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Level 1 Science, 2016

90940 Demonstrate understanding of aspects of mechanics

9.30 a.m. Monday 14 November 2016
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 14

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Merit Exemplar 2016

Subject:	Science	Standard:	90940	Total score:	14

Q	Grade score	Annotation
1	M6	(a) The motion of all 4 sections were described correctly. (b) The speed of the horse in Section B was calculated correctly. (c) The correct method was used to calculate the Weight. To get to Excellence the area of **each** foot is (0.0044 m^2) so this answer needed to multiplied by 4. (d) This student answered this question correctly.
2	A3	(a) The distance was calculated correctly. (b) A description of the net force and the effect on motion were given in both sections. However these forces were not named. (c) The work done and the power exerted were calculated correctly. (d) This student did not realise that the work done in both situations were the same and if the distances were different therefore the forces must be different.
3	M5	(a) A correct definition for mass and weight were given (b) The acceleration was calculated correctly with the correct unit (c) The velocity that the rocket would hit the ground was correctly calculated (and well set out) (d) This question was not discussed. The main forces involved are the weight force and, acting against this, is air resistance

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

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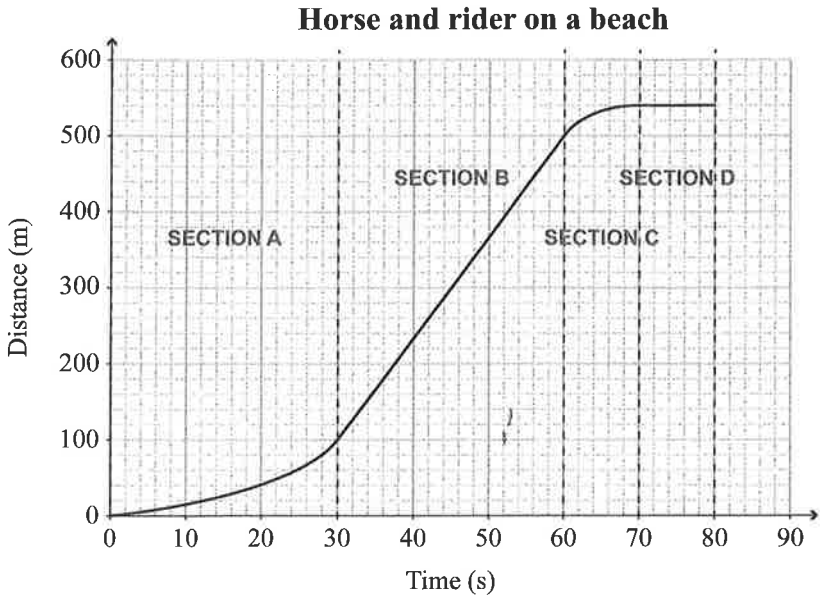
The graph below shows the motion of a horse and rider as they travel along a beach.



(a) Describe the motion of the horse and rider in each section of the graph.
(No calculations are required.)

Section A: accelerating

Section B: constant speed

Section C: decceleration

Section D: stationary

(b) Calculate the speed of the horse and rider in Section B of the graph.

$v = \frac{\Delta d}{\Delta t} = \frac{400m}{30s}$

$v = 13.3\ ms^{-1}$

(c) **Each** of the horse's hooves has a surface area of 44 cm^2 (0.0044 m^2) and sinks into the sand when the horse stops. The hooves exert a pressure of 200155 Pa.

Calculate the weight of the horse.

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

$\frac{F}{0.0044 m^2} = 200155 Pa$

$F = 200155 pa \times 0.0044 m^2$

$F_{weight} = 880.7 N$

(d) The rider walks beside the horse and then gets onto the horse.

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Explain why the horse's hooves sink further into the sand when the rider gets onto the horse.
In your answer you should consider the **pressure applied** and the **forces acting**.
(No calculations are necessary.)

The formula for pressure is $P = \frac{F}{A}$.

When the rider goes onto the horse the force is increased but the surface area of the horses hooves stay the same so the pressure the horses hooves exert on the sand must increase, causing the horse to sink further into the sand.

