HOLY CROSS COLLEGE

Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2018

Question/Answer Booklet

11 PHYSICS

Test 3 - Forces, Work and Energy

Name SOLUTIONS

Student Number: In figures

Mark: $\frac{}{47}$ 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					
Section Two: Problem-solving	7	7	60	47	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 cyclist moving at 15.0 ms^{-1} is brought to a halt in 10.0 s by an average retarding force of 1.20×10^2 N. If the mass of the cyclist and bicycle combined is 80.0 kg, calculate the change in momentum of the combination. [4 marks]

$I = Ft = m\Delta v = \Delta p$ Take forwards as +ve.

$\Delta v = v - u$

$= 0 - 15.0$ (1)

$= -15.0\ ms^{-1}$

$\therefore \Delta v = 15.0\ ms^{-1}$ backwards (1)

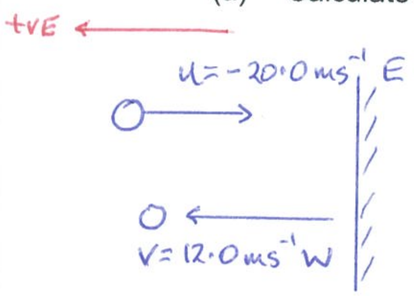
$\Delta p = m\Delta v$

$= (80.0)(15.0)$ (1)

$= \underline{1.20 \times 10^3\ kgms^{-1}\ \text{backwards}}$. (1)

2. A ball travelling at 20.0 ms^{-1} East collides with a wall and rebounds at 12.0 ms^{-1} West. the ball has a mass of 0.150 kg and is in contact with the wall for 0.0800 s. Ignore the vertical movement of the ball as it contacts the wall.

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



$\Delta v = v - u$

$= 12.0 - (-20.0)$ (1)

$= 32.0\ ms^{-1}$ W (1)

$\Delta p = m\Delta v$

$= (0.150)(32.0)$ (1)

$= \underline{4.80\ kgms^{-1}\ W}$ (1)

(b) Determine the impulsive force exerted by the wall onto the ball. [3 marks]

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

$\Rightarrow F = \dfrac{\Delta p}{t}$ (1)

$= \dfrac{4{\cdot}80}{0{\cdot}0800}$ (1)

$= \underline{60{\cdot}0 \text{ N West}}$ (1)

3. A body of mass 50.0 kg moving with a velocity of 20.0 ms^{-1} is brought to rest by a constant force in a distance of 5.00 m.

(a) Calculate the change in kinetic energy of the body. [3 marks]

$\Delta E_k = \frac{1}{2}mu^2 - \frac{1}{2}mv^2$ (1)

$= \frac{1}{2}(50{\cdot}0)\left[(20{\cdot}0)^2 - 0\right]$ (1)

$= \underline{1{\cdot}00 \times 10^4 \text{ J}}$. (1)

(b) What is the work done in stopping the body? [2 marks]

$W = \Delta E_k$

$= \underline{1{\cdot}00 \times 10^4 \text{ J}}$ (2)

(c) Determine the size of the force acting on the body. [3 marks]

$$W = \Delta E_K = Fs$$

$$\Rightarrow F = \frac{W}{s} \quad (1)$$

$$= \frac{1.00 \times 10^4}{5.00} \quad (1)$$

$$= \underline{2.00 \times 10^3 \text{ N}} \quad (1)$$

4. A lift of combined mass 2.05×10^3 kg is moving upwards at a constant velocity of 7.00 ms^{-1}. It then decelerates to a stop in 4.00 s as it reaches the top floor.

(a) Calculate the deceleration of the lift. [3 marks]

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

$u = -7.00 \text{ ms}^{-1}$ (1)

$a = ?$

$t = 4.00 \text{ s}$

$s = ?$

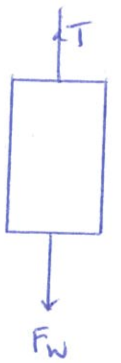
$\downarrow +ve$

$$a = \frac{v-u}{t}$$

$$= \frac{0-(-7.00)}{4.00} \quad (1)$$

$$= \underline{1.75 \text{ ms}^{-2} \text{ down}} \quad (1)$$

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



$\Sigma F \downarrow$

$$\Sigma F = F_W - T$$

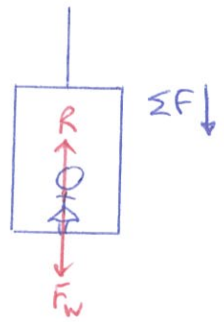
$$\Rightarrow T = F_W - \Sigma F \quad (1)$$

$$= mg - ma$$

$$= (2.05 \times 10^3)(9.80 - 1.75) \quad (1)$$

$$= \underline{1.65 \times 10^4 \text{ N}} \quad (1)$$

(c) the apparent weight of an 80.0 kg person in the lift during the last part of its motion. [3 marks]



$\Sigma F = F_W - R$

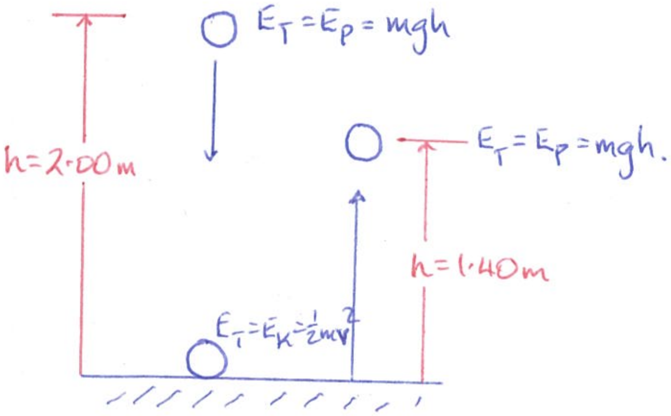
$\Rightarrow R = F_W - \Sigma F$ (1)

