SOLUTIONS

HOLY CROSS COLLEGE

Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2017

Question/Answer Booklet

11 PHYSICS

Test 3 - Forces, Work and Energy

Name

Student Number: In figures

Mark: $\frac{\quad}{36}$ In words

Time allowed for this paper
Reading time before commencing work: five minutes
Working time for paper: fifty 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					
Section Two: Problem-solving	4	4	50	36	100
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.

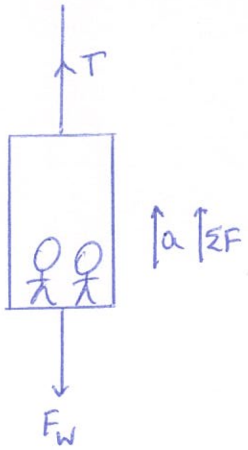
9. In all calculations, units must be consistent throughout your working.

1. A lift of mass 3.65×10^3 kg holding eight people of combined mass 5.10×10^2 kg is moving downwards at $3.50\ ms^{-1}$. It then decelerates to a stop at $0.500\ ms^{-2}$.

Calculate:

(a) the tension in the lift cable while the lift moves at constant velocity. (3 marks)

At constant velocity: $\Sigma F = 0$

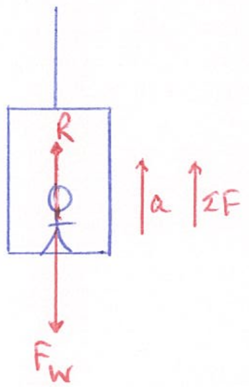


$$\Rightarrow T = F_W \quad (1)$$
$$= mg$$
$$= (3.65 \times 10^3 + 5.10 \times 10^2)(9.80) \quad (1)$$
$$= \underline{4.08 \times 10^4\ N} \quad (1)$$

(b) the tension in the cable while the lift stops. (3 marks)

$$\Sigma F = T - F_W$$
$$\Rightarrow T = \Sigma F + F_W \quad (1)$$
$$= ma + mg$$
$$= (3.65 \times 10^3 + 5.10 \times 10^2)(0.500 + 9.80) \quad (1)$$
$$= \underline{4.28 \times 10^4\ N} \quad (1)$$

(c) the apparent weight of a 70.0 kg person in the lift during the last part of its motion. (3 marks)



$\Sigma F = R - F_W$

$\Rightarrow R = \Sigma F + F_W$

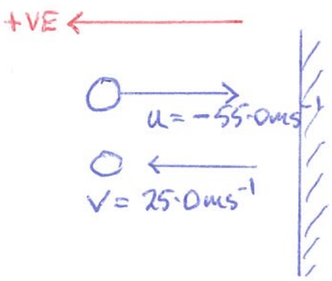
$= ma + mg$ (1)

$= (70.0)(0.500 + 9.80)$ (1)

$= \underline{7.21 \times 10^2 \text{ N}}$ (1)

2. During a game of squash, the 35.0 g ball travelling at 55.0 ms^{-1} horizontally strikes the front wall at 90.0° to the surface and rebounds horizontally from the surface at 25.0 ms^{-1}. If the ball deforms and is in contact with the wall for 15.0 ms, calculate:

(a) the change in momentum of the ball. (4 marks)



$\Delta v = v - u$

$= 25.0 - (-55.0)$ (1)

$= 80.0 \text{ ms}^{-1}$ away from the wall. (1)

$\Delta p = m\Delta v$

$= (0.0350)(80.0)$ (1)

$= \underline{2.80 \text{ kgms}^{-1} \text{ away from the wall}}.$ (1)

(b) the impulse exerted on the ball. (2 marks)

$I = Ft = m\Delta v = \Delta p.$ (1)

$\therefore \underline{I = 2.80 \text{ kgms}^{-1} \text{ away from the wall}}.$ (1)

(c) the force exerted by the wall on the ball. (2 marks)

