Excellence in Chemistry

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Chemistry

SENIOR SECONDARY
3
TEACHER'S GUIDE

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Contents

Introduction

Purpose of the curriculum

The general objectives of the curriculum are to enable students to:

- develop an interest in the subject of chemistry
- acquire basic theoretical and practical knowledge and skills in chemistry
- develop an interest in science, technology and mathematics (STM)
- acquire basic STM knowledge and skills
- be positioned to take advantage of the numerous career opportunities offered by chemistry
- be adequately prepared for further studies in chemistry.

Goals of the curriculum

The goals of the reviewed chemistry curriculum ensure that the teaching of chemistry will:

- facilitate a smooth transition in the use of scientific concepts and techniques acquired in the new Basic Science & Technology curriculum with chemistry
- provide students with the basic knowledge in chemical concepts and principles through efficient selection of contents and sequencing
- show chemistry and its interrelationship with other subjects
- show chemistry and its link with industry, everyday life activities and hazards
- provide a course which is complete for students not proceeding to higher education, while at the same time providing a reasonably adequate foundation for a post-secondary school chemistry course.

Time allocation

To cover this curriculum, the recommended weekly time allocation is 1 period of 40 minutes. Students need to do regular revision at home in order to cope with the content and new terminology.

Role of the teacher

One of the principle duties of a chemistry teacher is to prepare and present good lessons to his or her students. The teacher has to:

- be as well informed as possible on the scheme of work of the subject
- know the aims and objectives of each topic
- select appropriate content materials
- decide on the best methods of presentation, such as PowerPoint, workstations, videos, discussion groups, worksheets, question-answer sessions, debate, and experiments
- gather equipment and other resources required for the activities
- keep informed about new developments and news in chemistry in Nigeria and the rest of the world
- arrange outings and guest speakers from time to time.

To be effective in presentation, the teacher must do a written/typed plan for each lesson. This must include aims, objectives, resources, time frames, content for the lesson, activities, homework, assessment, and ideas/additional worksheets to cater for students requiring extension or learning support (remedial).

Prepare each topic in advance. Many teachers go into the classroom inadequately prepared. It is your responsibility as a chemistry teacher to actively involve your students in the learning process. It is a proven fact that students learn far more by *doing* than by *listening*.

You should endeavour to apply the scientific method throughout. Science involves being curious and asking questions. Wherever possible, ask questions to engage the students and to encourage independent thought processes. Start your lessons by asking the students to write down answers to questions related to your lesson (approximately 5). This will settle them into the lesson. You can use different types of questions in your lessons:

- *diagnostic*, enabling you to determine prior knowledge on the topic
- for *consolidation* of challenging concepts during the lesson
- for *stimulation* of interest in the subject
- for *concluding* the lesson. This will assist you to find out whether students have understood the concepts/terminology in the lesson. It will also highlight any areas that they need to revise at home or for you to revisit in the next lesson.

Teachers must ensure that they do not appear to have favourites in the class. So, devise a system to ensure that you ask questions fairly, but be careful not to embarrass weak students if they cannot answer questions.

How to use this guide

The purpose of this Teacher's Guide is to assist you in using the Student's Book so that you may be more thoroughly prepared and your teaching will be more meaningful to your students. This book supports a hands-on approach and lays a solid foundation for further study.

You need to be familiar with the key features of the Student's Book. The book is divided into 8 topics. Each topic is structured in the following way:

- performance objectives required by the curriculum
- content required by the curriculum
- activities to be completed individually, with a partner, in groups or as a class
- summary of the topic
- key words – this is essential vocabulary for the topic
- revision questions for revision of the topic.

How to use the scheme of work

A scheme of work is defined as the part of the curriculum that a teacher will be required to teach in any particular subject. Its primary function is to provide an outline of the subject matter and its content, and to indicate how much work a student should cover in any particular class. A scheme of work allows teachers to clarify their thinking about a subject, and to plan and develop particular curriculum experiences that they believe may require more time and attention when preparing lessons. The criteria all teachers should bear in mind when planning a scheme of work are continuity in learning and progression of experience. You can add your own notes to the scheme of work provided on pages viii to x.

The scheme of work is sequential. The sequence of the scheme of work is aligned with the textbook. Do not be tempted to jump around. Rather spend time carefully planning the term to ensure that you adhere to the scheme of work.

The year is divided into 3 terms. Each term is divided into 13 weeks. There are 2 topics in Term 1, 3 topics in Term 2 and 3 topics in Term 3. The end of term allows time for revision and an examination. This time frame may vary depending on the planning of your particular school.

The number of lessons per topic should be divided according to the content of the topic. These vary from 4 to 11 lessons per topic.

The first lesson is usually an introduction to the topic. Make an effort to make this lesson exciting and informative. You should always explain the meaning of the topic in this lesson, for example: What is chemistry? How can we use chemistry in daily life? What is the Scientific method?

The last lesson is allocated to revision. In this lesson you can give the class a revision worksheet, a test or design a fun activity such as a game or a quiz to consolidate the topic. Students can also do their own revision by making mind maps, concept maps or other types of summaries. They can also set tests for each other.

It is important to note that these are a suggested number of lessons for the topic. The amount will vary according to the ability of the students in your class and their prior knowledge. Your management of the class will have an enormous influence on your ability to adhere to the time frames. Focus on effective discipline strategies. You will have less discipline issues if you are: punctual, well prepared, follow a plan (write this on the board at the start of the lesson), keep your word (don't make empty threats), consistently adhere to rules, especially rules related to laboratory safety and strive to make chemistry an exciting subject.

A teacher of chemistry is a professional instructor who facilitates, promotes and influences students to achieve the outcomes of the scheme of work. It is the wish of the authors that the students will, at the end of each course in the series (SS1, SS2 and SS3), attain a level of proficiency in chemistry that will equip them for future studies in this field.

Scheme of work

Teaching scheme of work for SS3

Term	Week	Theme	Topic	Performance objectives (students should be able to:)	Content covered	SB page no
Term 1	1–5	The chemical world	1. Quantitative and qualitative analysis	1.1 titrate accurately and perform relevant calculations 1.2 analyse different salts for anions and cations 1.3 carry out simple tests for common gases 1.4 carry out simple redox titrations 1.5 test for fats, oils, proteins, starch, etc.	1. Acid-base titrations 2. Redox titrations involving $KMnO_4$, Fe^{2+}, C_2O_4, I_2, KI, $S_2O_3^{2-}$ 3. Tests for oxidants and reductants 4. Identification of ions (Fe^{2+}, NH_4^+, Fe^{3+}, Cu^{2+}, Pb^{2+}, etc.), chlorides, nitrates, sulphates, sulphides, bicarbonates, carbonates, sulphites, etc. 5. Tests for H_2, NH_3, HCl, NO_2, O_2, CO_2, Cl_2 (bleaching action) 6. Identification of fats and oils, simple sugars, proteins and starch	1–8 8–12 12–13 14–18 19–22 22–25
	6–10	Chemistry and industry	2. Petroleum or crude oil	2.1 explain the origin and state the composition of crude oil (petroleum) 2.2 discuss the exploration of and drilling for crude oil in Nigeria 2.3 explain the fractional distillation of petroleum and list the major fractions (products) 2.4 list the location of Nigerian refineries 2.5 explain the terms 'cracking' and 'reforming' 2.6 discuss the use of petrochemicals as starting materials of organic synthesis leading to organic compounds such as plastics, synthetic rubber, drugs, insecticides, detergents, fibres, etc. 2.7 explain the use of octane numbers in determining the quality of petrol 2.8 explain the occurrence, packaging and uses of natural gases 2.9 state the economic importance of petroleum	1. Origin and composition of crude oil 2. Searching and drilling for crude oil 3. Nigerian and world crude oil reserves 4. Fractional distillation and major fractions of crude oil 5. Location of Nigerian refineries 6. Cracking and reforming 7. Petrochemicals as starting materials of organic synthesis 8. Quality of petrol: the meaning of 'octane number' 9. Natural gas: occurrence, packaging as liquefied natural gas, and uses 10. Economic importance of petroleum	29–31 31–32 32–34 34–36 37 37–38 38–39 39–42 42–43 43–44
	11	Revision				
	12/13	Examination				

Term	Week	Theme	Topic	Performance objectives (students should be able to:)	Content covered	SB page no
Term 2	1–5	Chemistry and industry	3. Metals and their compounds	3.1 state the general characteristics of metals 3.2 identify what parts of the periodic table contain metals 3.3 state the relative abundance of metals in nature 3.4 list five classes of compounds formed by metals (sulphides, chlorides, etc.) 3.5 state the general principles of the extraction of metals 3.6 list the properties of alkali metals 3.7 describe the extraction and give the uses of sodium as a typical alkali metal 3.8 list five compounds of sodium 3.9 list the properties of alkaline earth metals 3.10 describe the extraction and give the uses of calcium as a typical alkaline earth metal 3.11 describe the extraction of aluminium 3.12 list five compounds of aluminium 3.13 list five uses of aluminium 3.14 describe the extraction of tin metal 3.15 state five uses of tin 3.16 name members of the first transition series 3.17 list the general characteristics and properties of transition elements 3.18 describe the extraction of copper 3.19 list five uses of copper	1. Metals: general characteristics: • chemical characteristics • relative abundance 2. Compounds of metals 3. Principles of extraction of metals: • electrolysis • reduction of oxides • reduction of chlorides • reduction of sulphides 4. Alkali metals 5. Sodium: extraction, properties, compounds, uses 6. Alkaline earth metals 7. Calcium: extraction, properties, compounds, uses 8. Aluminium: extraction, uses 9. Tin: extraction, uses 10. Transition metals: properties (first transition series 11. Copper: extraction, uses	47–48 48–49 49–52 52–53 53–54 54–55 55–56 56–57 57–58 58–59 59–60
	6–8		4. Iron	4.1 state the relative abundance of iron ore in nature 4.2 state the physical and chemical properties of iron 4.3 describe the process of extraction of iron from its ore 4.4 state the causes of rusting in iron 4.5 suggest ways of preventing the rusting of iron	1. Relative abundance of iron ore in nature 2. Extraction of iron 3. Uses of iron 4. Rusting of iron and steel, and methods of prevention	63 64–65 65–67 67–71
	9–10		5. Ethical, legal and social issues	5.1 state the adverse effects of chemical wastes on the environment 5.2 list some industrial pollutants of the environment 5.3 state ways of preventing environmental degradation 5.4 identify the role of governments in preventing and fighting environmental degradation	1. Chemical wastes 2. Pollutants 3. Legislation: Roles of government in preventing environmental degradation 4. Responsibilities of the people	73–74 74–77 78 79
	11	Revision				
	12/13	Examination				

