of results

1. Initial temperature of water = T_1
2. Final temperature of water = T_2
3. Mass of spirit burner before heating = m_1
4. Mass of spirit burner after heating = m_2
5. Specific heat capacity of water = $4.2J/g^0C$
6. Amount of heat gained by water = specific heat capacity X mass of water X rise in temperature.

Results, discussion and Conclusion

1. Write an expression that can be used to determine the amount of energy released by the burning ethanol.
   - Heat = mass of water X 4.2 x (T_2 – T_1)
2. State any assumptions made in the activity.
   - The density of water is one.
3. State any source of error in the activity.
   - Absorption of some heat to the copper calorimeter

- Loss of some heat to the surroundings

4. How can this error be minimized?
   - By using a wind shield
   - By using a copper calorimeter with a thin layer

Fair testing

When comparing different fuels, it is important to carry out a fair test. Several variables should be kept constant. They include;

- The volume of water used
- The temperature increases.
- The initial temperature of the water.
- The distance of the flame from the calorimeter.

More reliable results can be obtained by repeating the experiment many times

The biggest source of error in calorimeter is usually unwanted heat loss to the surroundings. This can be reduced by insulting the sides of the calorimeter and adding a lid.

Example

3.5g of a fuel were burnt to heat 50cm^3 of water. The temperature of water increased from 22°C to 71°C. Calculate the amount of energy released per gram of the fuel.

Answers

Temperature change = temperature of water after heating – temperature of water before heating.

= (71 - 22)°C

= 49 °C

Mass of water = density of water X volume of water heated

= 1 gcm^{-3} X 50cm^3

= 50g

The total amount of heat energy released

= 4.2 x 50 x 49

= 10,290 J

Energy released per gram = total energy released ÷ mass of the fuel

= 10290 ÷ 3.5

= 2940 J/g

Example 2

Ethanol burns in excess air according to the equation

$2CH_3OH(l) + 3O_2(g) \longrightarrow 2CO_2(g) + 4H_2O(g)$ $\Delta H = -730KJ/mol$

Given that 3.2g of methanol were burnt, determine i) The amount of heat liberated

ii) The mass of carbon dioxide produced

Solution

i) From the equation,

2 moles of CH_3OH liberate 730 KJ

2(12+1x3+16+1)g of CH_3OH liberate 730 KJ

64g of CH_3OH liberate 730 KJ

1g of CH_3OH liberate $(^{730}/_{64})$ KJ

3.2g of CH_3OH liberate $(^{730x3.2}/_{64})$ KJ

=32.5KJ

ii) From the equation,

2 moles of CH_3OH liberate 2 moles of CO_2

2(12+1x3+16+1)g of CH_3OH liberate 2(12+16x2)g of CO_2

64g of CH_3OH liberate 88g of CO_2

1g of CH_3OH liberate $(^{88}/_{64})$g of CO_2

3.2g of CH_3OH liberate $(^{3.2x88}/_{64})$g of CO_2

=4.4g of CO_2

1. Staff attendant uses 3 g gas to boil 400 cm3 of pure water from 22oC to 100oC to prepare morning tea for teachers. If the gas is 85% methane, 5% carbon dioxide, 5% nitrogen and the rest being hydrogen;
   a) calculate the amount of heat produced
   b) i) deduce the mass of methane used
      ii) if she uses the same mass of methane every day, calculate the mass of methane used for one weak.
      iii) If a kilogram of the gas costs UGX 11,000, calculate her total expenditure on the gas for ninety days.
2. 1 mole of gas X burns in excess oxygen to produce 252,000 Joules of energy. When 2 dm^3 of the gas were burnt at room temperature, they caused the temperature of 250 cm^3 of water to rise from 25oC to 45 oC. Calculate the amount of heat produced.

