Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Short Answers	15	15	60	61	38
Section Two: Problem-solving	6	6	90	80	50
Section Three: Comprehension	1	1	30	20	12
				161	100

Instructions to candidates

1. The rules for the conduct of examinations at Holy Cross College are detailed in the College Examination Policy. Sitting this examination implies that you agree to abide by these rules.
2. Write your answers in this Question/Answer Booklet.
3. Working or reasoning should be clearly shown when calculating or estimating answers.
4. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.
5. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
   - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.
6. Answers to questions involving calculations should be ***evaluated and given in decimal form.*** It is suggested that you quote all answers to ***three significant figures***, with the exception of questions for which estimates are required. Despite an incorrect final result, credit may be obtained for method and working, providing these are ***clearly and legibly set out***.
7. Questions containing the instruction *"**estimate**"* may give insufficient numerical data for their solution. Students should provide appropriate figures to enable an approximate solution to be obtained. Give final answers to a maximum of ***two significant figures*** and include appropriate units where applicable.
8. Note that when an answer is a vector quantity, it must be given with magnitude and direction.
9. In all calculations, units must be consistent throughout your working.

SECTION ONE: Short Answers

Marks Allotted: 61 marks out of 163 total.

Attempt ALL 15 questions in this section. Answers are to be written in the space below or next to each question.

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1. Perform the following conversions to standard units of kilograms, metres and seconds. **(4 marks)**

(a) 4.7×10^3 mm

4.7 m

(b) 791000 g

791 kg

[1 mark each]

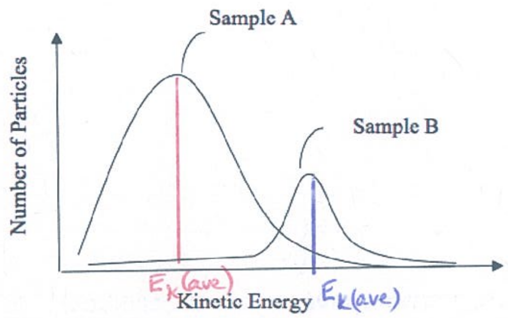
(c) 41.7 cm^2

$4.17 \times 10^{-3}\ m^2$

(d) 6.39×10^4 days

5.52×10^9 s

2. Below is a graph showing the distribution of kinetic energy of particles for two different samples of zinc that are at two different temperatures.



(a) Which of the two samples of zinc would have the higher temperature? Explain your choice. **(2 marks)**

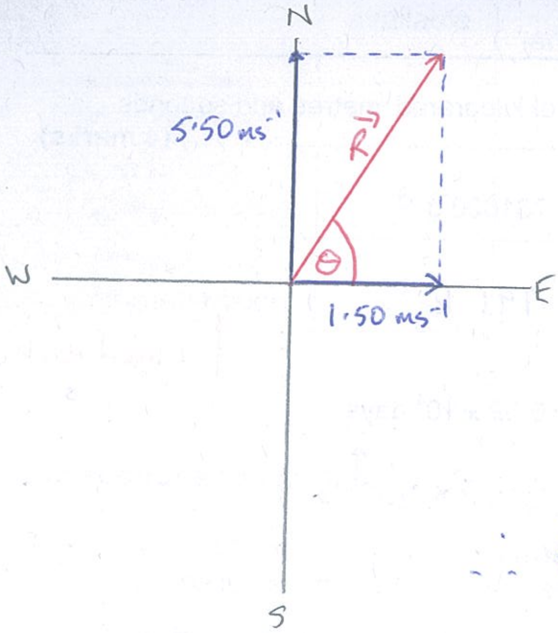
- B (1)
- Average E_K of the sample is higher. (1)

(b) Which is likely to have greater internal energy – an indoor swimming pool that has been heated to 28 °C or a stainless steel paper clip heated to 1,100 °C? Explain your answer. **(2 marks)**

- Pool (1)
- It has many more particles, which contribute the total energy. ($E_T = E_P + E_K$). (1)

3. Stephen is sailing a boat North at 5.50 m s^{-1} when he enters a current travelling East at 1.50 m s^{-1}. Calculate Stephen's resultant velocity once he enters the current. You must state the magnitude and direction of his resultant velocity.

(4 marks)



$$\vec{R} = \sqrt{(5.50)^2 + (1.50)^2} \quad (1)$$

$$= 5.70 \text{ ms}^{-1} \quad \left(\tfrac{1}{2}\right)$$

$$\tan\theta = \frac{5.50}{1.50} \quad (1)$$

$$\Rightarrow \theta = 74.7^\circ \quad \left(\tfrac{1}{2}\right)$$

$$\therefore \vec{R} = \underline{5.70 \text{ ms}^{-1} \text{ E } 74.7^\circ \text{ N}} \quad (1)$$

4. During a Myth Buster's programme investigating ballistics, a 1.75 g bullet is analysed by a high-speed video. It enters a pine board at a speed of 2.90 x 10^2 ms^{-1} and emerges out of the other side at 1.10 x 10^2 ms^{-1}. Calculate the work done by the board on the bullet.

(4 marks)

$$W = \Delta E_K = \tfrac{1}{2} m u^2 - \tfrac{1}{2} m v^2 \quad (1)$$

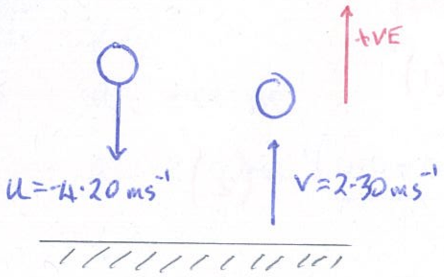
$$= \tfrac{1}{2}(1.75 \times 10^{-3})\left[(2.90 \times 10^2)^2 - (1.10 \times 10^2)^2\right] \quad (1)$$

Conversion (1)

$$= \underline{63.0 \text{ J}} \quad (1)$$

5. A basketball of mass 624 g is dropped onto concrete, striking it at 4.20 ms^{-1} and rebounding at 2.30 ms^{-1}. Calculate the ball's:

(a) change in velocity. **(2 marks)**



$\Delta v = v - u$

$= 2.30 - (-4.20)$ (1)

$= \underline{6.50\ ms^{-1}\ upwards}$ (1)

(b) change in momentum. **(2 marks)**

$\Delta p = m \Delta v$

$= (0.624)(6.50)$ (1)

$= \underline{4.06\ kgms^{-1}\ upwards}$ (1)

6. An electric kettle with a rating of 3.00 x 10^2 W takes 2.50 mins to heat water from 25.0 °C to 70.0 °C. Calculate how much water was in the kettle. (Assume the transfer of energy is 100% efficient and the kettle absorbs negligible energy.) **(4 marks)**

$P = \frac{Q}{t}$

$\Rightarrow Q = P.t$

$= (3.00 \times 10^2)(2.50 \times 60.0)$ (1)

$= 4.50 \times 10^4\ J$ (1)

$Q = m_w c_w \Delta T$

$\Rightarrow m_w = \frac{Q}{c_w \Delta T}$

$= \frac{4.50 \times 10^4}{(4.18 \times 10^3)(70.0 - 25.0)}$ (1)

$= \underline{0.239\ kg}$ (1)

7. During a golf tournament, a player used the driver to hit a ~~45.9~~ g golf ball off the tee in the ground. The stationary ball moves to 70.0 ms^{-1} in 4.00 x 10-4 s. Calculate the force exerte by the club onto the ball.

