

**Victorian Physics Teachers' Network
Physics Teachers' Conference
15 February 2019**

Session C1

Literacy from a physics education perspective

Neil Champion

Author of 11 science and physics textbooks currently in use across Australia

How do we expect our students to communicate? What values do we expect to see in their communications? It is high time physics teachers interrogated the way the literacy discourse has been commandeered by one academic discipline. We have a specialised literacy, which needs to be taught explicitly. This workshop will explore the specific literacy demands of the physics classroom and how those demands can be come part of the learning and assessment cycle.

Session Overview

1. **Discourse specific literacy**
 - 1.1. What is it?
 - 1.2. Explicit values
 - 1.3. Similarities and differences: English curriculum *cf.* Science/Physics

Response

2. **Focus on reading**
 - 2.1. Unpacking science textual material
Sciences: Yours to Discover 10 (Nelson/Cengage)
 - 2.2. Reading a VCE text
Physics 11 (Heinemann)

Response

3. **Writing physics genre**
 - 3.1. Poster

Response

4. **Review**
 - 4.1. Summary
 - 4.2. Evaluation sheets

Scientific Literacy

The Goodrum Report 2001¹ is an example of the capture of the word, *literacy*, to justify one or other of the academic disciplines as important for the development of the “well-informed citizen” – think “computer literacy”, “financial literacy” (I’ve even seen “Literacy skills: physical education” programs!).

Recommendation 1 was based on the following definition of scientific literacy (p.10):

The purpose of science education is to develop scientific literacy which is a high priority for all citizens, helping them to be interested in, and understand the world around them, to engage in the discourses of and about science, to be sceptical and questioning of claims made by others about scientific matters, to be able to identify questions and draw evidence-based conclusions, and to make informed decisions about the environment and their own health and well-being.

Goodrum drove the development of the national Science P-10 curriculum by ACARA. The three elements of each domain included: Science understanding; Science inquiry skills; Science as a human endeavour. Recently, Victorian Science curriculum innovations have de-emphasised “Science as a human endeavour”, thus taking us back 60 years to a time when the idea of “humanising” science education was just a twinkle in some few enlightened eyes.

Notice that Goodrum’s *scientific literacy* does not refer directly to the literacy that is specific to the sciences as academic disciplines. It does not even refer to the traditional view of literacy promulgated as reading, writing, listening, speaking. In what ever way we view the purpose of science curriculum design, the question about what constitutes “scientific literacy” still remains.

What are the literacy demands of the academic discourse of science/physics?

You are all familiar with the dominant pitch for power within schools by English teachers: “Every teacher is a teacher of English”. This manifests itself in English teachers becoming the privileged recipients of “Literacy coach” positions in most schools. Subsequently, science staff members are subjected to “literacy” as envisaged by the English academic discipline.

English in the Victorian Curriculum², is divided into three language modes:

- reading and viewing
- writing
- speaking and listening

What gives English teachers the right to demand that science teachers enter into their privileged discourse, a discourse which has demonstrably failed (never even attempted) to take seriously

¹ Goodrum, Denis. & Rennie, Leonie Jean. & Hackling, Mark W. & Australia. Department of Education, Training and Youth Affairs. (2001). *The status and quality of teaching and learning of science in Australian schools : a research report*. [Canberra : Department of Education, Training and Youth Affairs], http://www.dest.gov.au/sectors/school_education/publications_resources/science_in_australian_schools/documents/sciencereport_pdf.htm. See also: <https://catalogue.nla.gov.au/Record/879767>. Since its publication, this report should have been required reading for all science teachers, especially science-teachers-in-training. It includes a summary of research into science education spanning approximately 40 years. There is little reason to think that the last 18 years have seen major changes in the mismatch between the ideal and real situations as described by Goodrum *et.al*.

² <http://victoriancurriculum.vcaa.vic.edu.au/english/introduction/rationale-and-aims>

the kind of non-fiction writing, which is central to the comprehension and production of “texts” in science (or technology, engineering and mathematics for that matter)?

How to use this book

Heinemann Physics 11 4th edition

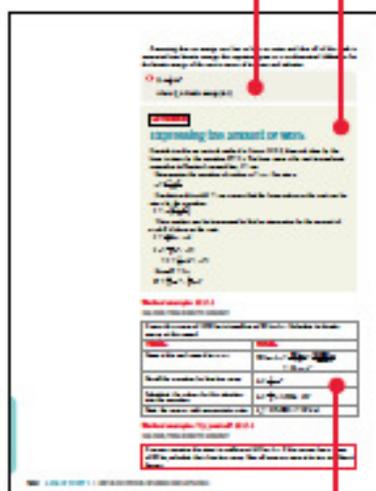
Heinemann Physics 11 4th edition has been written to the new VCE Physics Study Design 2016–2021. The book covers Units 1 and 2 in an easy-to-use resource. Explore how to use this book below.

