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90255

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 2 Physics, 2006

90255 Demonstrate understanding of mechanics

Credits: Six
2.00 pm Monday 20 November 2006

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 2–12 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.

You may find the following formulae useful.

$v = \frac{\Delta d}{\Delta t}$	$a = \frac{\Delta v}{\Delta t}$	$v_f = v_i + at$
$d = v_i t + \frac{1}{2}at^2$	$d = \frac{v_i + v_f}{2}t$	$v_f^2 = v_i^2 + 2ad$
$a_c = \frac{v^2}{r}$		
$F = ma$	$\tau = Fd$	$F = -kx$
$F_c = \frac{mv^2}{r}$	$p = mv$	$\Delta p = F\Delta t$
$E_p = \frac{1}{2}kx^2$	$E_k = \frac{1}{2}mv^2$	$\Delta E_p = mg\Delta h$
$W = Fd$	$P = \frac{W}{t}$	

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QUESTION ONE: ROWING

Steve is in a rowing race. The **total mass** of Steve and his boat is 120 kg.

(a) At the beginning of the race, he is at rest. When the race starts, he accelerates to a speed of 4.5 m s^{-1} in 5.00 s.

Calculate his **acceleration**.
Write your answer to the correct number of **significant figures**.

(b) Calculate the **distance** Steve travels in the first 5.00 s.

(c) Calculate the minimum average **power** Steve must produce to cause this acceleration. Write your answer with the correct **unit**.

(d) Explain clearly why the average power Steve must actually produce will be **greater** than that which you calculated in (c).

(e) Later in the race, the boat is moving at **constant velocity**. Determine the size of the **net** (or total) **force** acting on the boat.

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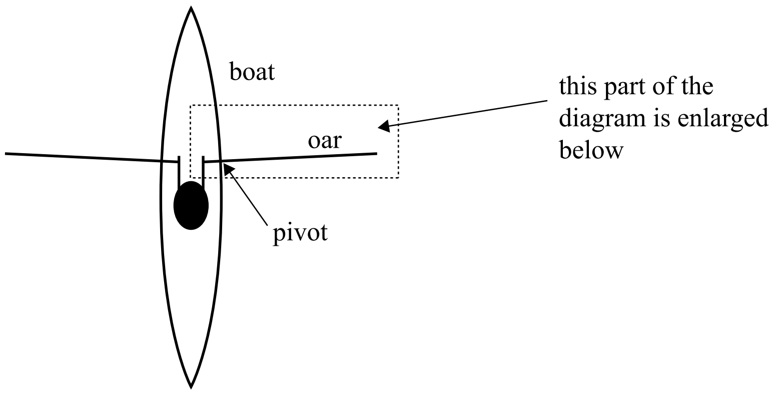
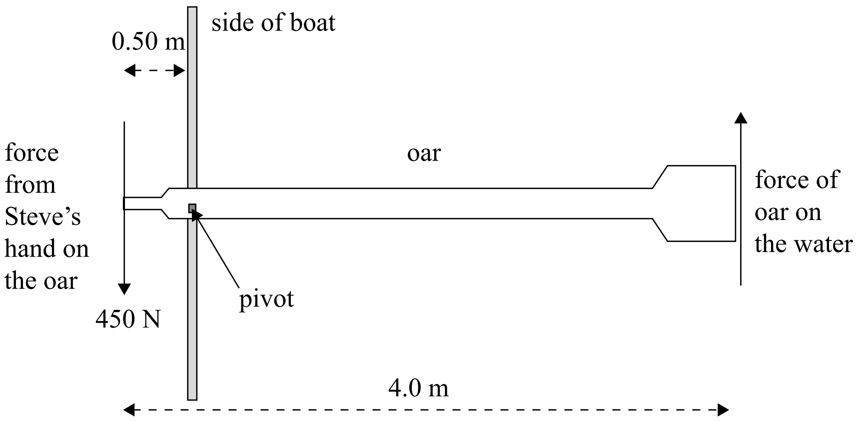
The diagram below shows part of the side of the boat and one of Steve's oars as seen from above.
The oar pivots on the side of the boat.
The oar is 4.0 m long. Steve's hand is 0.50 m from the pivot.
During a warm-up, Steve exerts a force of 450 N on the oar as shown in the diagram below.

Steve's boat



Steve's oar



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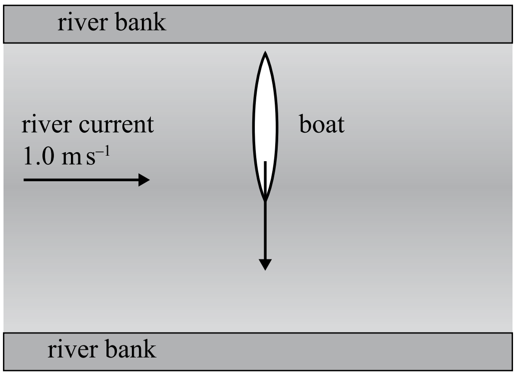
(f) Calculate the size of the force that the oar exerts on the water.

At the end of the race, Steve rows across a part of the river where there is a current flowing at a speed of 1.0 m s^{-1}. Steve points his boat at right angles to the river bank**.** His speed through the water is 3.0 m s^{-1}.



(g) Draw a velocity vector diagram showing the direction he travels.

Use the diagram to calculate the boat's **resultant speed**.

