

Trial Examination 2020

VCE Physics Units 1&2

Written Examination

Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

1	☐ A	☒ B	☐ C	☐ D
2	☐ A	☒ B	☐ C	☐ D
3	☒ A	☐ B	☐ C	☐ D
4	☐ A	☐ B	☒ C	☐ D
5	☐ A	☒ B	☐ C	☐ D
6	☐ A	☐ B	☒ C	☐ D
7	☐ A	☒ B	☐ C	☐ D
8	☐ A	☒ B	☐ C	☐ D
9	☐ A	☐ B	☐ C	☒ D
10	☐ A	☐ B	☒ C	☐ D

11	☐ A	☒ B	☐ C	☐ D
12	☐ A	☐ B	☒ C	☐ D
13	☐ A	☐ B	☒ C	☐ D
14	☐ A	☒ B	☐ C	☐ D
15	☐ A	☐ B	☐ C	☒ D
16	☐ A	☒ B	☐ C	☐ D
17	☐ A	☒ B	☐ C	☐ D
18	☐ A	☒ B	☐ C	☐ D
19	☐ A	☐ B	☒ C	☐ D
20	☒ A	☐ B	☐ C	☐ D

Question 1 B

The metal spoon is a solid, so the main method of heat transfer in the spoon is conduction.

Question 2 B

$$\Delta Q_{\text{water}} = \Delta Q_{\text{aluminium}}$$

$$5.0 \times 4200 (T - 20^\circ\text{C}) = 1.0 \times 880 (90 - T)$$

$$21\,000T - 420\,000 = 79\,200 - 880T$$

$$21\,880T = 499\,200$$

$$T = 22.82^\circ\text{C}$$

$$T = 23^\circ\text{C}$$

Question 3 A

$$Q = ml_{\text{f}}$$

$$= 0.00400 \times 1.05 \times 10^5$$

$$= 420 \text{ J}$$

Question 4 C

Hotter objects emit most of their radiation at shorter wavelengths. Shorter wavelengths have more energy and higher frequency than longer wavelengths; therefore, hotter objects will appear more blue than cooler objects.

Question 5 B

$$V = \frac{E}{Q}$$

$$= \frac{4.5}{3.0}$$

$$= 1.5 \text{ V}$$

Question 6 C

$150 + 150 = 300 \text{ } \Omega$ (bottom of branch for parallel component)

resistance of parallel component of combined circuit:

$$\frac{1}{R_{\text{total}}} = \frac{1}{300} + \frac{1}{150}$$

$$R_T = 100 \text{ } \Omega$$

total resistance of combined circuit:

$$R_{\text{effective}} = 100 + 150 = 250 \text{ } \Omega$$

Question 7 B

3.0 V across the LED leaves 2.0 V across the $100\ \Omega$ resistor.

$$V = IR$$

$$2.0 = I \times 100$$

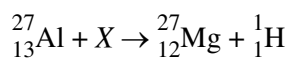
$$= 0.02\ \text{A}$$

$$= 20\ \text{mA}$$

Question 8 B

α decay: mass number decreases by 4; atomic number decreases by 2

β^- decay: no change to mass number; atomic number increases by 1

Question 9 D

$$27 + 1 = 27 + 1 \text{ (Mass numbers are equal on both sides of the equation.)}$$

$$13 + 0 = 12 + 1 \text{ (Atomic numbers are equal on both sides of the equation.)}$$

Question 10 C

The four observed fundamental forces are the weak nuclear force, strong nuclear force, electromagnetic force and gravitational force. Dark matter force is not an observed fundamental force because it is a theory.

Question 11 B

Displacement is the shortest distance from an initial position to a final position (in this case, the distance from point X to point Z). Therefore, displacement is 9.0 km.

Question 12 C

Taking right as positive:

$$u = 2.0$$

$$v = -4.0$$

$$t = 2.0$$

$$a = ?$$

$$v = u + at$$

$$-4.0 = 2.0 + 2.0a$$

$$a = -3.0\ \text{m s}^{-2}$$

The acceleration is $3.0\ \text{m s}^{-2}$ to the left.

