Neap:

Trial Examination 2017

VCE Physics Unit 2

Written Examination

Suggested Solutions

Area of study 1 – How can motion be described and explained?

Question 1 (10 marks)

a. graph **C** — 1 mark

The acceleration is constant, so the gain in velocity is linear (or increases at a constant rate). — 1 mark

The displacement will increase at a non-linear (or quadratic) rate. — 1 mark

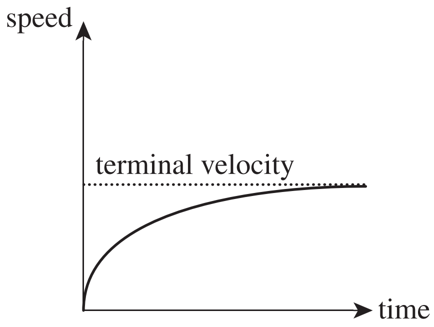
Note: Alternatively, students could explain using equations, such as:
$x = ut + \frac{1}{2}at^2$ *gives a quadratic shape for displacement.*

b. $v^2 = u^2 + 2as$

$v = \sqrt{0^2 + 2(9.8)(50)}$ — 1 mark

$= 31.3 \text{ m s}^{-1}$ — 1 mark

c.



2 marks
1 mark for correct shape.
1 mark for correct labels.

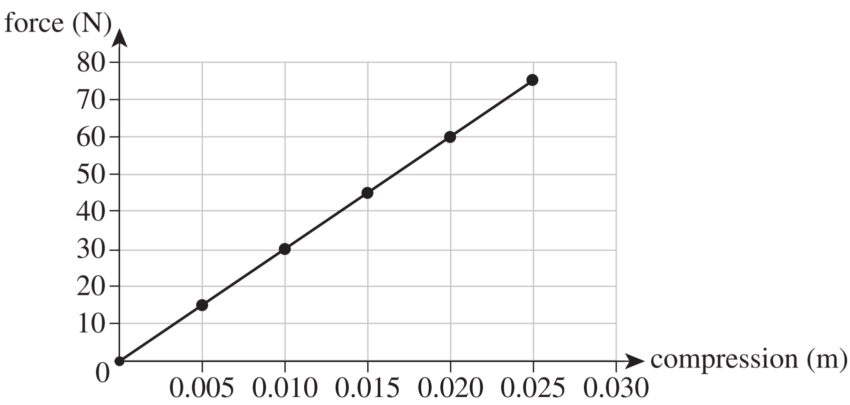
d. Initially when the ball is dropped there is no air resistance and $F_{net} = mg$. — 1 mark

As ball speed increases, so does the force of air resistance and F_{net} decreases. — 1 mark

Eventually, the force of air resistance = weight force, so $a = 0$ or $F_{net} = 0$. — 1 mark

Question 2 (17 marks)

a.



3 marks
1 mark for correct axes labels.
1 mark for correct points.
1 mark for correct scale.
Note: Compression scale could also be given in mm.

b. k is the gradient from the graph.

$$k = \frac{F}{x}$$

$$= \frac{75}{0.025}$$ 1 mark

$$= 3.0 \times 10^3 \text{ N m}^{-1}$$ 1 mark

Note: Compression needs to be converted into metres.

c. $$U_s = \frac{kx^2}{2}$$

$$= \frac{(3000)(0.025)^2}{2}$$ 1 mark

$$= 0.9375 \text{ J}$$

$$= 0.94 \text{ J}$$ 1 mark

Note: Consequential on answer to ***Question 2b.***

d. Use the spring energy in **part c.** to calculate the initial velocity of the rocket.

Then use straight-line motion equations to determine time of flight up/down.

