SCIENCE
GCE NORMAL LEVEL
5147 Syllabus T

STRUCTURE OF THE SYLLABUS

The syllabus has been designed on a 'core plus option' basis. The core constitutes 85% of the curriculum load while each of the options constitutes 15%.

The syllabus aims to give students the experience of doing hands-on science and, at the same time, provide a broad educational basis for further training in a technical context. As such, the syllabus provides a wide coverage of basic science knowledge that is relevant to technical courses. Hence, there is a strong bias towards the physical sciences in the syllabus. Throughout the syllabus, the emphasis is on the applications of science and technology in everyday life.

The options illustrate important applications to industrial processes and are chosen to cater for students' different interests and career inclinations. The options also provide opportunities for students to integrate knowledge and skills learnt in the core.

Three Options are available:

(a) Option A Petrochemical Industry and its Impact

(b) Option B Electronics and Communications

(c) Option C Science of Motor Vehicles

Candidates will be expected to study one out of the three Options.

Opportunities for candidates to have hands-on experience of practical work relevant to the syllabus should be built into both the Core and Options.

AIMS

The aims are to:

1. enable students to acquire knowledge and understanding so as to
    - 1.1 be suitably prepared for post-secondary courses;
    - 1.2 become confident citizens in a technological world.
2. enable students to develop abilities and skills that
    - 2.1 will be relevant and useful in the work place and daily life situations;
    - 2.2 encourage problem-solving and use of thinking processes;
    - 2.3 encourage safety consciousness and safe practice;
    - 2.4 encourage effective communication.
3. develop attitudes which
    - 3.1 are relevant to the study of science such as concern for accuracy and precision;

3.2 will enable the students to be responsible and productive citizens;

3.3 enable the students to have life-long learning skills.

4. stimulate

4.1 curiosity, interest, and enjoyment in science;

4.2 care and concern for the environment.

5. promote an awareness of

5.1 the impact of science and technology on society, industry, business, home and leisure;

5.2 the changing and progressive nature of science and technology.

6. promote an awareness of the importance of the use of information technology (I.T.) for communications and as a tool for data collection and analysis of experimental results.

ASSESSMENT OBJECTIVES

A Knowledge with understanding

Students should be able to demonstrate knowledge and understanding in relation to:

1. scientific phenomena, facts, laws, definitions, concepts, theories;

2. scientific vocabulary, terminology and conventions (including symbols, quantities and units);

3. scientific instruments and apparatus including techniques of operation and aspects of safety;

4. scientific quantities and their determinations.

The subject content defines the factual knowledge that candidates may be required to recall and explain. Questions testing those objectives will often begin with one of the following words: define, state, name, describe, explain or outline. (See glossary of terms.)

B Handling and applying information

Students should be able – in words or by using symbolic, graphical and numerical forms of presentation – to:

1. locate, select, organise and present relevant information from a variety of sources;

2. transpose information from one form to another;

3. process numerical and qualitative data;

4. use information to identify patterns, report trends and draw inferences;

5. present reasoned explanations for phenomena, patterns and relationships;

6. make predictions.

These assessment objectives cannot be precisely specified in the subject content because questions testing such skills may be based on information which is unfamiliar to the candidate. In answering such questions, candidates are required to use principles and concepts that are within the syllabus and apply them in a logical, reasoned or deductive manner to a novel situation. Questions testing these objectives will often begin with one of the following words: predict, suggest, calculate or determine.

C Experimental Skills and Investigations

Students should be able to:

1. select and organise techniques, apparatus and materials;

2. take readings accurately;

3. handle experimental data and observations;

4. interpret and evaluate experimental results and suggest improvements to experimental procedures.

Scientific subjects are, by their nature, experimental. It is therefore important that the candidates carry out appropriate practical work to facilitate the learning of this subject and to meet objectives C1–C4 above. A list of suggested practicals is provided.

