SCIENCE

COURSE FRAMEWORK

B S S S
AUSTRALIAN CAPITAL TERRITORY

INTRODUCTION

All programs of study for the ACT Year 12 Certificate should enable students to become

- creative and critical thinkers
- enterprising problem-solvers
- skilled and empathetic communicators
- informed and ethical decision-makers
- environmentally and culturally aware citizens
- confident and capable users of technologies
- independent and self-managing learners
- collaborative team members

and provide students with

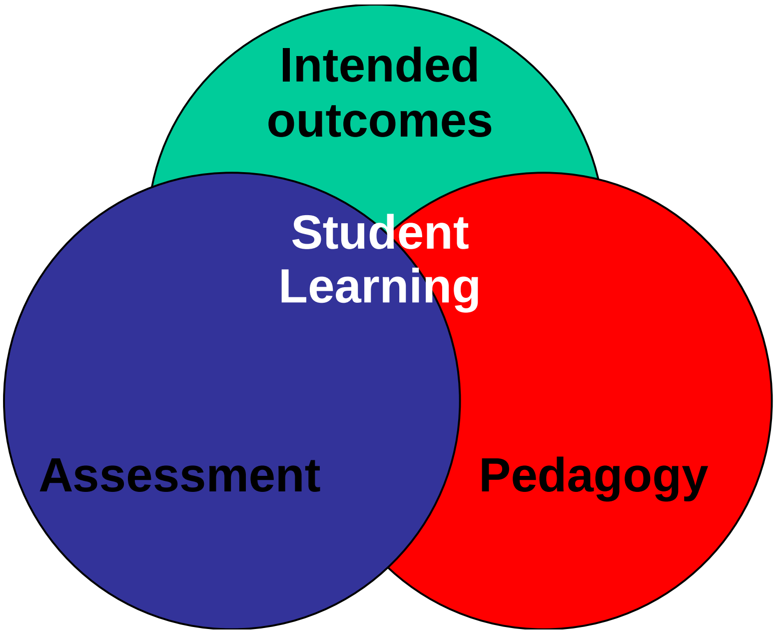
- a comprehensive body of specific knowledge, principles and concepts
- a basis for self-directed and lifelong learning
- personal attributes enabling effective participation in society.

Examples of these student capabilities are provided at Appendix A.

COURSE FRAMEWORKS

Course Frameworks provide the essential basis for the development and accreditation of any course within a broad subject area and provide a common basis for the assessment, moderation and reporting of student outcomes in courses based on the Framework.

Course Frameworks support a model of learning that integrates intended student outcomes, pedagogy and assessment. This model is underpinned by a set of beliefs and a set of learning principles.



Underpinning beliefs

- All students are able to learn.
- Learning is a partnership between students and teachers.
- Teachers are responsible for advancing student learning.

Learning principles

1. Learning builds on existing knowledge, understandings and skills.
   (Prior knowledge)
2. When learning is organised around major concepts, principles and significant real world issues, within and across disciplines, it helps students make connections and build knowledge structures.
   (Deep knowledge and connectedness)
3. Learning is facilitated when students actively monitor their own learning and consciously develop ways of organising and applying knowledge within and across contexts.
   (Metacognition)
4. Learners' sense of self and motivation to learn affect learning.
   (Self-concept)
5. Learning needs to take place in a context of high expectations.
   (High expectations)
6. Learners learn in different ways and at different rates.
   (Individual differences)
7. Different cultural environments, including the use of language, shape learners' understandings and the way they learn.
   (Socio-cultural effects)
8. Learning is a social and collaborative function as well as an individual one.
   (Collaborative learning)

9. Learning is strengthened when learning outcomes and criteria for judging learning are made explicit and when students receive frequent feedback on their progress. *(Explicit expectations and feedback)*

THE SCIENCE FRAMEWORK

This Science Course Framework replaces Course Frameworks in Agriculture, Biology, Chemistry, Earth Science, Electrotechnology, General Science and Physics.

The reason for having one Science Course Framework is to strengthen the concept of scientific literacy across all science disciplines and to support more consistent teaching and assessment in senior secondary science.

This Framework emphasises processes rather than content, in order for all students to develop skills in and deep understanding of science. The responsibility for the development of content lies more appropriately with course writers. The Science Course Framework is the basis for course development in the traditional science disciplines and also provides opportunities for colleges to develop innovative courses in science that cross traditional discipline boundaries. Courses should provide all students with the opportunity to study science relevant to their lives and futures.