Question 13 C

time to top:

$$v = u + at$$

$$0.0 = 9.8 - 9.8t$$

$$t = 1.0 \text{ s}$$

distance to top:

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

$$0 = 9.8^2 + 19.8s$$

$$s = 4.9 \text{ m}$$

time to bottom:

$$(9.8 + 4.9) = 0 + 4.9t^2$$

$$t = 1.7 \text{ s}$$

total time of flight:

$$t = 1.0 + 1.7$$

$$= 2.7 \text{ s}$$

Question 14 B

$$F_{\text{net}} = 0 \text{ N}$$

$$W - f = 0$$

$$f = 60 \times 9.8$$

$$= 588 \text{ N}$$

Question 15 D

In this graph of velocity versus time, the gradient is constant; $F_{\text{net}} = ma$, so F_{net} is constant.

Question 16 B

$$E_k = \frac{1}{2} \times 0.0459 \times (70.0)^2 = 112 \text{ J}$$

Question 17 B

loss in gravitational potential energy = gain in kinetic energy

$$m \times 9.8 \times 15.2 : m \times 9.8 \times (76.0 - 15.2)$$

$$15.0 : 60.8$$

$$1 : 4$$

Question 18 B

$$\tau_{\text{anticlockwise}} = \tau_{\text{clockwise}}$$

$$40.0 \times 9.8 \times 0.5 = 5.0 \times 9.8 \times 0.25 + F_{\text{Hannah}} \times 1.0$$

$$F_{\text{Hannah}} = 184 \text{ N m}$$

Question 19 C

$$\begin{aligned} F_{\text{one wire}} &= \frac{10 \times 9.8}{2 \cos 30} \\ &= 57 \text{ N} \end{aligned}$$

Question 20 A

The scenario in **A** is not accurate as the darts are far from the true value (the bullseye), but it is precise as the darts are close together.

SECTION B**Question 1** (3 marks)

A human has a greater average kinetic energy than the swimming pool water because they have a higher average temperature. 1 mark
1 mark

The swimming pool water has a greater total kinetic energy than a human because it has a greater volume of particles than the human. 1 mark

Note: For full marks, students must differentiate between average kinetic energy and total kinetic energy.

Question 2 (5 marks)

a. The substance changes state from a liquid to a solid. 1 mark

b. $Q = ml_{\text{fusion}}$

$$300\,000 = 0.20 \times l_{\text{fusion}} \quad 1 \text{ mark}$$

$$l_{\text{fusion}} = 1\,500\,000 \text{ J kg}^{-1} \quad 1 \text{ mark}$$

c. $Q = mc\Delta T$

$$100\,000 = 0.2 \times c \times (90 - 70) \quad 1 \text{ mark}$$

$$c = 25\,000 \text{ J kg}^{-1} \text{ K}^{-1} \quad 1 \text{ mark}$$

Question 3 (4 marks)

a. Step 1:

$$\begin{aligned}\Delta U &= Q - W \\ &= 70 - (-35) \\ &= 105 \text{ J}\end{aligned}$$

1 mark

Step 2:

$$\begin{aligned}\Delta U &= Q - W \\ &= 35 - 70 \\ &= -35 \text{ J}\end{aligned}$$

1 mark

Overall:

$$\begin{aligned}\Delta U &= Q - W \\ &= 105 - 35 \\ &= 70 \text{ J}\end{aligned}$$

1 mark

b. increase 1 mark

Question 4 (2 marks)

$$\lambda_{\max} = \frac{0.0028}{3900}$$

$$= 7.2 \times 10^{-7}$$

$$= 720 \text{ nm}$$

1 mark

1 mark

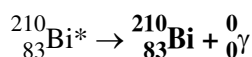
Question 5 (4 marks)

- a. The greenhouse gases absorb the infrared radiation emitted by Earth and re-emit it in all directions, heating up both Earth's atmosphere and Earth itself, therefore making Earth warm enough to sustain life. 1 mark

The infrared radiation emitted by Earth would radiate straight out of Earth's atmosphere if there were no greenhouse gases in the atmosphere. 1 mark

- b. Human activities such as burning fossil fuels increase the amount of greenhouse gases released in the atmosphere. 1 mark

The increase in greenhouse gases in the atmosphere results in extra heat being trapped, causing Earth's temperature to rise, which contributes to the enhanced greenhouse effect. 1 mark

Question 6 (2 marks)

2 marks

1 mark for ${}_{83}^{210}\text{Bi}$.1 mark for ${}_0^0\gamma$.**Question 7** (11 marks)

- a. ${}_{6}^{14}\text{C} \rightarrow {}_{7}^{14}\text{N} + {}_{-1}^0\beta + \text{antineutrino}$

3 marks

1 mark for the correct elements.