Term	Week	Theme	Topic	Performance objectives (students should be able to:)	Content covered	SB page no
Term 3	1–2	The chemistry of life	6. Fats and oils	6.1 identify sources of fats and oils 6.2 differentiate between fats and oils 6.3 state the physical and chemical properties of fats and oils 6.4 explain saponification using relevant equations 6.5 test for fats 6.6 state the uses of fats and oils	1. Sources 2. Physical and chemical properties of fats and oils 3. Reactions of fats and oils 4. Chemical tests for fats 5. Uses of fats and oils	83–84 84–87 87–89 89 90
	3–4		7. Soap and detergents	7.1 identify the materials for making soap 7.2 prepare soap from local sources 7.3 explain the emulsifying action of soap using relevant equations 7.4 define detergents 7.5 describe the mode of action of detergents 7.6 distinguish between soap and detergents	1. Materials for making soap 2. Preparation of soap 3. Soaps: How do they work? 4. Detergents 5 Soaps, detergents and the environment	92 93 97 99 102
	5–8		8. Giant molecules	8.1 mention some sources of sugar 8.2 classify sugar as: a. monosaccharides, disaccharides and polysaccharides b. reducing and non-reducing sugars 8.3 give examples of the different types of sugars 8.4 prepare glucose from starch and sucrose 8.5 test for starch and glucose using Fehling's solution 8.6 state the uses of starch and sugars	Sugars: 1. Sources of sugar 2. Classification as: a) monosaccharides, disaccharides and polysaccharides b) reducing and non-reducing sugars 3. Hydrolysis of sucrose and starch 4. Test for starch and sugars 5. Uses of starch and glucose	104–105 105–108 108–110 110 110–111
				8.7 list the sources of protein 8.8 give examples of protein 8.9 identify amino acids as the building blocks of proteins 8.10 state the physical and chemical properties of proteins 8.11 carry out confirmatory tests for proteins 8.12 state the uses of proteins	Proteins: 1. Sources of proteins 2. Examples of proteins 3. Amino acids: the building blocks of proteins 4. Physical and chemical properties of proteins 5. Testing for proteins	111 112 113 114 116
	9		All practicals			
	10		Revision			
	11/12/13		Examination			

THEME 1

The chemical world

Topic 1: Quantitative and qualitative analysis
Performance objectives
1.1 Titrate accurately and perform relevant calculations. **1.2** Analyse different salts for anions and cations. **1.3** Carry out simple tests for common gases. **1.4** Carry out simple redox titrations. **1.5** Test for fats, oils, proteins, starch, etc.

Introduction

In this topic, we look at quantitative analysis of acid-base titrations and redox titrations. We will discuss the qualitative analysis on how to identify oxidants and reductants, how to identify cations and anions, how to test for common gases, and how to identify fats, oils, simple sugars, proteins and starch.

Experiment 1.1: Determine the percentage acetic acid in vinegar (SB p. 3)

Resources

Student's Book, 250 cm^3 volumetric flask, vinegar, sodium hydroxide, 25.0 cm^3 pipette, phenolphthalein indicator, burette, conical flask

Guidelines

Facilitate: Carry out titrations to determine percentage purity.

Students should be able to determine the percentage acetic acid in vinegar, to determine the percentage purity.

Answers

The results of the activity may differ from student to student.

Assessment

Informal: teacher assessment

Experiment 1.2: Determine heat of neutralisation of an acid and a base

(SB p. 4)

Resources

Student's Book, 2 × 50 ml measuring cylinders, beakers, polystyrene cup calorimeter, thermometer, 0.5 M HCl, 0.5 M NaOH and 0.5 M HNO_3

Guidelines

Facilitate: Carry out titrations to determine heat of neutralisation.

Students should be able to determine the heat change for the neutralisation reaction between NaOH and HCl.

Answers

The results of the activity may differ from student to student.

Assessment

Informal: teacher assessment

Experiment 1.3: Percentage water of crystallisation (SB p. 7)

Resources

Student's Book, watch glass, mass meter, sodium carbonate, 250 ml volumetric flask, 25 ml pipette, conical flask, methyl orange, burette

Guidelines

Facilitate: Carry out titrations to determine percentage water of crystallisation.

Students should be able to carry out titration and calculate the percentage water of crystallisation, and record their findings in a table like the example in the Student's Book.

Answers (possible solutions)

1. Volume of acid used = 23.5 ml
   Volume of base = 25.0 ml
   Factor for the acid = 2
   Factor for the base = 1
   Molarity of acid = 0.2 M
   Molarity of base = ?
   $$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$$
   $$\frac{(0.2)(23.5)}{(c_b)(25.0)} = \frac{2}{1}$$
   $c_b = 0.094\ \text{mol·dm}^{-3}$ sodium carbonate

2. Sodium carbonate in 250 ml = 0.094 ÷ 4
   = 0.0235 moles in 250 ml
   ∴ 0.0235 × 106 g = 2.491 g
   ∴ 6.73 g – 2.491 g = 4.239 g
   Percentage water of crystallisation
   $$= \frac{4.239}{6.73} \times 100 = 63\%$$

3. We can calculate the value of '*x*' in the formula $Na_2CO_3{\cdot}xH_2O$. We already know that there are 0.0235 moles of sodium carbonate present in the crystals. We also know that there are 4.239 g of water present. This is equivalent to
   $$n = \frac{m}{M} = \frac{4.239}{18} = 0.2355\ \text{mol}$$
   Moles of Na_2CO_3:moles of H_2O
   0.0235 mol:0.2355 mol
   1:10
   ∴ $x = 10$

Assessment

Informal: teacher assessment

Activity 1.1: Acid-base titrations

INDIVIDUAL (SB p. 7)

Resources

Student's Book, relevant acids and bases

Guidelines

Facilitate: Guide a class discussion on the experiment that was performed.

Students should be able to use the information provided in the Student's Book and perform the necessary calculations.

Answers

1. a) Neutralisation occurs at the equivalence point (or endpoint) of the reaction where equal molar amounts of the acid and base have reacted according to the molar concentration ratio in the chemical equation.
   b) phenolphthalein (used when titrating a strong base with a weak acid)
   c) For NaOH: (cV)dilute = (cV)concentrated
   $$c_{\text{dilute}} = \frac{(cV)_{\text{concentrated}}}{V_{\text{dilute}}}$$
   $$= \frac{1.63\ \text{mol·dm}^{-3} \times 0.05\ \text{dm}^3}{1.0\ \text{dm}^3}$$
   $= 0.08\ \text{mol·dm}^{-3}$
   $n(\text{NaOH}) = cV = 0.08\ \text{mol·dm}^{-3} \times 0.04\ \text{dm}^3 = 3.2 \times 10^{-3}$ mol
   $2NaOH + H_2C_2O_4 \rightarrow Na_2C_2O_4 + H_2O$
   2 mol NaOH react with 1 mol acid
   $n(\text{acid}) = 2(3.2 \times 10^{-3})$
   $= 1.6 \times 10^{-3}$ mol
   $m(\text{acid}) = nM = 1.6 \times 10^{-3}\ \text{mol} \times 90.0\ \text{g·mol}^{-1} = 0.144$ g
   $$\%\ \text{purity} = \frac{0.144\ \text{g}}{0.25\ \text{g}} \times 100 = 57.6\%$$

2. a) $n(\text{NaOH}) = cV = (0.1\ \text{mol·dm}^{-3})(0.05\ \text{dm}^3) = 0.5$ mol
   b) $n(\text{HCl}) = cV = (0.1\ \text{mol·dm}^{-3})(0.05\ \text{dm}^3) = 0.5$ mol
   c) $Q = m \times C \times \Delta T = 50 \times 4.18 \times 0.75 = 156.75$ J
   d) The enthalpy change is approximately equal to the heat of the reaction.

3. Balanced equation: $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$
$n(HCl) = cV = 0.1 \times 0.02465 = 0.002465$ mol
Mole ratio:
$HCl:Na_2CO_3$
2:1
0.002465 mol:$\frac{1}{2}$(0.002465)
0.002465 mol:0.0012325 mol
Mass of Na_2CO_3:
$m(Na_2CO_3) = nM = 0.0012325 \times 106 = 0.130645$ g
Mass of water:
$m(H_2O) = 0.352$ g – 0.131 g = 0.221 g
Moles of water:
$n(H_2O) = \frac{m}{M} = \frac{0.221}{18} = 0.00123$ mol
Moles Na_2CO_3 present in this amount of $Na_2CO_3 \cdot xH_2O = 0.00123$ mol
∴ Value of x in $Na_2CO_3 \cdot xH_2O = \frac{0.0123}{0.00123} = 10$
∴ Formula is $Na_2CO_3 \cdot 10H_2O$

Assessment

Informal: teacher assessment

Experiment 1.4: Redox titration with potassium permanganate

(SB p. 10)

Resources

Student's Book, burette, conical flask, burette stand, pipette, measuring cylinder, standardised $KMnO_4$, iron(II) solution of unknown concentration, dilute H_2SO_4 solution

Guidelines

Facilitate: Guide students to perform a redox titration and record their findings.

Students should be able to standardise an iron(II) solution using a standard solution of potassium permanganate.

Assessment

Informal: teacher assessment

Activity 1.2: Redox titrations

INDIVIDUAL (SB p. 11)

Resources

Student's Book, relevant acids and bases

Guidelines

Facilitate: Guide a class discussion on how to perform a redox titration.

Students should be able to test for redox reactions and perform the necessary calculations.

Answers

1. a) $2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2e^-$
$I_2(aq) + 2e^- \rightarrow 2I^-(aq)$
$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$
b) Mass of iodine that reacts with 23.5 cm^3 of 0.012 $mol \cdot dm^{-3}$ sodium thiosulphate solution:
$n = cV = 0.012 \times 0.0235$
$= 0.000282$ mol
$S_2O_3^{2-}:I_2$
Mole ratio 2:1
0.000282 mol:0.000141 mol
$m = nM = 0.000141 \times 253.8$
$= 0.0358$ g

2. a) $Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^-$
b) $MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)$
c) $5Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$
d) *Step 1*: Calculate the amount of MnO_4^-.
$n(MnO_4^-) = 0.0200\ mol \cdot dm^{-3} \times 0.01295\ dm^3$
$= 0.000259$ mol
Step 2: From the equation, 5 mol of Fe^{2+} reacts with 1 mol of MnO_4^-.
$n(Fe^{2+})$ in each 20.00 ml sample
$= 5 \times 0.000259$ mol
$= 0.001295$ mol
$= 0.00130$ mol

e) Calculate the amount of Fe^{2+} in the 250.0 ml flask, remembering that only 20.00 ml was removed from the 250.0 ml flask for the titration.
$n(Fe^{2+})$ in 250.0 ml $= 0.00130 \times \frac{250}{20}$ mol
$= 0.0161875$ mol
$= 0.0162$ mol (three significant figures)

f) From the previous question, this is the amount of Fe^{2+} in 10 tablets, which equals the amount of $FeSO_4$ in 10 tablets. Calculate the mass of $FeSO_4$ in the 10 tablets, and then the mass of Fe^{2+} in 1 tablet.
$m(FeSO_4)$ in 10 tablets =
$0.0161875 \text{ mol} \times 151.847 \text{ g·mol}^{-1}$
$= 2.4580$ g
$m(FeSO_4)$ in 1 tablet $= \frac{2.4580}{10}$
$= 0.246$ g (three significant figures)

Assessment

Informal: teacher assessment

Practical demonstration: Test for reductants (SB p. 13)

This activity can be performed by the teacher, or students, working in small groups, and provided that sufficient equipment is available.

