Neap

Trial Examination 2021

# 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 C**

**C** is correct. Heat naturally flows in one direction only: from hot toward cold. **A**, **B** and **D** are incorrect. These diagrams do not show the heat flowing in the correct direction.

**Question 2 D**

$$U = Q - W$$
$$35 = Q - 15$$
$$Q = 50 \text{ J}$$

**Question 3 A**

$$Q = mc\Delta T$$
$$1.0 \times 4200 \times (T_f - 15) = -(0.9 \times 880 \times (T_f - 90))$$
$$4992T_f = 127\,800$$
$$T_f = 26.9$$

The final temperature of the mixture is closest to 27.0°C.

**Question 4 C**

Circuit X:

$$P_T = \frac{V_T{}^2}{R_T}$$
$$= \frac{1.0^2}{0.5}$$
$$= 2.0 \text{ W}$$

Circuit Y:

$$P_T = \frac{V_T{}^2}{R_T}$$
$$= \frac{1.0^2}{2.0}$$
$$= 0.5 \text{ W}$$

Circuit Z:

$$P_T = \frac{V_T{}^2}{R_T}$$
$$= \frac{1.0^2}{1.5}$$
$$= 0.7 \text{ W}$$

In order from lowest total power output to highest total power output, the circuits are Y, Z, X.

**Question 5 C**

$$\text{energy (kWh)} = 4.8 \times 2.0 \times 14$$
$$= 134.4 \text{ kWh}$$

$25.5 \times 134.4 = 3427.2$

The total cost of the energy consumed is $34.27.

**Question 6 D**

LHS = RHS

*X*:

$233 \rightarrow 229 + 4$

$92 \rightarrow 90 + 2$

Hence, $X = {}^{4}_{2}\alpha$.

*Y*:

$202 \rightarrow 202 + 0$

$81 \rightarrow 81 + 0$

Hence, $Y = {}^{0}_{0}\gamma$.

*Z*:

$82 \rightarrow 82 + 0$

$35 \rightarrow 36 + (-1)$

Hence, $Z = {}^{0}_{-1}\beta$.

**Question 7 D**

Slow cooker:

$$P = VI$$
$$200 = 240 \times I$$
$$I = 0.83 \text{ A}$$
$$P = \frac{V^2}{R}$$
$$200 = \frac{240^2}{R}$$
$$R = 288\ \Omega$$

Kettle:

$$P = VI$$
$$1000 = 240 \times I$$
$$I = 4.17 \text{ A}$$
$$P = \frac{V^2}{R}$$
$$1000 = \frac{240^2}{R}$$
$$R = 568\ \Omega$$

**Question 8 B**

$$\left(+\frac{2}{3}-\frac{1}{3}-\frac{1}{3}\right)=\left(+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}\right)+X$$

$$X=-1$$

Therefore, the other particle produced in this transformation is an electron.

**Question 9 B**

$$V_{\text{out}}=\frac{R_1}{\left(R_1+R_2\right)}\times V_{\text{in}}$$

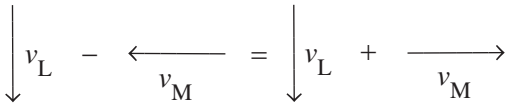
$$8=\frac{800}{800+R_2}\times 12$$

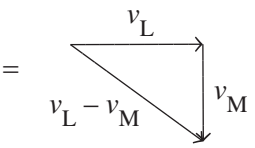
$$R_2=400\ \Omega$$

**Question 10 C**

**C** is correct. The conversion of an element into another element by bombarding it with a fundamental particle such as a neutron is known as artificial transmutation. **A**, **B** and **D** are incorrect. These terms do not represent the equation shown.

**Question 11 A**




**Question 12 D**

$$\text{total distance travelled}=3.0+3.0+2.0+2.0+6.0+6.0$$

$$=22.0\ \text{m}$$

**Question 13 C**

**C** is correct. Inertia is the tendency of an object to resist changes in its state of motion. The more inertia an object has, the more mass it has. This is because the mass of an object is solely dependent on the object's inertia. A feather has less inertia than a hammer because a hammer has greater mass, meaning a hammer has a greater tendency to resist changes in its state of motion. **A** is incorrect. A 10 kg bag of rice has a greater mass than a 2 kg bag and, therefore, has more inertia. **B** is incorrect. A bowling ball has a greater mass and more inertia than a pencil. **D** is incorrect. Bodies of different masses have different inertia, regardless of their proximity to the surface of the Earth.

