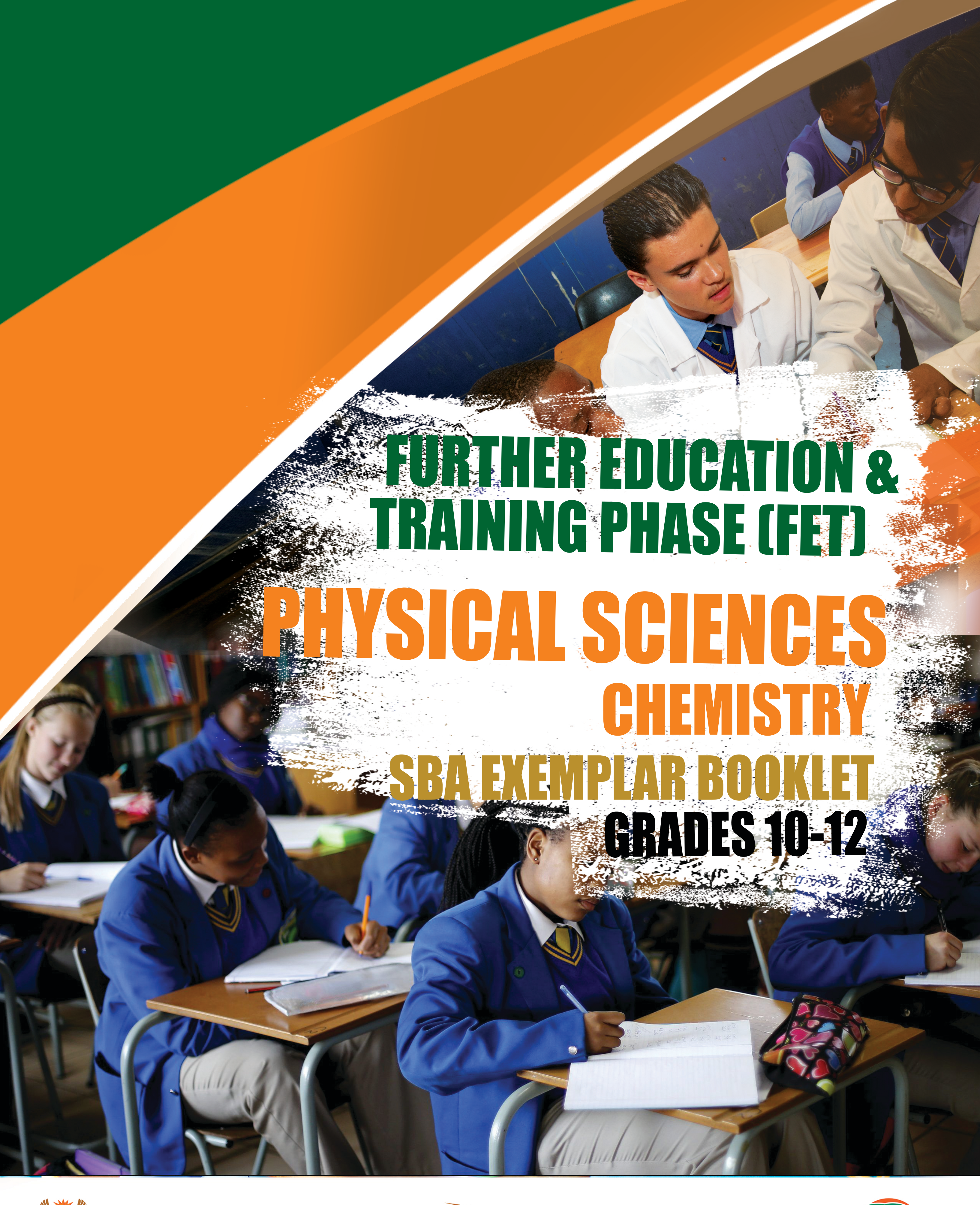


FURTHER EDUCATION & TRAINING PHASE (FET)

PHYSICAL SCIENCES

CHEMISTRY

SBA EXEMPLAR BOOKLET

GRADES 10-12

basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

FOREWORD

The Department of Basic Education has pleasure in releasing a subject exemplar booklet for School Based Assessment (SBA) to assist and guide teachers with the setting and development of standardised SBA tasks and assessment tools. The SBA booklets have been written by teams of subject specialists to assist teachers to adapt teaching and learning methods to improve learner performance and the quality and management of SBA.

The primary purpose of this SBA exemplar booklet is to improve the quality of teaching and assessment (both formal and informal) as well as the learner's process of learning and understanding of the subject content. Assessment of and for learning is an ongoing process that develops from the interaction of teaching, learning and assessment. To improve learner performance, assessment needs to support and drive focused, effective teaching.

School Based Assessment forms an integral part of teaching and learning, its value as a yardstick of effective quality learning and teaching is firmly recognised. Through assessment, the needs of the learner are not only diagnosed for remediation, but it also assists to improve the quality of teaching and learning. The information provided through quality assessment is therefore valuable for teacher planning as part of improving learning outcomes.

Assessment tasks should be designed with care to cover the prescribed content and skills of the subject as well as include the correct range of cognitive demand and levels of difficulty. For fair assessment practice, the teacher must ensure that the learner understands the content and has been exposed to extensive informal assessment opportunities before doing a formal assessment activity.

The exemplar tasks contained in this booklet, developed to the best standard in the subject, is aimed to illustrate best practices in terms of setting formal and informal assessment. Teachers are encouraged to use the exemplar tasks as models to set their own formal and informal assessment activities.

MR HM MWELI

DIRECTOR-GENERAL

DATE: 13/09/2017

PHYSICAL SCIENCES PAPER 2

SBA

Contents

Instructions to teachers

These are examples of SBA activities, developed by subject advisors. You are by all means encouraged to use these and alter them as you please.

Safety

All safety audits must be completed **before** any experiment is done. Safety audits are extremely important in the overall management of the safety of learners in the laboratories, they help the teacher and the learners to identify hazards posed by chemicals and laboratory settings, identify program deficiencies, and correct unsafe conditions in the laboratory. Self-audit's help raise awareness of safety issues and help promote the institutional safety.These safety audits need only to be developed once, updated regularly and kept for future use.

Teachers need to be aware that they are responsible for the safety of students in their care and should therefore take ALL the necessary precautions to protect the learners and the working environment during practical work. Teachers are further advised to know the steps to take in case of an emergency.

Information on chemicals can be sourced from available materials or downloaded from safety cards on the following URL:
http://www.ilo.org/safework/info/publications/WCMS_113134/lang--en/index.htm

1. PHYSICAL SCIENCES Grade 10: HEATING AND COOLING CURVE OF WATER

Formal experiment **TOTAL 40 MARKS**

Instruction sheet

NAME:
DATE:

BACKGROUND:
Heating and cooling curves show how the increases and decreases of temperature against time respond through the phases of materials. This phenomena is crucial in the processing of metals as it gives indications of how changes for different materials, especially alloys, happen and it helps to determine the usefulness of particular materials for different climatic conditions and extreme temperature variations. The relationship between the time and temperature during the various times of constant heating or cooling provides insights that show how the heat exchanges between molecules existing in various phases absorb and use the energy they absorb.

