

QCE Physics

Revision and Exam Guide

UNITS 3&4 VOLUME 1

WRITTEN BY RICHARD WALDING DEANNE O'CALLAGHAN

ILLUSTRATED BY







OXFORD

UNIVERSITY PRESS

Oxford University Press is a department of the University of Oxford. It furthers the University's objective of excellence in research, scholarship, and education by publishing worldwide. Oxford is a registered trademark of Oxford University Press in the UK and in certain other countries.

Published in Australia by Oxford University Press Level 8, 737 Bourke Street, Docklands, Victoria 3008, Australia.

© Oxford University Press 2021

The moral rights of the author have been asserted

First published 2021

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, without the prior permission in writing of Oxford University Press, or as expressly permitted by law, by licence, or under terms agreed with the reprographics rights organisation. Enquiries concerning reproduction outside the scope of the above should be sent to the Rights Department, Oxford University Press, at the address above.

You must not circulate this work in any other form and you must impose this same condition on any acquirer.



A catalogue record for this book is available from the National Library of Australia

ISBN 9780190326487

Reproduction and communication for educational purposes

The Australian *Copyright Act 1968* (the Act) allows educational institutions that are covered by remuneration arrangements with Copyright Agency to reproduce and communicate certain material for educational purposes. For more information, see copyright.com.au.



Edited by Marta Veroni Illustrated by Joshua Scott Designs Logo design by Tuumik Stuudio OÜ Typeset by Newgen KnowledgeWorks Pvt. Ltd., Chennai, India Proofread by Jane Fitzpatrick Printed in Singapore by Markono Print Media Pte Ltd

Links to third party websites are provided by Oxford in good faith and for information only. Oxford disclaims any responsibility for the materials contained in any third party website referenced in this work.



CONTENTS

Welco	ome to Oxford Study Buddy	vii	
Introd	lucing your Study Buddy: P.L.A.N.C.K. 3.0	xiii	
0100	III0I: The origin story of P.L.A.N.C.K. 3.0	xiv	
CHA	PTER 1 STUDYING FOR SUCCESS	3	
1.1	Overview of QCE Physics Units 3 & 4,	4	
1.2	Everything you need to know about the summative external assessment	7	
1.3	3 How to maximise your marks on the summative external assessment		
1.4	4 How to get the most out of your revision and exam preparation time		
1.5	Countdown to success	24	
CHA	PTER 2 REVISION	27	
Uni	t 3: Gravity and electromagnetism		
2.1	Topic 1: Gravity and motion • Vectors • Projectile motion • Inclined planes • Circular motion • Gravitational force and fields • Orbits		
2.2	Topic 2: Electromagnetism • Electrostatics • Magnetic fields • Electromagnetic induction • Electromagnetic radiation	51 	
Unit	t 4: Revolutions in modern physics		
2.3	Topic I: Special relativity • Special relativity	79 79	

iii

2.4	Topic 2: Quantum theory	95
	• Quantum theory	
2.5	Topic 3: The Standard Model	
	• The Standard Model	
	Particle interactions	
CHA	PTER 3 PRACTICE QUESTIONS	
Uni	t 3: Gravity and electromagnetism	
3.1	Topic I: Gravity and motion	
	Vectors	
	Projectile motion	
	Inclined planes	
	Circular motion	
	Gravitational force and fields	
~ ~	• Orbits	
3.2	lopic 2: Electromagnetism	
	Electrostatics Magnetic fields	
	Flaghetic fields	
	Electromagnetic radiation	
Unit	t 4: Revolutions in modern physics	
3.3	Topic I: Special relativity	
	Special relativity	
34	Topic 2: Quantum theory	210
5.1	• Quantum theory	
35	Topic 3: The Standard Model	237
5.5	The Standard Model and particle interactions	
0114		050
GHA	PIER 4 UFFIGIAL PASI PAPERS	
4.1	External assessment 2020: Physics Paper I	
	20 multiple choice (20 marks), 8 short response (24 marks)	
4.2	External assessment 2020: Physics Paper 2	
	• 9 short response (37 marks)	
CHA	PTER 5 ANSWERS	
Uni	t 3: Gravity and electromagnetism	
5.1	Topic I: Gravity and motion	
	• Vectors	
	Projectile motion	
	Inclined planes	
	Circular motion	
	Gravitational force and fields	
	Orbits	

