PHYSICAL SCIENCES
SCHOOL-BASED ASSESSMENT
EXEMPLARS – CAPS
GRADE 12
LEARNER GUIDE
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PRACTICAL WORK AS FORMAL ASSESSMENT TASKS

1. INTRODUCTION

Assessment of a learner’s progress in Grade 12 Physical Sciences consists of two components:

- A school-based programme of assessment consisting of six tasks, which makes up 25% (mark out of 100) of the total mark for Physical Sciences. Three of the six tasks comprise prescribed experiments.
- An external examination (out of 300 marks), which makes up the remaining 75%.

2. OBJECTIVES

Physical Sciences investigate physical and chemical phenomena. This is done through scientific enquiry and the application of scientific models, theories and laws in order to explain and predict events in the physical environment.

Practical work in Physical Sciences must be integrated with the theory to strengthen the concepts being taught. These may take the form of simple practical demonstrations or even an experiment or practical investigation.

As from 2014 THREE prescribed experiments will be done per year as practical activities for formal assessment:

- One Chemistry Practical during Term 1
- A Physics or a Chemistry Practical during Term 2
- A Physics Practical during Term 3.

This learner guide will provide support to the learner and teacher in performing these practical activities.

3. ASSESSMENT TASKS FOR GRADE 12 PRACTICAL WORK

The table below lists the prescribed formal assessment activities for practical work and the weighting for the annual SBA.

<table>
<thead>
<tr>
<th>TERM</th>
<th>PRESCRIBED PRACTICAL ACTIVITIES FOR FORMAL ASSESSMENT</th>
<th>WEIGHTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EXPERIMENT (CHEMISTRY) The preparation of esters and smell identification</td>
<td>15% of annual SBA</td>
</tr>
<tr>
<td>2</td>
<td>EXPERIMENT (CHEMISTRY) How do you use the titration of oxalic acid against sodium hydroxide to determine the concentration of the sodium hydroxide? OR EXPERIMENT (PHYSICS) The conservation of linear momentum</td>
<td>20% of annual SBA</td>
</tr>
<tr>
<td>3</td>
<td>EXPERIMENT (PHYSICS) Part 1 Determine the internal resistance of a battery. Part 2 Set up a series-parallel network with a known resistor. Determine the equivalent resistance using an ammeter and a voltmeter and compare with the theoretical value.</td>
<td>15% of annual SBA</td>
</tr>
</tbody>
</table>
4. EXEMPLARS OF PRACTICAL WORK AS FORMAL ASSESSMENT TASKS

TERM 1: PRACTICAL WORK

KNOWLEDGE AREA: MATTER AND MATERIALS

4.1 PREPARATION OF ESTERS AND SMELL IDENTIFICATION

INTRODUCTION

Esters have a very fruity smell. Naturally occurring esters are found in fruits. Esters can be synthesised by the reaction of a carboxylic acid and an alcohol. This reaction is known as esterification. This reaction can be catalysed by concentrated sulphuric acid.

AIM

Produce different esters by using a range of carboxylic acids and alcohols.

Identify the esters formed by their smell.

APPARATUS

- Safety goggles
- Test tubes
- Dropping pipettes
- 250 ml beaker
- Test tube rack
- Bunsen burner
- Heat resistant mat/tile
- Tripod
- Wire gauze
- Retort stand
- Chemicals: methanol, ethanol, propanol, ethanoic acid, salicylic acid, sulphuric acid and 0.5 mol.dm\(^{-3}\) sodium carbonate

METHOD

1. Place 1 drop of concentrated sulphuric acid in a test tube.
2. Add 10 drops of ethanoic acid in the same test tube.
3. Add 10 drops of ethanol to the mixture.
PREPARE A WATER BATH

1. Pour about 100 cm³ of water into the 250 cm³ beaker.
2. Carefully lower the tube into the beaker so that it stands upright.
3. Heat the beaker gently on a tripod and gauze until the water begins to boil, and then stop the heating.
4. Stand for 1 minute in the hot water. If the mixture in the tube boils, use the tongs to lift it out of the water until the boiling stops, and then return it to the hot water.
5. After 1 minute, carefully remove the test tube and allow it to cool.

6. When cool, pour the mixture into a test tube half-full of 0.5 mol.dm⁻³ sodium carbonate solution. There will be some effervescence. Mix well. A layer of ester will separate and float on top of the aqueous layer.
CAUTION! DO NOT PUT YOUR NOSE NEAR THE TOP OF THE TEST TUBE!!!

