HOLY CROSS COLLEGE

Life to the Full

Western Australian Certificate of Education
ATAR course examination, 2020

Question/Answer Booklet

12 PHYSICS

Name SOLUTIONS

Test 1 – Projectile and Circular Motion

Student Number: In figures

Mark: $\overline{}$ 32

In words ______________________________

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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	5	5	50	32	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(is) that you are continuing to answer at the top of the page.

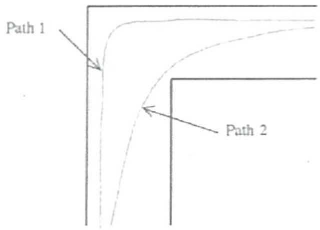
6. Answers to questions involving calculations should be ***evaluated and given in decimal form.*** It is suggested that you quote all answers to ***three significant figures***, with the exception of questions for which estimates are required. Despite an incorrect final result, credit may be obtained 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. Triathlon cyclists riding through the streets prefer path 2 to path 1 when turning around a corner at high speed.



Which of the following statements is the ***LEAST*** reasonable physical explanation for the cyclists' preference? Circle your choice. (1 mark)

(a) For the same frictional force, a cyclist on Path 2 can maintain a higher speed than a cyclist on Path 1.

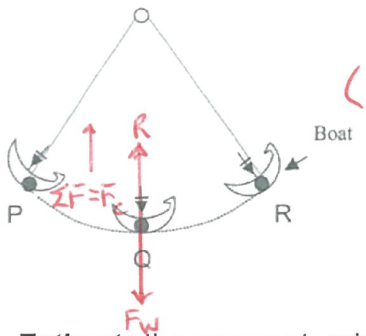
(1) (b) Path 1 has a smaller radius than path 2, resulting in a smaller centripetal force on the cyclist on Path 1.

(c) The cyclist on Path 1 has to decelerate and then accelerate much more than the cyclist on path 2, thus requiring more power.

(d) Path 2 is shorter than Path 1, so at the same speed a cyclist on Path 2 will take less time.

2. Bounty's Revenge is a ride at the Adventure World fun park. Riders sit in a large `boat', that can swing like a pendulum suspended from a frame.

(a) When it swings freely (without friction or a driving force), what is the ***direction*** of the acceleration of a child sitting in the middle of the boat when he is at the highest and lowest points in his motion, P, Q and R? (1 mark)



(1)

Answer	Acceleration at P	Acceleration at Q	Acceleration at R
A	↘	↑	↙
B	↓	a = 0	↓
C	a = 0	→	a = 0
D	→	↓	←

(b) ***Estimate*** the apparent weight of a 75.0 kg person at point Q if the boat is moving at 7.50 ms^{-1}. (5 marks)

Assume $r = 10$ m (1)

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

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

$$= \frac{mv^2}{r} + mg$$

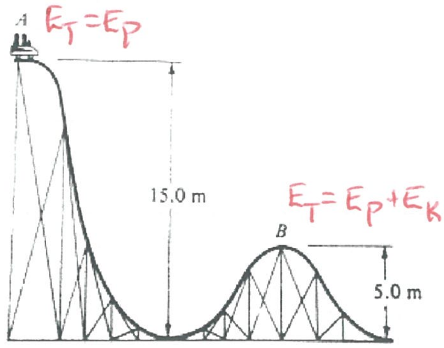
$$= (75.0)\left[\frac{(7.50)^2}{10} + 9.80\right] \quad (1)$$

$$= \underline{1.2 \times 10^3 \text{ N}} \quad (1)$$

[1-2 sig fig (1)]

3. In the picture below is a proposed roller coaster track. Each car will start from rest at point A and will roll with negligible friction.

What is the minimum safe value for the radius of curvature at point B so that the car does not leave the track? (5 marks)



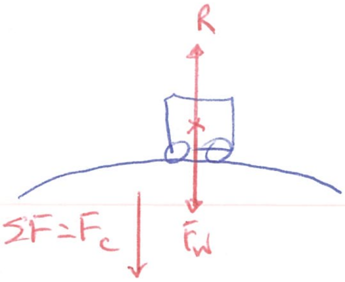
To calculate v at B:

$$E_T = E_p(A) = E_p + E_k\ (B) \quad (1)$$

$$\Rightarrow \cancel{m} g h_A = \cancel{m} g h_B + \tfrac{1}{2} \cancel{m} v^2$$

$$\Rightarrow (9.80)(15.0) = (9.80)(5.0) + \tfrac{1}{2} v^2 \quad (1)$$

$$\Rightarrow \quad v = 14.0\ \mathrm{ms^{-1}} \quad (1)$$



At B: $\Sigma F = F_c = F_w - R$

If $R = 0 \Rightarrow F_c = F_w \quad (1)$

$$\Rightarrow \frac{\cancel{m} v^2}{r} = \cancel{m} g$$

$$\Rightarrow \quad r = \frac{v^2}{g} \quad (1)$$

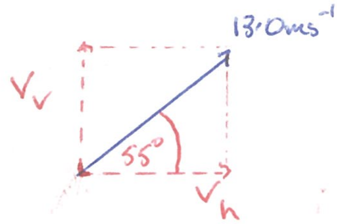
$$= \frac{(14.0)^2}{(9.80)}$$

$$= \underline{20.0\ \mathrm{m}} \quad (1)$$

4. A tennis player is forces to hit a defensive lob during a practice session. She plays the shot from 0.600 m above the court from a distance of 18.9 m from the opponent's baseline. The player hits the ball at 13.0 ms^{-1} at an angle of 55.0° to the horizontal.

