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NZQA

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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.

Achievement

TOTAL 12

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You may find the following formulae useful.

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

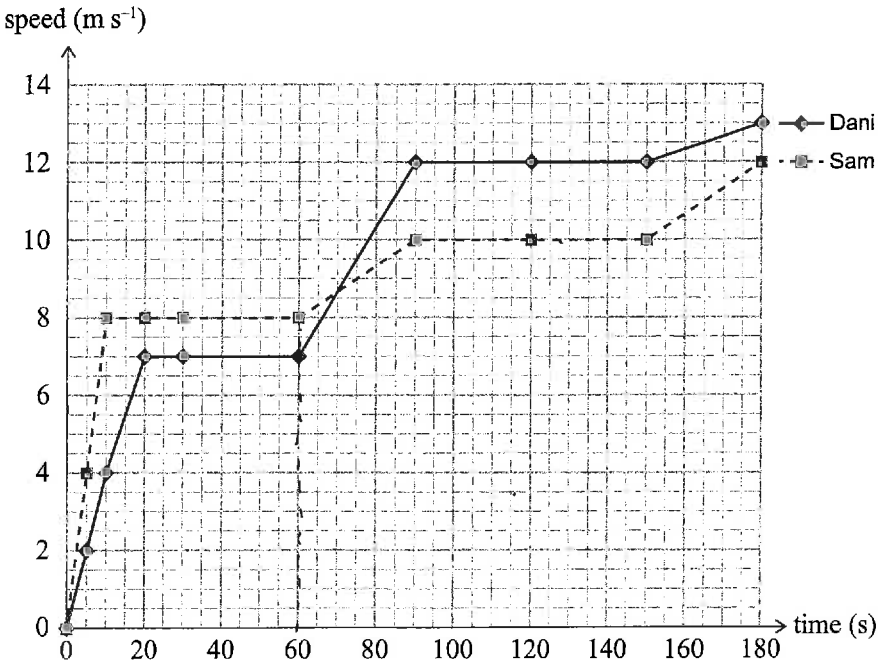
$$E_k = \frac{1}{2}mv^2 \qquad W = Fd \qquad g = 10 \text{ N kg}^{-1} \qquad P = \frac{W}{t}$$

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- speed - 7m/s

Sam- speed - 8m/s

Dani
acceleration:

$$a = \frac{\Delta v}{\Delta t} = \frac{7}{60} = 0.12 m/s^2$$

Sam
acceleration =

$$a = \frac{\Delta v}{\Delta t} = \frac{8}{60} = 0.13 m/s^2$$

Sam is travelling at a higher speed than dani and ~~is accelerating~~ has a higher acceleration.

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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.

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

$W = F \times d$ $F = m \times g$

$W = 3080N \times 40m$ $F = 308kg \times 10$

$W = 123200\ J$ $F = 3080\ N$

Sam and his horse have done 123200 J of work in the first 40m.

(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.

If a new, heavier jockey was on sams horse travelling at the same speed with the same acceleration, it would have an effect on the work and power because the horse would be carrying more weight as the jockey has a greater mass the sam, meaning more force is applied which will effect the distance the hose covers, in what time. It would also affect the power because the jockey weighs more then sam which means it will take more time for the horse to complete the race as the it will have to do more work.

