



Trial Examination 2017

VCE Physics Unit 2

Written Examination

Suggested Solutions

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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

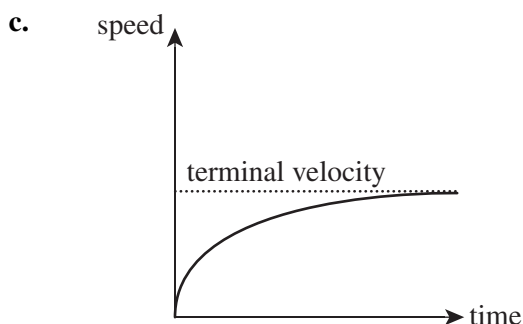
Note: Alternatively, students could explain using equations, such as:

$$x = ut + \frac{1}{2}at^2 \text{ gives a quadratic shape for displacement.}$$

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

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

$$= 31.3 \text{ m s}^{-1} \quad 1 \text{ mark}$$



2 marks

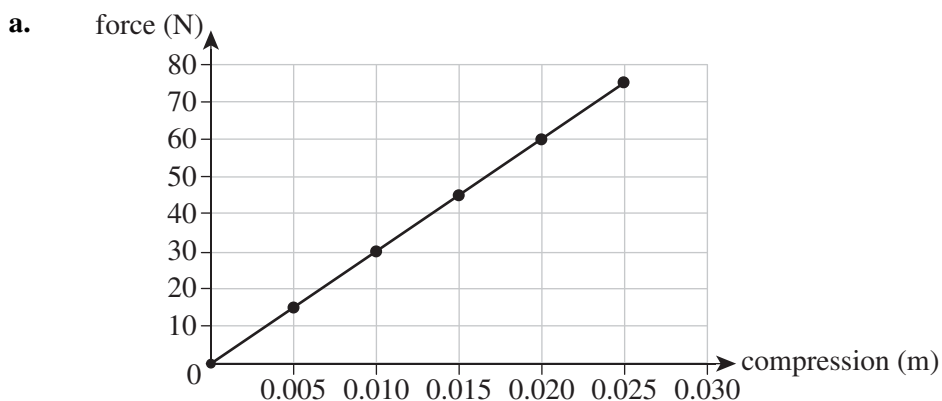
1 mark for correct shape.

1 mark for correct labels.

- d. Initially when the ball is dropped there is no air resistance and $F_{\text{net}} = mg$. 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 $F_{\text{net}} = 0$. 1 mark

Question 2 (17 marks)

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 = 2×0.44

$$= 0.88 \text{ s}$$

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.

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

$$= 66\% \quad 1 \text{ mark}$$

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 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:

$$\begin{aligned} \tau_{\text{Max}} &= 1082.9 \\ \rightarrow r_{\text{Max}} &= \frac{\tau}{F} \\ &= \frac{1082.9}{65(9.8)} \\ &= 1.7 \text{ m} \end{aligned} \quad 1 \text{ mark}$$

Question 4 (12 marks)

- a. $a = g \sin \theta$
 $= 9.8 \sin 15^\circ$
 $= 2.54 \text{ m s}^{-2}$ 1 mark
- $$\% = \frac{2.54}{9.8} \times 100$$
- $$= 26\% \quad 1 \text{ mark}$$

- b. $v = u + at$
 $= 0 + 2.54(3)$
 $= 7.6 \text{ m s}^{-1}$ 1 mark
- $$7.6 \times 3.6 = 27 \text{ km h}^{-1} \quad 1 \text{ mark}$$

Note: Consequential on answer to Question 4a.

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

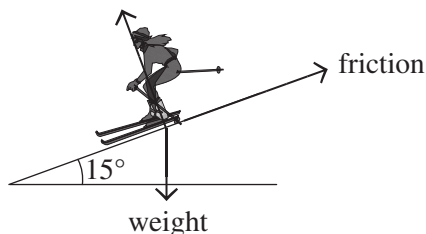
$$= 70(2.54)$$

$$= 178 \text{ N}$$

1 mark

Note: Consequential on answer to Question 4a.

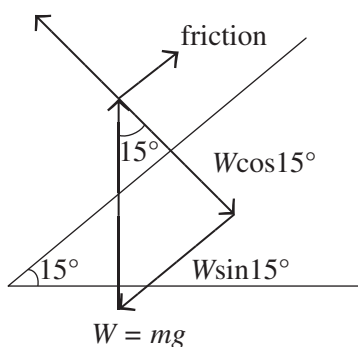
d. normal reaction



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 $fr = W \sin 15^\circ$

$$= 70 \times 9.8 \times \sin 15^\circ$$

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:

$$\text{normal} = \text{weight} \times \cos \theta$$

1 mark

$$\text{weight} = 70(9.8)$$

$$= 686$$

$$\text{normal} = 70(9.8) \cos 15^\circ$$

$$= 662.6$$

$$\therefore \text{normal} < \text{weight}$$

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

$$= -40$$

$$\rightarrow 40 \text{ m s}^{-1} \text{ (magnitude)}$$
 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 $\uparrow$ (vertical) and $\rightarrow$ (horizontal) as +.