Wafting is a technique of using your hand to draw air over the opening of a container in the direction of your nose. Air mixed with the substance is drawn into your nose so that the smell from the original substance is diluted.

7. Smell the product by gently wafting the odour towards your nose with your hand.
8. Repeat steps 1 to 10 but use METHANOL and PROPAOL as the alcohol.
9. Repeat steps 1 to 10 but use SALICYLIC ACID and METHANOL.

RESULTS AND INTERPRETATION OF RESULTS

Complete the tables below.

Choose ONE of the following to identify the ester formed by smell:

- Paint
- Pear
- Pineapple
- Strawberry
- Ice cream
- Nail polish remover
- Wintergreen
### EXPERIMENT 1: ETHANOL + ETHANOIC ACID

<table>
<thead>
<tr>
<th>SMELL</th>
<th>WORD EQUATION</th>
<th>STRUCTURAL FORMULA</th>
<th>CHEMICAL EQUATION</th>
<th>BALANCED CHEMICAL EQUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### EXPERIMENT 2: METHANOL + ETHANOIC ACID

<table>
<thead>
<tr>
<th>SMELL</th>
<th>WORD EQUATION</th>
<th>STRUCTURAL FORMULA</th>
<th>CHEMICAL EQUATION</th>
<th>BALANCED CHEMICAL EQUATION</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tbody>
</table>

### EXPERIMENT 3: PROPANOL + ETHANOIC ACID

<table>
<thead>
<tr>
<th>SMELL</th>
<th>WORD EQUATION</th>
<th>STRUCTURAL FORMULA</th>
<th>CHEMICAL EQUATION</th>
<th>BALANCED CHEMICAL EQUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
EXPERIMENT 4: METHANOL + SALICYLIC ACID

SMELL
(2)

DISCUSSION OF RESULTS

1. Which property of sulphuric acid makes it suitable to use as a catalyst for the preparation of esters?
   ____________________________________________________________
   (2)

2. Why do we heat the test tube in a water bath and not directly over a flame?
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   (2)

3. With reference to the characteristic smells of esters, name TWO examples where esters are used in different industries.
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   (4)

4. Why do esters with higher molecular weight not have strong fragrances?
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   (2)

TOTAL: 60
TERM 2: PRACTICAL WORK

KNOWLEDGE AREA: MECHANICS

4.2 CONSERVATION OF LINEAR MOMENTUM

INTRODUCTION

Momentum is mass in motion. The amount of momentum of an object is determined by two variables, namely mass and velocity.

Linear momentum (momentum in a straight line) can be defined as the product of mass and velocity.

The verification of the conservation of momentum can be determined experimentally during an explosion and a collision.

AIM

To verify the conservation of linear momentum during an explosion.

APPARATUS

- Trolley track
- Trolleys
- Meter ruler
- Buffers (wooden plank or brick)

METHOD

1. Place two trolleys, one of which contains a compressed spring, against each other on a smooth, horizontal floor.

2. Place another trolley on top of one of the other trolleys in Step 1. These two trolleys now represent a mass of 2 m, while the single trolley represents a mass of m.

3. Place two sturdy wooden planks on either side of the setup (not further than 1–1,5 m from the setup) as shown in the diagram below.

4. Release the spring of one trolley so that the two trolley systems move apart. Listen to the collisions against the wooden planks. The trolley systems hit the wooden planks at different times, because one trolley system moves more slowly than the other one (different velocities).
5. By means of trial and error, find a position from which the trolley systems move so that both trolleys will hit the wooden planks on both sides at the same time. Only a single collision should be heard.

6. Measure the distances \( \Delta x_1 \) and \( \Delta x_2 \) that each trolley moved from the starting point to the wooden plank. These distances represent the velocities of the two trolley systems respectively.

7. Repeat the above procedure to obtain two more sets of values.

**RESULTS**

Complete the following table.

<table>
<thead>
<tr>
<th>Trolley system 1</th>
<th>Trolley system 2</th>
<th>Total momentum after explosion ('unit')</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass (Trolley unit)</td>
<td>[Velocity ( v_1 )] Distance ( \Delta x_1 ) (cm)</td>
<td>Momentum ('unit')</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

(10)

**INTERPRETATION AND DISCUSSION OF RESULTS**

1. Formulate an investigative question for this practical activity.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________(3)

2. State the law of the conservation of momentum.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________(2)

3. Explain why it is acceptable to consider the distances travelled by the trolleys as a measurement of their velocities.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________(2)
4. Give a reason why this experiment must be performed more than once.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________ (2)

CONCLUSION

5. Draw a conclusion from the results you obtained.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________ (3)

EVALUATION

6. What recommendations can you make to improve the results of your experiment?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________ (4)

APPLICATION

7. A boy with a mass of 50 kg and a girl with a mass of 40 kg are standing on skateboards. They press their hands together and push each other apart as shown in the sketch. The girl moves to the right at 1 m.s\(^{-1}\).

