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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.**

Merit

TOTAL 16

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You may find the following formulae useful.

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

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

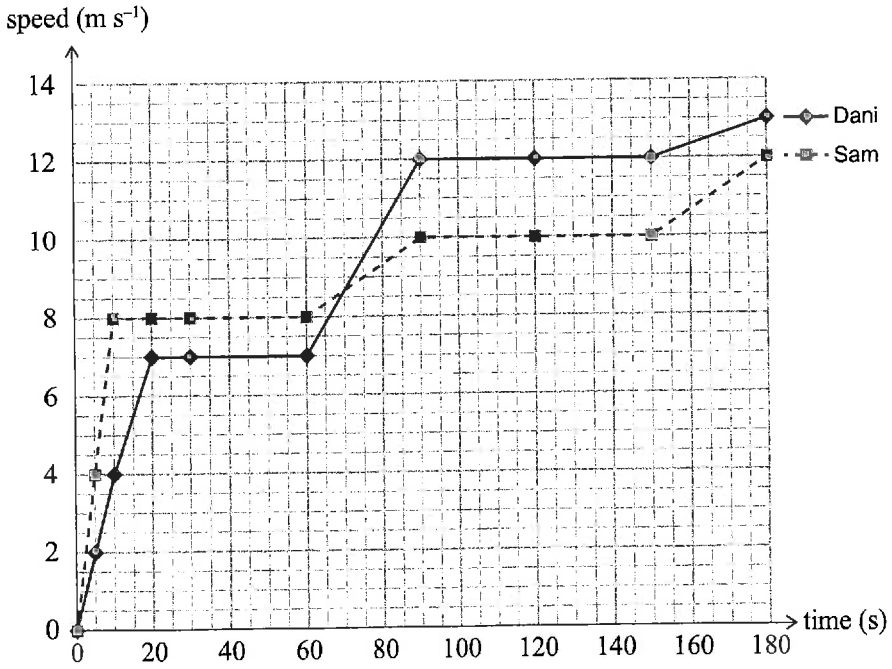
## QUESTION ONE

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.



ASSESSOR'S USE ONLY

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

Dani accelerated first 20 seconds and then moved in constant speed until 60 seconds passed. On the other hand Sam accelerated first 10 seconds and then moved in constant speed until 60 seconds.
Sam spent less time than Dani to accelerate but he accelerate the speed more than Dani.
The total distance traveled in these 20s is Sam is ~~140~~ 70 m and Dani is 120 m.
If I calculate the two's accelerations
Sam is $a = \frac{\Delta V}{\Delta t} = \frac{7}{10} = 0.7\ ms^{-2}$ in first 10 sec

However Dani is $a = \frac{\Delta V}{\Delta t} = \frac{4}{10} = 0.4\ ms^{-2}$ and then get slower to $a = \frac{\Delta V}{\Delta t} = \frac{3}{10} = 0.3\ ms^{-2}$. We can know Sam's acceleration is much slower than Dani.

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.

