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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.

Merit

TOTAL 21

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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.

$v = \Delta d \div \Delta t$

$v = 2400 \div 60$

$v = 40$

Average speed = 40 m s^{-1}

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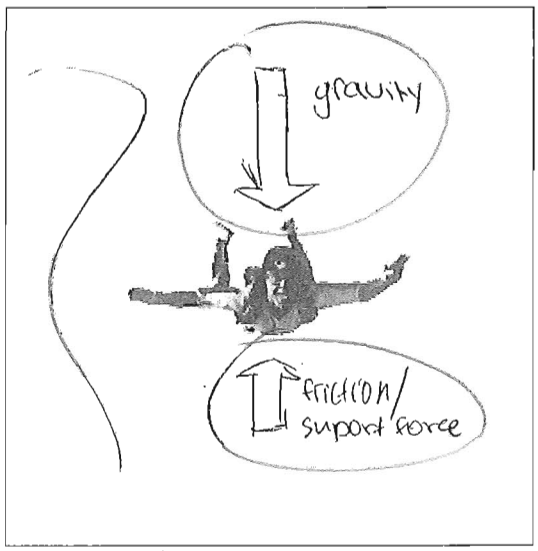
http://riverdaughter.files.wordpress.com/2009/07/free-fall1.jpg

(b) Candidate shows forces being unbalanced & states it too. No mention of acceleration so 1 M point here for part (b)



The forces are balanced as parachutist will be falling at a constant speed. The forces on the parachutist just after she jumps will be unbalanced as there is more gravitational pull than support force.

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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.

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

The parachute reduces the speed of the parachutist when it is just opened because as the parachute has a large surface area, it creates an area for the air to resist against meaning that the parachutist will fall slower. It will change the ~~net~~ net vertical force.

No mention here of net upward force & no mention of effect of Parachute on the air resistance and gravity
So no 2nd mp point
So no 2nd mp point
So now we go back at final 3 AO points
(i) 40 m/s
(ii) force diagram
(iii) large surface area = AO4

A4

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^{-2} 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.

Fnet = m x a //
Fnet = 60 x 0.2 //
Fnet = 12 //

Net force acting on the boy during section Y = 12 (~~kg~~ 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~~ power = work ÷ time
power = 12 ÷ 0.2 ~~power~~ work = force x distance
power = 60 work = 12 x 12.5 work = 150 J
power = 150 ÷ 5
power = 30

Power required by the boy during section Y = ~~60~~ 30 (~~per~~ J) unit

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

$V = \Delta d \div \Delta t$

$V = 12.5 \div 5$

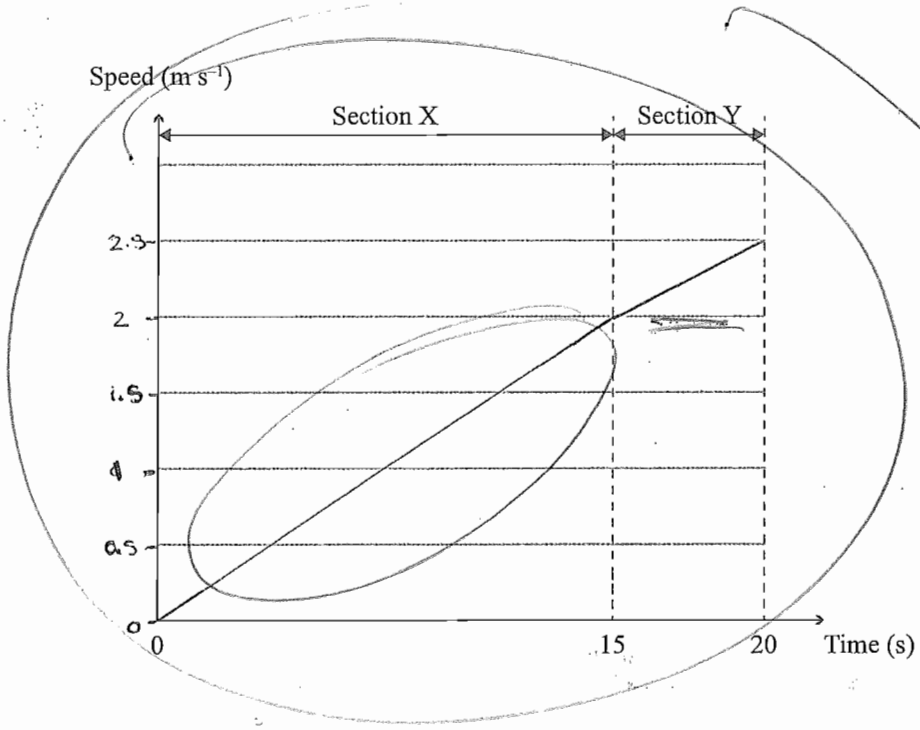
$V = 2.5$

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.

