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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

SUPERVISOR'S USE ONLY

Level 1 Science, 2013

90940 Demonstrate understanding of aspects of mechanics

9.30 am Monday 18 November 2013
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of mechanics.	Demonstrate in-depth understanding of aspects of mechanics.	Demonstrate comprehensive understanding of aspects 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.

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 2–14 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.

TOTAL

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

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You may find the following formulae useful.

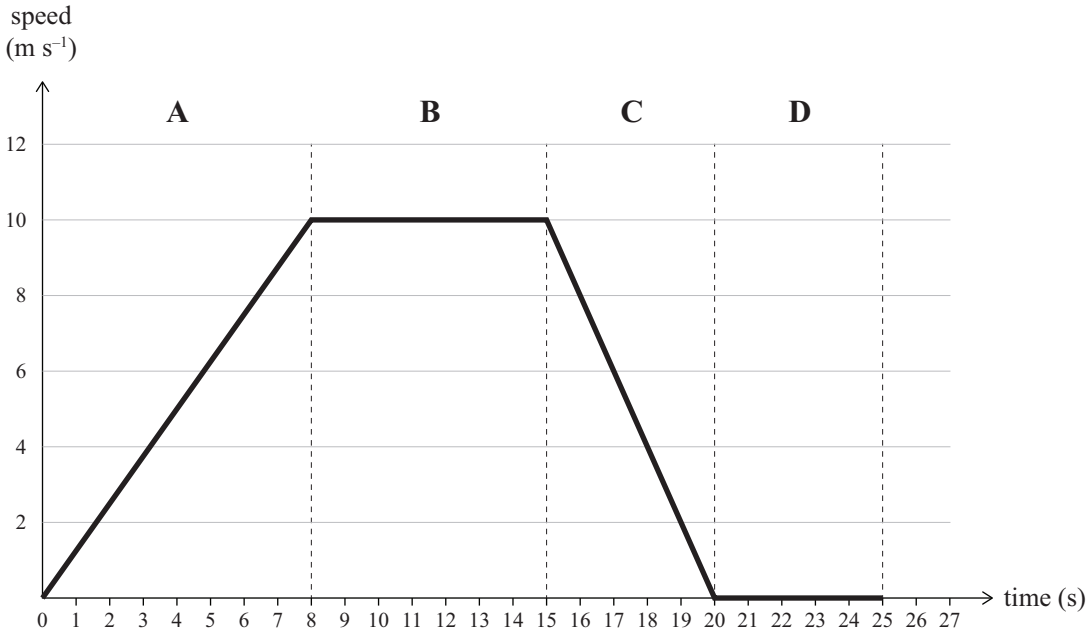
$$v = \frac{\Delta d}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad F_{net} = ma \qquad P = \frac{F}{A}$$

$$\Delta E_p = mg\Delta h \qquad E_k = \frac{1}{2}mv^2 \qquad W = Fd \qquad P = \frac{W}{t}$$

The value of g is given as 10 m s^{-2}

QUESTION ONE: THE RUNNER

A runner's speed is recorded for 25 seconds and graphed below.



(a) Describe the motion of the runner through sections A, B, C, and D.
Your answers should include descriptions AND any relevant calculations.

Section A: _____

_____

_____

Section B: _____

_____

_____

Section C: _____

_____

_____

Section D: _____

_____

_____

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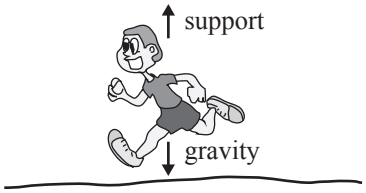
(b) On the diagrams below, draw and label the thrust and friction forces acting on the runner in sections A, B, and C.

In your answer you should:

- use arrows to show the directions of the thrust and friction forces
- beside each diagram, state if thrust is greater than friction, thrust is equal to friction, or if thrust is less than friction.

The gravity and support forces have been done for you.

Section A



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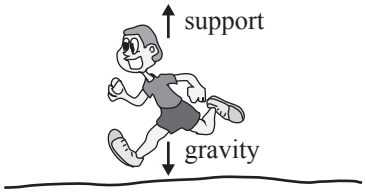
Section B



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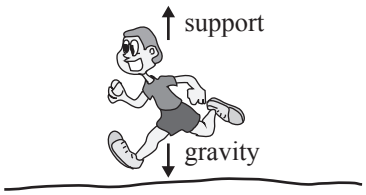
Section C



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(c) Referring to your force diagrams in part (b), explain the link between the net force acting on the runner in sections A, B, and C of the graph, and the type of motion.

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In your answer you should:

- describe what is meant by net force
- explain the link between net force and motion for EACH section
- compare the direction of the net force and the direction of the motion for EACH section.

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(d) Calculate the total distance the runner travels.

To assist you in your answers, the graph from page 2 is repeated below.

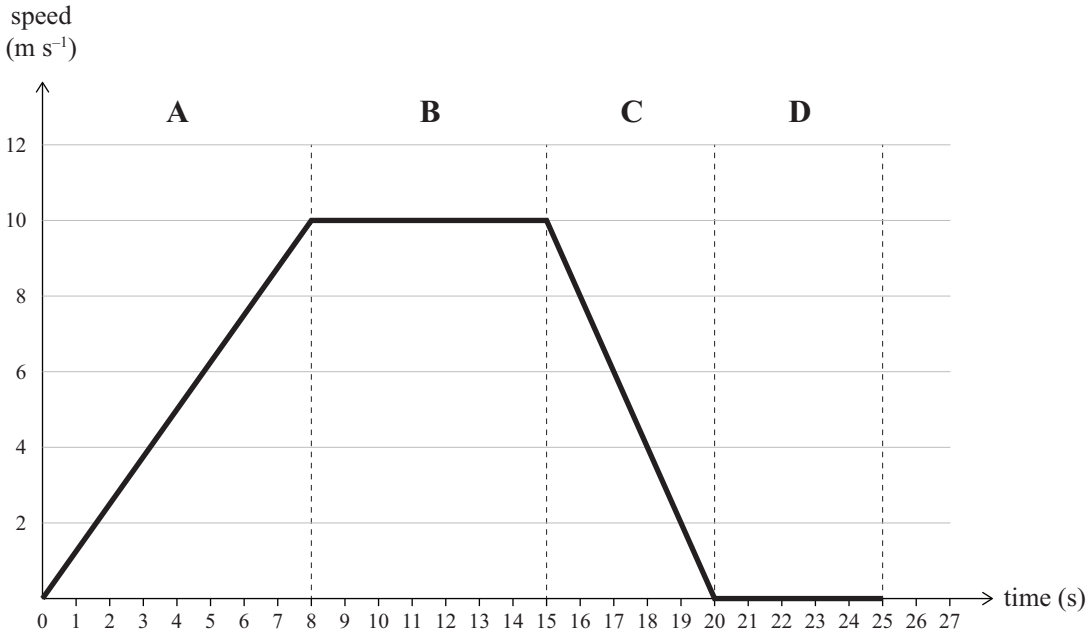
Distance travelled, section A: _____

Distance travelled, section B: _____

Distance travelled, section C: _____

Distance travelled, section D: _____

Total distance travelled: _____



QUESTION TWO: DROPPING A BALL

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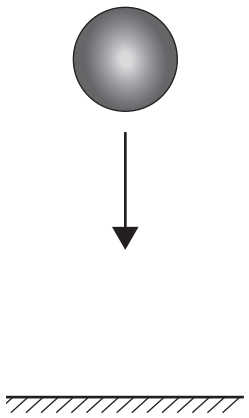
In a classroom experiment, a ball is dropped onto the floor.

Before the ball is dropped, it is not moving, and has only gravitational potential energy (E_p). As the ball falls, the gravitational potential energy is converted into kinetic energy (E_k).

The ball has a mass of 100 grams.

(a) Complete the labels for the diagram below to show the energy changes as the ball is dropped.

Assume that the gravitational potential energy is changed **only** into kinetic energy.



At the top: $E_p = 0.2$ J $E_k = 0$ J

Halfway: $E_p =$ _____ $E_k =$ _____

Just before it hits the floor: $E_p =$ _____ $E_k =$ _____

(b) The teacher tells the students that the ball will be travelling at 2 m s^{-1} just before it hits the floor. The students are asked to predict the speed of the ball halfway down from three options:

Option 1: The speed is **less** than 1 m s^{-1}.

Option 2: The speed is **equal** to 1 m s^{-1}.

Option 3: The speed is **greater** than 1 m s^{-1}.

State the correct option, explain your answer, and support your answer using energy calculations.

You may assume conservation of energy.

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This page has been deliberately left blank.

The examination continues on the following page.

(c) Explain why the ball will really be travelling **slower** than 2 m s^{-1} just before it hits the floor.

No calculation is required.

In your answer you should:

- describe all the energy changes that occur as the ball falls
- explain why the energy changes mean the speed is slower than 2 m s^{-1}.

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QUESTION THREE: LIFTING BOXES

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A box in a warehouse has a mass of 2 500 kg.

(a) Explain the difference between weight and mass.

(b) Calculate the weight of the box.

A forklift lifts the box 4 metres straight up so it can be placed on a shelf. It takes 5 seconds to lift the box at a constant rate.

http://www.123rf.com/stock-photo/

(c) Calculate the work done to lift the box to the height of 4 m, and then calculate the power needed by the forklift to lift it to this height.

Work:

Power:

(d) Find the **average speed** of the box as it moves up to the 4 m high shelf.

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(e) Explain how the power needed to lift the box would be affected if the box was lifted at twice the speed.

In your answer you should consider how increased speed affects the time taken.

QUESTION FOUR: FUN IN THE SNOW

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A family decides to spend a day at a snow field. The father hires a snowboard for himself and a pair of skis for his daughter.

www.evo.com

Assume the snowboard and skis are **rectangular** in shape.

The father and snowboard have a combined mass of 80 kg.

(a) Calculate the pressure exerted by the father and snowboard on the snow.

Your answer should include:

- an area calculation
- a calculation of the pressure.

(b) The father notices that his daughter on her skis has sunk further into the snow than he has on his snowboard.

The daughter and the skis have a combined mass of 58 kg.

Explain why the daughter on her skis sinks further into the snow than her father on his snowboard.

In your answer you should:

- calculate the pressure exerted by the daughter and her skis on the snow
- compare the pressure exerted by the daughter and father (from part (a)) on the snow
- explain the difference in pressure in terms of force AND area
- explain how pressure relates to how far the person will sink in the snow.

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

QUESTION NUMBER

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