Resources

Student's Book, acidified potassium permanganate solution, dilute H_2SO_4, test tube, pipette

Guidelines

Facilitate: Guide a class discussion on the outcome of the practical demonstration.

Assessment

Informal: teacher assessment

Activity 1.3: Tests for oxidants and reductants INDIVIDUAL (SB p. 13)

Resources

Student's Book, indicator extract from flowers, test tubes

Guidelines

Facilitate: Guide a class discussion on how to test for oxidants in redox reactions.

Students should be able to test for oxidants and reductants, and record their findings in a table like the example in the Student's Book.

Answers

1. a) Oxidants are electron acceptors. They are substances that cause oxidation in the substance they react with.
   b) Reductants are electron donors. They are substances that cause reduction in the substance they react with. The substance being reduced gains electrons from the reducing agent.
   c) Reduction is the half reaction in which a substance gains electrons.
   d) Oxidation is the half reaction in which a substance loses electrons.

2.

Reductant	Species on oxidation
I^- in neutral solution	a) I_2
Fe^{2+} in acidic solution	b) Fe^{3+}

3.

Oxidant	Species on reduction	Observation
MnO_4^- in acidic solution	Mn^{2+}	Purple to colourless
$Cr_2O_7^{2-}$ in acidic solution	Cr^{3+}	Orange to green
Iodine solution	I^-	Colourless to yellow-brown

Assessment

Informal: self-assessment

Practical activity 1.4: Test for nitrate ions

GROUPS/PAIRS (SB p. 16)

Resources

Student's Book, 2 cm^3 of potassium nitrate solution, 3 cm^3 of iron(II) sulphate solution, 2 cm^3 of concentrated sulphuric acid, test tube, a dropping pipette

Guidelines

Facilitate: Guide a class discussion on how to test for nitrate ions.

Students should be able to test for nitrate ions and record their findings.

Answers

The results of the activity may differ from student to student.

Assessment

Informal: teacher assessment

Experiment 1.4: Test for anions (SB p. 17)

Resources

Student's Book, test tubes, test tube rack, 0.1 M $AgNO_3$, 3 M HCl, 6 M HNO_3, stirring rod, 0.1 M Na_2SO_4, 0.1 M $BaCl_2$, 0.1 M Na_2CO3, water bath

Guidelines

Facilitate: Guide students to perform a test for anions and record their findings.

Students should be able to perform various tests to determine the anion present in the unknown salt.

Answers

The results of the experiment may differ from student to student.

Assessment

Informal: teacher assessment

Activity 1.5: Identify ions

INDIVIDUAL/PAIRS (SB p. 18)

Resources

Student's Book, relevant salts

Guidelines

Facilitate: Guide a class discussion on how to identify ions (cations and anions).

Students should be able to identify unknown anion and cations in samples, and record their findings in a table like the example in the Student's Book.

Answers

1. Take a 2 cm^3 sample of each sample. Add $BaCl_2$ solution and a precipitate will appear in each test tube. Add dilute hydrochloric acid drop for drop. If all the precipitate dissolves, the sulphite anion was present. In the case of the sulphate anion, the precipitate is insoluble.
2. Take a 2 cm^3 sample of each sample. Add $MgSO_4$ solution. If a precipitate forms, it confirms the carbonate anion is present. Heat the other test tube and a precipitate appears upon heating a sample with the bicarbonate ion.
3. a) SO_4^{2-} ions
   b) I^- ions
   c) Cl^- ions
4.

Ion	Reaction with	
	NaOH(*aq*)	NH_3(*aq*)
Cu^{2+}	a) Pale blue precipitate and insoluble in excess NaOH	Blue precipitate soluble in NH_3 and gives a blue solution
Fe^{2+}	Green precipitate turning brown on contact with air and insoluble in excess NaOH	b) Green precipitate turning brown on contact with air and insoluble in NH_3
c) Pb^{2+}	White precipitate and soluble in excess NaOH	White precipitate insoluble in excess NH_3

Ag^+	d) Brown precipitate and insoluble in excess NaOH	Brown precipitate soluble in excess NH_3 and forms a colourless solution

Assessment

Informal: teacher assessment

Practical demonstration: Preparing and testing of hydrogen gas (SB p. 19)

This activity can be performed by the teacher, or students, working in small groups, and provided that sufficient equipment is available.

Resources

Student's Book, zinc granules, hydrochloric acid, test tube, wooden splint, candle and matches

Guidelines

Facilitate: Guide the students to prepare hydrogen gas and test the gas to confirm that it is hydrogen gas.

Practical demonstration: Test for oxygen gas (SB p. 20)

This activity can be performed by the teacher, or students, working in small groups, and provided that sufficient equipment is available.

Resources

Student's Book, 3% hydrogen peroxide (H_2O_2), yeast, 125 ml Erlenmeyer flask (or small jar), stopper (or lid), wooden splint (or toothpicks), candle and matches, teaspoon

Guidelines

Facilitate: Guide the students to prepare oxygen gas and test the gas to confirm that it is oxygen gas.

Activity 1.6: Tests for H_2, NH_3, HCl, NO_2, O_2, CO_2, Cl_2 (bleaching action)

GROUPS (SB p. 22)

Resources

Student's Book, zinc granules, hydrochloric acid, test tube, wooden splint, candle and matches, litmus paper

Guidelines

Facilitate: Guide the students on how to test for bleaching action.

Students should be able to analyse common gases and perform simple tests for H_2, NH_3, HCl, NO_2, O_2, CO_2, Cl_2 and record their findings.

Answers

1. A
2. B
3. A
4. a) hydrogen
   b) ammonia
   c) chlorine
   d) hydrogen chloride

Assessment

Informal: self-assessment

Practical activity 1.7: Test for fats and oils

GROUPS/PAIRS (SB p. 23)

Resources

Student's Book, food sample, 2 dry test tubes, ethanol, 2 cm^3 of de-ionised water

Guidelines

Facilitate: Guide the students to test for the presence of fats and oils in a food sample.

Assessment

Informal: self-assessment

Practical activity 1.8: **Benedict's test for reducing sugars**

GROUPS/PAIRS (SB p. 24)

Resources

Student's Book, a liquid or a solid food sample, distilled water, test tube

Guidelines

Facilitate: Guide the students to test a liquid or a solid food sample for the presence of simple sugars.

Answers

The results of the activity may differ from student to student.

Assessment

Informal: teacher assessment

Practical activity 1.9: **Iodine test**

INDIVIDUAL (SB p. 25)

Resources

Student's Book, a potato, clean spatula, a white tile, (2–3) drops of iodine solution

Guidelines

Facilitate: Guide the students to determine the presence of starch in biological materials.

Assessment

Informal: teacher assessment

Revision questions: Answers

(SB p. 26)

(Informal teacher assessment)

1. C
2. A
3. B
4. A
5. B (5)
6. a) Mass concentration (NaOH) = $6.0\ g \cdot dm^{-3}$
   Molar mass (NaOH) = 23 + 16 + 1 = $40\ g \cdot mol^{-1}$
   Molar concentration = $\frac{\text{mass concentration}}{\text{molar mass}} = \frac{6\ g \cdot dm^{-3}}{40\ g \cdot mol^{-1}}$
   = $0.15\ mol \cdot dm^{-3}$ (5)

   b) Amount of NaOH used = $c \times V$ = (0.15) × 0.025) = 0.00375 mol (or 3.75×10^{-3} mol)
   From the equation: $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$
   2 mol of NaOH require 1 mol of H_2SO_4
   ∴ 3.75×10^{-3} mol of NaOH require $\frac{1}{2}(3.75 \times 10^{-3}\ mol)\ H_2SO_4$
   $n(H_2SO_4) = 1.88 \times 10^{-3}$ mol
   If 15.5 cm^3 of solution A contains 1.88×10^{-3} mol of H_2SO_4
   ∴ 1 000 cm^3 (1 dm^3) of solution contains $(\frac{1.88 \times 10^{-3}}{1} \times \frac{1\ 000}{15.5})$ = 0.121 mol
   ∴ Molar concentration of pure H_2SO_4 is 0.121 mol (8)

   c) Molar mass of H_2SO_4 = 2(1) + 32 + 4(16) = $98\ g \cdot mol^{-1}$
   mass concentration = molar concentration × molar mass = 0.121 × 98 = $11.9\ g \cdot dm^{-3}$ (4)

   d) Mass concentration of the impure acid in solution A = 4.0 g in 250 cm^3
   Its mass concentration in $g \cdot dm^{-3}$ = $(\frac{4}{250} \times \frac{1\ 000}{1}) = 16.0\ g \cdot dm^{-3}$
   Mass concentration of the pure acid = $11.9\ g \cdot dm^{-3}$
   ∴ Percentage purity = $\frac{\text{mass concentration of pure acid}}{\text{mass concentration of impure acid}} \times 100$
   $= \frac{11.9}{16.0} \times 100 = 74.46\%$ (4)

7. Equation: $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$
   From the equation: 2 moles of MnO_4^- require 5 moles of $C_2O_4^{2-}$
   $n(C_2O_4^{2-}) = c \times V = (0.025\ mol \cdot dm^{-3}) \times (0.025\ dm^3) = 0.000625$ mol (or 6.25×10^{-4} mol)
   5 moles of $C_2O_4^{2-}$ require 2 moles of MnO_4^-
   $n(KMnO_4) = \frac{2}{5} \times 0.000625\ mol = 2.5 \times 10^{-4}$ mol
   ∴ 19.3 cm^3 of $KMnO_4$ contains 2.5×10^{-4} mol
   ∴ 1 000 cm^3 (1 dm^3) of $KMnO_4$ contains $(2.5 \times 10^{-4}\ mol) \times \frac{1\ 000}{19.3} = 0.013$ mol
   Concentration ($KMnO_4$) = $0.013\ mol \cdot dm^{-3}$
   OR:
   $$\frac{c_{OA}V_{OA}}{c_{RA}V_{RA}} = \frac{n_{OA}}{n_{RA}}$$
   $$\frac{c_{OA} \times 19.3}{0.025 \times 25} = \frac{2}{5}$$
   $c_{OA} = 0.013\ mol \cdot dm^{-3}$ (5)