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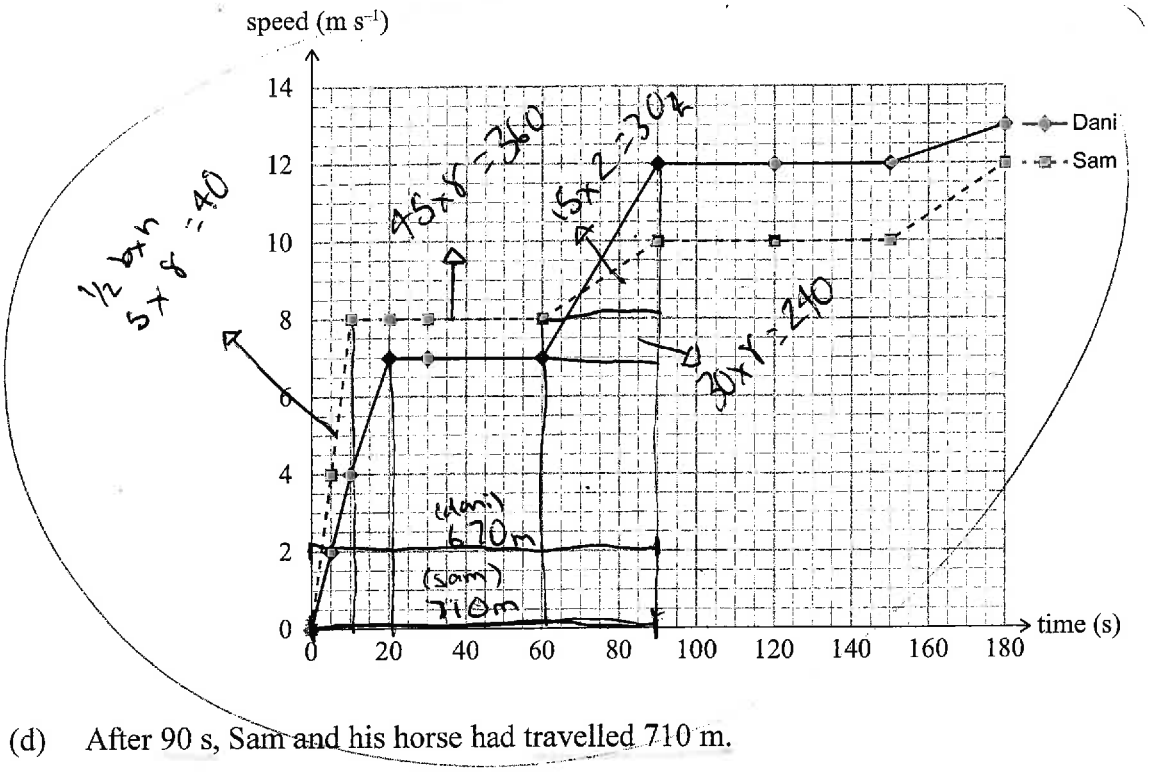
(The speed-time graph from page 2 is repeated below.)



(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.

After 90s Sam had travelled 710m
After 90s Dani had travelled 670m
Sam had travelled 40m further than Dani at this stage of the race. This could be due to Sam having a faster acceleration at the start of the race.

A4

QUESTION TWO

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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 an object

Weight - is the amount of gravity acting on that object

So this means, the amount of matter in the waka ama is 9.90kg

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

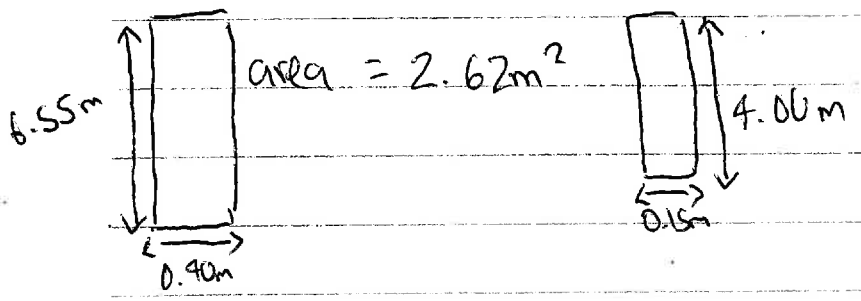
http://www.tangaroa.school.nz/small-gallery-article/waka-ama-nationals/134766/324377/

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.



(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 when a 67 kg paddler sits in it because he has a greater weigh, which means a greater amount of force is acting on the waka ama exerting more pressure onto it causing it to sink more.

A4

QUESTION THREE

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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.

$W = F \times d$

$W = 60000 \times 30$

$W = 1800000$ J

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

$P = \frac{W}{t}$

$P = \frac{600000 \text{ N}}{15 \text{ s}}$

$P = 4000 \text{ W}$

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

the work being done when the container is in the air is the force of the container on the crane and ~~the~~ holding the weight of it in the air.

(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**.

