Neap

Trial Examination 2023

VCE Physics Units 1&2

Written Examination

Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

1	**A**	B	C	D	11	A	**B**	C	D
2	A	B	C	**D**	12	A	**B**	C	D
3	A	B	C	**D**	13	A	B	**C**	D
4	A	**B**	C	D	14	A	B	**C**	D
5	A	B	C	**D**	15	**A**	B	C	D
6	**A**	B	C	D	16	A	B	C	**D**
7	A	**B**	C	D	17	A	**B**	C	D
8	A	**B**	C	D	18	A	B	**C**	D
9	A	**B**	C	D	19	A	**B**	C	D
10	A	B	**C**	D	20	A	B	C	**D**

Question 1 A

$$\lambda_{\max} T = b$$

$$T = \frac{2.9 \times 10^{-3}}{502 \times 10^{-9}}$$

$$= 5777 \text{ K}$$

$$= 5.78 \times 10^{3} \text{ K}$$

Question 2 D

$$c = f\lambda$$

$$f = \frac{3 \times 10^{8}}{250 \times 10^{-9}}$$

$$= 1.20 \times 10^{15} \text{ Hz}$$

Question 3 D

D is correct. Stars with a lower temperature emit a longer peak wavelength according to $\lambda_{\max} = \frac{b}{T}$. Longer wavelengths are associated with electromagnetic waves that have lower energy, such as infrared.

A, **B** and **C** are incorrect. These options are regions of the electromagnetic spectrum that have higher energy than visible light.

Question 4 B

B is correct. The neutron increases the amount of repulsion experienced between nucleons due to the strong nuclear force. Therefore, the amount of potential energy increases and the stability of the nucleus is reduced.

A is incorrect. The absorption of a neutron increases the mass number of the atom, not its atomic number.

C is incorrect. Although the nucleus does become more fissile, this is due to a decrease, not an increase, in binding energy. Adding a neutron increases the mass of a nucleus and thus decreases its binding energy.

D is incorrect. Adding a neutron to the nucleus decreases separation between nucleons, which results in increased repulsion due to the strong nuclear force.

Question 5 D

D is correct. Chain reactions are sustained due to the release of an exponentially increasing number of neutrons as the reaction continues. These neutrons are absorbed by other atoms, allowing them to undergo fission and thus continue releasing neutrons.

A is incorrect. The stability of fission products depends on their nuclear structure and binding energy, rather than their kinetic energy.

B is incorrect. Critical mass refers to the arrangement of fissile nuclei required to sustain a chain reaction by absorbing the neutrons emitted by each fission reaction. Critical masses must be composed of fissile nuclei rather than other particles.

C is incorrect. All particles can absorb heat from the reactor. The temperature of the reactor is related to the number of neutrons due to the subsequent fissions they cause, rather than their direct effect on heat in the reactor.

Question 6 A

A is correct. The short-term storage of radioactive waste prior to long-term disposal in Australia is a challenge due to the limited availability of local disposal sites.

B is incorrect. The exact products of fission cannot be predicted. While some resultant isotopes may be useful, there would still be a portion of the waste that needs to be disposed of.

C is incorrect. Efficient energy production cannot override other constraining factors such as disposal costs and environmental impact.

D is incorrect. While initial fission products may have short half-lives, the subsequent decay products may have longer half-lives that require long-term disposal.

Question 7 B

Resistance of the lower parallel branch:

$$R_{t_1} = 200 + 200$$
$$= 400\ \Omega$$
$$\frac{1}{R_{t_2}} = \frac{1}{400} + \frac{1}{400}$$
$$= \frac{1}{200}$$
$$R_{t_2} = 200\ \Omega$$

Equivalent resistance of the circuit:

$$R_T = 100 + 200$$
$$= 300\ \Omega$$

Question 8 B

$$V = IR$$
$$= 0.01 \times 400$$
$$= 4.0\ \text{V}$$

Question 9 B

$$R_{t_1} = 400\ \Omega$$

The equivalent resistance of the second branch is the same as the first branch. Each branch receives the same amount of voltage. As $I = \frac{V}{R}$, the magnitude of current flowing is also equal.

$$I = \frac{V}{R}$$
$$= \frac{4}{400}$$
$$= 0.010\ \text{A}$$

OR

Due to the equal resistance of both parallel branches, the same current flows in each branch.

Therefore, $I = 0.010$ A.

