SUPERVISOR'S USE ONLY

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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 2 Physics 2024

91171 Demonstrate understanding of mechanics

Credits: Six

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of mechanics.	Demonstrate in-depth understanding of mechanics.	Demonstrate comprehensive understanding 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 Sheet L2–PHYSR.

In your answers use clear numerical working, words, and / or diagrams as required.

Numerical answers should be given with an appropriate SI unit.

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 2–16 in the correct order and that none of these pages is blank.

Do not write in the margins (⁄⁄⁄). 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.

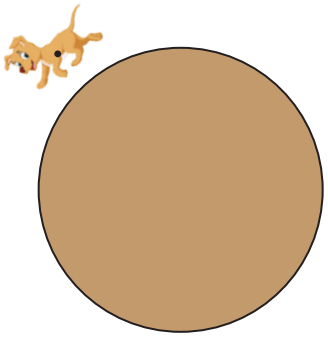
QUESTION ONE: MOMENTUM AND CIRCULAR MOTION

Jono and Tony are in the kitchen. Their dog is sitting on the floor next to them when the neighbour's dog comes in and playfully chases it around the table.

Source: https://www.hgtv.com/design/rooms/kitchens/round-kitchen-island

(a) The dog runs in a circle on the floor around the table.

Add a labelled arrow to the diagram below to show the force acting on the dog as it runs in a circle at a constant speed.



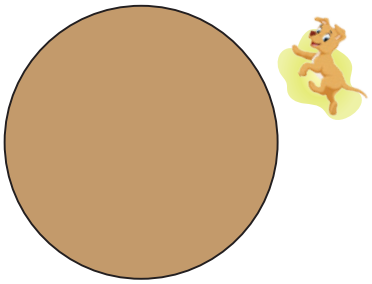
Source (adapted): www.shutterstock.com/search/dog-happy-dog-angry

If you need to redraw your response, use the diagram on page 11.

(b) The mass of the dog is 10 kg.
The dog is moving at 0.87 m s^{-1}.
The centripetal force is 15 N.

(i) Calculate the radius of the dog's path.

(ii) On the other side of the table, the dog hits a slippery patch of the floor and slides off at a tangent.



Use physics principles to explain the dog's velocity immediately after it starts moving off at a tangent.

(c) The dog slides along the floor towards Jono. Jono reaches down and cushions the dog as it slides into him by putting out his arms and then gradually bringing them in towards him. The dog takes 2.0 seconds to come to rest, unharmed.

Use physics principles to explain why Jono put out his arms to cushion the dog rather then let the dog stop quickly in 0.10 seconds.

Start by calculating the force experienced by the dog in the cushioned collision (2.0 s).

(d) Jono releases his 10 kg dog and it runs directly towards the neighbour's dog at 1.1 m s^{-1}. The neighbour's dog, mass 12 kg, runs directly towards Jono's dog. They collide, stick together, and slide across the floor at 0.30 m s^{-1}.

Source (adapted): www.tiktok.com/@nervousmonkey88

Calculate the speed that the neighbour's dog was moving at before the collision.

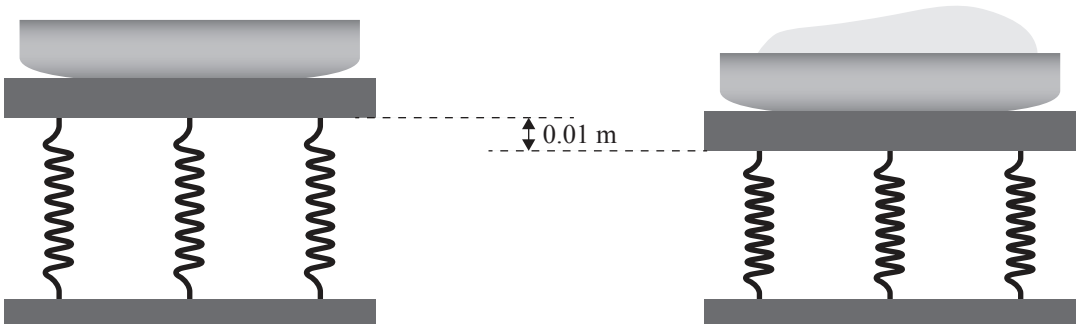
QUESTION TWO: SPRINGS AND EQUILIBRIUM

Tony decides to make a cake. Tony and Jono measure 0.11 kg of flour using a kitchen balance as shown below.

