SOLUTIONS

HOLY CROSS COLLEGE
Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2017

Question/Answer Booklet

11 PHYSICS

TEST 2 - MOTION

Name

Student Number: In figures | | | | | | | | | |

Mark: ___/44

In words _____

_____

Time allowed for this paper
Reading time before commencing work: five minutes
Working time for paper: sixty minutes

Materials required/recommended for this paper
To be provided by the supervisor
This Question/Answer Booklet
Formulae and Data Booklet

To be provided by the candidate
Standard items: pens, (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: non-programmable calculators satisfying the conditions set by the School Curriculum and Standards Authority for this course

Important note to candidates
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

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	8	8	60	44	100
Section Two: Problem-solving					
Section Three: Comprehension					
				Total	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***.

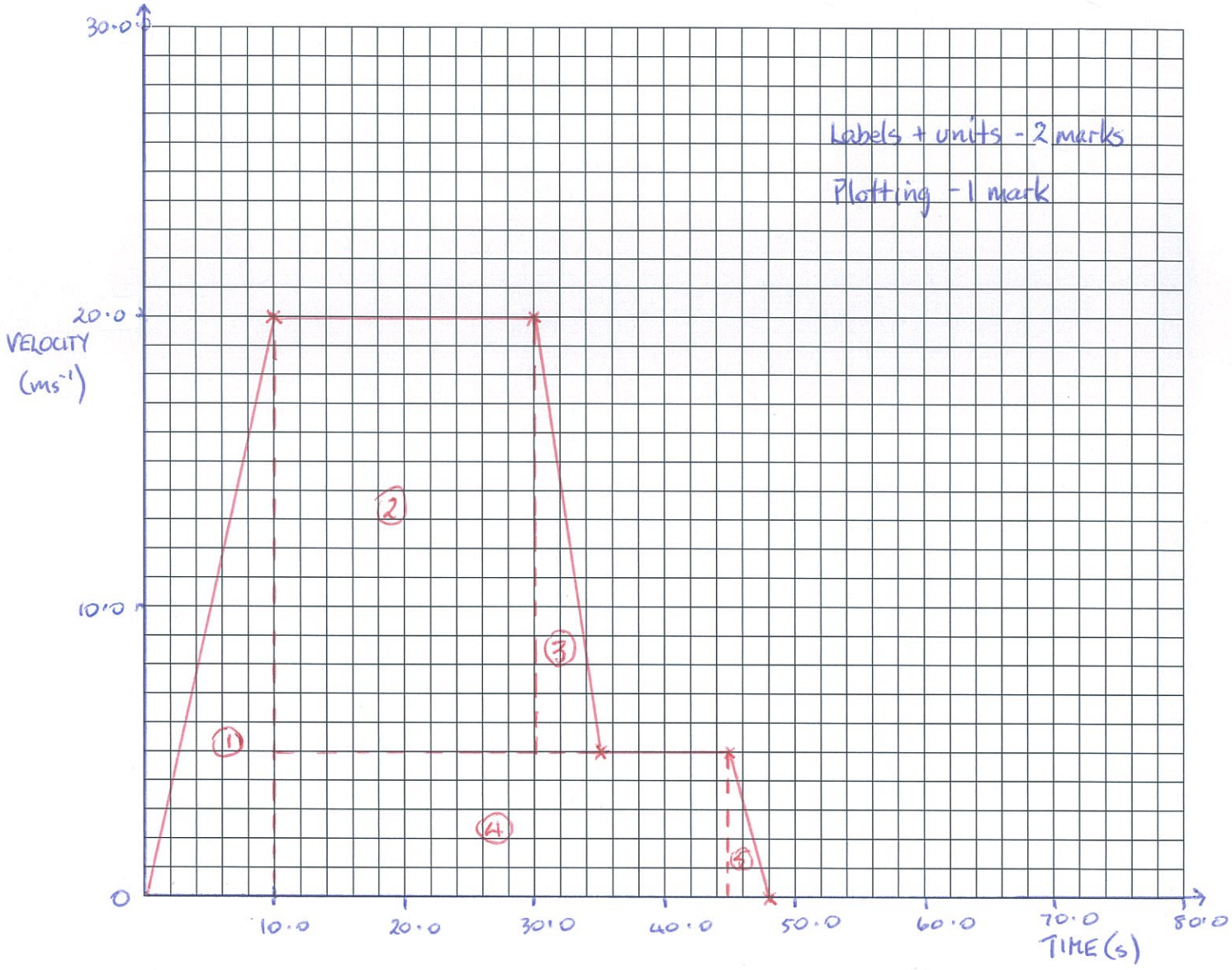
7. Questions containing the instruction "estimate" may give insufficient numerical data for their solution. Students should provide appropriate figures to enable an approximate solution to be obtained. Give final answers to a maximum of two significant figures and include appropriate units where applicable.