M6

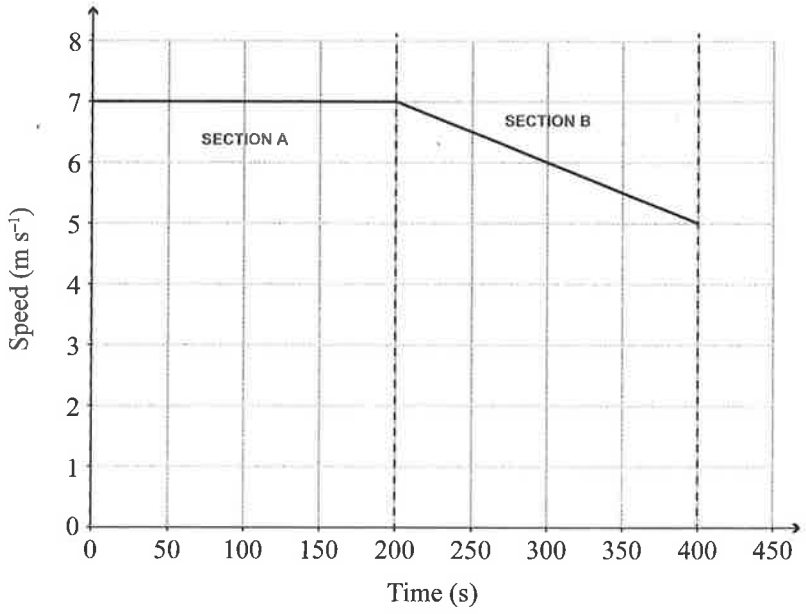
QUESTION TWO

A harvester was working in a paddock.

photo.elsoar.com

The speed-time graph shows the journey of the harvester.

Speed-time graph of a harvester



(a) Calculate the distance the harvester travelled in the first 200 seconds.

$d = v \times t$

$d = 7ms^{-1} \times 200s$

$= 1400m$

the harvester travelled 1400m in the first 200seco

(b) Explain how the **forces** acting on the harvester result in the motion shown in the graph (no calculations are needed).

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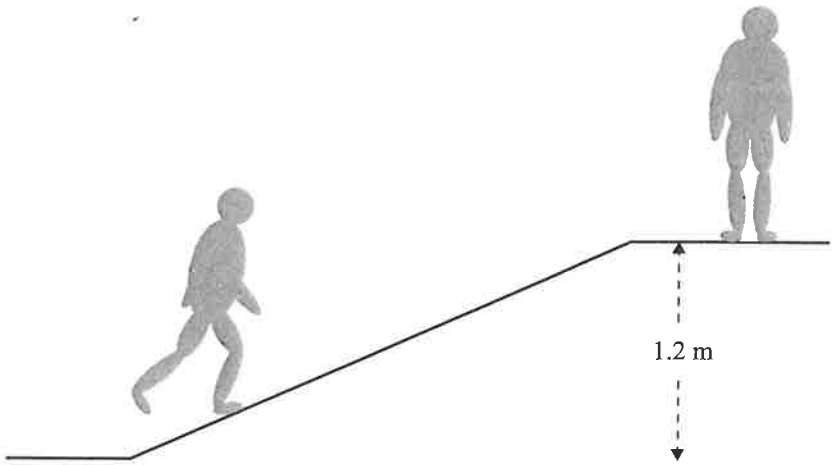
Include reference to the **net force**.

Section A: The forces are balanced and therefore the net force equals zero. This means the harvester is moving at a constant speed

Section B: ~~the force increases~~ The forces are no longer balanced meaning the net force doesn't ~~be~~ equal zero which results in ~~movement~~ acceleration or decceleration. In this case decceler

The harvested grain is stored in a shed with a ramp.

(c) An 85 kg worker climbed to the top of the ramp, a height of 1.2 m. This took 8 seconds.



Calculate the **work** done by the worker to get to the top of the ramp and therefore the **power** exerted.

Include units.

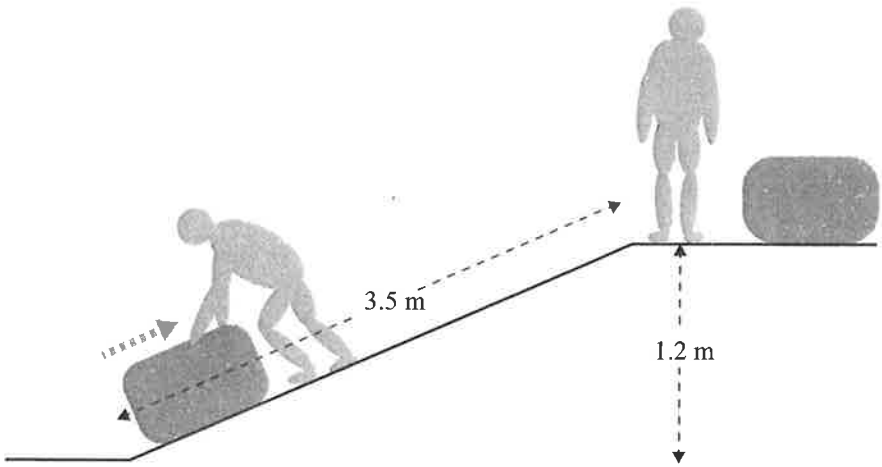
$F = m \times g$
$= 85 \times 10$
$= 850\text{N}$

