No part of the candidate evidence in this exemplar material may be presented in an external assessment for the purpose of gaining credits towards an NCEA qualification.

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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.

Excellence

TOTAL 22

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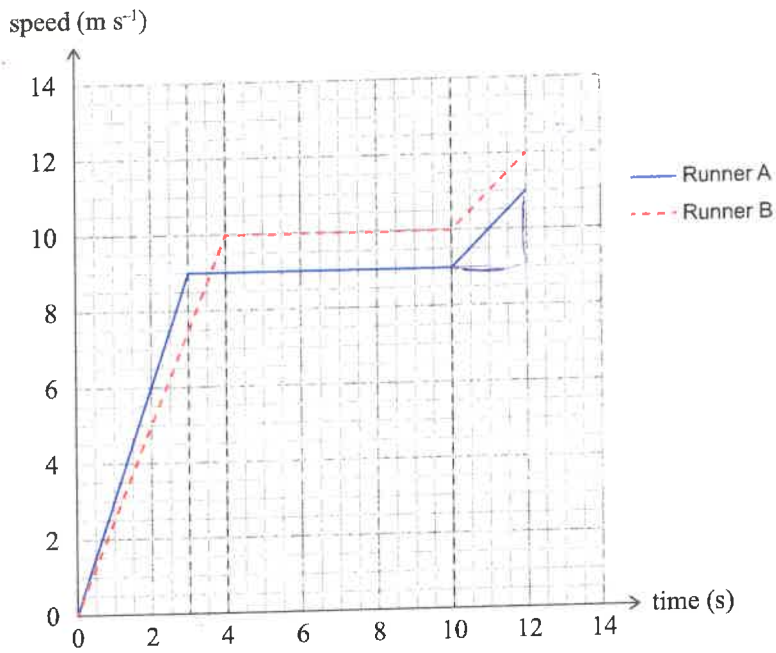
You may find the following formulae useful.

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

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

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.

Runner A ~~travels~~ accelerates to the ~~at~~ ~~the~~ speed of $9\,ms^{-1}$ during the first 3 seconds while Runner B accelerates to the speed of $7.5\ ms^{-1}$ during the first 3 seconds. This means that Runner A has ~~ana~~ acceleration of $3ms^{-2}$ and B has an acceleration of $2.5ms^{-2}$ and therefore Runner A has the greater acceleration

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

$a = \frac{\Delta v}{\Delta t}$ $\quad a = \frac{9}{3}$ $\quad a = 3ms^{-2}$

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(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.

During the first 3 seconds Runner A accelerates to ~~travels at~~ a speed of 9 ms^{-2} with an acceleration of $3ms^{-2}$.

Runner B accelerates to a speed of 10ms⁻¹ in the first 4 s with an acceleration of $2.5ms^{-2}$.

~~But~~ then from 3 s to 10 s (7 s) Runner A travels at a constant speed of 9ms⁻¹. From ~~anywhere along~~ 4 s to 10 s (6 s) Runner B travels at a constant speed of 10ms⁻¹.

(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 distance travelled (in 12 s) $= (\frac{1}{2}bh) + (bh) + (\frac{1}{2}bh + bh)$

$= (\frac{1}{2} \times 3 \times 9) + (7 \times 9) + (\frac{1}{2} \times 2 \times 2 + 2 \times 9)$

$= 13.5 + 63 + 20$

$= 96.5$

Runner B distance travelled (in 12 s) $= (\frac{1}{2}bh) + (bh) + (\frac{1}{2}bh + bh)$

$= (\frac{1}{2} \times 10 \times 4) + (6 \times 10) + (\frac{1}{2} \times 2 \times 2 + 10 \times 2)$

$= 20 + 60 + 22$

$= 104m$ ∴ Runner B finished 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.

$P = \frac{F}{A}$ $F = PA$

$A = 0.02 \times 2$

$= 0.04 m^2$

$P = 13000$

$F = 0.04 \times 13000$

$= 520 N$

E7

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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}.