RATIONALE

There is an innate human curiosity about and wish to understand the universe. The study of science encourages and enables students to develop complex and sophisticated understanding of the universe through observation, questioning, experimentation, discussion, critical analysis and creative thinking.

In a technologically based society, scientific literacy for all citizens is of paramount importance. The Program for International Student Assessment (PISA) defines scientific literacy as “the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand the natural world and the changes made to it through human history.” (*OECD: the 2003 PISA Assessment Framework*). Scientifically literate individuals contribute to the quality of their own lives and to society through informed decision-making.

Scientific processes challenge current understanding and are continually re-evaluated. Students are constantly encouraged, through their study of science, to examine and reconsider their understanding of scientific concepts and their interrelationships, of scientific inquiry methods and therefore of their world more generally. Science courses also help students understand and apply their learning in other subjects, in a scientific way.

The essence of science involves social, cultural, critical and aesthetic perspectives. An appreciation of the aesthetic qualities and understanding of the universe strengthens students’ curiosity and sense of wonder. The study of science equips students to be independent thinkers and life-long learners.

GOALS

Course Framework Goals focus on the essential things that students should know and be able to do as a result of studying any course in this subject area. They are **intended student outcomes**.

The goal of all science courses is the development of scientific literacy.

Therefore all courses based on this Course Framework should enable students to:

- demonstrate depth and breadth of scientific knowledge
- apply knowledge and understanding to solve problems in familiar and unfamiliar contexts
- critically research, analyse, evaluate and synthesise information from a variety of sources, including their own work and the work of their peers
- develop hypotheses and design, carry out and as necessary modify experiments
- follow instructions and make accurate and precise observations while conducting practical investigations, while safely using appropriate equipment and techniques
- communicate scientific information to diverse audiences in an appropriate manner using a variety of media and technologies
- appreciate the role and implications of science in the wider community – environmental, social, political and economic
- work independently and collaboratively.

GUIDE TO THE SELECTION OF CONTENT

Courses developed under this Framework will provide details of course content through the component units of the course.

Appendix B provides advice on content for chemistry, physics and the life sciences, as these are taught in all colleges.

Appendix C provides an indicative list of other science courses and units that are currently taught and/or may be developed in colleges.

Content of vocational programs will be determined by the requirements of the relevant Training Package.

While the content will differ according to the particular science discipline (or cross-disciplinary course) and the course classification (A, T or M, including vocational programs), all content will be chosen to address the essential concepts and skills of science (as outlined below) and enable students to work towards the achievement of the common and agreed goals of the Framework.

Essential concepts and skills

Scientific literacy and scientific method underpin the concepts and skills in all science courses.

All students should come to understand that:

- Science is a philosophy
  - Science is a way of knowing and describing the universe in a way we can understand. Science is a way of organising uncertainty. Scientists test their understanding of the universe through application of the scientific method to particular problems.
- Knowledge is provisional
  - Current understandings, some of which are accepted as "facts", need to be tested and will change as new information becomes available and theories are developed.
- Science is a community
  - Scientists do not work in isolation. They are accountable to the scientific and wider community. Scientists work across disciplines and across national borders.
- Science is relevant to contemporary society
  - New technologies arising out of scientific pursuit have ethical and social implications. Scientific understanding and processes can help find solutions to current cutting edge issues and challenges.

The essential skills developed in all science courses are those of the scientific method:

- observing
- predicting
- formulating hypotheses
- identifying variables and data
- designing/planning investigations
- handling materials and equipment
- collecting data/information
- recording data/information
- evaluating data and the validity of processes and results
- analysing and synthesising, including appropriate mathematical techniques
- drawing conclusions
- communicating findings.

Vocational Courses

Colleges with Registered Training Organization status (RTO) are eligible to deliver units of competence from Training Packages, or alternatively, they may develop vocational courses, classified as A or T, based on the Training Packages and consistent with the goals of this Framework.

Training Packages relevant to science are currently Laboratory Operations, Electrotechnology and Viticulture.

