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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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Level 1 Science, 2014

90940 Demonstrate understanding of aspects of mechanics

9.30 am Monday 10 November 2014
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 2–16 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 may find the following formulae useful.

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

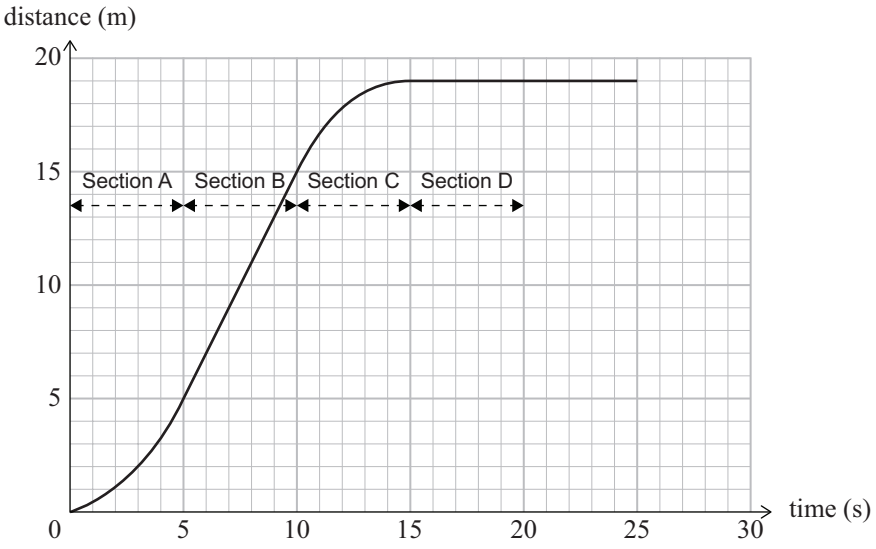
$$E_k = \frac{1}{2}mv^2 \qquad W = Fd \qquad g = 10 \text{ N kg}^{-1} \qquad P = \frac{W}{t}$$

QUESTION ONE: CYCLING

A cyclist and bike have a combined mass of 99 kg.

(a) Show that the combined weight is 990 N.

(b) The cyclist's journey was plotted on the distance / time graph below.



(i) Describe the motion of the cyclist in each of sections A, B, C, and D.
No calculations are required.

Section A:

Section B:

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Section C: _____

Section D: _____

(ii) Calculate the cyclist's speed during Section B.

(c) A bike with a mass of 20 kg is lifted onto a shelf that is 1.5 metres high. It takes 3 seconds to lift the bike.

Calculate the power required to lift the bike onto the shelf.

Before you calculate the power, you will need to:

- determine the weight force of the bike
- calculate the work done in lifting the bike.

(d) A person pushed the same bike up a ramp so that it was also at a height of 1.5 m. It took them a longer time to do this than lifting the bike in part (c).

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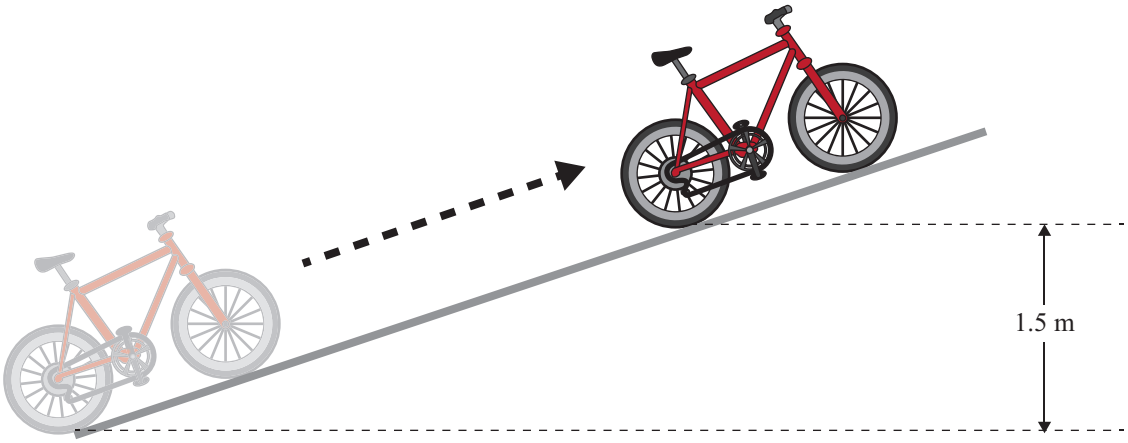

Explain whether the power needed to push the bike up the ramp is more or less than when it is lifted straight up to the same height.

In your answer you should refer to force and energy.

QUESTION TWO: FURNITURE

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A chair (15.0 kg) and footstool (15.0 kg) are shown below.

The chair has four legs in contact with the floor, whereas the base of the footstool does not have legs and is entirely in contact with the floor.

http://st.houzz.com/simgs/e0217bad0e26c829_4-5482/modern-armchairs.jpg

(a) It took 6 seconds to push the footstool a distance of 8.0 m across a room.

Calculate the average speed of the footstool as it is pushed.

(b) The footstool was pushed around the house.

Select the correct statement below and then explain your choice.

A. It is easier to push the footstool across carpet than across a wooden floor.

B. It is easier to push the footstool across a wooden floor than across carpet.

Write the letter of the correct statement: ☐

Explain why you have selected this statement.

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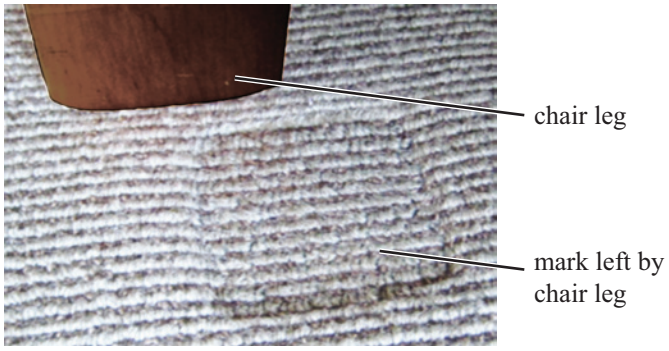
(c) The area of each chair leg in contact with the floor is 0.001 m^2.

Calculate the pressure that the chair (mass 15.0 kg) exerts on the carpet.

In your answer you must determine:

- the area of the chair legs in contact with the floor
- the weight force of the chair
- the pressure acting on the carpet.

(d) A person sat on the chair and then sat on the footstool for the same period of time. They noticed that the chair legs left deeper marks in the carpet than the footstool did, although both the chair and footstool have the same mass.



Explain these differences in terms of pressure, force, and surface area.

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QUESTION THREE: CONSTRUCTION

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During the construction of a building, a long beam was lifted into place using a crane.

http://www.countyofplumas.com/images/pages/N632//lifting%20beam.jpg

(a) Calculate the work done in lifting the beam with a weight of 6000 N through a distance of 50 m.

(b) Explain why there is no work being done when the beam is hanging in the air without moving.

(c) Another crane was lifting wood. The cable broke, and 150 kg of wood fell 12 m to the ground below.

The wood had 15 000 J of kinetic energy just before it landed on the ground below.

This was different from the amount of energy the wood had when it was hanging from the crane.

Explain why there is a difference in the energy the wood had when it was hanging from the crane compared to just before it hit the ground.

In your answer you should:

- name the type of energy the wood had when it was hanging from the crane
- calculate how much energy the wood had when it was hanging from the crane
- calculate the difference between the kinetic energy of the wood just before hitting the ground and the energy the wood had when it was hanging from the crane
- justify the difference in energy of the wood when it was hanging from the crane and then just before it hit the ground.

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http://theagregator.com/wp-content/uploads/2013/09/crane1.jpg

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There is more space for your answer to this question on the following page.

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This page has been deliberately left blank.

The examination continues on the following page.

QUESTION FOUR: GO-CART RACING

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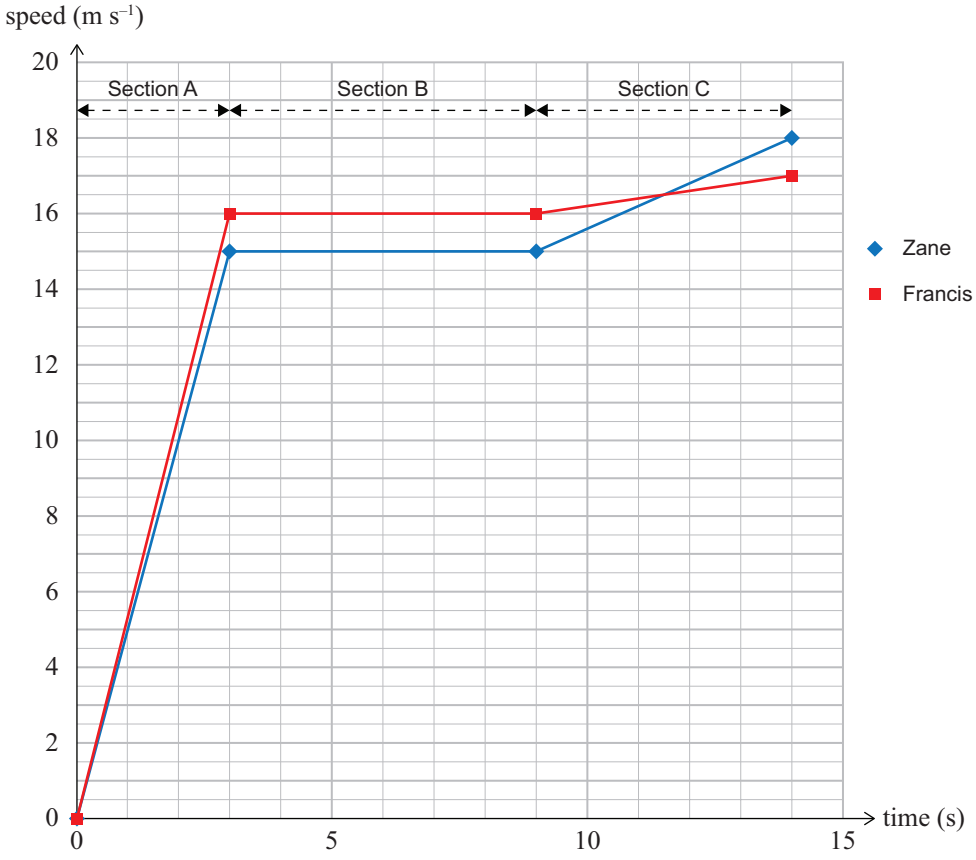
Two go-carts were racing on a track.

http://static2.stuff.co.nz/1377664598/017/9098017.jpg

A speed / time graph is shown below for each go-cart. Zane's graph is shown in blue, and Francis's in red.



(a) Calculate the acceleration of Zane in the first 3 seconds.

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(b) (i) On the photo below, draw and label ALL the forces acting on Zane's go-cart in **Section B** of the graph. The track is flat and horizontal.

Ensure that your labels show the relative sizes of the forces.

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www.kartsport.org.nz/Images/News/13GoProKSNZNatsYamJnrMarcusArmstrong-1.jpg

(ii) Discuss the forces that are acting on Zane's go-cart to explain its motion in Section B of the graph.

Question Four continues on the next page.

(c) Explain which go-cart travelled 200 m around the track first.

In your answer you should:

- use the information in the graph
- show all working for the calculations
- compare the distances travelled by Zane and Francis by the end of 14 s.

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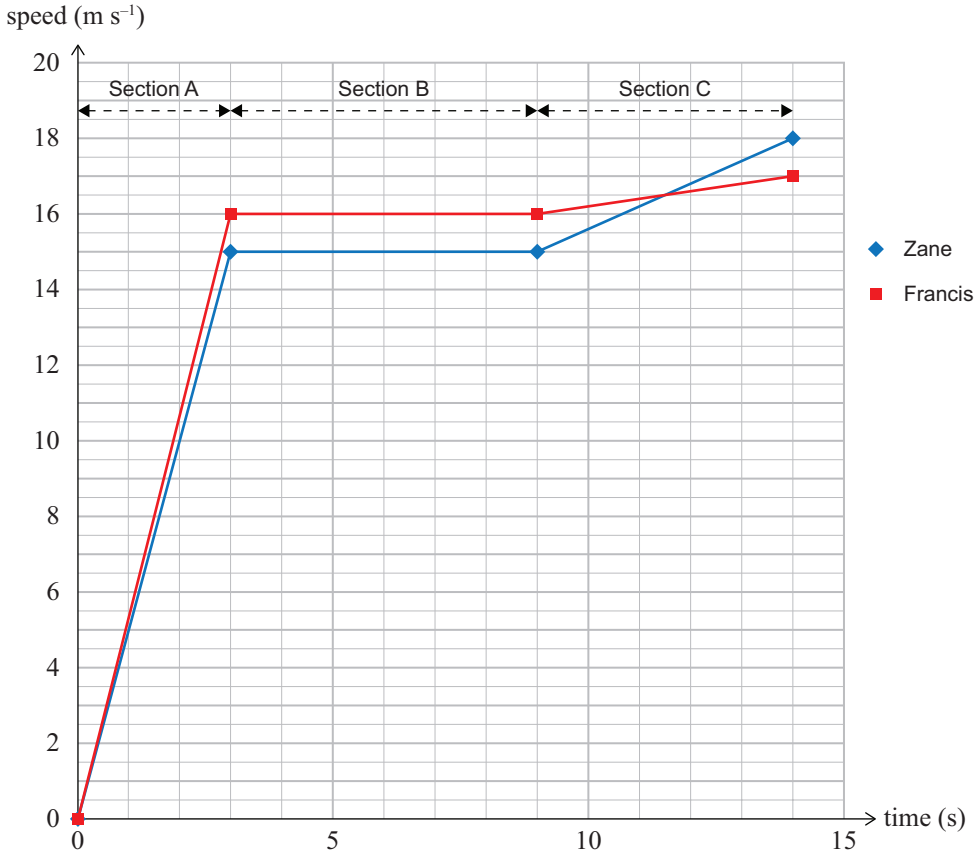
Graph from page 12



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

QUESTION NUMBER

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