iv

5.2	Topic 2: Electromagnetism	
	Electrostatics	
	Magnetic fields	
	Electromagnetic induction	
	Electromagnetic radiation	
Unit	: 4: Revolutions in modern physics	
5.3	Topic 1: Special relativity	
	Special relativity	
5.4	Topic 2: Quantum theory	
	• Quantum theory	
5.5	Topic 3: The Standard Model	
	The Standard Model and particle interactions	
5.6	External assessment 2020 answers: Physics Paper I	
5.7	External assessment 2020 answers: Physics Paper 2	
01001	III0I: The redemption of P.L.A.N.C.K. 3.0	
Appe	endix	
Physic	s - Formula and data book	343

ACKNOWLEDGEMENTS

The author and the publisher wish to thank the following copyright holders for reproduction of their material.

QCAA material reproduced from material from Physics General Senior Syllabus 2019: Assessment, https://www.qcaa.qld.edu.au/senior/senior-subjects/sciences/physics/ assessment, © State of Queensland (qcaa.qld.edu.au) 2019, licenced under CC BY 4.0.

Every effort has been made to trace the original source of copyright material contained in this book. The publisher will be pleased to hear from copyright holders to rectify any errors or omissions.

V

YOU MATTER TO ME! UNLESS YOU MULTIPLY YOURSELF BY THE SPEED OF LIGHT SQUARED... THEN YOU ENERGY TO ME! EITHER WAY, THERE IS NO TIME TO GET EMOTIONAL... INITIATE PLANNING MODE...

1

IN

CHAPTER STUDYING FOR SUCCESS

Before you start studying for your QCE Physics exams, it's important to set yourself up for success. That's exactly what this chapter is designed to do, so thanks for stopping by!

As soon as it's time to start studying for the external assessment, we recommend that you work through this whole chapter before doing anything else! You might do this at the start of the school year or at the start of your exam study period, but whatever you do, don't skip this chapter; it contains a lot of really important information and tips that might just give you the edge you're looking for.

> YOUR THIRST FOR KNOWLEDGE IS **CRYSTAL CLEAR!** COMPLETE THIS CHAPTER TO UNLOCK YOUR FIRST KNOWLEDGE CRYSTAL.



GOOD LUCK!

1.1 OVERVIEW OF QCE PHYSICS UNITS 3 & 4

In this section, we will:

- provide a brief overview of how the QCE Physics Units 3 & 4 course is structured
- list all of the concepts and topics that you will need to learn and understand
- explain how you will be assessed.



I.I.I Resource: Physics General Senior Syllabus

Study tip

The Physics General Senior Syllabus sets out all of the information you are expected to learn and also provides important information on how you will be assessed.

In this chapter, we have summarised all of the key information relating to external assessment you need to know, but the QCAA may update the syllabus from time to time, so it's important that you make sure you are using the most current version!

Make sure you visit the QCAA website and download a copy of the Physics General Senior Syllabus and read it carefully before you sit your external assessment. To save you time, we've also included a link to it on your <u>o</u>book <u>assess</u>!

UNDERSTANDING THE QCE PHYSICS UNITS 3 & 4 COURSE STRUCTURE

The Physics General Senior Syllabus is the most important document supporting the QCE Physics course. It sets out all the content – known as subject matter – that you will be expected to learn, and provides important information about how you will be assessed.

QCE Physics is a course of study consisting of four units (i.e. Units 1 and 2 and Units 3 and 4) taught over 2 years; but in this revision and exam guide, we will only be focusing on information relating to Units 3 and 4 of the course. The topics you will be learning about in Units 3 and 4 are summarised in Table 1.

Study tip

The notional hours shown in Table I are provided by the QCAA to help teachers with their planning, and to give them an estimate of how long to spend teaching the subject matter in each topic.

Notional hours can be a handy way to help you to structure and allocate your revision and preparation time for the external assessment because – as a general rule – there are likely to be more questions on subject matter with higher notional hours.