PEDAGOGY

Teaching strategies

As Science is an investigative endeavour, teaching strategies should reflect this philosophy as a way of knowing. "(Scientific) processes are mental - and sometimes physical - actions used in conceiving, obtaining interpreting and using evidence or data to gain knowledge or understanding." (*OECD: the 2003 PISA Assessment Framework*)

Teaching strategies that are particularly relevant and effective in Science include:

- practical / field work / excursions
- inquiry-based learning
- collaborative learning
- open-ended investigations
- visiting scientists
- modelling
- use of information and communication technologies (ICT), including data loggers, CD ROMs, Videos and the Internet
- peer tutoring / student presentations / student as teacher
- integration of teacher-student and student-student feedback
- teacher instruction – lectures, discussions, skills instruction
- teacher demonstrations
- student reflection on their learning.

These strategies are consistent with the Learning Principles (see introduction).

ASSESSMENT

The purpose of including assessment task types (with examples of tasks) and assessment criteria in Course Frameworks is to provide a common and agreed basis for the collection of evidence of student achievement. This collection of evidence enables a comparison of achievement within and across colleges, through moderation processes. This enables valid, fair and equitable reporting of student achievement on the Year 12 Certificate.

Assessment tasks elicit responses that demonstrate the degree to which students have achieved the goals of a unit (and the course as a whole).

Assessment Task Types (with **weightings**) group assessment tasks in ways that reflect agreed shared practice in the subject area and facilitate the comparison of student work across different assessment tasks.

Assessment Criteria (the qualities that teachers look for in evaluating student work) provide a common and agreed basis for judgement of performance against unit and course goals, within and across colleges. Over a course, teachers use all of these criteria to assess students' performance, but do not necessarily use all criteria on each task. Assessment criteria are to be used holistically on a given task and in determining the unit grade.

Assessment Rubrics draw on the general course framework criteria to develop assessment criteria for a task type and a continuum which indicates levels of student performance against each criterion.

Assessment Task Types

Tasks Types	**Student Investigations**	**Tests**
The following examples are a guide only	*Log book* *Prac Report* *Scientific Poster* *Research Assignment* *Seminar /Oral/Electronic presentations* *Project* *Essay* *Models*	*Unit tests* *Practical skills test* *Quizzes*
Weighting (most units)	*40 – 60%*	*40 – 60%*
Weighting (project based units)	*60 – 100%*	*0 – 40%*

Additional Assessment Advice

A variety of task types and modes of presentations should be used during the course. The range of assessment items needs to draw on all levels and facets of thinking. Resources to support assessment practice include the revised Bloom's Taxonomy ('remember, understand, apply, analyse, evaluate and create') and Wiggins & McTighe *Facets of Understanding* ('explanation, interpretation, application, perspective, empathy and self-knowledge'). See bibliography.

The ACT Board of Senior Secondary Studies recommends 4-6 summative assessment tasks across a full semester unit and 2- 3 assessment tasks for a .5 unit. These should not be a compilation of a number of small discrete tasks (eg mini-tests) as these detract from assessing depth of knowledge and skill.

It is recommended that an extended investigation be undertaken at least once during a minor and twice during a major as this provides evidence of the depth of student learning. An extended investigation may either be theoretical or practical or a combination of both. The investigation should be open-ended (that is, the outcomes are not pre-determined) and should be undertaken over a period of time.

Assessment Criteria

Students will be assessed on the degree to which they demonstrate:

- knowledge and understanding
- critical thinking
- investigative skills
- communication skills

- effective work practices.

Assessment Rubrics

A generic rubric is provided at Appendix D, with an example of how the generic rubric may be adapted for Practical Experiments.

Relating Assessment Task Types And Assessment Criteria To The Course Framework Goals

The following table shows the relationships between the goals, the assessment task types (the evidence) and the most relevant assessment criteria (the basis for judging the evidence).

GOALS	ASSESSMENT TASK TYPES	ASSESSMENT CRITERIA
• demonstrate depth and breadth of scientific knowledge	Student investigations Tests	• Knowledge and understanding
• apply knowledge and understanding to solve problems in familiar and unfamiliar contexts	Student investigations Tests	• Knowledge and understanding
• critically research, analyse, evaluate and synthesise information from a variety of sources, including their own work and the work of their peers	Student investigations Tests	• Knowledge and understanding • Critical thinking • Investigative skills
• develop hypotheses and design, carry out and as necessary modify experiments	Student investigations	• Investigative skills • Critical thinking • Effective work practices
• communicate using a variety of media and technology in a scientific manner to diverse audiences at appropriate levels	Student investigations Tests	• Communication skills
• follow instructions and make accurate and precise observations in conducting practical investigations safely, using appropriate equipment and techniques	Student investigations Tests (Practical skills test)	• Investigative skills • Effective work practices
• appreciate the role and implications of science in the wider community – environmental, social, political and economic	Student investigations Tests	• Knowledge and understanding • Critical thinking
• work independently and collaboratively	Student investigations	• Effective work practices

ACHIEVEMENT STANDARDS

Grade descriptors provide a guide for teacher judgement of students' achievement, based on the assessment criteria, over a unit of work in this subject. Grades are organized on an A-E basis and represent standards of achievement.