7.1 What is the total momentum of the boy and girl before they move apart?

________________________________________________________________________ (2)
7.2 Determine the velocity of the boy directly after they moved apart.
ALTERNATIVE METHOD – LINEAR AIR TRACK

METHOD

A collision instead of an explosion can be used to investigate the conservation of momentum.

The diagram below illustrates the collision of trolleys on an air track.

Trolley A with a mass of 2 kg and velocity of 1,5 m.s\(^{-1}\) to the right collides with a stationary trolley B with a mass of 1,5 kg.

After the collision, trolley A moves at 0,75 m.s\(^{-1}\) to the left and trolley B moves at 3 m.s\(^{-1}\) to the right.

INTERPRETATION OF RESULTS

8.1 In the verification of the conservation of momentum, why is it better to make use an air track rather than a trolley system?

________________________________________________________________________
________________________________________________________________________  

(2)

8.2 Prove with a calculation that the momentum was conserved during this collision.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________  

(5)

TOTAL: 40
4.3 DETERMINE THE INTERNAL RESISTANCE AND THE EQUIVALENT RESISTANCE OF A SERIES-PARALLEL NETWORK

INTRODUCTION

The term ‘lost volts’ refers to the difference between the emf and the terminal voltage. The voltage is not ‘lost’. It is the voltage across the internal resistance of the battery, but ‘lost’ for use in the external circuit.

The internal resistance of the battery can be treated just like another resistor in series in the circuit. The sum of the voltages across the external circuit plus the voltage across the internal resistance is equal to the emf:

\[ \varepsilon = V_{\text{load}} + V_{\text{internal resistance}} \quad \text{or} \quad \varepsilon = IR_{\text{external}} + Ir \]

REARRANGE TO GET: \[ V = -rI + \varepsilon \]

in the form \[ y = mx + c \] where \[ m = -r \]

PART 1

Determine the internal resistance of a battery.

AIM

To determine the internal resistance of a battery

APPARATUS

- Voltmeter (or multimeter)
- Ammeter (or multimeter)
- Any size carbon-zinc battery (Choose voltage in relation to the values of the resistors)
- Battery holder
- Rheostat
- Connecting wires
- Switch
METHOD

Set up the apparatus as shown in the diagram below and determine the ammeter and voltmeter readings for FIVE different rheostat settings.

![Diagram of circuit with ammeter (A) and voltmeter (V) connected to a battery and rheostat.]

PRECAUTION: Do not keep the switch on too long. It will heat the battery and cause it to run down.

RESULTS

1. Tabulate the terminal potential difference (volts)- and electric current (amperes) readings obtained from the experiment. (10)

INTERPRETATION AND DISCUSSION OF RESULTS

2. Identify the:
   
   2.1 Independent variable
   2.2 Dependent variable
   2.3 Controlled variable (3 x 2) (6)

3. Why do we include a rheostat in the circuit? (2)

4. Draw a graph of the voltmeter readings versus ammeter readings. (8)

5. Is the gradient of the graph positive or negative? Explain. (3)

6. Use the graph to determine the internal resistance of the battery. (4)

7. Which point on your graph represents the emf of the battery? Explain. (4)

CONCLUSION

8. Draw a conclusion from the results obtained. (2)
PART 2

Set up a series-parallel network with known resistors. Determine the equivalent resistance using an ammeter and a voltmeter and compare with the theoretical value.

AIM

To determine the equivalent resistance of a series-parallel network and compare it with the calculated theoretical value.

APPARATUS

- Three fixed resistors with known values (not too high values)
- Voltmeter (or multimeter)
- Ammeter (or multimeter)
- Battery (choose voltage in relation to the values of the resistors)
- Battery holder
- Connecting wires
- Switch

METHOD

Set up the circuit as shown in the diagram below.

Record the voltmeter and ammeter readings obtained.

INTERPRETATION AND DISCUSSION OF RESULTS

1. From the readings obtained in your experiment, determine the equivalent resistance of the circuit. (4)
2. By using the values of $R_1$, $R_2$, $R_3$, calculate the theoretical value of the equivalent resistance. (5)

CONCLUSION

3. Compare the values obtained in 1 and 2 above and draw a suitable conclusion. (2)

TOTAL: 50