Extension

Extension material goes beyond the core content of the Study Design. It is intended for students who wish to expand their depth of understanding.

Highlight

Focus on important information such as key definitions, formulae and summary points.



Worked examples

Worked examples are set out in steps that show both thinking and working. This enhances student understanding by linking underlying logic to the relevant calculations.

Each Worked example is followed by a Try Yourself: Worked example. This mirror problem allows students to immediately test their understanding.

Fully worked solutions to all Try Yourself: Worked examples are available on *Heinemann Physics 11 4th edition ProductLink*.

vi



Chapter opener

Chapter opening pages link the Study Design to the chapter content. Key knowledge addressed in the chapter is clearly listed.

Physics in Action

Physics in Action place physics in an applied situation or relevant context. These refer to the nature and practice of physics, applications of physics and the associated issues and the historical development of concepts and ideas.



PhysicsFile

PhysicsFiles include a range of interesting information and real world examples.

Victorian Curriculum: Level 5 English

Description

In Levels 5 and 6, students communicate with peers and teachers from other classes and schools, community members, and individuals and groups, in a range of face-to-face and online/virtual environments.

Students engage with a variety of texts for enjoyment. They listen to, read, view, interpret and evaluate spoken, written and **multimodal texts** in which the primary purpose is aesthetic, as well

as **texts designed to inform** and persuade. These include various types of media texts including newspapers, film and digital texts, junior and early adolescent novels, poetry, **non-fiction**, and dramatic performances.

Literary texts that support and extend students in Levels 5 and 6 as independent readers describe complex sequences, a range of non-stereotypical characters and elaborated events including flashbacks and shifts in time. These texts explore themes of interpersonal relationships and ethical dilemmas within real-world and fantasy settings. **Informative texts supply technical and content information about a wide range of topics of interest as well as topics being studied in other areas of the curriculum. Text structures include chapters, headings and subheadings, tables of contents, indexes and glossaries. Language features include complex sentences, unfamiliar technical vocabulary, figurative language, and information presented in various types of graphics.**

Students create a range of imaginative, informative and persuasive types of texts including narratives, **procedures**, performances, **reports, reviews, explanations and discussions**.

Language mode: Reading and Viewing

Language: Text structure and organisation

Investigate how the organisation of texts into chapters, headings, subheadings, home pages and sub pages for online texts and according to chronology or topic can be used to predict content and assist navigation [\(VCELA310\)](#)

Language: Expressing and developing ideas

Explain sequences of images in print texts and compare these to the ways hyperlinked digital texts are organised, explaining their effect on viewers' interpretations [\(VCELA311\)](#)

Language: Phonics and word knowledge

Understand how to use banks of known words, syllabification, spelling patterns, word origins, base words, prefixes and suffixes, to spell new words, including some uncommon plurals [\(VCELA312\)](#)

Literature: Literature and context

Identify aspects of literary texts that convey details or information about particular social, cultural and historical contexts [\(VCELT313\)](#)

Literature: Responding to literature

Use metalanguage to describe the effects of ideas, text structures and language features on particular audiences [\(VCELT314\)](#)

Literature: Examining literature

Recognise that ideas in literary texts can be conveyed from different viewpoints, which can lead to different kinds of interpretations and responses [\(VCELT315\)](#)

Understand, interpret and experiment with sound devices and imagery, including simile, metaphor and personification, in narratives, shape poetry, songs, anthems and odes [\(VCELT316\)](#)

Literacy: Texts in context

Show how ideas and points of view in texts are conveyed through the use of vocabulary, including idiomatic expressions, objective and subjective language, and that these can change according to context [\(VCELY317\)](#)

Literacy: Interpreting, analysing, evaluating

Navigate and read imaginative, **informative and persuasive texts by interpreting structural features, including tables of content, glossaries, chapters, headings and subheadings and applying appropriate text processing strategies, including monitoring meaning, skimming and scanning** [\(VCELY318\)](#)

Use comprehension strategies to analyse information, integrating and linking ideas from a variety of print and digital sources [\(VCELY319\)](#)