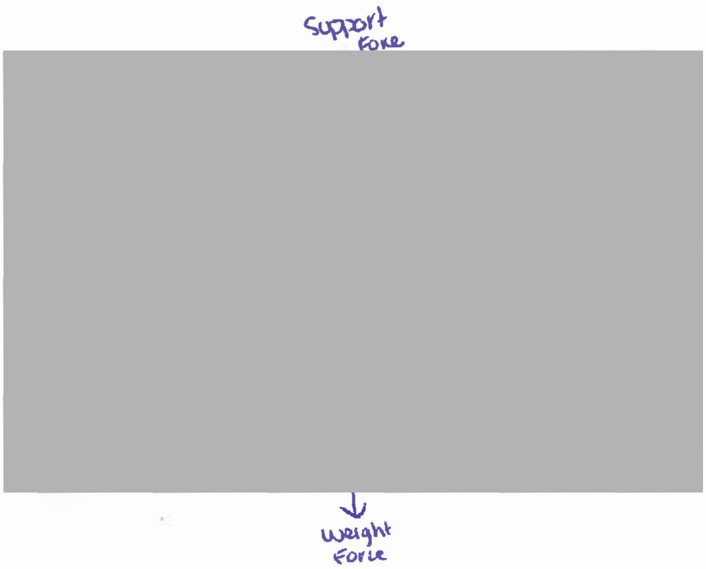
(a) Calculate the net force acting on the bike and rider when accelerating.

$F_{net} = ma$

$= 82 \times 0.8$

$= 65.6$ N

(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**.

When willow is accelerating the forces acting on her will be thrust and friction. If she is accelerating the thrust force will be greater than the friction force meaning that the forces are unbalanced, this means that there is a net force in the direction of movement and she will be accelerating

(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.

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(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.

The work need to get to the top of Ramp A is the same as ~~the~~ needed to get to the top of Ramp B. ~~The~~ Work is W= Fd and although the distance travelled is greater for Ramp A ~~different~~ the force needed would be greater on Ramp B * * which balances it out.

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

Calculations are not required.

The force required to ride up Ramp B is greater than Ramp A as because it's incline is higher ~~the~~ Willow would need to exert more force to be able to ride up it compared to Ramp A. In terms of ~~B~~ power Willow will need less power to travel up Ramp A than B. This is because although the work done to ride up these ramps is the same the time it would take would be longer. Time is inversley proportional to Power as $P = W/t$, Therefore when the time increases the power decreases. So, as the time it takes to ride up ramp A is longer than Ramp B due to it being longer (distance travelled is increased) the power needed to ride up them is less than Ramp B.

E7

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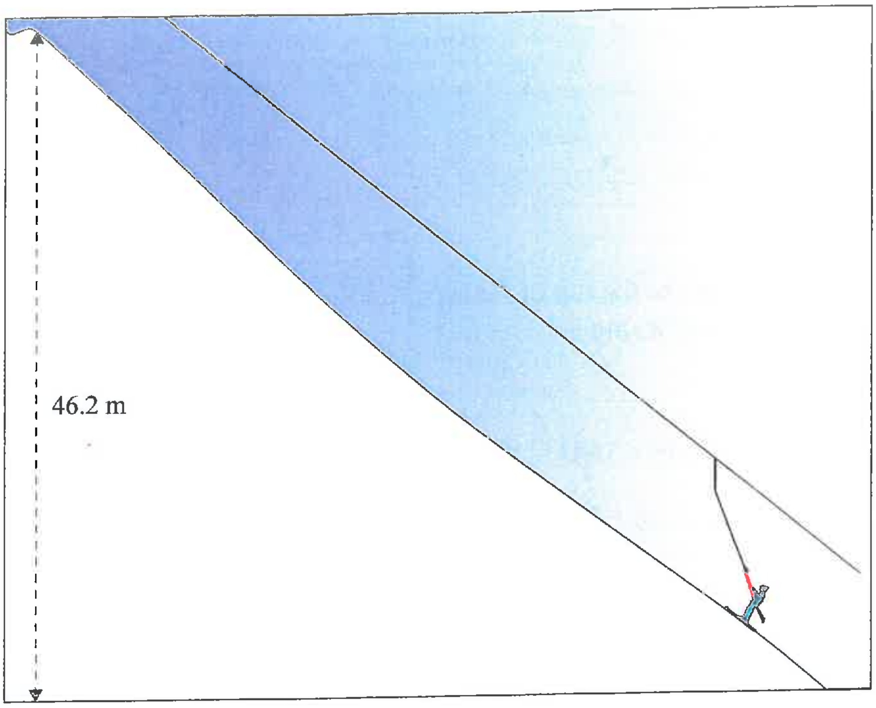
QUESTION THREE



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.

