Constructing Examination Questions in Physics

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Prescribed Focus Areas of the Stage 6 syllabus

Introduction

How do we best assess the Prescribed Focus Area (PFA) outcomes P/H 1 – P/H 5 ?

The syllabus has the following overview of the PFAs:

The Prescribed Focus Areas are different curriculum emphases or purposes designed to increase students' understanding of physics as an ever-developing body of knowledge, the provisional nature of scientific explanations in physics, the complex relationship between evidence and ideas in physics and the impact of physics on society.

Keeping this overview in mind, we will, in this workshop:

- analyse questions identified in the marking centre notes (2002/2003) as addressing the PFA outcomes
- identify module dot points with a PFA focus
- design questions for assessing the PFAs
- develop marking guidelines for these questions
- discuss how assessment of the PFAs might impact on classroom pedagogy

Prescribed Focus Areas

The above overview is expanded in the outcome statements P/H 1 – P/H 5. The PFA Objectives appear at first to be self-explanatory but the corresponding outcome statements require some comment before assessment items are developed.

H 1 History of physics

There is a distinct shift from a simple presentation of historical developments in physics in the Preliminary course to a more complex evaluation in the HSC course of changes in scientific thinking due to these developments.

H 2 Nature and practice of physics

It is beyond the scope of this workshop to critique the combination of Nature and Practice in this PFA. When developing examination questions for this PFA, reflect on the opening words in the HSC course outcome:

…***analyses the ways*** in which models, theories and laws in physics have been tested and validated

How does an understanding of the Nature of Science help in this analysis?
Science as inquiry requires students to develop a number of key skills:

1. Identify questions that can be answered through investigation.

2. Design and carry out the investigations.
3. Use the correct tools and technology to gather data about the questions.
4. Present their findings.
5. Thinking critically and logically.

The conduct of scientific inquiry may show evidence of one or more of the following tenets of the Nature of Science:

Tenets of Nature Of Science (NOS)

1. Scientific knowledge is tentative (subject to change)
2. Empirically based
3. Subjective (theory-laden)
4. Partly the product of human inference, imagination and creativity
5. Socially and culturally embedded
6. There are distinctions between observations and inferences
7. Functions of and relationships between theories and laws

From:
"The Nature of Science and Instructional Practice: Making the Unnatural Natural"
by Fouad Abd-El_Khalick, Randy L. Bell, Norman G. Lederman
Department of Science and Mathematics Education, Oregon State University, Weniger Hall 237, Corvallis, OR 973331, USA

What do examination questions look like if we assess these tenets of NOS and are these tenets supported by syllabus statements?

H 3 Applications and uses of physics

Both the Preliminary and HSC outcomes go beyond simple descriptions of technologies and require the students to have knowledge of the physics involved.

H 4 Implications for society and the environment

Both the Preliminary and HSC outcomes have a component of the NOS tenet 5 above with references to the impacts on society.

H 5 Current issues, research and developments in physics

The HSC course outcome is self-explanatory.

Activity One **2002, 2003 HSC Exam Questions (Core)**

Work in pairs to analyse the HSC examination questions identified as addressing the PFA outcomes.

(See Appendix A and B)

1. Write the outcome number you think the question addresses.

2002

Question	Outcome	Marking outcome

2003

Question	Outcome	Marking outcome

2. Choose one of the HSC questions and use it as a basis for a new PFA question:

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Activity Two **Core Module PFA Statements**

1. Choose a syllabus statement from one of the Core modules that you believe addresses a PFA outcome (identify that outcome):

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2. Write an examination question (free-hand diagrams if necessary) that you believe addresses this outcome:

3. Construct marking guidelines for this question:

MARKING GUIDELINES

Criteria	Marks

Activity Three **Teaching and the PFAs**

Assessment has a direct influence on classroom pedagogy. In this activity we will use the HSC course PFA outcomes and syllabus statements to design classroom teaching strategies that will allow assessment of student knowledge and understanding of the PFAs.

1. Choose a PFA outcome from the HSC course:

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2. Find a syllabus statement that addresses this outcome:

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3. Outline a teaching strategy that will allow you to assess the students' knowledge and understanding of your chosen PFA.

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Appendix A

Prescribed Focus Areas

The Prescribed Focus Areas are different curriculum emphases or purposes designed to increase students' understanding of physics as an ever-developing body of knowledge, the provisional nature of scientific explanations in physics, the complex relationship between evidence and ideas in physics and the impact of physics on society.

