VERIFICATION OF NEWTON'S SECOND LAW OF MOTION

PART A

Skills	0	1	2
	No Mark	1 Mark	2 Marks
Following the procedure	Unable to follow the method and assemble apparatus as required.	Able to follow the method with some assistance, but able to complete the set up on their own.	Able to follow the method and obtain results.
Analysis of results	Unable to use results obtained to determine the accelaration.	Able to use the results obtained, but had inaccuracies.	Able to use the results obtained with accurate results.
Observation of precautions	The learner works carelessly without any adherence to the precautions.	The learner works with care and puts the switch off after taking each reading.	

(5)

PART B

Aim: To investigate the relationship between the net force and the acceleration of an object if the mass remains constant.

1. Write down the hypothesis. (2)

2. Identify the:

    2.1. Independent variable (1)

    2.2. Controlled variable (1)

Apparatus:

- Trolley and Trolley track
- Rope
- Four mass pieces
- Hanger for mass pieces
- Brick/ stopper

Method:

- Place a trolley on a smooth runway and tilt the runway very slightly so that the slope compensates for the friction between the wheels and the runway. If pushed gently, the trolley should move at a constant velocity down the track.
- Measure the mass of the trolleys.
- Attach a smooth pulley vertically to the bottom of the runway.
- Tie a light thread to the trolley and allow the thread to hang freely over the almost frictionless pulley.
- Tie a small hook to the other side of the thread, from which a mass piece can hang. Test the trolley without a mass piece to see if it will move at constant velocity.
- Place a mass piece on the hook.
- Allow the trolley to be pulled down the slope by the mass piece.
- Repeat the experiment at least three times, each time hanging another 10 g mass piece on the hook.
- Calculate the acceleration and tabulate the results. Draw a graph of force versus acceleration.

Results:

1. Mass of the trolley and four mass pieces (= mass of the system). (1)

2. Redraw and complete the table below. (6)

Mass of the hanging mass pieces	F_{net} = hanging weight	Acceleration

3. Draw the graph of acceleration versus net force. (4)

4. Determine the gradient of the graph. (3)

5. Hence, calculate the mass of the system. (3)

6. Compare your answer in Question 5 to the actual mass of the system and calculate the percentage accuracy. (3)

7. Conclusion: (2)

Total: [26]

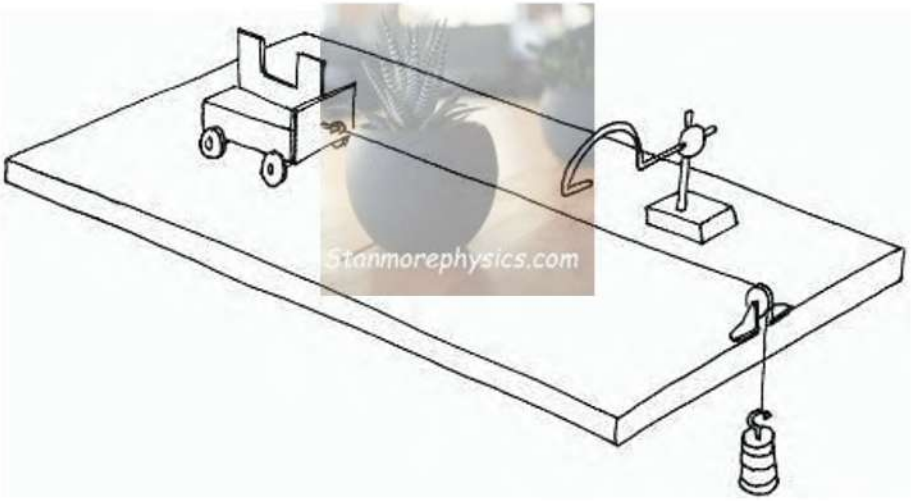
PART C

PRACTICAL EXAMINATION

VERIFICATION OF NEWTON'S SECOND LAW

1. Define the following terms
   1.1. Newton's Second Law of motion in words. (2)
   1.2. Resultant vector (2)
   1.3. Friction (2)

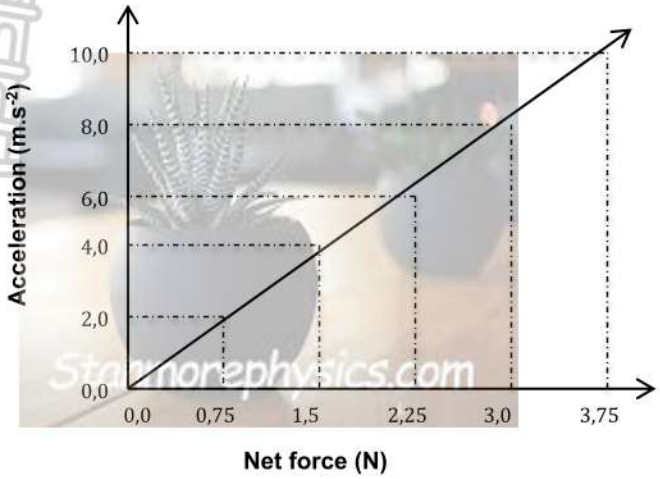
2. In an experiment to verify Newton's Second Law of motion, learners set up the apparatus as shown in the diagram below.