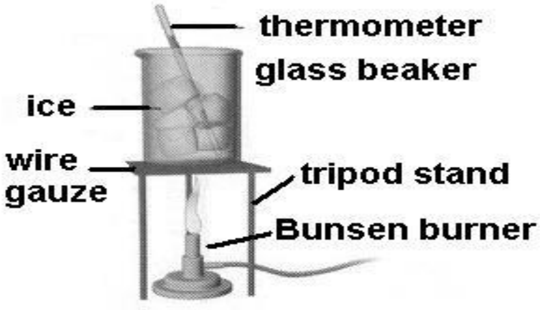
Safety audit

Open flames create the risk of clothing or other objects catching alight. Some materials used in Science experiments are flammable; creating additional risk. By taking safety precautions, you minimise those risks.

Experiment: Investigating the change in temperature when heating ice.

Materials

Glass beaker	Tripod stand
Crushed ice	Wire gauze
Heat source	Stopwatch
Thermometer	

	
1.1	Half-fill a glass beaker with crushed ice
1.2	Measure the temperature with a thermometer and note it in a table.
1.3	Place the beaker on a gauze wire on a tripod stand. Gently heat the beaker using a Bunsen burner.
1.4	While stirring continuously, measure the temperature every 5 minutes (in accordance to the teacher adjustment).
1.5	Continue stirring and measuring the temperature until the water has boiled for 3 minutes.
1.6	Make observations of the change in the phases as you continue heating the mixture of ice and water.

PART 2: THE COOLING CURVE

2.1	Repeat the experiment, but this time start with the boiling point
2.2	Place the beaker with the boiling water in a container filled with ice
2.3	Measure the temperature every 2 minutes as the water cools down
2.4	Stir continuously to ensure correct temperature readings.
2.5	Place the beaker in the freezer when the water has reached room temperature and continue measuring the temperature.
2.6	Note the temperature changes in a table until the water freezes.
2.7	Draw the cooling curve of water using the data obtained.

Safety audit

Clear the working space of any flammable material, cloth, paper and other chemicals. Pay attention that boiling water is handled with care so as not to cause accidents that might result in burns.

NB: Note all your temperature and time readings in a table. (Extend table if necessary.)

HEATING CURVE TABLE OF RESULTS			COOLING CURVE TABLE OF RESULTS	
Time (min)	**Temperature (°C)**		**Time (min)**	**Temperature (°C)**

4 marks for each table: Total 8 marks.

NAME:

GRAPH

1. **Draw a labelled heating and cooling curve on the same set of axes**

HEADING:

[7]

NAME:

WORKSHEET

Experiment-based questions:

1.1	What variables did you take into account in this experiment?	(2)
1.2	Which factors do you think could influence your results?	(2)
1.3	Define temperature of a substance.	(2)
1.4	Explain in your own words what happens when the water molecules change phase.	(3)
1.5	What are the precautionary measures you will take in conducting this experiment?	(2)
1.6	**Define the following** Freezing Melting point – Boiling point –	(6)
1.7	How does the obtained graph differ from the expected trends for the graph?	(2)
1.8	From the graph, what is the experimentally determined melting and boiling point of water? How does this compare with the known melting point and boiling point of water?	(4)
1.9	Write down the conclusion for both the heating and cooling curve experiments.	(4)

PHYSICAL SCIENCES Grade 10

WORKSHEET

HEATING AND COOLING CURVE OF WATER

MARKING GUIDELINE

NAME:	
DATE:	

Criteria for marking the Graphs	
Correct heading	√
Correct labelling of y-axis	√
Correct labelling of x-axis	√
Shape of the heating curve	√
Shape of the cooling curve	√
Points plotted correctly for heating curve	√
Points plotted correctly for cooling curve	√
TOTAL	**7 MARKS**

Answer the following experiment-based questions.

POSSIBLE ANSWERS:

1.1	What variables did you take into account in this experiment? *Temperature* √ *Time* √	(2)
1.2	Which factors do you think could influence your results? *Atmospheric pressure* √ *Amount of impurities in water* √ *Heat source*√	(3)
1.3	Define temperature of a substance *The average kinetic energy of particles of a substance*. √√	(2)

1.4	Explain in your own words what happens when the water molecules change phase. *Particles (water molecules) have enough energy to overcome the intermolecular forces √√* *As the intermolecular forces are overcome, the average kinetic energy of the molecules remains constant, thus temperature remains constant during phase change √√*	(4)
1.5	What are the precautionary measures you will take in conducting this experiment? *Keep any flammable substance(s) away from the open flame. √* *Boiling water must be handled with care. √*	(2)
1.6	**Define the following** Freezing – *the process by which a liquid turns into a solid. √√* Melting point – *the temperature at which a solid changes to a liquid. √√* Boiling point – *the temperature at which the vapour pressure of a substance equals the atmospheric pressure.√√*	(6)
1.7	How does the obtained graph differ from the expected trends for the graph? *Refer to the data set obtained in the table of results and take into account the factor(s) listed in (Q 1.2)*	(2)
1.8	From the graph, what is the experimentally determined melting and boiling point of water? How does this compare with the known melting point and boiling point of water? *Refer to own findings (data collected)* *1 mark for the value of melting point and correct unit √* *1 mark for the value of boiling point and correct unit √*	(4)

	2 marks for the comparison √√	
1.9	Write down the conclusion for both the heating and cooling curve experiments. *During any phase change, the temperature of water remains constant*√ *During heating, the temperature of the water rises*√ *When water is cooled, its temperature decreases*√ *The temperature of the substance is an indication of the average kinetic energy of its particles.* √ *NB - Accept any logical conclusion*	(4)

2. PHYSICAL SCIENCES GRADE 10 WATER PURIFICATION

Project

Instruction sheet

NAME:
DATE:

BACKGROUND

Water purification in an important activity that helps eliminate the dangers of impurities in water. Technically speaking, there is almost nothing pure. That is why we speak of percentage purity, as opposed to 100% pure, although substances that are around 99% pure are regarded as pure substances. Water in the rivers generally contains a lot of impurities from human and industrial activities; these include bacteria, viruses, trace metals, nitrates, halides and salts. It therefore becomes necessary to purify water so as to keep the impurities at a level that does not pose a danger to humanity. There are various ways of purifying water.

For this project, you are given an opportunity to be innovative and come up with an idea on how you will be able to clean water so as to make it safe for human consumption. Your project will involve building a device or mini-plant for the mechanical cleaning of water such that it does not contain debris and looks clean. Your second step will involve testing your pure water for ions, salts, nitrates and halides. Indicate the presence of these in the labelling of your water.

Chemistry: Water purification and quality of water

The project is an integrated assessment task with a focus on the following skills:

- Process skills
- Critical thinking and scientific reasoning
- Strategies used to do a scientific investigation

- Solve problems in a scientific, technological, environmental and every-day context

How to go about the research

1. Build a device that is able to turn grey water into water that looks clean.
2. Test your water for the presence of ions, salts, nitrates and halides.
3. Create a brand name and label for your water and indicate the presence or absence of ions, salts, nitrates and halides as information for your consumers.
4. Your water might still not be suitable for drinking as it has not been tested for bacteria and bio-hazards or organisms, but you will have cleaned it.

No matter which method you choose to present your project, you must have a short research task and then build the device, and conduct the required tests on your water.

Bibliography: List all your references alphabetically.