**Question 14 D**

$$\Sigma F = ma$$
$$F_{\text{applied}} - 15.0 = 20.0 \times 2.0$$
$$F_{\text{applied}} = 55.0 \text{ N}$$

**Question 15 B**

**B** is correct. The centre of mass of the beam is to the right of support Y, so it will have a clockwise torque due to its weight. Therefore, support X is under tension and support Y is under compression.

**Question 16 B**

$$\Sigma F = ma$$
$$60.0 = 6.0 \times a$$
$$a = 10.0 \text{ m s}^{-2}$$
$$F_{\text{R on S}} = 2.0 \times 10.0$$
$$= 20.0 \text{ N}$$

**Question 17 C**

**C** is correct. A dependent variable is the variable a scientist measures after selecting and changing the independent variable that is assumed to affect the dependent variable. **A** is incorrect. This option describes a controlled variable. **B** is incorrect. This option describes an independent variable. **D** is incorrect. This option does not describe any variable in an experiment.

**Question 18 A**

$$\text{impulse} = \text{area under force versus time graph}$$
$$= \frac{1}{2} \times 0.30 \times 0.30$$
$$= 4.5 \times 10^{-2} \text{ N s}$$

**Question 19 A**

**A** is correct. The bag's displacement in the vertical direction is 0.0 m. Hence, the work done against the bag's weight force is 0.0 N. **B** is incorrect. The work done against friction is 200 N. **C** is incorrect. The work done by the net force to move the bag is 300 N. **D** is incorrect. The work done horizontally by the applied force is 500 N.

**Question 20 C**

**C** is correct. In this set of results, all the arrows hit the target about an equal distance from and spaced equally around the bullseye; hence, the result is accurate. However, the arrows did not hit the target close to the bullseye; therefore, the result is not precise. **A** is incorrect. This set of results is precise but not accurate. **B** is incorrect. This set of results is not accurate or precise**. D** is incorrect. This set of results is precise and accurate.

## SECTION B

**Question 1** (5 marks)

**a.** $Q = mc\Delta T$

$2000 = m \times 385 \times 100$ 1 mark

$m = 0.05195$ 1 mark

$= 5.19 \times 10^{-2}$ kg (to 3 significant figures) 1 mark

**b.** The process is endothermic. 1 mark

It is endothermic because the piece of copper absorbs heat from the environment. 1 mark

**Question 2** (8 marks)

**a.** 20°C 1 mark

20 + 273 = 293 K 1 mark

**b.** At 80°C, the sample is changing state 1 mark

from a gas into a liquid, or from a liquid into a gas. 1 mark

**c.** $Q = mL_v$

$L_v = \dfrac{6.0 \times 10^3 - 2.0 \times 10^3}{0.05}$ 1 mark

$= 8.0 \times 10^4$ J kg$^{-1}$ 1 mark

**d.** $Q = mc\Delta T$

$10.0 \times 10^3 - 6.0 \times 10^3 = 0.05 \times c \times (80.0 - 20.0)$ 1 mark

$c = 1.3 \times 10^3$ J kg$^{-1}$ °C 1 mark

**Question 3** (4 marks)

$\lambda_{max} = \dfrac{0.0028 \text{ m K}}{T}$ 1 mark

$635 \times 10^{-9} = \dfrac{0.0028 \text{ m K}}{T}$

$T = \dfrac{0.0028}{635 \times 10^{-9}}$ 1 mark

$= 4409$ K 1 mark

$= 4409 - 273$

$= 4140$°C 1 mark

**Question 4** (4 marks)

**a.** **i.** equal to 1 mark

**ii.** less than 1 mark

**b.** Temperature is average kinetic energy. As both the cup and swimming pool are at the same temperature, the water molecules have the same average kinetic energy. Temperature is proportional to the average kinetic energy. 1 mark