Re-arranging kinetic energy equation: $v = \sqrt{\frac{2 \times U_s}{m}}$

$$= \sqrt{\frac{2 \times 0.9375}{0.1}}$$

$$= 4.33 \text{ m s}^{-1}$$ 1 mark

Use $v = u + at$, where $v = 0$, $u = 4.33$ and $a = -9.8$. Rearrange to solve for t.

$$t = \frac{0 - 4.33}{-9.8}$$

$$= 0.44 \text{ s}$$ 1 mark

time up = time down, so total flight time $= 2 \times 0.44$

$$= 0.88 \text{ s}$$ 1 mark

Note: Alternatively, students can also solve using $x = ut + \frac{1}{2}at^2$ *and* $0 = 4.33t - 4.9t^2$*, and solve for t.*

e. The potential energy from the spring is transferred to the rocket and it converts into gravitational energy as it rises. This equals the gravitational potential energy of the rocket.

$$mgh = U_s$$

$$= 0.9375$$ 1 mark

$$h = \frac{0.9375}{0.1 \times 9.8}$$

$$= 0.96 \text{ m}$$ 1 mark

Note: Consequential on answer to ***Question 2c.***

f. Use height difference between actual versus theoretical to calculate efficiency.

$\eta = \frac{0.63}{0.957} \times 100$ 1 mark

$= 66\%$ 1 mark

Note: Consequential on answer to ***Question 2c.***

g. Initially it had zero kinetic energy (maximum potential energy from spring). 1 mark

It gained kinetic energy from the spring (or $U_s \rightarrow$ kinetic energy), then as it went up it lost kinetic energy but gained gravitational potential energy. 1 mark

On the way down it lost gravitational potential energy but regained kinetic energy until it hit the ground. 1 mark

Question 3 (4 marks)

a. Neither person exerts a greater torque on the fulcrum of the see-saw than the other 1 mark
as they both are in rotational equilibrium around the fulcrum. 1 mark

b. $\tau_{\text{Sam}} = rF$

$= 1.3(85 \times 9.8)$

$= 1082.9 \text{ N m}$

$= 1.1 \times 10^3 \text{ N m}$ 1 mark

This torque is counterbalanced by Max, so:

$\tau_{\text{Max}} = 1082.9$

$\rightarrow r_{\text{Max}} = \frac{\tau}{F}$

$= \frac{1082.9}{65(9.8)}$

$= 1.7 \text{ m}$ 1 mark

Question 4 (12 marks)

a. $a = g \sin\theta$

$= 9.8 \sin 15°$

$= 2.54 \text{ m s}^{-2}$ 1 mark

$\% = \frac{2.54}{9.8} \times 100$

$= 26\%$ 1 mark

b. $v = u + at$

$= 0 + 2.54(3)$

$= 7.6 \text{ m s}^{-1}$ 1 mark

$7.6 \times 3.6 = 27 \text{ km h}^{-1}$ 1 mark

Note: Consequential on answer to ***Question 4a.***

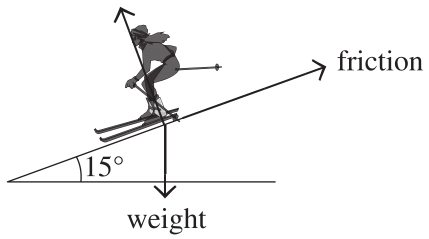
c. $F_{\text{net}} = ma$

$= 70(2.54)$

$= 178\text{ N}$ 1 mark

Note: Consequential on answer to ***Question 4a.***

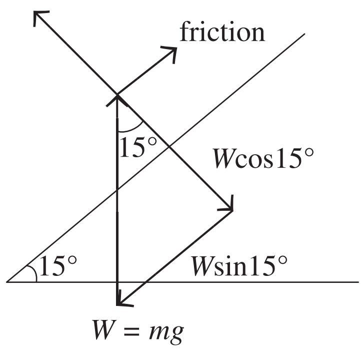
d.



3 marks

1 mark for each correctly labelled force.

e.



As seen in the diagram above the friction force equals the sine component of the weight force since the speed is constant.