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.

1. A car, initially at rest, accelerates uniformly for 10.0 s to a velocity of 20.0 ms^{-1}, which it maintains for 20.0 s. It then decelerates uniformly to 5.00 ms^{-1} in 5.00 s and maintains this velocity for 10.0 s before braking uniformly to a stop in 3.00 s.

(a) Draw a velocity-time graph for the motion. (3 marks)



(b) Calculate how far the car has travelled for the entire motion. (3 marks)

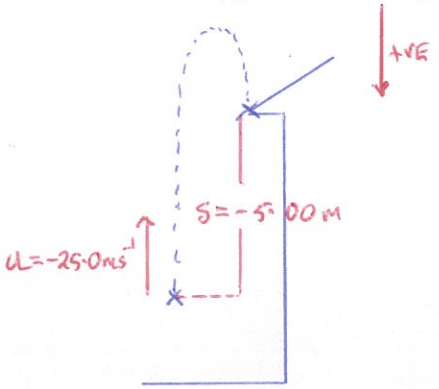
s = area under the graph (2)

$= \frac{1}{2}(10.0)(20.0) + (15.0)(20.0) + \frac{1}{2}(5.0)(15.0) + (35.0)(5.0) + \frac{1}{2}(3.0)(5.0)$

$= \underline{6.20 \times 10^{2}\ m}$ (1)

2. A boy throws a ball vertically upwards at 25.0 ms^{-1} and watches it just land on the edge of the roof of the building he is near . Given that the roof is 5.00 m above the release point of the ball and the motion of the ball is essentially vertical only, calculate:

(a) the velocity of the ball at impact with the roof. (3 marks)



$v = ?$
$u = -25.0\ ms^{-1}$
$a = 9.80\ ms^{-2}$
$t = ?$
$s = -5.00m$
[Signs - 1 mark]