Internal energy is the sum of total kinetic energy and potential energy within a substance. Hence, the swimming pool of water has more internal energy than the cup of water. 1 mark

**Question 5** (6 marks)

$R_T = 10.0 + 10.0 + 20.0$

$= 40.0\ \Omega$

$V_T = I_T \times R_T$

$24.0 = I_T \times 40.0$

$I_T = 0.6\ \text{A}$

$I_T = I_1 = I_2 = I_3 = 0.6\ \text{A}$

$V_1 = 0.6 \times 10.0$

$= 6.0\ \text{V}$

$V_1 = V_2 = 6.0\ \text{V}$

$V_3 = 0.6 \times 20.0$

$= 12.0\ \text{V}$

$P_1 = 12.0 \times 0.6$

$= 3.6\ \text{W}$

$P_1 = P_2 = 3.6\ \text{W}$

$P_3 = 0.6 \times 12$

$= 7.2\ \text{W}$

$P_T = 3.6 + 3.6 + 7.2$

$= 14.4\ \text{W}$

| | $\mathbf{R_1}$ | $\mathbf{R_2}$ | $\mathbf{R_3}$ | **Total** |
|---|---|---|---|---|
| ***V* (V)** | **6.0** | **6.0** | **12.0** | 24.0 |
| ***I* (A)** | **0.6** | **0.6** | **0.6** | **0.6** |
| ***R* (Ω)** | 10.0 | 10.0 | 20.0 | **40.0** |
| ***P* (W)** | **3.6** | **3.6** | **7.2** | **14.4** |

6 marks

*Note: Award 6 marks for all 12 correct values. Award 5 marks for 9–11 correct values. Award 4 marks for 7–8 correct values. Award 3 marks for 5–6 correct values. Award 2 marks for 3–4 correct values. Award 1 mark for 2 correct values.*

**Question 6** (7 marks)

**a.** 0.7 V (read from graph) 1 mark

**b.** $V_{\text{resistor}} = V_{\text{supply}} - V_{\text{diode}}$

$= 6.0 - 0.7$

$= 5.3 \text{ V}$ 1 mark

**c.** $V = I \times R$

$5.3 = I \times 100$ 1 mark

$I = 0.053 \text{ A}$ 1 mark

$= 53 \text{ mA}$ 1 mark

**d.** 6.0 V 1 mark

As there is no current in the circuit, there are 0 V across the resistor. Hence, the new potential difference across the diode is 6.0 V. 1 mark

**Question 7** (5 marks)

**a.** Double insulation means there are two layers of protection to prevent electric shock. 1 mark

The first layer of insulation insulates electrical cable from the internal component of the appliance. 1 mark

The second layer of insulation involves insulating any internal metal parts that could become live from the external casing. 1 mark

**b.** Double insulation prevents any possibility of the external casing of the appliance becoming live. 1 mark

The live wire cannot touch the casing even if wires inside become loose, so there is no need for an earth pin. 1 mark

**Question 8** (7 marks)

**a.** $^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + {}^{4}_{2}\text{He}$

2 marks

*1 mark for correct reactants and products.*
*1 mark for nucleons correctly balanced.*

**b.** $\text{mass}_{\text{defect}} = \left(238.0508 \text{ u} - (234.0426 \text{ u} + 4.0026 \text{ u})\right) \times 1.6605 \times 10^{-27}$ 1 mark

$= 9.2988 \times 10^{-30} \text{ kg}$ 1 mark

$E = mc^2$

$= 9.2988 \times 10^{-30} \times (3.0 \times 10^8)^2$ 1 mark

$= 8.3689 \times 10^{-13} \text{ J}$ 1 mark

$= 5.2306 \times 10^{6} \text{ eV}$ 1 mark

**Question 9** (9 marks)

**a.** 8 days 1 mark

**b.** $n = 4$ 1 mark

$$\frac{100}{2^4} = 6.25\%$$

$$= 6.3\%$$ 1 mark

**c.** As radioactive isotopes with relatively short half-lives decay quickly, they allow for a quick diagnosis 1 mark
and decrease the time in which harmful effects could occur. 1 mark