Measurement

- Measure length, time interval, temperature, volume, mass and weight using the appropriate instruments
- Determine the density of solids

Mechanics

- Determine the average speed of moving objects
- Investigate force, work done and power

Thermal Physics

- Determine melting and boiling points of substances
- Investigate the factors affecting heat transfer

Electricity and Magnetism

- Measure current and potential difference by using ammeters and voltmeters
- Determine the resistance of a circuit component using appropriate instruments

Matter

- Separate mixtures by filtration, evaporation, distillation and simple paper chromatography
- Investigate the properties of acids and alkalis

Health and Diseases

- Carry out microscopy work, e.g. on yeast and yeast dough
- Investigate the effects of anti-microbial agents (e.g. antiseptics, disinfectants) on micro-organisms (e.g. yeasts and other fungi)

Options

(A) Petrochemical Industry and its Impact

- Separate mixtures of miscible liquids
- Investigate the viscosity of various oils (e.g. liquid paraffin, bicycle oil, olive oil, castor oil, glycerine)

(B) Electronics and Communications

- Set up circuits that function like logic gates (AND, OR, NOT, NAND, NOR)
- Assemble and assess the effectiveness of an electrical or electronic device for a chosen purpose (e.g. for burglar alarms, for communications)

(C) Science of Motor Vehicles

- Build a simple d.c. motor and investigate the factors affecting its performance
- Investigate the factors (e.g. mass of car, conditions of the road surface) that affect stopping distance

This is not intended to be an exhaustive list. Reference may be made to the techniques used in these experiments in the theory papers but no detailed description of the experimental procedures will be required.

SCHEME OF ASSESSMENT

There will be two papers.

Paper	Type of Paper	Duration	Marks	Weighting
1	Multiple choice	1 h	40	40%
2	Short-answer or structured	1 h 15 min	60	60%

Paper 1 (1 h, 40 marks),	Paper 1 consists of 40 compulsory multiple choice items of the simple direct choice type, based on the Core.
Paper 2 (1 h 15 min, 60 marks),	Paper 2 consists of two sections. Section A will carry 45 marks and consist of a variable number of compulsory short-answer or structured questions based on the Core. One of the questions is a data response question, requiring candidates to handle experimental data and observations, interpret and evaluate experimental results, and suggest improvements to experimental procedures. Section B will carry 15 marks. There will be one structured question based on each of the Options (3 questions in total). Candidates are required to answer any one question.

Weighting of Assessment Objectives

Papers 1 and 2 (100 marks in total)

A **Knowledge with understanding**, approximately 65% of the marks with approximately one-third allocated to recall.
B **Handling and applying information**, approximately 35% of the marks.

Objectives A and B may be assessed through questions which involve experimental skills and investigations. These questions, when set, are also intended to meet appropriate aspects of objectives C1–C4.

Questions on experimental skills and investigations will normally be set within the bounds of the syllabus. If questions are based on apparatus or topics beyond the syllabus, candidates will not be assessed on knowledge of the apparatus or topics. They will be assessed on knowledge or general skills (e.g. reading of scales, data handling) which are required by the syllabus. Questions may be set requiring the candidates to:

(a) select appropriate experimental techniques;

(b) select and organise apparatus and materials;

(c) draw, complete or label diagrams of apparatus;

(d) record readings from diagrams of apparatus;

(e) read, complete or draw tables of data;

(f) take readings from or plot graphs;

(g) determine a gradient, intercept or intersection on a graph;

(h) interpret or draw conclusions from observations and experimental data;

(i) suggest a needed modification to a step in an experimental data;

(j) recognise or comment on possible sources of error from experimental data;

(k) comment on the safety or suggest safety procedures when using apparatus, materials and techniques.

SYLLABUS CONTENT

Most of the objectives specified below relate to *Knowledge with Understanding*, although some indication has been given as to where the skills of *Handling and Applying Information* may be developed.

CORE SECTION

1. MEASUREMENT

Overview

The study of this topic is based on the key idea that scientific measurement and data collection are the basis of scientific knowledge. The importance of units as representing physical quantities and their use when appropriate should be emphasised.