(4 marks

$$I = Ft = m\Delta v = \Delta p$$

$$\Rightarrow F = \frac{m\Delta v}{t} \quad (1)$$

$$= \frac{(45.9\times10^{-3})(70.0-0.0)}{4.00\times10^{-4}} \quad (2)$$

$$= \underline{8.03\times10^{3}\ N\ \text{forwards}} \quad (1)$$

8. During an Olympic power-lifting event, Ryan manages to snatch 140.0 kg from the floor to 2.10 m above the floor (and over his head) in a total time of 1.80 s. Determine the average power generated by Ryan during this lift.

(3 marks)

$$P = \frac{\Delta E_p}{t} = \frac{mg\Delta h}{t} \quad (1)$$

$$= \frac{(140.0)(9.80)(2.10)}{1.80} \quad (1)$$

$$= \underline{1.60\times10^{3}\ W} \quad (1)$$

9. (a) Just before she serves a ball in a tennis match, Serena Williams throws the ball towards the ground with an initial velocity of 3.00 ms^{-1}. If she releases the ball 1.10 m above the ground, with what velocity does it hit the ground? **(3 marks)**

+VE ↓

$v = ?$
$u = 3{\cdot}00\ ms^{-1}$
$a = 9{\cdot}80\ ms^{-2}$
$t = ?$
$s = 1{\cdot}10\ m$

$v^2 = u^2 + 2as$ (1)
$= (3{\cdot}00)^2 + 2(9{\cdot}80)(1{\cdot}10)$ (1)
$= 30{\cdot}56$
$\Rightarrow$ $v = 5{\cdot}53\ ms^{-1}$ down (1)

(b) If the ball has a mass of 59.4 g, what is its total energy as it hits the ground? **(3 marks)**

$E_T = E_K = \frac{1}{2}mv^2$ (1)
$= \frac{1}{2}(59{\cdot}4 \times 10^{-3})(5{\cdot}53)^2$ (1)
$= 0{\cdot}908\ J$ (1)

10. (a) Explain why heat transfer by conduction is more effective in liquids than in gases. **(2 mark**

- Conduction relies on particles passing on energy by colliding with each other. (1)
- Particles are much closer together in liquids so they conduct better than gases. (1)

(b) Explain why aluminium is a better conductor of heat than phosphorus, despite the fac that both are solids at room temperature and they have similar atomic masses. **(2 marks**

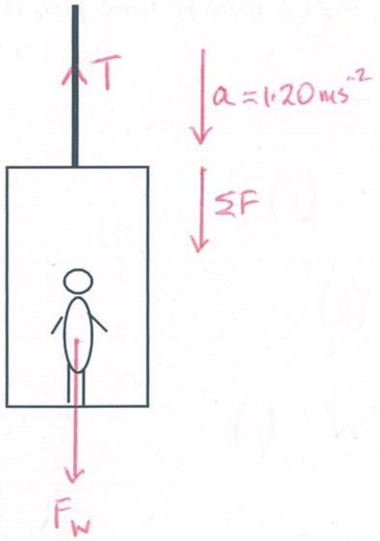
- Metals like Al have free electrons that can transfer heat energy to neighbouring atoms. (1)
- Non-metals like P don't have free electrons so energy is transferred slower by the vibration of the atoms. (1)

11. At the end of the last Apollo 15 moonwalk, Commander David Scott dropped a 1.32 kg geologic hammer and a 0.030 g falcon feather from a height of 1.60 m above the surface of the moon. He observed that when the feather and the hammer were dropped simultaneousl they both impacted the surface of the moon at the same time. Explain this observation. **(3 marks)**

- No atmosphere on the Moon means no air resistance. (1)
- Acceleration due to gravity is determined by the mass of the Moon - not the mass of the object. (1)
- Hence the two objects accelerate equally. (1)

12. An elevator carrying four passengers has a total combined mass of 2.00×10^3 kg. It is moving upwards and decelerates at $1.20\ ms^{-2}$ to stop at the twelfth floor. Calculate the tension in the cable holding the elevator as it decelerates.

(4 marks)



$$\Sigma F = F_W - T \quad (1)$$

$$\Rightarrow T = F_W - \Sigma F$$

$$= mg - ma \quad (1)$$

$$= (2.00 \times 10^3)[9.80 - 1.20] \quad (1)$$

$$= \underline{1.72 \times 10^4 \text{ N}} \quad (1)$$

13. Two bumper cars in an amusement park collide head-on. One has a mass of 4.50×10^2 kg and is moving at $4.50\ ms^{-1}$, while the other has a mass of 5.50×10^2 kg and is moving at $3.70\ ms^{-1}$. If the heavier vehicle rebounds at $0.500\ ms^{-1}$, calculate the final velocity of the lighter vehicle.