(a) Assuming the opponent does not intercept the ball, does it land in court? Justify your answer with a calculation. (6 marks)

$\downarrow$ +VE



$V_v = 13{\cdot}0 \cos 35{\cdot}0°$
$= 10{\cdot}65\,ms^{-1}$

$V_h = 13{\cdot}0 \cos 55{\cdot}0°$
$= 7{\cdot}46\,ms^{-1}$

VERT

$v = ?$
$u = -10{\cdot}65\,ms^{-1}$ (1)
$a = 9{\cdot}80\,ms^{-2}$
$t = ?$
$s = 0{\cdot}600m$

$v^2 = u^2 + 2as$
$= (-10{\cdot}65)^2 + 2(9{\cdot}80)(0{\cdot}600)$
$\Rightarrow v = 11{\cdot}2\,ms^{-1}$ down (1)

$v = u + at$
$\Rightarrow t = \dfrac{v-u}{a}$
$= \dfrac{11{\cdot}2-(-10{\cdot}65)}{9{\cdot}80}$
$= 2{\cdot}23\,s$ (1)

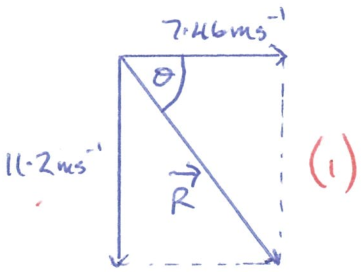
HOR.

$V_h = \dfrac{s_h}{t}$

$\Rightarrow s_h = V_h t$
$= (7{\cdot}46)(2{\cdot}23)$ (1)
$= 16{\cdot}6\,m$ (1)

$\therefore$ Ball lands in court (1)

(b) Determine the impact velocity of the ball with the court, irrespective of where it lands. (3 marks)



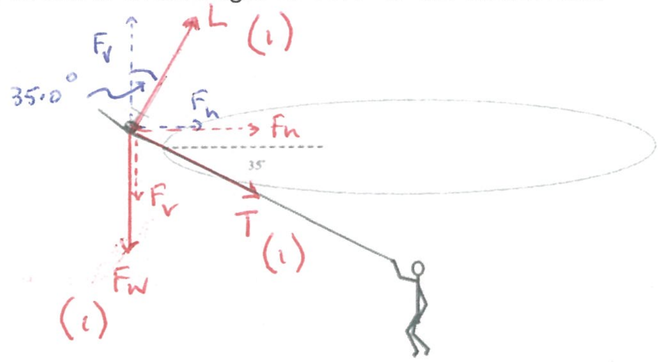
(1)

$\vec{R} = \sqrt{(11{\cdot}2)^2 + (7{\cdot}46)^2}$
$= 13{\cdot}5\,ms^{-1}$ (1)

$\tan\theta = \dfrac{11{\cdot}2}{7{\cdot}46}$
$\Rightarrow \theta = 56{\cdot}3°$ (1)

$\therefore$ $v = 13{\cdot}5\,ms^{-1}$ at $56{\cdot}3°$ to the horizontal and down.

5. The diagram below shows a person holding a model aeroplane in horizontal circular motion by a light rope, which is at an angle of 35.0° to the horizontal.



(a) Draw the forces acting on the plane in the diagram above. (3 marks)

(b) If the tension in the rope is 22.0 N and the lift force perpendicular to the wings of the model aeroplane is 34.0 N, what centripetal force keeps the plane in circular motion? (3 marks)

HORIZONTALLY $\Sigma F = F_c = L\cos\phi + T\cos\theta$ (1)

$= 34.0\cos 55.0° + 22.0\cos 35.0°$ (1)

$= \underline{37.5 \text{ N horizontal}}$ (1)

(c) Determine the mass of the plane? (3 marks)

VERTICALLY $\Sigma F_v = 0$

$\Rightarrow L\cos\theta = F_W + T\cos\phi$ (1)

$\Rightarrow (34.0\cos 35.0°) = m(9.80) + (22.0\cos 55.0°)$ (1)

$\Rightarrow \underline{m = 1.55 \text{ kg}}$ (1)

(c) What will be the period of revolution of the model aeroplane if it moves in a circle with a radius of 15.0 m? (4 marks)

$$F_c = \frac{mv^2}{r} = \frac{4\pi^2 mr}{T^2} \quad (1)$$

$$\Rightarrow T = \sqrt{\frac{4\pi^2 mr}{F_c}} \quad (1)$$

$$= \sqrt{\frac{4\pi^2(1.55)(15.0)}{37.5}} \quad (1)$$

$$= \underline{4.95\,s} \quad (1)$$