education

MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES (PHYSICS)
GRADE 12 TERM 1 FORMAL EXPERIMENT – PART 1
CONSERVATION OF LINEAR MOMENTUM

Introduction

The linear momentum of an object is determined by two variables, namely **mass** and **velocity**.

It is defined as the product of mass and velocity of an object.

The verification of the conservation of momentum can be determined experimentally during a **collision**.

AIM: To verify the conservation of linear momentum during collision.

APPARATUS

- A smooth horizontal trolley track
- 1 x Trolley
- Meter ruler
- triple beam balance /digital scale / spring balance
- A mass piece
- Sticky tape
- Ticker timer with ticker tape

PRECAUTIONS

In order to obtain reliable results, the trolley track must be

- smooth and frictionless.

METHOD

1. Measure the mass of the trolley and then measure the of the mass piece

2. Elevate your trolley runway to compensate for friction as shown in the diagram below.

3. Thread the ticker tape through the ticker timer and attach it to the trolley

4. Place the trolley on the elevated runway as shown in the diagram below.
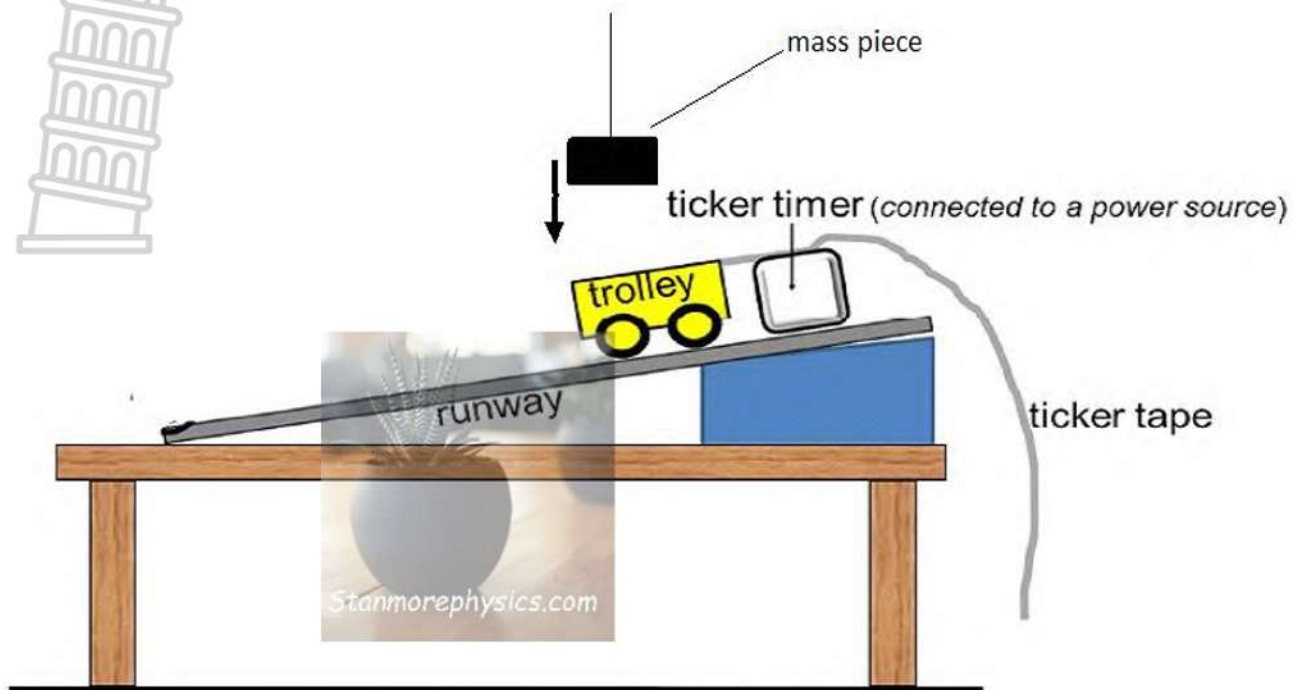
5. Switch on the ticker timer and give the trolley a slight push

6. Once the trolley has reached the end of the runway, remove the ticker tape and analyse it to ensure that the trolley had been moving at a constant velocity.

7. If the trolley was not moving at constant velocity adjust the elevation of the runway and repeat steps 3 to 6 until the trolley moves at constant velocity.