8. a) $5Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(aq)$ (4)

   b) *Step 1*: Calculate the amount of the given reactant, MnO_4^-.
   $n(MnO_4^-) = c \times V$
   $= 0.0300\ mol \cdot dm^{-3} \times 0.02022\ dm^3$
   = 0.006066 mol
   Step 2: From the equation, 5 mol of Fe^{2+} reacts with 1 mol of MnO_4^-.
   $n(Fe^{2+}) = 5 \times 0.006066$ mol
   = 0.003033 mol
   Step 3: The 0.2 g wire sample was dissolved, making up a 25 cm^3 solution, which was titrated.
   $n(Fe^{2+})$ in 25 cm^3 solution = 0.00303 mol (6)

c) $\% \text{ Fe} = \frac{0.00303 \text{ mol} \times 55.847 \text{ g·mol}^{-1}}{0.2 \text{ g}} \times 100 = 84.7\%$ (3)

d) The endpoint is recognised by the first permanent pink colour caused by excess permanganate ions. (2)

e) Wear safety glasses and a laboratory coat; hold pipette close to the top when fitting pipette filler. (3)

9. a) To identify the aqueous ammonium trioxocarbonate (IV), add a few drops of NaOH to a sample of the solution. If no precipitate appears, add more NaOH to the sample and heat the solution. Test the gas with red litmus paper. If the litmus paper turns blue, it is NH_4^+ ions in the solution. (4)

To test for the carbonate ions, add magnesium sulphate. If a white precipitate ($MgCO_3$) forms, carbonate ions are present. In another sample, HCl can be added and the gas produced during the reaction can be tested with limewater. If the limewater turns milky, it is a positive test for CO_2, which is a product when a carbonate reacts with an acid. (4)

b) To identify the aqueous ammonium chloride, add a few drops of NaOH to a sample of the solution. If no precipitate appears, add more NaOH to the sample and heat the solution. Test the gas with red litmus paper. If the litmus paper turns blue, it is NH_4^+ ions in the solution. (4)

To test for chloride ions, add $AgNO_3$ solution to a sample of the solution. If a white precipitate forms, the ions in solution are chloride. (4)

10. Biuret test and iodine test. (2)

11.

Test	Test for the product	Anion
Substance X + dil. HCl →	Rotten egg smell Turns lead(II) ethanoate paper silvery black	a) S^{2-}
Substance Y + $BaCl_2$ →	White precipitate Insoluble in dil. HNO_3	b) SO_4^{2-}
Substance Z + dil. HCl →	Turns limewater milky	c) CO_3^{2-}

(3)

12. a) D
b) A
c) E
d) C
e) B (5)

13. a) HCO_3^-
b) SO_4^{2-}
c) NO_3^-
d) Cl^-
e) SO_3^{2-} (5)

Total marks: 80

How are you doing? (SB p. 25)

Take this opportunity to ask students if there is anything that they do not understand. You can check their understanding by asking them some questions about the information covered in the topic. Explain anything that students do not understand.

Key words

anion – negatively charged ion

cation – positively charged ion

endpoint – that point where the indicator changes colour in a titration reaction

neutralisation – occurs between the H^+ ions from the acid and the OH^- ions from the base

oxidising agents (oxidants) – substances that cause oxidation in the substance they react with; oxidising agent gains electrons and it is reduced

redox titration – the chemical reaction between the oxidising agent and reducing agent in aqueous solutions under suitable conditions

reducing agents (reductants) – substances that cause reduction in the substance they react with; reducing agent loses electrons and it is oxidised

standard solution – a solution of known concentration

titration – a method for determining the amount or concentration of an unknown substance

water of crystallisation – the water which is trapped between ions in a crystalline structure

Checklist for self-evaluation

Theme 1 Topic 1

EVALUATION GUIDE:

	Criteria	4	3	2	1	Comments
1.1	Carry out titration and calculate: • percentage purity • heat of neutralisation • water of crystallisation.					
1.2	Identify unknown cations and anions in samples.					
1.3	Carry out simple tests to identify sugars, starch, fats and oils, proteins, etc. in given samples.					

Code for evaluation:			
4 – Very well	3 – Well	2 – Fairly well	1 – Not well at all

THEME 2

Chemistry and industry

Topic 2: Petroleum or crude oil
Performance objectives
2.1 Explain the origin and state the composition of crude oil (petroleum). **2.2** Discuss the exploration of and drilling for crude oil in Nigeria. **2.3** Explain the fractional distillation of petroleum and list the major fractions (products). **2.4** List the location of Nigerian refineries. **2.5** Explain the terms 'cracking' and 'reforming'. **2.6** Discuss the use of petrochemicals as starting materials of organic synthesis leading to organic compounds such as plastics, synthetic rubber, drugs, insecticides, detergents, fibres, etc. **2.7** Explain the use of octane numbers in determining the quality of petrol. **2.8** Explain the occurrence, packaging and uses of natural gases. **2.9** State the economic importance of petroleum.

Introduction

The liquid we call 'petrol' is one of the most widely used fuels in the world. 'Petrol' is an abbreviation of petroleum. In this topic, we discuss some of the properties of crude oil, or 'petroleum'. Petrol is one of the many important substances we obtain from crude oil. The wide variety of chemicals derived from crude oil is often grouped under the term 'petrochemicals'.

Activity 2.1: Research industrial uses

INDIVIDUAL (SB p. 30)

Resources

Student's Book, Internet, library, pictures from newspapers or magazines

Guidelines

Guide the students to use a library or the Internet to do some research on the industrial uses of 'carbon black' or methane.

Facilitate: Guide a class discussion on the different industrial uses of 'carbon black' and methane.

Students should be able to do research and list the uses of their choice.

Answers

Students should come up with a variety of uses.

Assessment

Informal: teacher assessment

Activity 2.2: Find out what your family spends on energy

INDIVIDUAL (SB p. 32)

Resources

Student's Book, Internet, library, workbook

Guidelines

Facilitate: Guide a class discussion on the different types of energy and a breakdown of the different costs. Using this information, they will know what sort of questions to ask their parents/caregiver on how much is spent on energy, and be able to calculate how this expenditure is divided between electricity, gas, paraffin, petrol (running the family car), coal and wood.

Students should be able to ask questions, and calculate total expenditure and divide between sources of energy.

Answers

Students should come up with a variety of calculations.

Assessment

Informal: teacher assessment

Activity 2.3: Debate energy usage in Nigeria

GROUPS/CLASS (SB p. 34)

Resources

Student's Book, Internet, library

Guidelines

Facilitate: Guide a class discussion on whether Nigeria should move its energy usage to 'cleaner' sources, or whether Nigeria needs no adjustment to its energy policies.

Students should be able to comfortably and confidently debate both sides of the topic.

Answers

Students should come up with a variety of opinions both for and against the topic being debated.

Assessment

Informal: teacher assessment

Practical demonstration: Refining of 'crude oil'

(SB p. 34)

This activity can be performed by the teacher, or students working in small groups, and provided that sufficient equipment is available. It is a messy experiment, and if it is done in groups, you must remember that the 'artificial crude oil' (like its real counterpart) is flammable and harmful. Ensure that all students wear eye protection and an apron or laboratory coat.

Resources

Student's Book; Bunsen burner; asbestos mat; side-arm heavy glass boiling tube, with a bung, drilled to take a thermometer; thermometer, graduated to 360 °C; small test tubes (in a suitable rack) to collect fractions; 100 ml beaker containing cold water; glass delivery tube, with rubber connecting tube; watch glasses; dropper pipettes ('teat pipettes'); ceramic fibre; wooden splints; glass-marking pencil; about 2 ml of crude oil substitute

(It is recommended that a substitute be used instead of 'the real thing', because crude oil contains high concentrations of some very harmful substances.) The crude oil substitute is made up of a mixture of hydrocarbons, of varying chain length and boiling point. A little black oil paint is used as 'artificial colouring'.

Guidelines

'Recipe' for synthetic crude oil:

(Remember: components are flammable and poisonous. Wear eye protection and do not work near any source of ignition. The students should not be allowed to prepare the mixture.)

1. Mix together:
   - 55 ml 'liquid paraffin' ('medicinal')
   - 20 ml paraffin oil (kerosene)
   - 11 ml white spirit
   - 4 ml petroleum ether (100–120 °C);
   - 4 ml petroleum ether (80–100 °C);
   - 6 ml petroleum ether (60–80 °C).
2. Add a small quantity (3–4 ml) of artist's black oil paint.
3. Stir well.
4. Shake before using. The colouring agent tends to settle out.

Notes:

- The proportions of the components can be varied, but it's a good idea to keep a record of the proportions you use.
- Petroleum ether is also known as 'petroleum spirit'.
- White spirit is also known as mineral spirits, mineral turpentine, or turpentine substitute.

- Liquid paraffin can be obtained from pharmacies or a pharmaceutical supply agent.
- Turpentine substitute is obtainable from hardware stores.
- Petroleum ether, of the various boiling points, is obtainable from chemical supply companies.
- Artist's oil colours are obtainable from art or hobby shops.

Facilitate: Guide the students to describe and report on the demonstration.

Answers

The results of the activity may differ from student to student.

Assessment

Informal: teacher assessment

Activity 2.4: Conduct a survey on energy sources PAIRS/SMALL GROUPS (SB p. 38)

Resources

Student's Book, workbook

Guidelines

Facilitate: Guide the students on how to conduct a survey, what kind of questions to ask, and how to calculate and record their findings.

Students should be able to list the energy sources used in various households (excluding their own), in decreasing order of monthly expenditure.

Answers

The results of the survey may differ from student to student.

Assessment

Informal: teacher assessment

Activity 2.5: Discuss the impact of oil usage on the ecosystem CLASS (SB p. 44)

Resources

Student's Book, workbook

Guidelines

Facilitate: Guide the students to invite a speaker from the community to come to the class to talk about the impact of oil usage on the ecosystem. Encourage the students to ask questions and discuss the important points raised in the talk.

Students should be able to understand the impact of oil usage on the environment, and ask questions.

Answers

The results of the discussion might differ from student to student.

