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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Level 1 Science, 2018

90940 Demonstrate understanding of aspects of mechanics

9.30 a.m. Thursday 15 November 2018
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 room for any answer, use the extra space 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.

Merit

TOTAL 15

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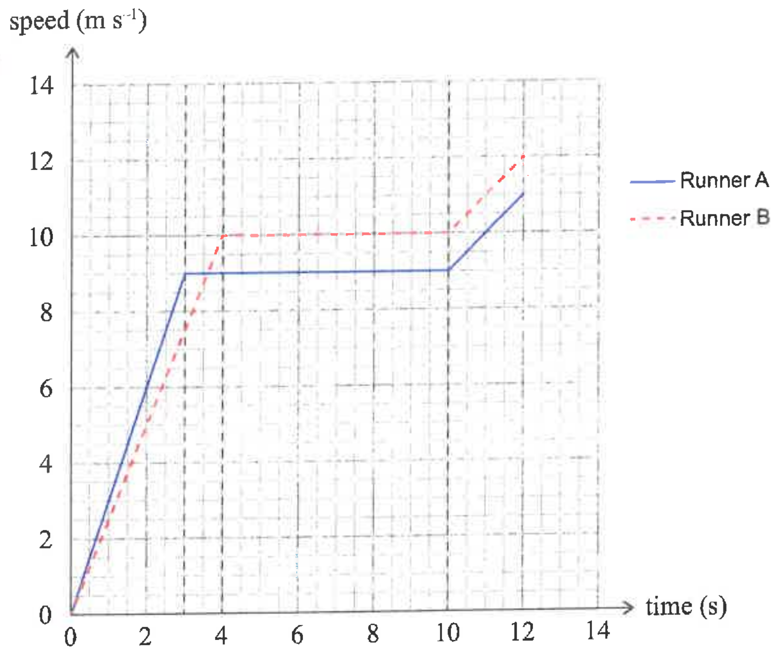
You may find the following formulae useful.

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

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

QUESTION ONE

The speed-time graph shows the motion of two runners in a 100 m race.



(a) From the graph, which runner has the greater acceleration in the first 3 seconds?

Explain your answer.

Calculations are not required.

In the first 3 seconds Runner A has a faster acceleration as the graph is much steeper and reaches a higher speed at 3 seconds.

(b) Using the graph, calculate Runner A's acceleration during the first 3 seconds.

$9/3 = 3\ \text{ms}^{-2}$ $\qquad a = \frac{\text{Change is speed}}{\text{Time.}}$

(c) (i) Use the information in the graph to compare the speed AND acceleration of Runner A and Runner B in the first 10 seconds.

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Runner A
3second accecation $= 9/3 = 3ms^{-2}$

4seconds-10 Second no accecation $8ms^{-1}$
Runner B
4 seconds $10/4 = 2.5ms^{-2}$ = accecation.

5-10 second no accecation $10ms^{-1}$.

Runner A accelerates quickly in the first 3 seconds reaching $8ms^{-1}$ for the rest of the run. Runner B accerates a wee bit slowly but reaches $10\ ms^{-1}$ in 4 seconds.

(ii) Use the information in the graph and calculations to show which runner, Runner A or Runner B, finished the 100 m first.

Runner A 3second $= 0.5 \times 3 \times 8 = 12$ m

$4-10 = 6 \times 8 = 48$ m (60) 10-12 $0.5 \times 2 \times 11 = 11$m Total 71

Runner B 4 second $0.5 \times 4 \times 10 = 20$ 4-10 =

$6 \times 10 = 60$ $10-12 = 0.5 \times 2 \times 12 = 12$ Total = 92

Runner B finish first.

(d) **Each** of Runner A's feet has a surface area of 200 cm^2 (0.0200 m^2), which sink into the track. Together, the feet exert a pressure of 13 000 Pa.

Calculate the **weight** of Runner A.

$13\,000 \times 0.02 = 260$ N

A

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QUESTION TWO

Willow and her mountain bike have a combined mass of 82 kg. She accelerates at the start of a race at 0.80 m s^{-2}.

(a) Calculate the net force acting on the bike and rider when accelerating.