Course structure for QCE Physics Units 3	& 4
Unit 3	
Gravity and electromagnetism	

Unit 3 Gravity and electromagnetism	Unit 4 Revolutions in modern physics
Topic 1: Gravity and motion	Topic 1: Special relativity
Subject matter:	Subject matter:
• Vectors [2 hours]	Special relativity [16 hours]
Projectile motion [4 hours]	Topic 2: Quantum theory
 Inclined planes [4 hours] 	Subject matter:
Circular motion [4 hours]	• Quantum theory [16 hours]
 Gravitational force and fields [4 hours] 	Topic 3: The Standard Model
Orbits [4 hours]	Subject matter:
Topic 2: Electromagnetism	The Standard Model [5 hours]
Subject matter:	Particle interactions [8 hours]
• Electrostatics [7 hours]	
Magnetic fields [7 hours]	
Electromagnetic induction [7 hours]	
Electromagnetic radiation [2 hours]	

Table I Each unit is developed to a notional (i.e. estimated) time of 55 hours of teaching and learning, including assessment. Notional times for each sub-topic are also provided.

> Modified from Physics General Senior Syllabus 2019 v1.2 © State of Queensland (QCAA) 2019, licensed under CC BY 4.0

UNDERSTANDING THE QCE PHYSICS UNITS 3 & 4 ASSESSMENT STRUCTURE

You will be expected to complete a total of four summative assessments in QCE Physics Units 3 & 4. Summative assessments are designed to evaluate your understanding of the subject matter and compare your performance against the understanding of students from across the state.

Three of these assessments are **internal** and one is **external**, but all will contribute to your Australian Tertiary Admission Rank (ATAR) calculation and to your Queensland Certificate of Education (QCE).

Study tip

(

This revision and exam guide is only designed to help you prepare for the Summative external assessment, so if you need any further information about any of the Summative internal assessments in **QCE** Physics Units 3 & 4, ask your teacher or refer to the syllabus.

INTERNAL ASSESSMENTS

- Schools will develop three internal assessments for QCE Physics based on the subject matter described in Units 3 and 4 of the syllabus.
- The three summative internal assessments will be endorsed (i.e. the mark awarded by your teacher will be cross-checked and verified by an independent marker) and the results confirmed by the QCAA.
 - As shown in Figure 1 (page 6), the three internal assessments will contribute 50% to your overall mark.

JUST SO YOU KNOW... I WAS **PLANCKING** BEFORE IT WAS COOL! SOMETHING TO PONDER AS YOU START YOUR REVISION...

P

6

CHAPTER **REVISION**

In this chapter, we provide a clear, concise summary of all examinable content from QCE Physics Units 3 & 4 to help you revise and prepare for the external assessment.

Everything has been organised by unit, topic and sub-topic in the General Senior Syllabus to help you focus your time and attention where it is needed most.

The revision notes are not designed to replace your teacher or your textbook. Instead, they have been designed to help you gauge your level of understanding and confidence of the subject matter before the exam. You can use them to identify those topics you know inside out and those that still require some extra attention.

The revision notes are also supported by a bunch of handy features, tips and icons designed to help you get the very best result on the day.

WE'RE ON A QUEST FOR YOUR SECOND KNOWLEDGE CRYSTAL! DON'T DOUBT YOURSELF - OF QUARTZ YOU CAN DO IT!



2.1 UNIT 3 TOPIC 1 - GRAVITY AND MOTION



More detail on pages 36–41 of New Century Physics for Queensland Units 3 & 4



Questions on pages 124–126

VECTORS

SUBJECT MATTER

Before the external assessment, you should be able to:

- use vector analysis to resolve a vector into two perpendicular components
- solve vector problems by resolving vectors into components, adding or subtracting the components and recombining them to determine the resultant vector.

Modified from *Physics General Senior Syllabus 2019 v1.2* © State of Queensland (QCAA) 2019, licensed under CC BY 4.0

DEFINING VECTORS

KEY CONCEPT

A vector is a quantity that has both magnitude and direction.

A vector quantity can be represented graphically by an arrowed line segment, or symbolically by a bold typeface or overhead arrow.