Solution

a) Amount of heat energy produced = mass of water x specific heat capacity of water x temperature change

= 400 x 4.2 x 78

= 131,040 J

b) i) Mass of methane = 0.85 x 3 = 2.55 g

ii) 2.55 x 7 = 17.85g

Let learners calculate the total expenditure

2. Let learners calculate the amount of heat produced

Energy transformation and fuels

When fuels are burnt, the chemical energy that is released can be used to generate another form of energy, such as heat, light, motion, or electricity.

A fuel is a substance that provides energy as a result of a chemical change.

A fuel may provide energy in the form of heat, light, motion or electricity.

Energy transformation is a change from one form of energy to another.

Energy transformation is also called an energy conversion. Changing chemical energy into heat is an example of an energy transformation.

Fuels contain stored energy.

The stored energy in fuels can be released by combustion.

Combustion is the burning of a substance. The release of energy from fuels is used to make other forms of energy.

When gasoline burns in a car engine, some of the chemical energy in the gasoline is converted into heat. The heat is converted into heat. The heat is converted into mechanical energy. The mechanical energy moves the car.

Burning fuel in an electric power plant produces heat.

The heat is used to boil water to make steam. The steam turns a turbine. The turbine turns magnets inside a generator.

The turning magnets produce an electric current. Each of the steps in this process involves an energy transformation.

Energy flow through an ecosystem

An ecosystem is a biological community of interacting organisms and their physical environment.

Energy that supports ecosystems, originates from the sun.

Primary producers convert the sunlight energy to chemical energy by a process of photosynthesis.

Energy at producer level is lost through respiration as heat, transpiration and fossilization where it's stored in fossil fuels as chemical energy.

The surplus energy then flows to primary consumers (herbivores) and then to secondary consumers (carnivores) as chemical energy in form of food.

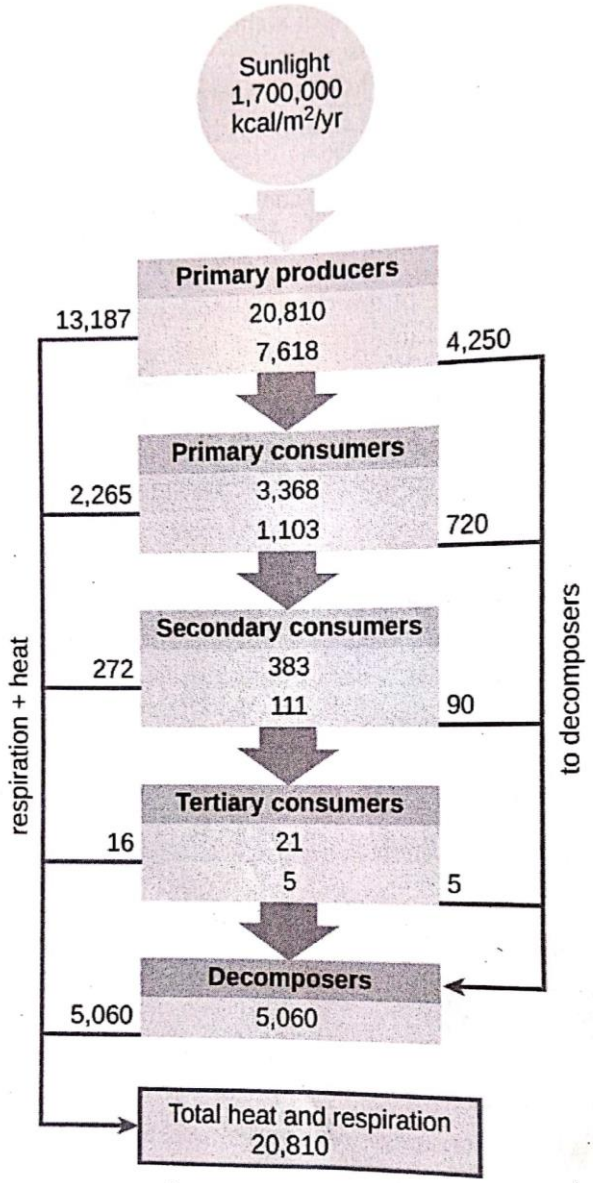
Energy at consumer level is lost through excretion and respiration as well as through fossilization as chemical energy in fossil fuels.