Grades are awarded on the proviso that the assessment requirements have been met. Teachers will consider, when allocating grades, the degree to which students demonstrate their ability to complete and submit tasks within a specified time frame.

The following descriptors are consistent with the **system grade descriptors** which describe generic standards of student achievement across all courses.

All students, regardless of **A or T course** enrolment, have the goal of improving their learning and should all strive to achieve higher order thinking and investigative skills. Both **A and T courses** should extend students in all aspects of their learning.

In interpreting the following grade descriptors for A and T courses, the key differences to consider are the context of the course, the depth of understanding and application of concepts and the weighting of assessment tasks.

A and T courses

Grade	Descriptors
A student who achieves the grade **A** typically	**Knowledge and understanding:** • demonstrates broad knowledge and deep understanding of scientific concepts presented. Applies this knowledge to familiar and unfamiliar contexts, displaying originality and lateral thinking in problem solving **Critical thinking:** • describes patterns and trends in data observations and makes valid inferences. Discriminates between ideas by assessing the value of the scientific evidence presented **Investigative skills:** • plans and performs scientific investigations with skill and initiative. Selects and uses appropriate resources and equipment efficiently and in a safe and correct manner. Displays an ability to collect data and assess its validity and accuracy **Communication:** • collects information, organises it logically and presents data in a range of forms to reveal patterns and relationships. Presents complex ideas and information clearly by the appropriate use of scientific terminology. Uses language appropriate to various audiences **Work practices:** • organises time and resources to work in a productive manner independently and in a team environment. Facilitates effective outcomes in other team members
A student who achieves the grade **B** typically	**Knowledge and understanding:** • demonstrates sound knowledge and understanding of scientific concepts presented and applies this knowledge in familiar and unfamiliar contexts to solve problems **Critical thinking:** • describes patterns and trends in data observations and can make some valid inferences. Compares the validity of ideas by assessing the value of the scientific evidence presented **Investigative skills:** • plans and performs scientific investigations. Selects and uses appropriate resources and equipment in a safe and correct manner. Displays an ability to collect data and assess its validity **Communication:** • collects information, organises it and presents data in a range of forms to reveal patterns. Can present ideas and information clearly by the use of scientific terminology. Can use language appropriate to various audiences **Work practices:** • works in a productive manner independently and in a team environment
A student who achieves the grade **C**	**Knowledge and understanding:** • demonstrates knowledge of scientific concepts presented and applies this to familiar contexts to solve problems

typically	**Critical thinking:** • describes trends in data observations and can make inferences. Compares the validity of ideas with assistance **Investigative skills:** • demonstrates an ability to perform scientific investigations. Can plan investigations with guidance. Uses appropriate resources and equipment in a safe and correct manner. Displays an ability to collect data **Communication:** • collects information, organises it and presents data effectively in some forms. Can present ideas and information by the use of scientific terminology **Work practices:** • works in a productive manner independently and in a team environment, with assistance
A student who achieves the grade **D** typically	**Knowledge and understanding:** • demonstrates knowledge of some scientific concepts presented and applies this to familiar contexts with assistance **Critical thinking:** • recognises trends in data observations and makes inferences with assistance **Investigative skills:** • demonstrates an ability to perform scientific investigation with assistance. Uses equipment in a safe and correct manner under supervision. Displays an ability to collect data **Communication:** • collects information and presents data in some forms with assistance. Can present ideas and information by the use of simple scientific terminology **Work practices:** • works in a productive manner on guided tasks with assistance
A student who achieves the grade **E** typically	**Knowledge and understanding:** • can recall some scientific concepts with assistance **Critical thinking:** • recognises trends in data observations with assistance **Investigative skills:** • can perform guided tasks with assistance. Uses equipment under supervision to collect data **Communication:** • collects information and presents data with guidance and assistance **Work practices:** • can work on guided tasks with direction

MODERATION

Moderation is a system designed and implemented to:

- provide comparability in the system of school-based assessment
- form the basis for valid and reliable assessment in senior secondary schools
- involve the ACT Board of Senior Secondary Studies and colleges in cooperation and partnership
- maintain the quality of school-based assessment and the credibility, validity and acceptability of Board certificates.