Question 10 C

C is correct. Elements in series share voltage. Therefore, the battery supplies enough voltage for both the parallel section of the circuit and the 100 Ω resistor.

A is incorrect. The 200 Ω resistor branch is in parallel with the 400 Ω resistor branch. Therefore, when current splits at the junction, individual electrons carry the same amount of energy that remains from the battery.

B is incorrect. The additional pathway affects the amount of current flowing through the battery, rather than the voltage it provides.

D is incorrect. Junctions affect the direction of current flow and individual charges retain the potential energy they already have. Therefore, junctions have no impact on voltage.

Question 11 B

B is correct. The car is travelling at a constant speed when $a = 0$, which occurs in the interval of 10–25 s.

A, **C** and **D** are incorrect. Although acceleration is constant during these intervals, the value of a is not 0, so speed is not constant.

Question 12 B

$$\begin{aligned}\Delta v &= \text{area} \\ &= (1.5 \times 10) - (15 \times 1) \\ &= 0\end{aligned}$$

Therefore, the final speed of the car is the same as its initial speed, 5.0 m s^{-1}.

Question 13 C

Given that $F_{net} = 0$:

$$\begin{aligned}T\cos\theta &= R \\ 24 \times \cos\theta &= 16 \\ \theta &= 48°\end{aligned}$$

Question 14 C

$$\begin{aligned}p &= mv \\ &= 5 \times 1.2 \\ &= 6.0 \text{ N s}\end{aligned}$$

Question 15 A

$$\begin{aligned}P &= Fv \\ &= 16 \times 1.2 \\ &= 19.2 \text{ W} \\ &= 19 \text{ W}\end{aligned}$$

Question 16 D

D is correct. According to Newton's third law, force pairs act between the same set of objects. Therefore, the force pair is $F_{\text{rope on cart}} = -F_{\text{cart on rope}}$.

A is incorrect. This option does not specify the object that is exerting the resistive forces.

B is incorrect. The normal force is exerted by the ground and is in a different plane to the force of the rope pulling on the cart.

C is incorrect. The gravitational force is exerted by Earth and is in a different plane to the force of the rope pulling on the cart.

Question 17 B

$$F_g = mg$$
$$2450 = 9.8m$$
$$m = 250 \text{ kg}$$

Question 18 C

$$\tau = r_{\perp} F$$
$$= 1.8 \times 2450$$
$$= 4410 \text{ N m}$$

Question 19 B

B is correct. Maintaining the position of each mass on the seat ensures that it is the mass that causes the change in seat height, rather than the torque produced by an uncentred mass.

A is incorrect. Using different increments of mass does not prevent the mass from acting as the independent variable.

C is incorrect. The number of trials is associated with repeatability and precision, rather than validity.

D is incorrect. The direction the ruler is viewed from contributes to random error, not validity; during measurement, no other variable changes.

Question 20 D

D is correct. By conducting multiple trials for each mass, the students will produce an average for each measurement, which is less affected by random or fluctuating errors.

A is incorrect. Reproducibility relates to other experimenters carrying out the method.

B is incorrect. Resolution is affected by the measuring devices used in the investigation.

C is incorrect. When conducting multiple trials, the variables that affect the validity of the investigation do not change.

SECTION B

Question 1 (9 marks)

a. The method of heat transfer that occurs between the Sun and the ice cream is radiation. 1 mark

For example, any one of:

- This is because no contact is between made between the two samples.
- This is due to electromagnetic waves being used to transmit energy.

1 mark

Note: Accept any reasonable justification.

b. $34.4 \times 10^3 = 34\,400 \text{ J}$

$\frac{125}{1000} = 0.125 \text{ kg}$

$Q = mL$

$34\,400 = 0.125L$ 1 mark

$L = 2.75 \times 10^5 \text{ J kg}^{-1}$ 1 mark

c. The phase change breaks the bonds between ice cream particles. 1 mark

This allows the particles to move more freely, allowing for greater vibration and thus increasing their kinetic energy and temperature. 1 mark

d. $Q = cm\left(T_f - T_i\right)$

$3150 = 2100 \times 0.125\left(T_f - 10\right)$ 1 mark

$T_f = 22°\text{C}$

$T = 22°\text{C}$

$T = (22 + 273.15) \text{ K}$ 1 mark

$T = 295.15 \text{ K}$ 1 mark

Note: 1 mark may be awarded for a correct conversion to kelvin using an incorrect T_f.

