



**PHYSICAL SCIENCES (PHYSICS)**  
**GRADE 11 TERM 1 FORMAL EXPERIMENT – PART 1**  
**VERIFICATION OF NEWTON'S SECOND LAW**

**LEARNER'S NAME** : \_\_\_\_\_  
**SCHOOL** : \_\_\_\_\_  
**GRADE** : \_\_\_\_\_  
**DATE** : \_\_\_\_\_

**Aim:** To determine the relationship between force and acceleration, when mass of the system remains the same.

**Apparatus:**

- A power supply (12 V)
- Ticker timer and tape
- Trolley track
- Trolley
- A light inextensible string
- 10 g slotted mass holder with  $4 \times 10$  g mass pieces
- Frictionless pulley
- Mass meter
- Prestik
- Clamp (to hold the pulley on the track)

**Method:**

**Section A:**

**Setting up a friction compensated track**

1. Clamp a pulley to the one end of the track.
2. Place a stopper on the track in front of the pulley to stop the trolley before it bumps into the pulley.
3. Position the track at the edge of a table so that when a weight is hung from the pulley it can fall freely to the ground.
4. Connect the ticker timer unit to the AC power pack with the two connecting leads.
5. Position the ticker timer unit on the other end of the track. Ensure it is firmly in place.
6. Raise the end of the track which has the ticker timer unit on it by placing a few books under it.
7. Measure a length of ticker tape equal to the length of the track + 10 cm. Run the ticker tape through the ticker tape unit and attach the tape to one end of the trolley.
8. Place the trolley on the raised end on the track and hold it in a position which will allow it to run down the track to the other end.
9. Start the ticker timer and release the trolley, allowing it to run freely down the track while it pulls the tape through the timer.
10. Stop the timer when the trolley reaches the stopper at the other end.
11. Examine the ticker tape:
  - 11.1 If the gaps between the dots increase gradually along the length of the tape the trolley is accelerating. Lower the height of the track a little (by removing a book or two) and repeat the procedure from step 7.
  - 11.2 If the gaps between the dots on the tape are of equal length, the trolley is running at constant velocity. Move on to Part B of the procedure.

## Investigating the relationship between acceleration and net force on a system with constant mass.

1. Measure the mass of the trolley.
2. Ensure that the track is stable and secure.
3. Cut a length of string which extends from the trolley at its maximum height and for about 5 cm over the pulley.
4. Attach one end of the string to the trolley and the other end to the hook of the slotted mass holder.
5. Place four of the slotted (10 g) mass pieces on the trolley.
6. Feed a new length of ticker tape through the ticker timer and attach it to the trolley. Label the tape with the mass of the slotted mass holder.
7. Hold the trolley on the track while you position the string over the pulley. Allow the hooked slotted (10 g) mass holder on the other end of the string to hang freely over the edge of the table.
8. Start the timer and release the trolley and the mass holder so that the trolley accelerates down the track as the mass holder falls to the ground.
9. Move one of the four slotted mass pieces from the trolley to the mass holder and repeat steps 6 to 8.
10. Repeat step 9 until all four mass pieces have been moved from the trolley onto the mass holder.

## RESULTS:

Analyse each ticker tape as follows and complete the table below as you work through this section:

1. Choose a section of tape where the gaps between the dots are easy to see.
2. Mark off consecutive segments of five gaps between dots until you have three consecutive segments of five gaps on each tape.
3. Copy the table below, calculate and record the force exerted on the trolley by the mass pieces. Record the length of each of the segments for each tape in the table.

| Mass (m) on holder (kg) | Force (N) | Segment 1 (m) | Segment 2 (m) | Segment 3 (m) |
|-------------------------|-----------|---------------|---------------|---------------|
| 0,01                    |           |               |               |               |
| 0,02                    |           |               |               |               |
| 0,03                    |           |               |               |               |
| 0,04                    |           |               |               |               |
| 0,05                    |           |               |               |               |





