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90255

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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

# Level 2 Physics, 2008

## 90255 Demonstrate understanding of mechanics

Credits: Six
2.00 pm Tuesday 25 November 2008

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 answer ALL the questions in this booklet.

For all numerical answers, full working must be shown. The answer should be given with an SI unit.

For all 'describe' or 'explain' questions, the answer should be in complete sentences.

**Formulae you may find useful are given on page 2.**

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

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

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

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| Achievement Criteria | | |
|---|---|---|
| **Achievement** | **Achievement with Merit** | **Achievement with Excellence** |
| Identify or describe aspects of phenomena, concepts or principles. | Give descriptions or explanations in terms of phenomena, concepts, principles and / or relationships. | Give concise explanations that show clear understanding in terms of phenomena, concepts, principles and / or relationships. |
| Solve straightforward problems. | Solve problems. | Solve complex problems. |
| **Overall Level of Performance (all criteria within a column are met)** | | |

You are advised to spend 60 minutes answering the questions in this booklet.

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You may find the following formulae useful.

$$v = \frac{\Delta d}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad v_f = v_i + at$$

$$d = v_i t + \frac{1}{2}at^2 \qquad d = \frac{v_i + v_f}{2}t \qquad v_f^2 = v_i^2 + 2ad$$

$$a_c = \frac{v^2}{r}$$

$$F = ma \qquad \tau = Fd \qquad F = -kx$$

$$F_c = \frac{mv^2}{r} \qquad p = mv \qquad \Delta p = F\Delta t$$

$$E_p = \frac{1}{2}kx^2 \qquad E_k = \frac{1}{2}mv^2 \qquad \Delta E_p = mg\Delta h$$

$$W = Fd \qquad P = \frac{W}{t}$$

where needed, use $g = 9.8 \text{ m s}^{-2}$

## QUESTION ONE: THE SOCCER MATCH

Louise is playing soccer for her 1st XI soccer team. Louise has a mass of 65 kg.

(a) Louise is running **towards the goal** at 8.0 m s$^{-1}$. She slows down to 6.0 m s$^{-1}$ in 3 s.

Calculate the distance she travels over the 3 s. Write your answer to the correct number of significant figures.

(b) State the main energy change when she is decelerating.

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(c) Calculate her kinetic energy while she is running at 8.0 m $s^{-1}$.

(d) Calculate the **size** of Louise's momentum while she is running at 8.0 m $s^{-1}$.
Write your answer with the correct units.

(e) While she is running at 6.0 m $s^{-1}$ to the right, the ball rolls at 4.0 m $s^{-1}$ to the left.

Calculate the speed of the ball **relative to Louise**.

(f) Determine the size of the average **net force** acting on her when she is running at **constant speed**. Explain your answer.

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Louise kicks the ball **vertically** up, as shown in the diagram. It **rises** and then **falls**. You may assume air resistance is negligible**.**

(g) Describe and explain what happens to:

(i) the **force** on the ball

(ii) the ball's **acceleration**

(iii) the ball's **velocity**

**after** the ball is kicked and as it **rises** and **falls**.

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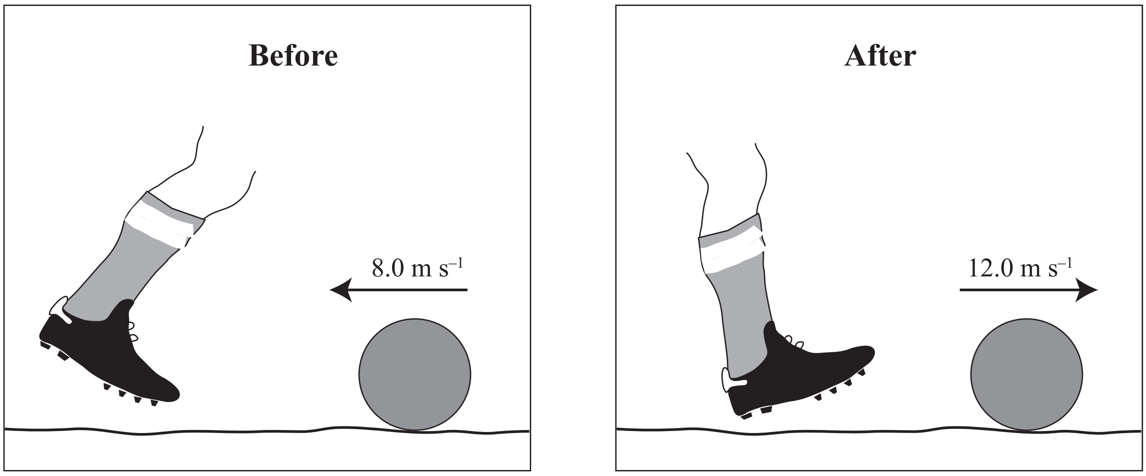
A while later, the ball is rolling towards Louise at a speed of 8.0 m $s^{-1}$ as shown in the diagram below. She kicks it and it rolls in the **opposite** direction with a speed of 12.0 m $s^{-1}$. The ball's mass is 450 g. Her foot is in contact with the ball for 0.10 s.




(h) Calculate the **size** of the unbalanced **force** on **the ball**.

(i) State the **size** and **direction** of the force of the ball **on her foot**.

Size: ________

Direction: ________

## QUESTION TWO: GOING TO THE PLAYGROUND

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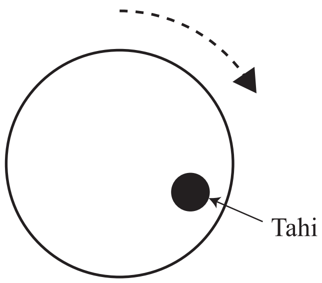
Tahi and Rua are at the playground. Tahi is sitting on a merry-go-round that is spinning clockwise. He is 3.0 m from the centre and has a speed of 1.5 m $s^{-1}$.

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www.retrojunk.com/img/art-images/merrygoround.jpg

(a) Draw labelled arrows on the diagram to show the direction of Tahi's **velocity** and **acceleration.**

(b) State the name of this acceleration.

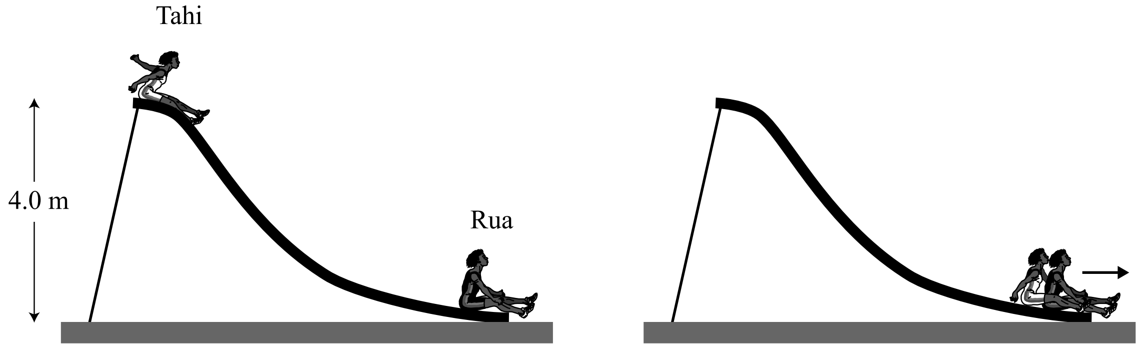
(c) Calculate the **size** of his acceleration.

(d) State the **direction** of the horizontal force acting on Tahi, and explain clearly why there must be a horizontal force acting on him.

(e) Rua pushes the merry-go-round so that its **period is halved**.

Explain exactly what this does to the **size** of the horizontal **force** acting on Tahi.

Tahi then climbs to the top of a slide. The slide is 4.0 m high. He slides down.
Assume all the gravitational potential energy is converted into kinetic energy.
At the bottom he collides with Rua, who is initially stationary.
Tahi's mass is 55 kg and Rua's mass is 65 kg.

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(f) This collision is **inelastic**.

State what this means.