Lack of knowledge of speed-time graph and units lowered grade.

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.

$\Delta Ep = mg\Delta h$ $h = \Delta Ep \div mg$

$h = 5100 \div (60 \times 10)$

$h = 8.5$ 8.5m

(b) In reality, the girl reaches a height of only 8 m.

Explain why the **energy** used by the girl during the climb does **not** equal the work she does to reach the vertical height of 8 m.

In your answer you should:

- name the type of energy the girl has when she is 8 m above the ground
- calculate the work done to reach a height of 8 m above the ground
- calculate the difference between the work done and the energy used by the girl
- explain where the "missing" energy has gone, and why this occurs.

when the girl is 8m above the ground she has gravitational potential energy.

work = force × distance

work = (60 × 10) × 8

work = 4800j

the difference between the work done and the energy used by the girl is:

5100 − 4800 = 300

300j

The 'missing' 300j of energy has been transfered into heat and sound energy. This is because when the girl was climbing the rope she lost some energy in the heat and sound she created. (300j)

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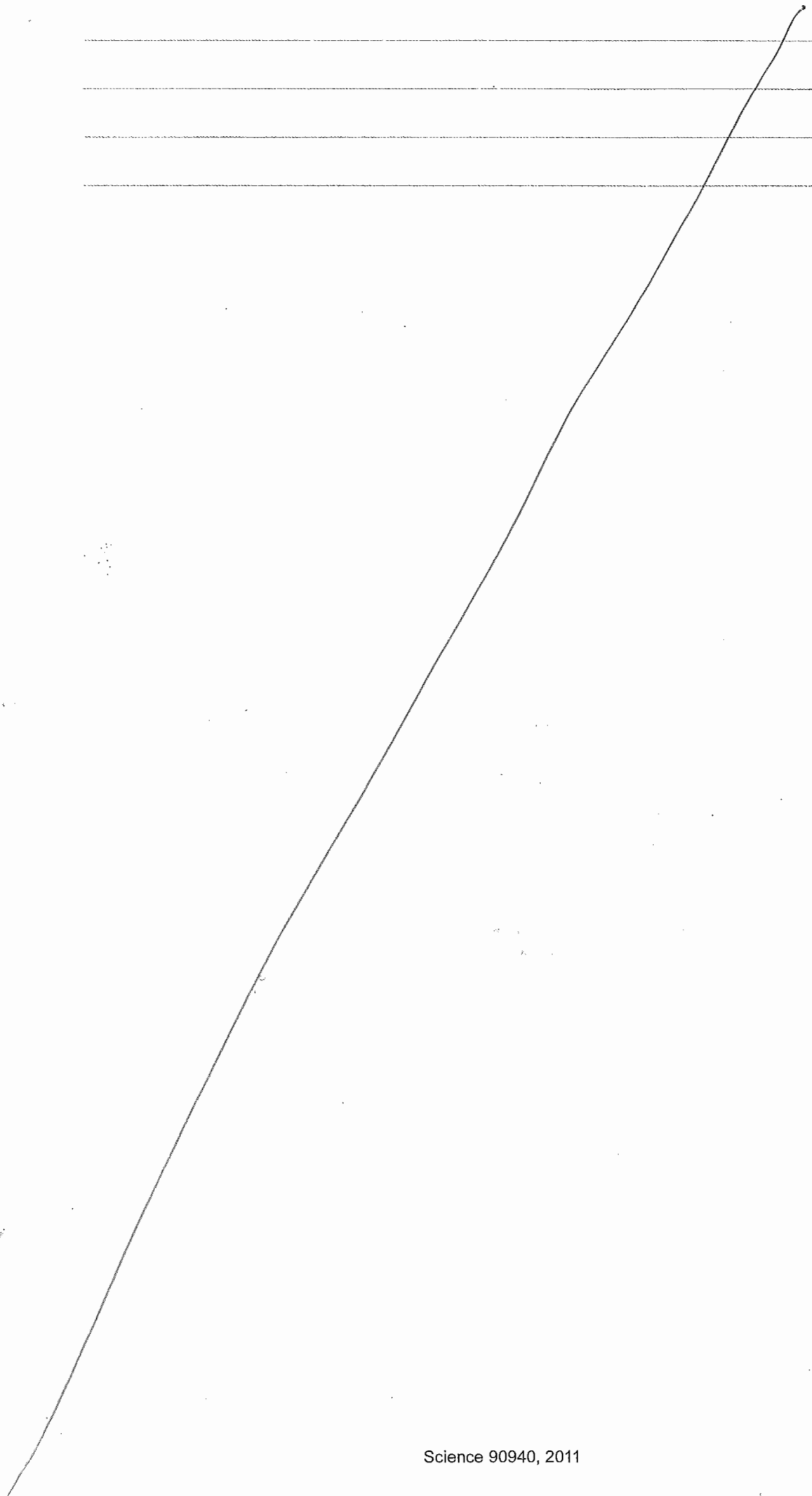