$82 \times 0.8 = 65.5\,N$ $\quad F_{net} = ma.$

(b) (i) Draw and label arrows on the diagram below to show ALL the forces acting on Willow and her bike when accelerating.

https://commons.wikimedia.org/w/index.php?curid=24096670

(ii) Explain the size of the forces involved when Willow and her bike are **accelerating**.

The biggest force will be the thrust force as she is accelerating. If she was moving at a constant speed the thrust force and the friction force will be equal.

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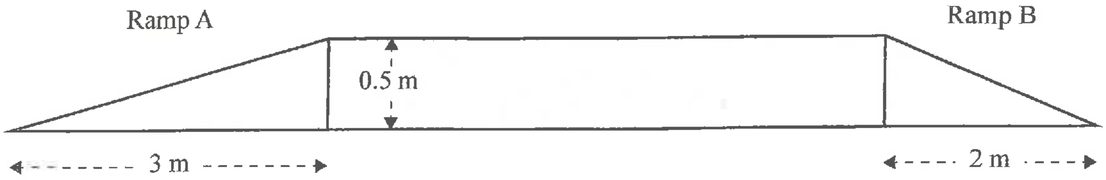
(c) Willow had to choose between two ramps to ride her bike to the top of an incline. It takes less time to use Ramp B.



(i) Is the **work** needed to get to the top of **Ramp A** more, less, or the same as the work needed to get to the top of Ramp B?

Explain your answer.

W= Fd   Ramp A = 3×65.5 =196.5 J

~~B~~ Ramp B = 2×65.5=131 J

Ramp B take less work.

(ii) Explain how the two ramps differ in terms of the **force** and **power** needed to ride up them.

Calculations are not required.

Both ramps will have the same amount of force because Willow is using the same amount of force either way she goes but the power will be different because you divide the work over the time it takes to get up the ramp. Ramp A will use more power because it will take more work to get up it and a longer time.

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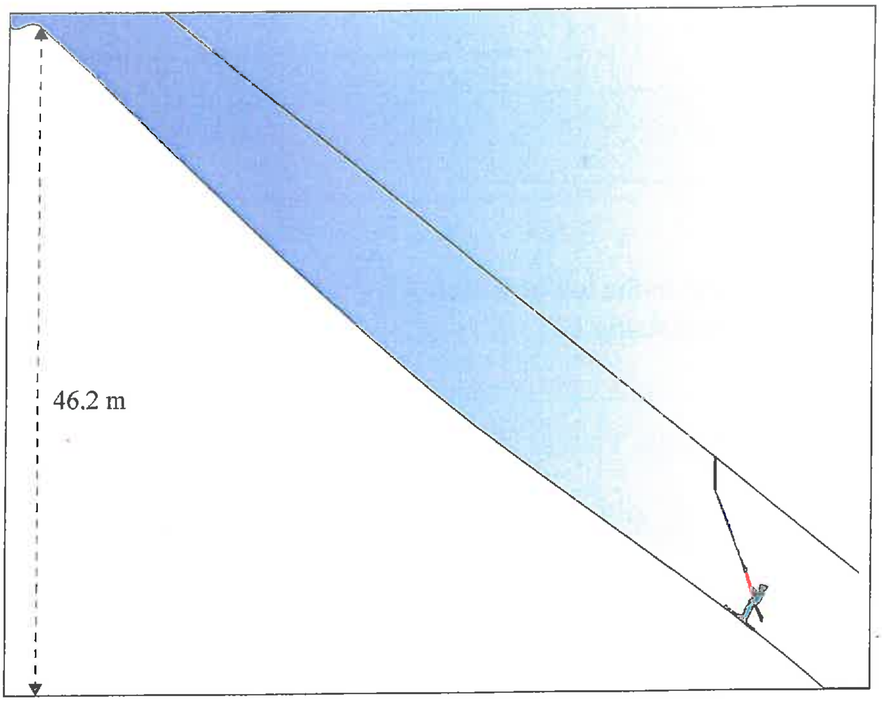
QUESTION THREE



Marama is snow skiing and uses a ski tow to get to the top of the slope.