Assessment

Informal: teacher assessment

Revision questions: Answers

(SB p. 45)

(Informal teacher assessment)

1. It will contain 18 hydrogens. The general formula for an alkane is $C_n H_{(2n+2)}$. Thus if $n = 8$, $2n + 2 = 18$ (3)
2. Enzymes. (1)
3. Four: two in Port Harcourt, one in Kadura and one in Warri. (4)
4. Reservoir. (1)
5. Rock oil. (1)
6. Organisation of Petroleum Exporting Countries. (2)
7. 16 (1)
8. Naphthas have 6 to 11 carbons. The lightest in the series therefore has 6 carbons – giving $6 \times 12 = 72$ amu. But it also has $(2n + 2)$ hydrogens, where $n = 6$. Thus, 14 hydrogens, at 1 amu each = 14 amu. Therefore, $72 + 14 = 86$ amu for the lightest in the series. By the same reasoning and calculation, the heaviest naphtha has a molecular mass of 156 amu. (4)
9. Its oil has a low sulphur content. (2)
10. The density of the material varies, and its water content is also variable. (2)
11. CH_4 (1)
12. Methane has 4 hydrogen atoms – the lightest atom known. And it has only 1 carbon. (Air is about 80% nitrogen, which, as N_2, has a molecular mass of 28 amu. Oxygen – the other 20%, roughly – is O_2 and thus 32 amu. Both these molecules are therefore substantially heavier than a single carbon atom.) The information in brackets hasn't been given in the topic, but the first bit is a good enough answer. The teacher can add the extra information if he/she sees it as appropriate. (4)
13. The gas does not ignite in a uniformly expanding 'bubble' or 'envelope' moving through the cylinder volume. It ignites as 'hotspots' in different parts of the volume, and does not deliver its energy smoothly in the cylinder. Shock waves produce the knocking sound. (4)
14. Short, branched hydrocarbon chains are less inclined to produce knocking than longer, unbranched hydrocarbons. (2)
15. The materials in greatest demand (for fuels) are less common, in the crude distillate, than the market requires. By breaking down longer molecules, a higher proportion of the shorter, more valuable molecular types is produced. (3)
16. Giga = one thousand million = one billion = 10^9. (2)
17. CH_3^- (The dash after the symbol indicates that it is not a complete molecule: it is a part of a molecule, thus a 'group'.) (2)
18. Gases. (1)

Total marks: 40

How are you doing?

(SB p. 44)

Take this opportunity to ask students if there is anything that they do not understand. You can check their understanding by asking them some questions about the information covered in the topic. Explain anything that students do not understand.

Key words

abiotic – without life

alkane – hydrocarbon with no double bonds, i.e. a saturated molecule

cracking – breaking of molecules to produce shorter ones

hydrocarbon – a molecule comprising only carbon and hydrogen

knocking – ignition occurring unevenly through the cylinder, leading to inefficient energy delivery and abnormally high pressures on parts of the cylinder and piston

mercaptan – organic sulphur compounds; strongly odoriferous (the smell of the small animal called a skunk is due to a mercaptan); also known as thiol

reforming – (in the context of crude oil refining) shortening and changing the 'architecture' of components of the distillate, to produce 'reformates' that are used to improve the anti-knocking property of the petrol (and also to produce 'starting materials' for organic synthesis)

Checklist for self-evaluation

Theme 2 Topic 2

EVALUATION GUIDE:

	Criteria	4	3	2	1	Comments
2.1	List the composition of crude oil.					
2.2	State the importance of cracking and reforming.					
2.3	Discuss the impact of the petrochemical industry on the Nigerian economy.					
2.4	Assess the quality of petrol from the given octane number.					
2.5	State the uses of natural gas.					

Code for evaluation:			
4 – Very well	3 – Well	2 – Fairly well	1 – Not well at all

Topic 3: Metals and their compounds

Performance objectives

3.1 State the general characteristics of metals.
3.2 Identify what parts of the periodic table contain metals.
3.3 State the relative abundance of metals in nature.
3.4 List five classes of compounds formed by metals (sulphides, chlorides, etc.).
3.5 State the general principles of the extraction of metals.
3.6 List the properties of alkali metals.
3.7 Describe the extraction and give the uses of sodium as a typical alkali metal.
3.8 List five compounds of sodium.
3.9 List the properties of alkaline earth metals.
3.10 Describe the extraction and give the uses of calcium as a typical alkaline earth metal.
3.11 Describe the extraction of aluminium.*
3.12 List five compounds of aluminium.
3.13 List five uses of aluminium.
3.14 Describe the extraction of tin metal.
3.15 State five uses of tin.
3.16 Name members of the first transition series.
3.17 List the general characteristics and properties of transition elements.
3.18 Describe the extraction of copper.
3.19 List five uses of copper.

(**Note*: We have adopted the British spelling for the metal aluminium. The American spelling – with adjusted pronunciation – is aluminum.)

Introduction

About 92 elements are naturally occurring. The lightest of these is hydrogen (the most abundant element in the universe), with an atomic number of 1, and atomic mass of 1 amu (atomic mass unit). The heaviest is uranium, with an atomic number of 92, and atomic mass of 238 amu.

These elements show a very wide range of properties, and chemists have been able to deduce much of their internal organisation, and their behaviour, by means of a rather complex but logical system of classification. This system is expressed in the periodic table, which rests largely on the work of Dmitry Mendeleyev (1834–1907: the last in a family of 17 children). The periodic table might be described as a triumph of scientific classification. (See the periodic table at the beginning of the Student's Book.)

Very broadly, the elements can be divided into three categories: metals, metalloids and non-metals. In this topic, we study metals and their compounds.

Activity 3.1: Work with the periodic table

PAIRS/SMALL GROUPS (SB p. 47)

Resources

Student's Book, workbook, periodic table of elements

Guidelines

Facilitate: Explain the general characteristics of metals, and lead the students to identify parts of the periodic table containing metals.

Students should be able to list the first 30 elements of the periodic table and classify them as metals, non-metals or metalloids.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Activity 3.2: Research Nigeria's mineral resources

PAIRS/SMALL GROUPS (SB p. 48)

Resources

Student's Book, Internet, library

Guidelines

Facilitate: Guide students by using a chart to show the relative abundance of metals in nature, with emphasis on the occurrence of certain metals as minerals in Nigeria.

Students should be able to do the relevant research, and write a short paragraph on their findings, in their own words and using good English, titled: 'Nigeria's mineral wealth: a sleeping giant?'

Answers

The information in the paragraphs might differ from student to student.

Assessment

Informal: teacher assessment

Activity 3.3: Investigate the main ores of metals

PAIRS (SB p. 49)

Resources

Student's Book, workbook

Guidelines

Facilitate: Lead a class discussion on the different main ores of metals and their properties.

Give the students practice calculations. This activity can be used as a class test.

Students should be able to identify the main ores of metals, and how to calculate the percentage, by mass, of a given metal in one of its ores – their solution should be shown as a worked example in their workbook.

Answers

The results of the activity will differ from student to student.

Assessment

Informal: teacher assessment

Activity 3.4: Research sodium compounds

PAIRS (SB p. 55)

Resources

Student's Book, workbook, Internet, library

Guidelines

Facilitate: Guide a class discussion on the properties of sodium compounds.

Students should be able to work in pairs to research uses and dangers of the sodium compounds sodium azide and sodium cyanide, and record their findings in their workbook.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Activity 3.5: Explain the use of a reducing agent

INDIVIDUAL (SB p. 57)

Resources

Student's Book, workbook, Bunsen burner, coke, copper oxide

Guidelines

Facilitate: Guide a class discussion on the extraction, properties and uses of sodium, calcium, aluminium and tin. Perform a basic experiment to show aluminium as a reducing agent.

Students should be able to watch the experiment, and record their findings using three or four sentences, in their own words and good English, explaining what happens when coke is strongly heated, in air, with copper oxide.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Activity 3.6: List important everyday uses of metals

INDIVIDUAL (SB p. 61)

Resources

Student's Book, workbook, Internet, library

Guidelines

Facilitate: Guide students in a discussion of the different metals used in everyday life.

Students should be able to research their everyday uses of metals, their compounds and their alloys, and record their findings in the form of a list of at least six important metals (or their alloys or compounds) in their workbook.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Revision questions: Answers

(SB p. 62)

(Informal teacher assessment)

1. They smelt it. (1)
2. 'Roasting' is heating, in air, without melting the materials. In 'smelting', at least some of the materials are melted. (3)
3. In 'smelting', various substances (often coke, or coal) are added to the mixture in the furnace, in order to promote chemical reactions with the melted substances. 'Melting' is simply a change from solid to liquid, due to heating. (3)
4. 'Reduction' would probably be the best word. Metals are electropositive. They 'donate' electrons. To purify the metal, the electrons need to be 'given back' to the metal. Adding electrons is called reduction. (4)
5. 'Halite' is the salt sodium chloride. (Not to be confused with 'halide'. Halides are salts in general.) (2)
6. Wolfram. (1)
7. 'Pyro-' means hot, or heat. (1)
8. Copper. (1)
9. Lithium, sodium, potassium, rubidium, caesium, francium. Francium is the 'odd one out'. It is the only one of these that has no stable isotope. (8)
10. Pure sodium reacts with water and produces hydrogen. In air, this can lead to explosions. (It also produces sodium hydroxide, which is a dangerously corrosive alkali.) (3)
11. -chloride, -hydroxide, -carbonate, -bicarbonate, -silicate. (5)
12. Beryllium, magnesium, calcium, strontium, barium, radium. (Any three) (3)
13. Stalactites. (1)
14. Transition metals have an incompletely filled 'd' subshell. The outermost (s) subshell is full. (2)

Total marks: 38

How are you doing?

(SB p. 61)

Take this opportunity to ask students if there is anything that they do not understand. You can check their understanding by asking them some questions about the information covered in the topic. Explain anything that students do not understand.

Key words

electrolysis – literally, destruction by electricity; 'lysis' means disintegration or destruction; the process refers to the use of an electric current to separate substances carrying electric charges

electrowinning – the process by which, in electrolysis, a substance accumulates, in pure form, on one of the electrodes in an electrolytic cell

halite – common salt, more specifically in the form of 'rock salt', but the same chemical substance

metallurgy – the processes involved in separating mixtures or compounds of metals from each other; metallurgy includes the study of the properties of the various metals

ore – a compound containing some important substance; not to be confused with awe – or oar for that matter; these are homophones (words having the same sound as another, but a different meaning)

pyro- – heat; hot

smelt – to melt, by heating in combination with other substances, crude materials that react with the additives (such as coke); smelting contributes to the purification of one or more of the components in the molten mixture

Checklist for self-evaluation

Theme 2 Topic 3

EVALUATION GUIDE:

	Criteria	4	3	2	1	Comments
3.1	List five characteristics of metals.					
3.2	List the first 30 elements of the periodic table and classify them as metals, non-metals or metalloids.					
3.3	List the properties of each class.					
3.4	Give three methods of extraction of metals.					
3.5	Discuss the extraction, properties and uses of sodium, calcium, aluminium, tin and copper.					
3.6	Suggest methods for the prevention of corrosion in metals.					

Code for evaluation:			
4 – Very well	3 – Well	2 – Fairly well	1 – Not well at all

Topic 4: Iron	
Performance objectives	
4.1	State the relative abundance of iron ore in nature.
4.2	State the physical and chemical properties of iron.
4.3	Describe the process of extraction of iron from its ore.
4.4	State the causes of rusting in iron.
4.5	Suggest ways of preventing the rusting of iron.

Introduction

In terms of materials, iron, with its family of ores, is still number one. We use these materials as burglar guards and as armaments. Sadly, our need for such things is getting greater, not smaller.

We have talked a little about iron in Topic 3. We now look further into this most interesting metal.

Activity 4.1: Find examples of iron and steel items

INDIVIDUAL (SB p. 65)

Resources

Student's Book, workbook

Guidelines

Facilitate: Guide a class discussion on the examples of iron and steel items that can be found in the home and classroom.