Content

1.1 Length, volume and time

1.2 Mass, weight and density

Learning Outcomes:

Candidates should be able to:

1.1 Length, volume and time

(a) use the following instruments for measuring lengths: rulers and vernier callipers

(b) use a measuring cylinder to measure volume of liquids/solids

(c) use clocks and stopwatches for measuring time intervals

1.2 Mass, weight and density

(a) state that mass is a measure of the amount of substance in a body and that it differs from weight which is a measure of gravitational force on a mass

(b) use appropriate balances to measure mass and weight

(c) explain what is meant by density

(d) state the density of water and show an appreciation of the differences in densities of solids, liquids and gases

2. MECHANICS

Overview

In order to develop an understanding of the physics of motion, the study of this topic can be within the context of the car. The relationships among distance, speed, acceleration and time are analysed in visual, symbolic, numerical, and graphical modes. A key idea is that of balance in science, e.g. unbalanced forces can produce motion of objects and unbalanced turning moments can produce rotation or toppling. Another key idea is that of order in nature. If energy were not conserved but destroyed, the world would run out of energy. If energy could be created, the world would be accumulating energy, e.g. a car would work without fuel.

Content

2.1 Speed and acceleration

2.2 Forces

2.3 Work, energy and power

Learning Outcomes:

Candidates should be able to:

2.1 Speed and acceleration

(a) explain what is meant by speed and acceleration

(b) identify instances of motion for which there is an acceleration

(c) calculate average speed and acceleration

(d) plot and interpret a distance-time graph

(e) recognise from the shape of a distance-time graph when a body is:

(i) at rest

(ii) moving with constant speed

2.2 Forces

(a) predict and explain the effect of a force on the size and shape of a body

(b) describe the ways in which a force may change the motion of a body

(c) show an understanding of how force is measured by the extension and compression of a spring

(d) describe the effects of friction on the motion of a body

(e) recognise the use of lubricants, ball bearings, rollers and wheels for reducing friction in practical applications

(f) describe the moment of a force in terms of its turning effect and give everyday examples

(g) calculate the moment of a force using the formula:

moment of a force about a point = force x perpendicular distance from the point

(h) make simple calculations involving the principle of moments (with force diagrams given)

2.3 Work, energy and power

(a) relate the work done to the magnitude of a force and the distance moved in the direction of the force and make calculations involving *F x d*

(b) give examples of energy in different forms, its conversions and conservation, and apply the principle of energy conservation to simple systems

(c) relate power to energy transferred and time taken, using appropriate examples and using the equation $P = \frac{E}{t}$ in simple systems

3. THERMAL PHYSICS

Overview

Heat is very important to human life. Heat is everywhere. In this topic, students learn about the effects and applications of heating and cooling matter in everyday life. By learning about heat, students understand that phenomena can be measured and controlled in various ways.

Content

3.1 Measuring temperature

3.2 Thermal properties

3.3 Controlling temperature

3.4 Heat transfer and its consequences

Learning Outcomes:

Candidates should be able to:

3.1 Measuring temperature

(a) show an understanding that temperature is a measure of the degree of hotness or coldness

(b) describe the Celsius temperature scale

(c) describe how a physical property which varies with temperature may be used for the measurement of temperature with reference to the following thermometers: liquid-in-glass, thermocouple and bimetallic

(d) recognise the need for fixed points and identify the fixed points

(e) read different types of thermometers (analogue and digital)

3.2 Thermal properties

(a) describe melting/solidification and boiling/condensation as changes of state without a change in temperature

(b) compare the thermal expansion of solids, liquids and gases of the same volume for the same increase in temperature

(c) explain the following everyday applications and consequences of thermal expansions:

(i) riveting

(ii) gaps in bridges, pavement and MRT lines

(iii) bimetallic strips

3.3 Controlling temperature

(a) state that the function of the thermostat is to control temperature

(b) outline the working principle of the thermostat in a vehicle engine and an electric iron

3.4 Heat transfer and its consequences

(a) explain what is meant by conduction, convection and radiation of heat

(b) give some examples of good and bad conductors of heat

(c) show an understanding that absorption and emission of radiation are affected by:

  (i) temperature

  (ii) nature of the surface (shiny/dull and light/dark)

(d) identify and explain some everyday applications and consequences of conduction, convection and radiation

4. ELECTRICITY AND MAGNETISM

Overview

Electricity is one of the most useful forms of energy but it can be very dangerous if it is not used carefully. In this topic, students learn about circuits and make connections to daily applications, including the cost of electrical energy and the safety of electrical appliances. Students also learn how electricity and magnetism are related.