State the author (surname and initials), date, title (underlined), publisher, city of publication. Referenced pages. e.g. Gray, A, et al. 2005. Physics, a contextual approach, Oxford, Britain, p. 30, 35.

Building a device

I. Research on pollution.

i. Identify and investigate the types of pollution that occur in a river and/or dam nearby your house or town. Mention the causes of the pollution and identify how big the problem is. What effect will the pollution have on humans, animals and the ecology around the water reservoir of the town? Mention different ways in which water can be purified simply and effectively.

(10)

ii. Once you know how you plan to design a device for purifying your water, draw plans for your device and choose the materials that you plan to use.

(5)

iii. Explain the purpose of every step in your journal. (5)

iv. Collate all costs of building the model. (5)

v. Explain why you chose the particular materials. (5)

vi. Note the challenges in building the device. (5)

2. Build a functioning water purification system or device.

The water purification system must be able to purify the polluted water up to a point where it looks clear to the eye. (30)

3. Test the filtered product for the indicated chemical substances.

At this point you need to indicate either the presence or absence of specifically:

ions, salts, nitrates and halides

(20)

4. Brand and market your water

Pour 500 ml of your water in a used water bottle.

- Design and paste a label for your water indicating:

1. The brand name of your water
2. Something interesting about your water
3. Source of your water
4. The chemicals that have tested positive or negative from the list of chemicals tested. (At this stage you need not worry about the amount of these chemicals present.) (10)

- Cost your water and justify the cost. (5)

Total (100)

3. PHYSICAL SCIENCES GRADE 11: THE EFFECTS OF INTERMOLECULAR FORCES

60

Formal experiment

Instruction sheet

NAME:

DATE:

BACKGROUND

Intermolecular forces are electrostatic forces in-between molecules. They exist because of the interaction between the electrons of one compound and their attraction to the protons of a nearby molecule, usually of the same compound. These forces are responsible for the state of substance at various temperatures and pressure: solids, liquid or gases. The differences in the properties of a solid, liquid, or gas reflect the strengths of the attractive forces between the atoms, molecules, or ions that make up each phase. The phase in which a substance exists depends on the relative extent of its **intermolecular forces**. These intermolecular forces affect the boiling point, melting point, capillarity, vapour pressure and viscosity of organic molecules**.**

In this experiment we investigate the effect of intermolecular forces on **evaporation, surface tension, capillarity, solubility, boiling point and surface tension** as characteristics that exist because of intermolecular forces.

Teacher to develop safety audits for all substances used in all parts of this experiment before the experiment is performed. <u>Include all the substances to be used in this experiment and complete the Safety audit.</u>

Danger	Prevention	Action in case of danger
Ethanol		
Add all chemicals to be used e.g. glycerine and nail polish remover		

Part 1: Evaporation

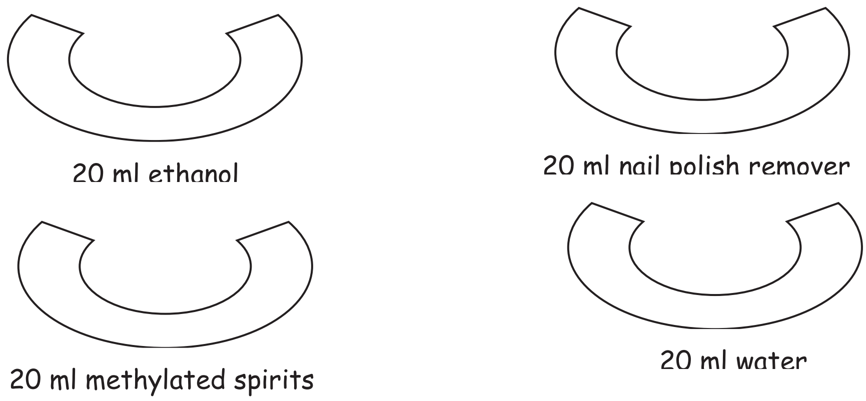
AIM

To investigate evaporation and determine the relationship between evaporation and intermolecular forces.

APPARATUS	Chemical substances
Evaporation dishes or shallow basins	Ethanol, nail polish remover (acetone), methylated spirit, water

INSTRUCTIONS

1. Place 20 ml of each substance given in separate evaporation dishes. Put the evaporation dish on top of a labelled piece of paper, indicating the substance in the dish.
2. Carefully move each dish to a warm (sunny) spot.
3. Mark the level of liquid in each dish using a permanent marker. Make several marks at different positions around the dish and allow the marker to dry. If the permanent marker leaves a smudge rather than a noticeable mark, carefully wipe the side of the dish and try again.
4. Observe each dish every minute and note which liquid evaporates fastest.



RESULTS

Record your results in the table below. You do not need to measure the level of the liquid, but rather just write how much the level has dropped (e.g. for water you might write that you did not notice any decrease in the level or for ethanol you might write that almost all the liquid had evaporated, etc.). (12)

Substance	1 min	2 min	3 min	4 min	5 min
Ethanol					
Water					
Nail polish remover (acetone)					
Methylated spirits					
Table 1 (3 marks for each row's recordings)					

Part 2: Surface tension

Aim: To investigate surface tension and to determine the relation between surface tension and intermolecular forces.

APPARATUS	Chemical substances
Dropper Small coin Absorbent tissue paper	Water, cooking oil (sunflower oil), glycerin, nail polish remover (acetone), methylated spirits

Method

1. Place a coin on a clean piece of absorbent material.
2. Carefully place and count drops of each liquid so that the coin can still hold the liquid drops before the surface tension breaks.
3. Repeat for all liquids.
4. Observe the shape of the meniscus.
5. Record your observations.
6. Record the number of drops in a table

Results

Record your results in the table below. You just need to give a qualitative result (in other words what you see in the experiment). (10)

Substance	Shape of meniscus	No. of droplets
Water		
Oil		
Glycerine		
Nail polish remover		
Methylated spirits		

Table 2 (1 mark for each recording)

Part 3: The effects of intermolecular forces – solubility

Aim

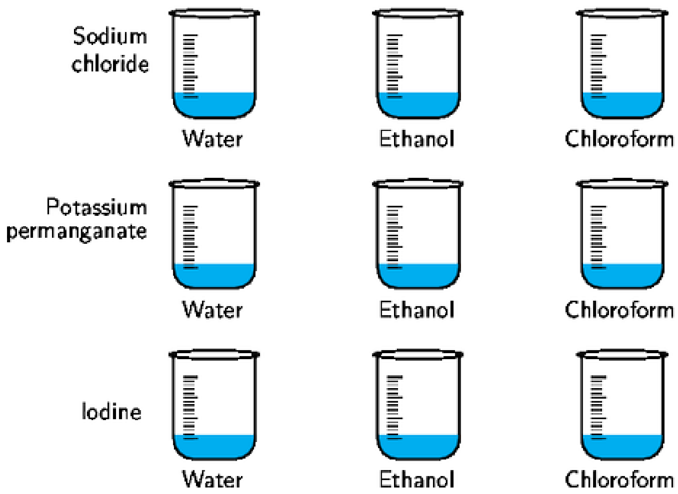
To investigate solubility and to determine the relation between solubility and intermolecular forces.

