E408 PHYSICAL SCIENCE (YEAR 12) – 2008-2009

General Aims

One of the overriding purposes of Physical Science is the development of scientific literacy and numeracy. People who are literate and numerate in science are able to use scientific knowledge, processes and skills. In addition, such people will understand the nature of science, including the limitations of the scientific approach. They will also understand the relationship between science and the broader culture.

In order to develop such literacy and numeracy in science,the following aims have been constructed for this subject.

Understanding the physical world

Students should acquire knowledge that will give them a greater awareness and understanding of the physical environment. At the end of the subject, students should be able to demonstrate their competence in:

- recall and comprehension of factual material in the units
- understanding the concepts and conceptual schemes covered in the subject
- using their knowledge and critical appraisal of available information to solve scientific problems and make reasoned judgements.

Understanding science and scientific processes

Students should understand the nature and methods of science. This is reflected in such behaviour as:

- designing and using simple experiments in the laboratory and elsewhere to solve specific problems
- organising and formulating ideas accurately and communicating them to others
- reviewing explanations in the light of new evidence.

Developing attitudes about science and the community

Students should be able to discuss and give examples of the impact of science in relation to technological, societal and economic developments.

As a result of consideration of the significance of science from a technological, social and economic viewpoint, students should be concerned about applications of science in the community.

Teaching – Learning Program

The topics, or objectives within topics, can be taught in any order in keeping with the needs of teachers and students.

The completion of the Year 11 subject in this subject is considered desirable but not essential for the study of the Year 12 subject. Also, a satisfactory prerequisite for the study of the Physical Science Year 12 subject may be Chemistry and/or Physics studied in Year 11.

The subject consists of a core (Materials, Energy and Change), and a number of optional sections. Students should study all the core and at least one optional section, which is to be different to that studied by the student in Year 11.

Each school will decide which option is to be included in the subject offered at the school.

Laboratory requirement

Laboratory work is an essential component of this subject. Opportunities must be provided which allow students to develop the following skills:

- definition of variables
- hypothesising
- manipulation of variables
- measurement in specified units
- making observations
- recording of data and observations
- graphically representing data
- analysis and interpretation of data
- evaluation of experimental techniques
- communication of outcomes orally and in written form
- awareness and practice of laboratory safety procedures.

Laboratory investigations should be used both to introduce new concepts and to reinforce ideas that have been discussed in class. The subject provides students with a wide range of opportunities for experimental work. **However, all students should, as a minimum, do laboratory investigations based upon the objectives in italics, under 'Core Content and Objectives".**

Units and prefixes

Students are required to use the international system (SI) of units when performing calculations involving physical quantities. Formal definitions of units are not examinable. Use of prefixes micro-, milli-, kilo-, mega-, and giga- is expected where appropriate.

Core content and objectives

Materials

Atomic structure and ion formation

Students should be able to:

- describe the model of the atom in terms of a positive nucleus surrounded by a negative electron cloud
- write the symbols and the names of the following elements:

  He, Li, C, N, O, F, Ne, Na, Mg, Al, Si, P, S, Cl, Ar, K, Ca, Cr, Mn, Fe, Co, Ni, Cu, Zn, Br, Ag, I, Ba, Au, Hg, Pb.
- write electron configurations (shells only) of the first twenty elements of the periodic table given their atomic number
- determine, using a periodic table the number of valence electrons in groups I to VIII (A only)

- state that the number of valence electrons in the atom of an element is important in determining the chemical properties of the element
- identify that an outer shell of eight electrons is a stable configuration, as illustrated by the noble gases

- write the symbols and names of the following ions

H^+, Na^+, K^+, Ag^+, Cu^+, Mg^{2+}, Ca^{2+}, Ba^{2+},
Fe^{2+}, Cu^{2+}, Zn^{2+}, Pb^{2+}, Al^{3+}, Fe^{3+}, NH_4^+,
Cl^-, F^-, Br^-, I^-, O^{2-}, S^{2-}, OH^-, NO_2^-,
NO_3^-, HCO_3^-, HSO_4^-, CH_3COO^-,
CO_3^{2-}, SO_4^{2-}, SO_3^{2-}, PO_4^{3-}.