Students should be able to make a list of all these items in their workbook, and include the special properties they would expect the ferrous materials in each of these items to have.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Activity 4.2: Research types of steel

INDIVIDUAL/PAIRS (SB p. 67)

Resources

Student's Book, workbook, Internet, library

Guidelines

Facilitate: Students should be able to either work on their own or in pairs and use the Internet or local library to research 'chrome vanadium steel' and 'high speed steels', and write a short paragraph on each in their workbook.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Practical demonstration: Show that water and oxygen are necessary for rusting

(SB p. 68)

This activity can be performed by the teacher, or students working in small groups, and provided that sufficient equipment is available.

Note: This experiment can be extended to include small aluminium, brass, stainless steel or zinc-coated items, each in its own flask of (unboiled) water. You will notice that these will not rust in circumstances which cause the iron to rust.

Resources

Student's Book; 2 long (100–120 mm) clean, rust-free iron nails; two 250 ml or 500 ml flat-bottomed or conical flasks, with rubber bungs; clean water, preferably tap water; and a Bunsen burner or other source of heat

Guidelines

Facilitate: Guide the students to describe and report on the demonstration.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Activity 4.3: Find information on calamine

INDIVIDUAL/PAIRS (SB p. 71)

Resources

Student's Book, workbook, Internet, library

Guidelines

Facilitate: Encourage the students to use either the Internet or local library to research calamine and calamine lotion, and prepare some notes.

Students should be able to either work alone or in pairs, and use the Internet or local library to research calamine and calamine lotion, and record their findings in their workbook.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Revision questions: Answers

(SB p. 72)

(Informal teacher assessment)

1. 26. (1)
2. In the 'd block'; the section that includes the transition metals. (2)
3. Haematite, limonite and magnetite. (3)
4. Limestone causes the silicates to melt and form 'slag', which trickles down to the bottom of the furnace and can be removed by drainage. If this didn't happen, the impurities would not melt, and the furnace would get blocked. (4)
5. About 4%. (1)
6. Wrought iron and cast iron. (2)
7. Although the boron is added at very small concentrations, its presence allows less of other expensive alloying metals to be used, to achieve the desired effects. (3)
8. Chromium. (1)
9. Tungsten. (1)
10. The concrete may crack and pieces may break off. This is called 'spalling'. It is caused by expansion of the iron as it converts to its oxide. (3)
11. The 'heat exchanger' in the furnace is an arrangement by which the hot waste gases leaving the top of the furnace are used to heat the incoming air at the bottom of the furnace. This increases the energy efficiency of the process. (It wastes less heat.) (4)
12. A 'sacrificial anode' is an electrode that 'donates' electrons to the ferrous metal, thus preventing it from losing electrons. The ferrous metal (which is acting as a cathode) is therefore protected from oxidation. (3)

Total marks: 28

How are you doing?

(SB p. 72)

Take this opportunity to ask students if there is anything that they do not understand. You can check their understanding by asking them some questions about the information covered in the topic. Explain anything that students do not understand.

Key words

annealing – a heat treatment of steel, which increases its strength and/or hardness

banded iron formation (BIF) – iron-rich strata in sedimentary rock

blast furnace – a modern furnace in which high temperatures are achieved by feeding air, under pressure, into the bottom of the furnace; this increases the rate of combustion, and therefore the rate of heat output

case hardening – a process that hardens only the outer 'shell' of a steel item; case hardening can be achieved by packing high-carbon material around the item, and heating it strongly for several hours

cast iron – iron with a relatively high carbon content (roughly 2–4%); it is very hard, but brittle, and therefore inclined to crack; it is neither malleable nor ductile

ferroalloys – alloys of iron with other metals; to qualify as a 'ferroalloy' the iron content must not be less than 50%

'pigs' (pig iron) – shapes in which iron is cast when it emerges from the furnace; the name was given because the size and shapes of the lumps of iron reminded people of small pigs; the name 'piglet iron' never caught on, so it was simply 'pig iron'

slag – molten waste material formed in a blast furnace by reacting refractory solids (those with a very high melting point) with calcium oxide (formed, in the furnace, from limestone – calcium carbonate); the calcium oxide causes the impurities to melt, forming slag, which runs down inside the furnace and can be drained off

spalling – damage to concrete caused by rusting, and swelling, of reinforcing steel embedded in the concrete

wrought iron – very nearly pure iron, with a carbon content of less than 0.08%, and only very small amounts of other impurities; unlike 'cast iron', it is very malleable and ductile

Checklist for self-evaluation

Theme 2 Topic 4

EVALUATION GUIDE:

	Criteria	4	3	2	1	Comments
4.1	State five physical and chemical properties of iron.					
4.2	Describe the process of extracting iron.					
4.3	List the causes of rusting of iron.					
4.4	Discuss ways of preventing rust.					

Code for evaluation:			
4 – Very well	3 – Well	2 – Fairly well	1 – Not well at all

Topic 5: Ethical, legal and social issues

Performance objectives
5.1 State the adverse effects of chemical wastes on the environment.
5.2 List some industrial pollutants of the environment.
5.3 State ways of preventing environmental degradation.
5.4 Identify the role of governments in preventing and fighting environmental degradation.

Introduction

Like many other animals, humans are 'territorial'. This means we tend to settle, and live, in a place and call it 'ours'. And we have to defend our territory – whether the territory is a house, an apartment in a block, or a whole country. It may be simply a room in a building. If we can't, or don't, defend it, we will lose it. Territory, and defence of territory, is an important part of our social structure. This also means looking after the territory we regard as our own.

Activity 5.1: Write about pollution

INDIVIDUAL (SB p. 74)

Resources

Student's Book, workbook, newspapers and magazines, observation of community

Guidelines

Facilitate: Guide the students in a class discussion about the different types of pollution they might observe in and around their community.

Students should be able to observe their community for a month, and write a paragraph on one specific instance of pollution damage they saw.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Activity 5.2: Research motor oil disposal

PAIRS/SMALL GROUPS (SB p. 75)

Resources

Student's Book, workbook, visit to a local garage

Guidelines

Facilitate: Guide a class discussion on personal safety when visiting premises outside the school. Remind students that they are to visit a local garage either in pairs or small groups, and ask the manager/owner to explain how old motor oils are disposed of, as well as find out what happens to the oils after removal from the garage premises.

Students should be able to either work in pairs or small groups – always keeping in mind personal safety – and visit the local garage, and record their findings in their workbook.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Activity 5.3: Visit a local business

GROUPS/CLASS (SB p. 78)

Resources

Student's Book, workbook, local business, relevant legislation

Guidelines

Facilitate: Take the students on a visit to chemical industries. Make sure the students understand the importance of personal safety, and to not touch anything on the premises they are visiting.

The class could be divided into 4 or 5 groups, so that each group is a manageable size.

Students should be able to compile a list of questions for the local business about the discharge of effluents and toxicities, and government regulations that restrict their activities. Students must record their findings in their workbook.

Answers

The results of the activity might differ from student to student. Students should be able to identify the impact of a local chemical industry on the environment, and suggest ways of reducing the chemical degradation of the environment caused by the local industry.

Assessment

Teacher assessment: Evaluate this activity as a project for formal assessment.

Activity 5.4: Discuss the responsibility of government agencies

SMALL GROUPS (SB p. 79)

Resources

Student's Book, workbook, relevant legislation

Guidelines

Facilitate: Guide a class discussion on the role of government in preventing overpopulation – and whether central, state or local government agencies in your area are doing enough to promote family planning.

Students should be able to record their findings in their workbook.

Answers

The results of the activity will differ from student to student.

Assessment

Informal: teacher assessment

Activity 5.5: Have a debate on the reason for global pollution

CLASS (SB p. 79)

Resources

Student's Book, workbook, relevant legislation

Guidelines

Facilitate: Encourage the students to participate in the debate on global pollution, either holding the position of motion or opposition.

Motion: The main reason for current levels of global pollution is that there are too many people.

Opposition: Pollution can be adequately controlled, with current trends in human growth, simply by more efficient processes of management and distribution of toxic waste.

Students should be able to participate in a lively and fruitful debate.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Activity 5.6: Discuss the reduction of the human population

SMALL GROUPS (SB p. 81)

Resources

Student's Book, workbook

Guidelines

Facilitate: Lead a class discussion on ways in which the world's human population might be reduced.

Students should be able to listen to their fellow students, and record their findings as a paragraph in their workbook, summarising the discussion.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Revision questions: Answers

(SB p. 82)

(Informal teacher assessment)

1. Arsenic, cadmium, lead, mercury. (4)
2. *Deinococcus radiodurans.* (2)
3. The National Environmental Standards and Regulation Enforcement Agency. (2)
4. Biochemical Oxygen Demand. (2)
5. The pumping of natural gas into oil wells in order to increase the pressure in the reservoir, and make it easier for crude oil to be pumped from the well. (3)
6. About 170 million. (1)
7. About 75 million people. (1)
8. Efficiency can only reach 100% (quite a lot less, in reality), but quantities of energy needed, and pollutants created, may exceed the amounts that can be supplied, or removed, even at 100% efficiency. The environmental threat is a matter of increasing quantities beyond what can be 'handled', regardless of levels of efficiency. (5)
9. 'Stock pollutants' and 'Fund pollutants'. The former are those that cannot be processed and rendered harmless. They simply accumulate in the environment. The latter are those that can be processed and removed up to a certain rate. (4)
10. Rapid growth of algae in a water body. It is dangerous because dead algae are broken down aerobically. This reduces the amount of free oxygen in the water body, to levels that may be dangerous or lethal to other organisms. (4)

Total marks: 28

How are you doing?

(SB p. 81)

Take this opportunity to ask students if there is anything that they do not understand. You can check their understanding by asking them some questions about the information covered in the topic. Explain anything that students do not understand.

Key words

aerobic process – a process involving the use of oxygen

biochemical oxygen demand (BOD) – the amount of oxygen needed by organisms to break down the organic materials in a particular volume of water (usually 1 litre) at a given temperature (usually 20 °C) over a given time (usually five days)

biodegradable – able to be broken down to simpler, harmless substances by biological processes

bioremediation – use of biological processes to 'heal' or repair damaged ecosystems

demos – means 'the people' (Greek); from it we get the word democracy

per capita – literally, per head; in other words, per individual

pollutant – substances, heat, light or noise that are present inappropriately in a particular environment, in excessive quantities

sequester – to keep something separate from the surroundings

xenobiotic – a foreign substance found within an organism

Checklist for self-evaluation

Theme 2 Topic 5

EVALUATION GUIDE:

	Criteria	4	3	2	1	Comments
5.1	Name some chemical industries in Nigeria.					
5.2	List the adverse effects of chemical wastes on the environment.					
5.3	Carry out the project and: • identify the impact of a local chemical industry on the environment • suggest ways of reducing the chemical degradation of the environment caused by the local industry.					
5.4	Describe the ways the government can prevent environmental degradation.					
5.5	Explain methods used in purifying water.					