$W = F\ d$ $\qquad W = 620 \times 46.2$

$F = mg$ $\qquad = 28644\ J$

$= 62 \times 10$

$= 620\ N$

(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.

$P = W/t$ $\qquad W = 28644$ $\qquad t = 525$

$P = \frac{28644}{525}$

$= 54.56\ W$

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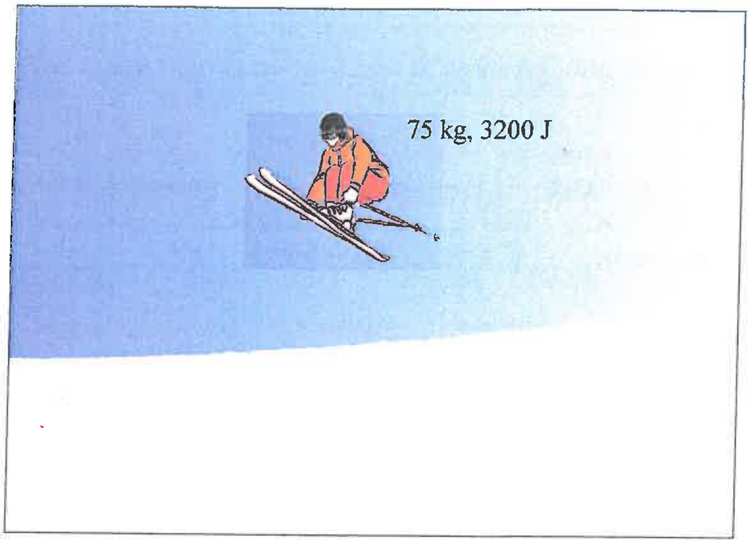
(c) Jake has a mass of 75 kg and is doing a jump.



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.

Assuming energy conserved $E_p = E_K$

$E_K = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2E_K}{m}}$

$v = \sqrt{\frac{2 \times 3200}{75}}$

$v = 9.2\,ms^{-1}$ (1 dp)

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

Jake's actual speed when he lands is slower because in part (i) we were assuming that energy is conserved which means that $E_p = E_K$ as there is no friction. However, in real life ~~some~~ energy from the gravitational potential energy would be transferred into kinetic energy as well as heat energy ~~friction~~. This is because the heat energy is ~~friction~~ ~~is~~ a result from air resistance as when Jake is (extra space)

Question Three continues on the following page.

see

(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.

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

Calculations are not required.

When calculating pressure (the spread of force over an area) we use the formula $P = \frac{F}{a}$. If Jake uses his wide skis they have a larger surface area as the width increases from 5cm to 10cm which will make the total surface area larger as the length remains the same. As ~~pressure~~ area is inversely proportional to pressure, as the area of his skis increases the pressure exerted by him and his skis onto the snow will decrease as his

see

E8

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

QUESTION NUMBER

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3) ii) moving through the air he has to push air particles out of his way which causes some friction. This means that $E_p \neq E_K$ anymore as due to some of the energy being tranformed into heat $E_K < E_p$. This would cause ~~the~~ Jake's speed to decrease as velocity is proportional to kinetic energy meaning that if it decreases his speed will as well. Therefore, making Jake's actual speed slower than ~~what~~ was calculated in part (i).

d) weight force ~~has also~~ has remained constant. therefore, when Jake uses his wide skis he doesn't sink into the snow as much because ~~then the~~ the pressure has decreased.

Annotated Exemplar Template

Subject	Science	***Standard***	90940	***Total score***	22

Q	***Grade score***	***Annotation***
1	E7	This question was well done with this candidate making one small mistake in adding the distance travelled by runner B. 20 + 60 + 22 = 102 (not 104 as stated by this candidate)
2	E7	Again, this question was well done. However, in section (c ii) this candidate did not fully explain why the force was greater for Ramp B. If the work force stays the same and the distance decreases then the force must increase due to the equation W = Fd with the distance in this instance being the distance up the slope.
3	E8	This question was very well done, well set out and well explained. It could have been done a little more concisely, however, it was a very good answer.