8. Repeat steps 3 to 5 and then drop the mass piece on to the trolley as it reaches the middle of the runway.

9. Repeat step 8 once.

10. Collect the trolley, mass piece and the ticker tapes from end of the run way

11. Cut the two ticker tapes as shown in the diagram below
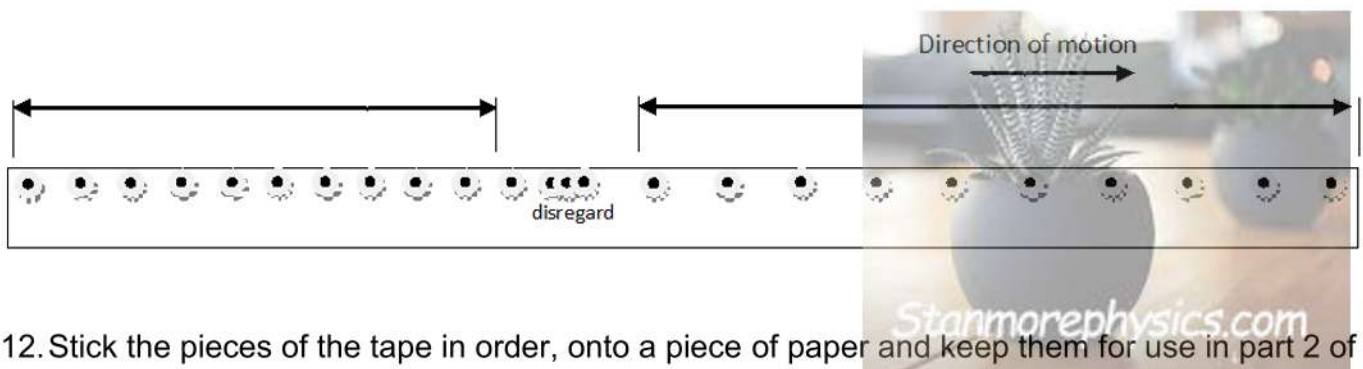
12. Stick the pieces of the tape in order, onto a piece of paper and keep them for use in part 2 of the experiment.

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MARKING GUIDELINE / RUBRIC

LEARNER'S NAME   : _____

SCHOOL   : _____

GRADE   : _____

DATE   : _____

CONSERVATION OF LINEAR MOMENTUM

Skills	0 Marks	1 Mark	2 Marks	Mark obtained
Setting up the apparatus	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.	The apparatus has been set up correctly in all respects, and readings to be taken would be reliable.	
Reading and following instructions	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 two) of the experiment.	Learners follow instructions appropriately and conduct the experiment appropriately without help from the teacher.	
Observations, data collection, recording and presentation		Inaccurate results on the ticker tapes i.e. spacing of the dots indicate that the trolley was not moving at constant velocity	Accurate results on the ticker tapes i.e. spacing of the dots indicate that the trolley was moving at constant velocity	
Observation of precautions	The learners work carelessly without any adherence to the precautions.	The learners followed only one precaution.	Learners followed all the precautions (e.g. the trolley track is perfectly level and learners use trolleys of equal mass.)	
			TOTAL:	

[8]

TOTAL MARKS OBTAINED: $\dfrac{\quad}{8} + \dfrac{\quad}{42} = \dfrac{\quad}{50}$

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GRADE 12 TERM 1 FORMAL EXPERIMENT - PART 2   **TIME: 1 HOUR**

CONSERVATION OF LINEAR MOMENTUM

INDIVIDUAL WORK (should be done under strict supervision)

Write a scientific report which must include the following

1. **Aim**   (1)

2. **Apparatus**   (1)

3. **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)

4. **Observations and Recording of results** (Copy tables A and B below onto your book or sheet of paper and transfer the results you recorded when conducting the experiment).

    4.1. Determine the period of the ticker timer   (3)

    4.2. Complete the attached table by analysing the tapes obtained from Part 1 of the experiment and doing the necessary calculations.   (20)

Analysis and Interpretation of results and observations

5. Explain why the velocity with which the block hit the trolley cannot be used to calculate the momentum of the block before collision.   (3)

6. Give a reason why the experiment must be performed more than once.   (1)

7. What precautions were taken to ensure that the results are reliable?   (3)

8. Discuss your finding by comparing the magnitudes of P_{before} and P_{after}.   (2)

•   **CONCLUSION**.