1 mark for the correct mass numbers.

1 mark for the correct atomic numbers.

- b.

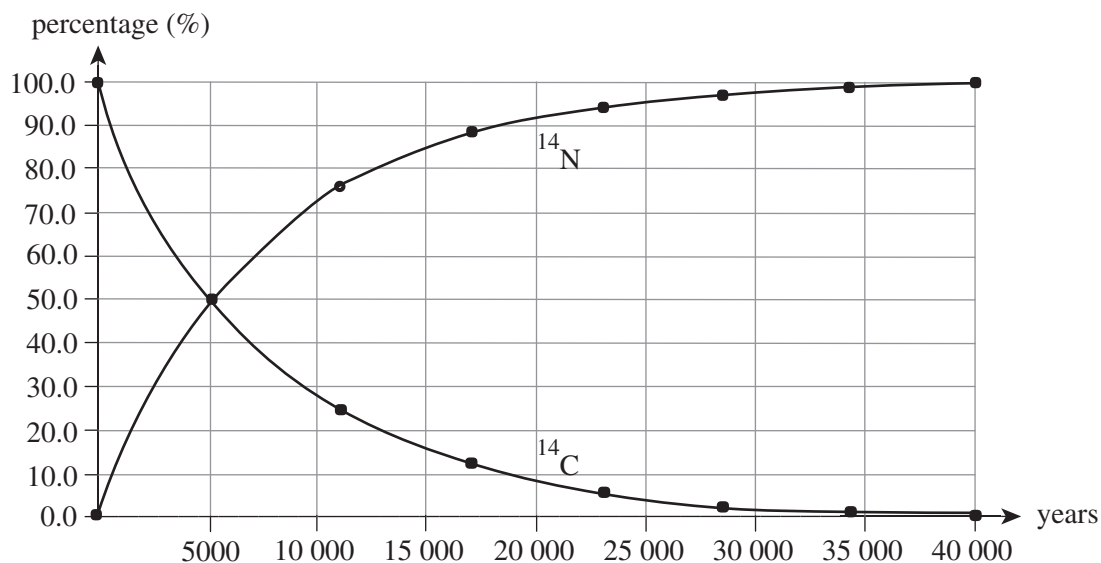
Years from present	0	5700	11 400	17 100	22 800	28 500	34 200	39 900
% ${}^{14}\text{C}$	100.0	50.0	25.0	12.5	6.3	3.1	1.6	0.8
% ${}^{14}\text{N}$	0.0	50.0	75.0	87.5	93.8	96.9	98.4	99.2

3 marks

1 mark for the correct years.

1 mark for correct percentages for ${}^{14}\text{C}$.1 mark for correct percentages for ${}^{14}\text{N}$.

c.



4 marks

1 mark for correct ^{14}C plotting.1 mark for ^{14}C line of best fit.1 mark for correct ^{14}N plotting.1 mark for ^{14}N line of best fit.

d. $\frac{1}{2^{10}} = 9.8 \times 10^{-4}$

$\therefore n = 10$

The carbon-14 in an organic material will become difficult to detect after approximately 10 half-lives (9.8×10^{-4}).

1 mark

Question 8 (7 marks)

a. weight of three protons:

$$3 \times 1.6726 \times 10^{-27} = 5.0178 \times 10^{-27} \text{ kg}$$

weight of four neutrons:

$$4 \times 1.6749 \times 10^{-27} = 6.6996 \times 10^{-27} \text{ kg}$$

The total weight of 3 protons and neutrons is $1.1717 \times 10^{-26} \text{ kg}$.

difference from the lithium-7 nucleus:

$$1.1717 \times 10^{-26} - 1.1650 \times 10^{-26} = 6.7400 \times 10^{-29} \text{ kg}$$

3 marks

1 mark for weights of protons and weights of neutrons.

1 mark for total weight of protons and neutrons.