Code for evaluation:			
4 – Very well	3 – Well	2 – Fairly well	1 – Not well at all

THEME 3 The chemistry of life

Topic 6: Fats and oils
Performance objectives
6.1 Identify sources of fats and oils.
6.2 Differentiate between fats and oils.
6.3 State the physical and chemical properties of fats and oils.
6.4 Explain saponification using relevant equations.
6.5 Test for fats.
6.6 State the uses of fats and oils.

Introduction

Fats and oils are produced by organisms. They provide fuel, structure, and in many cases protection for the organism. Fats and oils are second only to proteins in importance as 'biomolecules'. There is a huge variety of fats and oils, but all of them share a few physical and chemical properties, and we can therefore describe and discuss them in some general terms.

The first generality is that fats and oils belong in a group called lipids. (Waxes also belong in the lipid group, but we will restrict our discussion to fats and oils.)

Activity 6.1: Visit a factory CLASS (SB p. 84)

Resources

Student's Book, workbook, observation at factory

Guidelines

Facilitate: Take the students on a visit to a local vegetable oil factory. Make sure the students understand the importance of personal safety, and to not touch anything on the premises they are visiting.

Students should be able to observe the oil making process, and record the most important points about the process in their workbook.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Practical demonstration: Investigate the solubility of lipids (SB p. 84)

This activity can be performed by the teacher, or students working in pairs or small groups, provided that sufficient equipment is available.

Resources

Student's Book; workbook; a small number of solvents, including water (which is known, inappropriately, as a 'universal solvent'); non-aqueous, non-polar solvents, e.g. benzene, chloroform, ether, toluene and petrol; cooking oil, butter or margarine; test tubes

Guidelines

Facilitate: Perform a simple demonstration to show the solubility of lipids.

Note: Most of these non-aqueous solvents are dangerous. This is why the demonstration will be performed by the teacher.

Students should be able to watch the demonstration, understand and record their findings in their workbook.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Experiment 6.1: Test for lipids

PAIRS/SMALL GROUPS (SB p. 89)

Resources

Student's Book; workbook; 3 small containers, and 3 liquids: a solution of sugar in water, a solution of protein in water, and a small volume of cooking oil (1 to 2 ml of each liquid is quite sufficient); Sudan Red dye; brown wrapping paper or newspaper

Guidelines

Facilitate: Ask the students to bring food substances that contain fats and oils to class. Perform a simple demonstration to test for lipids.

Students should be able to use two different methods to test for the presence of fats and oils in food substances. Students should be able to observe and record their findings in their workbook.

Answers

You should find that the two non-lipid spots have disappeared, or grown very faint, because the water has evaporated. The lipid spot will still be present, and will look like a typical 'grease spot'.

Assessment

Informal: teacher assessment

Revision questions: Answers

(SB p. 91)

(Informal teacher assessment)

1. Triglycerides. (1)
2. The acid has a long hydrocarbon 'tail', which is hydrophobic. (2)
3. Saponification. (1)
4. Esterification. (1)
5. – OH (1)
6. Glucose (a sugar). (1)
7. Melting point. Fats have higher melting points. (2)
8. The breaking of a bond by adding the atoms of water across it. (Literally, 'breaking with water'.) (3)
9. The grease spot test; the Sudan Red dye test. (4)
10. Chloroform, benzene, methanol, toluene, ether. (Any two) (2)
11. Arachidonic acid. (2)

Total marks: 20

How are you doing?

(SB p. 90)

Take this opportunity to ask students if there is anything that they do not understand. You can check their understanding by asking them some questions about the information covered in the topic. Explain anything that students do not understand.

Key words

esterification – the combination of an alcohol and an acid, for example, in the joining of glycerol and fatty acids

humectant – a substance that tends to attract water, thus to remain moist; glycerol (glycerine) is an example

hydrophilic – water-loving

hydrophobic – water-hating

lipogenesis – the synthesis of lipid in the tissues of an organism

saponification – the chemical breaking up of a lipid into glycerol and fatty acids, to give a soap

saturated (in relation to chemical structure) – a molecule with no double bonds

unsaturated (in relation to chemical structure) – a molecule with one or more double bonds

Checklist for self-evaluation

Theme 3 Topic 6

EVALUATION GUIDE:

	Criteria	4	3	2	1	Comments
6.1	Name substances containing fats and oils.					
6.2	State two differences between fats and oils.					
6.3	List the physical and chemical properties of fats and oils.					
6.4	Define saponification and write and balance equations for the reactions.					
6.5	State the uses of fats and oils.					

Code for evaluation:			
4 – Very well	3 – Well	2 – Fairly well	1 – Not well at all

Topic 7: Soap and detergents
Performance objectives
7.1 Identify the materials for making soap. **7.2** Prepare soap from local sources. **7.3** Explain the emulsifying action of soap using relevant equations. **7.4** Define detergents. **7.5** Describe the mode of action of detergents. **7.6** Distinguish between soap and detergents.

Introduction

In Topic 6, we studied fats and oils. We saw that the main industrial use of these biomolecules is in soap production. In this topic, we learn more about soap and detergents, and we apply some of the chemical processes involved in soap-making.

Activity 7.1: Visit a factory CLASS (SB p. 93)

Resources

Student's Book, workbook

Guidelines

Facilitate: Take the students on a visit to a local soap factory. Make sure the students understand the importance of personal safety, and to not touch anything on the premises they are visiting.

Guide the students to identify the raw materials and processes for making soap and detergents.

Students should be able to observe the process, and record the most important points in their workbook.

Practical demonstration: Soap-making (SB p. 93)

(*Note*: If the teacher feels that the soap-making activity can be done by the students, working in small groups, and provided that sufficient equipment is available, the activity can be offered as such. In this case, however, it is STRONGLY RECOMMENDED that the teacher must do the dissolving of the NaOH for the class. The NaOH should be dissolved slowly, in a glass vessel, by adding the solid material gradually to the water, and stirring gently with a glass rod. DO NOT ADD THE WATER TO THE SOLID. Wear goggles and gloves.)

Resources

Materials: a simple lipid (triglyceride), such as palm oil or palm kernel oil, or a mixture of the two; margarine; sunflower oil; olive oil; sodium hydroxide; water; fragrance (perfume), such as 'essential oil' (optional); one or more suitable colouring agents (optional); Student's Book; workbook

(*Note*: Sodium hydroxide is poisonous and dangerous. It must be handled with extreme care. It is also known as caustic soda or lye. The word 'caustic' comes from Latin and Greek, and means 'burn'. Sodium hydroxide is corrosive. It reacts with various substances, and can cause severe burns on skin. When working with this substance, you must wear rubber gloves, goggles and a laboratory coat. Do not inhale the vapour from a solution of sodium hydroxide.)

Apparatus:
- a suitable laboratory beaker or glass, earthenware or china bowl, with a capacity appropriate to the volumes of oil and base to be added
- a glass stirring rod
- a (glass) beaker of about 1 litre (This is for dissolving the NaOH.)
- laboratory measuring jar and weighing apparatus (*Note*: The oil must be measured by mass: NOT by volume.)

Guidelines

Facilitate: Demonstrate the preparation of soap. Then assign students in groups to make soap from locally available materials.

Students should be able to observe the demonstrations, and be able to prepare soaps from locally available materials.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Practical activity 7.2: Prepare salt solutions

SMALL GROUPS (SB p. 101)

Resources

Student's Book; workbook; 3 litres of distilled water or rain water; 2 grams of calcium chloride or magnesium chloride; block of ordinary toilet soap; a tablespoon of a synthetic detergent; 3 containers

Guidelines

This practical activity requires the use of soap and detergent with three different water samples.

Facilitate: Assign students in groups to prepare salt solutions.

Prepare 3 water samples, using distilled water or rain water. One litre of each is adequate. To each of two of the water samples, add about 50 ml of a solution of calcium chloride or magnesium chloride. (One gram of either salt in 50 ml will be sufficient.) These two samples have therefore been converted into hard water. The third sample, as rain or distilled water, is soft water. Now use a block of ordinary toilet soap and form a lather in the soft water, and in one of the two hard water samples. To the other hard water sample, add about a tablespoon of a synthetic detergent and stir briefly.

Students should be able to prepare the three different salt solutions, examine all three samples after a while to look for signs of scum, and write their observations in their workbook.

Answers

The results of the activity might differ from student to student.

Assessment

Informal: teacher assessment

Revision questions: Answers

(SB p. 103)

(Informal teacher assessment)

1. Lye is sodium hydroxide (NaOH). (2)
2. Stoichiometry is the branch of chemistry that involves the amounts of substances taking part in chemical reactions. (3)
3. A wetting agent is a surfactant or 'surface active agent'. (2)
4. Nonmiscible means 'not mixing'. (1)
5. Water has a high surface tension. This causes water to 'try' to minimise its surface area. A sphere has the smallest surface in relation to the volume it encloses. (3)
6. 'Amphi-' means 'two', or 'of both kinds'. A molecule that has both hydrophilic and hydrophobic parts has both of the solubility characteristics, in terms of its behaviour with water. (4)
7. In a soap, the anionic part is a carboxyl group. In synthetic detergents, the charged part is not a carboxyl group. (3)
8. Alkylbenzenesulphonate is commonly used as the anionic end of the hydrocarbon chain in a synthetic detergent. (2)
9. Soaps form an insoluble 'scum' ('lime soap') in hard water. This scum is difficult to wash away. It is also not easily broken down in the environment. Synthetic detergents do not form insoluble salts in hard water. (4)
10. Early synthetic detergents were based on branched-chain hydrocarbons. These are not easily broken down in the environment. Modern synthetic detergents use straight-chain hydrocarbons. They break down more easily. (4)
11. A detergent is a substance that enhances the cleansing action of water. (2)

Total marks: 30

How are you doing?

(SB p. 102)

Take this opportunity to ask students if there is anything that they do not understand. You can check their understanding by asking them some questions about the information covered in the topic. Explain anything that students do not understand.

Key words

emulsion – one liquid 'dissolved', or dispersed, in another liquid

exfoliant – a substance or process that removes surface layers; the word is used in the cosmetics industry, where the outermost layers of (dead) skin cells are removed by gentle abrasion

exothermic – giving out heat

lye – a strong base (alkali), usually sodium hydroxide; NaOH ('caustic soda')

micelle – a more or less spherical cluster of soap molecules, in which the hydrophobic 'tails' point inward, and the hydrophilic 'heads' point outward, into the surrounding water

miscible/nonmiscible – miscible: capable of being mixed; non-miscible: not mixing

stoichiometry – the science dealing with the numerical relationships (proportions) between the quantities of substances taking part in a reaction, or contributing to a compound

Checklist for self-evaluation

Theme 3 Topic 7

EVALUATION GUIDE:

	Criteria	4	3	2	1	Comments
7.1	Describe soap and detergents.					
7.2	Name materials for making local soap.					
7.3	Describe the cleansing action of soap and detergents.					
7.4	Prepare soap from locally available materials.					
7.5	State the differences between soap and detergents.					