ASSESSOR'S USE ONLY

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

~~F = ma = 308~~

~~a = Δv / Δt~~

$v = \frac{\Delta d}{\Delta t} = \frac{40}{10} = 4 ms^{-1}$

$a = \frac{\Delta v}{\Delta s} = \frac{4}{10} = 0.4 ms^{-2}$

$F = ma = 308 \times 0.4 = 123.2 N$

$W = Fd = 123.2 \times 40 = 4928 J$

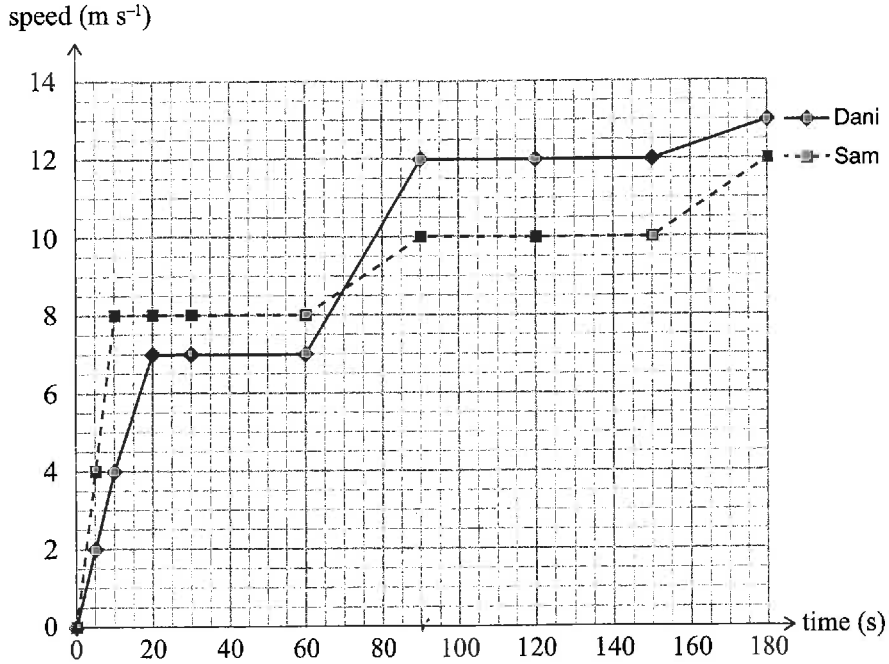
(c) Explain the effect on **work** AND **power** if a new, heavier jockey was on Sam's horse, which had the same speed and acceleration over the race.

*Calculations are not required.*

When there is heavier jockey on the mass increase. If the acceleration is same the net force increase as the mass increase. ~~The~~ Then if the ~~mass increase~~ net force increase work also increase. Finally the power also affect on work and increase as well. Which means if there is new object added such as heavier jockey the work and the power also increase.

ASSESSOR'S USE ONLY

(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.*

$\left(\frac{20 \times 7}{2}\right) + (70 \times 7) + \left(\frac{30 \times 5}{2}\right) = 630\text{ m}$

~~X~~ used $d = vt$

$710 - 630 = 75\text{ m}$

They traveled 75m further than Dani and her horse.

M6

## QUESTION TWO

ASSESSOR'S USE ONLY

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 a measure of how much ~~a~~ matter does object has, where as ~~that~~ weight is a downward force due to gravity.

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.

$A = 6.55 \times 0.4 + 0.16 \times 4 = 3.22\ m^2$

$W = mg = 9.9 \times 10 = 99$

$P = \frac{F}{A} = \frac{99}{3.22} = 30.75\ Pa$

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

ASSESSOR'S USE ONLY

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

Use calculations to support your answer.

When paddler on the waka ama the total mass increase so the total weight force increase as well. When the ~~pressure~~ weight force increase with same size of area the pressure increase. The formula of calcalating pressure is $P = \frac{F}{A}$ and the calaulation is dirivion when the front number increase the answer increase as well.

Now I know paddler cause ~~a~~ increase of pressure. If the pressure increase the waka ama sinks further. This is why the paddler cause a sinking.

MS

## 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.

$W = Fd = 60000 \times 30 = 1800000\ J$

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

$P = \frac{W}{t} = \frac{1800000}{15} = 120000\ W$

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

~~lifting. There is a force that attracts gravity~~
~~an object to ground, but the crane~~
~~lifts it up with lift force to it~~
No work has done. If an object does not move which means the distance is 0m
No matter how much weight force are there if it multiplied by 0 there is no work.