**d.** **Mass:** Beta-minus radiation is lighter. 1 mark

**Charge:** Beta-minus radiation has a negative charge, not a positive charge. 1 mark

**Penetrating ability:** Beta-minus radiation is more penetrating. 1 mark

**Ionising ability:** Beta-minus radiation is less ionising. 1 mark

**Question 10** (3 marks)

No, the forces are not an example of an action–reaction pair in terms of Newton's third law. 1 mark

The weight force is $F_{\text{on Ethan by the Earth}}$, and the normal force is $F_{\text{on Ethan by the surface}}$. 1 mark

This is not an action–reaction pair as both forces act on the same body, Ethan. 1 mark

**Question 11** (12 marks)

**a.**

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$1.0\times10^3\times25.0 + 6.0\times10^3\times11.0 = 1.0\times10^3v + 6.0\times10^3v$$ 1 mark

$$7.0\times10^3v = 9.1\times10^4$$ 1 mark

$$v = 13 \text{ m s}^{-1}$$

**b.** **i.**

$$\Delta_{\text{Pcar}} = m(v-u)$$

$$= 1.0\times10^3\times(13-25.0)$$ 1 mark

$$= -12\,000 \text{ kg m s}^{-1}$$ 1 mark

*Note: Consequential on answer to **Question 11a**.*

**ii.**

$$\Delta_{\text{Pminibus}} = m(v-u)$$

$$= 6.0\times10^3\times(13-11.0)$$ 1 mark

$$= 12\,000 \text{ kg m s}^{-1}$$ 1 mark

*Note: Consequential on answer to **Question 11a**.*

**c.** The vehicles are in contact with the ground and, through friction with the ground, their momentum is transferred to the Earth. 1 mark 1 mark

**d.** **i.** If the time of impact were increased by a factor of 4, the force of impact would decrease by a factor of 4. 1 mark

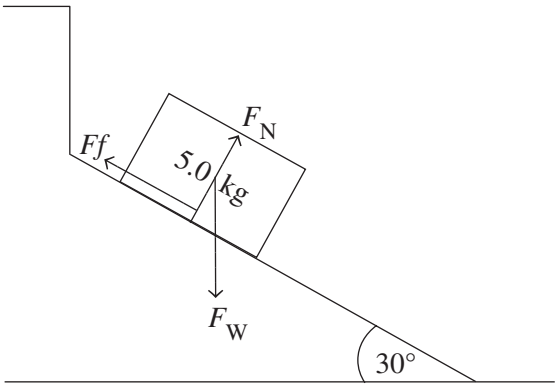
The product of the force and time of impact is the same for the same change in momentum. 1 mark

**ii.** Crumple zones increase the time of impact, meaning the time it takes for the momentum of a car's occupants to change increases. 1 mark

Therefore, the force of impact would decrease, reducing the severity of injuries. 1 mark

**Question 12** (10 marks)

**a.**




3 marks
*1 mark for the normal force.*
*1 mark for the weight force.*
*1 mark for the frictional force.*
*Note: Do not award a mark for a component of the weight force.*

**b.** $F_N = mg\cos\theta$

$= 5.0 \times 9.8\cos 30$ 1 mark

$= 42$ N 1 mark

**c.** $F_{net} = mg\sin\theta - f$ 1 mark

$5.0 \times a = 5.0 \times 9.8\sin 30 - 10$ 1 mark

$a = 2.9$ m s$^{-2}$ 1 mark

**d.** work done $= F \times s$

$= 10.0 \times 5.0$ 1 mark

$= 50$ J 1 mark

**Question 13** (14 marks)

**a.**

| Classification | Variable |
|---|---|
| independent | **hanging mass** |
| dependent | **total length of the spring** |
| controlled | **the spring** |