So $fr = W\sin 15°$

$= 70 \times 9.8 \times \sin 15°$ 1 mark

$= 177.6\text{ N}$

$= 1.8 \times 10^2\text{ N}$ 1 mark

f. Students can use the force diagram in **part e.** to point out the following:

normal = weight × $\cos\theta$ 1 mark

weight = 70(9.8)

= 686

normal = $70(9.8)\cos 15°$

= 662.6

$\therefore$ normal < weight 1 mark

OR

Students can explain that normal = weight when angle is 0° ($\cos 0 = 1$, which is its maximum value) 1 mark

and decreases as θ increases *(or words to that effect).* 1 mark

Question 5 (8 marks)

a. $p = mv$

$= 0.17(24)$

$= 4.1 \text{ kg m s}^{-1}$ 1 mark

b. Take the initial direction as positive.

$\Delta v = v_{\text{final}} - v_{\text{initial}}$

$= -16 - 24$ 1 mark

$= -40$

$\rightarrow 40 \text{ m s}^{-1}$ (magnitude) 1 mark

c. area under the graph = impulse

$\frac{tF_{\text{max}}}{2} = \Delta p$ 1 mark

$F_{\text{max}} = \frac{\Delta p}{0.5\Delta t}$

$= \frac{m\Delta v}{0.5\Delta t}$

$= \frac{0.17(40)}{0.025}$ 1 mark

$= 272 \text{ N}$ 1 mark

Note: Consequential on answer to ***Question 5b.***

d. action: $F_{\text{on wall by puck}}$ 1 mark

reaction: $-F_{\text{on puck by wall}}$ 1 mark

Question 6 (9 marks)

a. Take ↑ (vertical) and → (horizontal) as +.

$F_{\text{vertical}} = 450\sin 30° - 450\sin 40°$

$= -64.25 \text{ N}$ (force is ↓ direction) 1 mark

$F_{\text{horizontal}} = 450\cos 30° + 450\cos 40° - 100$

$= 734.43 - 100$

$= 634.43 \text{ N}$ (force is → direction) 1 mark

$F_{\text{resultant}} = \sqrt{(64.25)^2 + (634.43)^2}$

$= 637.7 \text{ N}$ 1 mark

direction is $\theta = \tan\left(\frac{64.25}{634.43}°\right)^{-1}$

$= 5.8°$ below (from horizontal) 1 mark

b. $W_{net} = F_{net}s$

$= 637.69 \times 25$ 1 mark

$= 15\ 942$ J

$= 16$ kJ 1 mark

Note: Consequential on answer to ***Question 6a.***

c. gain in kinetic energy = net work done

$= 16$ kJ 1 mark

Note: Consequential on answer to ***Question 6b.***

d. $P = \frac{\text{work done}}{t}$ 1 mark

$= \frac{16\ 000}{40}$

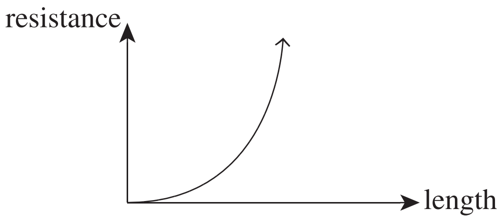
$= 400$ W 1 mark

Note: Consequential on answer to ***Question 6b.***

Area of Study – Practical investigation

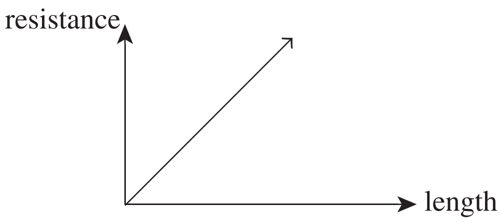
Question 1 (30 marks)

a. Hugo's hypothesis



2 marks
1 mark for correct labels.
1 mark for correct shape.