The following Prescribed Focus Areas are developed in this syllabus:

History of physics

Knowledge of the historical background of physics is important to adequately understand natural phenomena and explain the applications of those phenomena in current technologies. Students should develop knowledge of:

- the developmental nature of our understanding of energy, matter and their interrelationships
- the part that an understanding of energy, matter and their interrelationships plays in shaping society
- how our understanding of energy, matter and their interrelationships is influenced by society.

Nature and practice of physics

A study of physics should enable students to participate in scientific activities and develop knowledge of the practice of physics. Students should develop knowledge of the provisional nature of physical explanations and the complex relationship between:

- existing physical views and the evidence supporting these
- the process and methods of exploring, generating, testing and relating ideas
- the stimulation provided by technological advances and constraints imposed on understanding in physics by the limitations of current technology that necessitates the development of the required technology and technological advances.

Applications and uses of physics

Setting the study of physics into broader contexts allows students to deal with real problems and applications. The study of physics should increase students' knowledge of:

- the relevance, usefulness and applicability of laws and principles related to physics
- how increases in our understanding in physics have led to the development of useful technologies and systems
- the contributions physics has made to society, with particular emphasis on Australian achievements.

Implications of physics for society and the environment

Physics has an impact on our society and the environment, and students need to develop knowledge of the importance of positive values and practices in relation to these. The study of physics should enable students to develop:

- understanding about the impact and role of physics in society and the environment
- skills in decision-making about issues concerning physics, society and the environment.

Appendix B

2002

14 During the early 1950s most transistors were manufactured using germanium.

Why was germanium used instead of silicon?

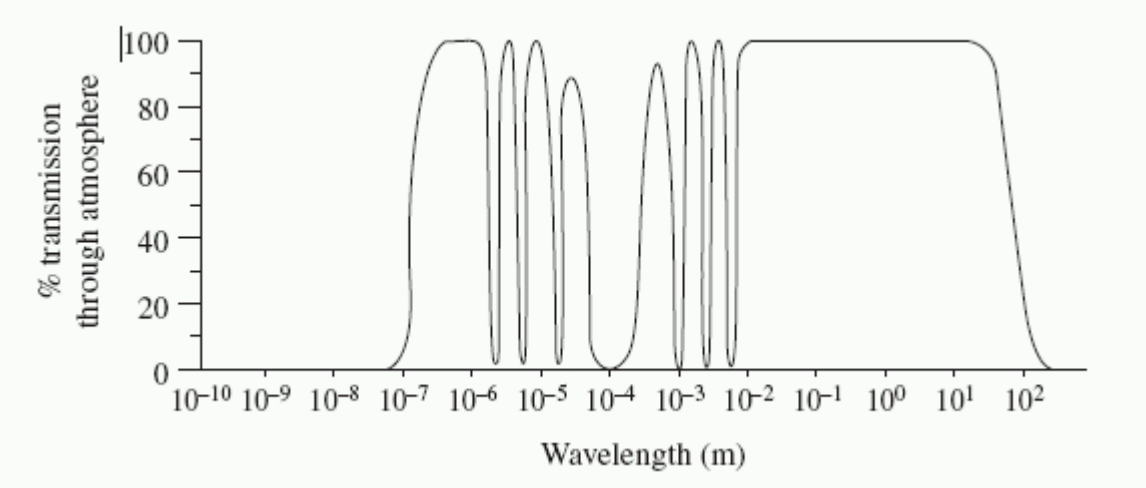
(A) Silicon is more brittle than germanium.
(B) Germanium could be more easily produced in a purified form.
(C) Germanium is a more abundant raw material.
(D) Silicon does not retain its semiconductor properties at high temperatures.

Question 17 (4 marks)

Describe TWO difficulties associated with effective or reliable communications between satellites and Earth.

Question 18 (3 marks)

The graph shows the percentage transmission of electromagnetic radiation of various wavelengths through the Earth's atmosphere.



The Voyager II spacecraft transmits electromagnetic radiation to Earth at a frequency of 2295 MHz.

Use the graph to justify the use of this transmission frequency.

Question 19 (4 marks)

In one of Einstein's famous thought experiments, a passenger travels on a train that passes through a station at 60% of the speed of light. According to the passenger, the length of the train carriage is 22 m from front to rear.

(a) A light in the train carriage is switched on. Compare the velocity of the light beam as seen by the passenger on the train and a rail worker standing on the station platform.