9. Write down a conclusion for your experiment and explain how you reached to your conclusion.   (4)
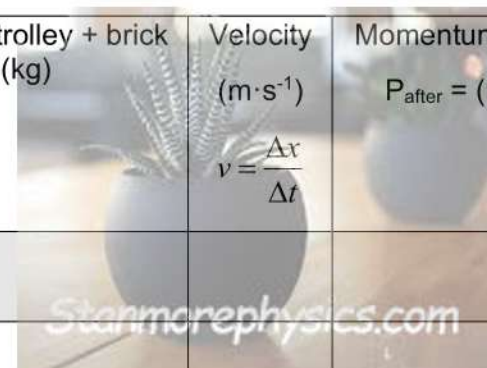
[42]

NAME: _____

Before drop/collision					After drop/collision				
Mass (kg)		Δx (m)	Δt (s)	Velocity (m·s⁻¹) $v = \dfrac{\Delta x}{\Delta t}$	Momentum (kg·m·s⁻¹) $P_{before} = m_t v + m_b v$	Δx (m)	Δt (s)	Mass of trolley + brick (kg)	Velocity (m·s⁻¹) $v = \dfrac{\Delta x}{\Delta t}$	Momentum (kg·m·s⁻¹) $P_{after} = (m_t + m_b) v$
$m_{trolley}$	m_{block}			$v_{trolley}$	v_{block}					

Before drop						After drop				
Mass (kg)		Δx (m)	Δt (s)	Velocity (m.s⁻¹) $v = \dfrac{\Delta x}{\Delta t}$	Momentum (kg.ms⁻¹) $P_{before} = mv$	Δx (m)	Δt (s)	Mass of trolley + brick (kg)	Velocity (m.s⁻¹) $v = \dfrac{\Delta x}{\Delta t}$	Momentum(kg.m.s⁻¹) $P_{after} = mv$
$m_{trolley}$	m_{block}			$v_{trolley}$ v_{block}						

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CONSERVATION OF LINEAR MOMENTUM

1. Aim stated correctly. ✓   (1)

2. All apparatus listed. ✓   (1)

3. All steps of the method correct and logically stated, ✓✓ correct tense used. ✓✓   (4)

4.1 $T = \frac{1}{f}$ ✓ $= \frac{1}{correct\ value}$ ✓ $=$ correct value ✓   (3)

4.2 Refer to the attached table.   (20)

5. The velocity with which it hit the trolley is <u>perpendicular to the direction of motion</u>✓, the velocity used to calculate the momentum is the <u>velocity parallel to the direction of motion</u>✓, which is <u>zero</u>✓.   (3)

6. For reliable / fair results ✓   (1)

7. Compensate for friction by✓

    - Inclining the trolley track. ✓

    - Ensuring that the wheels and the track are clean and smooth. ✓   (3)

8. P_{before} (momentum before collision) is equal to the P_{after} (momentum after collision)✓✓   (2)

9. The total linear momentum of a closed / isolated system is conserved / constant. ✓✓
    Explanation:
    Calculations in the table indicate that the total linear momentum before collision is equal the total linear momentum after collision. ✓✓   (4)

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Before drop/collision						After drop/collision				
Mass (kg)		Δx (m)	Δt (s)	Velocity $(m \cdot s^{-1})$ $v = \dfrac{\Delta x}{\Delta t}$	Momentum $(kg \cdot m \cdot s^{-1})$ $P_{before} = m_t v + m_b v$	Δx (m)	Δt (s)	Mass of trolley + brick (kg)	Velocity $(m \cdot s^{-1})$ $v = \dfrac{\Delta x}{\Delta t}$	Momentum $(kg \cdot m \cdot s^{-1})$ $P_{after} = (m_{t+} m_b) v$
$m_{trolley}$	m_{block}			$v_{trolley}$ $\quad$ v_{block}						

Marking guidelines for the table:

- Mass of trolley ✓
- Mass of block ✓
- Displacement of the trolley before the drop (Δx) ✓✓
- <mark>Time before the drop (Δt) ✓✓</mark>
- Velocity of the trolley before the drop (Δx) ✓✓
- Velocity of the block before the drop (Δx) ✓
- Total momentum before the drop ✓✓
- Mass of trolley + block ✓
- Displacement of the trolley and block after the drop (Δx) ✓✓
- <mark>Time after the drop (Δt) ✓✓</mark>
- Velocity of the trolley and block after the drop (Δx) ✓✓
- Total momentum after the drop ✓✓