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QUALIFY FOR THE FUTURE WORLD
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Level 2 Physics 2022

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.

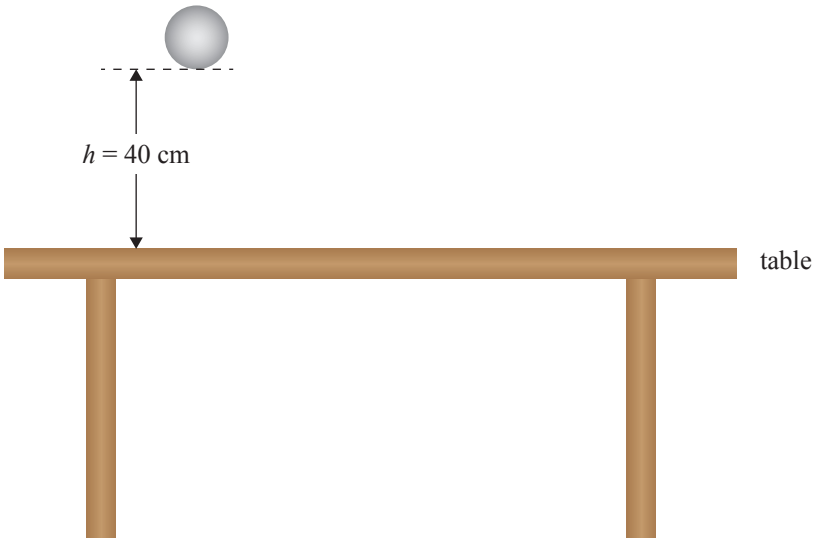
Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

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

QUESTION ONE: KINEMATICS AND PROJECTILE MOTION

A steel ball is held 40 cm above a table. The ball is released, and the time for it to fall to the table is measured.



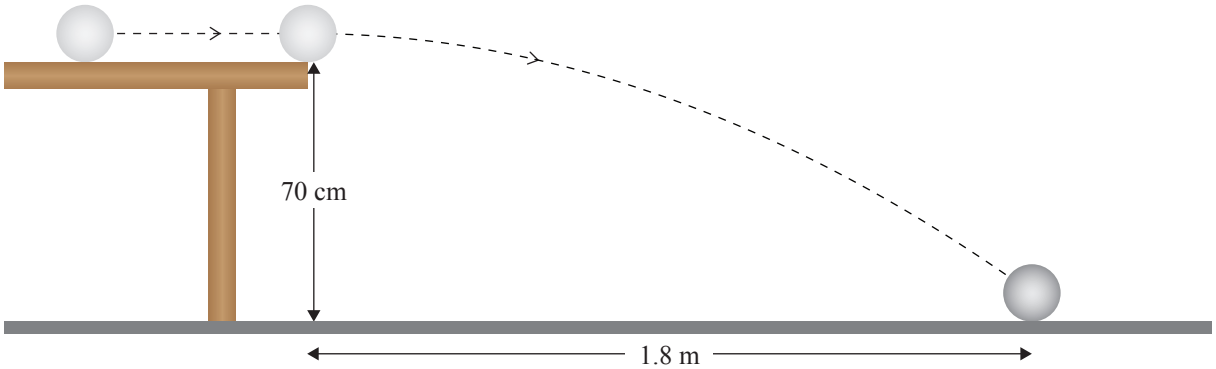
(a) Calculate the time it takes for the ball to fall to the table.

(b) The experiment was repeated with another ball of the same size, but half the mass.

Ignoring any effects of air resistance, use physics principles to explain how the time for this second ball to fall compares to the time for the first ball to fall.

(c) The steel ball is now rolled along the table and off the edge, as shown.

The height of the table is 70 cm, and the ball hits the ground 1.8 m past the edge of the table.



(i) Calculate the ball's final vertical velocity.

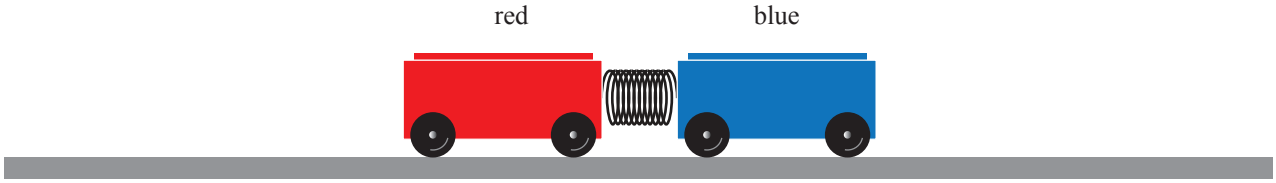
(ii) What assumption have you made?