1 mark for difference in weight from the lithium-7 nucleus.

b. The difference of mass is converted to energy released by the seven nucleons. 1 mark

c. $E = mc^2$

$$= 6.7400 \times 10^{-29} \times (3 \times 10^8)^2$$

$$= 6.0660 \times 10^{-12} \text{ J} \quad 1 \text{ mark}$$

$$= \frac{6.0660 \times 10^{-12}}{1.6 \times 10^{-13}}$$

$$= 37.91 \text{ MeV} \quad 1 \text{ mark}$$

Question 9 (6 marks)

a. $R_T = 100 + 200 + 300$

$$= 600 \, \Omega \quad 1 \text{ mark}$$

$$V_T = I_T \times R_T$$

$$6.0 = I_T \times 600$$

$$I_T = 0.010 \text{ A}$$

$$= 10 \text{ mA} \quad 1 \text{ mark}$$

$$V_{\text{drop/voltmeter}} = 0.010 \times 300$$

$$= 3.0 \text{ V} \quad 1 \text{ mark}$$

b. $\frac{1}{R_T} = \frac{1}{200} + \frac{1}{300}$

$$R_T = 120 \, \Omega \quad 1 \text{ mark}$$

$$V_T = I_T \times R_T$$

$$6.0 = I_T \times 120$$

$$I_T = 0.050 \text{ A}$$

$$I_T = 50 \text{ mA} \quad 1 \text{ mark}$$

$$V_{\text{voltmeter}} = 6.0 \text{ V (same as the supply)} \quad 1 \text{ mark}$$

Question 10 (8 marks)

- a. component X 1 mark

Component X is ohmic because its resistance is constant for all current–voltage pairs, as shown by the straight line through the origin.

- b. i. 30 mA 1 mark

- ii. 80 mA 1 mark

- iii. resistance of component X:

$$R = \frac{8.0}{0.08}$$

$$= 1000 \, \Omega$$

1 mark

resistance of component Y:

$$R = \frac{8.0}{0.03}$$

$$= 2667 \, \Omega$$

1 mark

effective resistance:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_T} = \frac{1}{1000} + \frac{1}{2667}$$

1 mark

$$R_T = 727 \, \Omega$$

1 mark

Question 11 (3 marks)

- a. A person could get an electric shock. 1 mark

- b. If an active wire comes into contact with the metal case, the outer casing could become live. 1 mark

There is a 240 V AC potential difference between the person's hand and the ground, and a current may flow.

1 mark

Question 12 (15 marks)

- a. $10.0 \, \text{m s}^{-1}$ 1 mark

The direction is East. 1 mark

- b. $a = \frac{40.0}{4.0}$ 1 mark

$$= 10.0 \, \text{m s}^{-2}$$

1 mark

The direction is West. 1 mark

c. distance = $\frac{1}{2} \times 6.0 \times 20.0 + 4.0 \times 20.0 + \frac{1}{2} \times 2.0 \times 20.0 +$ 1 mark

$$\frac{1}{2} \times 2.0 \times 20.0 + 6.0 \times 20.0 + \frac{1}{2} \times 4.0 \times 20$$
 1 mark

