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.

90940

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1

SUPERVISOR'S USE ONLY

Level 1 Science, 2017

90940 Demonstrate understanding of aspects of mechanics

9.30 a.m. Wednesday 15 November 2017
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 2–12 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.

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

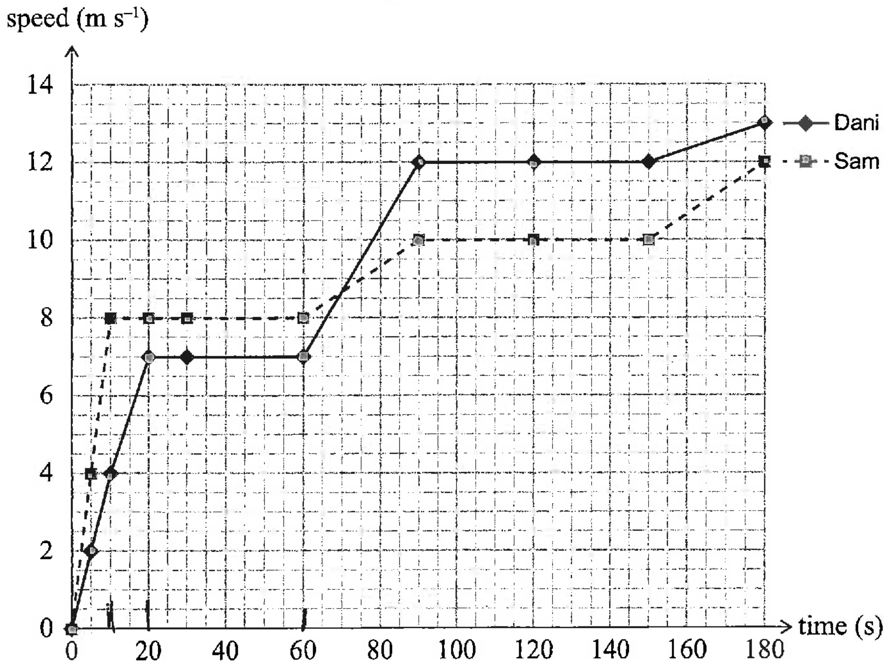
$$E_{\text{k}} = \frac{1}{2}mv^2 \qquad W = Fd \qquad g = 10\text{ N kg}^{-1} \qquad P = \frac{W}{t}$$

QUESTION ONE

Two horses, ridden by Dani and Sam, are racing against each other.

www.cambridgejockeyclub.co.nz

The speed-time graph of their two horses is shown below.



(a) Use the information in the graph to compare the speed AND acceleration of Dani and Sam in the **first 60 seconds**.

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~~Dani - Is going at a speed of 7ms⁻¹ in the first 5s 20s*, Dani's speed stays goes to at 7ms⁻¹ in the first 60s. His aceleration is 1.2ms⁻² DANI~~

~~and ms⁻¹ at 10s~~

~~$a = \frac{\Delta v}{\Delta t}$ $a = \frac{V_f - V_i}{t}$ $a = \frac{7-0}{6s}$ = $a = \frac{7ms^{-1}}{6s} = 1.2ms^{-2}$~~

Sam - Is going at a speed of $4ms^{-1}$ in 5s, $8ms^{-1}$ at 10s, and $8ms^{-1}$ for the rest of the 60 s

His Aceleration is $a = \frac{\Delta v}{\Delta t} = a = \frac{8ms^{-1} - 0}{\cancel{60}\ 10} = \frac{8ms^{-1}}{\cancel{60}\ 10s} = \cancel{0.13ms^{-2}}$ $0.8ms^{-2}$

Aceleration = $0.13ms^{-2}$

Dani - Is going at a speed of $2ms^{-1}$ in 5s, $4ms^{-1}$ in 10s, $7ms^{-1}$ at 20s, and $7ms^{-1}$ for the rest of 60s

His aceleration is $a = \frac{\Delta v}{\Delta t} = a = \frac{7-0}{20\ \cancel{60}} = \frac{7ms^{-1}}{\cancel{60}\ 20} = \cancel{0.12ms^{-2}}$ $0.35ms^{-2}$

Sam has a aceleration of ~~0.13ms⁻²~~ $0.8ms^{-2}$ and Dani has a aceleration of ~~0.12ms⁻²~~ $0.35ms^{-2}$.