Source: www.farmers.co.nz/home/kitchen/food-preparation/cinemon-vincent-vintage-kitchen-scale-6338445

There are three springs in the balance. Each gets compressed 0.01 m when the flour is added.

The simplified diagram shows the springs in the balance.



without the flour

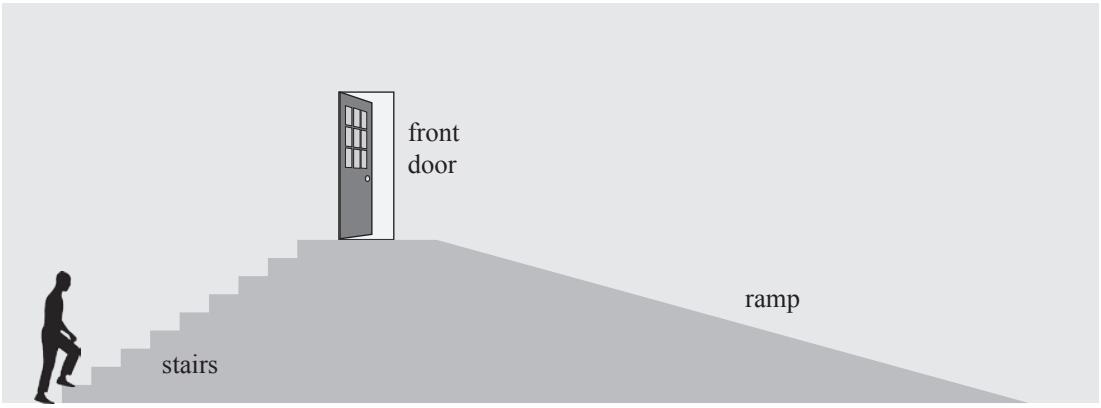
with the flour

(a) Add labelled arrows to the diagram above right (with the flour) to show the two forces acting on the flour.

If you need to redraw your response, use the diagram on page 11.

(b) Calculate the spring constant for one spring.

(c) When Jono brings the groceries to the front door, he has a choice of climbing the stairs or using the ramp. He has found that it takes less time to go up the ramp than the stairs.



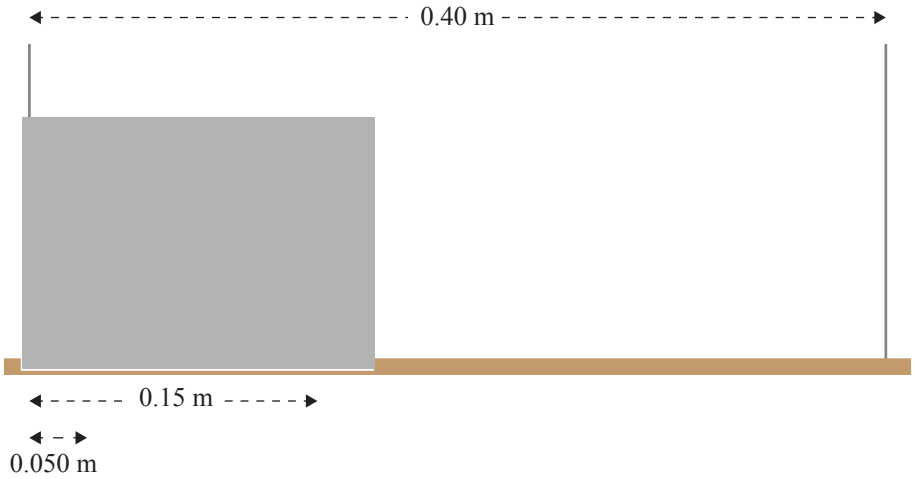
Compare both routes by considering:

- work done
- force required
- power.