**PHYSICAL SCIENCES**  
**GRADE 11 TERM 1 FORMAL EXPERIMENT – PHYSICS**  
**MARKING GUIDELINE / RUBRIC – PART 1**

LEARNER'S NAME : \_\_\_\_\_  
SCHOOL : \_\_\_\_\_  
GRADE : \_\_\_\_\_  
DATE : \_\_\_\_\_

**VERIFICATION OF NEWTON'S SECOND LAW**

| Skills   | 0 Marks  | 1 Mark   | 2 Marks  | Mark obtained |
|--|--|--|--|---------------|
| <b>Setting up the apparatus</b>                                  | The apparatus are incorrectly set up and the set up cannot give readings.  | An attempt has been made to set up the apparatus correctly but there are one or two mistakes which can compromise the readings. (e.g. the trolley is accelerating, the string is impeded thus experiencing friction) | The apparatus has been set up correctly in all respects, and readings to be taken would be reliable.   |               |
| <b>Reading and following instructions</b>                        | Learners are totally unable to follow instructions and conduct the experiment. They need to be assisted with every step of the experiment. | Learners need to be assisted with some steps (one or more) of the experiment.  | Learners follow instructions appropriately and conduct the experiment appropriately without help from the teacher.   |               |
| <b>Observations, data collection, recording and presentation</b> | Data collected is inaccurate and there is no attempt to record data in the provided table.   | Data is recorded in the provided table, but is insufficient, or it is incorrect, or inaccurate in some instances.  | Data recorded is <b>logical, sufficient and</b> appropriately in the provided table.<br>• Accurate recordings of the mass, force and lengths of the segments on each tape. |               |
| <b>Observation of precautions</b>                                | The learners failed to set up a friction compensated track.  | The learners managed to set up a friction compensated track..  |  |               |
| <b>TOTAL:</b>  |  |  |  |               |

[7]

**TOTAL MARKS OBTAINED:**  $\frac{\quad}{7} + \frac{\quad}{43} = \frac{\quad}{50}$



## PHYSICAL SCIENCES (PHYSICS)

## GRADE 11 TERM 1 FORMAL EXPERIMENT - PART 2

TIME: 1 HOUR

VERIFICATION OF NEWTON'S SECOND LAW OF MOTION

INDIVIDUAL WORK (should be done under strict supervision).

Write a scientific report which must include the following:

- **Aim** (1)
- **Apparatus** (1)
- **Method** (This should be a description of what you did; it should not be a copy of the method on the worksheet provided to you), (4)
- **Observations and Recording of results** (Copy the table below onto your book or sheet of paper and transfer the results you recorded when conducting the experiment).
- **Analysis and Interpretation of results and observations**
  - Calculate the following for each tape and record your results in the table below:
  - the average speed in the first and last segments.
  - the acceleration of the trolley. (11)

| Mass (m)<br>on holder<br>(kg) | Force<br>of holder<br>(N) | Segment<br>1<br>(m) | Segment<br>2<br>(m) | Segment<br>3<br>(m) | Average<br>Speed<br>1 ( $v_1$ )<br><u>Segment 1</u><br>$\frac{\Delta t}{\Delta t}$<br>( $\text{m} \cdot \text{s}^{-1}$ ) | Average<br>Speed<br>3 ( $v_3$ )<br><u>Segment 3</u><br>$\frac{\Delta t}{\Delta t}$<br>( $\text{m} \cdot \text{s}^{-1}$ ) | Accelerati<br>on<br>$\frac{v_3 - v_1}{2\Delta t}$<br>( $\text{m} \cdot \text{s}^{-2}$ ) |
|-------------------------------|---------------------------|---------------------|---------------------|---------------------|--|--|---|
| 0,01                          |                           |                     |                     |                     |  |  |   |
| 0,02                          |                           |                     |                     |                     |  |  |   |
| 0,03                          |                           |                     |                     |                     |  |  |   |
| 0,04                          |                           |                     |                     |                     |  |  |   |
| 0,05                          |                           |                     |                     |                     |  |  |   |

Use the information in your table and the provided graph paper to draw a graph of acceleration versus force. Extend the graph so that it cuts the y-axis. (6)

- **Conclusion.**
  - Write down a conclusion for your experiment. (2)

Refer to your experiment results and answer the following questions:

1. Write down the formula for calculating force of the holder. (1)
2. Explain how the average speed of the trolley is calculated. (3)
3. Write down the dependent variable in this experiment? (1)
4. Which two variables were controlled during the experiment? (2)
5. Write down the investigative question for this experiment. (2)
6. Calculate the gradient of the graph. (4)
7. What quantity does the gradient of the graph represent? Explain briefly. (5)

LEARNER'S NAME: \_\_\_\_\_

GRADE: \_\_\_\_\_







**PHYSICAL SCIENCES (PHYSICS)**  
**GRADE 11 TERM 1 FORMAL EXPERIMENT - PART 2**

**VERIFICATION OF NEWTON'S SECOND LAW OF MOTION**

**MARKING GUIDELINE**

- Aim stated correctly. ✓ (1)
- All apparatus listed. ✓ (1)
- All steps of the method correct and logically stated, ✓✓ correct tense used. ✓✓ (4)

**Observations and Recording of results:**

Learners will use results obtained during experiment to complete the table below.

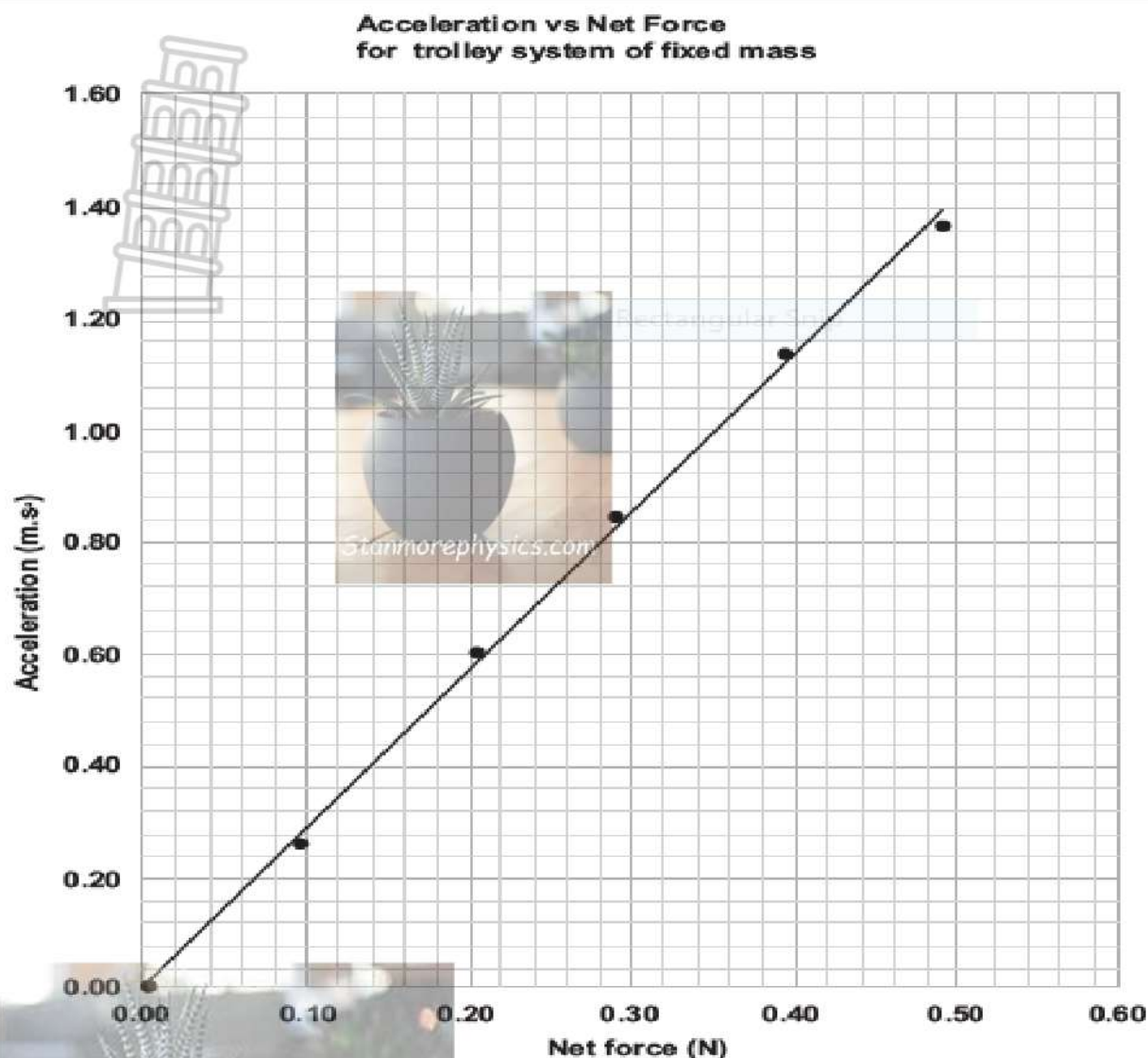
- ✓ for correct values for segment 1
- ✓ for correct values for segment 2
- ✓ for correct values for segment 3
- ✓✓ for correct force values
- ✓✓ for correct values of  $v_1$
- ✓✓ for correct values of  $v_3$
- ✓✓ for correct values for acceleration