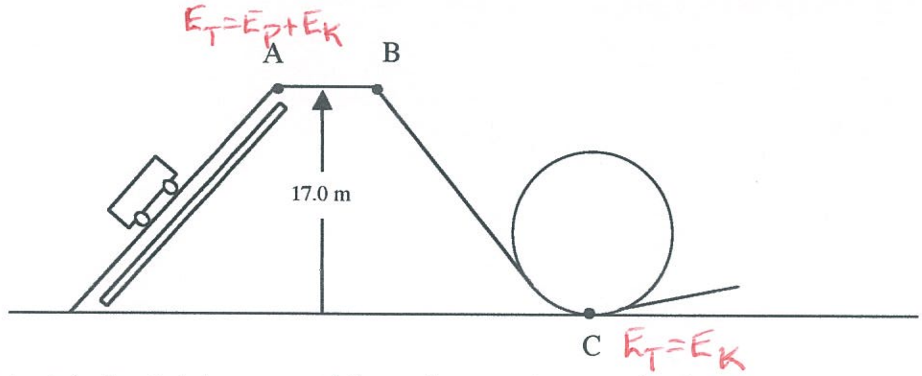
$$I = Ft = m\Delta v = \Delta p$$

$$\Rightarrow F = \frac{\Delta p}{t}$$

$$= \frac{2.80}{15.0 \times 10^{-3}} \quad (1)$$

$$= \underline{1.87 \times 10^{2}\ \text{N away from the wall}}. \quad (1)$$

3. An electric motor rated at 4.90×10^5 W is used to pull a roller coaster of total mass 6.70×10^3 kg up to a height of 17.0 m, as shown in the diagram. At point A, the coaster has a speed of 1.50 ms^{-1}, which it maintains to point B. Assume no energy is lost due to friction.



(a) Calculate the total energy of the roller coaster at point A. (4 marks)

$$E_T = E_p + E_K \quad (1)$$

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

$$= (6.70\times10^3)(9.80)(17.0) + \tfrac{1}{2}(6.70\times10^3)(1.50)^2 \quad (1)$$

$$= \underline{1.12 \times 10^6\ \text{J}} \quad (1)$$

(b) Theoretically, how long would it take the motor to lift the roller coaster up to point A? Assume the vehicle travels at a constant velocity. (3 marks)

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

$$\Rightarrow \quad t = \frac{E_T}{P} \qquad (1)$$

$$= \frac{1{\cdot}12 \times 10^6}{4{\cdot}90 \times 10^5} \qquad (1)$$

$$= \underline{2{\cdot}29\,s} \qquad (1)$$

(c) If the coaster then rolls down to point C, what would be its speed? (3 marks)

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

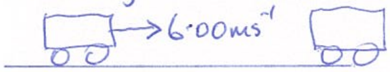
$$\Rightarrow 1{\cdot}12 \times 10^6 = \frac{1}{2}(6{\cdot}70 \times 10^3)v^2 \qquad (1)$$

$$\Rightarrow \underline{v = 18{\cdot}3\ ms^{-1}} \qquad (1)$$

4. In the railway marshalling yards, a carriage (mass 5.00×10^4 kg) was shunted against a stationary smaller carriage, which has half the mass of the larger carriage. If the heavier carriage was travelling at $6.00\ ms^{-1}$ and the two join together on impact:

(a) calculate the velocity with which the two carriages move off at after collision. (3 marks)

$m_1 = 5.00 \times 10^4$ kg $\qquad m_2 = 2.50 \times 10^4$ kg $\qquad \longrightarrow +vE$



$$\Sigma p_i = \Sigma p_f$$

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

$$\Rightarrow (5.00 \times 10^4)(6.00) + 0 = (5.00 \times 10^4 + 2.50 \times 10^4) v \quad (1)$$

$$\Rightarrow \underline{v = 4.00\ ms^{-1} \text{ forwards}} \quad (1)$$

(b) compare the kinetic energy of the larger carriage before the collision and the kinetic energy of both carriages after coupling. (4 marks)

Initially
$$E_K(i) = \tfrac{1}{2} m_1 u_1^2 + \tfrac{1}{2} m_2 u_2^2$$
$$= \tfrac{1}{2}(5.00 \times 10^4)(6.00)^2 + 0 \quad (1)$$
$$= 9.00 \times 10^5\ J \quad (1)$$

Finally
$$E_K(f) = \tfrac{1}{2}(m_1 + m_2) v^2$$
$$= \tfrac{1}{2}(5.00 \times 10^4 + 2.50 \times 10^4)(4.00)^2 \quad (1)$$
$$= 6.00 \times 10^5\ J \quad (1)$$

$$\therefore \underline{E_K(i) = 1.50 \times E_K(f)}.$$

(c) has the principle of Conservation of Energy been obeyed? Explain your answer. (2 marks)

- No. (1)
- $E_K(i) \neq E_K(f)$. (1)