Different ways of representing vectors

Arrowed line segment	$v = 25 \text{ m s}^{-1}$
Bold (accent)	$\boldsymbol{v} = 25 \text{ m s}^{-1}$ to the right
Arrow (accent)	$\vec{v} = 25 \text{ m s}^{-1}$ to the right
Tilde (accent)	$\tilde{v} = 25 \text{ m s}^{-1}$ to the right

Table I

RESOLVING VECTORS

KEY CONCEPT

Vectors can be resolved into two perpendicular components.

Examiner's tip

You should be familiar with all methods of representing vectors. You may answer a question with any of the above, but be familiar with all as you do not know which one QCAA will use in the external exam.

In vector resolution, a vector can be broken up into its vertical and horizontal components. This is done so the laws of physics can be applied to solve complex problems.





Two or more vector quantities can be combined. When they are combined they produce a single **resultant vector**.

The resolved vector, or resolution, is the resultant vector broken up into its components.

HOW TO SOLVE VECTOR PROBLEMS BY RESOLVING VECTORS

When you are asked to determine the resultant vector to solve problems there are two methods that can be used:

- 1 **The components method:** Resolving the vectors into their horizontal and vertical components or adding and subtracting the components and recombining them to determine the resultant vector. Let v_1 represent the first vector, v_2 the second vector and θ is the angle from the horizontal.
 - **Step 1:** Resolve each vector into its vertical component using $v_{1y} = v_1 \sin \theta$ and $v_{2y} = v_2 \sin \theta$.
 - **Step 2:** Resolve each vector into its horizontal component using $v_{1x} = v_1 \cos \theta$ and $v_{2x} = v_2 \cos \theta$.
 - **Step 3:** If resolving two vectors that are in different directions, choose which directions will be positive and which will be negative, then find the net vector in the horizontal and vertical directions. For the horizontal direction use $\vec{v}_x = \vec{v}_{1x} + \vec{v}_{2x}$ and for the vertical direction use $\vec{v}_y = \vec{v}_{1y} + \vec{v}_{2y}$.
 - **Step 4:** To find the magnitude of the resultant vector use Pythagoras' theorem, $v_r = \sqrt{v_v^2 + v_x^2}$, where v_r is the resultant vector.
 - **Step 5:** To find the angle from the horizontal (direction) of the resultant vector, use $\theta = \tan^{-1}\left(\frac{\text{opposite}}{\text{adjacent}}\right)$.
- 2 **The sine-cosine rule method:** Using the cosine rule and sine rule. For most questions you will be able to first use the cosine rule, $a^2 = b^2 + c^2 - 2bc \cos C$, rearranged to solve for *a*, the missing side. Then use the sine rule, $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$, along with other

geometry rules from junior mathematics to find the unknown angle.

29

resultant vector

the result of two or more vectors combined, either through vector addition or vector subtraction

Examiner's tip

The components method is the method that is most used in physics problems and what you have learnt in class, although you would have been taught the sincosine method in mathematics. Either can be used to solve problems, and the QCAA will accept either method in the external exam.

I HAVE BEEN INFORMED THAT PRACTICE EXAMINATION QUESTIONS CAN CAUSE ANXIETY IN HUMAN ADOLESCENTS, SO ALLOW ME TO LIGHTEN THE MOOD WITH A JOKE: 'A ROBOT WALKS INTO A BAR. IT GOES CLANG!' ENOLIGH SENTIMENT. LET'S BEGIN...

7

6

lannan

 $\langle \rangle$

CHAPTER BRACTICE QUESTIONS

In this chapter, we provide a range of practice questions for all of the examinable content from QCE Physics Units 3 & 4. What a surprise... not! Did the title give it away?

No fancy tricks here, just heaps of questions organised by topic so you can move effortlessly between revision and practice as you study. We've also grouped the multiple choice and short response questions together so you can prepare for both papers and build your confidence.



COMPLETE THIS CHAPTER TO MINE YOUR THIRD KNOWLEDGE CRYSTAL! YOU (BIG SHINY) ROCK!

3.1 UNIT 3 TOPIC 1 – GRAVITY AND MOTION

VECTORS

MULTIPLE CHOICE QUESTIONS

QUESTION 1

A velocity vector is shown in the diagram below.

Answers on page 274

124

Which one of the following diagrams correctly represents the vertical and horizontal components of vector X?

X



QUESTION 2

A force vector has a magnitude of 44 N and is directed 22° above the horizontal and towards the left. Which one of the following diagrams correctly represents the vertical and horizontal components of the vector?