(5 marks)

u_1 m_2 m_1 u_2 v_2

Take direction of heavier vehicle as +ve.

$$\Sigma p_i = \Sigma p_f$$

$$\Rightarrow m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2 \quad (1)$$

$$\Rightarrow (4.50 \times 10^2)(-4.50) + (5.50 \times 10^2)(3.70) = (4.50 \times 10^2)v_1 + (5.50 \times 10^2)(-0.500) \quad (1)$$

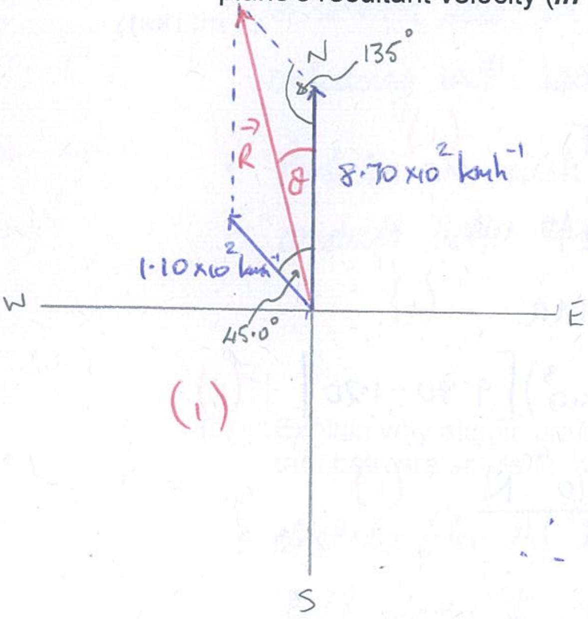
Sign conventions (1)

$$\Rightarrow v_1 = \underline{0.633\ ms^{-1}} \text{ in the original direction of the heavier car.}$$

(1)

Direction (1)

14. A plane flying due north from Perth at 8.70×10^2 kmh^{-1} has to contend with a wind of 1.10×10^2 kmh^{-1} heading northwest. Draw a suitable vector diagram and determine the plane's resultant velocity (***in kmh^{-1}***) over the ground. **(5 mark**



$$\vec{R} = \sqrt{(8.70\times10^2)^2 + (1.10\times10^2)^2 - 2(8.70\times10^2)(1.10\times10^2)\cos 135}$$

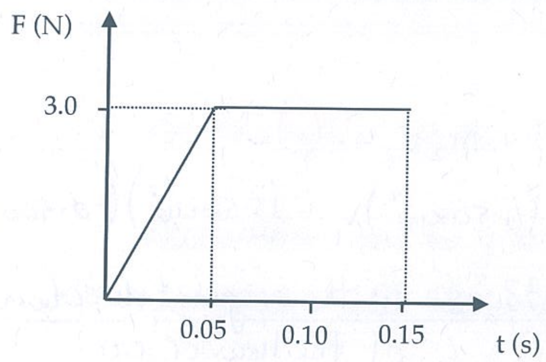
$= 951$ kmh^{-1} $\left(\frac{1}{2}\right)$

$$\frac{951}{\sin 135^\circ} = \frac{1.10\times10^2}{\sin\theta} \quad (1)$$

$\Rightarrow \theta = 4.69^\circ$ $\left(\frac{1}{2}\right)$

$\therefore \vec{R} = 951$ kmh^{-1} N 4.69° W (1)

15. A force is applied to an object over a short period of time as shown in the graph below. Us the graph to determine the impulse acting on the object. **(3 marks**



I = area under graph (1)

$= \frac{1}{2}(0.05)(3.0) + (0.10)(3.0)$ (1)

$= \underline{0.38 \text{ Ns forwards}}$ (1)

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SECTION TWO: Problem Solving

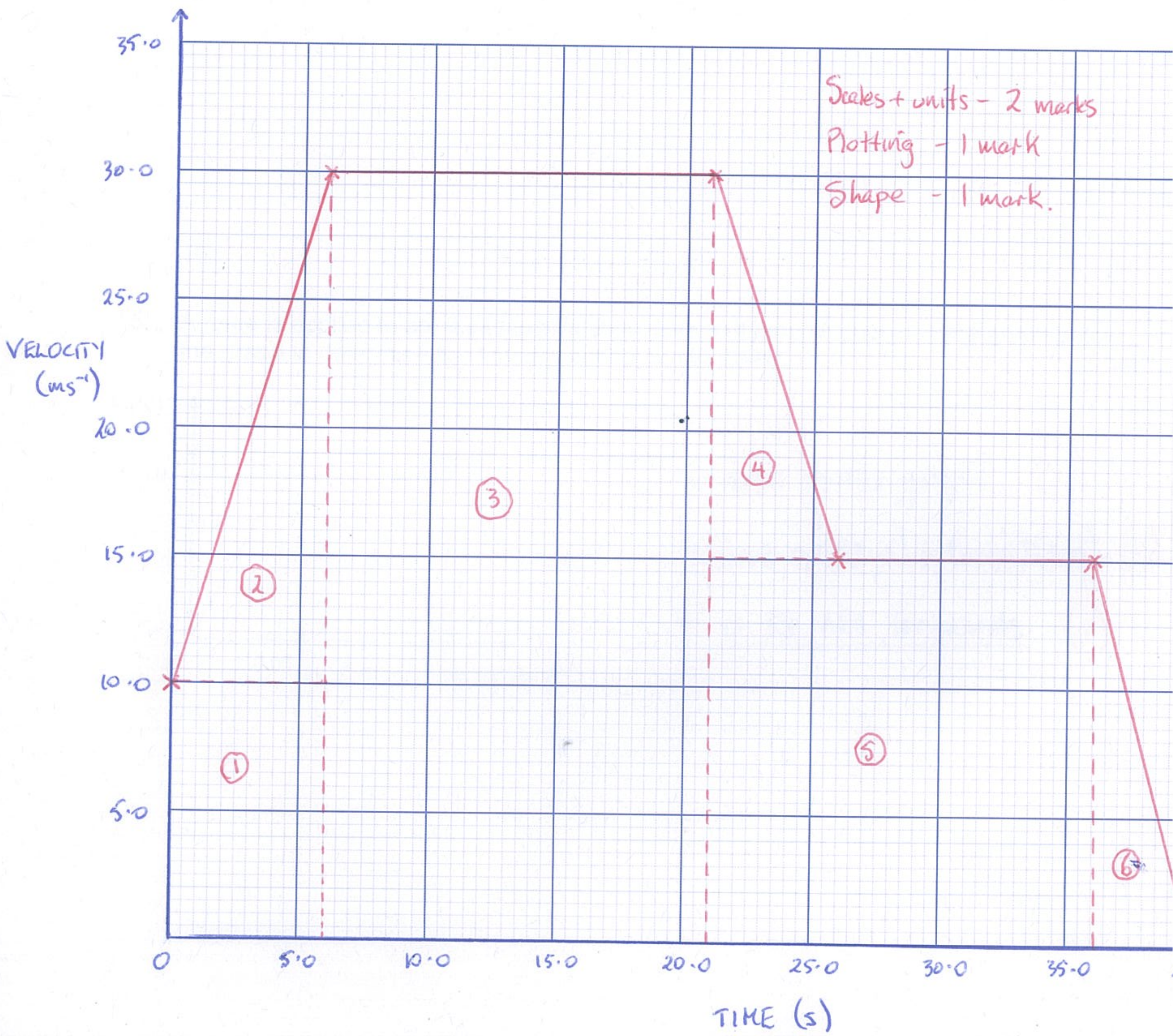
Marks allotted: 80 marks out of 163 marks total.