   2.1. How did we compensate for friction? (2)
   2.2. What safety precautions were considered during the experiment? (1)
   2.3. Draw a labelled free-body diagram showing all the forces acting on the hanging object. (2)

3. Learners then plotted the graph from the results obtained from conducting the above experiment.

GRAPH OF THE NET FORCE VERSUS ACCELERATION



3.1 Calculate the gradient. (3)

3.2 Determine the mass of the system from the gradient (3)

3.3 Draw conclusions from the graph. (2)

[Total: 19 marks]

MARKING GUIDELINE

Aim: To investigate the relationship between the net force and the acceleration of an object if the mass remains constant.

PART A

Skills	0	1	2
	No Mark	1 Mark	2 Marks
Following the procedure	Unable to follow the method and assemble apparatus as required.	Able to follow the method with some assistance, but able to complete the set up on their own.	Able to follow the method and obtain results.
Analysis of results	Unable to use results obtained to determine the acceleration.	Able to use the results obtained, but had inaccuracies.	Able to use the results obtained with accurate results.
Observation of precautions	The learner works carelessly without any adherence to the precautions.	The learner works with care and puts the switch off after taking each reading.	
Total			5

PART B

1. Write down the hypothesis. (2)

   - *Net force is directly proportional to acceleration*✓✓

2. Identify the:

   2.1. Independent variable (1)

   - *Net force* ✓

   2.2. Controlled variable (1)

   - *Mass* ✓

Apparatus:

- Trolley and Trolley track
  Rope
- Four mass pieces
- Hanger for mass pieces
- Brick

Method:

- Place a trolley on a smooth runway and tilt the runway very slightly so that the slope compensates for the friction between the wheels and the runway. If pushed gently, the trolley should move at a constant velocity down the track.
- Measure the mass of the trolleys.
- Attach a smooth pulley vertically to the bottom of the runway.
- Tie a light thread to the trolley and allow the thread to hang freely over the almost frictionless pulley.
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- Place a mass piece on the hook.
- Allow the trolley to be pulled down the slope by the mass piece.
- Repeat the experiment at least three times, each time hanging another 10 g mass piece on the hook.
- Calculate the acceleration and tabulate the results. Draw a graph of force versus acceleration.

Results:

1. Mass of the trolley and four mass pieces (= mass of the system). (1)

   - *(Trolley + 4 used mass pieces= 530 + 4x10 = 570 g = 0.57kg)* ✓

2. Complete the table below. (6)

Mass of the hanging mass pieces (kg)	F_{net} = hanging weight (N)	Acceleration ($m.s^{-2}$)
0.01	0.098	0.185
0.02	0.196	0.370
0.03	0.294	0.555
0.04	0.392	0.740

✓✓	✓✓	✓✓
2 mark for each column		

m = 0.53 kg

$F_{net} = ma$

$0.098 = 0.53\ a$

$a = 0.185\ m.s^{-2}$

3. Draw the graph of net force versus acceleration. (4)

- *Labels (axis)* ✓
- *All points correctly plotted* ✓
- *Best fit line* ✓
- *Title* ✓

4. Determine the gradient of the graph. (3)
   - *Change in y and change in x values* ✓
   - *Substitution* ✓
   - *Answer* ✓

$$gradient = \frac{\Delta a}{\Delta Fnet}$$

$$= \frac{0.740 - 0.185}{0.392 - 0.098}$$

$$= 1.888$$

5. Hence, calculate the mass of the system. (3)

POSITIVE MARKING FROM QUESTION 4

- $\frac{1}{m}$ = *gradient* ✓
- *answer* ✓

$\frac{1}{m}$ = *gradient*

$\frac{1}{m} = 1.888$

m = 0.53 kg

6. Compare your answer in Question 5 with the actual mass of the system and calculate the percentage accuracy. (3)

- *Comparison* ✓
- *Percentage accuracy*✓✓
- $\%accuracy = \frac{\text{calculated mass}}{\text{weighed mass}} \times 100$

$$= \frac{0.53}{053} \times 100$$

$$= 100\ \%$$

7. Conclusion: (2)

Net force is directly proportional to the acceleration✓✓

[Total: 26]

PART C

PRACTICAL EXAMINATION

VERIFICATION OF NEWTON'S SECOND LAW

1. Define the following terms

1.1. Newton's Second Law of motion in words. (2)

When the net force acts on an object the object accelerate in the direction of the net force. The acceleration is directly proportional to the net force and inversely proportional to the mass. ✓✓