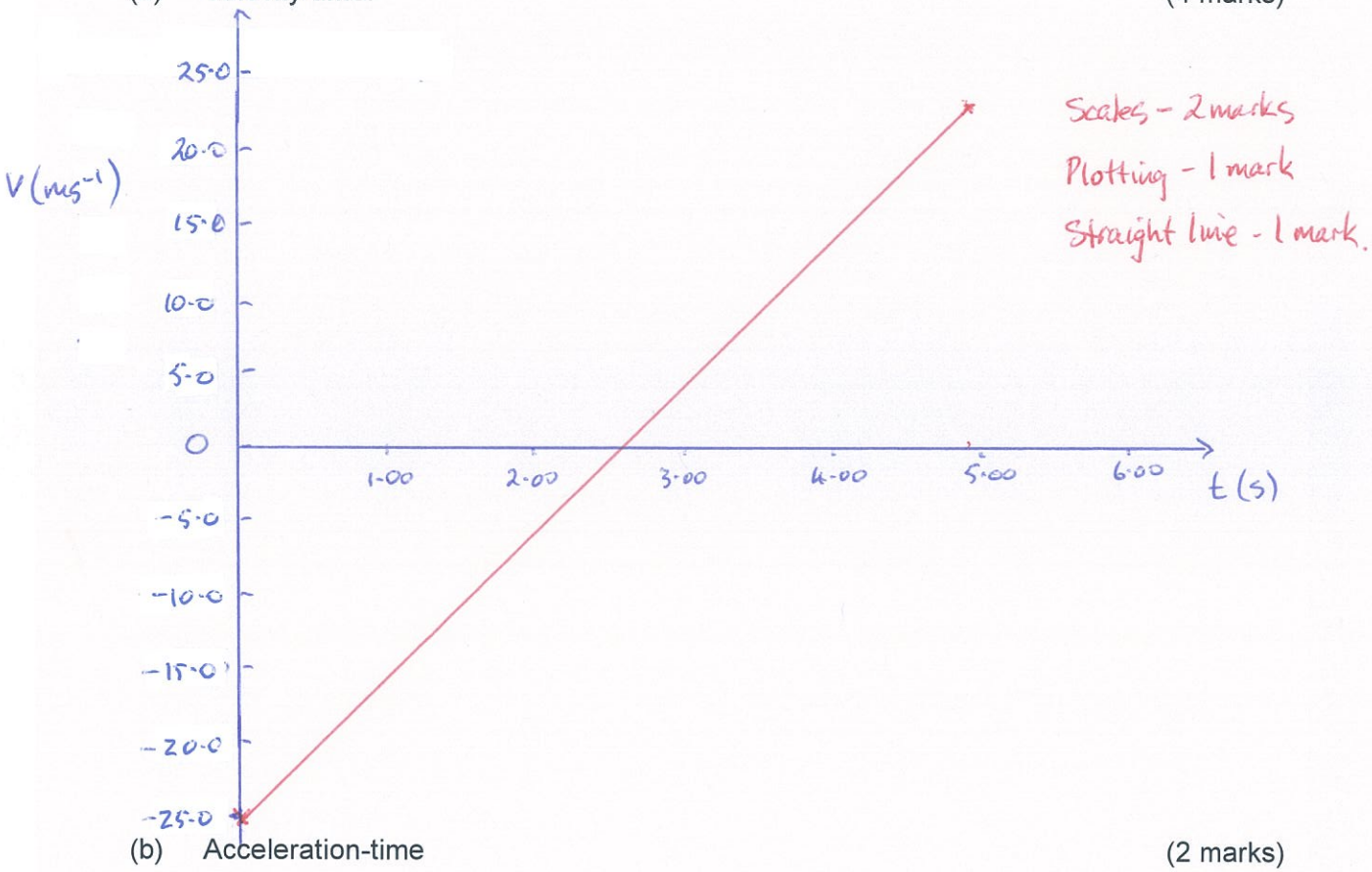
$v^2 = u^2 + 2as$
$= (-25.0)^2 + 2(9.80)(-5.00)$ (1)
$\Rightarrow v = \underline{23.0\ ms^{-1}\ down}$. (1)

(b) the time of flight for the ball. (2 marks)