Attempt ALL 6 questions in this section. The marks allocated to each question are given and th answers should be written in the spaces provided.

(16 marks)

16. A motorbike, which is initially travelling at a 10.0 ms^{-1} along a straight road, accelerates to 30.0 ms^{-1} in 6.0 s. It maintains this velocity for 15.0 s before braking uniformly for 5.0 s, reducing speed to 15.0 ms^{-1}. It continues for another 10.0 s before braking uniformly to a stop in 4.0 s.

(a) Draw a velocity-time graph for the motion of the motorbike, including scales and labe on the axes. (Assume the motion is in a straight line.) **(4 mark**



(b) From the graph, determine the distance between the lights and the stop sign. **(5 marks)**

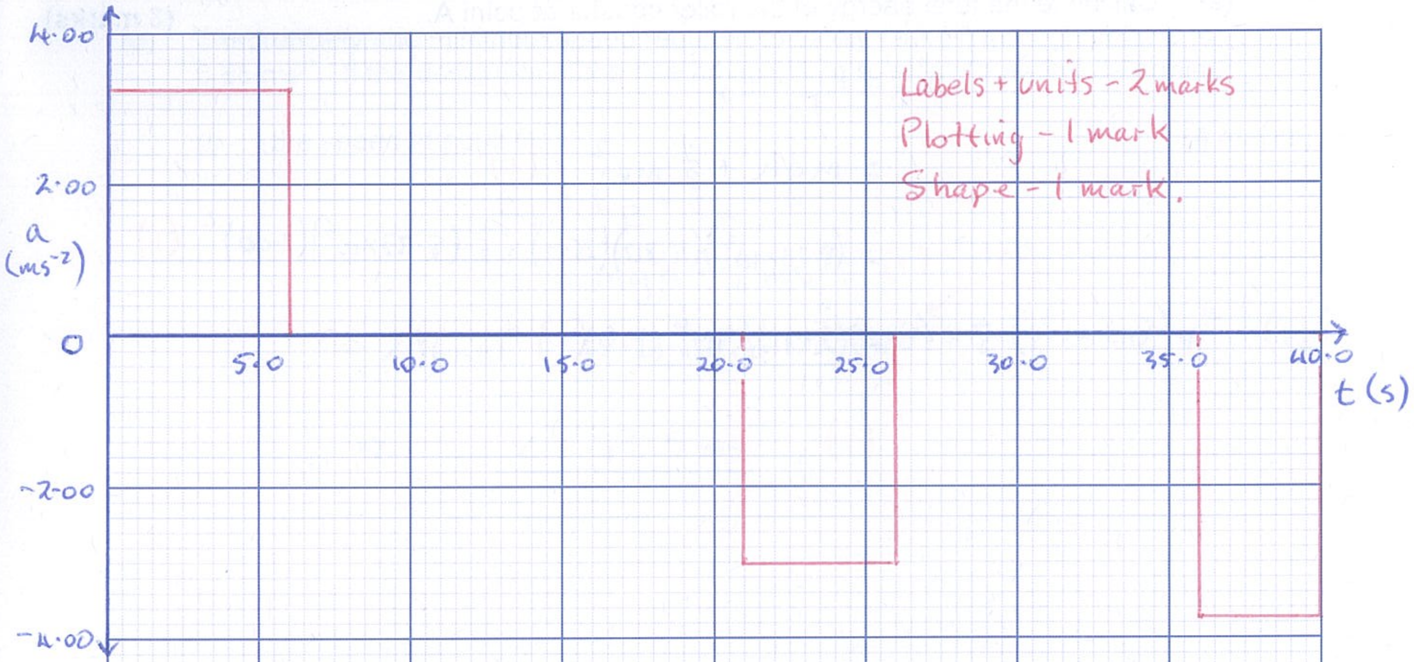
s = area under graph (1)

$= (6.0)(10.0) + \frac{1}{2}(6.0)(20.0) + (15.0)(30.0) + \frac{1}{2}(5.0)(15.0) + (15.0)(15.0) + \frac{1}{2}(4.0)(15.0)$ (3)

$= 862.5\ \text{m}$

$\therefore\ \underline{s = 862\ \text{m}}$ (1)

(c) Draw an acceleration – time graph of this motion, giving ***clear scales*** on each axis. You may need to do some calculations. Use the spare pages at the end of this answer booklet. **(7 marks)**



$a_1 = \frac{30.0 - 10.0}{6.00}$

$= 3.33\ \text{ms}^{-2}$ (1)

$a_2 = \frac{15.0 - 30.0}{5.0}$

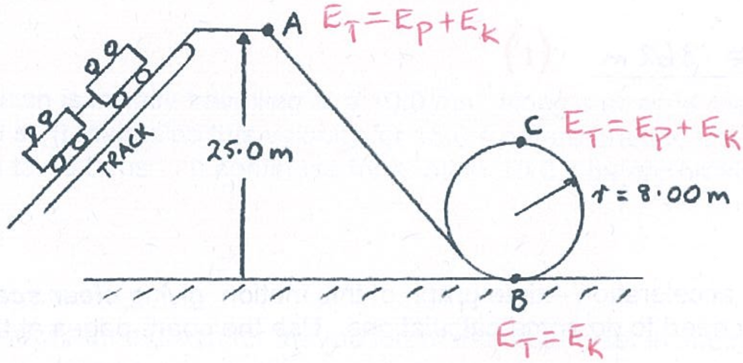
$= -3.00\ \text{ms}^{-2}$ (1)

$a_3 = \frac{0.0 - 15.0}{4.0}$

$= -3.75\ \text{ms}^{-2}$ (1)

(14 marks)

17. A roller coaster of total mass 8.73 x 10^3 kg is pulled by a mechanical track up to the top of the track as shown below. It takes 22.0 seconds to reach the top and is moving at 2.00 ms^{-1} at point A.