Decomposer feed at each trophic level breaking down organic matter releasing heat energy.

Energy flow is unidirectional.

Summary chart of energy flow through an ecosystem.

How energy in fossil fuels can be utilized.



- They provide heat to warm our homes.
- They provide energy that run vehicles
- They provide power used for running manufacturing industries.
- They provide us electricity.

Heat of reaction and energy profiles of chemical reactions.

This is the heat change which takes place when substances react to form one mole of the product.

The heat content of a reacting system is denoted by H and we normally consider the changes in heat content-delta H, (ΔH) since it is not easy to precisely determine H.

ΔH=H(product)-H(reactants)

Types of heat (enthalpy) changes

- Hear of combustion/enthalpy of combustion
- Heat of neutralization/enthalpy of neutralization.
- Heat of solution/enthalpy of solution.
- Heat of displacement/enthalpy of displacement.

Heat of combustion/enthalpy of combustion

This is the heat change when one mole of a substance is completely burnt in oxygen. All combustion reactions are exothermic hence heat is always evolved and ΔH value is always negative.

For example;

$C(s) + O_2(g) \longrightarrow CO_2(g)$ $\Delta H = -394KJ/mol$

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$ $\Delta H = -1560KJ/mol$

Heat of solution or enthalpy of solution

Heat of solution is the heat change which takes place when one mole of a substance is dissolved in a specified amount of solvent.

The enthalpy change can either be negative if the reaction is exothermic of positive if it is endothermic.

Example

1. When 10g of ammonium chloride was dissolved in 100 cm^3 of water, the temperature changed from 21°C to 19°C. Determine the molar heat of solution of ammonium chloride (SHC of solution=4.2J/g/°C; density of water= 1 g/cm^3; N=14, H=1, Cl=35.5)

Solution

Heat change of solution = mass of solution x SHC of solution x Temperature change

Mass of solution = mass of water + mass of ammonium chloride

=(100 x 1) + 10, = 110g

Temperature change = 21-19 =2°C

$\Delta H_{Solution}$ = (110 x 4.2 x2) J

= 924 J

Molar mass of NH_4Cl= 14+1x4+35.5 = 53.5g

10 g of NH_4Cl liberates 924J

1 g of NH_4Cl liberates $(^{924}/_{10})$J

53.5 g of NH_4Cl liberates $(^{53.5x924}/_{10})$J

=4943.4 J

Or 4.9434 KJ

The molar heat of solution of ammonium chloride is 4.9434 KJ/mol.

2. When 16g of anhydrous copper (II) sulphate were dissolved in 150 cm^3 of water, the temperature changes from 24°C to 29°C. Determine the heat of solution of the anhydrous copper (II) sulphate and with a reason, state whether the reaction is exothermic or endothermic.

Solution

$CuSO_4(s) + 5H_2O(l) \longrightarrow CuSO_4.5H_2O$; ΔH = -78.2KJ

Heat change of solution = mass of solution x SHC of solution x Temperature change

Mass of solution = mass of water + mass of copper(II)sulphate

=(150 x 1) + 16, = 166g

Temperature change = 29-24 =5°C

$\Delta H_{Solution}$ = (166 x 4.2 x5) J

= 3486 J

Molar mass of $CuSO_4$= 64+32+16x4= 160g

16 g of $CuSO_4$ liberates 3486 J

1 g of $CuSO_4$ liberates $(^{3486}/_{16})$J

160 g of $CuSO_4$ liberates $(^{3486x160}/_{16})$J

=34860 J

Or 34.860KJ

The molar heat of solution of copper(II)sulphate is 34.860KJ/mol.

The reaction is endothermic as it was accompanied by heat absorption and rise in the temperature of the product.

Heat of neutralization/enthalpy of neutralization

This is the heat change that takes place when an acid reacts with a base to produce one mole of water.

The heat change is as a result of the reaction of hydrogen ions of the acid and hydroxyl ions of the base.