Moderation commences within individual colleges. Teachers develop assessment programs and instruments, apply assessment criteria, and allocate Unit Grades, according to the relevant Course Framework. Teachers within course teaching groups conduct consensus discussions to moderate marking or grading of individual assessment instruments and unit grade decisions.

The Moderation Model

Moderation within the ACT encompasses structured, consensus-based peer review of Unit Grades for all accredited courses, as well as statistical moderation of course scores, including small group procedures, for T courses.

Moderation by Structured, Consensus-based Peer Review

Review is a subcategory of moderation, comprising the review of standards and the validation of Unit Grades. In the review process, Unit Grades, determined for Year 11 and Year 12 student assessment portfolios that have been assessed in schools by teachers under accredited courses, are moderated by peer review against system wide criteria and standards. This is done by matching student performance with the criteria and standards outlined in the unit grade descriptors as stated in the Course Framework. Advice is then given to colleges to assist teachers with, and/or reassure them on, their judgments.

Preparation for Structured, Consensus-based Peer Review

Each year, teachers teaching a Year 11 class are asked to retain originals or copies of student work completed in Semester 2. Similarly, teachers teaching a Year 12 class should retain originals or copies of student work completed in Semester 1. Assessment and other documentation required by the Office of the Board of Senior Secondary Studies should also be kept. Year 11 work from Semester 2 of the previous year is presented for review at Moderation Day 1 in March, and Year 12 work from Semester 1 is presented for review at Moderation Day 2 in August.

In the lead up to Moderation Day, a College Course Presentation (comprised of a document folder and a set of student portfolios) is prepared for each A and T course offered by the school, and is sent in to the Office of the Board of Senior Secondary Studies.

The College Course Presentation

The package of materials (College Course Presentation) presented by a college for review on moderation days in each course area will comprise the following:

- a folder containing supporting documentation as requested by the Board Secretariat through memoranda to colleges
- a set of student portfolios containing marked and/or graded written and non-written assessment responses and completed criteria and standards feedback forms. Evidence of all assessment responses on which the unit grade decision has been made is to be included in the student review portfolios.

Specific requirements for subject areas and types of evidence to be presented for each moderation day will be outlined by the Board Secretariat through memoranda and Information Papers.

BIBLIOGRAPHY

References for Curriculum Development

Key documents for course development are:

BSSS, *Guidelines for the Development and Accreditation of A, T and M Courses* (current edition)

http://www.decs.act.gov.au/bsss/publicat.htm

The BSSS website also provides the following links:

BSSS Course Frameworks
http://www.decs.act.gov.au/bsss/frameworks.htm

Other state and territory sites and related information
http://www.decs.act.gov.au/bsss/sites.htm

Course Developers should refer to the *National Consistency in Curriculum Outcomes* project for science (due for completion late 2005).

Other useful background references for curriculum development in science are:

OECD Programme for International Student Assessment (Science)
www.pisa.oecd.org/

University of York Science Education Group, Nuffield Curriculum Centre, *21st century Science project*
http://www.21stcenturyscience.org/home/index.asp

Champagne, A. et al, 2004, *NAEP Science Issues Paper Panel*, National Assessment of Educational Progress
www.edgateway.net/naep/shareddocs/ ISSUESPAPERFINAL_112204.htm

Teacher References in Science

Detailed lists of texts and resources are best provided in specific courses rather than in the Course Framework.

However, the following books and websites are considered useful for teaching generally and to support improved science curriculum, teaching and assessment.

ACT Government 2004, *Teachers: the key to student success, a discussion paper for ACT Government Schools*
http://www.decs.act.gov.au/publicat/pdf/teaching_excellence_paper.pdf

Anderson, L & Krathwohl D (eds) 2001, *A Taxonomy for Learning, Teaching and Assessing: a revision of Bloom's Taxonomy*, Longman, New York

Assessment in Science
http://directory.google.com/Top/Science/Educational_Resources/Assessment/

Australian Science Teachers Association
http://www.asta.edu.au/home

Frangenheim, E 1998, *Reflections on Classroom Thinking Strategies*, Robin Educational Consulting, Princeton

Inquiry models
http://www.education.tas.gov.au/ltag/effeccttteach/planning/planning.htm
http://books.nap.edu/html/inquiry_addendum/ch2.html

National Science Standards Committee, Australian Science Teachers Association Inc. 2002, *National professional standards for highly accomplished teachers of science*

National Science Teachers Association (US)
http://www.nsta.org/

Science teaching standards (US)
http://www.nbpts.org/

The Standards Site (UK)
http://www.standards.dfes.gov.uk/keystage3/subjects/science/

Wiggins, G & McTighe, J 1998, *Understanding by Design*, Association for Supervision and Curriculum Development, Alexandra

Note: all web links were accurate as at July 2005.