Content

4.1 Current, electricity and circuits

  4.1.1 Current

  4.1.2 Potential difference

  4.1.3 Resistance

  4.1.4 Circuits

4.2 Practical electric circuitry

4.3 Magnets

4.4 Transformers

4.5 Motors

Learning Outcomes:

Candidates should be able to:

4.1 Current, electricity and circuits

4.1.1 Current

(a) state that current is the rate of flow of charge

(b) measure current using an ammeter

4.1.2 Potential difference

(a) state that a potential difference is required to cause a current flow

(b) measure potential difference using a voltmeter

4.1.3 Resistance

(a) state that resistance = pd/current and use the equation $R = \frac{V}{I}$

(b) show a qualitative understanding of the effect of length and cross-sectional area on the resistance of a metallic conductor

4.1.4 Circuits

(a) label and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), ammeters, voltmeters, fuses, magnetising coils, bells and bulbs

(b) relate the properties of conductors and insulators to their uses in various parts of electrical appliances and circuits

(c) show an understanding that the current at every point in a series circuit is the same

(d) apply the principle that the current from the source is the sum of the currents in the separate branches of a parallel circuit, the current from the source being larger than that in each of the branches

(e) apply the principle that the sum of the potential differences in a series circuit is equal to the potential difference across the whole circuit

(f) calculate the combined resistance of two or more resistors in series

(g) calculate the effective resistance of two resistors in parallel

(h) measure current, potential difference and resistance using a multimeter

4.2 Practical electric circuitry

(a) state some uses of electricity

(b) state the difference between a.c. and d.c., and give examples of sources of a.c. and d.c.

(c) use the equations $P = VI$, $E = VIt$

(d) calculate the cost of electricity in using electrical appliances

(e) state the hazards of:

- (i) damaged insulation
- (ii) overheating of cables (wires of incorrect ratings)
- (iiI) damp conditions
- (iv) poor or loose connections

(f) state the need for the following:

(i) fuses and fuse ratings
(ii) earthing metal case
(iii) double insulation
(iv) circuit breakers

(g) state the meaning of the terms: *live*, *neutral* and *earth*

(h) identify and explain the functions of the wires in a mains plug and wire a mains plug

(i) explain why switches and fuses are necessary in live leads

4.3 Magnets

(a) state the properties of magnets

(b) distinguish between magnetic and non-magnetic materials

(c) state the methods of magnetisation and demagnetisation

(d) distinguish between permanent magnets and electromagnets and give examples of their everyday uses

4.4 Transformers

(a) state the purpose of a basic iron-core transformer (electromagnetic induction is **not** required)

(b) state the differences between step-up and step-down transformers and give everyday examples of their use (including high voltage transmission of electricity)

(c) use the equation $V_p/V_s = N_p/N_s$

(voltage across primary coil / voltage across secondary coil = number of turns in primary coil / number of turns in secondary coil)

4.5 Motors

(a) state that the purpose of a motor is to convert electrical energy to kinetic energy

(b) state the two basic components that make the motor work, namely a magnet and a current carrying coil

(c) state the uses of motors in everyday life

5. MATTER

Overview

In this topic, students become familiar with the basic constituents of matter. They learn about the properties of elements, mixtures and compounds. They become familiar with natural phenomena and everyday technologies that demonstrate chemical change. The basic principles of acid-base chemistry are also studied.

Content

5.1 Atoms and molecules

5.2 Elements, compounds and mixtures

5.3 Chemical change

5.4 Acids, bases and salts

Learning Outcomes:

Candidates should be able to:

5.1 Atoms and molecules

(a) state that an atom consists of a positively charged nucleus surrounded by negatively charged electrons

(b) state that a molecule is made up of two or more atoms bound together and these atoms can be the same or different

5.2 Elements, compounds and mixtures

(a) describe the differences between elements, compounds and mixtures

(b) state the meaning of solute, solvent and solution and their roles in the separation of mixtures

(c) outline techniques for separating the components of the following mixtures:

(i) liquid-liquid
(ii) solid-solid
(iii) liquid-solid

Separation techniques to be covered include:

(i) dissolving
(ii) filtration
(iii) evaporation
(iv) crystallisation
(v) distillation
(vi) paper chromatography

