Neap

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**

$$\Delta Q_{\text{water}} = \Delta Q_{\text{aluminium}}$$
$$5.0 \times 4200\,(T - 20°C) = 1.0 \times 880(90 - T)$$
$$21\,000T - 420\,000 = 79\,200 - 880T$$
$$21\,880T = 499\,200$$
$$T = 22.82°C$$
$$T = 23°C$$

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**

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

resistance of parallel component of combined circuit:

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

$R_T = 100\ \Omega$

total resistance of combined circuit:

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

Question 7 B

3.0 V across the LED leaves 2.0 V across the 100 Ω resistor.

$V = IR$

$2.0 = 1 \times 100$

$= 0.02 \text{ A}$

$= 20 \text{ mA}$

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

$^{27}_{13}\text{Al} + X \rightarrow {}^{27}_{12}\text{Mg} + {}^{1}_{1}\text{H}$

27 + 1 = 27 + 1 (Mass numbers are equal on both sides of the equation.)

13 + 0 = 12 + 1 (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 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

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

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**

$$F_{\text{one wire}} = \frac{10 \times 9.8}{2\cos 30}$$

$$= 57 \text{ N}$$

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

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

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

c. $Q = mc\Delta T$

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

$c = 25000 \text{ J kg}^{-1}\text{K}^{-1}$ 1 mark

Question 3 (4 marks)

a. Step 1:

$\Delta U = Q - W$

$= 70 - (-35)$

$= 105 \text{ J}$ 1 mark

Step 2:

$\Delta U = Q - W$

$= 35 - 70$

$= -35 \text{ J}$ 1 mark

Overall:

$\Delta U = Q - W$

$= 105 - 35$

$= 70 \text{ J}$ 1 mark

b. increase 1 mark

Question 4 (2 marks)

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

$= 7.2 \times 10^{-7}$ 1 mark

$= 720$ nm 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)

$${}^{210}_{83}\text{Bi}^* \rightarrow \mathbf{{}^{210}_{83}Bi + {}^{0}_{0}\gamma}$$

2 marks

1 mark for ${}^{210}_{83}Bi$.

1 mark for ${}^{0}_{0}\gamma$.

Question 7 (11 marks)

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

3 marks

1 mark for the correct elements.
1 mark for the correct mass numbers.
1 mark for the correct atomic numbers.

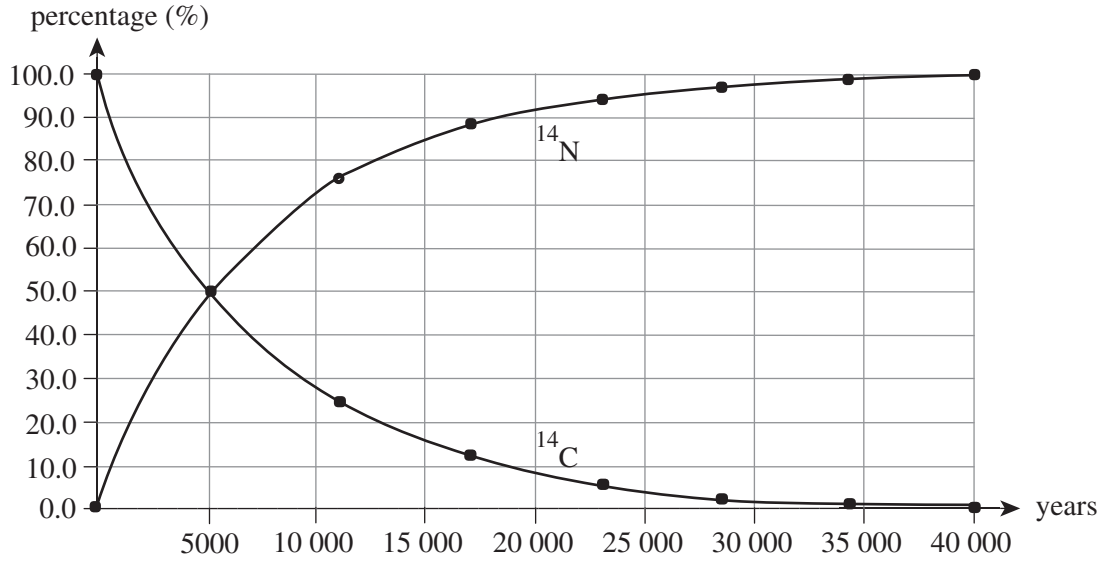
b.