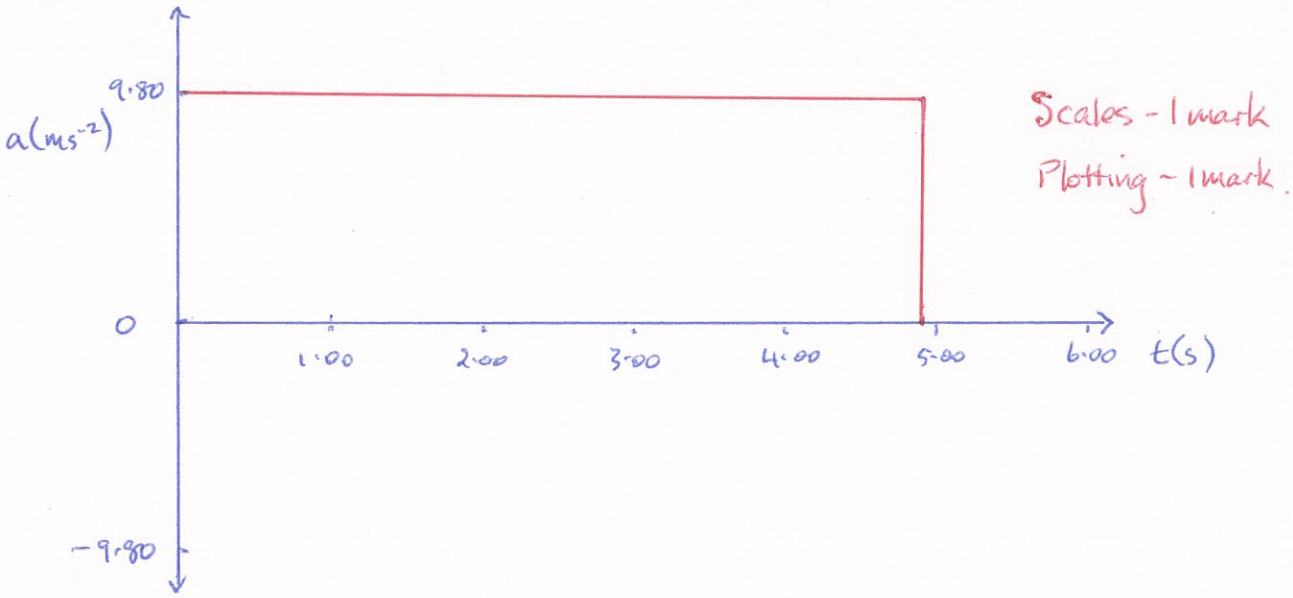
$v = u + at$
$\Rightarrow t = \frac{v-u}{a}$
$= \frac{23.0 - (-25.0)}{9.80}$ (1)
$= \underline{4.90\ s}$. (1)

3. Consider the motion of the ball in question 2 above. Draw the following graphs of its motion. Include scales showing significant points in the movement.

(a) Velocity-time. (4 marks)



(b) Acceleration-time (2 marks)



4. Sports shoes have soft energy-absorbing pads and soles within them to reduce the risk of injury to a person from "heel-strike" when running on hard surfaces.

Explain the Physics principle behind this development and why it prevents injury. (3 marks)

- From $F = \frac{m\Delta v}{t} = \frac{\Delta p}{t}$, Δp of the foot remains constant. (1)

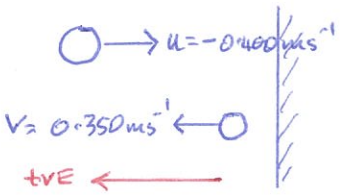
  $\Rightarrow F \propto \frac{1}{t}$ (1)

- Soft soles increase the time of contact with the ground.

  $\Rightarrow$ F is smaller. (1)

5. A billiard ball of mass 86.0 g moves across a billiard table at 0.400 ms^{-1} with negligible rolling friction. It strikes a cushion at right angles and remains in contact with it for 0.0910 s before rebounding at 0.350 ms^{-1} back along its original path. Calculate:

(a) the change in velocity of the ball. (3 marks)



$\Delta v = v - u$

$= 0.350 - (-0.400)$ (1)

$= \underline{0.750\ ms^{-1}\ away\ from\ the\ cushion}$.

(1) (1)

(b) the impulsive force exerted by the cushion onto the ball. (3 marks)

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

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

$= \frac{(86.0 \times 10^{-3})(0.750)}{(0.0910)}$ (1)

$= \underline{0.709\ N\ away\ from\ the\ cushion}$. (1)

6. A toy locomotive of mass 0.420 kg moving at 0.300 ms^{-1} S collides head-on with a carriage of mass 0.200 kg moving at 0.320 ms^{-1} N. If they become coupled together, calculate their common velocity after the collision. (4 marks)