$= mg - ma$

$= (80.0)(9.80 - 1.75)$ (1)

$= \underline{6.44 \times 10^2 \text{ N}}$ (1)

5. Describe **ALL** of the energy changes that take place when a 65.0 g golf ball is dropped from a height of 2.00 m onto a concrete floor and rebounds to 1.40 m above the floor. (Include numerical energy values in your answer.) [5 marks]



<u>At top:</u> $E_T = E_P = mgh$

$= (0.065)(9.80)(2.00)$

$= 1.27 \text{ J}$ (1)

<u>On way down:</u>
- E_P becomes E_K
- Energy lost due to friction. (1)

<u>At bottom:</u>
- $E_T = E_K$ (1)
- Energy lost as heat + sound.

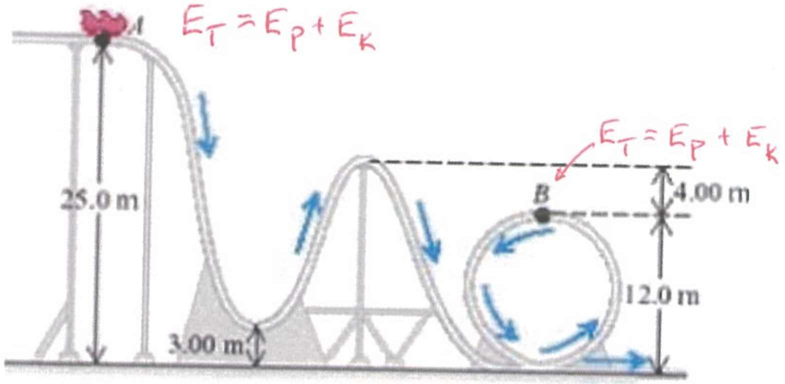
<u>On way up:</u>
- E_K becomes E_P. (1)
- Energy lost due to friction.

<u>At top:</u> $E_T = E_P = mgh$

$= (0.065)(9.80)(1.40)$

$= \underline{0.892 \text{ J}}$ (1)

6. The diagram below shows a roller coaster of mass 3.50×10^3 kg moving at 5.00 ms^{-1} at point A. Assume the track is smooth and friction is negligible.



(a) Determine the total energy of the roller coaster at point A. [3 marks]

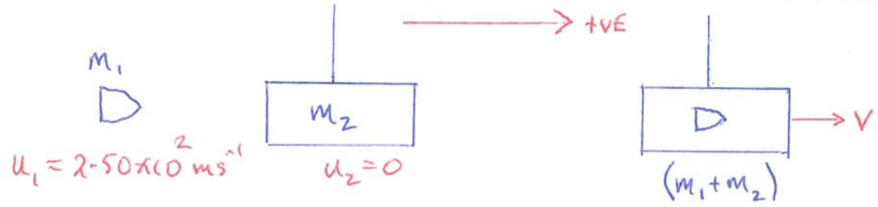
$$E_T = E_p + E_K \quad (1)$$
$$= mgh + \frac{1}{2}mv^2$$
$$= (3.50\times10^3)(9.80)(25.0) + \frac{1}{2}(3.50\times10^3)(5.00)^2 \quad (1)$$
$$= \underline{9.01\times10^5 \text{ J}} \quad (1)$$

(b) Calculate the speed of the roller coaster at point B. [3 marks]

$$E_T = E_p + E_K$$
$$= mgh + \frac{1}{2}mv^2 \quad (1)$$
$$\Rightarrow 9.01\times10^5 = (3.50\times10^3)(9.80)(12.0) + \frac{1}{2}(3.50\times10^3)v^2 \quad (1)$$
$$\Rightarrow \underline{v = 16.7 \text{ ms}^{-1}} \quad (1)$$

7. A 20.0 g bullet travelling at 2.50×10^2 ms^{-1} strikes a block of wood of mass 2.00 kg that is suspended on a long string. The bullet embeds in the block.

(a) With what velocity will the block and bullet move after the collision? [3 marks]



$$\Sigma p_i = \Sigma p_f$$

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

$$\Rightarrow (0{\cdot}0200)(2{\cdot}50 \times 10^2) + 0 = (0{\cdot}0200 + 2{\cdot}00) V \quad (1)$$

$$\Rightarrow \underline{V = 2{\cdot}47\ ms^{-1} \text{ in the direction of the bullet}}. \quad (1)$$

(b) Is mechanical energy conserved in this system? Justify your answer by comparing the kinetic energy of the system before and after the bullet embeds. [5 marks]

<u>INITIAL</u>

$$\Sigma E_K = \tfrac{1}{2} m_1 u_1^2 + \tfrac{1}{2} m_2 u_2^2 \quad (1)$$

$$= \tfrac{1}{2} (0{\cdot}0200)(2{\cdot}50 \times 10^2)^2 + 0$$

$$= 6{\cdot}25 \times 10^2\ J \quad (1)$$

<u>FINAL</u>

$$\Sigma E_K = \tfrac{1}{2} (m_1 + m_2) v^2 \quad (1)$$

$$= \tfrac{1}{2} (0{\cdot}0200 + 2{\cdot}00)(2{\cdot}47)^2$$

$$= 6{\cdot}16\ J \quad (1)$$

$\therefore$ <u>E_K is not conserved</u>. (1)