Question 20 (3 marks)

A student is investigating inertial and non-inertial frames of reference. The student carries out a series of activities on a boat floating on a large, calm lake. The boat remained level during these activities.

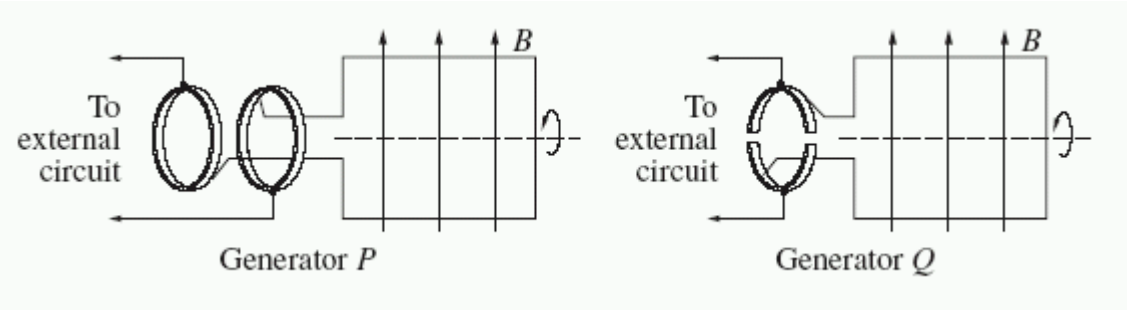
Each activity and the student's observed results are recorded in the table.

Activity	*Observation*
Dropped a ball from a set height	Ball fell vertically with increasing velocity
Rolled a ball from one side of the boat to the other	Ball rolled across the floor with a constant velocity
Rolled a ball from the back of the boat towards the front of the boat	Ball rolled across the floor with a constant velocity

Justify the student's conclusion that: 'The boat can be regarded as an inertial frame of reference'.

Question 22 (6 marks)

Two types of generator are shown in the diagram.



(c) Outline why AC generators are used in large-scale electrical power production.

Question 23 (7 marks)

(c) Explain how the principle of induction can be used to heat a conductor.

Question 24 (8 marks)

In terms of band structures and relative electrical resistance, describe the differences between a conductor, an insulator and a semiconductor.

Appendix C

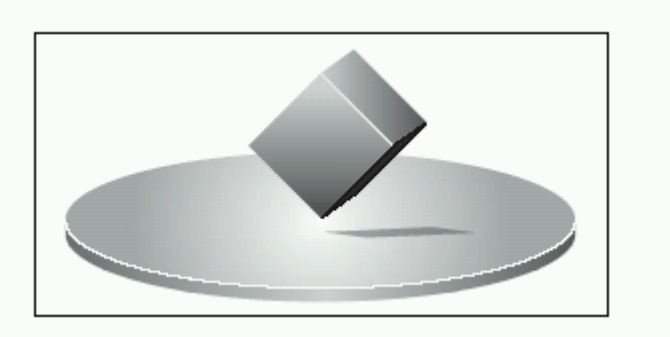
2003

11 Which of the following did the Braggs investigate using X-ray diffraction?

(A) Cathode rays
(B) Crystal structure
(C) Photoelectric effect
(D) Superconductivity

Question 23 (6 marks)

The following image shows a magnet hovering above a superconducting disk.



(b) Compare the model for the conduction of electricity in metals at room temperature with the model for conduction of electricity in superconductors below the critical temperature.

Question 26 (6 marks)

Describe Einstein's contributions to Special Relativity and to Quantum Theory and how these contributions changed the direction of scientific thinking in the Twentieth Century.

Appendix D

Objectives	**Preliminary Course Outcomes**	**HSC Course Outcomes**
Students will develop knowledge and understanding of :	*A student :*	*A student :*
1. the history of physics	P1. outlines the historical development of major principles, concepts and ideas in physics	H1. evaluates how major advances in scientific understanding and technology have changed the direction or nature of scientific thinking
2. the nature and practice of physics	P2. applies the processes that are used to test and validate models, theories and laws of science with particular emphasis on first-hand investigations in physics	H2. analyses the ways in which models, theories and laws in physics have been tested and validated
3. applications and uses of physics	P3. assesses the impact of particular technological advances on understanding in physics	H3. assesses the impact of particular advances in physics on the development of technologies
4. implications for society and the environment	P4. describes applications of physics which affect society or the environment	H4. assesses the impacts of applications of physics on society and the environment
5. current issues, research and developments in physics	P5. describes the scientific principles employed in particular areas of research in physics	H5. identifies possible future directions of physics research