Question 2 (7 marks)

a. Urbanisation replaces forest vegetation with materials that can absorb heat more readily and increase in temperature more easily. 1 mark

The darker colour of the buildings and roads results in a greater range of wavelengths being absorbed, which increases the amount of energy that can be absorbed. 1 mark

The lower specific heat capacity of the materials causes the temperature of the buildings to rise more rapidly, resulting in a higher possible maximum temperature that can be reached more quickly. 1 mark

b. As the temperature of the air increases, the air expands and thus decreases in density, which causes the warm air to rise. This allows cooler, more dense air to flow and take its place. 1 mark

If the warmer regions on the land reach higher temperatures due to urbanisation, 1 mark
the strength of convection currents increases due to a greater volume of air moving upwards. 1 mark

A greater volume results in a stronger air current forming, which leads to stronger winds flowing to replace the air moving upwards. 1 mark

Question 3 (13 marks)

a. $^{18}_{9}\text{F} \rightarrow {}^{18}_{8}\text{O} + {}^{0}_{1}\beta + \nu_e + \text{energy}$

2 marks
1 mark for correct elements.
1 mark for correct radiation particles.

b. Gamma rays are highly penetrating due to their fast movement and negligible size. 1 mark

Thus, gamma rays can travel through the spaces between cells with a low risk of collision; 1 mark
this presents a low risk to the patient. 1 mark

c. $DE = AD \times \text{quality factor}$

$16 \text{ mSv} = AD \times 1$

$AD = 16 \text{ mGy}$ 1 mark

$$AD = \frac{\text{energy}}{\text{mass}}$$

$$16 \times 10^{-3} = \frac{\text{energy}}{1.3}$$ 1 mark

$\text{energy} = 0.021 \text{ J}$ 1 mark

d. effective dose $= DE \times$ weighting factor

$ED_{\text{brain}} = 16 \times 0.01$
$= 0.16 \text{ mSv}$

$ED_{\text{kidney}} = 12 \times 0.009$
$= 0.108 \text{ mSv}$

$ED_{\text{bladder}} = 12 \times 0.04$
$= 0.48 \text{ mSv}$

1 mark
1 mark for calculating all three individual effective doses.

$ED_{\text{total}} = 0.16 + 0.108 + 0.48$
$= 0.75 \text{ mSv}$ 1 mark

e. $$A = \frac{A_0}{2^n}$$

$$12.5 \times 10^6 = \frac{0.2 \times 10^9}{2^n}$$ 1 mark

$2^n = 16$

$n = 4$ 1 mark

$t = nt_{\frac{1}{2}}$
$= 4 \times 2$
$= 8 \text{ hours}$ 1 mark

Question 4 (11 marks)

a. $P = \dfrac{V^2}{R}$

$1200 = \dfrac{240^2}{R}$ 1 mark

$R = 48\ \Omega$ 1 mark

b. Finding the current flowing through the blender gives:

$P = VI$

$1200 = 240I$

$I = 5$ A 1 mark

OR

Finding the charge using the resistance of the blender gives:

$I = \dfrac{V}{R}$

$= \dfrac{240}{48}$

$= 5$ A 1 mark

$t = 12 \times 60$

$= 720$ seconds 1 mark

Finding the charge flowing through the blender gives:

$Q = It$

$= 5 \times 720$

$= 3600$ C 1 mark

*Note: Responses that use the resistance of the blender are not awarded consequential marks if the resistance found in **Question 4a.** is incorrect.*

c. $P = \dfrac{E}{t}$

$E = Pt$

$= 1200 \times 720$

$= 8.64 \times 10^5$ J 1 mark

$P = \dfrac{1200}{1000}$

$= 1.2$ kW

$t = \dfrac{12}{60}$

$= 0.2$ h 1 mark

$E = Pt$

$= 1.2 \times 0.2$

$= 0.24$ kW h 1 mark

d. A circuit breaker breaks the circuit when excess current flows. 1 mark

The circuit breaker is placed on the active wire to ensure that no current is able to flow into the blender if there is an electrical fault. 1 mark

This prevents a person who touches the blender from completing the circuit while voltage is running through it and thus causing electrocution. 1 mark