QUESTION FOUR: FOOTBALL BOOTS

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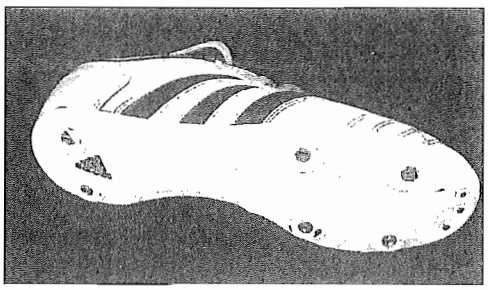
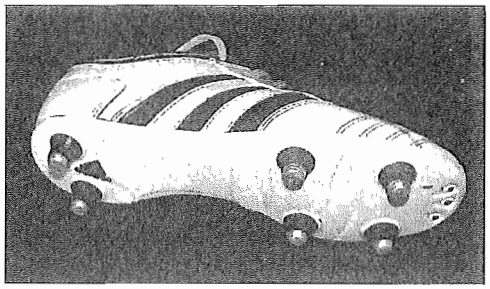


Boot **without** studs.



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

pressure = 40 ÷ 0.0165

pressure = 2424.2 ^

Pressure exerted by ONE foot for the boot **without** studs = 2424.2 (pa) unit

(ii) With studs: pressure = force ÷ area

pressure = 40 ÷ 0.0006

pressure = 66666.7 ^

Pressure exerted by ONE foot for the boot **with** studs = 66666.7 (pa) unit

Units wrong here & using F = 40

So would only be a A point.

(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 gained by the student when running on a soft grass football field while wearing the steded boots compared to the boots without studs is as they are exerting more pressure they will have a better grip on the grass. The studs are gaining all the pressure and so as its a smaller area the studs will sink into the grass giving the student better footing. The boots without studs pressure is less as it is spread on a bigger area so it will not take up grip.

stud = 66666.7, without = 2424.2

66666.7 - 2424.2 = 64242.5pa the difference in pressure is 64242.5pa. The relationship between surface area and pressure is that the larger the surface area the less the grip

Excellent comparitive answer here worthy of 2 LE points Linking Pressure created by small area to grip & comparing with other boot clearly.

= LE7

See also extra discussion on page 13.

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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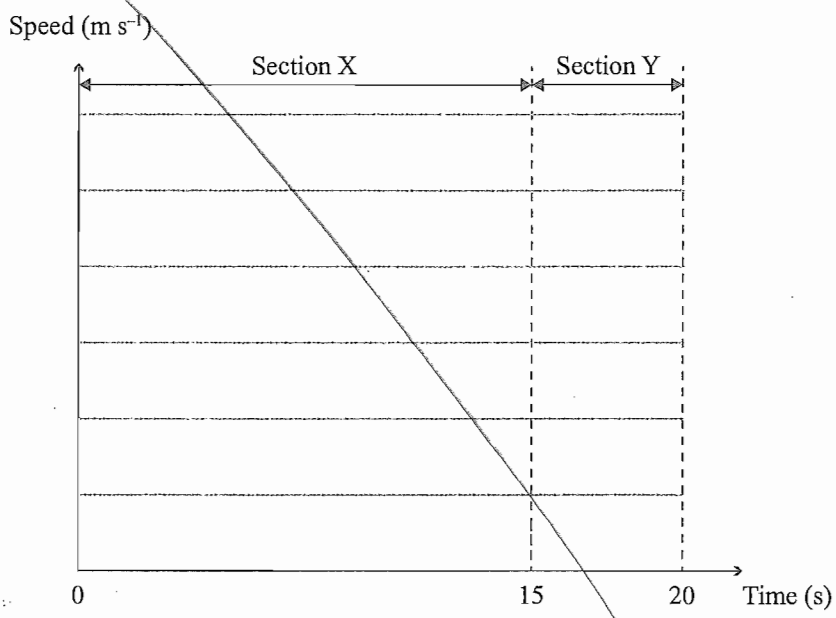

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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4b. the pressure will be, and the smaller the surface area is, the larger the pressure will be. The difference in pressure will help the student wearing boots with studs to run better as since the pressure has a smaller surface area that will sink into the soft grass and give him grip. whereas the boots without studs, since the pressure is less and its on a bigger surface area, the boot will not give the student grip. instead it may glide on the grass.

(seen)