Apparatus	Chemical substances
9 beakers or test-tubes; 3 A4 sheets of paper	**Solids**: sodium chloride (table salt), iodine, potassium permanganate. **Solvents**: water, ethanol, chloroform

Method

1. Place about 20 ml of each solvent given in separate beakers. Place this set on a piece of paper labelled "sodium chloride".
2. Repeat this step twice. The second set is for potassium permanganate (so your piece of paper will say "potassium permanganate") and the third set is for iodine (so your piece of paper will say "iodine"). You should now have nine beakers in total.

3. Into the first set, add about 2 g of sodium chloride.
4. Into the second set, add about 2 g of potassium permanganate.
5. Into the third set, add about 2 g of iodine.
6. Observe how much of each substance dissolves in the solvent.



Results

Record your results in the table below. If you observed that only a small amount of the solid dissolves, then write that very little solid dissolved. If the entire solid dissolves, then write that the solid dissolved.

(9)

Substance	Water	Chloroform	Ethanol
Sodium chloride			
Potassium permanganate			
Iodine			

Table 3 (1 mark for each recording)

Part 4: The effects of intermolecular forces – Boiling point

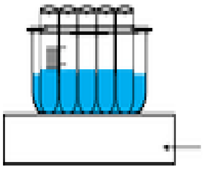
Aim

To investigate boiling point and to determine the relation between boiling point and IMF.

Apparatus	Chemical substances
Test-tubes Beaker Hot plate or burner 3 A4 sheets of paper	Water, cooking oil (sunflower oil), glycerine, nail polish remover, methylated spirits

INSTRUCTIONS

1. Place about 20 ml of each substance given in separate test-tubes.
2. Half-fill the beaker with water and place on the hot plate. Place the test-tubes in the beaker.
3. Observe how long each substance takes to boil. As soon as a substance boils, remove it from the water bath.



Results

Substance	Boiling point
Water	
Cooking oil	
Glycerine	
Nail polish remover	
Methylated spirits	

Part 5: The effects of intermolecular forces – Capillarity

Aim

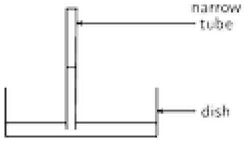
To investigate capillarity (how far up a tube a liquid rises or how far down a liquid falls) and to determine the relation between capillarity and intermolecular forces.

Apparatus	Chemical substances
Large shallow dish, narrow glass tube (with one end closed)	Water, cooking oil (sunflower oil), nail polish remover, methylated spirits

Method

1. Place about 20 ml of water in the shallow dish. Hold the narrow tube just above the level of the water in the dish. Observe how far up the tube the water travels.

2. Repeat for the other three substances, remembering to wash and dry the dish and tube well between each one.



Results

5.1 Record results in the table below. Measure how far up the tube the substance travelled. (4)

Substance	Distance travelled up tube
Water	
Oil	
Nail polish remover	
Methylated spirits	

Table 4 (1 mark for each recording)

WORKSHEET

NAME: **DATE:**

Answer the following experiment-based questions.

Questions:

1. EVAPORATION

1.1	Table of results – 2 marks for all correct entries in each row x 5	(10)
1.2	Arrange the liquids in order of increasing rate of evaporation	(2)
1.3	Arrange the substances in increasing order of strength of intermolecular forces	(2)
1.4	Conclusion	(2)

2. SURFACE TENSION

2.1	Table of results – 1 mark for each observation entry x 5	(5)
2.2	Arrange the liquids in order of increasing surface tension.	(5)
2.3	Refer to the strength of intermolecular forces to explain the **DIFFERENCE** in observations made for the five liquids	(2)
2.4	Conclusion	(4)

3. SOLUBILITY

3.1	Table of results – 1 mark for each correct entry in each row x 9	(9)
3.2	Deduce the relationship between the strength of the intermolecular force of the solute and the strength of the intermolecular forces of the solvent.	(2)
3.3	Explain why iodine will not dissolve in water.	(2)
3.4	Conclusion	(2)

4. BOILING POINT

4.1	Table of results – 1 mark for each correct boiling point x 6	(6)
4.2	Define boiling point	(2)
4.3	Refer to the strength of intermolecular forces to explain the **DIFFERENCE** in observations made for the five liquids.	(5)
4.4	Conclusion	(2)

5. CAPILLARITY

5.1	Table of results – 1 mark for each correct entry x 4	(4)
5.2	Conclusion	(2)

MARKING GUIDELINE

1. EVAPORATION

1.1	*Table of results – 2 marks for all correct entries in each row x 5*	(10)
1.2	• Conclusion – *the stronger the intermolecular forces, the slower the rate of evaporation* √√ • *Relevant discussion* √√ • *Accept any logical variation of the same argument*	(4)
1.3	*Arrangement of liquids in order of increasing rate of evaporation*	(2)
1.4	*Arrangement of substances in increasing order of strength of intermolecular forces*	(2)

2. SURFACE TENSION

2.1	*Table of results – 1 mark for each observation entry x 5*	(5)
2.2	Arrange the liquids in order of increasing surface tension.	(5)
2.3	Refer to the strength of intermolecular forces to explain the **DIFFERENCE** in observations made for the five liquids.	(2)
2.4	Conclusion –*The strength of the surface tension increases as the strength of the intermolecular for increases* √√	(4)

3. SOLUBILITY

3.1	*Table of results – 1 Mark for each correct entries in each row x 9*	(9)
3.2	Deduce the relationship between the strength of the intermolecular force of the solute and the strength of the intermolecular forces of the solvent. *Solutes with strong intermolecular forces will readily dissolve in solvents with strong intermolecular forces and solutes with weak intermolecular forces will dissolve in solvents with weak intermolecular forces. "Like dissolves like"* √√	(2)
3.3	Explain why iodine will not dissolve in water. *Iodine is a non-polar solute and water is a polar solvent.* √√	(2)
3.4	Conclusion *The same order of strength of intermolecular forces in solvent and solute leads to a higher degree of solubility.* √√	(2)

4. BOILING POINT

4.1	*Table of results – 1 mark for each correct boiling point x 6*	(6)
4.2	Definition of boiling point *The temperature at which the vapour pressure of a substance equals the atmospheric pressure.* √√	(2)
4.3	Refer to the strength of intermolecular forces to explain the **DIFFERENCE** in observations made for the five liquids. *Correct explanation based on the TYPE and STRENGTH of the intermolecular force*	(5)
4.4	Conclusion *The stronger the intermolecular force, the higher the boiling point.* √√	(2)

5. CAPILLARITY

5.1	*Table of results – 1 Mark for each correct entry x 4*	(4)
5.2	Conclusion *The stronger the intermolecular forces of a substance, the lower its capillarity√√*	(2)

4. PHYSICAL SCIENCES GRADE 11: VERIFICATION OF BOYLE'S LAW

Aim

To investigate the relationship between the pressure and the volume of an enclosed gas.

> Knowledge on gas laws is very important during chemical reactions. Reactions that involve the use of gases or that will produce gases can cause explosions if confined in small spaces for example. It is therefore important to have proper equipment as well as an observation of temperature and pressure and an accurate calculation of the molar quantities involved.