Analyse the text structures and language features used in imaginative, **informative and persuasive texts to meet the purpose of the text** [\(VCELY320\)](#)

Language mode: Writing

Language: Text structure and organisation

Understand that the starting point of a sentence gives prominence to the message in the text and allows for prediction of how the text will unfold [\(VCELA321\)](#)

Understand how the grammatical category of possessives is signalled through apostrophes and how to use apostrophes with common and proper nouns [\(VCELA322\)](#)

Language: Expressing and developing ideas

Understand the difference between main and subordinate clauses and that a complex sentence involves at least one subordinate clause (VCELA323)

Understand how noun groups/phrases and adjective groups/phrases can be expanded in a variety of ways to provide a fuller description of the person, place, thing or idea (VCELA324)

Understand the use of vocabulary to express greater precision of meaning, and know that words can have different meanings in different contexts (VCELA325)

Language: Phonics and word knowledge

Recognise and write less familiar words that share common letter patterns but have different pronunciations (VCELA326)

Literature: Creating literature

Create literary texts that experiment with structures, ideas and stylistic features of selected authors (VCELT327)

Create literary texts using realistic and fantasy settings and characters that draw on the worlds represented in texts students have experienced (VCELT328)

Literacy: Creating texts

Plan, draft and publish imaginative, **informative and persuasive print and multimodal texts, choosing text structures, language features, images and sound appropriate to purpose and audience** (VCELY329)

Reread and edit own and others' work using agreed criteria for text structures and language features (VCELY330)

Develop a handwriting style that is becoming legible, fluent and automatic (VCELY331)

Use a range of software including word processing programs to construct, edit and publish written text, and select, edit and place visual, print and audio elements (VCELY332)

Language mode: Speaking and Listening

Language: Language variation and change

Understand that the pronunciation, spelling and meanings of words have histories and change over time (VCELA333)

Language: Language for interaction

Understand that patterns of language interaction vary across social contexts and types of texts and that they help to signal social roles and relationships (VCELA334)

Understand how to move beyond making bare assertions and take account of differing perspectives and points of view (VCELA335)

Literature: Responding to literature

Present a point of view about particular literary texts using appropriate metalanguage, and reflecting on the viewpoints of others (VCELT336)

Literacy: Interacting with others

Clarify understanding of content as it unfolds in formal and informal situations, connecting ideas to students' own experiences, and present and justify a point of view or recount an experience using interaction skills (VCELY337)

Participate in informal debates and plan, rehearse and deliver presentations for defined audiences and purposes incorporating accurate and sequenced content and multimodal elements (VCELY338)

Practical Investigation: Modelling a diver falling into water

Purpose

To analyse the motion of a model diver in terms of:

- Kinematic quantities: position, time, speed, acceleration
- Dynamic quantities: forces applied, energy transfers, momentum transfers.

Introduction

A diver falling towards water should accelerate uniformly until entry, where the force applied by the water slows the diver. It is possible for the diver to reach terminal velocity

in the water. The diver will be modelled by a falling piece of mouldable clay. Water can be used directly or modelled as a fluid such as corn syrup.

Possible variables

In any kinematic or dynamic analysis of motion, mass, length and time are fundamental. Rates of change depend on time measurements. Change in position depends on length measurements. Change of velocity depends on change in position. Acceleration depends on the rate of change of velocity, hence the rate of the rate of change of position. Force depends on acceleration and mass.

The force applied by the water on impact may depend on the mass of the object, its shape (how do you quantify “shape?”), the speed with which it strikes the water and water temperature.

Suggested equipment

- 2-3 sticks of mouldable clay or small metal balls
- column of fluid, such as a 1.5 m length of PVC pipe (at least 90 mm diameter), watertight at one end, or long measuring cylinder filled with corn syrup
- retort stand and clamps
- motion measuring equipment such as mobile phone app, electronic datalogger or ticker timer and tape

Planning

Identify the data tables you will need in order to record:

- primary data
- derived data

Suggested Procedure

- Make sure you can use the measuring system correctly.
- Physically set up, trial and modify the equipment so as to collect accurate and precise data,
- Identify the elements of your model situation.
- Identify two independent variables and one dependent variable you will investigate

