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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Science 2023

90940 Demonstrate understanding of aspects of mechanics

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of mechanics.	Demonstrate in-depth understanding of aspects of mechanics.	Demonstrate comprehensive understanding of aspects of mechanics.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Make sure that you have Resource Booklet L1–SCIER.

If you need more room for any answer, use the extra space provided at the back of this booklet.

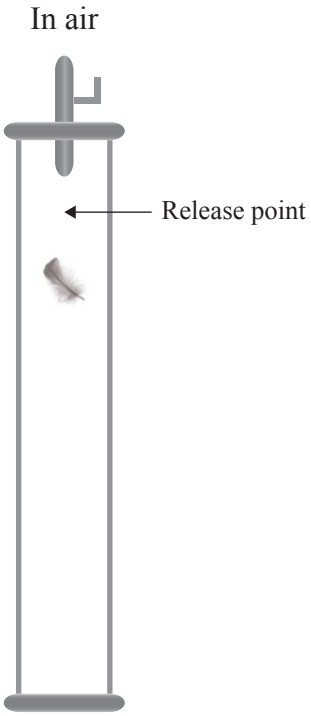
Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA DO NOT WRITE). This area will be cut off when the booklet is marked.

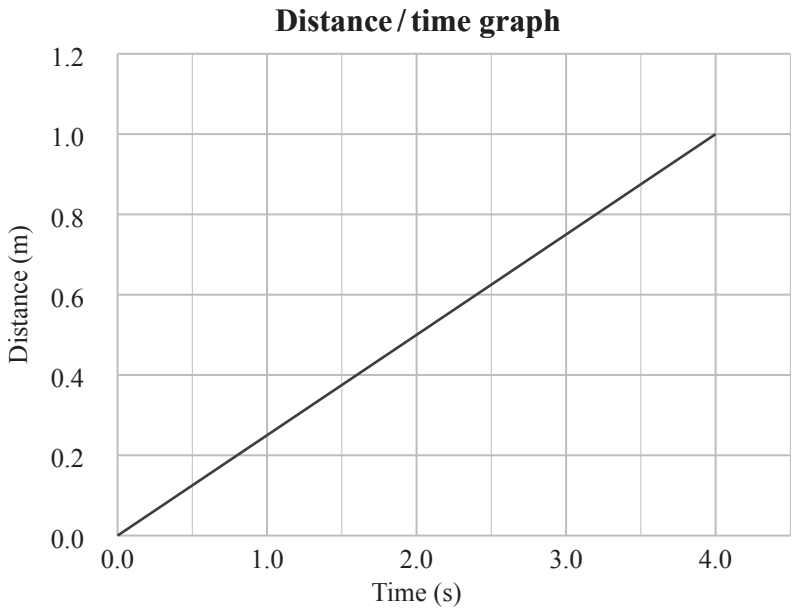
YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

QUESTION ONE: FEATHERS

In an experiment, a feather is dropped through air inside a sealed tube.



Below is a distance / time graph for the feather's fall in air.



(a) Describe the motion of the feather over the first 4.0 s.

(b) Calculate the average speed for the feather's fall.

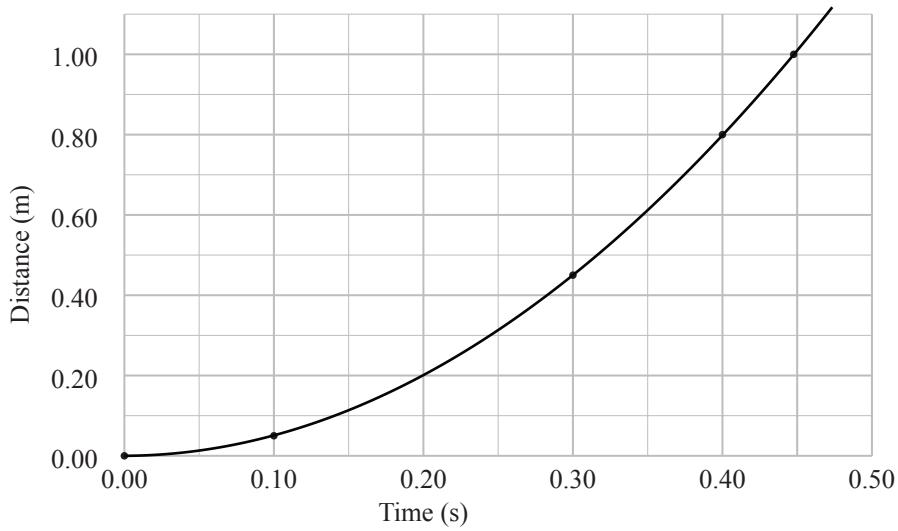
(c) Draw and label arrows to show the size and direction of the **vertical** forces acting on the feather at a distance of 0.5 metres down the tube.

In air

(d) Explain how the net force affects the motion of the feather throughout the fall.

The air inside the tube is then completely removed, and the feather dropped again. Below is a distance-time graph of the feather's fall.