$$= 340 \text{ m}$$
 1 mark

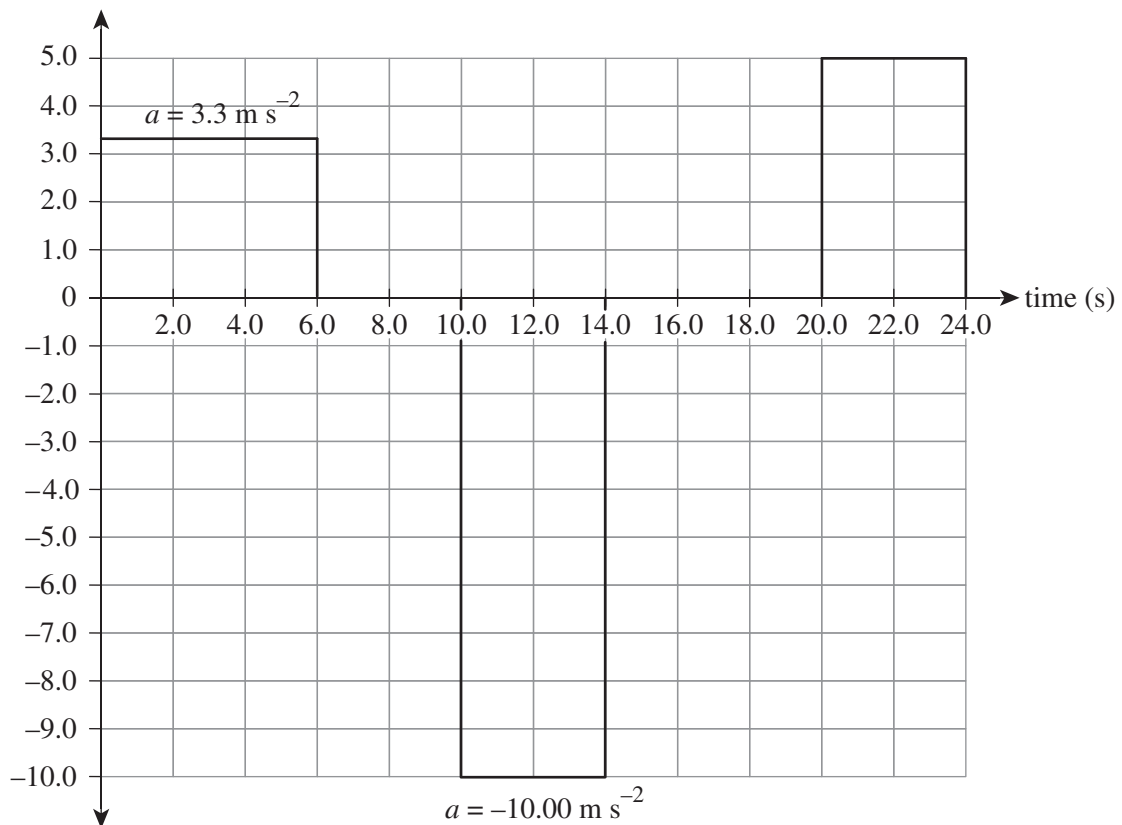
NA 1 mark

d. displacement = $\left(\frac{1}{2} \times 6.0 \times 20.0 + 4.0 \times 20.0 + \frac{1}{2} \times 2.0 \times 20.0 \right) -$ 1 mark

$$\left(\frac{1}{2} \times 2.0 \times 20.0 + 6.0 \times 20.0 + \frac{1}{2} \times 4.0 \times 20.0 \right)$$

$$= 20 \text{ m}$$
 1 mark

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



4 marks

1 mark for correct scale.

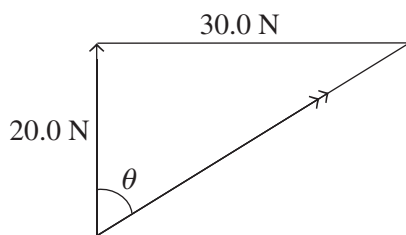
1 mark for correct shape.

1 mark for acceleration = 3.3 m s^{-2} East.

1 mark for acceleration = 10.0 m s^{-2} West.

Question 13 (4 marks)

a.



1 mark

b.

$$F_{\text{net}} = \sqrt{20.0^2 + 30.0^2}$$

1 mark

$$F_{\text{net}} = 36.1 \text{ N}$$

1 mark

$$\tan \theta = \frac{30.0}{20.0}$$

$$= 56^\circ$$

The direction is N56°E.

1 mark

*Note: Consequential on answer to Question 13a.***Question 14** (6 marks)

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

$$300 = 60a$$

1 mark

$$a = 5 \text{ m s}^{-2}$$

1 mark

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

$$F_{\text{A on B}} = 40 \times 5$$

1 mark

$$= 200 \text{ N}$$

1 mark

Note: Consequential on answer to Question 14a.

c. $F_{\text{B on A}} = 200 \text{ N}$

1 mark

The direction is to the left.

1 mark

*Note: Consequential on answer to Question 14b.***Question 15** (5 marks)

a. $F_N = ma$

$$T - 4.0 \times 9.8 = 4.0a$$

$$5.0 \times 9.8 - T = 5.0a$$

$$5.0 \times 9.8 - (4a + 4.0 \times 9.8) = 5.0a$$

$$9.8 = 9.0a$$

1 mark

$$a = 1.1 \text{ m s}^{-2}$$

1 mark

The direction is up.

1 mark

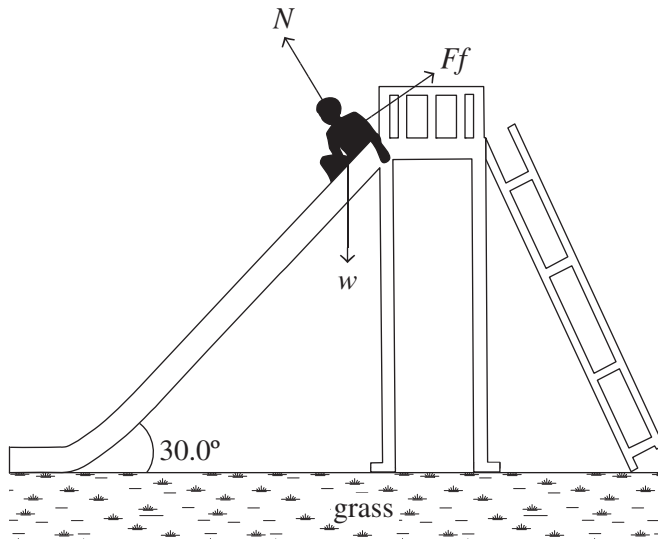
b. $T - 4.0 \times 9.8 = 4.0 \times 1.1$
 $T = 43.6 \text{ N}$