Sam aceleration is $0.8ms^{-2}$

Dani aceleration is $0.35ms^{-2}$

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Sam's horse accelerates for the first 10 s of the race AND covers a distance of 40 m. Sam and his horse have a total mass 308 kg.

F = m × a

(b) Use the acceleration to calculate the work that Sam and his horse have done in the first 40 m.

W = F × d   F = 308 kg × 0.8 ms^{-2}
= 246.4 N

W = 246.4 N × 40 m
= 9856 J

Work done in the fist 40m is 9856J.

(c) Explain the effect on **work** AND **power** if a new, heavier jockey was on Sam's horse, which had the same speed and acceleration over the race.

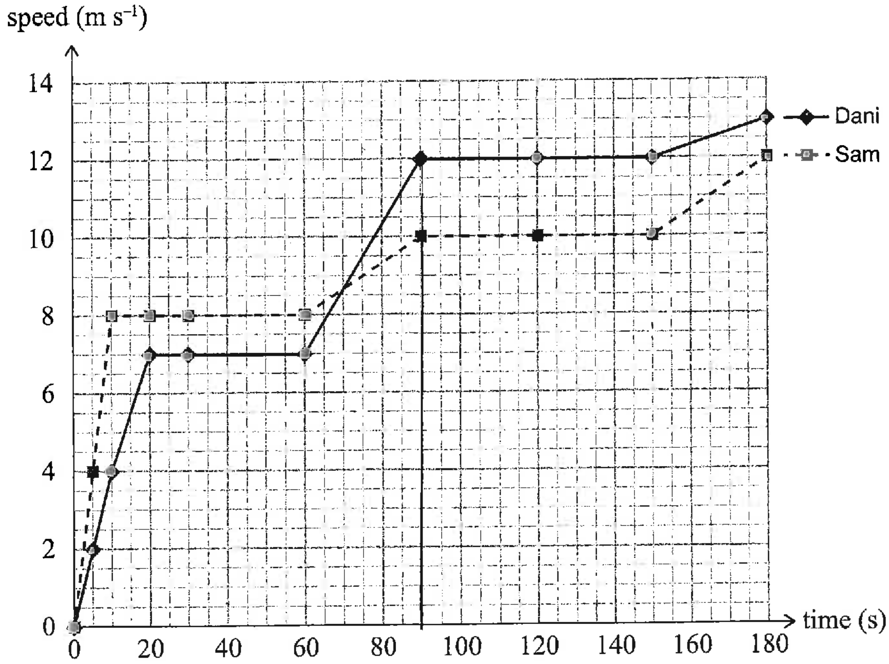
Calculations are not required.

The work done would be more because there is a larger force, as the mass of the new jockey is heavier. W = F × d

Power is work done divided by time. P = W/t
If there is more work but the same amount time means there would be more power also. $P = \frac{W}{t}$ W = more, t = same → more power

(The speed-time graph from page 2 is repeated below.)

ASSESSOR'S USE ONLY



(d) After 90 s, Sam and his horse had travelled 710 m.

How much further had they travelled compared to Dani and her horse at this stage in the race?

Use the information in the graph and any necessary calculations to answer.

Dani: $\Sigma(\frac{1}{2} \times b \times h) + (b \times h) + (\frac{1}{2} \times b \times h + b \times h)$

30×7

$= \frac{1}{2} \times 20 \times 7 + 40 \times 7 + \frac{1}{2} \times 30 \times 5 + \cancel{7 \times 30}$

$= 70 + 280 + 75 + 210$

$= \underline{635 m}$

Sam − Dani = 710m − 635 m

$= \underline{75m}$

Sam and his horse travelled 75m more than Dani and her horse in the 90 s

M6

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QUESTION TWO

A lightweight waka ama (outrigger canoe) has a mass of 9.90 kg.