Nature of bonding and chemical formulae

Students should be able to:

- describe ionic bonding as electrostatic attraction between oppositely charged ions in solids
- write formulae for ionic compounds
- describe covalent bonding in terms of electron sharing and the octet rule
- write the formulae and names of simple molecular substances
- classify compounds as ionic or molecular substances
- draw electron dot diagrams to represent simple ionic compounds and simple covalent molecules
- describe metallic bonds in terms of a lattice of positive ions surrounded by delocalised electrons
- describe bond strength in terms of primary bonds (ionic, covalent and metallic) and secondary bonds (Van der Waals forces)
- describe the types of secondary bonds (intermolecular forces): dispersion forces, dipole-dipole forces and hydrogen bonding
- state that the dispersion forces between molecules increase with increasing relative molecular mass.

The polarity of molecules

Students should be able to:

- use the concepts of valence shell electron pair repulsion (VSEPR) to predict the shape of simple molecules
- relate the ability of an element to attract electrons to its position in the periodic table
- explain that bond dipoles are formed by unequal sharing of electrons between elements
- predict whether a simple molecule is polar or non-polar from its shape and the bond dipoles.

Polarity and solubility

Students should be able to:

- explain why polar molecules and ionic substances tend to dissolve in polar solvents
- explain why non-polar molecules usually dissolve in non-polar solvents
- identify polar and non-polar solvents from their structural formulae
- define the terms 'solute' 'solvent' 'soluble', 'solution', 'insoluble', 'solubility'
- describe the process of dissolving of ionic solid and polar molecules in water
- write appropriate equations for ionic solids and polar molecules dissolving in water
- *use the table of solubility rules of selected compounds in water to predict the solubility of a compound*
- *write ionic equations to represent the formation of insoluble salts.*

The types of bonding and the properties of matter

Students should be able to:

- describe the structure of ionic, covalent and metallic solids
- relate the structure of ionic solids, covalent network solids, molecular solids and metallic solids, to their properties (melting point, boiling point, hardness, brittleness and conductivity)
- describe an alloy as a solution of two or more elements at least one of which is a metal
- describe the property changes that occur when a pure metal forms an alloy
- describe the constituents, a major property and use of the alloys brass, bronze, steel, solder, alnico and nichrome.

Carbon-based materials

Students should be able to:

- explain the covalent bonding of carbon-based compounds
- identify alkanes as saturated hydrocarbons which contain only single bonds between the carbon atoms
- identify alkenes and alkynes as unsaturated hydrocarbons which contain a double or triple bond respectively
- draw structural formulae for alkanes, cycloalkanes, alkenes, alkynes and simple aromatic compounds.
- *distinguish between addition and substitution reactions*
- relate the chemical reactivity of alkenes and alkynes to the presence of double and triple covalent bonds respectively
- write equations for the combustion of carbon compounds
- identify the functional groups of alcohols, aldehydes, ketones, alkylhalides, carboxylic acids, esters, ethers and amines
- apply the IUPAC nomenclature system to name simple structures (C_1 – C_8) which contain the above functional groups
- describe the general properties and uses of compounds containing the above functional groups
- draw structural formulae for simple molecules which include the above functional groups
- *write equations for the reaction of carboxylic acids with metals, alkalis, alcohols (preparation of an ester)*
- state the common names of the following better known organic compounds: ethanol, methanol, propanone, ethanoic acid, methanoic acid, 1,2,3-propantriol, ethoxyethane, sodium stearate
- explain in simple terms the preparation of alcohol (by fermentation) and the preparation of soap
- distinguish between soaps and detergents in terms of their general structure
- describe the cleaning action of soaps and detergents
- describe the effects of soaps and detergents on the environment
- describe the difference in solubility of soap and detergent molecules in hard water and relate this to the difference in cleaning action.