1 mark

1 mark

*Note: Consequential on answer to Question 15a.***Question 16** (9 marks)

a.



3 marks

*1 mark for showing force due to weight (w).**1 mark for showing force due to normal reaction (N).**1 mark for showing frictional forces (Ff).*

b. $F_{\text{normal force}} = 80 \times 9.8 \cos 30$
 $= 679.0 \text{ N}$

1 mark

1 mark

c. $F_{\text{net}} = 80 \times 9.8 \sin 30 - 100$
 $= 292.0 \text{ N}$

1 mark

1 mark

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

$$292.0 = 80a$$

1 mark

$$a = 3.7 \text{ m s}^{-2}$$

1 mark

Note: Consequential on answer to Question 16b.

Question 17 (4 marks)

a. $k = \text{gradient} = \frac{5.0 \times 10^3}{0.1}$ 1 mark

$= 5.0 \times 10^4 \text{ N m}^{-1}$ 1 mark

$= 50\,000 \text{ N m}^{-1}$

b. elastic potential energy $= \frac{1}{2} \times 2.5 \times 10^3 \times 0.05$ 1 mark

$= 62.5 \text{ J}$ 1 mark

Question 18 (12 marks)

a.

Total mass (kg)	Acceleration (m s^{-2})	$\frac{1}{\text{total mass}}$ (kg^{-1})
0.500	3.9	2.0
0.750	2.7	1.3
1.000	2.0	1.0
1.250	1.6	0.8
1.500	1.3	0.7
1.750	1.1	0.6

2 marks

*1 mark for correct entry of (kg^{-1}).**1 mark for correct entry of 1.3.*

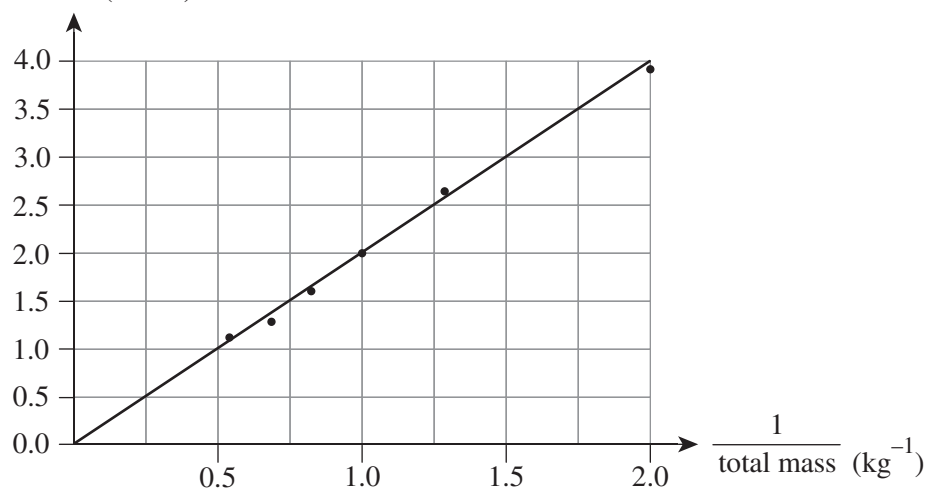
b.

Classification	Variable
controlled	total mass of system (trolley + masses)
dependent	acceleration
independent	force applied/falling mass

3 marks

Award 1 mark for each correct entry.

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



3 marks

1 mark for data points.

1 mark for line of best fit.

1 mark for horizontal axis unit kg^{-1} .

d. $\text{gradient} = \frac{\text{rise}}{\text{run}} = \frac{4.0}{2.0}$
 $= 2.0$

1 mark

1 mark

e. $\text{gradient} = \frac{a}{\left(\frac{1}{m}\right)} = ma$

$F_{\text{applied}} = \text{gradient}$

1 mark

$= 2.0 \text{ N}$

1 mark