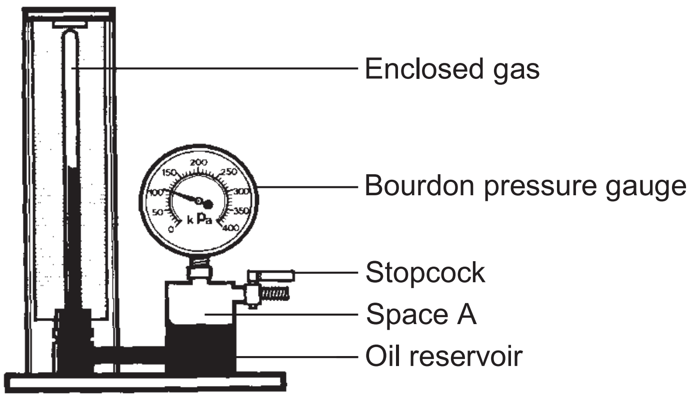
Apparatus

Boyle's apparatus

Bicycle pump

Method

1. Boyle's apparatus, shown in the sketch below, has a fixed mass of gas trapped in the vertical tube.



   The volume of the gas is read on the scale mounted behind the tube. Ensure that the zero mark on the scale corresponds with the top of the tube.

2. Measure the volume of the gas and the reading on the pressure gauge at atmospheric pressure.
3. Use the bicycle pump to pump air through the stopcock into space A. The pressure on the oil in the reservoir is increased and the oil rises in the tube.

4. Wait a minute and then measure the volume of the gas and the reading on the pressure gauge at this higher pressure.
5. Repeat steps 3 and 4 at higher pressures up to 300 kPa.

Results and interpretation of results

1. Redraw the table below into your practical book and record the results.

Volume (cm^3)	**Pressure (kPa)**	$\frac{1}{p}$ **(kPa^{-1})**	**pV**

2. Calculate the reciprocal values of each pressure value and complete column 3 in the table.
3. Calculate the product of pressure and volume for each set of values and complete column 4 in the table.
4. Draw a graph of:

4.1 Volume versus pressure for the enclosed gas (Graph 1)

4.2 Volume versus $\frac{1}{\text{pressure}}$ for the enclosed gas (Graph 2)

Conclusion and questions

1. For this investigation, identify the:

1.1 Independent variable

1.2 Dependent variable

2. Write down TWO variables that must be controlled during this investigation.

3. Formulate an investigative question for this investigation.

4. Give a reason why a minute must elapse before measurements are taken after each pressure increase.

5. Describe the shape of graph 1,i.e. the graph of volume versus pressure.

6. Describe the shape of graph 2, i.e. the graph of volume versus $\frac{1}{p}$.

7. Calculate the gradient of graph 2. How does this value compare to the product of *pV* calculated in column 4 of the table.

8. Write down the physical quantity represented by the product *pV*. Use cancellation of basic units to show how you arrived at the answer.

9. Write down a mathematical relationship between pressure and volume as represented in the graphs.

10. Write down an equation that can be derived from the relationship in QUESTION 9.

11. Draw a conclusion from results obtained.

12. You pump a bicycle tyre at a filling station.

12.1 To what air pressure will you pump the tyre?

12.2 What will the reading on the pressure gauge be if your bicycle tyre is flat?

12.3 What is the true air pressure inside the flat tyre?

13. Use Boyle's law to explain each of the following everyday scenarios:

13.1 A baker bakes a cake in Johannesburg using a Durban recipe and finds that the cake collapses.

13.2 The lungs of a scuba diver can explode if he holds his breath while rising to the surface.

Formal experiment

Instruction sheet

NAME:
DATE:

BACKGROUND

A **titration** is a technique where a solution of known concentration is used to determine the concentration of an unknown solution. Acid-base reactions are commonly used as examples of titrations as common examples that are part of our daily lives. When excess **acid** is produced in your stomach for example due to a variety of factors, discomfort usually sets in and this usually causes great discomfort. A dose of common antacids, which are **bases** are usually used to relieve the discomfort.

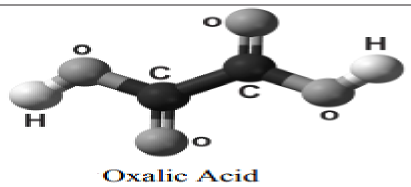
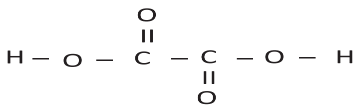
Antacids are medicines containing **bases** such as aluminum hydroxide and magnesium hydroxide amongst other substances available at ordinary supermarkets and spaza shops. These are used to **neutralise** (oppose the effect, in this case to reduce the acidity) gastric acid, which is composed of hydrochloric **acid** and other compounds in the human stomach. Gastric acids or stomach acid, with a pH in the range of 1, 5 – 3, 5, is useful in food digestion and in preventing harmful bacteria from invading our stomachs as long as the gastric acid is kept within the normal limits. This experiment demonstrates what happens in a titration at a molecular and subatomic level.

Safety audit

Oxalic acid

Danger	**Prevention**	**Action in case of danger**
 ***Flammable***	No open flames, no sparks and no smoking. Above 39°C explosive vapour/air mixtures may be formed. Risk of fire and explosion on contact with strong oxidants.	Use powder, alcohol-resistant foam, water spray or carbon dioxide. In case of fire use water to spray.
Inhalation	Use ventilation, local exhaust or breathing protection.	Fresh air, rest. Half-upright position. Medical attention.
Skin	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap. Rinse skin with plenty of water for at least 15 minutes. Medical attention.
Ingestion	Do not eat, drink, or smoke during work	Rinse mouth. Do NOT induce vomiting; one small glass of water may be given to drink within a few minutes of ingestion. Seek medical attention
Environment care	Do NOT let this chemical enter the environment. Collect leaking liquid in sealable containers. Cautiously neutralise spilled liquid with sodium carbonate only under the responsibility of an expert. Consult the local Department of Environmental Affairs for advice on disposal.	

NB: PLEASE COMPLETE SAFETY AUDITS FOR ALL CHEMICALS BEFORE PERFORMING EXPERIMENT

Ball and Stick Model	**Structural Formula**
	 **Oxalic Acid**

This experiment is carried out in two parts: Part 1 is when a ***standard solution*** of the weak oxalic acid is prepared and Part 2 is when the actual titration is carried out.

Part 1: Preparation of a standard solution of oxalic acid

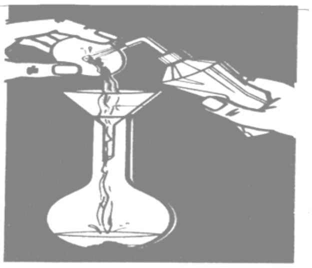
AIM: To prepare a standard solution of oxalic acid.

MATERIALS

Apparatus	Chemicals
1. Mass meter/balance 2. 250 ml conical flask 3. Beaker 4. Wash bottle 5. Non-permanent marking pen	1. Oxalic acid dihydrate ($H_2C_2O_4.2H_2O$) 2. Distilled water

INSTRUCTIONS

1. Determine the mass of the clean, dry watch glass.
2. Label the conical flask, indicating the name and the mass of what is going to be put in the flask.
3. Use the wash bottle and distilled water to transfer the oxalic acid crystals into the conical flask as shown below.