(a) Calculate the total energy of the roller coaster at point A. **(3 mar**

$$E_T = E_p + E_k$$
$$= mgh + \frac{1}{2}mv^2 \quad (1)$$
$$= (8.73\times10^3)(9.80)(25.0) + \frac{1}{2}(8.73\times10^3)(2.00)^2 \quad (1)$$
$$= \underline{2.16\times10^6 \text{ J}} \quad (1)$$

(b) What is the average power of the motor driving the track that lifts the roller coaster t point A. **(2 mark**

$$P = \frac{\Delta E_T}{t}$$
$$= \frac{2.16\times10^6}{22.0} \quad (1)$$
$$= \underline{9.82\times10^4 \text{ W}} \quad (1)$$

(c) How fast would the roller coaster travel at point B? **(3 marks)**

$E_T = E_K = \frac{1}{2}mv^2$ (1)

$\Rightarrow 2.16\times10^6 = \frac{1}{2}(8.73\times10^3)v^2$ (1)

$\Rightarrow \underline{v = 22.2 \text{ ms}^{-1}}$ (1)

(d) Theoretically, the minimum speed required to safely make it through point C is 8.85 ms^{-1}. If the designers of the ride have built in a "safety margin", determine:

(i) the speed at point C. **(4 marks)**

$E_T = E_P + E_K$

$= mgh + \frac{1}{2}mv^2$ (1) (1)

$\Rightarrow 2.16\times10^6 = (8.73\times10^3)(9.80)(16.0) + \frac{1}{2}(8.73\times10^3)v^2$ (1)

$\Rightarrow \underline{v = 13.5 \text{ ms}^{-1}}$ (1)

(ii) the safety margin built in, expressing the answer as a percentage. **(2 marks)**

Safety margin $= \frac{(13.5 - 8.85)}{8.85} \times \frac{100}{1}$ (1)

$= 52.5\ \%$ (1)

(12 marks)

18. In a laboratory investigation, a group of students applied forces of differing sizes onto a[n] object. Each force was applied for a time of 1.20 s. The students measured the change [in] velocity of the object for each trial. The results are given below.

Force (N)	Change in Velocity (ms^{-1})
0	0
1.6	1.8
3.1	3.5
4.9	5.8
7.8	8.9
11.3	13.0
15.4	17.5

(a) Graph these results on the graph paper provided. Draw the line of best fit. (HINT: Graph "change in velocity" on the x-axis.) **(4 ma[rks])**

(b) Calculate the gradient of the line of best fit. **(4 ma[rks])**

$$\text{gradient} = \frac{17.6 - 0.0}{20.0 - 0.0} \quad (1)$$

$$= \underline{0.880 \ Nm^{-1}s \ (kgs^{-1})}$$
(1) (1)

