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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 2 Physics, 2009

90255 Demonstrate understanding of mechanics

Credits: Six
2.00 pm Tuesday 17 November 2009

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.

For Assessor's use only	**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.

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

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

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

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

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

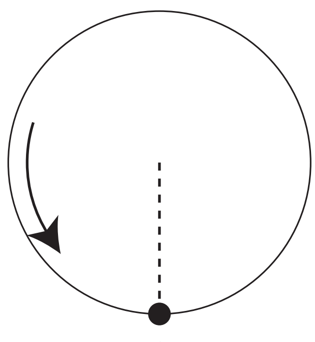
$$E_p = \frac{1}{2}kx^2 \qquad E_k = \frac{1}{2}mv^2 \qquad \Delta E_p = mg\Delta h$$

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

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

QUESTION ONE: CIRCULAR MOTION

Jordan ties a ball on a string and swings it in a horizontal circle in an anticlockwise direction, as shown below.



(a) On the diagram above, draw a **labelled arrow** to show the direction of **acceleration of the ball** at position **A**.

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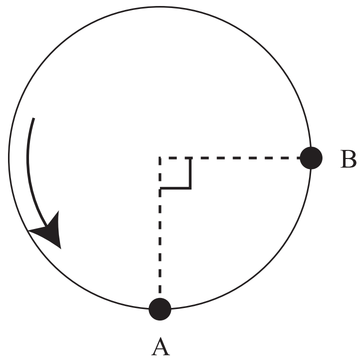
The ball continues to move at a constant speed of 5.0 m s^{-1} in a circular path. The radius of the circle is 1.59 m.

(b) Calculate the centripetal acceleration of the ball.

The diagram below shows the path of the ball as it swings from position A to position B.



(c) On the diagram above draw arrows to indicate the direction of the velocity of the ball at each of the positions A and B.

Hence, calculate the **size and direction** of the **change in velocity** of the ball as it swings from position A to position B. The ball is moving at a constant speed of 5.0 m s^{-1}.
Show your working clearly.
Draw a vector diagram to justify your calculations.

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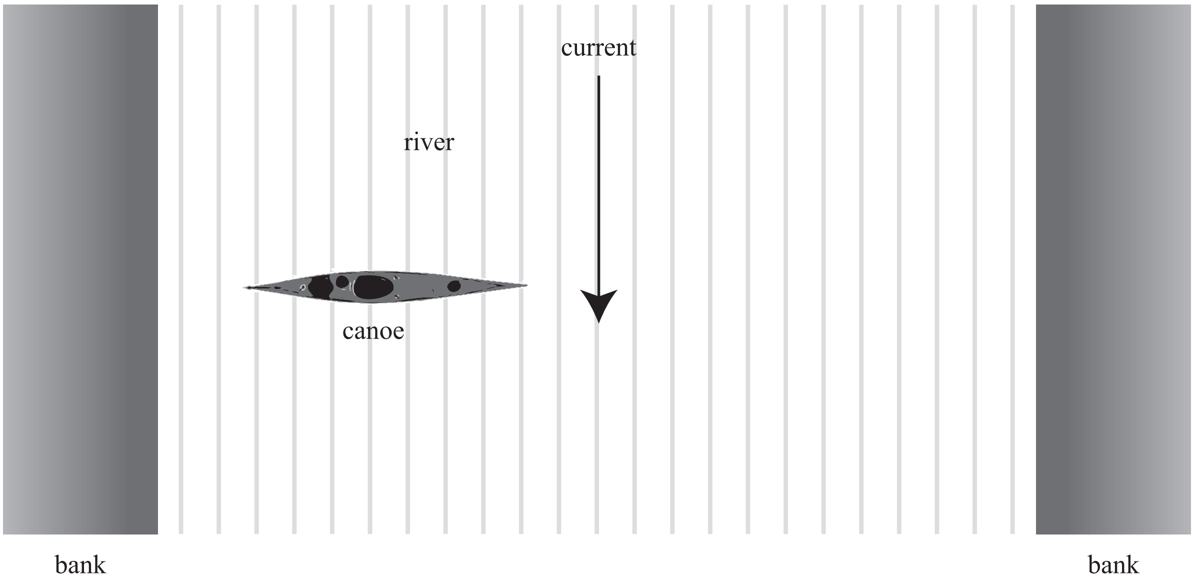
(d) Jordan unties the ball and drops it to the floor. The ball bounces up and down a few times.

Explain using energy considerations, why the height of bounce of the ball, changes with time.

QUESTION TWO: RELATIVE VELOCITY AND PROJECTILES



Jordan uses a canoe to cross a river that is 45 m wide. There is a current flowing with a speed of 0.67 m s^{-1} as shown in the diagram.

Jordan paddles with a speed of 1.39 m s^{-1} relative to the water.

Jordan wants to paddle the canoe so it moves at right angles to the bank and lands straight across from where it started.

(a) In the space below draw a **labelled vector diagram** showing the direction Jordan must point the canoe, in order to land straight across on the other side.

Your diagram should have each of the following named clearly:

- the velocity of the current
- the velocity of the canoe relative to the water
- the velocity of the canoe relative to the ground.

No calculations are necessary.

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(b) Jordan points the canoe so that it lands straight across from where it started.

Calculate the **time** it takes to cross the river.

After leaving the canoe, Jordan goes to basketball practice.
Jordan throws a basketball **vertically upward**.

(c) Describe and explain what happens to the **velocity and acceleration** of the ball while it is in the air.

Jordan then throws the basketball **horizontally**, with an initial horizontal velocity of 7.8 m s^{-1}, at a height of 1.4 m from the floor.

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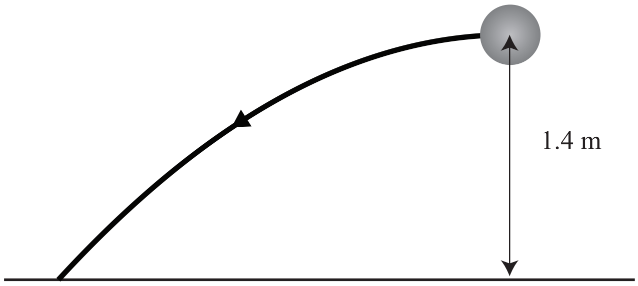

(d) Calculate the **velocity** (magnitude and direction) of the ball just before it hits the floor.

Space for diagram if required.

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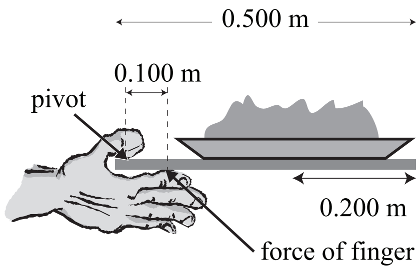
QUESTION THREE: EQUILIBRIUM, MOMENTUM AND SPRINGS

Harry carries his tray of food to his cafeteria table for lunch. The **uniform tray** is 0.500 m long and has a mass of 0.20 kg. It holds a 0.40 kg plate of food where the centre of the plate is 0.200 m from the right hand edge. Harry holds the tray on the left-hand side with one hand, using his thumb as the pivot (fulcrum), and pushes up 0.100 m from the pivot (fulcrum) with his fingertips.



(a) State the conditions necessary for the tray to be in equilibrium.

(b) Calculate the weight (force of gravity) on:

(i) the plate of food

(ii) the tray.

(c) Calculate the size of the upward force that Harry's **fingertips** must exert to keep the tray level.

One of the games that Harry plays is cricket.

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(d) The ball approaches the batsman with a speed of 21 m s^{-1}. The ball has a mass of 0.161 kg. The batsman hits the ball hard with an average force of 2560 N, and the ball moves away in the opposite direction at 30.0 m s^{-1}.

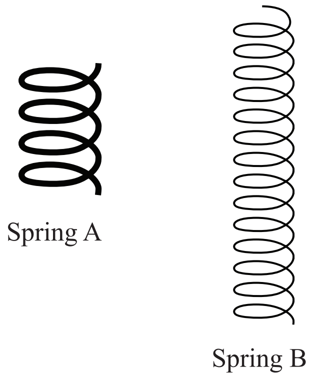
Calculate the time the ball was in contact with the bat.

(e) Express your answer to Question Three (d) to the correct number of significant figures. State the reason for your choice of significant figures for your final answer.

(f) Harry is a fielder near the batsman.

Explain, using physics principles, why Harry usually pulls back his hand while catching a ball.

The springs (A) used in Harry's car seats are different from the spring (B) that Jill uses to hang a toy spider from the ceiling of her room. The diagram shows two types of spring.



(g) Compressing spring A by 0.20 m requires 150 J of work. Stretching spring B by 0.30 m requires 210 J of work.

By using **appropriate working and reasoning**, show by calculation which spring is **stiffer**.

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

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Question number