The structure and properties of polymers

Students should be able to:

- state examples of natural polymers
- distinguish between thermosets and thermoplastics in terms of their structure
- relate the properties of elastomers to their structure
- state that petroleum products are a major source of raw materials for plastics
- describe the significance of recycling plastics
- state examples of plastics that are significant pollutants
- describe the polymerisation process
- describe the properties and uses of the common polymers: rubber, polythene, polyvinyl chloride, PET and polystyrene.

Change

Chemical reactions and solutions

Students should be able to:

- perform the following types of calculations involving chemical reactions using the mole concept: mole-volume, mass-volume
- perform volume-volume calculations for reactions involving gases only
- define concentrations of solutions in moles per litre
- describe the use of volumetric analysis to determine unknown concentrations
- *perform an acid-base titration to determine an unknown concentration*
- perform calculations involving acid-base titrations (HCI – NaOH only).

Chemical equilibria

Students should be able to:

- define the term 'equilibrium'
- distinguish between static and dynamic equilibria
- explain chemical equilibria as examples of dynamic equilibria
- describe the reversible nature of chemical reactions
- explain chemical equilibria in terms of reversible chemical reactions
- distinguish between endothermic and exothermic reactions
- describe the factors affecting chemical equilibria, i.e. concentration and temperature (and pressure in the case of gaseous species)
- describe Le Ch>telier's Principle
- explain, using Le Ch>telier's Principle, how changes to a chemical equilibrium affect the position of equilibrium
- describe the Haber process (raw materials, reaction conditions and economic importance) as an example of a chemical equilibrium.

Redox reaction

Students should be able to:

- define 'oxidation' and 'reduction' in terms of loss or gain of electrons
- explain that oxidation and reduction occur together
- use oxidation numbers to identify redox reactions
- describe a variety of redox reactions
- identify redox half reactions from a redox equation
- *use redox half reactions to write balanced redox equations (metal/metal ion)*
- calculate the cell emf's associated with redox reactions by using a table of standard reduction potentials
- predict the outcome of a redox reaction using standard reduction potentials
- compare the uses of a number of portable commercial power sources (dry cell, alkaline manganese cell, mercury cell, lead accumulator and fuel cell)
- describe the major factors which cause corrosion and affect the rate of corrosion
- explain corrosion in terms of redox reactions
- describe the redox reactions involved in rusting
- describe the impact and cost of corrosion to the community
- describe methods of preventing corrosion
- *describe the process of electrolysis as an application of redox reactions*
- describe the use of electrolysis in electroplating
- describe the electrolytic production of Al, NaOH and Cl_2 as examples of the use of electrical energy to produce materials which are important to modern industrial societies.

Industrial case study

Students should be able to:

- make a detailed case study of at least one Western Australian chemical industry, with its economic and environmental implications from the following list:
  - nickel extraction and production
  - the production of alumina from bauxite
  - the sea salt chemical industry
  - the production of ammonia
  - sulfuric acid production
  - the titanium beach sand industry
  - phosphate fertiliser production
  - petroleum refining
  - natural gas industry.

Energy

Working and energy transfer

Students should be able to:

- define 'energy', 'force' and 'displacement'
- define 'work' in terms of energy transfer
- perform calculations involving F = ma
- perform calculations involving W = Fs
- describe examples of energy transfers that result in changes of temperature
- define 'gravitational acceleration (g)'
- define 'potential energy (E_p)' and 'kinetic energy (E_k)' of a system
- describe energy changes that occur when a body changes its position in a gravitational field
- perform calculations involving potential energy and kinetic energy

  ($E_p = mgh$, $E_k = \frac{1}{2}mv^2$)
- relate work to changes in potential and kinetic energy