COURSE FRAMEWORK DEVELOPMENT GROUP

Name	**College**
Lynne Bean	Dickson College
Anne Brown	Canberra Institute of Technology
Jef Byrne	Canberra College
Joel Cowey	Lake Tuggeranong College
Alex Cozadinos	Trinity Christian School
Brian Filby	Erindale College
Penny George	Hawker College
Lis Haakonssen	Copland College
Troy Hayduk	Marist College
Margaret Locke	Narrabundah College
Joy McArthur	Canberra Girls' Grammar School
Frank Pereira	St Edmunds' College
Vivan Sabbagh	St Clare's College
Inderpal Singh (Fiona Buining)	Daramalan College
Andrew Westerman	Merici College

The group gratefully acknowledges the work of previous groups who developed and revised Course Frameworks in Agriculture, Biology, Chemistry, Earth Science, Electrotechnology, General Science and Physics.

APPENDIX A

All programs of study for the ACT Year 12 Certificate should enable students to become:

	The examples are indicative and not exhaustive. Those in **bold** relate particularly to the Employability Skills; those in *italics* to the Across Curriculum Perspectives.
• creative and critical thinkers	exploring, imagining, observing, predicting**, thinking laterally**, **generating ideas**, **inquiring and researching**, interrogating, conceptualising, collecting and **analysing data and information**, **classifying**, interpreting, formulating hypotheses, generalising, synthesising, **reflecting**, justifying conclusions, understanding different perspectives, **understanding and application of different thinking strategies, understanding of scientific and mathematical language**, **using scientific and mathematical techniques** (eg estimating, reading and interpreting data, interpolation and extrapolation)
• enterprising problem-solvers	showing **initiative**, **resourcefulness**, resilience, persistence, assessing and taking risks, **recognising and seizing opportunities**, **problem-posing**, **problem-identification**, **problem clarification**, being practical, **being innovative**, using mathematical techniques, **using appropriate technologies**, **working independently** and/or **collaboratively** to achieve a solution, testing assumptions and solutions, modifying approaches
• skilled and empathetic communicators	**oral and written skills in Standard Australian English**, **matching communication to audience and purpose**, using terminology and style appropriate to particular disciplines, **using mathematical language**, creating and **communicating meaning** using multi-modal forms, **imagining the feelings and views of others**, respecting and valuing diversity
• informed and ethical decision-makers	**finding information** and using evidence as the basis for judgements and decisions, **developing awareness of differing perspectives**, having integrity, taking action, **exploring and critically reflecting on own values, attitudes and beliefs**
• environmentally and culturally aware citizens	understanding *the interconnectedness of the natural and constructed world*; the *multicultural nature of Australian society*; *Indigenous perspectives*; and global economic, social and *environmental* issues; *respecting difference*, exercising rights and responsibilities, **acting in the public sphere**, understanding consequences of choices and decisions
• confident and capable users of technologies	**having a range of IT skills**, accessing and evaluating *information*, **designing** and making, **communicating using technologies**, **choosing most appropriate technologies for the task**, refining processes, **willingness to learn new skills**

• independent and self-managing learners	eg **understanding self (***including gender***)**, **having personal goals**, **evaluating and monitoring own performance**, **taking responsibility**, flexibility in adapting course of action, **openness to new ideas**, **managing time and resources**, **planning and organising**
• collaborative team members	eg **contributing to group effectiveness**, **building trust**, **capacity to take different roles within a team**, **respecting differing strengths (***including contributions of boys and girls***)**, **skills in negotiation and compromise**, **sustaining commitment to achieve group goals**

and provide students with

• a comprehensive body of specific knowledge, principles and concepts	through subjects, cross-disciplinary courses and/or projects, **work experience**
• a basis for self-directed and lifelong learning	**through understanding and managing self, developing capabilities and modelling an approach ('taking stock, taking steps') that prepares for an social and economic environment of greater individual responsibility**
• personal attributes enabling effective participation in society	**developing social skills** and capabilities for citizenship, **work experience and recognition of outside learning;** through understanding of a globalised knowledge society

APPENDIX B

The following guide is provided to support course writing in the science disciplines of Chemistry, Physics and Life Sciences, which are taught in all ACT colleges.