Question 5 (8 marks)

a. *Any one of:*

- Non-ohmic devices have variable resistance depending on voltage or current. 1 mark
  As seen in the graph, the resistance of the LED changes when the amount of voltage supplied changes and becomes undefined when voltage supplied exceeds the LED's forward voltage. 1 mark
- Ohmic devices have a constant resistance when either current or voltage is varied. 1 mark
  As seen in the graph, the LED does not have a constant resistance and therefore cannot be an ohmic device. 1 mark

b. $V_R = 4.5 - 1.8$

$= 2.7 \text{ V}$ 1 mark

$$R = \frac{V}{I}$$

$$= \frac{2.7}{0.0139}$$

$= 194.24\ \Omega$ 1 mark

c. $P = VI$

$= 1.8 \times 0.0139$ 1 mark

$= 0.025 \text{ W}$ 1 mark

d. Reducing the resistance of the limiting resistor would increase the current flowing in the circuit, according to $I = \frac{V}{R}$. 1 mark

The increased current in the circuit would increase the power output of the LED according to $P = VI$. The LED would therefore produce more intense light. 1 mark

Note: Equations are not required for full marks but may be used to develop the response.

Question 6 (7 marks)

a. 45 000 Ω (*read from graph*) 1 mark

b. **Method 1:**

$1.5 : 4.5 = 45\ 000 : x$ 1 mark

$\frac{1}{3} = \frac{45\ 000}{x}$ 1 mark

$x = 135\ 000\ \Omega$ 1 mark

Method 2:

$$V_{\text{out}} = \frac{V_{\text{in}} R_1}{R_1 + R_2}$$

$$1.5 = 6 \times \frac{45\ 000}{45\ 000 + R_2}$$ 2 marks

1 mark for determining the voltage used by the resistor.
1 mark for showing appropriate working.

$R_2 = 135\ 000\ \Omega$ 1 mark

c. **Method 1:**

$157.5 \times 10^3 = 157\ 500\ \Omega$ 1 mark

$1.5 : 4.5 = x : 157\ 500$ 1 mark

$x = 52\ 500\ \Omega$

$T = 15°\text{C}$ (*read from graph*) 1 mark

Method 2:

$$V_{\text{out}} = \frac{V_{\text{in}} R_1}{R_1 + R_2}$$

$$1.5 = 6 \times \frac{R_1}{R_1 + 157\ 500}$$ 1 mark

$R_1 = 52\ 500\ \Omega$ 1 mark

$T = 15°\text{C}$ (*read from graph*) 1 mark

Question 7 (9 marks)

a. distance = area

$$= \frac{1}{2}(120 \times 8)$$

$$= 480 \text{ m}$$ 1 mark

b. $v = \frac{s}{t}$

$$= \frac{480}{120}$$

$$= 4 \text{ m s}^{-1}$$ 1 mark

c. $s = ut + \frac{1}{2}at^2$

$480 = \frac{1}{2} \times a \times 80^2$ 1 mark

$a = 0.15 \text{ m s}^{-2}$ 1 mark

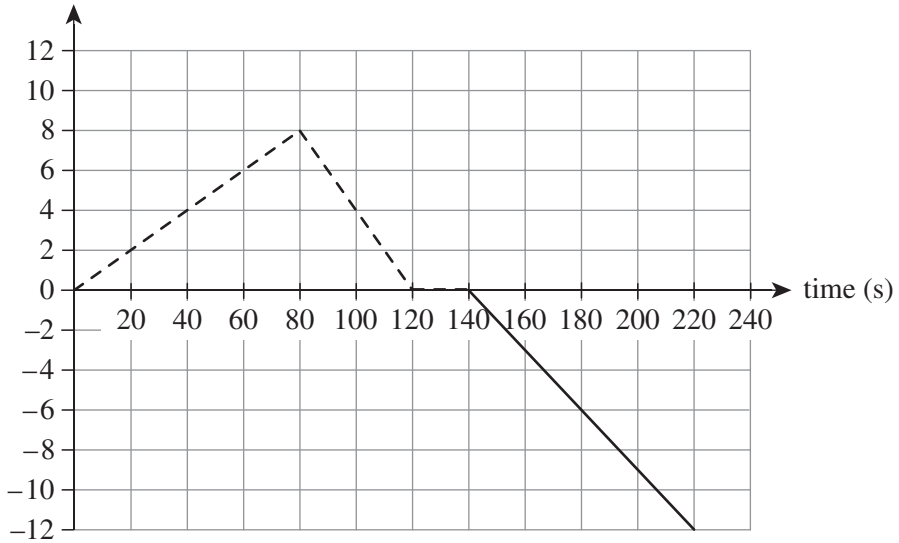
d. $v = u + at$

$= 0 + 0.15 \times 80$ 1 mark

$= 12 \text{ m s}^{-1}$ 1 mark

*Note: Consequential on answer to **Question 7c.***

e. velocity (m s^{-1})