- perform calculations involving change in kinetic energy
  perform calculations relating work to changes in
  $(\Delta E_k = \frac{1}{2}mv^2 - \frac{1}{2}mu^2)$
  potential and kinetic energy
  $(W = \Delta E_p ; W = \Delta E_k)$,
- define 'power' as the rate of working.

$$P = \frac{W}{t}$$

Electrical work and energy transfer

Students should be able to:

- explain energy transfer in electrical systems in terms of work
- explain potential difference, electric current and resistance
- identify the energy changes occurring in common electrical appliances
- *explain the relationship between voltage and electrical current in a current carrying resistor (Ohm's law)*
- perform calculations based on Ohm's law (V = IR)
- *interpret circuit diagrams which contain series and parallel connections (use of voltmeter and ammeter)*
- explain the reasons for use of series and parallel connections
- perform simple calculations of resistance in series and parallel arrangements

$$(R_T = R_1 + R_2 + R_3 + \ldots \text{ and } \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots)$$

- describe electrical power as the rate of energy transfer in an electrical converter
- perform calculations involving electrical power (P = VI)
- perform calculations involving electrical work (W = VIt).

Energy conservation

Students should be able to:

- identify isolated and non-isolated systems
- relate work to temperature changes
- use the law of conservation of energy when describing an energy transfer, i.e. the first law of thermodynamics
- interpret examples which illustrate that energy flows naturally from hot objects to cooler ones, and in the process, can be made to do work
- explain that it is impossible to convert a given quantity of energy fully into work, i.e. some of the energy is always degraded in any energy transfer process
- distinguish between the terms energy conservation, energy degradation and useful energy
- compare the efficiency of energy conversion mechanisms
- perform calculations involving transfer of energy and efficiency
- suggest methods that may be used to minimise energy degradation
- describe a recycling process and explain how it might conserve energy
- outline some social implications of energy use and energy conservation.

Content and objectives of options

Water

The importance of water to humans

Students should be able to:

- list the uses of water
- describe human dependence on water.

The pure liquid – its structure and properties

Students should be able to:

- *list the constituents in water*
- describe the structure of water
- *compare the following physical properties of water with those of other liquids: boiling point, melting point, surface tension, viscosity, solvent characteristics*
- describe the phases of water
- relate the following unique properties of water to its uses and importance to the community: density, specific heat, latent heat.

The water cycle

Students should be able to:

- describe the hydrological cycle in nature
- describe the effect of human activities on the water cycle
- describe, using appropriate terminology, the following types of water pollution: bacterial and viral contamination, organic chemical spills, radioactive contaminations, releases of toxic chemicals, thermal changes, oil spillages and eutrophication
- *describe tests for various water pollutant e.g. turbidity (suspended solids, dissolved solids), pH, bacterial and algae detection, dissolved oxygen content, oil content, and simple tests for chemical content*
- list the organisations involved in the various areas of water management in Western Australia.

Examples of water management problems

Students should be able to:

Drinking water

- describe good quality drinking water
- describe the treatment of drinking water from sources such as dams, confined and unconfined ground water
- describe the water resources in the Perth region.

Washing water

- *define hard water*
- distinguish between temporary and permanent hard water
- describe the cleaning action of soaps and detergents in normal water and hard water
- describe the quality of washing water in terms of hardness
- *describe the following methods of remedying hardness in water: boiling, washing soda, distillation, detergents*

- describe how ion exchange resins remedy water hardness.

Waste disposal by the sewerage system

- define 'sewage'
- describe the sewerage system
- list the phases of sewage treatment in terms of primary, secondary and tertiary treatment and the treatment of sludge
- describe the treatment phases outlined above
- describe the problems associated with sewage disposal.

Desalination

- describe what is meant by desalination
- explain the following desalination methods: distillation processes, membrane processes, ion exchange
- identify the applications and limitations of the desalination processes listed above
- explain the need for developing desalination technology.

