Xiao L. WU Robert FARR

hsc course

PHYSICS IN FOCUS

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About the authors

Dr Xiao L. (William) Wu graduated from Sydney Boys High School with first place in physics, and received the Premier's All Rounder Award for his Higher School Certificate. He completed Bachelor of Medicine and Surgery degrees (Honours) at the University of New South Wales (UNSW) while simultaneously studying chemistry, physics and biology as a part of his Bachelor of Science (Honours) degree.

Dr Wu is passionate about teaching. He has taught at UNSW and in eight years of high school tutoring has produced many outstanding students, some of whom were among the top 10 in Higher School Certificate science subjects, with perfect UAI scores. Many of his students have gone on to study Medicine and Law. Besides pursuing a career in orthopaedic surgery, Dr Wu will continue to dedicate his time in teaching high school sciences.

Rob Farr has been teaching physics for 25 years in New South Wales schools. He has been on review panels for the current physics syllabus and has extensive experience as a marker, senior marker and supervisor in physics and chemistry. Rob graduated with a Bachelor of Science (Honours) degree from the University of Sydney in 1982 and completed his Diploma of Education the next year. He has a Master of Arts, specialising in science education and school leadership, from Macquarie University. Rob's passion for science and science teaching have led him to become a consultant and contributor to the *Biology in Focus* series, especially in developing the approach to the Prescribed Focus Areas. He is currently Science Coordinator at Brigidine College St Ives, Sydney.

To the student

Physics is rich in its history, its accidental discoveries, its geniuses and in the way theories, models and laws have been developed or discarded. Importantly, physics has many varied and profound impacts on society and the environment, both positive and negative. The teaching and learning of physics without reference to these impacts is akin to teaching words with no sentences. Ultimately, it is to science that we turn to find solutions to the wide variety of problems arising from overpopulation, pollution and threats from outer space in an effort to ensure our survival. Learning Physics within these contexts gives it relevance; hopefully this will encourage students to pursue the subject at tertiary levels.

Physics in Focus is a succinct and easy-to-follow book for the New South Wales Stage 6 Physics Syllabus. As in the syllabus, the text is divided into modules. Each module is made up of chapters based on the divisions in the syllabus. Chapters are divided into sections to specifically cover the syllabus dot points.

The Preliminary volume covers all four core modules; the HSC volume covers three core modules and three optional modules: 'From quanta to quarks', 'Medical physics' and 'Astrophysics'.

Physics in Focus is a valuable guide, not only to the syllabus content but also to practical procedures. The NSW Board of Studies intends, as with all science courses, that physics is taught in the contexts formed by the five Prescribed Focus Areas (PFAs). The PFAs have been a misunderstood concept for too long. This book attempts to address this shortfall by giving specific examples and information that relates to these broader issues.

Physics in Focus clearly indicates where the skills, PFAs and first-hand investigations are being addressed within the text. It also provides risk assessments, animations, exercises and worked examples, all marked with icons and colour coding.

The dot points in the 'students learn to' columns are marked in blue and the third column investigations are marked in green. Exceptions are for made for dot points that start with either 'solve' or 'analyse'; these are marked in red, emphasising that students may need some guidance to learn this material, rather than learning by themselves through investigations.

Other features within the text include the use of 'notes'  to highlight tips and hints or to clarify confusing and difficult concepts. 'Analogies' are used to help to explain difficult concepts. There are extensive practice questions as well as examination-style questions to assist students to consolidate the concepts and to prepare for their HSC exams.

The authors would like to emphasise that the studying of any science subject can be considered as a four-step process: reading, understanding, memorising and applying. Understanding is the most important step, and for this students need their teacher's help. Applying comes after understanding and memorising and can be perfected by completing the practice questions in this book.

Finally, the authors hope that this book will help students to enjoy learning physics.

Acknowledgments

From Xiao L. Wu

I would like to thank my parents and friends for their understanding, support and encouragement during the creation of this book.

In addition, I would like to thank my students for transcribing a part of this text and drafting parts of the solutions to the exercise questions.

I encourage students to understand and enjoy science and have tried to make it interesting and easy by providing study strategies.

From Rob Farr

I would like to offer my heartfelt thanks to my wife, Elisa, who has assisted me in many ways in the construction of this text, including the proofing of my manuscript. She has given me much support and encouragement, allowing her dining room table to be converted into a workspace and keeping our young children happy and content when my mind has been elsewhere.

I would also like to thank my colleagues at Brigidine College St Ives for their understanding during the writing of this text. Glenda Chidrawi deserves a special mention for suggesting that I get involved with this project.

Thanks also to my students over the years who have helped me maintain my enthusiasm and love of teaching, so that now, 25 years after graduating, I still enjoy what I do.

List of Board of Studies verbs

Account	Account for: state reasons for, report on Give an account of: narrate a series of events or transactions
Analyse	Identify components and the relationship among them; draw out and relate implications
Apply	Use, utilise, employ to a particular situation
Appreciate	Make a judgement about the value of
Assess	Make a judgement of value, quality, outcomes, results or size
Calculate	Ascertain/determine from given facts, figures or information
Clarify	Make clear or plain
Classify	Arrange or include in classes/categories
Compare	Show how things are similar or different
Construct	Make; build, put together items or arguments
Contrast	Show how things are different or opposite
Critically (analyse/evaluate)	Add a degree or level of accuracy depth, knowledge and understanding, logic, questioning, reflection and quality to (analysis/evaluation)
Deduce	Draw conclusions
Define	State meaning and identify essential qualities
Demonstrate	Show by example
Describe	Provide characteristics and features
Discuss	Identify issues and provide points for and/or against
Distinguish	Recognise or note/indicate as being distinct or different from; to note differences between
Evaluate	Make a judgement based on criteria; determine the value of
Examine	Inquire into
Explain	Relate cause and effect; make the relationships between things evident; provide why and/or how
Extract	Choose relevant and/or appropriate details
Extrapolate	Infer what is known
Identify	Recognise and name
Interpret	Draw meaning from
Investigate	Plan, inquire into and draw conclusions about
Justify	Support an argument or conclusion
Outline	Sketch in general terms; indicate the main features of
Predict	Suggest what may happen based on available information
Propose	Put forward (for example a point of view, idea, argument, suggestion) for consideration and action
Recall	Present remembered ideas, facts or experiences
Recommend	Provide reasons in favour
Recount	Retell a series of events
Summarise	Express concisely the relevant details