1 mark

Note: The dashed line represents the part of the graph provided in the question.

f. The graph would show the return journey with a positive gradient, ending at a speed of 12 m s^{-1}. 1 mark

Speed versus time graphs are scalar graphs and therefore cannot exist below the time axis. Negative regions of the graph would imply direction, which is a vector property. 1 mark

Question 8 (6 marks)

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

$0 = 16^2 - 2 \times 9.8 \times s$ 1 mark

$s = 13$ m 1 mark

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

$-4.6^2 = 16^2 - 2 \times 9.8 \times s$ 1 mark

$s = 12$ m 1 mark

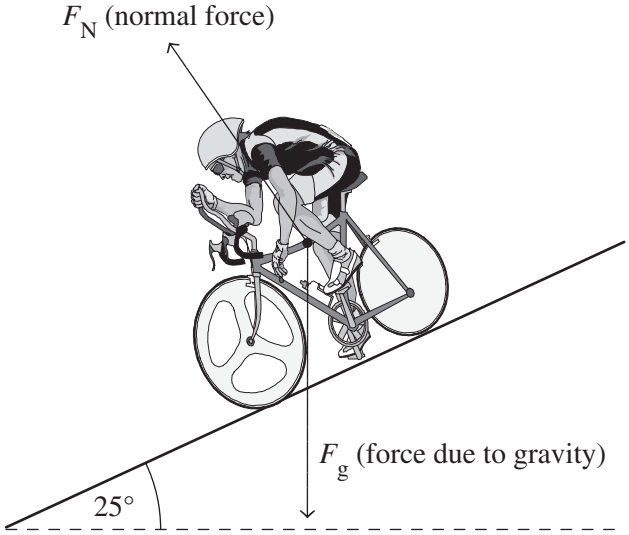
c. $v = u + at$

$-4.6 = 16 - 9.8t$ 1 mark

$t = 2.1$ s 1 mark

Question 9 (11 marks)

a.



2 marks

1 mark for drawing a labelled arrow for F_N in the correct direction.
1 mark for drawing a labelled arrow for F_g in the correct direction.
Note: Deduct 1 mark if the student has attempted to resolve the force due to gravity into a component parallel to the plane.
Deduct 1 mark if the F_g arrow is labelled as gravity.

b. Only the component of the force due to gravity that is acting parallel to the plane contributes to the net force acting on the cyclist. 1 mark

This component is equivalent to $g\sin\theta$, which is less than 9.8 m s^{-2}. 1 mark

c. Given that $F_{\text{net}} = 0$:

$F_{\text{brakes}} = mg\sin\theta$

$= 80 \times 9.8 \times \sin 25$ 1 mark

$= 3.3 \times 10^2 \text{ N}$ 1 mark

d. The force exerted by the brakes is exerted between the brakes and the wheels, whereas the force due to gravity is exerted between Earth and the combined entity of Josephine and the bicycle. 1 mark

Although these forces have an equal magnitude and act in opposite directions, they act between different sets of objects. 1 mark

e. The normal force only balances the component of the force due to gravity that is acting perpendicular to the plane. 1 mark

$N = mg\cos\theta$

$= 80 \times 9.8 \times \cos 25$ 1 mark

$= 7.1 \times 10^2 \text{ N}$ 1 mark

Question 10 (6 marks)

a. $W = \text{area}$

$= \left(\frac{1}{2}(40 \times 200) + \frac{1}{2}(40 + 160) \times 200\right) \times 1000$ 1 mark

$= 2.40 \times 10^7 \text{ J}$ 1 mark

b. $E_{\text{loss}} = 400 \times \left(2.0 \times 10^4\right)$

$= 8 \times 10^6 \text{ J}$ 1 mark

$\Delta E_k = W - E_{\text{loss}}$

$= 2.4 \times 10^7 - 8 \times 10^6$ 1 mark

$= 1.6 \times 10^7 \text{ J}$ 1 mark

$\Delta E_k = \frac{1}{2} m\left(v^2 - u^2\right)$

$1.6 \times 10^7 = \frac{1}{2} \times 160\,000 \times \left(v^2 - 5^2\right)$

$v = 15 \text{ m s}^{-1}$ 1 mark

Note: Consequential on answer to ***Question 10a.***

Question 11 (4 marks)