5.3 Chemical change

(a) explain what is meant by the term chemical reaction

(b) give examples of everyday changes that involve chemical reactions, including:

(i) burning
(ii) rusting
(iii) decay of food

(c) state, with reference to practical applications, the chemical reaction that matter undergoes when:

(i) heated, e.g. cooking, making a cake

(ii) exposed to light, e.g. photography

(iii) mixed, e.g. concrete mixing

(iv) an electric current is passed through it, e.g. electroplating

5.4 Acids, bases and salts

(a) describe the physical properties of acids and bases, including taste, effect on litmus paper and effect on Universal Indicator

(b) describe the characteristic properties of acids as in reactions with metals, bases and carbonates

(c) describe the characteristic property of bases as in reaction with acids

(d) explain what is meant by pH indicators

(e) describe neutrality, relative acidity and alkalinity in terms of pH (whole number only), measured using Universal Indicator paper and solution

(f) investigate the pH changes as a result of mixing solutions of different pH

(g) state that neutralisation takes place when an acid reacts with a base and the products are salt and water only

(h) state some applications of neutralisation, e.g. action of toothpaste; action of indigestion tablets, controlling acidity in soil; neutralising industrial wastes

6. Health and Diseases

Overview

The study of this topic is relevant to students' personal well-being. In particular, the sub-topic on Good Heath and Wellness has a strong element of personal perspective/reflection. The learning outcomes on genes and hereditary diseases serve to introduce the concept of genes and inheritance, albeit at a rudimentary level, and present an opportunity for students to discuss ethical issues such as gene therapy. Knowledge of these areas can assist students in making informed choices regarding nutrition, exercise, and other factors that influence how their body functions.

Content

6.1 Good health and wellness

6.2 Transmissible diseases and non-transmissible diseases

Learning Outcomes:

Candidates should be able to:

6.1 Good health and wellness

(a) define good health as a state of physical and mental well-being, dependent on receiving a balanced diet and on appropriate physical and mental activity

(b) show an understanding of the importance of good health, e.g. feeling good, being productive at work

(c) outline how personal lifestyle choices, e.g. balanced diet, daily exercise, stress management, can contribute to a healthy lifestyle

(d) show an understanding that individual lifestyle choices can affect others, e.g. family, community

(e) show an understanding that technology has allowed us to control our wellness, e.g. facilitated reproduction, pharmaceuticals, plastic surgery

(f) show an understanding of the ethical issues that arise from the use of technology in (e)

(g) evaluate information related to health and wellness from the mass media for biases, e.g. glamorisation of smoking in movies, promotion of unrealistic role models in magazines

6.2 Transmissible diseases and non-transmissible diseases

(a) distinguish between signs of a disease, e.g. rash, high temperature, which can be seen or measured, and symptoms, e.g. pain, which can only be described by the patient

(b) distinguish between transmissible and non-transmissible diseases

(c) state the chief signs and symptoms for each of the following transmissible diseases: influenza; severe acute respiratory syndrome (SARS) and dengue fever

(d) state the chief signs and symptoms for each of the following non-transmissible diseases: colon cancer, coronary heart disease and diabetes

(e) list general disease prevention measures such as personal hygiene, healthy lifestyle and regular medical check-ups

(f) state that genes determine many of the characteristics that are passed on from parents to offspring, e.g. physical appearance, personality

(g) state that some diseases are hereditary by nature, i.e. passed through the parents' genes, e.g. thalassemia and sickle cell anaemia

OPTIONS

A PETROCHEMICAL INDUSTRY AND ITS IMPACT

Overview

In this option, students learn about the use of chemistry in industrial and domestic settings, recognising that chemical use is pervasive in modern society. The potential harmful effects of some chemicals on the environment are discussed, and methods to ensure safe use and disposal are identified.