(d) Calculate the size and direction of the velocity of the ball just before it hits the ground.

You should start by showing the horizontal velocity of the ball is 4.8 m s^{-1}.

QUESTION TWO: MOMENTUM AND IMPULSE

Two carts are set up with a spring between them. The spring is compressed by 10 cm. When the spring is released, the carts rapidly move apart in opposite directions.



(a) The spring has a spring constant of 250 N m^{-1}.

Calculate the total energy released from the spring.

(b) The mass of the red cart is 0.5 kg, and the mass of blue cart is 2 kg. The final velocity of the blue cart is 0.5 m s^{-1}.

(i) Calculate the final velocity of the red cart.

(ii) What assumption, if any, have you made?

In a different experiment, the red and blue carts are set moving in opposite directions with equal momentum. The blue cart is stopped at the end of the track by a solid board, and the red cart is stopped by a padded wall.

(c) Use physics principles to explain whether the blue cart or the red cart will suffer the most damage as they both stop.

(d) The 2 kg blue cart, moving at 2 m s^{-1}, took 0.02 s to stop when it collided with the solid board.

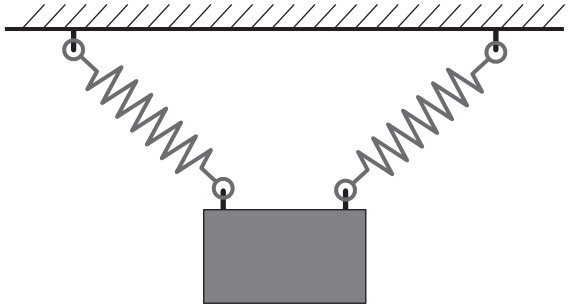
(i) State Newton's third law of forces in the context of the collision of the blue cart and the solid board.

(ii) Calculate the size and direction of the average force experienced by the solid board during this impact.

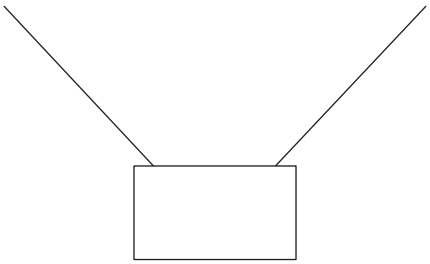
QUESTION THREE: FORCES

(a) Calculate the spring constant for a spring that extends 200 mm when a 2.94 N weight is hung on it.

(b) A block is attached to two identical springs and hung from the ceiling.



(i) On the diagram below, add labelled arrows to show all the forces acting on the block.



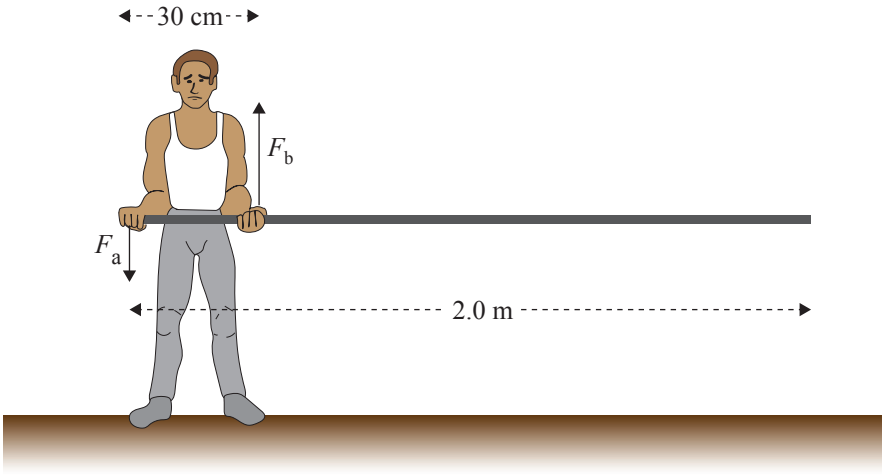
If you need to redraw your response, use the diagram on page 9.

(ii) Draw a labelled vector diagram to show how the three forces acting on the block add together.

If you need to redraw your response, use the diagram on page 9.

(c) An athlete in training holds a uniform rod, 2.0 m long, stationary in a horizontal position.