QUESTION 3

Two force vectors P and Q act on object X as shown in the diagram below.



Which one of the following diagrams correctly shows the addition of the forces and the resultant force on object X?



QUESTION 4

The diagram below shows two forces acting upon an object. This diagram is not to scale.



Select which of the following correctly shows the resultant force acting upon the object.



QUESTION 5

Two velocity vectors are shown in the diagram below.



Which one of the following diagrams correctly shows the subtraction of vector A from vector B?



OXFORD Study Buddy

SHORT RESPONSE QUESTIONS



Answers on pages 277–281

QUESTION 15 (2 marks)

A football player kicks a ball with an initial velocity of 25 m s⁻¹ at an angle of 55° above the horizontal. Determine the vertical and horizontal components of the ball's initial velocity Express your answers to 1 decimal place.



QUESTION 16 (3 marks)

Object A has an initial horizontal velocity of 4 m s⁻¹.



Calculate the angle at which Object B needs to be projected if it has an initial speed of 17 m s^{-1} , but the same initial horizontal velocity as Object A. Show your working.



© State of Queensland (QCAA) Sample assessment 2020, Physics Paper 1 Question 27

QUESTION 17 (3 marks)

A projectile has an initial velocity of 12 m s⁻¹ at an angle of 35° above the horizontal.

Calculate the vertical component of the projectile's initial velocity. Show your working.



Velocity = $_$ m s⁻¹ (to 1 decimal place)

© State of Queensland (QCAA) Sample assessment 2020, Physics Paper 1 Question 22

QUESTION 18 (3 marks)

A helicopter is travelling horizontally at a velocity of 110 m s^{-1} and a height of 75.0 metres above point Q on the horizontal ground when it releases a package.



a) Determine how long it will take the package to reach the ground. Express your answer to 2 decimal places. [1 mark]



MAY THE MASS X ACCELERATION BE WITH YOU AS YOU COMPLETE THESE PRACTICE EXAMS!

6

115

CHAPTER

OFFICIAL PAST PAPERS

In this chapter, things get serious! It's now time for you to put your revision and practice to the test – literally – by completing the official QCE Physics External assessment from 2020!

We recommend you:

- don't look at this chapter until you've finished with your revision and completed all of the practice questions in Chapter 3.
- complete these papers under exam conditions (i.e. follow the instructions regarding perusal time and working time; don't refer to any notes or other materials that will not be allowed during the real exams)
- refer to the answers in Chapter 5 and use the marking advice to self-assess your responses once you've finished.

Remember... these are the QCE Physics papers from 2020, so – if you complete them under exam conditions – they are arguably the best indicator of how well you're likely to perform on the day! Good luck!

SHINE ON! ACE THESE PRACTICE EXAMS TO BAG YOUR FOURTH KNOWLEDGE CRYSTAL!



EXTERNAL ASSESSMENT 2020 4.1 **PHYSICS** PAPER 1

Time allowed

- Perusal time 10 minutes
- Working time 90 minutes

General instructions

- · Answer all questions in this question and response book.
- QCAA-approved calculator permitted.
- · QCAA formula and data book provided.
- · Planning paper will not be marked

Section 1 (20 marks)

· 20 multiple choice questions

Section 2 (24 marks)

8 short response questions

© State of Queensland (QCAA) External assessment 2020, Physics Paper 1 For more information visit: https://www.qcaa.qld.edu.au/copyright

Section 1 (20 marks)



OUESTION 1

Which of the diagrams correctly represents the forces acting on an object resting on an inclined plane?

(B)



Answers on pages 327-333







QUESTION 2

The definition of average speed is the rate of change of

- (A) velocity.
- (B) distance.
- (C) acceleration.
- (D) displacement.

QUESTION 3

The diagram shows two vectors.



Calculate the magnitude of the resultant vector when Vector A is added to Vector B.

- (A) 15 km
- (B) 16.5 km
- (C) 21 km
- (D) 108 km

QUESTION 4

The diagram shows a current-carrying loop moving from one magnetic field to another magnetic field in 0.600 seconds.