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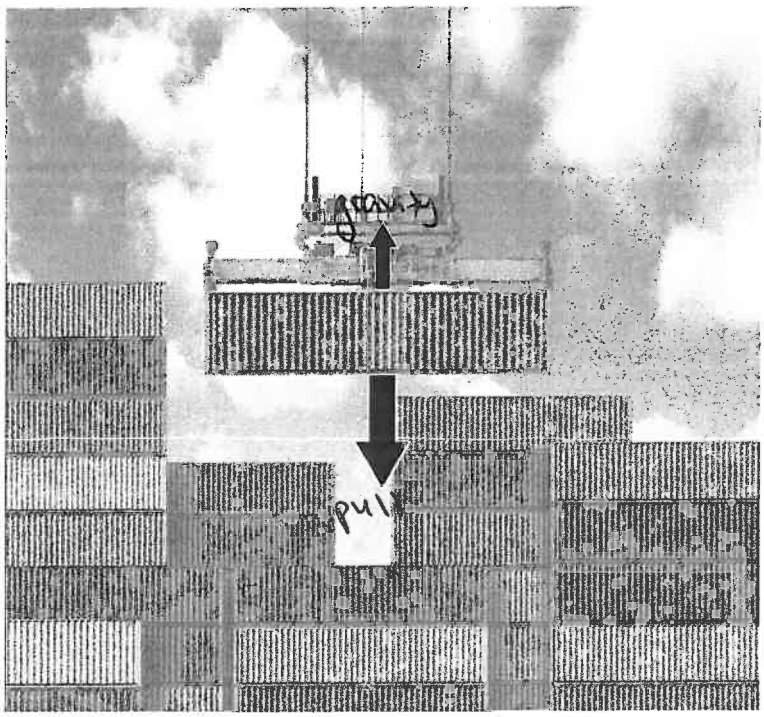
In your answer, you should:

- 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 result of an unbalanced force, it is calculated by the objects mass times its acceleration. While the container is being lowered, the link between the vertical net force acting on the container and the type of motion produced is, that the container is traveling ~~down~~ in a downwards direction and the motion is downwards well because ~~it is~~ the forces acting on the container are unbalanced resulting in a ~~net force~~ vertical net force and motion.

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.

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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.

$\Delta E_p = mg\Delta h$

$\Delta E_p = 6500kg \times 10 \times 15$

$\Delta E_p = 975000J$

The container had a ~~[illegible]~~ GPE of 975000J before the cable broke. The container then had 170 000J kinetic energy as it was falling but some of this was lost due to heat and sound. The container ~~[illegible]~~ also had gravity and air resistance acting on it as it was falling which would have slown it down. 5000J were lost to heat and sound ~~and also the~~ energy and the forces acting on the container as it fell also would have caused this.

A4

Achieved exemplar 2017

Subject:	Science	Standard:	90940	Total score:	12

Q	Grade score	Annotation
1	A4	1(a) This student recognised that Sam was travelling faster than Dani but did not use data from the graph correctly. They also incorrectly calculated the acceleration as neither rider accelerated for the entire 60 seconds. 1(b) There was one correct calculation here using an incorrect value for acceleration. The riders are accelerating on the flat not under free fall so 10 ms^{-2} cannot be used in this case. It must be calculated from the graph. 1 (c) This candidate realised that an increase in the weight increases the weight force and hence the work, but they did not mention an increase in power nor that distance (for work) and time (for power) needs to be kept the same. 1(d) The distance travelled using the area under the graph was used and comparison of distances between the two riders was made. *There is a basic level of understanding of Physics here for an Achieved in this question*
2	A4	2(a) A definition of mass and weight was stated but this question also asked for a calculation of weight which was not provided. 2 (b) The area of both hulls of the waka ama was calculated but a calculation of the pressure was not given. 2 (c) An understanding of increasing the weight increases the pressure was certainly given but this was not supported by calculations *Students need to answer the whole question to be considered for award of higher grades.*
3	A4	3(a) The work done was calculated correctly. This figure needed to be carried through to part (ii) to calculate the power used. 3(b) If there is no movement then there is no work being done was mentioned which adequately answers this question. 3 (c) Here the student has started to explain what the term Net Force means but has not appreciated that an unbalanced force will cause an acceleration in the downwards direction. 3(d) This is starting to be a good answer. A calculation of gravitational kinetic energy was done correctly, and this student mentioned that the "missing" energy (5000J) was converted into heat and sound, however, the link that this was due to air resistance was not clear.