$W = F \times d$
$= 850\text{N} \times 1.2\text{m}$
$= 1020\text{ J}$

$P = \frac{W}{T} = \frac{1020\text{J}}{8\text{ seconds}} = 127.5\text{ W}$

(d) The worker dragged a 25 kg bag of grain up the 3.5 m ramp to reach the height of 1.2 m.

It took longer to drag the bag up the ramp than to lift the bag straight up to the top of the ramp.



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(i) Explain why the **force** needed to drag the bag of grain up the ramp to the top is less than the force needed to lift the bag straight up (vertically). Ignore friction.

work done using the ramp $W = F \times d$

$= 250 \times 3.5m$

$= 875 J$

work done lifting vertically $= 250 \times 1.2m$

$= 300 N$

(ii) Explain whether the **power** needed to drag the bag of grain to the top of the ramp is more or less than the power needed when the bag is lifted straight up (vertically) to the top of the ramp.

(No calculation is required.)

A3

QUESTION THREE

A small rocket has a mass of 2.60 kg and a weight of 26.0 N.

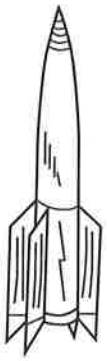
(a) Explain the difference between mass and weight.

mass is the amount of matter in an object and is measured in kg, mass does not change. Weight is the downward force due to gravity acting on an object and is measured in N. weight can change depending on planet you are on.

(b) The rocket was fired vertically. It left the launch pad and after 1.2 s was travelling at 20 m s^{-1}.

Calculate the rocket's acceleration.

$a = \frac{\Delta v}{\Delta t} = \frac{20 ms^{-1}}{1.2 s} = 16.7 ms^{-2}$



(c) The rocket had gained 1950 J of potential energy at its maximum height. It then fell back to the ground.

What was the maximum speed it could reach just before hitting the ground (assuming energy is conserved)?

gpe gained = kinetic energy gained

$E_K = 1/2 \times m \times v^2$

$1950 J = 1/2 \times 2.60 kg \times v^2$

$1/2 \times 2.60 kg \times v^2 = 1950 J$

$v^2 = \frac{1950 J \times 2}{2.60 kg} = 1500$

$v = \sqrt{1500}$

$v = 38.73 ms^{-1}$

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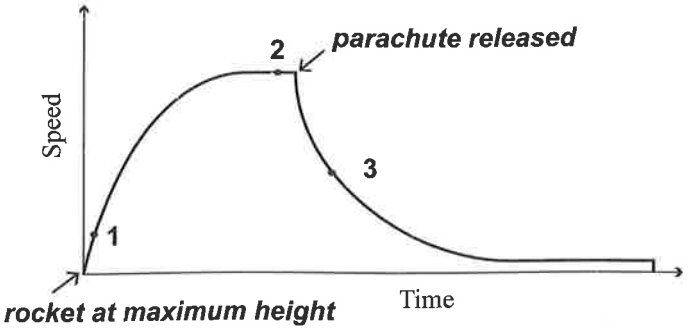
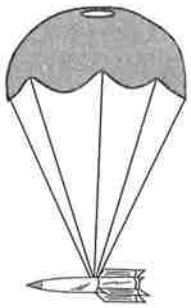
(d) The rocket was fired again. After it reached its maximum height, it began to fall back to the ground. As it fell, a parachute was released.

The graph below shows the speed-time graph of the rocket **falling from its maximum height** back to ground. Just after point **2**, a parachute is released.





Discuss the change in speed at points **1**, **2**, and **3** as the rocket falls to the ground.

In your answer you should:

- describe the forces involved, and whether they are unbalanced or balanced
- explain what is causing the change in speed
- describe the frictional forces acting as the rocket falls.

From points 1 to 2 the forces involved are thrust and ~~gravity~~ weight force. These forces are unbalanced

MS

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

QUESTION NUMBER

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