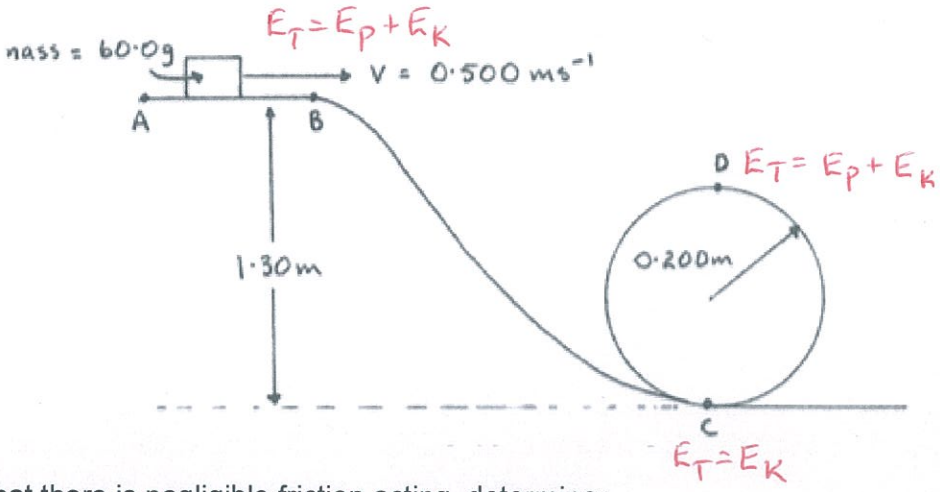
$$\Sigma p_i = \Sigma p_f$$

$$\Rightarrow m_1u_1 + m_2u_2 = (m_1 + m_2)v \quad (1)$$

$$\Rightarrow (0.420)(0.300) + (0.200)(-0.320) = (0.420 + 0.200)v \quad (2)$$

$$\Rightarrow v = 0.100\ ms^{-1} \text{ in the direction of the 0.420 kg car.} \quad (1)$$

7. A child set up the following car track. The toy car has a mass of 60.0 g and is moving at 0.500 ms^{-1} at point B on the track.



Given that there is negligible friction acting, determine:

(a) its speed at point C. (3 marks)

$E_T(B) = E_T(C)$

$\Rightarrow mgh + \frac{1}{2}mv_1^2 = \frac{1}{2}mv_2^2$ (1)

$\Rightarrow (60.0\times10^{-3})(9.80)(1.30) + \frac{1}{2}(60.0\times10^{-3})(0.500)^2 = \frac{1}{2}(60.0\times10^{-3})v_2^2$ (1)

$\Rightarrow v_2 = 5.07\ ms^{-1}$ (1)

NOTE: $E_T(B) = mgh + \frac{1}{2}mv^2$

$= (60.0\times10^{-3})(9.80)(1.30) + \frac{1}{2}(60.0\times10^{-3})(0.500)^2$

$= 0.772\ J$

(b) whether it can make it to point D, and if so, with what speed. (3 marks)

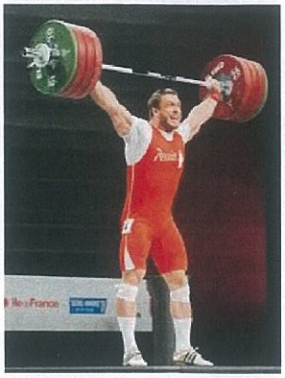
$E_T(D) = E_p + E_K = mgh + \frac{1}{2}mv^2$

$\Rightarrow 0.772 = (60.0\times10^{-3})(9.80)(0.400) + \frac{1}{2}(60.0\times10^{-3})v^2$ (1)

$\Rightarrow v = 4.23\ ms^{-1}$. (1)

∴ The car does reach D. (1)

8. Ben is practising his weightlifting by lifting a 1.60×10^2 kg barbell a distance of 1.90 m from the floor. He completes the lift in 1.25 s, holds it stationary for 3.00 s and then allows it to drop to the floor.



$E_T = E_P = mgh$

(a) How much work has Ben done in lifting the barbell? (3 marks)

$W = \Delta E_p = mg\Delta h$ (1)

$= (1.60 \times 10^2)(9.80)(1.90)$ (1)

$= 2.98 \times 10^3$ J (1)

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

(b) What is Ben's power rating during the lift? (2 marks)

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

$= \frac{2.98 \times 10^3}{1.25}$ (1)

$= 2.38 \times 10^3$ W (1)

(c) How fast does the barbell impact with the floor? (3 marks)

$E_T(\text{top}) = E_T(\text{floor})$

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

$\Rightarrow v = \sqrt{2gh}$

$= \sqrt{2(9.80)(1.90)}$ (1)

$= 6.10 \text{ ms}^{-1}$ down (1)