Callum's hypothesis



2 marks
1 mark for correct labels.
1 mark for correct shape.

b. length of wire — 1 mark

c. resistance — 1 mark

d. *Any two of:*

- diameter (or thickness) of wire
- uniform density of wire
- power pack setting
- time of measurement
- temperature
- or other plausible variable

2 marks

e. systematic error — 1 mark

The needle is constantly offset from the zero on the scale, so all readings will be out. — 1 mark

f. Usually uncertainty is $\frac{1}{2}$ of a division, so in this case ±0.5 mm. — 1 mark

Note: May also accept a whole smallest division (1 mm).

g. $\text{percentage uncertainty} = \frac{0.5}{2} \times 100$

$= 25\%$ — 1 mark

Note: Consequential on answer to ***Question 1f.***

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h. The callipers, 1 mark
since it has the most number of significant figures OR has the lowest percentage uncertainty OR can read to 0.1 mm whilst ruler is 0.5 mm. 1 mark

i. $\text{percentage error (calipers)} = \frac{0.1}{2.1} \times 100$

$= 4.76\%$ 1 mark

$\text{percentage reduction} = 25 - 4.76$

$= 20.2\%$ 1 mark

Note: Consequential on answer to ***Question 1g.***

j. a random error 1 mark
It is a one-off and not consistent (or systematic). 1 mark

k. Callum is correct. 1 mark
The wire's temperature has changed significantly and this has most likely altered the wire's resistance. 1 mark
It is also varying one of the control variables and this needs to be avoided when possible. 1 mark

Note: Also accept some other plausible explanations.

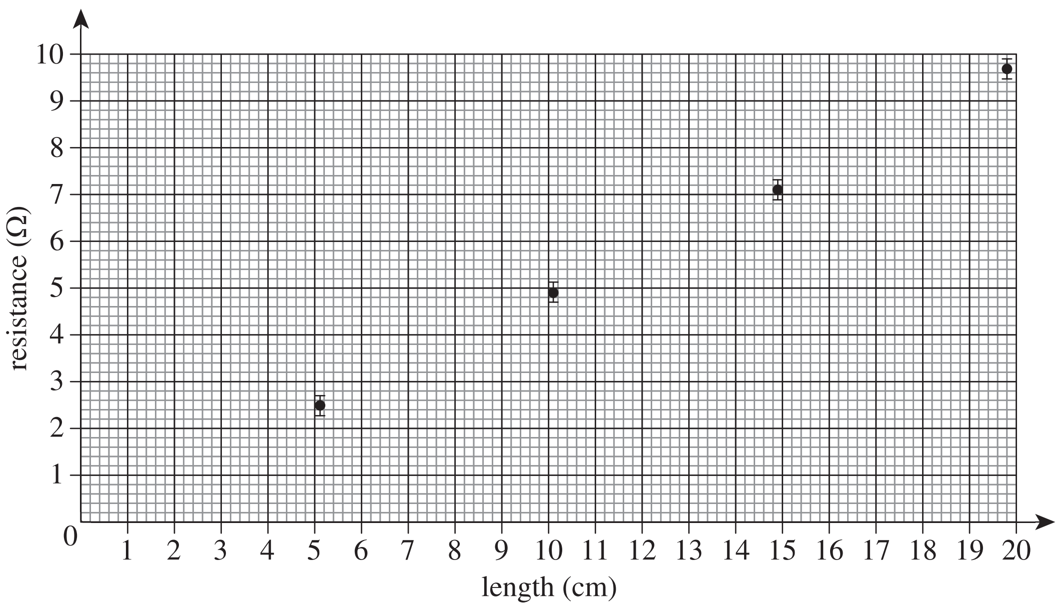
l. $\text{mean} = \frac{\text{sum of values}}{\text{number of values}}$

$= \frac{20.4}{4}$

$= 5.1\Omega$ 1 mark

m. The maximum variance is for reading 2, such as $5.1 - 4.9 = 0.2\Omega$.
This gives an uncertainty value of ±0.2. 1 mark

n.



3 marks
1 mark for correct plot.
1 mark for correct vertical error bars.
1 mark for correct labels.

o. The shape of the graph suggests a linear relationship of resistance is directly proportional to length, 1 mark
and (0, 0) is part of the line. 1 mark

p. Callum's hypothesis is supported by the data. 1 mark

The shape of the line is linear. 1 mark

Note: Students may draw a line of best fit through the points instead for the second mark.