4. Ensure that ALL the crystals and washing water go into the conical flask.
5. Half-fill the volumetric flask with water and cover it with the stopper.
6. Now swirl the flask so that all the crystals are dissolved. [DO NOT SHAKE THE FLASK UP AND DOWN.] Note that the crystals are more soluble in warm water.
7. Top-up the flask with distilled water until the water is at 250 ml calibration on the neck of the flask.
8. Calculate the concentration of the oxalic acid solution. (5)

Part 2: Titration of oxalic acid with sodium hydroxide

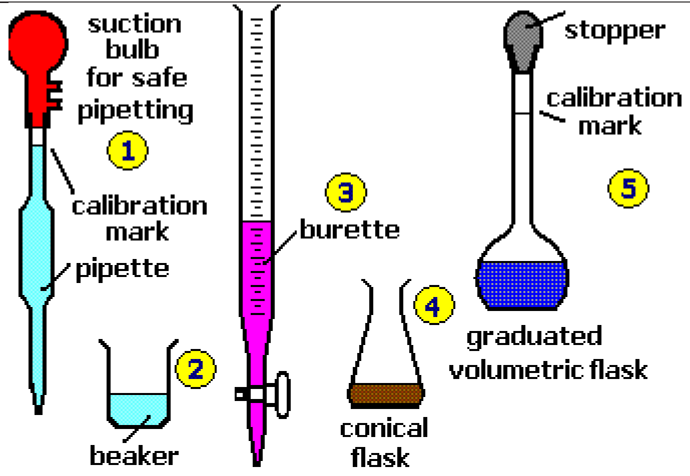
AIM: To determine the unknown concentration of a solution of sodium hydroxide by titrating it against a standard solution of oxalic acid.

Sodium hydroxide safety audit

Danger	Prevention	Action in case of danger
Skin and eyes	Avoid direct skin contact. Wear protective clothing and goggles	Flush with lots of cold water Medical attention
Inhalation	Make use of appropriate breathing protection	Remove affected person from exposure. If not responsive and not breathing normally, do CPR Seek medical attention
Ingestion	No eating or drinking anything when handling sodium hydroxide	Rinse mouth, DO NOT induce vomiting. Seek medical attention.
Disposal and environment		
Indicator (complete information on the indicator used		

MATERIALS

Apparatus:	Chemicals:
1. 2x 50ml burettes 2. White tile	1.Standard solution of Oxalic acid dihydrate prepared in part 1 2. Sodium hydroxide solution 3. Phenolphthalein indicator



INSTRUCTIONS

1. Fill one burette to the 0 mark with the standard solution of oxalic acid from Part 1. Label this burette indicating the name of the contents.
2. Fill the second burette to the 0 mark with the sodium hydroxide and label it indicating the name of the solution.
3. Run 25 cm^3 of oxalic acid from the first burette into the Erlenmeyer flask.
4. Add 3 to 5 drops of phenolphthalein into the Erlenmeyer flask. Observe the colour of this solution.
5. Place the Erlenmeyer flask containing the oxalic acid on top of a white tile and then place it under the spout of the burette containing the sodium hydroxide solution.
6. Open the tap of the second burette with the sodium hydroxide until the contents of the Erlenmeyer flask changes colour.
7. Note the reading on the burette at the point where the colour changed and record this reading as the "*trial run*". *The "trial run" reading only gives you an indication of where the endpoint could be*. Dispose of the contents of the Erlenmeyer flask and rinse with some distilled water.
8. Repeat steps 3 to 6 again and record your readings in the table below. *Be careful with the next set of readings. As you get close to the "end point", add one drop at a time, shake the flask until the colour disappears and continue until the colour stays.*

9. As you approach the volume at which the colour changed during the trial run, reduce the flow and add drops to the flask.
10. Do not use the "*trial run*" reading when you calculate the average readings.
11. Take the average of the last three volumes that you recorded as the end points.
12. Write a ***<u>scientific report</u>*** which ***must include*** the following headings:
    - Aim
    - Apparatus
    - Safety precautions required
    - Method
    - Observation and recording of results
    - Analysis and interpretation
    - Conclusion
    - Application

Table of Results

Experiment Number	**Volume of oxalic Acid (mℓ)**	**Initial reading of NaOH**	**Final reading of NaOH**	**Volume of NaOH (mℓ)**
1				
2				
3				
			Average	
				(4 marks)

Write down the conclusion for Part 2 of the experiment

____(2)

The following rubric will be used to measure the **skills** necessary to conduct an experiment.

Criteria	High **(3)**	Medium **(2)**	Low **(1)**	None **(0)**	Your Mark
Making of standard solution of oxalic acid	Able to weigh out the correct amount of acid crystals and make up the solution correctly.	Only managed to weigh an approximate amount OR the making up of the solution is not exactly 250 ml.	Only managed to weigh an approximate amount and the making up of the solution is not exactly 250 ml	Needs assistance in weighing and making up of solution.	
Handling of apparatus and material	Able to fill the burette and pipette with25 ml independently.	Only managed to fill the burette with NaOH or pipette with25 ml of the acid.	Some help was needed for filling of the burette and pipetting the acid.	Could only do with the help of the teacher.	
Performing the titration	Able to do the titration independently and got the end point correctly.	Able to titrate independently but overshot by a few drops but managed to get the endpoint.	Able to titrate but overshot by a large volume and struggled to get the endpoint.	Needs a lot of assistance to carry out the titration.	
				9 Marks	

TOTAL [20]

WORKSHEET

1. Write down a balanced equation for the neutralisation reaction.

____ (3)

2. How many moles of base will react with one mole of acid?

____ (1)

3. Calculate the number of moles of oxalic acid in the Erlenmeyer flask.

____

____ (3)

4. Calculate the number of moles of sodium hydroxide needed to neutralise the acid in the Erlenmeyer flask.

____

____

____ (3)

5. Calculate the concentration of the sodium hydroxide solution.

____

____

____ (4)

6. Calculate the pH of the base.

____

____

____

____ (4)

7. What is the reason for doing three repetitions for the titration?

____

____ (1)

8. During the titration, base spilled onto the sides of the flask can be washed into the solution using the wash bottle. Give a reason why addition of water to the measured volume of acid will not influence the results.

____

____ (1)

9. Give a reason why sodium hydroxide is classified as a strong base.

____ (1)

10. Give a reason why oxalic acid can be classified as a *diprotic weak acid*.

____ (2)

11. Define the term *neutralisation*.

____

____ (2)

12. Define the term *hydrolysis*.

____

____ (2)

13. Explain why phenolphthalein (pH range from 7,5 - 10,5) is used in this titration. Support your explanation with a relevant reaction equation.