(d) Tony is using a spice rack hanging by wires above the work bench, as shown below. The ginger spice has a mass of 0.030 kg, the salt 0.50 kg, and the uniform rack has a mass of 0.37 kg and is 0.40 m long.

The ginger spice is placed 0.15 m and the salt is placed 0.050 m from the left-hand wire, as shown below.

The maximum tension force that each wire can provide is 5.0 N.



https://mrsrogers.co.nz/product/coarse-iodised-sea-salt-bag/

(i) State the conditions required for the spice rack to be in equilibrium.

(ii) By performing suitable calculations, decide if the wires can hold the spice rack with the ginger and bag of salt.

QUESTION THREE: MOTION

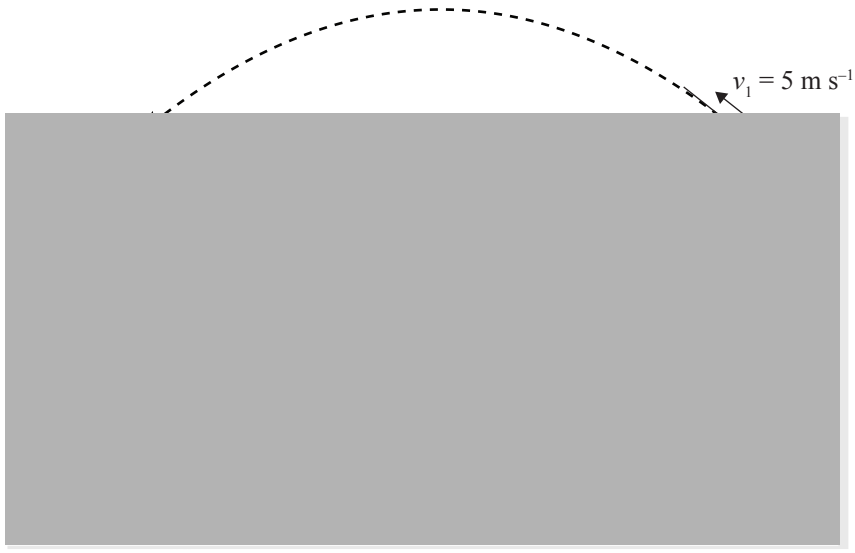
Tony is going to add apples to the cake. His friend Jono rolls an apple along the table. The apple leaves his hand at 0.56 m s^{-1}, and stops in front of Tony. It takes 4.0 seconds to roll along the table top.

Source (adapted): https://www.homesweetwhare.co.nz/products/salisbury-ext-dining-table-1200x850

(a) Calculate the acceleration of the apple.

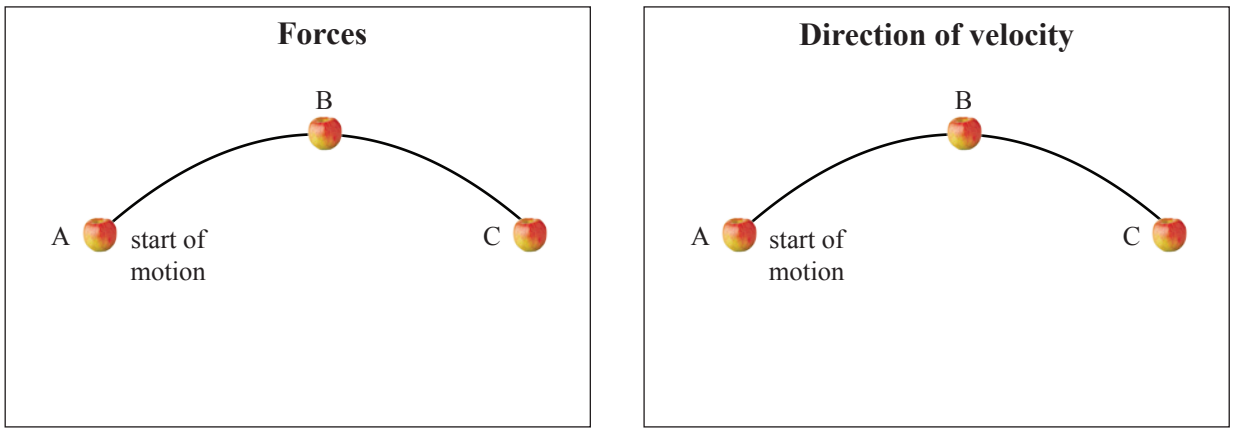
Tony now throws the apple to Jono.