(a) What is the difference between **mass** and **weight**?

Use the waka ama as an example, and include a calculation for weight.

Mass is the amount of matter in something, if you change planets in cannot be changed and it is measured it kgs. A lightweight waka ama has a mass of 9.90kg. Weight is the amount of gravity acting on a object, it can be changed if you change planets and it is measured in Newtons (N). $F_{weight} = m \times g = 9.90kg \times 10Nkg^{-1}$ $= 99N$. The weight of the waka ama is 99N.

A sketch of the waka ama hulls is shown below right.

http://www.tangaroa.school.nz/small-gallery-article/waka-ama-nationals/134766/324377/

www.selway-fisher.com/Opcan17.htm

(b) Calculate the pressure exerted by the waka ama (both hulls) on the water.

Your answer should include:

- an area calculation (assume both waka ama hulls are rectangular in shape, and the measurements above show the area in contact with the water)
- a calculation of the pressure.

$A = (b \times h) + (b \times h)$

$= (0.40 \times 6.55) + (0.15 \times 4)$

$= 2.62m^2 + 0.6m^2$

$= 3.22m^2$

$F = m \times g$

$= 9.90kg \times 10NKg^{-1}$

$= 99N$

$P = F/A$

$P = \dfrac{99N}{3.22m^2}$

$= 30.75 Nm^{-2}$

The pressure is ~~30.75N~~ 30.75Nm⁻²

(c) The waka ama sinks further into the water when a 67 kg paddler sits in it.

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Explain why the waka ama sinks further into the water when the paddler sits in it.

Use calculations to support your answer.

The waka ama sinks further into the water because the pressure exerted has increased, as the force has increased but the area has remained the same

Mass is now 9.90kg + 67 kg = 76.9kg

Fweight = 76.9kg x10 = 769N

Area = 3.22m²

$P = F/A$

$= \frac{769N}{3.22m^2}$

$= 238.82 Nm^{-2}$

The pressure the waka ama + paddler exerts on the water is $238.82 Nm^{-2}$. The waka ama sinks in further, because a larger ~~force~~ weight has been distributed over the same area resulting in a larger pressure exerted on the water causing the waka ama to sink in further.

ES

QUESTION THREE

ASSESSOR'S USE ONLY

www.turbosquid.com/3d-models/3d-model-port-container-crane-industrial/689347

(a) The crane shown above lifted a container 30 m in 15 s. The weight of the container is 60 000 N.

(i) Calculate the work done by the crane in lifting the container 30 m.

W = F × d
= 60 000N × 30m
= 18 00000 J

(ii) Calculate the power of the crane while lifting the container 30 m in 15 s.

P = W/t
= 18 00000 J / 15 s
= 12 0000 W

(b) Explain what work is being done on the container when it is hanging in the air without moving.

W = F × d Work done requires distance – movement. As work done is measured is energy joules and energy transferred, therefore work to be done it needs to be moving. The container in the air isn't moving so therefore there is no work being done.