Sound and light

Sound and its propagation

Students should be able to:

- describe the wave nature of sound
- identify sources of sound
- explain sound propagation through media
- *measure the speed of sound in air*
- calculate the speed of sound in air

  $(v = f\lambda)$

Reflection, refraction and interference

Students should be able to:

- *describe reflection properties of materials*
- describe the transmission properties of materials
- describe the acoustical properties of materials
- explain the process of reverberation
- describe the relevance of reverberation to building design
- describe refraction
- explain interference
- *explain beats*
- describe stationary waves
- *explain and describe the Doppler effect.*

Quality of sound and music

Students should be able to:

- distinguish between wave patterns of noise and musical sounds
- explain pitch, loudness and quality in a note
- *describe the difference between fundamental and harmonic notes*
- describe wind, string and percussion instruments
- classify instruments into groups: wind, string, percussion
- *describe methods of vibration in different instrument groups*
- describe methods of changing pitch in different instrument groups.

Recording, storing and reproducing sound

Students should be able to:

- explain the principles of operation of the microphone
- explain the operation of a loudspeaker
- explain frequency response of a loudspeaker
- describe sound storage systems such as digital recording, magnetic tape, film soundtrack, disc recording
- describe the significance of sound systems in communications and entertainment.

Noise pollution

Students should be able to:

- describe the characteristics of noise
- name sources and types of noise
- define the 'decibel'
- describe the effects of noise on health
- describe noise problems from road and air traffic
- describe noise problems from industrial and domestic sources
- describe the methods of noise reduction
- describe the need for noise abatement legislation.

The nature of light

Students should be able to:

- describe the particle model of light
- describe the wave model of light
- describe the reflection of light
- describe the refraction of light

Reflection from mirrors

Students should be able to:

- *explain the laws of reflection using ray diagrams*
- *explain the principles of reflection from plane, convex and concave mirrors*
- describe the images produced by these mirrors.

Refraction and lenses

Students should be able to:

- *explain refraction using ray diagrams*
- explain refraction in solids and liquids
- describe the images produced by convex and concave lenses.

A case study of an optical device

Students should be able to describe the historical development, the principle of operation and uses of one optical device such as the telescope, the microscope, the projector, the camera, the laser or spectacles.

Engines and fuels

Types of fuels

Students should be able to:

- define a 'fuel'
- classify fuels as either fossil or non-fossil
- classify coal, coke, charcoal, petrol, fuel oil, kerosene, LPG, CNG and natural gas, as either solid, liquid or gaseous fuels.

Heat values of fuels

Students should be able to:

- define the term 'heat value' as applied to a fuel
- rank the heat values for coal, petrol, fuel oil, kerosene, LPG and natural gas
- *describe a simple laboratory method for determining the heat value of one of the fuels listed above*
- compare the costs of production of the above fuels.

Ignition points and burning

Students should be able to:

- define 'flash point' and 'spontaneous ignition temperature'
- state that petrol has a lower flash point than kerosene
- *describe the optimum burning conditions for fuels*
- explain the term 'octane rating' as it applies to petrol.

Heat engines and efficiency

Students should be able to:

- describe a heat engine as a device for converting heat energy into mechanical work
- describe the cyclic nature of a heat engine
- define an 'ideal engine'
- describe entropy as a measure of disorder
- describe the efficiency of an ideal engine as

$$\frac{\text{useful energy}}{\text{energy input}} \times \frac{100}{1}$$

- describe the efficiency of an engine in terms of the difference in temperature between the working fluid and the environment
- explain that gases are the working fluids in heat engines.

Engines

Students should be able to:

- compare the operation of petrol and diesel engines in relationship to fuel used, compression values, ignition systems and operating temperature
- relate the uses of the various fluids used as fuels, coolants and lubricants in engines to their properties
- *describe the operation of a two- and four-stroke cycle internal combustion engine*
- describe the operation of a turbine engine
- list the differences between a steam and a gas turbine engine
- explain the advantages of a turbine engine compared to an internal combustion engine
- relate the improvement in the efficiency of engines to developments in technology.