a. $F_{\text{horizontal}} = T\cos\theta$

$2100 = T \times \cos 60$ 1 mark

$T = 4200 \text{ N}$ 1 mark

b. $F_{\text{vertical}} = T\sin\theta$

$= 4200 \times \sin 60$

$= 3637 \text{ N}$ 1 mark

$F_{\text{g}} = 2 \times F_{\text{vertical}}$

$= 7275 \text{ N}$

$F_{\text{g}} = mg$

$7275 = 9.8m$

$m = 742 \text{ kg}$ 1 mark

Question 12 (6 marks)

a. Calculating the force exerted on the bridge by the left pylon by using the right pylon as a balance gives:

$\tau_{\text{net}} = 0$

$\left(F_{\text{g}} \times 5\right) + \left(F_{\text{left}} \times -20\right) = 0$ 1 mark

$2500 \times 9.8 \times 5 = 20F_{\text{left}}$

$F_{\text{left}} = 6125 \text{ N}$ 1 mark

Calculating the force exerted on the bridge by the right pylon by using the left pylon as a balance gives:

Method 1:

$\tau_{\text{net}} = 0$

$(F_{\text{g}} \times 25) + (F_{\text{right}} \times 20) = 0$ 1 mark

$2500 \times 9.8 \times 25 = -20F_{\text{right}}$

$F_{\text{right}} = -30\ 625 \text{ N}$ 1 mark

Method 2:

Given that $F_{\text{net}} = 0$:

$F_{\text{right}} = F_{\text{left}} + F_{\text{g}}$ 1 mark

$= 6125 + 2500 + 9.8$

$= 30\ 625 \text{ N}$ 1 mark

Note: The torque radii used in the solution are calculated from the position of the right pylon, then the left pylon respectively. Students can select any position as a reference point for their calculations as long as their torque directions remain consistent.

b. The force exerted by the left pylon is in the same direction as F_{g}. 1 mark

Therefore, to exert a downwards force on the bridge, the left pylon must be attached to it so that it can pull downwards. 1 mark

Question 13 (13 marks)

a.

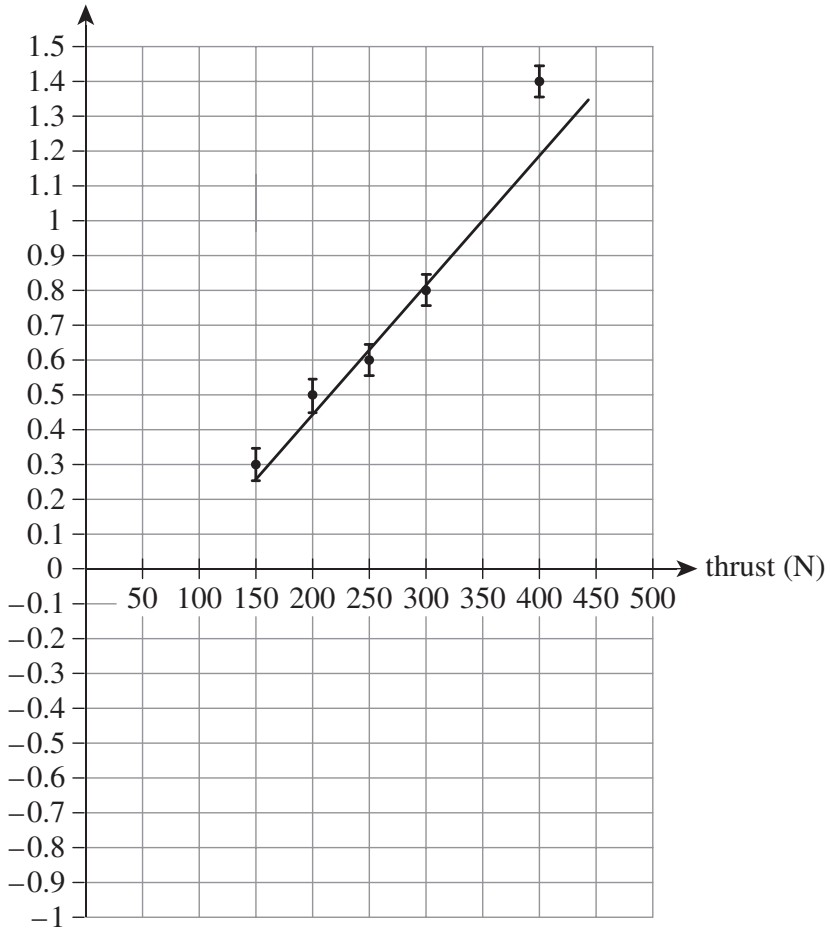
Thrust (N)	Acceleration (m s^{-2})			
	Trial 1	**Trial 2**	**Trial 3**	**Average**
150	0.25	0.30	0.30	**0.30**
200	0.45	0.50	0.50	**0.50**
250	0.60	0.55	0.60	**0.60**
300	0.70	0.65	0.95	**0.80**
400	1.25	1.35	1.50	**1.40**