CHEMISTRY

In addition to the essential concepts and skills outlined in the Framework, all Chemistry major courses should cover:

- Periodicity
- Atomic structure
- Stoichiometry
- Chemical change
- Solubility
- Organic chemistry
- Rates
- Equilibrium
- Bonding and structure
- Types of reactions
- Acids and bases
- Electrochemistry
- Energy.

Minor courses may be structured from a selection of the above.

Course developers are encouraged to include the historical, biological, physical, environmental, analytical and industrial aspects of chemistry.

PHYSICS

In addition to the essential concepts and skills outlined in the Science Course Framework, all Physics major courses should cover:

- Measurement: SI unit system, uncertainty analysis, graphical techniques, instrumentation
- Vectors
- Motion: linear motion, graphical techniques, instrumentation
- Forces: Newton's Laws, gravity, momentum, machines
- Energy: work, kinetic energy, gravitational / elastic potential energy, power, conservation laws.

The following topics are examples of content that may also be included:

- Waves: types, properties, electromagnetic waves, sound
- Non-linear motion eg circular, projectile and simple harmonic motion
- Fields: comparisons and properties of g, E and B fields
- Electricity, magnetism, electromagnetism: electrostatics, current electricity, permanent magnetism, electromagnetic induction

- Electronics: semiconductors, digital, analogue, circuit construction
- Photonics: light, properties and interactions
- Fluids: laminar / turbulent flow, principles – Archimedes / Bernoulli / Pascal, viscosity
- Atomic physics: spectra, structure of the atom, quantum physics, wave-particle duality
- Nuclear physics: scattering, subatomic particles, fission, fusion, nuclear forces
- Heat: kinetic theory, calorimetry, thermodynamics
- Properties of materials: Hooke's Law, Young's Modulus, stress and strain
- Astronomy: solar system, stars, cosmology, space exploration
- History of physics.

Minor courses may be structured from a selection of the above.

LIFE SCIENCES

In addition to the essential concepts and skills outlined in the Science Course Framework all Life Science major courses should cover the following broad areas:

- Interdependence
- Characteristics of life
- Diversity, similarities, evolution and classification
- Adaptations, structure and function
- Human impact

A broad guide to these areas is provided below. Course developers could take a thematic approach that cuts across these broad areas.

- **Interdependence**: the nature of the ecosystem and relationships existing within them.
- **Characteristics of life**: common requirements of organisms; ways in which organisms maintain themselves, reproduce and develop; the survival of organisms in situations of challenge and environmental stress; application of technology to explore, maintain or modify biological functions.
- **Diversity, similarities, evolution and classification**: origin and diversity of life on Earth; need to classify organisms into groups; inheritance; adaptation, speciation and extinction; structure and function of DNA; bio-technology, including genetic engineering, as means of altering the path of evolution.
- **Adaptations, structure and function**: basic structure of plants and animals; specialisation leading to modification; structural characteristics of organisms related to particular functions and to the environment they inhabit.
- **Human impact**: human interactions with the environment; conservation, recycling and pollution: significance in social, economic, technological and personal contexts.

Minor courses may be structured from a selection of the above.

APPENDIX C

In all course writing in science, content choice should be driven by needs of the particular student group, consistent with the Goals and Essential Concepts and Skills of the Science Course Framework. Course writers should note the ACT Board of Senior Secondary Studies definition of a course as a "combination of units with coherence of purpose".

A and T courses and/or units could focus on or include content from the areas of science listed below. It should be noted that this is not a definitive list.

Agriculture

Animal husbandry

Aquatic science

Astronomy

Biotechnology

Climatology

Cosmetics and hair care

Electronics

Electrotechnology

Environmental science

Forensic science

Forestry

Geology

Horticulture

Laboratory skills

Marine biology

Materials science

Meteorology

Mineralogy

Natural disasters

Oceanography

Physiology

Viticulture

The Science Framework supports the development of innovative and relevant science programs that encourage the widest possible participation of students in science education.

APPENDIX D: GENERIC SCIENCE RUBRIC, USING THE UNIT GRADE DESCRIPTORS

This rubric is intended to be modified depending on the assessment task and relevant assessment criteria.