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

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

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

$$= 734.43 - 100$$

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

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

$$= 637.7 \text{ N}$$
 1 mark

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

$$= 5.8^\circ \text{ below (from horizontal)}$$
 1 mark

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

$$= 637.69 \times 25$$

1 mark

$$= 15\,942 \text{ J}$$

$$= 16 \text{ kJ}$$

1 mark

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

c. gain in kinetic energy = net work done

$$= 16 \text{ kJ}$$

1 mark

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

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

1 mark

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

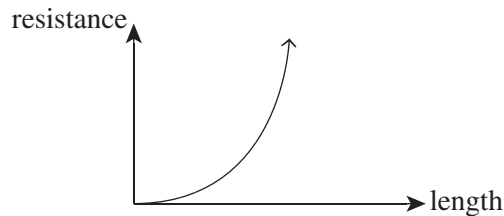
$$= 400 \text{ W}$$

1 mark

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

Area of Study – Practical investigation**Question 1** (30 marks)**a.**

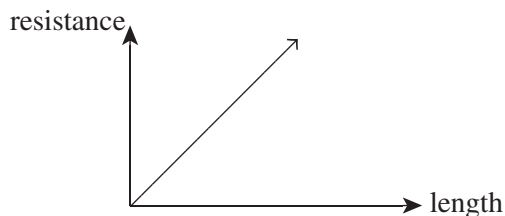
Hugo's hypothesis



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. percentage uncertainty = $\frac{0.5}{2} \times 100$
 $= 25\%$

1 mark

Note: Consequential on answer to Question 1f.

- 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. percentage error (calipers) = $\frac{0.1}{2.1} \times 100$
 $= 4.76\%$ 1 mark

percentage reduction = $25 - 4.76$
 $= 20.2\%$ 1 mark

Note: Consequential on answer to Question 1g.

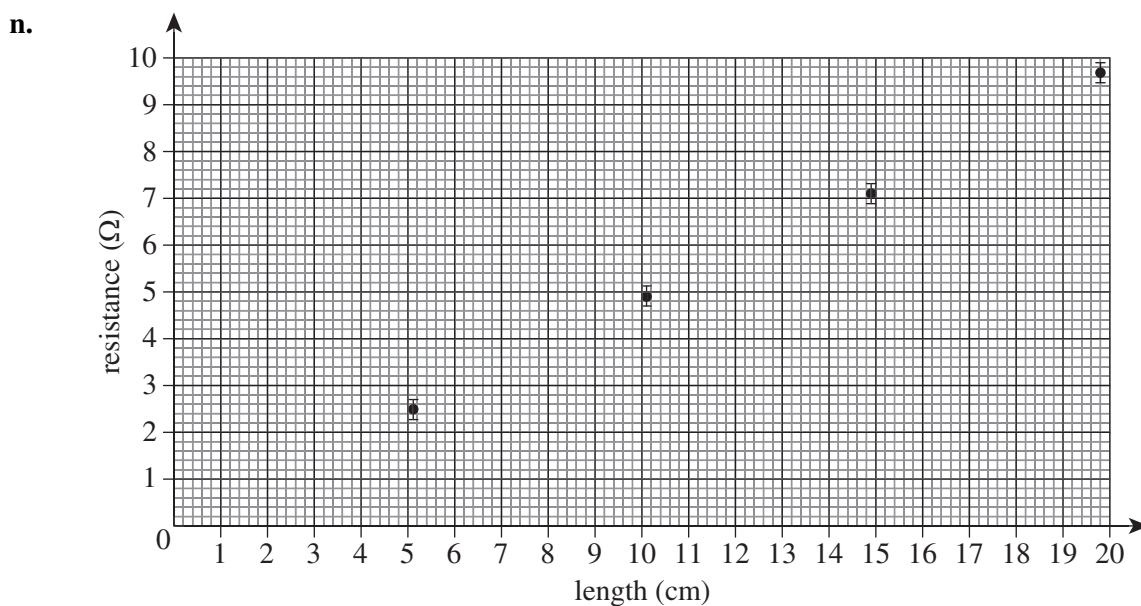
- j.** a random error 1 mark
 It is a one-off and not consistent (or systematic). 1 mark

- 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. 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



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.