Sig. fig. - 1 mark

(c) Use the gradient to determine the mass of the object. **(4 mar[ks])**

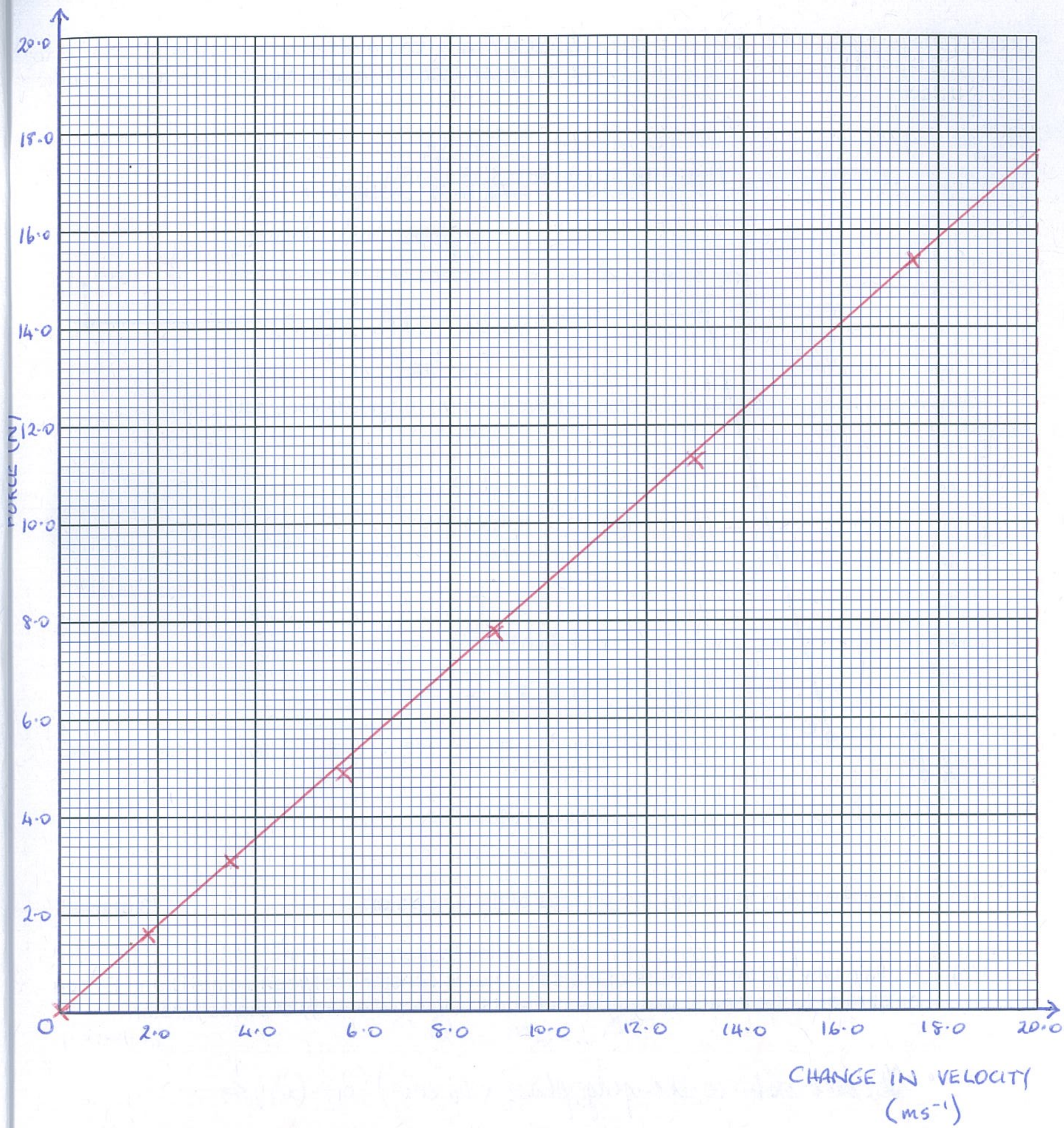
$$F = \frac{m\Delta v}{t}$$

$$\Rightarrow \text{gradient} = \frac{F}{\Delta v} = \frac{m}{t} \quad (1)$$

$$\Rightarrow \quad m = \text{gradient} \times t \quad (1)$$

$$= 0.880 \times 1.20 \quad (1)$$

$$= \underline{1.06 \ kg} \quad (1)$$



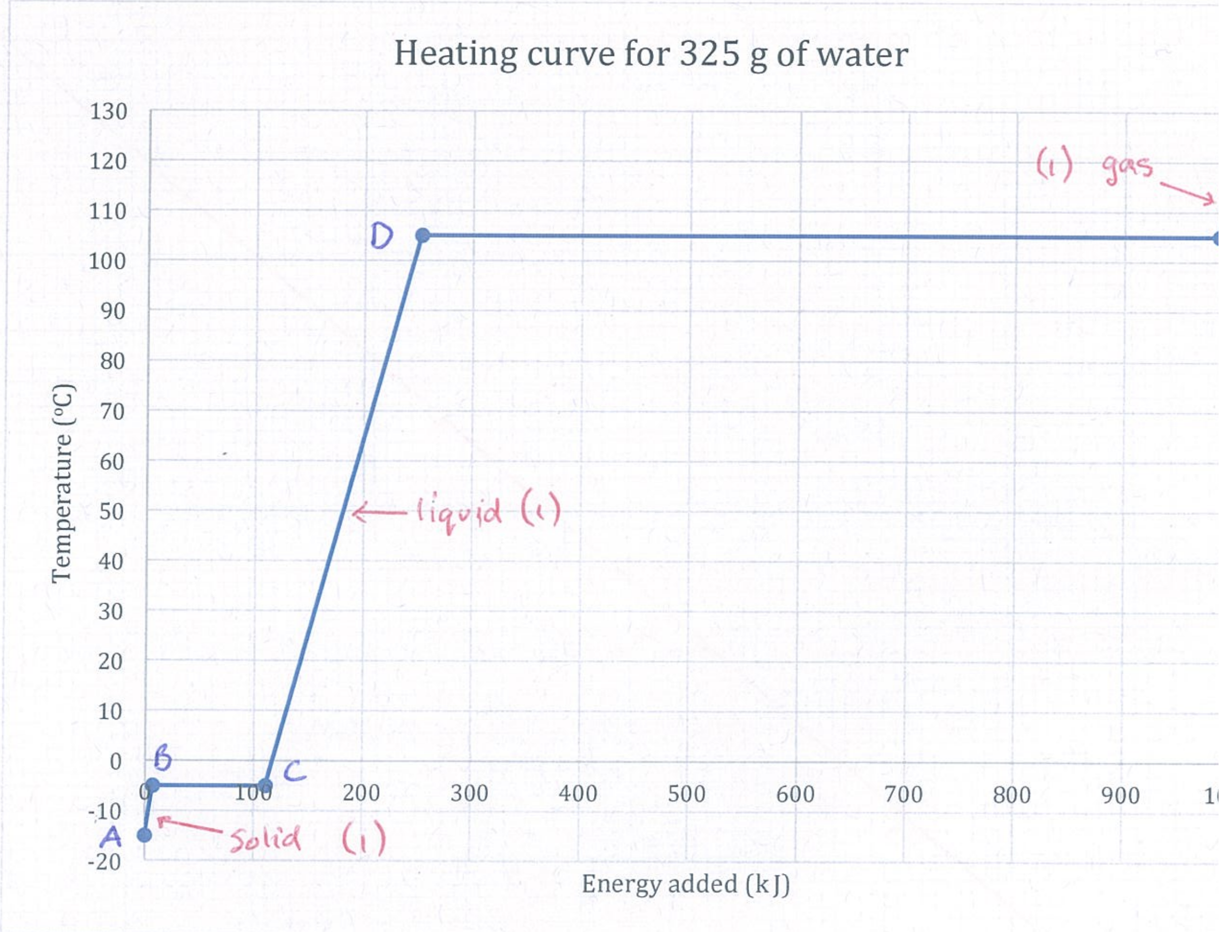
Scales + labels - 2 marks

Plotting - 1 mark

Line of best fit - 1 mark

(17 marks)

19. To investigate the properties of salt water, Lia heated 325 g of frozen salt water at -15.0 a temperature of 115 °C in an insulated container. Her results are shown in the heating below.



(a) Label the graph to identify the ***phases*** of the salt water. **(3 mar**

(b) Explain why the temperature of the salt water is constant between points D and E. must refer to the kinetic particle model and the internal energy of the salt water. **(4 mar**

- The salt water is changing phase (boiling). (1)
- The energy supplied to the salt water is causing the particles to separate, increasing their E_p. (1)
- Temperature is a measure of the average E_K of the particles. (
- As there is no temperature increase, the average E_K of the particles remains constant. (1)

(c) Why is the plateau DE much longer than BC? **(2 marks)**

- DE – particles must be totally separated so they can move independently as a gas – this requires a lot of energy.
- BC – particles are separated slightly so that they can move independently in a liquid but still interact with each other – this requires much less energy.

(d) (i) How much heat is absorbed by the salt water in DE? **(1 mark)**

$$Q = 990 - 250$$
$$= 740 \text{ kJ} \quad (1)$$

(ii) Use your answer to (c) (i) above to determine the latent heat of vaporisation. **(3 marks)**

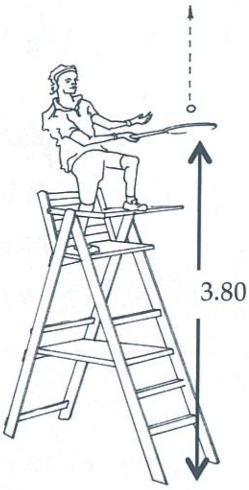
$$Q = mL_v$$
$$\Rightarrow L_v = \frac{Q}{m} \quad (1)$$
$$= \frac{740 \times 10^3}{0.325} \quad (1)$$
$$= \underline{2.28 \times 10^6 \text{ J kg}^{-1}} \quad (1)$$

(e) Calculate the specific heat of salt water from the graph. **(4 marks)**

$$Q = m_w c_w \Delta T$$
$$\Rightarrow (250 - 110) \times 10^3 = (0.325)\, c_w \,(105 - (-5.0)) \quad (1)$$
$$(1) \Rightarrow \underline{c_w = 3.92 \times 10^3 \text{ J kg}^{-1}\,^{\circ}\text{C}^{-1}} \quad (1)$$

(14 marks)

20. Andy Murray celebrates his Wimbledon victory by climbing onto the top of the umpire's chair and smashing a tennis ball vertically upwards.