_______________________________________________

_______________________________________________

(g) Calculate their combined speed if they stick together after the collision.

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(h) Is Tahi's momentum conserved as he moves down the slide?

Explain your answer.

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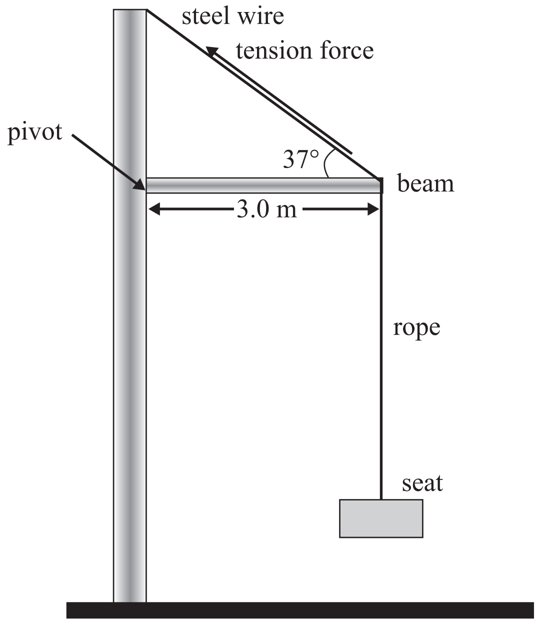
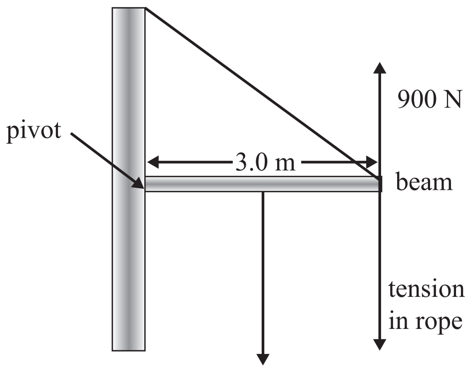
Rua goes across to the pole swing. The swing hangs on a rope attached to a uniform beam, as shown in the diagram.
The beam is 3.0 m long and has a mass of 35 kg.
The angle between the steel wire and the beam is 37°.
The tension force in the steel wire is 1500 N.



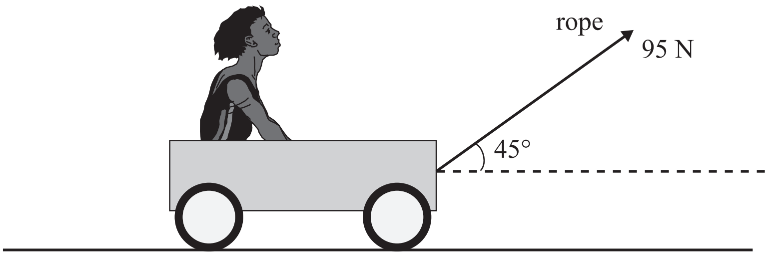

(i) The force exerted on the beam by the steel wire can be split into two components.

Show that the **vertical component** of the force exerted on the beam by the steel wire is 900 N.

(j) By calculating the torques on the beam about the pivot, calculate the **tension force** in the rope.



Rua then climbs onto a trolley and Tahi tows him with a rope, as shown in the diagram below. Rua's mass is 65 kg, the mass of the trolley is 11 kg.
The tension force in the rope attached to the trolley is 95 N, and the rope is at an angle of 45° to the ground.
There is a 35 N friction force on the trolley.




(k) Calculate the size of the trolley's acceleration.

(l) The rope stretches 1.0 cm with the 95 N tension force.

Calculate the elastic potential energy stored in the stretched rope.

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(m) After a while, Rua is rolling at constant speed. He throws a ball vertically upwards (relative to the trolley). Air resistance is negligible.

Where will the ball land? Explain your answer. (You may draw a diagram in the box below.)

(n) Rua throws the ball vertically at 9.8 m $s^{-1}$.

Calculate how long it takes the ball to return to the same level.

**Extra paper for continuation of answers if required.**
**Clearly number the question.**

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Question number