3 marks
*1 mark for each correct variable.*

**b.** **i.** $F_R = 0.0500 \times 9.8$
$= 0.49\ \text{N}$ 1 mark

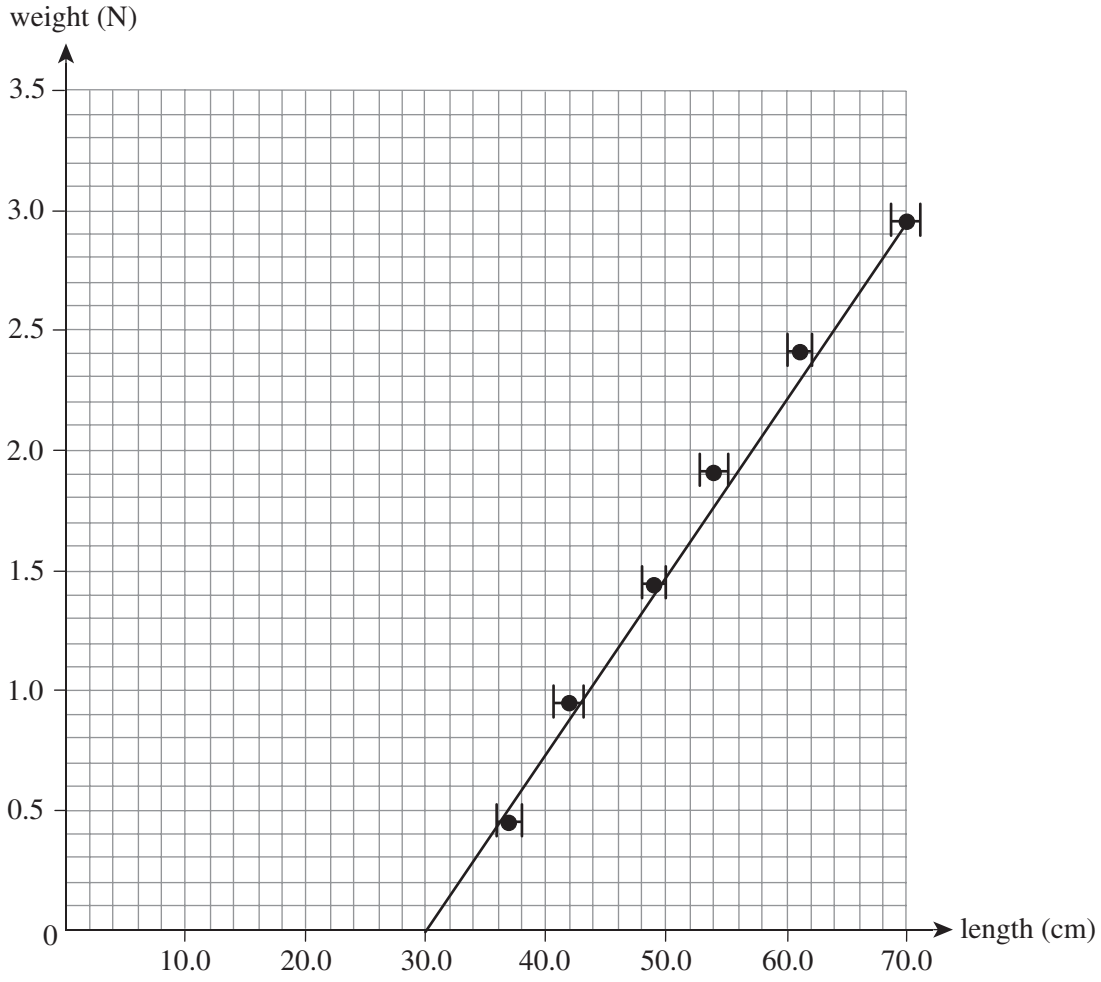
**ii.**

| Hanging mass (g) | Weight of hanging mass (N) | Total length of spring (cm) ± 1.0 cm |
|---|---|---|
| 50.0 | 0.49 | 37.0 |
| 100.0 | **0.98** | 42.0 |
| 150.0 | **1.47** | 49.0 |
| 200.0 | **1.96** | 54.0 |
| 250.0 | **2.45** | 61.0 |
| 300.0 | **2.94** | 70.0 |

3 marks

*Note: Award 1 mark for 1–2 correct weights. Award 2 marks for 3–4 correct weights. Award 3 marks for 5 correct weights.*

**c.**




3 marks

*1 mark for correct plotted points.*
*1 mark for correct line of best fit.*
*1 mark for correct uncertainty bars.*