____

____

____

____ (3)

TOTAL

[30]

MARKING GUIDELINE FOR PART 1 AND 2:

Part 1: Preparation of a standard solution of oxalic acid dihydrate

HYPOTHETICAL

$$c = \frac{m}{MV} \checkmark$$

$$= \frac{3,2}{126\,(0,25)}$$

$= 0,102 \text{ mol d.m}^{-3} \checkmark$ (5)

Part 2: Titration of oxalic acid with sodium hydroxide

RESULTS:

Experiment Number	Volume of oxalic Acid (mℓ)	Initial reading of NaOH	Final reading of NaOH	Volume of NaOH (mℓ)
1				
2				
3				
			Average	
				(4 marks)

CONCLUSION (2)

RUBRIC (9)

MARKING GUIDELINE FOR THE WORKSHEET

1. $(COOH)_2 + 2NaOH$✓ → $(COO)_2Na_2 + 2H_2O$ ✓ Bal✓ (3)
OR
$H_2C_2O_4$ (aq) + 2 NaOH (aq)✓ --> $Na_2C_2O_4$ (aq) + 2 H_2O (l)✓ (bal) ✓

2. 2 moles (1)

3. $n_a = cV$ ✓
$= (0,1)(25 \times 10^{-3})$✓
$= 2,5 \times 10^{-3}$ mol✓ (3)

4. $n_a / n_b = ½$✓

$n_b = 2n_a$

$= 2(25 \times 10^{-3})$ ✓

$= 5 \times 10^{-3}$ mol (3)

5 **POSITIVE MARKING FROM PART 1**

(HYPOTHETICAL)

$n_bC_aV_a = n_aC_bV_b$✓

(2)(0,102)(<u>0,025</u>) (correct substitution)✓ = (1)(C_b)(<u>0,03015</u>) (correct substitution)✓

$C_b = 0{,}17$ mol.dm^{-3}✓ (4)

6 **POSITIVE MARKING FROM QUESTION 5**

$NaOH \rightarrow Na^+(aq) + OH^-(aq)$

$[OH^-] = [NaOH] =$ (Ratio - 1:1)

$[H_3O^+][OH^-] = 10^{-14}$✓

$[H_3O^+] = \frac{10^{-14}}{0{,}17}$ ✓

$= 5{,}88 \times 10^{-14}$

$pH = -\log[H_3O^+]$ ✓

$= -\log[5{,}88 \times 10^{-14}]$

$= 13{,}23$✓ (4)

7. Improve accuracy.✓ (1)

8. The number of moles is constant.✓ (1)

9. Completely dissociated / ionised (to form a high concentration of hydronium ions) (1)

10. Diprotic acid – an acid that can donate two protons in aqueous solution and weak acid – ionises partially in solution to form hydronium ions. ✓ (2)

11. Reaction of an acid and a base ✓to form a salt and water. ✓ (2)

12. When an acid and base react, a salt is formed✓. (2)

13. In the titration of a weak acid against a strong base, the salt formed at the equivalence point will have a pH higher than 7✓. So the indicator that you should be using must have a pH greater than 7. That is why phenolphthalein of pH range 8-10 is used✓.Reaction of a salt with water. ✓ (3)

6. PHYSICAL SCIENCES GRADE 12 ESTERS

Formal experiment

Instruction sheet

Name:
Date:

You will be expected to write a full scientific report on this practical so take note of your procedure and findings.

BACKGROUND

Esters are hydrocarbons that have a wide range of uses in everyday life in both living world and industries. Some common esters have sweet, fruity smells which occur naturally as flavours, a property that makes them suitable for the preparation of cosmetics and perfumes. The daily application of esters has given rise to the high demand for their artificial chemical production through the use of alcohols and organic acids.

AIM

Synthesis of different esters by using a range of organic acids and alcohols.
Identifying the ester formed by smell.

APPARATUS

Equipment/ Glassware	Chemicals / Reagents
Test tubes Water soluble marker Test tube rack Eye dropper 250 ml beakers Electronic balance/ Mass Meter Hot plate/ Bunsen burner Tripod Tongs Lab apron safety goggles	Pentan-1-ol (Any other suitable alcohol) Ethanol Concentrated sulphuric acid Glacial acetic acid (Ethanoic acid) Propanoic acid Water

Insert a safety card for all chemicals that are going to be used in this activity.

Complete the following table as an extension to your safety audit above.

CHEMICAL	HAZARD LABEL	MEANING OF LABEL
Ethanol		2.1 ______________________________
Pentanol		2.2 ______________________________
Ethanoic acid (Acetic acid)		2.3 ______________________________
Concentrated sulphuric acid		2.4 ______________________________

INSTRUCTIONS

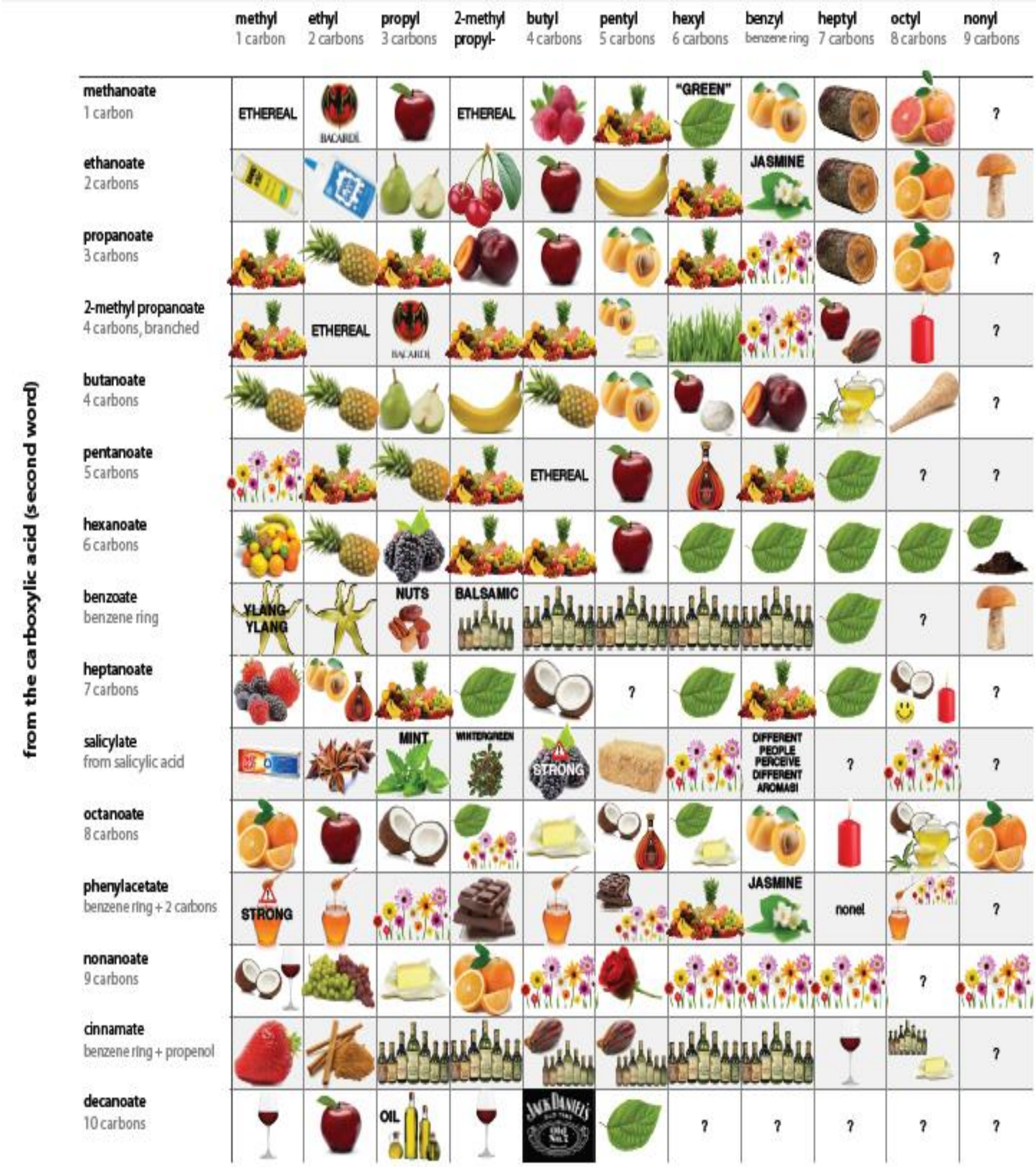
Boil some water in a kettle for preparing a heat bath before commencing the experiment.