H^+(aq) + OH^- (aq) $\longrightarrow$ H_2O(l) $\Delta H_{Neutralization}$

Example.

50cm^3 of 2M HCl and 50 cm^3 of 2M NaOH both at 22°C where mixed in a plastic beaker. The mixture was stirred and the maximum temperature contained was 35°C.(SHC of solution=4.2J/g/°C; Density of solution =1 g/cm^3) a) Write the ionic equation for the reaction

b) Calculate the heat change for the reaction
c) Calculate the heat change when 1 mole of the acid is neutralized by 1 mole of the base i.e. molar enthalpy of neutralization.
d) In another experiment, 50 cm^3 of 2M NH_4OH was used instead of the NaOH. State whether the heat of reaction was greater than, equal to or less than the value you calculated.

Solution

a) H^+(aq) + OH^-(aq) $\longrightarrow$ H_2O(l)

b) Heat change = mass of solution x SHC of solution x Temperature change

= (50+50)x1 x 4.2 x (35-22) J

=(100x4.2x13) J

=5460J

c) Number of moles in $50cm^3$ of 2M HCl

$1000cm^3$ of solution contains 2 moles of HCl

$1cm^3$ of solution contains $(^{2}/_{1000})$ moles of HCl

$50cm^3$ of solution contains $(^{2x50}/_{1000})$ moles of HCl

= 0.01 moles of HCl

0.01 moles of HCl produces 5.46KJ

1mole of HCl produces $(^{5.46}/_{0.01})$ KJ

=546 KJ

d) Ammonium hydroxide is a weak base and not completely ionized, its heat of neutralization is less than the calculated value.

Exercise

1. When $50cm^3$ of 0.5M HCl acid solution was added to $50cm^3$ of 0.5M KOH solution in a calorimeter, there was a temperature rise from 27.5°C to 30.8°C. Calculate the enthalpy of neutralization of the reaction. (density of water=$1g/cm^3$ and its heat capacity is 4.2 J/g/°C)

Interpretation of energy profile diagrams

Study the figures below and answer the questions that follow.

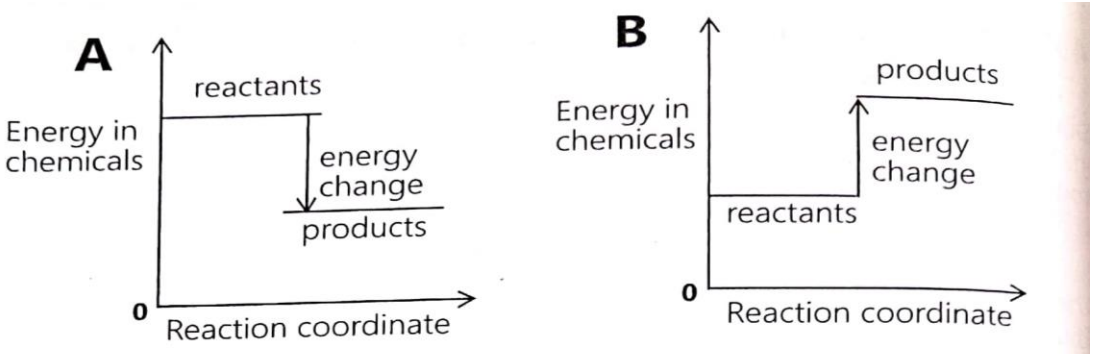


Figure 4.4: *Energy profile diagrams*

a) Identify the type of reaction in Figure 4.4.
b) Give reasons to support your answer in (a)
c) Discuss the examples of reactions in A and B.
d) What will be the sign of the value of heat of reaction in the energy profiles A and B in Figure 4.4.
e) Give reasons to support your answer in (d).
f) State how they can you apply the concepts of heat of reaction and profile diagrams in everyday life.