**d.** Reading from the graph:

30.0 cm 1 mark

*Note: The original length of the spring is found from the x-axis intercept. Accept responses 30.0 ± 1.0 cm. Consequential on answer to **Question 13c**.*

**e.** $k = \text{gradient}$

$= \dfrac{\text{rise}}{\text{run}}$

$\approx \dfrac{2.9}{0.40}$ 1 mark

$\approx 7.3 \text{ N m}^{-1}$ 1 mark

**f.** Reading from the graph:

1.5 N 1 mark

*Note: Accept responses in the range 1.4–1.7 N. Consequential on answer to **Question 13c**.*

**Question 14** (16 marks)

**a.** Reading from the graph:

$2.00 \text{ m s}^{-1}$ 1 mark

East 1 mark

**b.** $a = \text{gradient of a velocity versus time graph}$

$= \dfrac{2.00}{2.00}$ 1 mark

$= 1.00 \text{ m s}^{-2}$ 1 mark

West 1 mark

*Note: The car is travelling East and decelerating, so the acceleration is in the opposite direction.*

**c.** $\text{distance} = (3.0 \times 2.0) + \left(\frac{1}{2} \times 3.0 \times 2.0\right) + \left(\frac{1}{2} \times 2.0 \times 2.0\right) + (2.0 \times 8.0) + \left(\frac{1}{2} \times 2.0 \times 2.0\right)$ 1 mark

$= 29.0 \text{ m}$ 1 mark

N/A 1 mark

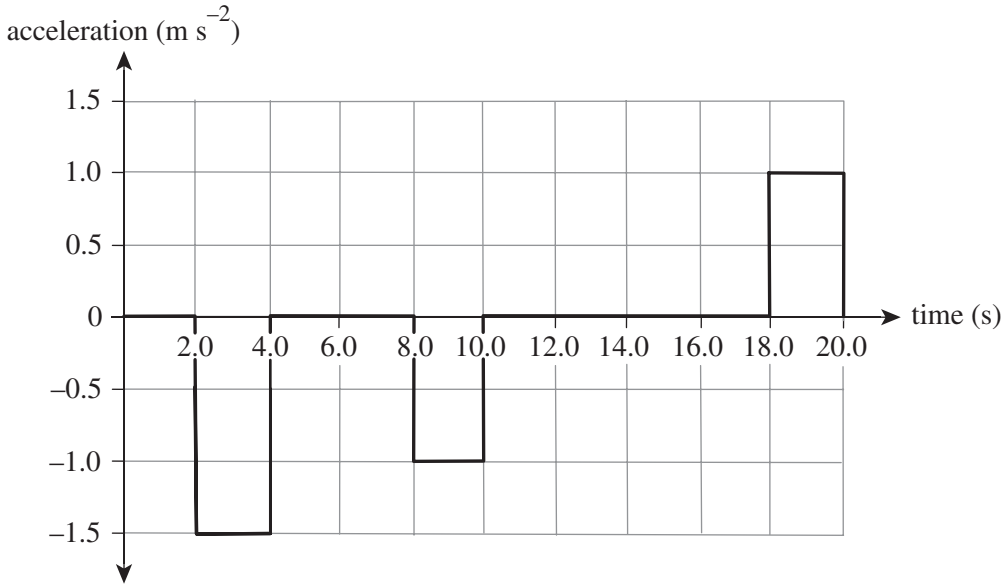
**d.** $\text{displacement} = \left((3.0 \times 2.0) + \left(\frac{1}{2} \times 3.0 \times 2.0\right)\right) - \left(\left(\frac{1}{2} \times 2.0 \times 2.0\right) + (2.0 \times 8.0) + \left(\frac{1}{2} \times 2.0 \times 2.0\right)\right)$ 1 mark

$= -11.0 \text{ m}$

$= 11.0 \text{ m}$ 1 mark

East 1 mark

**e.**




5 marks

*1 mark for correct axis labels.*

*1 mark for appropriate axis scales.*

*Note: More than half the graph area must be employed to obtain a mark.*

*1 mark for correct axis units.*

*1 mark for correct magnitudes of acceleration.*

*1 mark for correct directions of acceleration.*