The ball is launched from a position 3.80 m above the ground with an initial velocity of 24.2 ms^{-1} upwards.

The ball has a mass of 56.7 grams.

You may ignore air resistance in this question.

(a) Calculate the maximum height that the ball reaches above the ground. **(4 marks)**

$\downarrow$ +VE

Consider movement to the top.

$v = 0\ ms^{-1}$

$u = -24.2\ ms^{-1}$

$a = 9.80\ ms^{-2}$

$t = ?$

$s = ?$

Correct signs (1)

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

$\Rightarrow 0 = (-24.2)^2 + 2(9.80)s$ (1)

$\Rightarrow s = -29.9\ m$ (1)

$\therefore$ height $= 29.9 + 3.80$

$= \underline{33.7\ m \text{ above the ground}}$ (1)

(b) Determine the impact velocity of the ball with the ground. **(3 mar**

$\downarrow$ +VE

Consider movement from the top.

$v = ?$

$u = 0\ ms^{-1}$

$a = 9.80\ ms^{-2}$

$t = ?$

$s = 33.7\ m$ (1)

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

$= 0 + 2(9.80)(33.7)$ (1)

$\Rightarrow \underline{v = 25.7\ ms^{-1} \text{ down}}$ (1)

(c) How long is the ball in flight? **(2 marks)**

+VE

$v = 25.7\ ms^{-1}$

$u = -24.2\ ms^{-1}$

$a = 9.80\ ms^{-2}$

$t = ?$

$s = 3.80\ m$

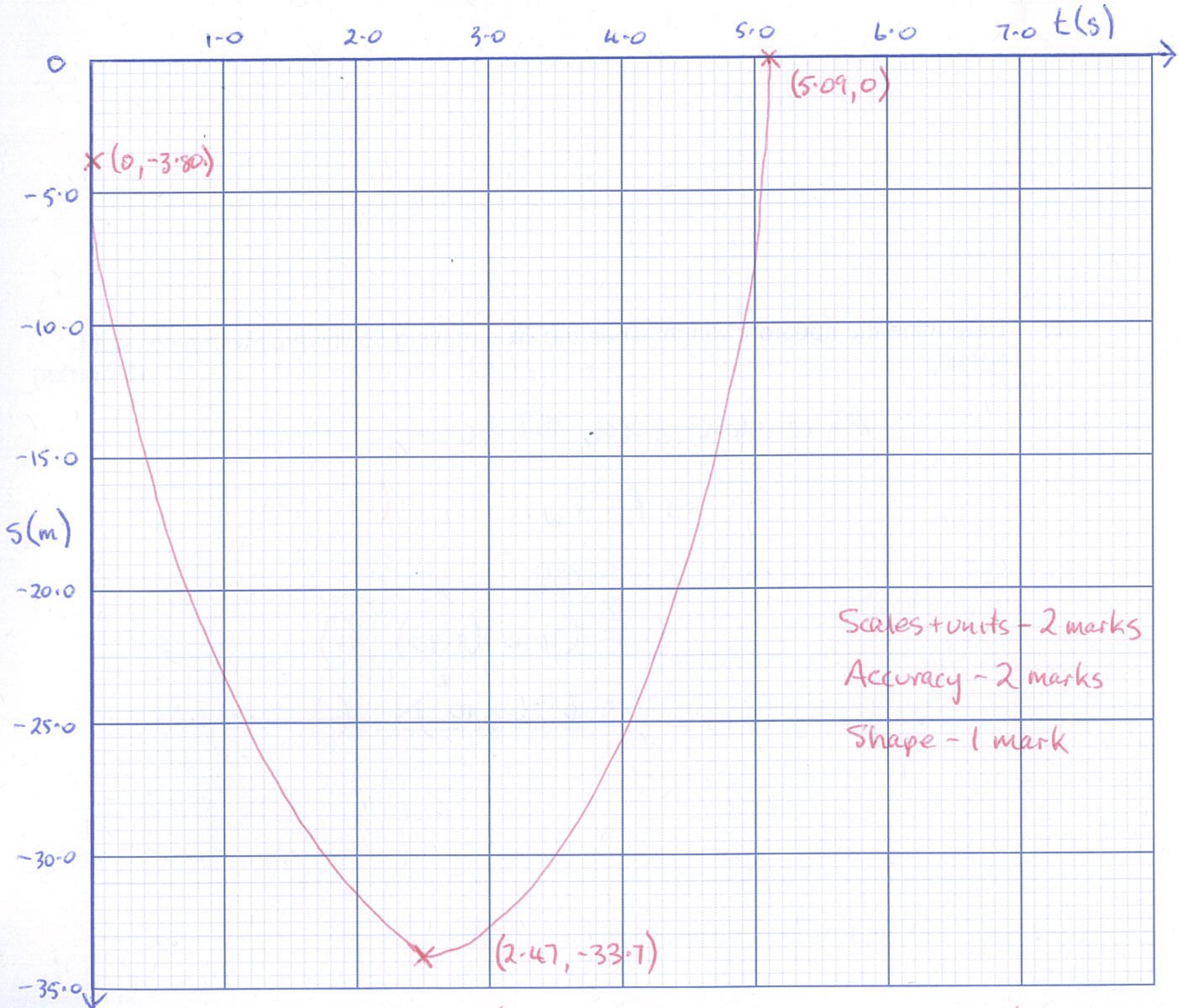
$v = u + at$

$\Rightarrow 25.7 = -24.2 + 9.80t$ (1)

$\Rightarrow t = 5.09\ s$ (1)

(d) Draw a ***displacement-time graph*** for the motion of the ball. Include ***clear scales*** on each axis. **(5 marks)**

Take the ground as 0.



Calculate time to top.