Code for evaluation:			
4 – Very well	3 – Well	2 – Fairly well	1 – Not well at all

Topic 8: Giant molecules

Performance objectives

(Sugars)
8.1 Mention some sources of sugar.
8.2 Classify sugar as: a) mono-, di- and polysaccharides; and b) reducing and non-reducing sugars.
8.3 Give examples of the different types of sugar.
8.4 Prepare glucose from starch and sucrose.
8.5 Test for starch and glucose using Fehling's solution.
8.6 State the uses of starch and sugars.
(Proteins)
8.7 List the sources of protein.
8.8 Give examples of proteins.
8.9 Identify amino acids as the building blocks of proteins.
8.10 State the physical and chemical properties of proteins.
8.11 Carry out confirmatory tests for proteins.
8.12 State the uses of proteins.

Introduction

In this topic, we learn something about two very important classes of compounds called 'giant molecules', or 'macromolecules'.

In more 'technical' terms, the compounds in these two classes are carbohydrates and proteins. This may be a little misleading, because, in fact, not all of the carbohydrates are giant molecules. Many carbohydrate molecules are small. We'll explain the differences as we progress, and with luck there will be no confusion!

Practical activity 8.1: Preparing of glucose

PAIRS/SMALL GROUPS (SB p. 108)

This activity can be done in pairs, small groups, or as a demonstration by you. As a source of starch, you will have to provide a solution of corn flour in water. (This will have been prepared beforehand, by dissolving 1–2 grams of flour in about 50 ml of hot water.)

Resources

Each experimental 'station' will need:

- a small beaker containing about 50 ml of a starch solution
- another beaker containing about the same quantity of a sucrose solution
- a small beaker or large test tube containing a few ml of a glucose solution
- 4 large test tubes or small beakers
- a boiling water bath (this is best achieved by using a Bunsen burner under a 500 ml beaker, and heating 200–300 ml of water to near boiling)
- a small quantity of freshly made Fehling's solution
- a 1 ml pipette
- gloves, tongs, or a thick piece of cloth, to handle the test tubes without burning your fingers
- a glass-marker

Fehling's reagent

Fehling's A:
Dissolve 6.3 g $CuSO_4 \cdot 5H_2O$ (i.e. crystalline copper sulphate) and make to 100 ml with distilled water. If the solution is cloudy, add 1.0 ml dilute sulphuric acid.

Fehling's B:
Dissolve 35.2 g sodium potassium tartrate (Rochelle salt) in about 60 ml of distilled water. Add 15.4 g NaOH and make to 100 ml with distilled water.

(The working reagent is prepared by mixing equal volumes of A and B, just before conducting the test.)

Guidelines

Facilitate: Perform simple experiments to demonstrate the hydrolysis of starch and of sucrose to produce glucose. Then assign students in groups to test for glucose using Fehling's solution.

Students should be able to observe the teacher's demonstrations, and prepare glucose by hydrolysis of starch and of sucrose. Students should record the results, with a brief conclusion, in their workbook.

Answers

1. Starch is not a reducing sugar.
2. Sucrose a not a reducing sugar.
3. Glucose is a reducing sugar.
4. Salivary amylase hydrolyses starch into its component monomers (glucose units).
5. None. Sucrose is hydrolysed by sucrase, which is one of the enzymes (actually a couple of related enzymes) in the small intestine.

Assessment

Informal: self-assessment

Practical activity 8.2: Testing for starch

CLASS/SMALL GROUPS (SB p. 110)

The activity can be performed by the teacher as a class demonstration, or it can be performed by the students, working in small groups.

Resources

Each experimental 'station' will require:

- 2 small beakers, each containing about 40 ml of starch, prepared as for the previous experiment
- a solution of iodine
- some saliva ('spit')

Guidelines

Facilitate: Perform simple experiments to demonstrate the hydrolysis of starch. Then assign students in groups to test for starch using the iodine solution.

Students should be able to observe the demonstrations, test for starch, and record their results, with a brief conclusion, in their workbook.

Answers

Starch reacts with iodine to give a blue-violet colour. This is one of the standard tests for starch. The enzyme in saliva (salivary amylase) hydrolyses starch to its component monomers (glucose units). Thus the enzyme 'destroys' the starch.

Assessment

Informal: teacher assessment

Practical activity 8.3: Denaturation of a protein

PAIRS/SMALL GROUPS (SB p. 115)

This is a fun activity that can be performed in pairs or small groups.

Resources

Student's Book; one egg per student; saucer; a pot with water, or pan with a small amount of oil; stove or hot plate

Guidelines

Facilitate: Guide the students to crack their eggs, first to taste the albumin, and then to fry the egg and observe the physical change in the albumin.

Students should be able to describe the structure of proteins and record their findings in their workbook.

Assessment

Informal: teacher assessment

Practical activity 8.4: Destabilisation of a protein-rich emulsion

GROUPS (SB p. 116)

This practical activity demonstrates the destabilisation of a protein-rich emulsion.

Resources

Student's Book; 10–20 ml of milk; lemon juice or white vinegar, or dilute hydrochloric acid; container

Guidelines

Facilitate: Students should be able to notice that the milk forms 'floccules' – that is, very small 'clumps', and record their findings in their workbook.

Answers

What is happening is that the milk proteins (and lipids) are precipitating because of the acidity caused by the lemon juice or vinegar. The acidity of the liquid has changed some of the chemical and physical properties of the proteins, which has resulted in a reduced solubility. Therefore, they precipitate.
We could say that the change in pH has destabilised the solution. We talked about emulsions in the previous topic. Milk is an emulsion, with the proteins acting as the emulsifiers. The acidity has destabilised the emulsion by interfering with the charges on the proteins.

Assessment

Informal: teacher assessment

Experiment 8.1: Testing for proteins

GROUPS (SB p. 117)

In this experiment, you will perform the biuret test for proteins. The students should read and understand the entire experiment before you commence work.

Resources

Student's Book; some protein solutions, of varying concentrations; test tubes; test tube rack; distilled water; glass-marking pen; biuret solution

Note: As a source of protein, you can use skim milk powder, or bovine serum albumin (BSA), obtainable as a laboratory biochemical. Most simply, you can use ordinary raw egg albumin – by breaking an egg and separating (and discarding) the yolk.

Prepare a concentrated solution of the protein material – say 1 g in 100 ml if you're using milk powder or BSA. If you use the raw egg albumin, dilute about 10 ml of the liquid material with the same volume of distilled water.

Biuret reagent

1. Prepare 0.2 M NaOH by dissolving 8 g NaOH (cautiously!) in about 500 ml of distilled water; then make to 1 litre with distilled water.
2. Dissolve in 400 ml of the 0.2 M NaOH, *in the following order*:
   - 9 g sodium potassium tartrate
   - 3 g $CuSO_4 \cdot 5H_2O$
   - 5 g potassium iodide
3. Make to 1 litre with the 0.2 M NaOH.

Note: Your students may be interested to know that although the above reagent is called the 'biuret reagent', it does not contain biuret. Biuret is a product in the fertiliser industry, where it is formed from urea. Its alternative name is carbamyl urea. The test is called the 'biuret test' because the compound biuret happens to give the same reaction, to this reagent, as do proteins.

Guidelines

Facilitate: Perform simple experiments to demonstrate how to test for proteins.

Students should be able to perform simple experiments to test for proteins, and record their findings and conclusion in their workbook.

Answers

The results of the experiments may differ from student to student. Examine the colour in the tubes, noting differences.

Revision questions: Answers

(SB p. 120)

(Informal teacher assessment)

1. A compound of a carbohydrate (sugar) and a protein. (2)
2. Cellulose. (1)
3. Because the monomers are beta 1-4 linked to each other. This bond cannot be broken by the great majority of animals. (3)
4. $C_6H_{12}O_6$ (2)
5. A few. (2)
6. Animal starch. (1)
7. Aldehydes and ketones. (2)
8. Reduction of Cu^{2+} to Cu^{+}, which is insoluble and brick red. (3)
9. In the paper industry. (2)
10. Glucose. (1)
11. Ascorbic acid. (2)
12. Glucose and fructose. (2)
13. Haeme (or 'heme') and globin. (The latter is the protein part.) (2)
14. Zein. (1)
15. Because it has an amino group and a carboxylic acid group. (2)
16. Glycine. (1)
17. See Figure 8.5 on SB page 113. (5)
18. Twenty. (1)
19. Denaturation. (1)
20. Peptide linkages (bonds). (2)
21. The chain is most commonly arranged in a 'corkscrew'. (2)

Total marks: 40

How are you doing?

(SB p. 119)

Take this opportunity to ask students if there is anything that they do not understand. You can check their understanding by asking them some questions about the information covered in the topic. Explain anything that students do not understand.

Key words

aldehyde group – one of the reactive groups on a sugar molecule, which allows it to act as a reducing agent (see also ketone)

alpha 1-4 linkage – the main type of bond linking monosaccharide units in glycogen and starch chains

amino group – one of the reactive groups on an amino acid, which contributes, with a carboxyl group, to a peptide bond

beta 1-4 linkage – the main type of bond linking monosaccharide units in the cellulose

C-terminus – the end of a protein chain that starts with a carboxyl group; the opposite of the N-terminus

denaturation – disruption of the 'native' structure of a protein

glycoprotein – molecule formed by a protein and a sugar

haemoglobin – molecule, comprising 'haeme', and a protein (globin), involved in oxygen carriage in the blood of many animals

inulin – a storage polysaccharide in some plants

ketone – one of the reactive groups on a sugar molecule, which allows it to act as a reducing agent (see also aldehyde)

lipoprotein – molecule comprising a protein and a lipid

macromolecule – very large molecule

N-terminus – the end of a protein chain that starts with an amino group; the opposite of the C-terminus

peptide bond – the bond joining amino acids together in a protein chain; it is formed by an amino group and a carboxyl group

polymer – a chain of repeating units in a (long) molecule

salivary amylase – the starch-hydrolysing enzyme present in saliva; also known as ptyalin

Checklist for self-evaluation

Theme 3 Topic 8

EVALUATION GUIDE:

	Criteria	4	3	2	1	Comments
8.1	Give examples of proteins.					
8.2	Describe the structure of proteins and identify amino acids as the building blocks of proteins.					
8.3	List the physical and chemical properties of proteins.					
8.4	Enumerate the uses of proteins.					
8.5	Test for proteins.					

Code for evaluation:			
4 – Very well	3 – Well	2 – Fairly well	1 – Not well at all

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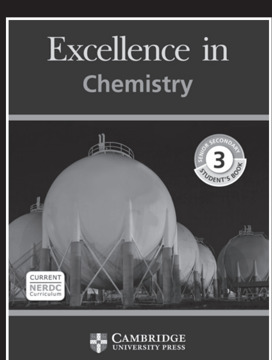

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