Communication

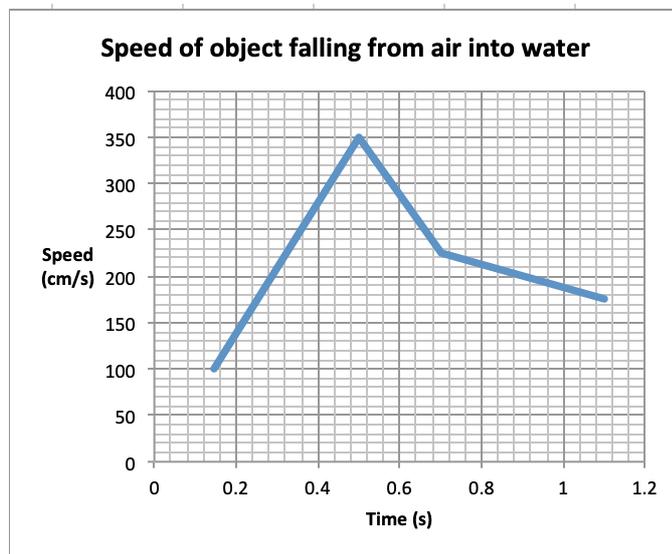
Write a textbook section to show your understanding of the way the experiment illustrates the relevant physics: Newton’s three laws; Work-energy; Impulse-momentum

Response

What do you expect to see in the student response?

- Identify two independent variables and one dependent variable for consideration
- Identify the data tables and graphs that should be used
- Identify the diagrams and/or photos needed to illustrate the details of the experiment.

Writing example:



- Use all three of Newton's Laws to explain, qualitatively and quantitatively, what is happening when the diver (a) falls towards the water (b) enters the water (c) falls through the water.

Practical Investigation: Diving into water

Task

Write a textbook-style article that demonstrates understanding of both the practical investigation and the Newtonian model of motion.

- The article should be written so that a Year 11 student can understand how Newtonian dynamics applies to the investigation including: Newton's three laws of motion; work-energy; impulse-momentum
- The article should include a description of the design of the experiment and the way it was conducted.

Relevant material should include:

- diagrams and/or photos - annotated
- data tables – properly constructed
- graphs – properly constructed and including uncertainty bars.
- mathematical relationships, which link the variables under investigation
- Provide a conclusion that shows the main finding of the investigation.
- Comment on the validity and reliability of results and how the experiment might be improved.

Assessment criteria

Independently³ undertakes a systematic and comprehensive approach to the investigation of motion and related energy transformations.

- Formulates and justifies an appropriate investigation
- Identifies relevant variables
- Explains constraints in the experimental design.

logbook/5

Independently conducts experimental procedures, demonstrating a systematic and comprehensive approach.

- Systematically collects data which is relevant to the question under investigation.
- Suggests insightful refinements to investigative procedures and experimental design for the purpose of making reliable and accurate data.
- Clearly and accurately records insightful and detailed observations.
- Applies safe work practices independently and responsibly.

³ "Independently" means that you have gained mastery of your work. Independent researchers consult widely with teacher, colleagues, texts etc. All assistance and references should be acknowledged.

logbook/5

Maintains a logbook (hardcopy) detailing the work undertaken at the time it was undertaken.

- Keeps clear notes on all experimental procedures and other activity associated with the investigation
- Provides a visual record (annotated diagrams and/or photographs – videos should be uploaded to a website and URL noted in the logbook)
- Keeps data in appropriately constructed data tables and/or spreadsheets –spreadsheets should be printed, dated and attached securely to the logbook).
- Produces appropriate graphs, which are attached securely to the logbook.

logbook/5

Describes and explains qualitative and quantitative concepts using appropriate and correct scientific language and conventions consistently.

- Demonstrates a sophisticated level of understanding of the Newtonian model and concepts related to motion including: Force and Newton’s three laws; Work-Energy transfers and transformations; Momentum transfers

article/10

Analyses data accurately and fully.

- Presents all data appropriately and correctly in a variety of formats to represent experimental data.
- Identifies experimental uncertainties and errors and evaluates them in terms of reliability and accuracy.
- Estimates uncertainties in data and derived quantities correctly.

article/10

Communicates valid conclusions, relating data to hypotheses, and takes into account sources of error and uncertainty and limitations of experimental design.

- Makes cause–effect judgments and offers explanations to link information.
- Demonstrates an insightful understanding of the investigation.
- Provides appropriate acknowledgments.

article/10

Authentication

An oral discussion based on the logbook record may be undertaken to ensure the authenticity

A+	A	B+	B	C+	C	D+	D	E+	E
45-36		35-31		30-26		25-21		20-16	