The angle of the throw is 40° and the initial velocity is 5 m s^{-1}, as shown in the diagram below.



(b) Calculate the vertical and horizontal components of the initial velocity.

(c) Explain the motion of the apple shown below:



(i) Identify the type of motion.

(ii) For the points A , B, and C on the appropriate diagram above, add labelled arrows of appropriate length to show:

- the force(s), if any, acting on the apple
- the direction of the velocity of the apple.

If you need to redraw your responses, use the diagram on page 11.

(iii) Describe how the vertical velocity and horizontal velocity of the apple change throughout its flight.

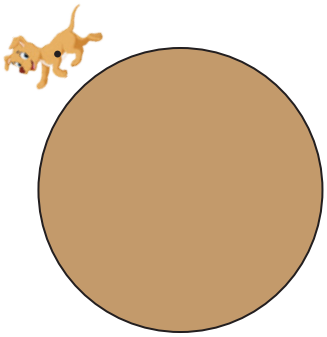
Question Three continues on the following page.

(d) The ceiling is 1.5 m above the table surface.

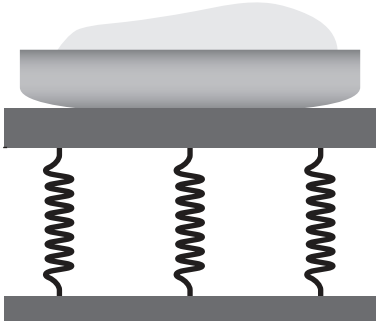
By calculating the maximum height reached by the apple, as well as the horizontal distance covered, determine whether the apple will reach Tony, 2.0 m away.

SPARE DIAGRAMS

If you need to redraw your response to Question One (a), use the diagram below. Make sure it is clear which answer you want marked.

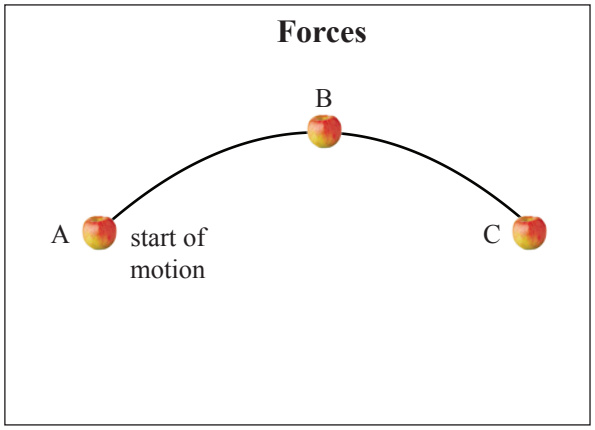


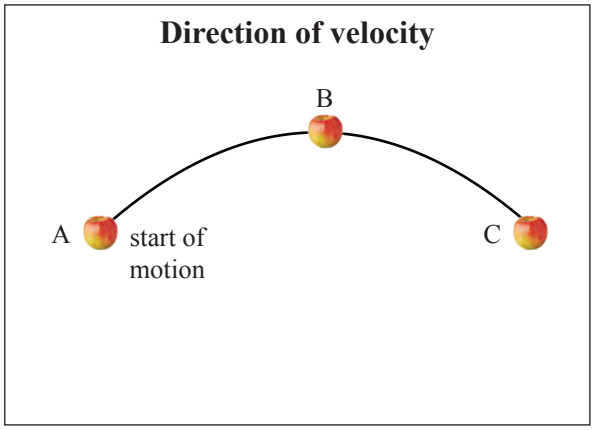
If you need to redraw your response to Question Two (a), use the space below. Make sure it is clear which answer you want marked.



with the flour

If you need to redraw your response to Question Three (c)(ii), use the space below. Make sure it is clear which answer you want marked.





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

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