4. Compile a report of their group findings and present it to the rest of the class.

Suggested responses

a) A - Exothermic reaction
   B - Endothermic reaction
b) In figure A, heat is released. Thus, products have less energy than the reactants.
   In figure B, heat is absorbed. Thus, products have more energy than the reactants.
c) A- Reaction between a strong acid and water involves evolution of heat.
   B- Boiling of water involves absorption of heat.
d) A - The value of heat of reaction is negative
   B - The value of heat of reaction is positive.
e) A - The products are at a lower energy than the reactants.
   B - The products are at a higher energy than the reactants.
f) Let learners discuss how the two concepts can be applied in everyday life.

The heat of reaction is the heat change in a chemical reaction at standard standard condition between the numbers of moles of reactants shown in the equation for the reaction.

The heat of reaction is represented by the symbol ΔH. The unit of ΔH is kJmol-1.

a) The total energy is the same on each side of the arrow, in a reaction. So, in exothermic reactions, the products

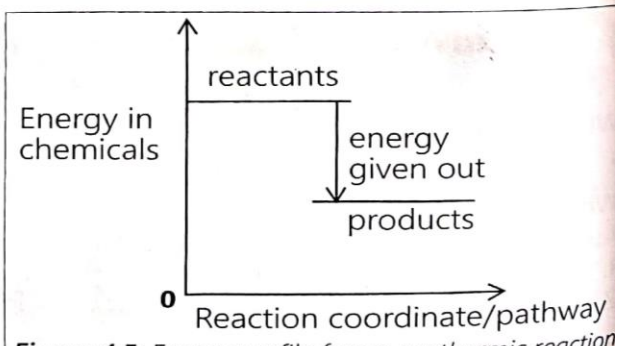


Figure 4.5: *Energy profile for an exothermic reaction*

have lower energy than the reactants. This is shown on the energy level diagram as in Figure 4.5.

b) In an endothermic reaction, energy is transferred from the surrounding. Since energy is taken in, the products must have more energy than the reactants. This is shown on the energy level diagram in Figure 4.6

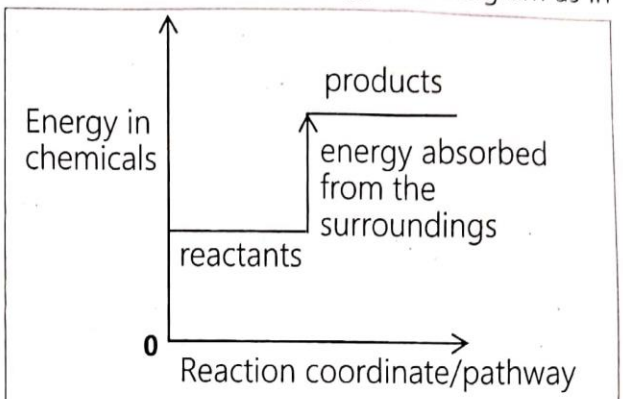


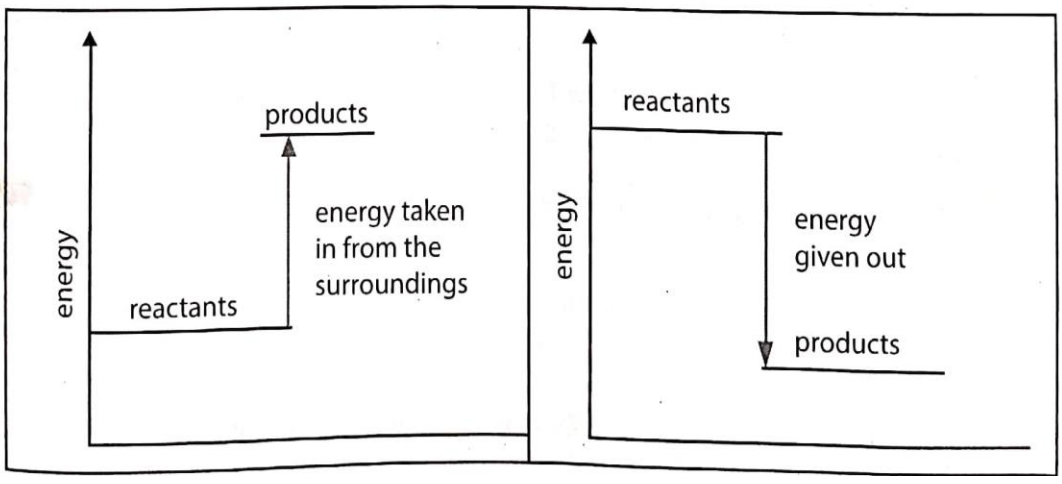
Figure 4.6: *Energy profile for an endothermic reaction*