Content

A1 Crude oil

A2 Cracking and reforming

A3 Petrochemicals

A4 Polymers

Learning Outcomes:

Candidates should be able to:

A1 Crude oil

(a) show an understanding that crude oil is a valuable natural resource

(b) state that crude oil is a mixture of mainly hydrocarbons and can be separated into useful fractions by fractional distillation

(c) state the use of the following fractions of crude oil as fuels:

(i) refinery gases as bottled gases
(ii) gasoline (petrol) as fuel for cars
(iii) kerosene as fuel for jet aircraft
(iv) diesel oil as fuel for cars (e.g. taxis in Singapore) and large vehicles

A2 Cracking and reforming

(a) state what is meant by the term *cracking*

[Candidates will **not** be expected to give details of the plant, reaction conditions or names of catalysts]

(b) name ethene and hydrogen as useful products obtained by cracking crude oil fractions

(c) state what is meant by the process *reforming*

(d) explain why cracking and reforming are important processes

A3 Petrochemicals

(a) state what is meant by *petrochemicals*

(b) state the uses of petrochemicals in home and industry for making the following products from ethene such as polythene, polyvinyl chloride (PVC) and polystyrene

(c) state the uses of glycols, esters, alcohols and CFCs in home and industry

(d) state some pollutants formed by the burning of fossil fuels

(e) show an understanding of the following problems caused by the burning of fossil fuels:

(i) the formation of carbon dioxide in large quantities is increasing its proportion in the atmosphere and contributing to the greenhouse effect
(ii) the formation of acidic gases such as sulfur dioxide that contribute to acid rain

A4 Polymers

(a) state the meaning of *polymer* and *polymerisation*

(b) state two typical physical properties for each of the following polymers and give examples of products related to their properties:

(i) Polythene
(ii) Polyvinylchloride (PVC)
(iii) Polystyrene
(iv) Teflon
(v) Acrylics
(vi) Nylon

(c) state the advantages of using polymers compared to other materials

(d) show an understanding of the problems of disposal due to extensive use of non-biodegradable polymers

B ELECTRONICS AND COMMUNICATIONS

Overview

In this option, students learn about the function of various electronic components, investigate electronic decision-making in electronics, and explore the use of electronics in communications. Through the study of these areas, students will have the opportunity to build on knowledge about electricity learnt in the core.

Content

B1 Electronics

B2 Communications

Learning Outcomes:

Candidates should be able to:

B1 Electronics

(a) use the symbols and state the actions of the following in a circuit:
- (i) capacitors
- (ii) diodes
- (iii) transistors
- (iv) input devices: switch, LDR (light), reed switch (magnetism), thermistor (temperature sensor)
- (v) output devices: lamp, LED, buzzer
- (vi) logic gates: AND, OR, NOT, NAND and NOR gates

(b) interpret the resistance value of a resistor given a colour code

(c) state in words and in truth table form the action of the following logic gates: AND, OR, NOT, NAND and NOR

(d) recognise the use of gates as simple, electronic switches

(e) label and state the functions of the electronic components given in the circuit for the following electronic systems:
- (i) burglar alarm
- (ii) heat detector with a relay to operate an alarm bell at higher voltage
- (iii) half-wave rectifying circuits with smoothing

B2 Communications

(a) state the different means of transmitting information: electricity through wire, light through optical fibres and EM waves

(b) state the advantages and disadvantages of transmitting signals by wires, optical fibres and EM waves

(c) compare wired network and wireless network in terms of transmission of signals, e.g. telephone versus cellular phone; local area network (LAN) versus wireless LAN

(d) describe briefly the set-up of a wireless network system and compare it with the wired network system

(e) give everyday examples of different systems that exchange information through the telephone/cable network, e.g. electronic banking via phone, fax and computer networks

C SCIENCE OF MOTOR VEHICLES

Overview

In this option, students learn about the engine system, the exhaust system, the electrical system, and the braking system of a car. Through the study of these systems, students will have the opportunity to build on knowledge about mechanics and electricity learnt in the core. The issue of safe driving conditions is also emphasised.