Calculate the **angle** between the **river bank** and the **boat's velocity**.

Draw your vector diagram here.

speed of the boat = ____________ angle = ____________

QUESTION TWO: CIRCULAR MOTION

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Jan is competing in a hammer-throw event. This event involves swinging a 10 kg iron ball attached to a steel wire in a horizontal circle.

The diagrams below show Jan and the hammer from above.

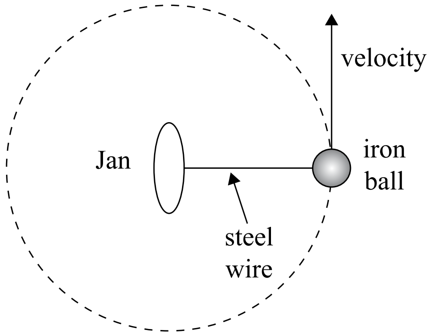

Diagram 1

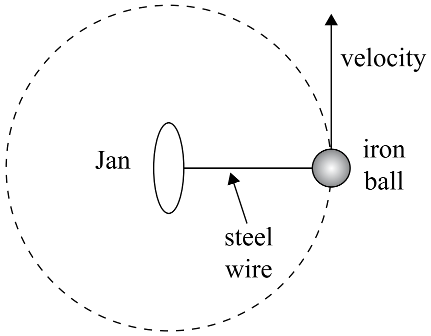

Diagram 2

(a) On Diagram 1, draw an arrow showing the direction of the **iron ball's acceleration**. Label it "a".

(b) On Diagram 2, draw an arrow showing the direction of the force the steel wire exerts **on Jan**. Label it "F".

(c) Explain why a horizontal force is needed on the ball, even though it is moving at constant speed.

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The ball rotates in a horizontal circle of **radius** 2.0 m.
The **time** for one rotation is 1.5 s.
The iron ball's **mass** is 10 kg.
The **circumference** of a circle is: $C = 2\pi r$.

(d) Calculate the size of the **centripetal force** acting on the iron ball.

(e) After a few rotations, the ball has the **same radius** of rotation, but a **shorter period.** Explain what effect this will have on the horizontal **force** acting **on Jan**.

QUESTION THREE: PROJECTILE MOTION

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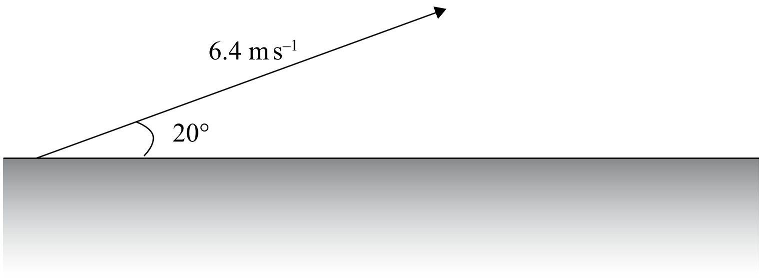
Marama is a long-jumper. She runs down a track, and jumps as far as she can horizontally. Her take-off **velocity** is shown in the diagram below.

You can assume there is no air resistance.

Acceleration due to gravity = 9.8 m s^{-2}.



(a) Show that the **horizontal component** of her **initial velocity** is 6.0 m s^{-1}.

(b) Show that the **vertical component** of her **initial velocity** is 2.2 m s^{-1}.

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(c) Calculate the distance she jumps horizontally.

(d) State the **size** and **direction** of her **acceleration** at the highest point.

size

direction

(e) Explain why the **horizontal component** of her velocity is **constant**.

QUESTION FOUR: MOMENTUM

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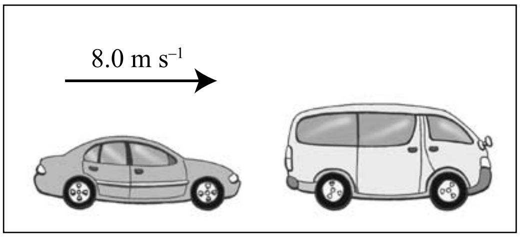
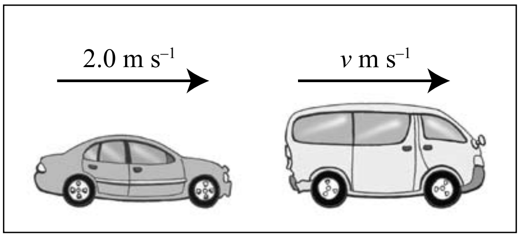
Marama is driving her car home after her event, when she collides with a **stationary** van. Assume there are no outside horizontal forces acting during the collision.

(a) Name the physical quantity that is **conserved** in this collision.





The mass of the car is 950 kg and the mass of the van 1 700 kg.
The car is travelling at 8.0 m s^{-1} before the collision and 2.0 m s^{-1} immediately after the collision, as shown in the diagram above.

(b) Calculate the **size** and **direction** of the car's **momentum change.**

(c) Calculate the **speed** of the van immediately after the collision.

(d) If the **average force** that the van exerts on the car is 3 800 N, calculate how long the collision lasts.

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(e) Marama had a bag resting on the front seat. Use relevant physics concepts to explain why the bag fell onto the floor during the collision.

(f) The front of modern cars is designed to crumple or gradually compress during a collision. Use the idea of **impulse** to explain why this is an advantage for the people in the car.

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

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Question number