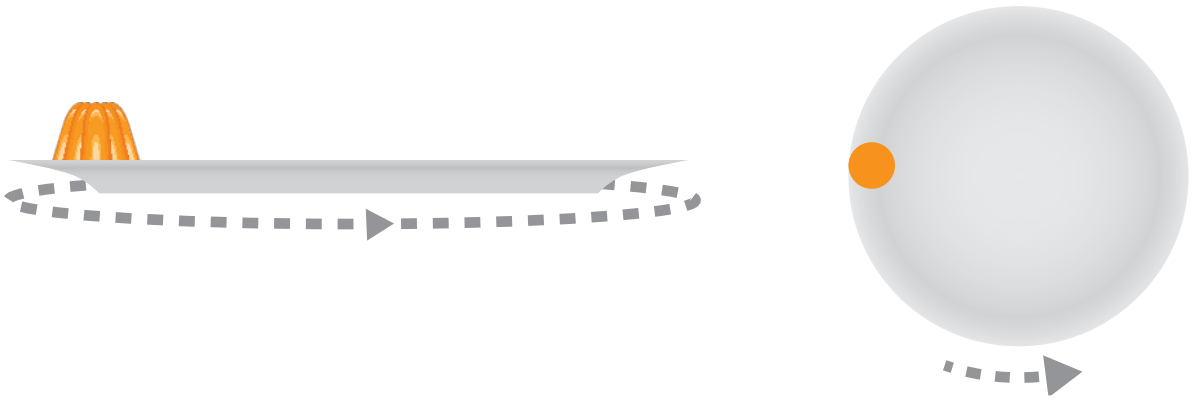
The mass of the rod is 3.0 kg.



Calculate the forces F_a and F_b that are required by the athlete's hands to hold the rod in equilibrium, in the horizontal position.

Question Three continues on the next page.

(d) A jelly is placed on the edge of a plate, and the plate starts to spin so the jelly is moving in a circle. As the plate speed increases, the jelly initially maintains its position at the edge of the plate, until it eventually slides off.



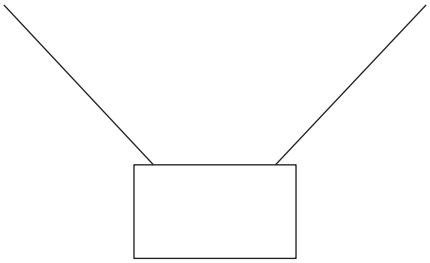
Use physics principles to explain why the jelly initially stays on the plate, but as the speed increases, it slides off.

Your answer should include:

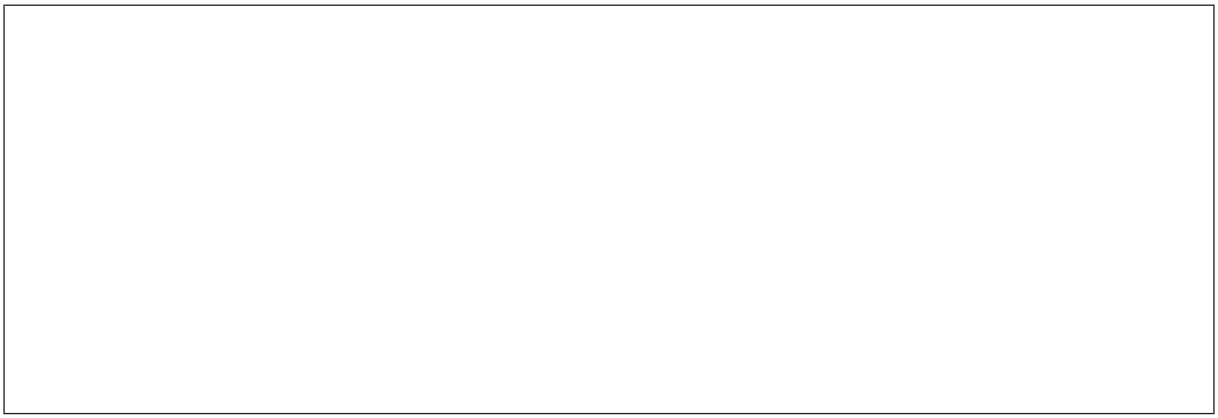
- naming of any relevant force(s) involved
- how increasing the velocity affects the situation
- a description of the path the jelly would take when it first slides off.

SPARE DIAGRAMS

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



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



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

QUESTION NUMBER

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QUESTION NUMBER