1 mark

b. Conducting multiple trials allows the range of the data around the average to be considered and any present outliers to be removed, thus enhancing the precision of the data. 1 mark

The resolution of the data can only be enhanced by using measuring devices with smaller increments. 1 mark

c. acceleration (m s^{-2})



6 marks

1 mark for labelling both axes and including units.
1 mark for using appropriate scales on both axes.
1 mark for plotting the data points.
1 mark for including the uncertainty bars.
1 mark for drawing a line of best fit.
1 mark for using more than half of each axis.

d. $\text{gradient} = \dfrac{1 - 0.8}{350 - 300}$

$= 0.004$

$a = \dfrac{T - R}{m}$

$\therefore \text{gradient} = \dfrac{1}{m}$

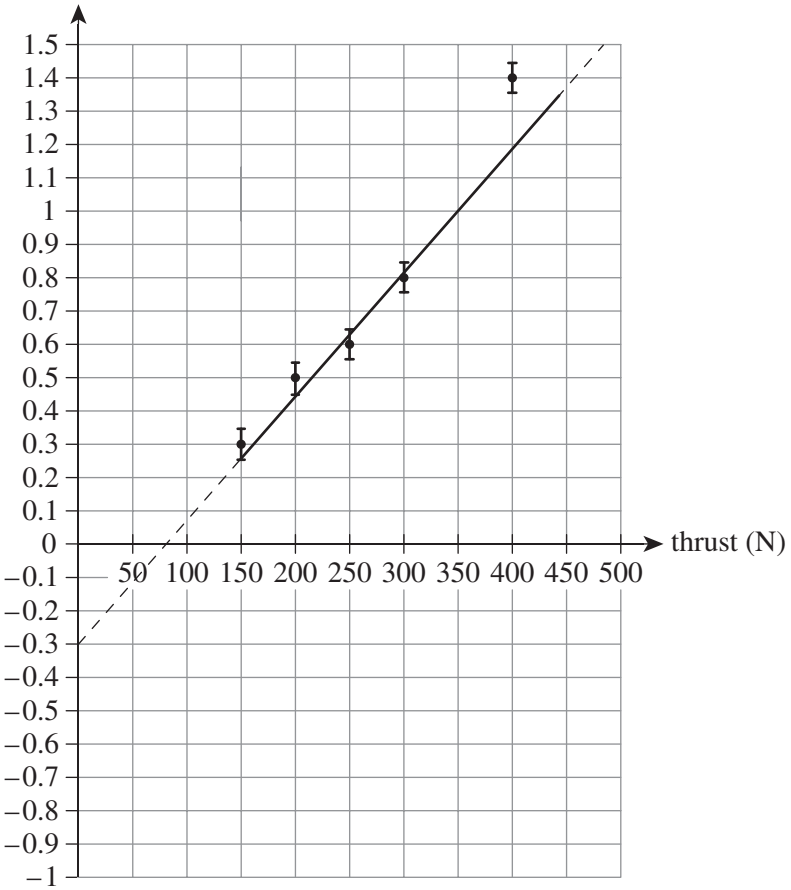
$\dfrac{1}{m} = 0.004$ 1 mark

$m = 250 \text{ kg}$

The investigation is somewhat accurate. 1 mark

Note: The final mark is consequential on the calculation of any reasonable gradient using the graph drawn in ***Question 13c.***

e. Extrapolating the line of best fit to find the *y*-intercept gives:



$\therefore$ *y*-intercept = –0.3

$y\text{-intercept} = -\dfrac{R}{m}$

$-0.3 = -\dfrac{R}{250}$ 1 mark

$R = 75 \text{ N}$ 1 mark

Note: Consequential on answer to ***Question 13d.***