Exercise 4.2

1. Are the following reactions exothermic or endothermic?
   a) Reaction between sodium and water
   b) Burning a candle
   c) Frying an egg
2. Draw and explain an energy level diagram for an;
   a) endothermic reaction
   b) exothermic reaction

Suggested responses

1. Is it exothermic or endothermic?
   a) exothermic b) exothermic c) endothermic.
2.



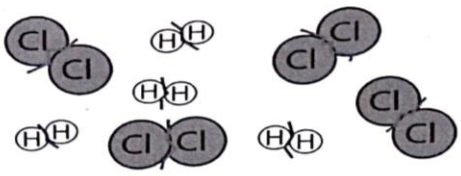
Explaining energy changes

Making and breaking bonds

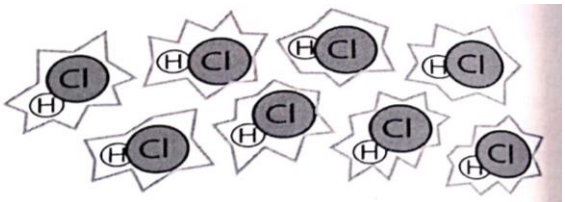
In a chemical reaction, bonds must first be broken. Then new bonds form. Breaking bonds absorbs energy while making bonds releases energy.

For example;

When hydrogen reacts with chlorine in sunshine, to form hydrogen chloride:



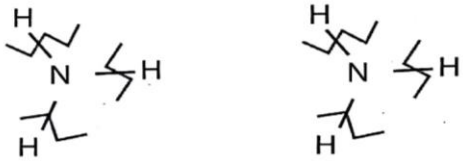
1. First, the bonds in the hydrogen and chlorine molecules must be broken. Energy is absorbed for this. (Energy from the sun will suffice)



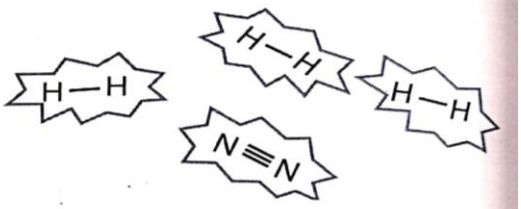
2. Now, new bonds form between hydrogen and chlorine atoms, giving molecules of hydrogen chloride. This step releases energy.

The energy absorbed in step 1 is less than the energy given out in step 2. So, this reaction gives out energy, overall. The process is exothermic.

When ammonia is split (with the help of the catalyst like nickel) into hydrogen and nitrogen: (Here lines are used to show the bonds, and note the triple bond in nitrogen.)



1. First, the bonds in the ammonia must be broken. Energy is absorbed for this.



2. Now, the hydrogen atoms bond together, so do the nitrogen atoms. This releases energy.

The energy absorbed in step 1 is greater than the energy given out in step 2. So, the reaction absorbs in energy, overall. The process is endothermic.