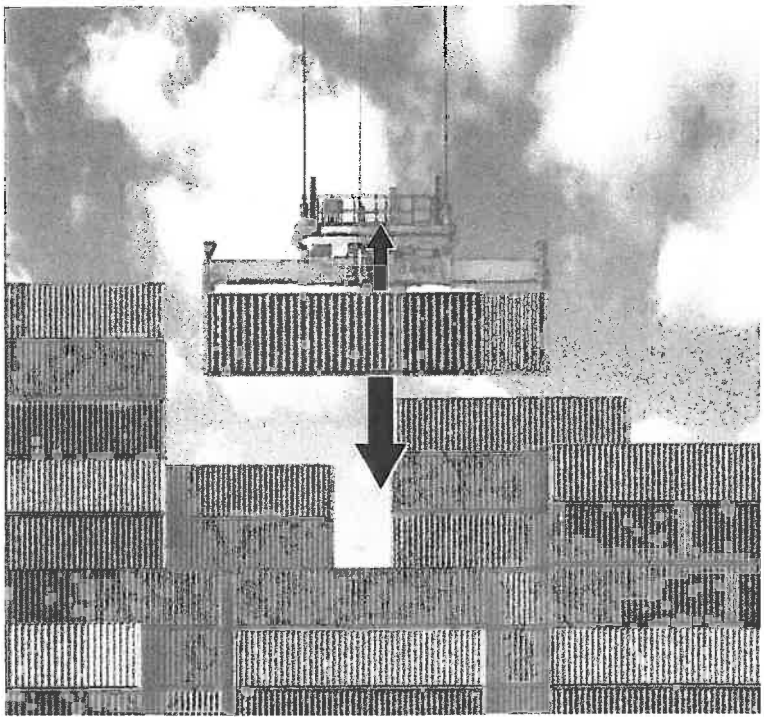
(c) Referring to the force diagram below, explain the link between the vertical net force acting on the container, and the type of motion produced, while the container is **being lowered**.

ASSESSOR'S USE ONLY

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 a difference between 2 force opposing each other. The force facing on top vertically is lift force and the other side one is weight force which also be called force of gravity. In the case on the diagram weight force is bigger than lift force so there is net force and it facing same way as weight force which is vertically downward.

**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.

ASSESSOR'S USE ONLY

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.

Energy before the cable broke

$\Delta E_p = mg\Delta h = 6500 \times 10 \times 15 = 975000\ J$

The difference between 2 energies is 975000 − 970000 = 5000 J. The reason why there is a difference is because when graritational potencial energy turned into kinetic energy while it falls some energies are lost by heat, sound energy and air resistance due to friction of atmosphere.

MS

| Subject: | Science | Standard: | 90940 | Total score: | 16 |
|---|---|---|---|---|---|

| Q | Grade score | Annotation |
|---|---|---|
| 1 | M6 | 1(a) This candidate has calculated the acceleration of Sam and Dani correctly and made a comparison. However this comparison is incorrect as Sam's acceleration is greater than Dani's for the first 20 seconds as can be seen by a steeper line.<br>1(b) The calculation for Sam's acceleration (which is needed to calculate the work done) uses values from the graph but should be 4/5 not 4/10. This incorrect value for acceleration is carried forward and used correctly to calculate both Force and Work.<br>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.<br>*These small errors in the first three parts stopped this student getting to the next level*<br>1(d) The distance travelled using the area under the graph was used and the correct comparison of distances was made. |
| 2 | M5 | 2(a) A definition of mass and weight was stated but this question also asked for a calculation of weight which was not provided.<br>2(b) This question was done well with the combined areas of both hulls calculated as well as calculating the correct pressure (with the correct unit).<br>2(c) An understanding of increasing the weight increases the pressure was certainly given but this was not supported by calculations nor an understanding that for pressure to increase, due to an increase in weight, only happens if the area stays the same |
| 3 | M5 | 3(a) The correct values for both work and power are calculated correctly (with the correct units).<br>3(b) An understanding of no work is done if the object does not move was shown by the student in this question.<br>3(c) Here the student has started to explain what the term Net Force means and has mentioned that the unbalanced force is in the downwards direction but has not mentioned that this causes an acceleration.<br>3(d) A calculation of gravitational kinetic energy was done correctly, and this student mentioned that the difference between gravitational and kinetic energy (5000J) was converted into heat and sound and that this was due to friction. This student did mention air resistance as if it were a type of energy which is incorrect.<br>*To get to the next level students need to be precise in their explanations*. |