Years from present	0	5700	11 400	**17 100**	**22 800**	**28 500**	**34 200**	39 900
% ^{14}C	100.0	**50.0**	**25.0**	**12.5**	**6.3**	**3.1**	**1.6**	**0.8**
% ^{14}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}C.
1 mark for correct percentages for ^{14}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:

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

weight of four neutrons:

$4 \times 1.6749 \times 10^{-27} = 6.996 \times 10^{-27}$ kg

The total weight of 3 protons and neutrons is 1.1717×10^{-26} kg.

difference from the lithium-7 nucleus:

$1.1717 \times 10^{-26} - 1.1650 \times 10^{-26} = 6.7400 \times 10^{-29}$ 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. $E = mc^2$

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

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

$= \dfrac{6.0660 \times 10^{-12}}{1.6 \times 10^{-13}}$ 1 mark

$= 37.91$ MeV 1 mark

Question 9 (6 marks)

a. $R_T = 100 + 200 + 300$

$= 600\ \Omega$ 1 mark

$V_T = I_T \times R_T$

$6.0 = I_T \times 600$

$I_T = 0.010$ A

$= 10$ mA 1 mark

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

$= 3.0$ V 1 mark

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

$R_T = 120\ \Omega$ 1 mark

$V_T = I_T \times R_T$

$6.0 = I_T \times 120$

$I_T = 0.050$ A

$I_T = 50$ mA 1 mark

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

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

$= 340$ m 1 mark

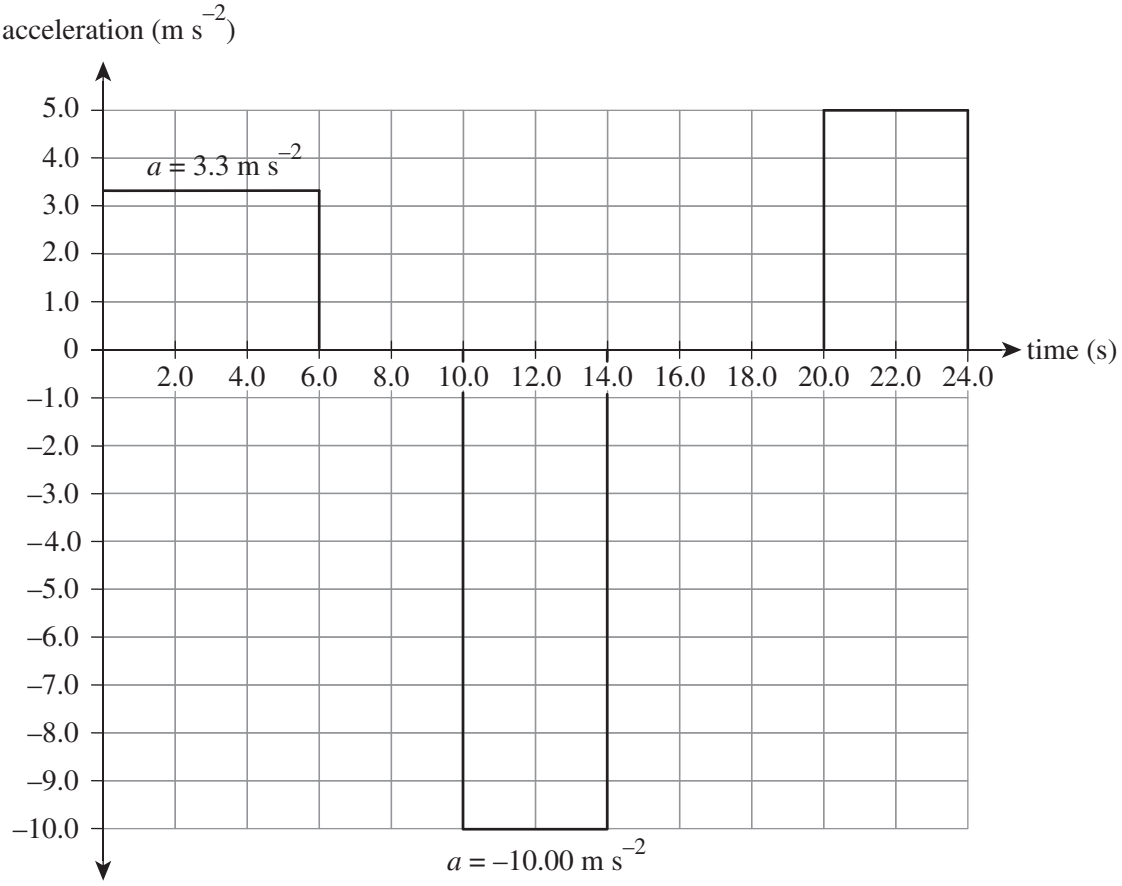
NA 1 mark

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

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

$= 20$ m 1 mark

e.