Sample Activity of Integration

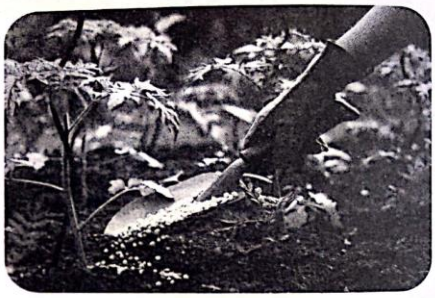
In the recent years, motor fire accidents have increased in Uganda, resulting into deaths, injuries and property damage.
Some of such cases are;

1. In October, 2022, a Mercedes Benz car veered off along Masaka-Mbarara highway and caught fire leaving one person dead and another got severely burnt. (Source: https://www.monitir.co.ug/uganda/news/national/one-dead-driver-in-critical-condition-after-car-bursts-into-flames--399357,accessed on 19th December,2022)
2. In September, 2016, a Toyota Corona car caught fire in the middle of the road at Wandegeya, next to Public Service in Kampala (Source: https://www.monitor.co.ug/uganda/news/national/car-catches-fire-in-middle-of-road-1664902, accessed on 19th December, 2022)

In the effort to reduce the occurrence, the Ministry of Works and Transport, together with Uganda Police, have organised a one-day workshop to sensitize taxi drivers in Kampala on causes and control of car fires.

As a chemistry learner, prepare a presentation which you would deliver to the drivers, in which you explain the causes of car fires and how they can be reduced.

Sample Activity of Integration



The government through the ministry of agriculture gave out high yield seeds to farmers in your community. Despite the rains, the plant yield remained low. Upon investigation, soil scientists discovered that the nitrate content in soil was very low. They recommended the use of ammonium nitrate fertiliser by farmers. This fertiliser can be applied in solution form when dissolved in water. When farmers dissolved the fertiliser, the resultant solution was extremely cold. Some farmers who kept the fertiliser near heat; the fertiliser exploded with a lot of heat. Farmers have now refused to apply the fertiliser holding to a thinking that the fertiliser is likely to affect their soil or health badly. The government efforts are going to waste.

The ministry of Agriculture has organised a sensitisation workshop for farmers on the behaviour of the fertiliser. Your knowledge on this matter is a strong pillar the workshop leans on.

Task:

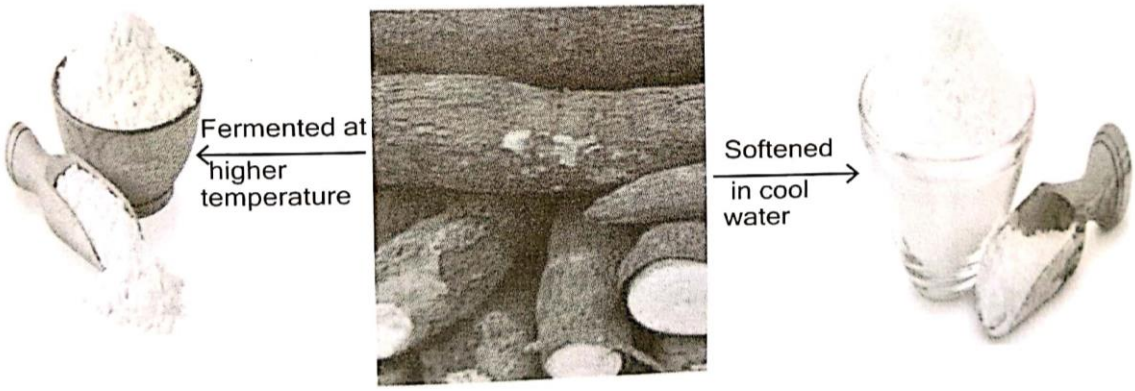
Prepare a presentation to sensitise the farmers in the workshop on this matter.

Activity of integration

Certain community in "Ombakora" village in north western Uganda predominantly depends on cassava as one of their staple food and source livelihood. This community developed a practice of obtaining a particular quality of cassava flour by storing fresh cassava tubers in cold water until they turned soft. The soft tubers were peeled, dried and made into flour.

A neighbouring immigrant community were shocked by this practice. They could not believe that any conditions cooler than ordinary room condition could ever cause any such change or reaction in the fresh cassava tubers. This is because the immigrant community had a tradition of preparing cassava flour by warming peeled cassava tubers in the sun for two to three days depending on the sun heat. Warmed tubers are then piled and kept at an even higher temperature to ferment the tubers before dried flour were obtained. If higher temperatures are not provided, the tubers would never ferment, The resulting cassava flour after fermentation had a totally different quality and taste from that of the indigenous community.