Fuels and the future

Students should be able to:

- describe the history of human use of energy with specific reference to fuels
- list the factors which determine the use of fuels in the community
- identify the major problems associated with the use of existing fuels
- describe examples of major developments in fuel technology; bioconversion methods and the use of hydrogen gas as a portable energy source.

Time Allocation

The subject has been designed to be completed through a structured education program of approximately 110 hours in any suitable contexts and series of learning experiences. Typically the subject will be studied over the period of one school year. For administrative reasons schools wishing to vary this delivery pattern (e.g. over a shorter period or over a longer period up to two school years) are required to notify the Chief Executive Officer of the Curriculum Council.

Subject Completion

Students must complete the school's structured educational and assessment program for a subject in order to be eligible to receive a grade unless there are exceptional and justifiable circumstances. In situations where the school considers that insufficient information has been gathered to justify the award of a grade for the subject, a result of U (for unfinished) should be allocated. The Curriculum Council offers the flexibility for the U to be converted to a grade after the final grades have been submitted. Further details on assessment and grading are provided in Volume I of the Syllabus Manuals.

Resources

Note: The resources in this list were available at the time of printing, but please be aware that their subsequent availability cannot be guaranteed.

No specific textbook is recommended for the subject, so schools are advised to set up a physical science library.

Some recommended books are:

James, M., et al., *Chemical Connections: Materials, Chemicals in Everyday Life*, Jacaranda, Milton, Qld, 1996.

Johnson, K., *Physics for You*, Stanley Thornes, Cheltenham, UK, 1991.

Tuart College resource materials: Materials, Water, Energy, Change.

Examination Details

The examination will consist of one written paper of three hours duration which consists of questions based on the core of the syllabus (85%) and optional units (15%).

Part A: **The core of the subject (85%)**

Section 1: multiple choice questions (20%)

Section 2: short answers and problem solving (55%)

Section 3: comprehension exercise (10%). Students will be presented with a text and will be asked questions about related scientific matters.

Part B: **Optional units (15%).** Candidates should select one optional unit of the syllabus and answer all the questions addressed to that unit.

Resources:

- A protractor, a drawing compass and coloured pencils
- Candidates will need a 2B, B or HB pencil for answering multiple choice questions.

Calculators satisfying the conditions set by the Curriculum Council for this subject, which are listed on the Curriculum Council website:

http://www.curriculum.wa.edu.au/pages/student/calculators.htm

Note: Candidates may use graphics calculators in this examination. However, no question will be set which requires the use of the specific capabilities of a graphics calculator.

Assessment Structure

Assessment structures are an integral part of all Accredited Subjects.

The structure specifies:

1. the components and learning outcomes to be included in assessment
2. weightings to be applied to these components
3. the types of assessment considered appropriate for the subject.

Table 1

Syllabus Content	Weighting percentage
Materials	20-30
Energy	15-25
Change	35-45
Option	10-15

Table 2

Learning Outcomes	Weighting percentage
Cognitive e.g. knowledge, process	80-90
Sensorimotor	10-20

The provisions of Table 2 may be satisfied by following the guidelines detailed in Table 3.

Table 3

Types of Assessment	Weighting percentage
Examinations/tests	75-85
Assignments	5-10
Practical performance	5-10
Practical work	5-10

The assessment program must provide students with the opportunity to demonstrate achievement of the requirements of the subject.

and

Students must complete the requirements of the subject.

Notes on Table 3

The ratio of examination marks to test marks should be about 3:1.

Examinations held later in the subject should be given a larger weighting of the examination component.

Grade-Related Descriptors

Grade-Related Descriptors describe the student performance standards that are used to award grades in this subject. Schools delivering this subject have been provided with a copy of the document. Additional copies may be purchased from the Curriculum Council.