4 marks

1 mark for correct scale.

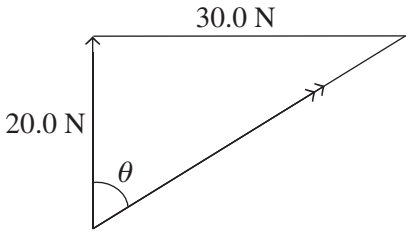
1 mark for correct shape.

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

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

$= 56°$

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

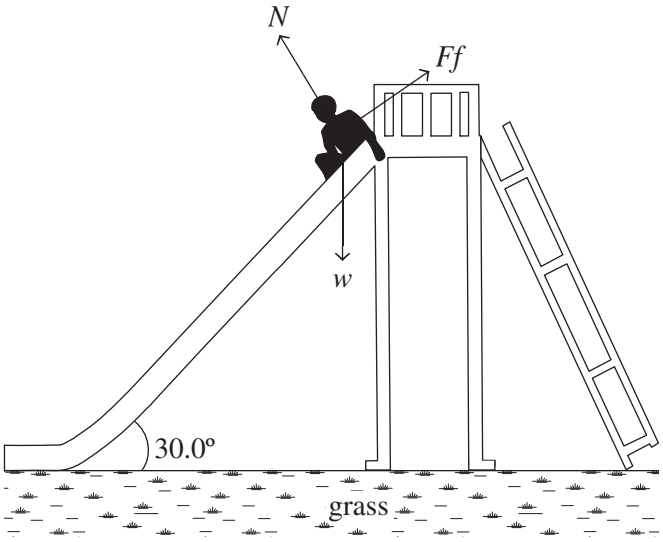
b. $T - 4.0 \times 9.8 = 4.0 \times 1.1$ 1 mark

$T = 43.6$ N 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. $F_{\text{normal force}} = 80 \times 9.8 \cos 30$ 1 mark

$= 679.0$ N 1 mark

c. $F_{\text{net}} = 80 \times 9.8 \sin 30 - 100$ 1 mark

$= 292.0$ N 1 mark

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

$292.0 = 80a$ 1 mark

$a = 3.7$ m s^{-2} 1 mark

*Note: Consequential on answer to **Question 16b.***

Question 17 (4 marks)

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

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

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

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

$= 62.5 \text{ J}$ 1 mark

Question 18 (12 marks)

a.

Total mass (kg)	**Acceleration (m s^{-2})**	**$\dfrac{1}{\text{total mass}}$ (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.

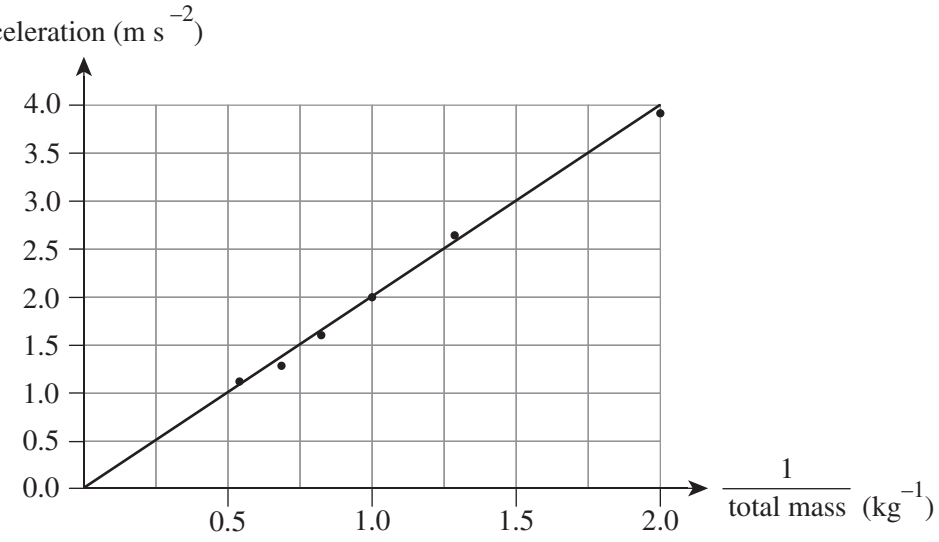
b.

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.



3 marks

1 mark for data points.

1 mark for line of best fit.

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

d. $\text{gradient} = \frac{\text{rise}}{\text{run}} = \frac{4.0}{2.0}$ 1 mark

$= 2.0$ 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