1. Take three test tubes and in each put 20 drops of ethanol, 20 drops of pentan-1-ol, and 20 drops of 3-methylbutan-2-ol.
2. In each test tube add 20 drops of ethanoic acid or propanoic acid.
3. Add 1 drop of concentrated sulfuric acid (H_2SO_4) in each test tube.
4. Place all the test tubes in the beaker with hot water for about 15 -20 minutes, replace the water if it cools down too much.

5. Gently shake the test tubes often.
6. Take a beaker and put about 20 mℓ of cold water into it, now add the contents of one of your small test tubes into it, cover the opening with the palm of your hand and shake it gently.
7. Try now to identify the smell, by wafting
8. If the smell of the acid is still notable, add 1 mℓ calcium carbonate ($CaCO_3$) to the mixture to neutralise the remaining acid.

Write a scientific report after performing this experiment. (15)

The following is table of fragrances from known esters.



PHYSICAL SCIENCES Grade 12

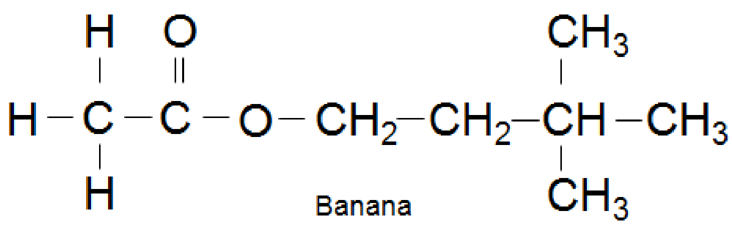
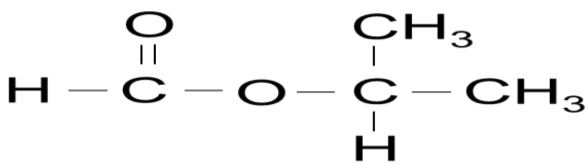
Formal Experiment

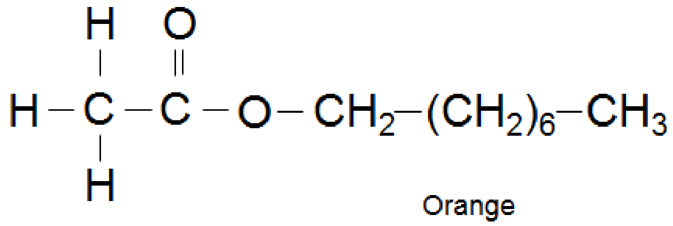
ESTERS

/35

Name

Answer the following questions related to the experiment.

1	What is the function of the concentrated sulphuric acid?	(2)
2	Why were the reactants of each test tube heated in a water bath and not directly over a flame?	(2)
3	Is the organic **product** soluble in water?	(1)
4	For each of the following structures below, identify the acid and alcohol used to prepare these esters. Also give the name of the ester.	
4.1	 Name of the acid used: Name of the alcohol used: Name of the Ester:	(6)
4.2	 Name of the acid used: Name of the alcohol used: Name of the Ester:	(6)

4.3	 Orange Name of the acid used: Name of the alcohol used: Name of the Ester:	(6)
5	Using structural formulae, write down the balanced equation for each of the following reactions.	
5.1	Ethanol and ethanoic acid	(4)
5.2	Pentan-1-ol and Propanoic acid	
5.3	Propan-1-ol and Ethanoic acid	
		[35]

PHYSICAL SCIENCES Grade 12

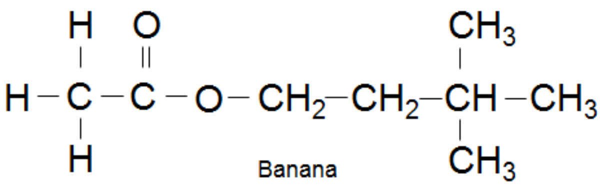
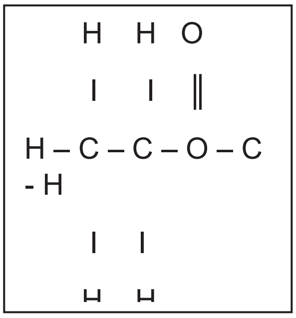
Formal Experiment

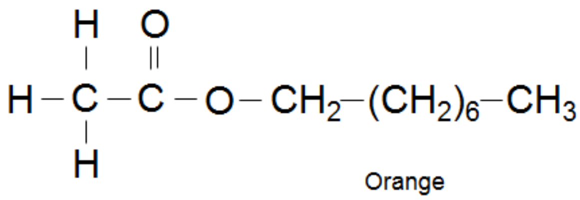
/35

ESTERS

MARKING GUIDELINE

Answer the following questions related to the experiment.

1	What is the function of the conc. H_2SO_4? Catalyst ✓✓	(2)
2	Why were the reactants of each test tube heated in a water bath and not directly over a flame? The alcohol in the mixture is highly flammable ✓✓	(2)
3	Is the organic **product** soluble in water? Not soluble ✓(ester is produced as an oil that floats on the water.)	(1)
4	For each of the following structures below, identify the acid and alcohol used to prepare these esters. Also give the name of the ester.	
4.1	 Name of the acid used: ethanoic acid ✓✓ Name of the alcohol used: 3,3-dimethyl butanol ✓✓ Name of the Ester: 3,3-dimethyl butylethanoate ✓✓	(6)
4.2	 Name of the acid used: methanoic acid ✓✓ Name of the alcohol used: ethanol ✓✓ Name of the Ester: ethylmethanoate✓✓	(6)

4.3	 Name of the acid used: ethanoic acid ✓✓ Name of the alcohol used: octanol ✓✓ Name of the Ester: octylethylanoate	(6)
5	Give the structural formula of the ester formed from the following.	
5.1	Ethanol and ethanoic acid. O ‖ BASIC STRUCTURE ONLY C – C –O – C – C (Learners must show a full correct structure)	(4)
5.2	Pentan-1-ol and Propanoic acid. O BASIC STRUCTURE ONLY ‖ C – C – C – C – C – O - C – C - C (Learners must show a full correct structure)	(4)
5.3	Propan-1-ol and Ethanoic acid O BASIC STRUCTURE ONLY no hydrogen bonds ‖ C – C – C – O – C - C (Learners must show a full correct structure)	(4)
		[35]

222 Struben Street, Pretoria, 0001
Private Bag X895, Pretoria, 0001, South Africa
Tel: 012 357 3000 • Fax: 012 323 0601

Private Bag X9035, Cape Town, 8000, South Africa
Tel: 021 486 7000 • Fax: 021 461 8110
Call Centre: 0800 202 933

ISBN 978-1-4315-3123-3

Department of Basic Education

www.education.gov.za

www.twitter.com/dbe_sa

www.facebook.com/BasicEd