| Mass (m)<br>on holder<br>(kg) | Force (mg)<br>of holder<br>(N) | Segment<br>1<br>(m) | Segment<br>2<br>(m) | Segment<br>3<br>(m) | Average<br>Speed<br>1 ( $v_1$ )<br><u>Segment 1</u><br>0,1<br>(m·s <sup>-1</sup> ) | Average<br>Speed<br>3 ( $v_3$ )<br><u>Segment 3</u><br>0,1<br>(m·s <sup>-1</sup> ) | Acceleration<br>$\frac{v_3 - v_1}{0,2}$<br>(m·s <sup>-2</sup> ) |
|-------------------------------|--------------------------------|---------------------|---------------------|---------------------|--|--|---|
| 0,01                          |                                |                     |                     |                     |  |  |   |
| 0,02                          |                                |                     |                     |                     |  |  |   |
| 0,03                          |                                |                     |                     |                     |  |  |   |
| 0,04                          |                                |                     |                     |                     |  |  |   |
| 0,05                          |                                |                     |                     |                     |  |  |   |

(11)

**Analysis and Interpretation of results and observations**

The graph below is an example of the type of graph expected from the results. The actual co-ordinates of the plotted points will be or might be different from the learners' results or graphs.



**Marking guidelines for the graph:**

- Appropriate title (heading) e.g. Acceleration (of the system) against net force (for constant mass). ✓
- Appropriate scale on x-axis and y-axis with label and SI units ✓✓
- All points plotted correctly. ✓✓
- Best fit straight-line graph extended back to cut the y-axis. ✓

(6)

**Conclusion:**

The acceleration is directly proportional to the net force ✓ provided the mass of the system remains constant. ✓

(2)

1.  $F = mg$  ✓ (1)

2. • Calculate the period (time taken to form one interval) of the ticker timer using the frequency ( $T = \frac{1}{f}$ ) ✓  
 • Calculate the time taken to make the 5 intervals on the ticker tape. ✓  
 • Divide the length of the five interval segment by time taken to form the five intervals. ✓ (3)

3. Dependent – Acceleration ✓ (1)

4. Mass of the system ✓  
 Angle of incline ✓ (2)

5. What is the relationship between the acceleration of an object and the force exerted on it?  
 OR  
 What effect does the force exerted on an object have on its acceleration? ✓✓ (2)

6.  $\text{gradient} = \frac{\Delta a}{\Delta F}$  or  $\frac{\Delta y}{\Delta x}$  ✓  

$$= \frac{a_2 - a_1}{F_{\text{net}2} - F_{\text{net}1}} \quad \checkmark \checkmark \text{ (any suitable values from the learners' graph)}$$
  

$$= \text{accurate calculation} \quad \checkmark \quad (4)$$

7. Gradient represents the inverse of the mass OR  $\frac{1}{\text{Mass of the system}}$  ✓

$F_{\text{net}} = ma$  ✓ from Newton's second law. ✓

From the graph we have  $\text{Gradient} = \frac{\Delta a}{\Delta F} \quad \checkmark = \frac{\Delta a}{m \Delta a} = \frac{1}{m} \quad \checkmark$

(5)

**TOTAL : [43]**