The ski tow pulls Marama up the slope to a height of 46.2 m. The combined mass of Marama and her ski gear is 62 kg.

(a) Calculate the work done for Marama to reach the top of the slope.

Force = 62 × 10 Nkg⁻¹ = 620 N

620 × 46.2 = 28644 J

(b) It takes 525 s for the tow to pull Marama to the top of the slope.

Calculate the power needed to get Marama to the top.

For this question, ignore friction.

$P = \frac{W}{T}$ 28644/525 = 54.56 W

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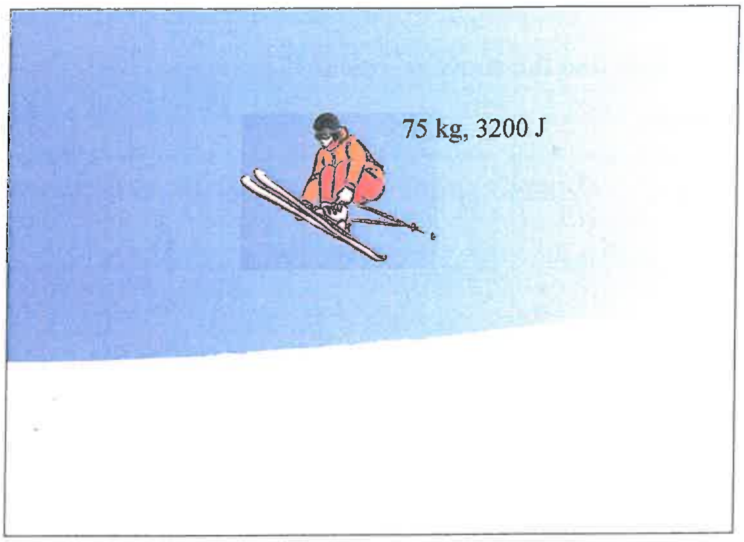
(c) Jake has a mass of 75 kg and is doing a jump.



He has 3200 J of gravitational potential energy at the top of his flight.

(i) Calculate his downward (vertical) speed just before he lands, assuming energy is conserved.

$75 \times 10 \times 46.2 = 34650$ N.

(ii) Explain why Jake's actual speed when he lands is slower than that calculated in part (i).

Jake's speed is slower than calculated because some energy is lost because of air friction and air resistance

Question Three continues on the following page.

(d) Jake changes to his wide skis. The skis measure 10 cm in width compared with normal skis of 5 cm. Both sets of skis are the same length.

Explain why Jake does not sink into the snow as much when he uses his wide skis.

Calculations are not required.

Jake doesn't sink as far into the snow on his wide skis as much because there is a bigger surface area and his weight is distributed more evenly.

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M5

Annotated Exemplar Template

Subject	Science	***Standard***	90940	***Total score***	15

Q	***Grade score***	***Annotation***
1	M5	This candidate was prevented from moving to the excellence level due to a number of small errors. In question 1(ci) they incorrectly read the steady speed off the graph as $8ms^{-1}$ instead of $9ms^{-1}$. In Question c(ii) they used the right method to calculate the distance travelled but did not calculate the answer correctly and in question 1(d) they needed to double this answer to reflect that this runner had two feet.
2	M5	This candidate calculated the net force correctly and drew the correct vectors on the cyclist with the correct sizes. They did appreciate that the thrust force was bigger than the frictional force; however, did not state that this will cause an acceleration in the direction of this unbalanced force. It also may not have been the biggest force just the one that was unbalanced to cause the accelerated motion. In section (c) this candidate did not realise that the vertical height of both ramps would be the same so therefore the cyclist would do the same amount of work travelling up each ramp. Since the work is the same the power and force up Ramp B would be larger.
3	M5	Section (a) and (b) was well done by this candidate. The section that let them down was part (c). They did not use the formula for kinetic energy ($E_k = 1/2mv^2$) to calculate the vertical speed of the skier nor mention that not all of the skier's gravitational potential energy is converted into kinetic energy as some of this is converted into heat and sound due to air resistance and this accounts for a loss of speed. In part (d) this student realised that wider skis had a larger surface area but could not explain that this would result in a lower pressure since the weight of the skier would stay the same