$v = 0\ ms^{-1}$

$u = -24.2\ ms^{-1}$

$a = 9.80\ ms^{-2}$

$t = ?$

$s = -29.9\ m$

$v = u + at$

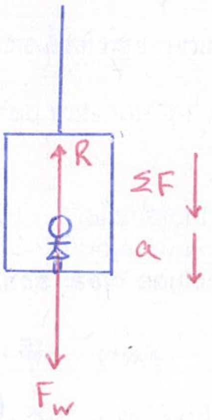
$\Rightarrow 0 = -24.2 + 9.80t$

$\Rightarrow t = 2.47\ s.$

(7 marks)

21. A 70.0 kg person is in a lift that is stationary at the thirtieth floor of a building. The lift uniformly accelerates downwards at 1.75 ms^{-2} for 3.00 s before maintaining its speed. nears the ground floor, the lift decelerates uniformly at 2.00 ms^{-2} to bring the lift to a sto

(a) What is the apparent weight of the person as the lift starts to move down from the thirtieth floor? **(4 ma**



$$\Sigma F = F_w - R \quad (1)$$

$$\Rightarrow R = F_w - \Sigma F$$

$$= mg - ma \quad (1)$$

$$= (70.0)(9.80 - 1.75) \quad (1)$$

$$= \underline{5.64 \times 10^2 \text{ N}} \quad (1)$$

(b) Determine the apparent weight when the lift is moving downwards with a constant speed. **(3 ma**

At constant speed, $\Sigma F = 0$

$$\Rightarrow R = F_w \quad (1)$$

$$= mg$$

$$= (70.0)(9.80) \quad (1)$$

$$= \underline{6.86 \times 10^2 \text{ N}} \quad (1)$$

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SECTION C: Comprehension and Interpretation

Marks Allotted: 20 marks out of 163 marks total.

Read the passage carefully and answer all of the questions at the end. Candidates are remi of the need for correct English and clear and concise presentation of answers. Diagrams (sketches), equations and/or numerical results should be included where appropriate.

(20 marks) **Firewalking**

Para 1
There has recently been a return to the craze of "firewalking". People are willing to pay large of money to be taught the secret of safely walking over red-hot coals. They are encouraged undertake a period of spiritual purification beforehand. They are given an uplifting address b charismatic teacher, then taken to see the fire lit. The claim that is over a "thousand degrees seems fair. The fire seems very hot, much hotter than it really is for a very interesting reasor are used to a heat source being a point source and as such, the inverse square law applies. double the distance we are from the heat source, the intensity is reduced by a factor of 4. W conclude that when we measured the heat a distance from the heat source, the heat at the a site will be much greater. In fact, the firewalkers' bed of flames is not a point source at all an inverse square law does not apply. Thus, the observer gets a false impression of the temper of the coals.

Para 2
The fire is left to get to an uniform temperature and the audience is given another uplifting tal stressing the need for purity, determination and giving school, especially Physics, your very b Then outside, off with the shoes and everyone follows the leader across the coals. The secre be quick, usually not more than a couple of seconds at the most. Much attention is given to t preparation of the fire. The red-hot embers are like fluffy bits of charcoal. They are certainly but contain very little heat energy since they are so light. Thus, when the bare foot touches t coal, very little heat energy is transferred. After a person has skipped across, black marks ar clearly visible on the coals where the feet have been. In a moment, the marks vanish as the embers warm up when heat flows from the interior of the fire. Many people get small blisters do not notice them since they are in a temporary trance. One unfortunate Physics student st on the coals for ten seconds and had to be rushed to Joondalup Hospital with third degree bu

Para 3
There is then no secret to firewalking. It is a straightforward demonstration of the basic ideas involved in Year 11 Physics. In a similar way, you know that when you take a meat pie out of oven and eat it straight away, you burn your tongue, not on the pastry but the filling. When th pastry touches your tongue, heat energy is transferred from the hot pastry to your relatively c (37 °C) tongue. The filling has much more heat energy than the pastry since it contains more and water, which has a high specific heat.

Para 4
In the Middle Ages, soldiers used to defend their castles by pouring oil at 300 °C onto the attackers. This proved a very effective defence mechanism, even though the specific heat of approximately half that of water.

1. If the source was a point source like a potbelly stove or Bunsen burner, by what factor would the intensity be reduced when you are three (3) times as far away? (Para 1) **(1 mark)**

$$\text{factor} = \frac{1}{3^2} = \frac{1}{9}$$

$\therefore$ Intensity is $\frac{1}{9}$ of the original value. (1)

2. You stupidly put your hand in an oven at 350 °C and quickly removed it. Give two (2) Physics reasons why you would ***not*** be burnt. (Para 2) **(2 marks)**

- The air in the oven is very hot but there is very little of it.
- Only a few grams of air would be in contact with the hand and it would contain very little heat energy.
- Air is also a poor conductor of heat.

[Any 2 valid points - 2 marks]

3. Now you hold on to a metal tray in the same oven - why is the sensation different? **(2 marks)**

- Steel tray has a mass 0.5 - 1.0 kg, so the tray contains far more heat energy than the air. (1)
- Steel is an excellent conductor so it supplies enough energy to burn the skin on the fingers. (1)

4. What evidence is there that heat energy has been transferred in firewalking? (Para 2) **(2 marks)**

- The coals change colour for a short time - black marks appear. (1)
- Firewalker has blisters on his/her feet. (1)

5. What property do the red coals have that makes firewalking "safe"? Why does this property have this effect? (Para 2) **(3 m**

- The coals are "fluffy bits of charcoal". (1)
- They contain little heat energy since they have a small mass. (
- They are also poor conductors so very little heat is transferred. (

6. Why does a skilful firewalker move quickly? (Para 2) **(1 m**

- This minimises the total time they are in contact with the coals. (1)

7. You say to the firewalker: "I see that you can walk on hot coals that are 1000 °C for 5 seconds; would you please stand for 5 seconds on this electric hotplate." Suggest what the firewalker's considered response to this might be. **(3 ma**

- The firewalker's feet will burn. (1)
- The hot plate is metal and a good conductor of heat, so the heat transfer is very good. (1)
- It is the amount of heat energy transferred, and not temperature that causes burns and pain. (1)

8. Why is it when you eat a meat pie that has been in the oven, the filling burns more than crust? Are they both at the same temperature? (Para 3) **(3 ma**

- They are both at the same temperature, but the filling has more mass and higher specific heat. (1)
- Hence the filling holds much more heat than the crust. (1)
- The crust can cool easily as it is on the outside, and it has a low mass. It is full of air and is a poor conductor. (1)

9. In the Middle Ages, defenders of castles used to pour boiling oil on to attackers. Explain why they used oil rather than water, using simple calculations to justify your answer.

(3 marks)

- The temperature difference between human skin and the respective liquids is the key point. (1)
- Consider 1·00 kg of each liquid.

$H_2O: \; Q = m_w c_w \Delta T = (1{\cdot}00)(4{\cdot}18\times10^{3})(100-20)$

$= 3{\cdot}35\times10^{5}\ \text{J}$ (1)

$\text{oil}: \; Q = m_o c_o \Delta T = (1{\cdot}00)(2{\cdot}09\times10^{3})(300-20)$

$= 5{\cdot}85\times10^{5}\ \text{J}$ (1)

$\therefore$ Oil holds far more heat.

END OF EXAMINATION