Physics skills—an introduction

During the Higher School Certificate course, it is expected that students will further develop skills in planning and conducting investigations, communicating information and understanding, scientific thinking and problem solving and working individually and in teams. Each module specifies content through which skill outcomes can be achieved. Teachers should develop activities based on that content to provide students with opportunities to develop the full range of skills.

HSC course outcomes	**Content**
A student:	*Students:*
H11. justifies the appropriateness of a particular investigation plan	**11.1 identify data sources to:** a) analyse complex problems to determine appropriate ways in which each aspect may be researched b) determine the type of data that needs to be collected and explain the qualitative or quantitative analysis that will be required for this data to be useful c) identify the orders of magnitude that will be appropriate and the uncertainty that may be present in the measurement of data d) identify and use correct units for data that will be collected e) recommend the use of an appropriate technology or strategy for data collection or information gathering that will assist efficient future analysis
	11.2 plan first-hand investigations to: a) demonstrate the use of the terms 'dependent' and 'independent' to describe variables involved in the investigation b) identify variables that needed to be kept constant, develop strategies to ensure that these variables are kept constant, and demonstrate the use of a control c) design investigations that allow valid and reliable data and information to be collected d) describe and trial procedures to undertake investigations and explain why a procedure, a sequence of procedures or the repetition of procedures is appropriate e) predict possible issues that may arise during the course of an investigation and identify strategies to address these issues if necessary
	11.3 choose equipment or resources by: a) identifying and/or setting up the most appropriate equipment or combination of equipment needed to undertake the investigation b) carrying out a risk assessment of intended experimental procedures and identifying and addressing potential hazards c) identifying technology that would be used during investigation, determining its suitability and effectiveness for its potential role in the procedure or investigation d) recognising the difference between destructive and non-destructive testing of material and analysing potentially different results from these two procedures

HSC course outcomes	**Content**
A student:	*Students:*
H12. evaluates ways in which accuracy and reliability could be improved in investigations	**12.1 perform first-hand investigations by:** a) carrying out the planned procedure, recognising where and when modifications are needed and analysing the effect of these adjustments b) efficiently undertaking the planned procedure to minimise hazards and wastage of resources c) disposing carefully and safely of any waste materials produced during the investigation d) identifying and using safe work practices during investigations
	12.2 gather first-hand information by: a) using appropriate data collection techniques, employing appropriate technologies, including data loggers and sensors b) measuring, observing and recording results in accessible and recognisable forms, carrying out repeat trials as appropriate
	12.3 gather information from secondary sources by: a) accessing information from a range of resources, including popular scientific journals, digital technologies and the internet b) practising efficient data collection techniques to identify useful information in secondary sources c) extracting information from numerical data in graphs and tables as well as written and spoken material in all its forms d) summarising and collating information from a range of resources e) identifying practising male and female Australian scientists and the areas in which they are currently working and information about their research
	12.4 process information to: a) assess the accuracy of any measurements and calculations and the relative importance of the data and information gathered b) identify and apply appropriate mathematical formulae and concepts c) best illustrate trends and patterns by selecting and using appropriate methods, including computer-assisted analysis d) evaluate the validity of first-hand and secondary information and data in relation to the area of investigation e) assess the reliability of first-hand and secondary information and data by considering information from various sources f) assess the accuracy of scientific information presented in mass media by comparison with similar information presented in scientific journals
H13. uses terminology reporting styles appropriately and successfully to communicate information and understanding	**13.1 present information by:** a) selecting and using appropriate text types or combinations thereof, for oral and written presentations b) selecting and using appropriate media to present data and information c) selecting and using appropriate methods to acknowledge sources of information d) using symbols and formulae to express relationships and using appropriate units for physical quantities e) using a variety of pictorial representations to show relationships and present information clearly and succinctly f) selecting and drawing appropriate graphs to convey information and relationships clearly and accurately g) identifying situations where use of a curve of best fit is appropriate to present graphical information

HSC course outcomes	**Content**
A student:	*Students:*
H14. assesses the validity of conclusions drawn from gathered data and information	**14.1 analyse information to:** a) identify trends, patterns and relationships as well as contradictions in data and information b) justify inferences and conclusions c) identify and explain how data supports or refutes a hypothesis, a prediction or a proposed solution to a problem d) predict outcomes and generate plausible explanations related to the observations e) make and justify generalisations f) use models, including mathematical ones, to explain phenomena and/or make predictions g) use cause and effect relationships to explain phenomena h) identify examples of the interconnectedness of ideas or scientific principles
	14.2 solve problems by: a) identifying and explaining the nature of a problem b) describing and selecting from different strategies those that could be used to solve a problem c) using identified strategies to develop a range of possible solutions to a particular problem d) evaluating the appropriateness of different strategies for solving an identified problem
	14.3 use available evidence to: a) design and produce creative solutions to problems b) propose ideas that demonstrate coherence and logical progression and include correct use of scientific principles and ideas c) apply critical thinking in the consideration of predictions, hypotheses and the results of investigations d) formulate cause and effect relationships