Content

C1 Starting and running the engine

C2 Combustion and exhaust gases

C3 Charging battery

C4 Brakes and tyres

C5 Safety

Learning Outcomes:

Candidates should be able to:

C1 Starting and running the engine

(a) show, on a block diagram, how the following are functionally connected: ignition system, alternator, starter motor and electrical accessories

(b) state the working principle of a 4-stroke engine

C2 Combustion and exhaust gases

(a) state the main gases produced, i.e. carbon dioxide, carbon monoxide, oxides of nitrogen, when a fuel/air mixture is ignited in the combustion chamber

(b) describe the effects of some exhaust gases on the environment

(c) state the function of catalytic converter

C3 Charging battery

(a) label the main parts of the lead-acid accumulator

(b) state that the accumulator is a device for storing electricity and the energy changes that occur during the charging and the discharging process

(c) show on diagram the electrical connection for charging

C4 Brakes and tyres

(a) relate pressure to force and area, using appropriate examples and the equation $P = \frac{F}{A}$

(b) show an understanding that pressure at a given depth of a liquid at rest acts equally in all directions

(c) show an understanding of the hydraulic system of braking

(d) state how friction is used in the braking of a car with reference to drum and disc brakes, and tyres

(e) show a qualitative understanding of the relationship between stopping distance and the following:

(i) braking force
(ii) speed
(iii) mass of car
(iv) the conditions of the road surface
(v) human reaction time
(vi) condition of tyres

C5 Safety

(a) describe in terms of forces how the following can minimise injuries in a collision:

(i) crumple zone
(ii) use of safety belts/seats
(iii) air bags
(iv) side-impact beam

PHYSICAL QUANTITIES, SYMBOLS AND UNITS

Candidates should show familiarity with the following quantities and their symbols. They should also be able to state the units in which these quantities are measured.

Quantity	**Symbols**	**Units**
length	*l, h* ...	km, m, cm, m
area	*A*	m^2, cm^2
volume	*V*	m^3, dm^3, cm^3
		l, L, m*l*, mL
		(1*l* = 1000 cm^3 = 1 dm^3)
weight	*W*	N
mass	*m, M*	kg, g
		tonne (1 *t* = 1000 kg)
time	*t*	h, min, s
density	ρ, *d*	g/cm^3, kg/m^3
speed	*u, v*	km/h, m/s, cm/s
acceleration	*a*	m/s^2
force	*F, P* ...	N
moment of force		Nm
work done	*W, E*	J, kJ
		kWh
energy	*E*	J, kJ
power	*P*	W, kW
pressure	*p*, *P*	N/m^2, Pa
		millibar (1 mbar = 100 Pa)
temperature	θ , *T*	°C
speed of rotation		rev/min, rev/s
potential difference	*V*	kV, V, mV
voltage	*V*	kV, V, mV
current	*I*	A, mA
resistance	*R*	Ω, kΩ

CHEMICAL NAMES, SYMBOLS AND FORMULAE

Candidates should show familiarity with the following chemical names and chemical symbols/formulae of the following elements and compounds. [NB: They will not be assessed on the symbols/formulae.]

Elements/Compounds	**Chemical Symbols/Formulae**
Hydrogen	H
Oxygen	O
Nitrogen	N
Aluminium	Al
Carbon	C
Chlorine	Cl
Chromium	Cr
Copper	Cu
Iron	Fe
Lead	Pb
Nickel	Ni
Manganese	Mn
Tin	Sn
Hydrochloric acid	HCl
Nitric acid	HNO_3
Sulfuric acid	H_2SO_4
Calcium carbonate	$CaCO_3$
Calcium oxide	CaO
Calcium hydroxide	$Ca(OH)_2$
Potassium hydroxide	KOH
Sodium hydroxide	NaOH
Sodium hydrogencarbonate	$NaHCO_3$
Water	H_2O
Ammonia	NH_3
Carbon dioxide	CO_2
Carbon monoxide	CO
Hydrogen gas	H_2
Oxygen gas	O_2
Nitrogen gas	N_2

NOTES

Students will be expected to be familiar with the nomenclature used in the syllabus. The proposals in "*Signs, Symbols and Systematics*" (The Association for Science Education Companion to 16-19 Science, 2000) and the recommendations on terms, units and symbols in 'Biological Nomenclature (2000)' published by the Institute of Biology, in conjunction with the ASE, will generally be adopted although the traditional names sulfate, sulfite, nitrate, nitrite, sulfurous and nitrous acids will be used in question papers. Sulfur (and all compounds of sulfur) will be spelt with f (not with ph) in question papers, however students can use either spelling in their answers.

Any calculator used must be on the Singapore Examinations and Assessment Board list of approved calculators.