Distance / time for feather's fall with air removed

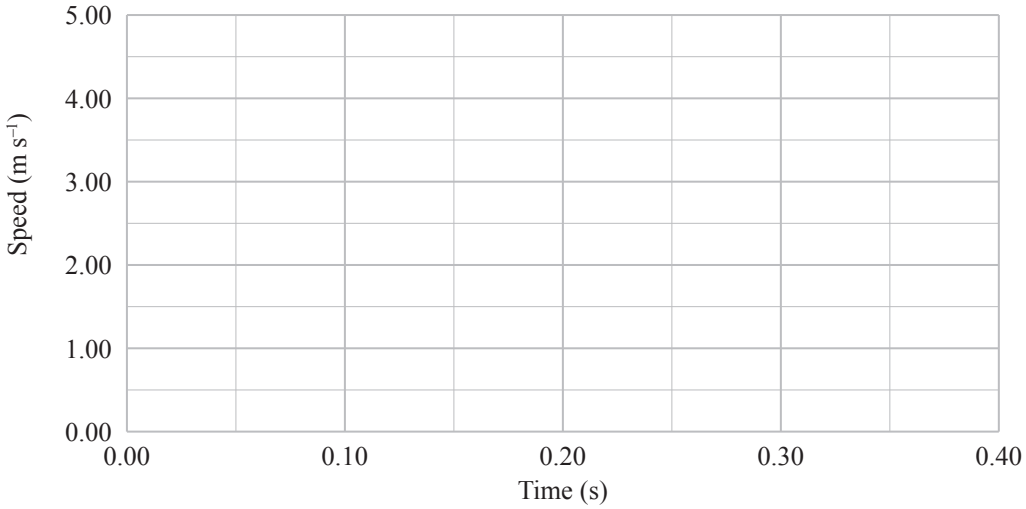


(e) Describe the motion of the feather shown in the graph above.

(f) Use the distance / time graph to calculate the speed of the feather at 0.40 seconds after release.

(g) Draw a speed / time graph for the feather's fall with the air removed, assuming $g = 10$ m s^{-2}.

Speed / time for feather's fall with air removed



(h) Draw and label arrow(s) to show the size and direction of the **vertical** forces on the feather at a distance of 0.5 metres down the tube with the **air removed**.

Air removed

(i) Explain how the net force affects the motion of the feather throughout the fall.

QUESTION TWO: WATER PARKS

A water park on a lake has a climbing wall that is 8.5 m high.

Source: www.kiwiwaterpark.com/about-1?lightbox=dataItem-l62u39ts

Scarlett (mass of 55 kg) and Angus (mass of 70 kg) climb 8.5 m to the top.

(a) Calculate the weight force of Scarlett and of Angus.

(b) Calculate the work done by Scarlett AND Angus as they climb to the top.

(c) Scarlett and Angus climb 8.5 m to reach the top. Scarlett takes 9 seconds and Angus takes 12 seconds.

Calculate the power for both Scarlett and Angus, and explain which person is more powerful.

(d) Scarlett and Angus jump from the 8.5 m diving board. Angus insists that he will hit the water faster because he is heavier.

Source: www.kiwiwaterpark.com/about-1?lightbox=dataItem-l62u39ts

Using conservation of energy, and assuming no other external factors, calculate the speed and kinetic energy of Scarlett and Angus as each hits the water.

In your answer you should:

- calculate the kinetic energy of Scarlett and Angus just before each hits the water
- describe from which form this kinetic energy has transformed
- state whether Angus is correct, and why.

(e) Explain why neither Scarlett nor Angus will reach these high speeds calculated in real life.

QUESTION THREE: FOOTPRINTS

Moa footprints which are millions of years old have been found in the Kye Burn river in Otago, South Island.

Sources: www.newshub.co.nz/home/new-zealand/2019/05/moa-footprints-discovered-in-south-island-for-the-first-time.html
www.wikidata.org/wiki/Q899705#/media/File:Extinctbirds1907_P42_Dinornis_ingens0375.png

The area of each footprint is 0.04 m^2. The moa which left these footprints had a mass of 150 kg.

(a) Explain the difference between mass and weight.

(b) Calculate the weight of the 150 kg moa.

(c) Calculate the total pressure generated when this moa was standing on TWO feet.

Question Three continues on the next page.

A moa could jump with two feet, accelerating upwards at 7 m s^{-2}.

(d) (i) Calculate the force required to accelerate the moa (150 kg) upwards at 7 m s^{-2}.

(ii) Calculate the new total pressure on the ground when the moa first jumps upwards with two feet.

(e) Explain why the pressure on the ground is higher when the moa jumps upwards, compared to when it is standing still.

(f) One type of moa had a sharp-edged beak and could cut the leaves of harakeke (flax) and twigs. The moa beak is similar to secateurs (garden scissors).

Upland Moa, Megalapteryx didinus, collected Cromwell, New Zealand. Purchased 1943. CC BY 4.0. Te Papa (S.000400)

Source: www.aliexpress.com/i/1005002548386874.html

Using your knowledge of pressure, explain how a sharp-edged beak would help the moa cut leaves of harakeke and twigs.

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER