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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 1 Science, 2011

90940 Demonstrate understanding of aspects of mechanics

9.30 am Monday 21 November 2011
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.

Show ALL working.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–13 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.

Achievement

TOTAL 15

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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}

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

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QUESTION ONE: PARACHUTING

A parachutist of mass 75 kg jumps from a plane at a height of 4 000 m above sea level.

(a) The parachutist falls through a distance of 2 400 m during the first 60 seconds. Calculate the average speed of the parachutist during this time.

Speed = (v) V = distance ÷ time

2400 ÷ 60 = 40

Average speed = 40 m s^{-1}

Good diagram clearly shows unbalanced forces

Has the concept of unbalanced forces but no mention of acceleration

If had referred to Newtons 2nd Law would have got M.

But only on A Point (b)

(b) Explain the vertical motion of the parachutist **just after** she jumps out of the plane (before the parachute opens).

In your answer you should:

- draw and label the vertical force(s) acting on the parachutist and show their relative sizes on the image to the right
- describe the net vertical force and state whether the force(s) are balanced or unbalanced
- describe the vertical motion of the parachutist
- explain how the net vertical force affects the vertical motion.

The vertical net forces acting on her are unbalenced as she is going down at a very fast Pace Approx 80 net down 20 net up. the net force affects the vertical motion of an object by pushing that object in the direction of the weaker net force as it is not able to hold it unlike if the forces were even the object would be stationary.

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(c) After the 60 seconds, the parachutist pulls the cord and opens her parachute.

Explain how the parachute reduces the speed of the parachutist when it is just opened.

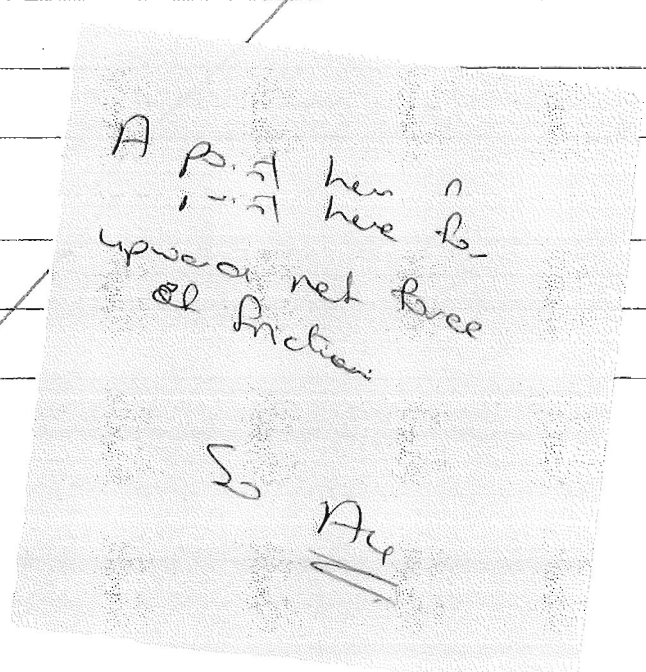
In your answer you should consider:

- how the motion of the parachutist changes when the parachute is opened
- the effect of the size of the parachute on the motion
- the effect of the parachute on the ~~net vertical force.~~

For copyright reasons, this image has not been reproduced here.

http://www.wallpaper-free.eu/wallpapers/parachute/parachute001_1400x1050.jpg

The Parachute reduces the speed of the Parachutist as it has a greater airia for the upward & Net forces like air resstance (friction) to act on thus evening out the Net forces to an appro 60 down & up So it is harder for the gravitational Net force to Push down the object making it travel slower.



QUESTION TWO: RUNNING

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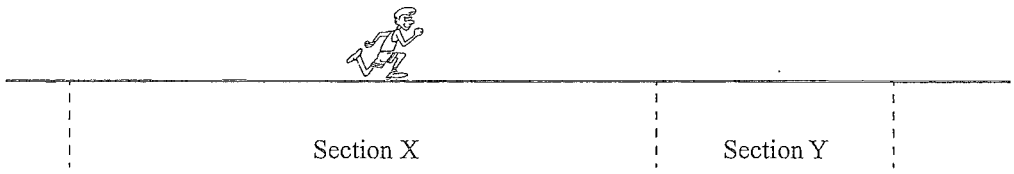

A boy runs along a track, as shown above.

During section X, he runs with a **constant speed** of 2 m s^{-1} for 15 seconds.

During section Y, he runs with a **constant acceleration** of 0.2 m s^{-2}.

(a) Calculate the net force acting on the boy (mass 60 kg) during **section Y**.

Give an appropriate unit with your answer.

Net force = mass x acceleration
mass = 60 acceleration = 0.2
60 x 0.2 = 12

Net force acting on the boy during section Y = 12 (N) unit

(b) The boy runs 12.5 m during section Y in 5 seconds.

Calculate the power required by the boy to produce the constant acceleration of 0.2 m s^{-1} in 5 seconds during section Y.

Give an appropriate unit with your answer.

Power = force ÷ Acceleration
force = 12N Acceleration = 0.2
12 ÷ 0.2 = 60
Power = work ÷ time = 5
work = force x distance, force = 12 distance = 12.5
12 x 12.5 = 150 (work) time = 5, 150 ÷ 5 = 30

Power required by the boy during section Y = 30 (J) unit

Calculations correct - wrong unit in (b)

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(c) (i) Calculate the speed of the boy as he reaches the end of section Y.

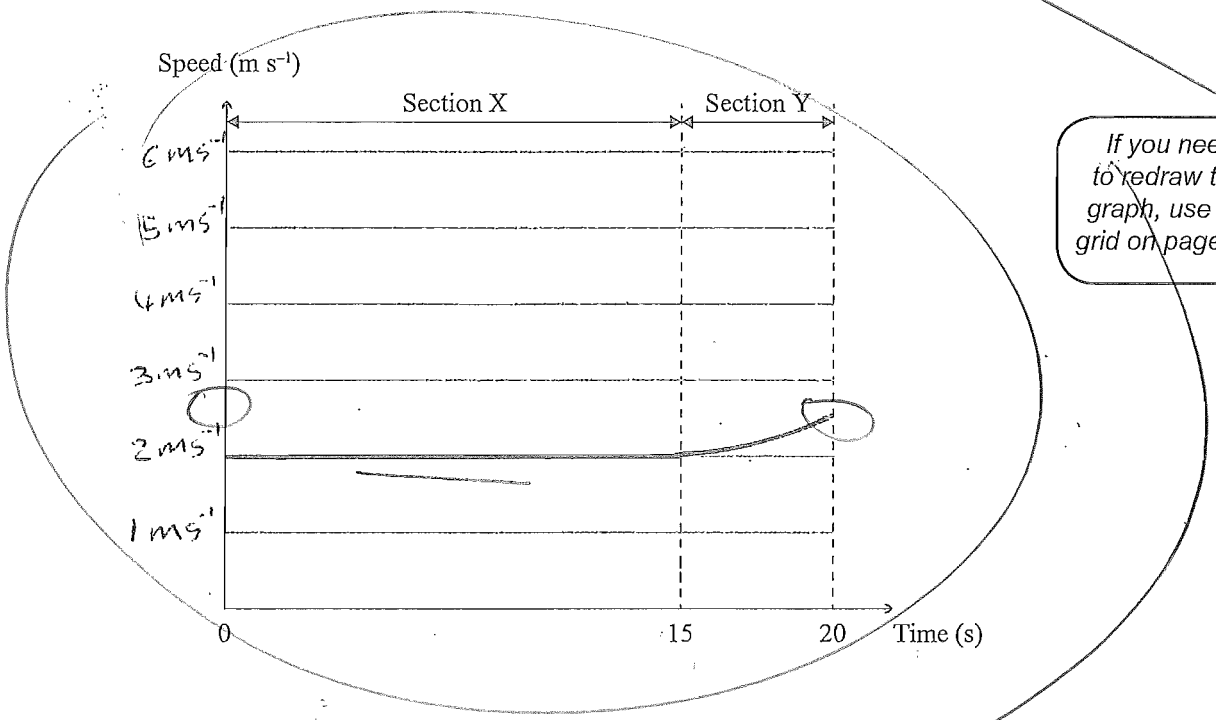
Speed = distance ÷ time, distance = 12.5m
time = 5 12.5 ÷ 5 = 2.5

Speed at the end of section Y = 2.5 m s^{-1}

(ii) Use this and the other information provided in the question to complete the speed/time graph below.

On your graph, you should:

- label the speed values on the vertical axis
- draw a line on the graph to show the speeds for section X and section Y.



If you need to redraw this graph, use the grid on page 12.

M point for correct shape of graph.

= M1

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QUESTION THREE: ROPE CLIMBING

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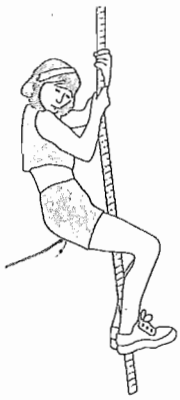

A girl of mass 60 kg uses 5 100 J of energy when she climbs a vertical rope.

(a) Calculate the maximum height it would be possible for the girl to reach.

height = ener... in
5100 ÷ 60x10 = (

Mentions Gravitated Potential Energy
Calculates Work Correctly but no mention of energy change of 300J.
No mention of W = ΔP or that Heat Energy is produced so 3ok.
1 Point for ΔPE
1 Point for 4800J = A3

(b) In reality, the girl reaches a heigh...

Explain why the energy used by ... the work she does to reach the ve...

In your answer you should:

- name the type of energy th...
- calculate the work done to...
- calculate the difference between the work done ... the girl
- explain where the "missing" energy has gone, and why this occurs.

The energy used by the girl does not equal the work she does to reach the vertical hight of 8m because she looses it during the climb this is because it converts to gavitational Potential energy the higher she goes.
the work done to reach 8m is mass x 10 x hight mass = 60
hight = 8 60 x 10 x 8 = 4800J.
So in reality she uses 4800J of energy to climb 8m the rest of it is converted to gravitational Potential energy

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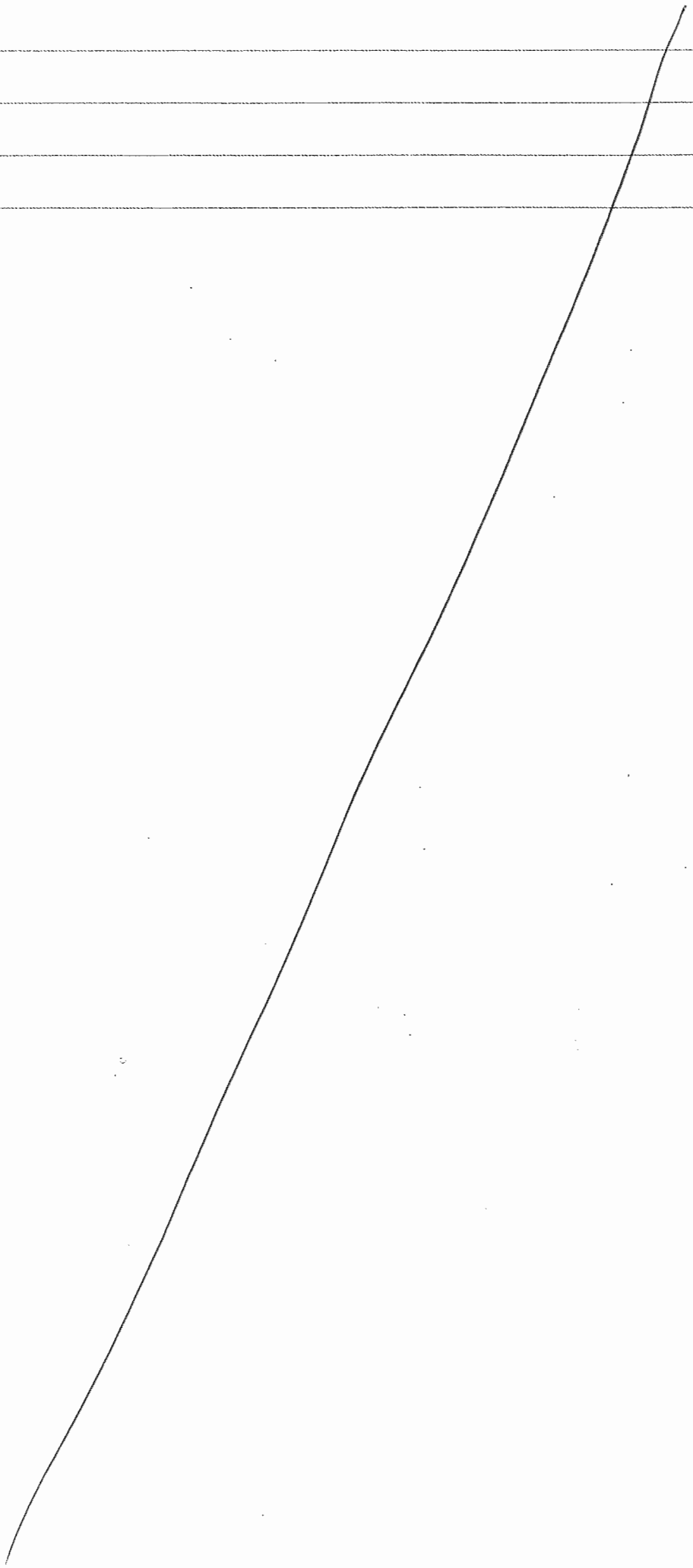

QUESTION FOUR: FOOTBALL BOOTS

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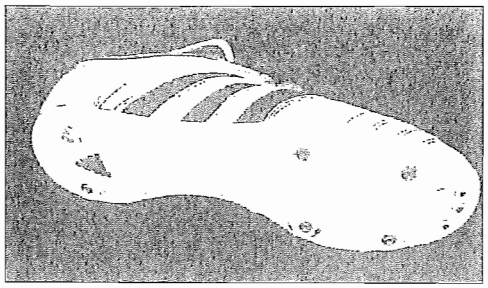
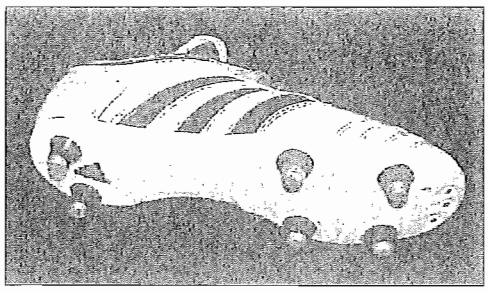


Boot **without** studs.



Boot **with** studs.

A student of mass 40 kg uses the football boots shown above.

ONE boot **without** studs has a surface area of 165 cm^2 (0.0165 m^2) in **contact** with the ground.

ONE boot **with** six studs has a surface area of only 6 cm^2 (0.0006 m^2) in **contact** with the ground.

(a) Calculate the pressure exerted if the student stands on ONE foot on a **hard surface**, for the boot **without** studs AND for the boot **with** studs.

Give an appropriate unit with your answers.

(i) Without studs: Pressure = Force ÷ Area

force = 40N Area = 0.0165m^2 40 × 0.0165 = 2,424.24 2424

Pressure exerted by ONE foot for the boot **without** studs = 2424 (Pressure unit)

(ii) With studs: Pressure = force ÷ Area

force = 40N Area = 0.0006m^2

40 ÷ 0.0006 = 66,666.6666

Pressure exerted by ONE foot for the boot **with** studs = 66,666.6666 (Pressure unit)

Incorrect units
40N for force
correct for A

(b) Discuss the advantage gained by the student when running on a soft grass football field while wearing the boots with studs compared to wearing boots of the same size without studs.

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In your answer you should:

- compare the pressure exerted on the ground by the boot with the studs AND the boot without studs
- explain the relationship between surface area and pressure exerted
- explain how the difference in pressures would help the student run on a softer surface like grass.

The advantage of wearing boots with studs on soft grass is the Pressure is concentrated on a smaller surface area causing the studs to dig into the ground giving the runner more traction, wereas the boot with no studs would have no traction causing the runner to slip.

If you need to redraw the graph from Question Two (c), draw it on the grid below. Make sure it is clear which graph you want marked.

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