FINALLY... TIME TO CHECK YOUR ANSWERS! WHATEVER HAPPENS, KEEP CALM AND **BARYON!** LIKE MY INVENTOR ALWAYS SAYS, IF AT FIRST YOU DON'T SUCCEED... CALL IT **VERSION 1.0!**

P

6

CHAPTER 5

ANSWERS

OMG, another cliffhanger... what on Earth could be in this chapter I wonder? You guessed it; in this chapter we provide the answers to absolutely everything! Sounds simple, I know, but to get the most out of this chapter, don't just cast an eye over the answers provided and move on.

If you really want to increase your chances of excelling on the exam, we recommend you look carefully over each of your answers in Chapters 3 and 4 and compare them with the answers in this chapter. Use the 'My mark' box under each short response question to self-assess your own answers. This will help you get into the habit of structuring your responses in order to receive maximum marks and show you what the exam marker will be looking for.

Notice to students

The answers and marking advice in this chapter are provided for practice purposes only. Unless specifically credited, the QCAA has not written this material and does not endorse the content.

> A KNOWLEDGE CRYSTAL IS JUST A PIECE OF COAL THAT HANDLED PRESSURE REALLY WELL! COMPLETE THIS CHAPTER TO MINE YOUR FINAL ONE! YOU'VE GOT THIS!



5.1 UNIT 3 TOPIC 1 – GRAVITY AND MOTION

VECTORS

MULTIPLE CHOICE ANSWERS

Correct answer	Explanation
В	When placed head to tail, the vectors in (B) result in the X vector. The other options, when placed head to tail, do not.
В	When placed head to tail, the vectors in (B) result in the resultant vector of 44°N at 22° to the horizontal. The other options, when placed head to tail, do not.
D	(D) shows vectors being placed head to tail and the resultant from the tail of the first to the head of the second is correctly drawn. The others do not.
D	B B C B C B C C C B C C C C C C C C C C C C C
D	$\vec{B} - \vec{A} = \vec{B} + (-\vec{A})$ so reverse the direction of vector A and add it to vector B. This gives a resultant like option D. D \vec{B} 25 m s ⁻¹ \vec{A} 25 m s ⁻¹ $\vec{B} - \vec{A}$ or $\vec{B} - \vec{A}$ or
	Correct answer B D D D

• 1 mark for each correct multiple choice question

A. C

Chapter 5 | Answers

OXFORD Study Buddy

SHORT RESPONSE ANSWERS

QUESTION 6 (2 marks)

 $F_{\rm H} = 46 \times \cos 25^{\circ}$

- = 42 N to the right
- $F_{\rm v} = 46 \times \sin 25^{\circ}$
 - = 19 N
- *1 mark* for resolving the force into its horizontal component.
- *1 mark* for resolving the force into its vertical component.

QUESTION 7 (8 marks)



Using the cosine rule:

 $c^2 = a^2 + b^2 - 2ab\cos C$

- $= 300^2 + 500^2 2 \times 300 \times 500 \cos(20 + 40)^\circ$
- $= 340\,000 150\,000$
- = 190000
- c = 435.9 N (436 N to the nearest whole number)
- **PROJECTILE MOTION**

MULTIPLE CHOICE ANSWERS

Using the sine rule: $\frac{\sin A}{a} = \frac{\sin C}{c}$ $\frac{\sin A}{300} = \frac{\sin 60^{\circ}}{435.9}$ $\angle A = 36.6^{\circ}$ Angle = 20°+36.6° $= 56.6^{\circ}$ to the horizontal

Direction:

56.6° to horizontal up the page to the left

Or 56.6° above x-axis directed to the left

The angle of acceleration will be in the same direction as the resultant force: 56.6° to the horizontal up the page to the left.

- *1 mark* for drawing initial vectors added head to tail.
- 1 mark for drawing resultant vector.
- *1 mark* for indicating direction of resultant vector.
- 1 mark for cosine transposition.
- *1 mark* for accurately calculating the resultant force.
- *1 mark* for transposing into sine formula correctly.
 - 1 mark for determining final angle.
- *1 mark* for accurately stating direction and magnitude of resultant force.

Assign marks similarly if using the vector decomposition method.