ASSESSMENT CRITERIA	A	B	C	D	E
Knowledge and understanding	Demonstrates broad knowledge and deep understanding of scientific concepts presented. Applies this knowledge to familiar and unfamiliar contexts, displaying originality and lateral thinking in problem solving.	Demonstrates sound knowledge and understanding of scientific concepts presented and applies this knowledge to familiar and unfamiliar contexts to solve problems.	Demonstrates knowledge of scientific concepts presented and applies this to familiar contexts to solve problems.	Demonstrates knowledge of some scientific concepts presented and applies this to familiar contexts with assistance.	Can recall some scientific concepts with assistance.
Critical Thinking	Describes patterns and trends in data observations and makes valid inferences. Discriminates between ideas by assessing the value of the scientific evidence presented.	Describes patterns and trends in data observations and can make some valid inferences. Compares the validity of ideas by assessing the value of the scientific evidence presented.	Describes trends in data observations and can make inferences. Compares the validity of ideas with assistance.	Recognises trends in data observations and makes inferences with assistance.	Recognises trends in data observations with assistance.
Investigative skills	Plans and performs scientific investigations with skill and initiative. Selects and uses appropriate resources and equipment efficiently and in a safe and correct manner. Displays an ability to collect data and assess its validity and accuracy.	Plans and performs scientific investigations. Selects and uses appropriate resources and equipment in a safe and correct manner. Displays an ability to collect data and assess its validity.	Demonstrates an ability to perform scientific investigations. Can plan investigations with guidance. Uses appropriate resources and equipment in a safe and correct manner. Displays an ability to collect data.	Demonstrates an ability to perform scientific investigation with assistance. Uses equipment in a safe and correct manner under supervision. Displays an ability to collect data.	Can perform guided tasks with assistance. Uses equipment under supervision to collect data.

Communication	Collects information, organises it logically and presents data in a range of forms to reveal patterns and relationships. Presents complex ideas and information clearly by the appropriate use of scientific terminology. Uses language appropriate to various audiences.	Collects information, organises it and presents data in a range of forms to reveal patterns. Can present ideas and information clearly by the use of scientific terminology. Can use language appropriate to various audiences.	Collects information, organises it and presents data effectively in some forms. Can present ideas and information by the use of scientific terminology.	Collects information and presents data in some forms with assistance. Can present ideas and information by the use of simple scientific terminology.	Collects information and presents data with guidance and assistance.
Work practices	Organises time and resources to work in a productive manner independently and in a team environment. Facilitates effective outcomes in other team members.	Works in a productive manner independently and in a team environment.	Works in a productive manner independently and in a team environment, with assistance.	Works in a productive manner on guided tasks with assistance.	Can work on guided tasks with direction.

RUBRIC FOR ASSESSING PRACTICAL EXPERIMENT INVESTIGATIVE SKILLS

(based on the generic rubric)

ASSESSMENT CRITERIA	A	B	C	D	E
Critical Thinking	Describes patterns and trends in data observations and makes valid inferences. Discriminates between ideas by assessing the value of the scientific evidence presented.	Describes patterns and trends in data observations and can make some valid inferences. Compares the validity of ideas by assessing the value of the scientific evidence presented.	Describes trends in data observations and can make inferences. Compares the validity of ideas with assistance.	Recognises trends in data observations and makes inferences with assistance.	Recognises trends in data observations with assistance.
Investigative skills	Plans and performs scientific investigations with skill and initiative. Selects and uses appropriate resources and equipment efficiently and in a safe and correct manner. Displays an ability to collect data and assess its validity and accuracy.	Plans and performs scientific investigations. Selects and uses appropriate resources and equipment in a safe and correct manner. Displays an ability to collect data and assess its validity.	Demonstrates an ability to perform scientific investigations. Can plan investigations with guidance. Uses appropriate resources and equipment in a safe and correct manner. Displays an ability to collect data.	Demonstrates an ability to perform scientific investigations with assistance. Uses equipment in a safe and correct manner under supervision. Displays an ability to collect data.	Can perform guided tasks with assistance. Uses equipment under supervision to collect data.
Work practices	Organises time and resources to work in a productive manner independently and in a team environment. Facilitates effective outcomes in other team members.	Works in a productive manner independently and in a team environment.	Works in a productive manner independently and in a team environment, with assistance.	Works in a productive manner on guided tasks with assistance.	Can work on guided tasks with direction.