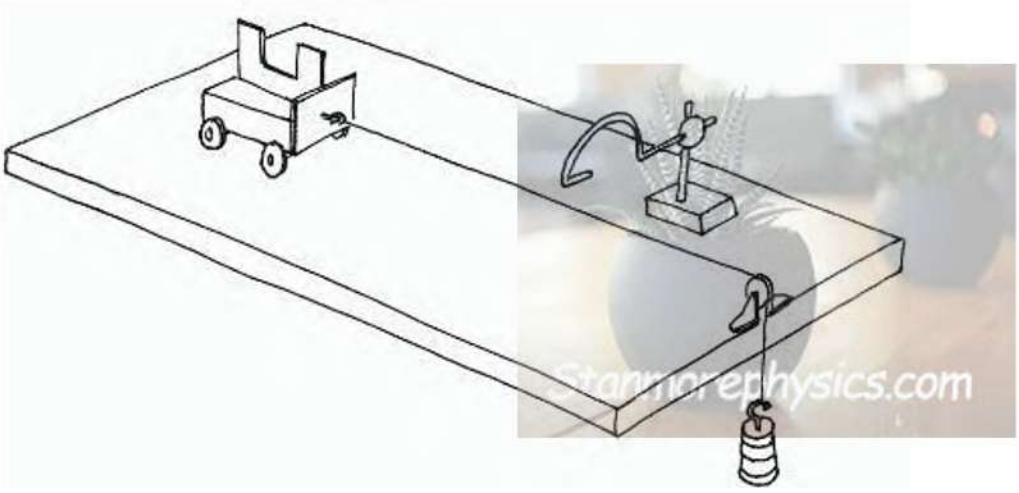
1.2. Resultant vector. (2)

The single vector which has the same effect as the original vectors acting together. ✓✓

1.3. Friction (2)

The force that opposes the motion of an object and acts parallel to the surface with which the object is in contact. ✓✓

2. In an experiment to verify Newton's Second Law of motion, learners set up the apparatus as shown in the diagram below.



2.1. How did we compensate for friction? (2)

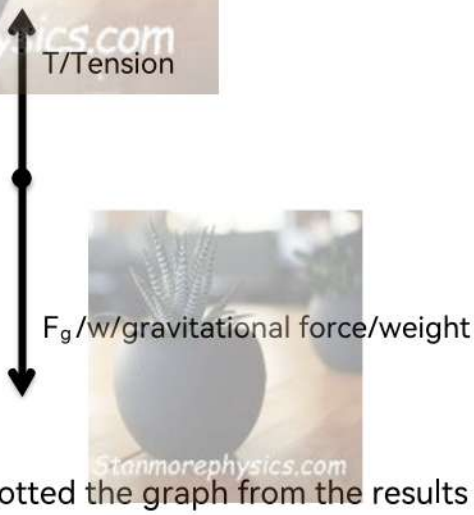
- *Use frictionless pulley* ✓
- *Ensure that the surface of the table is smooth*✓

2.2. What safety precautions were considered during the experiment? (1)

- *Take care when masses fall to the floor.*
- *Use a box or tray lined with bubble wrap (or similar) under heavy objects being lifted. This will prevent toes or fingers from being in the danger zone.* ✓

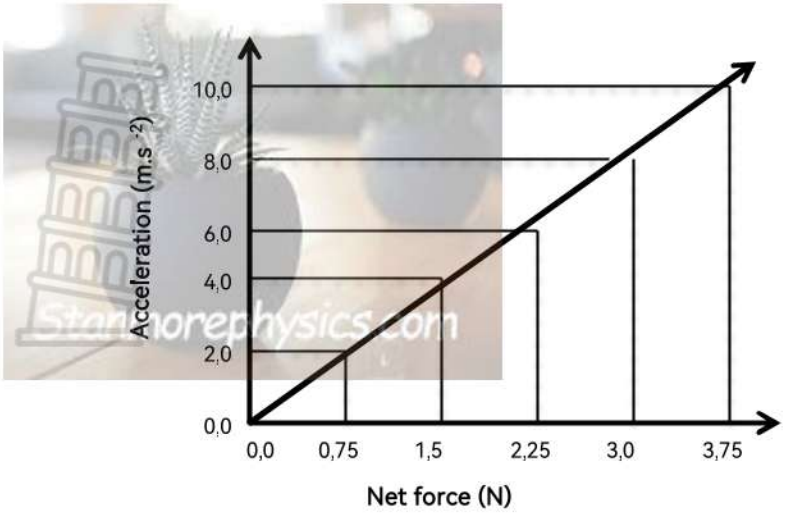
(Any of the above)

2.3. Draw a labelled free-body diagram showing all the forces acting on the hanging object. (2)



3. Learners then plotted the graph from the results obtained from conducting the above experiment.

GRAPH OF THE NET FORCE VERSUS ACCELERATION



3.1 Calculate the gradient. (3)

$$gradient = \frac{\Delta \text{ acceleration}}{\text{change in net force}}$$

$$= \frac{10-8}{3,75-3}$$

$$= 2,67$$

3.2 Determine the mass of the system from the gradient (3)

$$\frac{1}{m} = \frac{10-8}{3,75-3}$$

$$= \frac{2}{0,75}$$

$$m = 0,375\ kg$$

3.3 Draw conclusions from the graph. (2)

- *Net force is directly proportional to the acceleration*

[Total: 19 marks]