Question	Correct answer	Explanation
QUESTION 1	А	It must start with a high upward speed that decreases to zero at the top of flight and then increases in speed during downward motion. The other options are only partly correct.
QUESTION 2	С	$u_y = 60 \sin 30^\circ = 30$ $u_x = 60 \cos 30^\circ = 52$ Only option (C) has this correctly. Option (D) has them the wrong way around. Options (A) and (B) have used 60 as the angle and 30 as the speed.
QUESTION 3	В	The time of fall is independent of mass as shown by the vertical motion formula: $s_y = u_y t + \frac{1}{2}gt^2$. It is only dependent on the vertical displacement. As the time of flight for both balls is therefore equal, they will have the same horizontal range as they have the same horizontal velocity. Thus, the range ratio is 1.

YOU'VE REACHED THE PART OF THE BOOK MOST LIKELY TO BE USELESS OR BURST... **THE APPENDIX!** LUCKY FOR YOU, THIS APPENDIX CONTAINS THE DATA AND FORMULAS YOU'LL NEED TO ACE THOSE EXAMS!

APPENDIX

PHYSICS Formula and data book

The QCAA has developed a formula sheet that will be provided for you to use during both examination papers. It provides a selection of useful formulas for you to refer to during the exam.

We wanted you to have everything you need in one spot so that you can study effectively with this book whenever and wherever you are – on the bus, in the bath... anywhere! For that reason we've included the formula and data booklet here too.

Shucks, that's what buddies are for!



Processing of data
Percentage uncertainty (%) = $\frac{\text{absolute uncertainty}}{\text{measurement}} \times 100$
Percentage error (%) = $\left \frac{\text{measured value} - \text{true value}}{\text{true value}} \right \times 100$

Heating processes

$T_{\rm K} = T_{\rm C} + 273$	Q = mL	
$Q = mc\Delta T$	$\Delta U = Q + W$	
$n = \frac{\text{energy output}}{100} \times \frac{100}{100} \%$		

energy input 1

P = VI

Ionising radiation and nuclear reactions

$$N = N_0 \left(\frac{1}{2}\right)^n \qquad \Delta E = \Delta mc^2$$
Electrical circuits
$$I = \frac{q}{t} \qquad P = I^2 R$$

$$V = \frac{W}{q} \qquad V_t = V_1 + V_2 + \dots V_n$$

$$P = \frac{W}{t} \qquad R_t = R_1 + R_2 + \dots R_n$$

$$R = \frac{V}{I} \qquad I_t = I_1 + I_2 + \dots I_n$$

$$P = VI \qquad \frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \dots \frac{1}{R_n}$$

Physics 2019 v1.2 Formula and data booklet, © State of Queensland (QCAA) 2019, licensed under CC BY 4.0

Appendix | Formula and data book

OXFORD StUDY Buddy

345

Linear motion and force		
v = u + at	$W = \Delta E$	
$s = ut + \frac{1}{2}at^2$	W = Fs	
$v^2 = u^2 + 2as$	$E_{\rm k} = \frac{1}{2}mv^2$	
$a = \frac{F_{\text{net}}}{m}$	$\Delta E_{\rm p} = mg\Delta h$	
p = mv	$\sum \frac{1}{2}mv_{\rm before}^2 = \sum \frac{1}{2}mv_{\rm after}^2$	
$\sum mv_{\rm before} = \sum mv_{\rm after}$		

Waves	
$v = f\lambda$	$L = (2n-1)\frac{\lambda}{4}$
$f = \frac{1}{T}$	$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$
$L = n\frac{\lambda}{2}$	$I \propto \frac{1}{r^2}$

Gravity and motion	
$v_y = gt + u_y$	$v = \frac{2\pi r}{T}$
$s_y = \frac{1}{2}gt^2 + u_yt$	$a_{\rm C} = \frac{v^2}{r}$
$v_y^2 = 2gs_y + u_y^2$	$F_{\rm net} = \frac{mv^2}{r}$
$v_x = u_x$	$F = \frac{GMm}{r^2}$
$s_x = u_x t$	$g = \frac{F}{m} = \frac{GM}{r^2}$
$F_g = mg$	$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$

Physics 2019 v1.2 Formula and data booklet, © State of Queensland (QCAA) 2019, licensed under CC BY 4.0

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means OXFORD UNIVERSITY PRESS