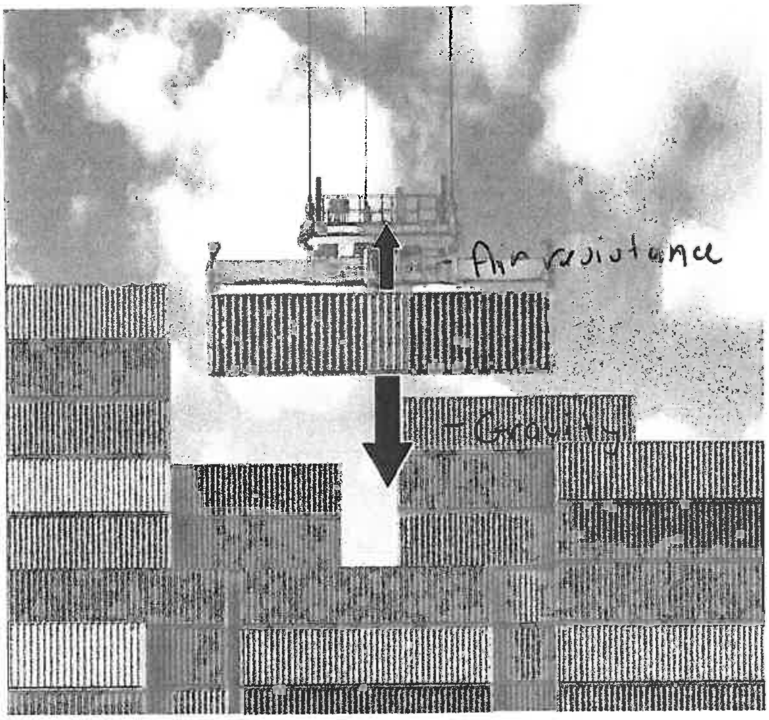
ASSESSOR'S USE ONLY

(c) Referring to the force diagram below, explain the link between the vertical net force acting on the container, and the type of motion produced, while the container is **being lowered**.

In your answer, you should:

- describe what is meant by net force
- explain the link between the direction of the vertical net force and motion.

Force diagram



Net force is the overall force acting on a object, if forces are balanced net force equals 0N and if forces are unbalanced ~~force~~ net force is greater than 0N. The vertical forces are unbalanced so therefore net force is greater than 0N. The vertical forces acting are gravity/weight and air resistance. Gravity is pulling the weight down and the air resistance is opposing the motion. The motion is accelerating as the gravity is larger than the Air resistance, ~~net fo~~ as gravity and air resistance point opposite directions they are subtracted as gravity is larger the net force points ↓ downwards. Therefore the container is accelerating towards the ground, as net force points in this direction and gravity is pulling the ~~c~~ container down.

Question Three continues on the following page.

(d) The crane was lifting another container and the cable broke. The 6500 kg container fell 15 m to the ground below. The container had 970 000 J of kinetic energy just before it hit the ground.

Calculate the energy the container had before the cable broke.

AND

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

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The energy the contain had before it broke was Gravitational Potential Energy (Ep), it had kinetic Energy (Ek) just before it hit the ground.

$Ep = m \times g \times h$

$= 6500kg \times 10Nkg^{-1} \times 15m$

$= 975000J$

The Ep was 975000J

Differenca $Ep - Ek = 975000J - 970000J$

$= 5000J$

The Ep and Ek are different because as the container fell the Ep energy converted into Ek kinetic energy but 5000J was lost to heat and sound energy. Heat and sound energy was produced as the container fell there was friction between air particles rubbing against the container generating heat and sound energy.

E8

Subject:	Science	Standard:	90940	Total score:	22

Q	Grade score	Annotation
1	M6	1(a) This candidate has calculated the acceleration of Sam and Dani correctly and made a comparison between the two. 1(b) The calculation for Sam's acceleration (which is needed to calculate the work done) uses values from the graph correctly. This value for acceleration is carried forward and used correctly to calculate both Force and Work 1 (c) This student realised that an increase in the weight increases the weight force and hence the work. They mentioned that an increase in power results from this if the time stays the same but did not mention that work is increased only if the distance stays the same. 1(d) The distance travelled using the area under the graph was used and the correct comparison of distances was made in this question.
2	E8	2(a) A definition of mass and weight was stated as well as a calculation of weight. 2(b) This question was done well with the combined areas of both hulls calculated as well as the correct pressure. A correct unit for pressure was also given. 2(c) An understanding of increasing the weight increases the pressure was given and this was supported by calculations of both an increase in weight and an increase in pressure. A statement that the area stays the same was also provided.
3	E8	3(a) The correct values for both work and power are calculated correctly (with the correct units). 3(b) An understanding of no work is done if the object does not move was stated in this answer. 3(c) Here the student has explained what the terms net force and unbalanced forces are and has mentioned that this unbalanced force is in the downwards direction and that this causes an acceleration towards the ground. 3(d) A calculation of gravitational kinetic energy was done correct and that the difference between the gravitational potential energy and the kinetic energy (5000J) was converted into heat and sound and even though this student did not use the term air resistance they certainly described it.