The immigrant community accused the indigenous Ombakora community of using evil spirits in cool water sources to cause reactions that can soften fresh cassava tubers to obtain flour. They claimed the flour evil.



TASK

The local leaders have requested you to prepare a written sensitization message to solve the dispute about use of evil spirit that cause changes/reactions at low temperature

End of chapter questions

End-of-Chapter Questions

1. Fill in the blanks with appropriate words.
   a) All chemical substances have energy stored in the form called _____
   b) The symbol for enthalpy is_____.
   c) Enthalpy change is usually measured in _____.
   d) For endothermic reactions, enthalpy change is _____.
   e) White washing is _____in nature.
   f) Respiration is a process of _____ food molecules.
   g) The energy released during respiration is trapped in the form of ____.
   h) _____is the opposite of cellular respiration.
   i) Water evaporation is an example of a _____reaction.
   j) The SI unit of energy is _____
2. Classify the following statements as True or False.
   a) Chemical reactions often involve changes in energy due to the breaking and formation of bonds.
   b) The system is that particular part of the universe where a reaction does not take place.
   c) Burning carbon with oxygen produces water.
   d) For endothermic reactions, ΔH is negative.
   e) Rusting of iron is an exothermic reaction.
   f) Fuel combustion produces large amounts of heat.
   g) Photosynthesis takes place in plants and animals.
   h) Frying an egg is an endothermic process.
   i) Energy cannot be created or destroyed; instead, it changes forms.

End of Chapter Questions

1 a) Explain the following terms;
   i) endothermic reaction ii) exothermic reaction

   b) i) Draw an energy level diagram for the following reaction.
   $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$ $\Delta H = -57\ kJmol^{-1}$

   ii) Is the reaction endothermic or exothermic?

   c) i) Draw an energy level diagram for this reaction.
   $2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$ $\Delta H = +575\ kJmol^{-1}$

   ii) Is the reaction endothermic or exothermic?

2 Write down the factors one has to consider as most important when choosing a particular fuel for any of the given purposes;
   a) cooking stove, b) aircraft, c) vehicles.

3 When potassium hydroxide is dissolved in water, there temperature rise;
   a) What type of reaction is that?
   b) How can you explain the temperature change?

4 a) What is meant by heat of reaction?
   b) How does the heat content of the products of a reaction system compare with the heat content of reactants when the reaction is:
   i) exothermic ii) endothermic.
   c) What is the basis for assigning a negative value and a positive value to the change in heat content (ΔH) in an exothermic and endothermic reaction respectively?

End – Of – Chapter Questions

1. Fill in the blanks with appropriate words
   a) All chemical substances have energy stored in the form called_____.
   b) For a reaction in beaker, the _____is the chemicals reacting in a beaker.
   c) The symbol for enthalpy is_____
   d) ΔH is usually measured in_____
   e) For endothermic reactions, ΔH is_____
   f) White washing is_____in nature.
   g) Respiration is a process of_____food molecules.
   h) The energy released during respiration is trapped in the form of_____.
   i) _____is the opposite of the cellular respiration.
   j) Water evaporation is an example of_____reaction.
   k) The SI unit of energy is _____.
   l) The temperature products transfer heat to the surroundings_____.
2. Classify the following statements as True or False
   a) Chemical reactions often involve changes in energy due to the breaking and formation of bonds.
   b) The word outside the defined system is known as surroundings.
   c) The burning of carbon with oxygen produces water.
   d) For endothermic reactions, ΔH is negative.
   e) Rusting of iron is an exothermic reaction.
   f) White washing is exothermic in nature.
   g) Respiration is a process of reducing food molecules.
   h) Fuel combustion produces large amounts of heat.
   i) Photosynthesis is found in plants and animals.
   j) Frying an egg is an endothermic process.
   k) Energy cannot be created or destroyed, instead it changes forms.

Your education is your life, guard it well. Prov: 4:13