Eswatini General Certificate of Secondary Education

EGCSE

Examinations Council of Eswatini

BIOLOGY SYLLABUS Subject Code : 6884

For Examinations in 2024 - 2026

CONTENTS

ESWATINI GENERAL CERTIFICATE OF SECONDARY EDUCATION

Broad Guidelines

The Ministry of Education and Training is committed, in accordance with the National Policy Statement on Education, to provide a Curriculum and Assessment System so that at the completion of senior secondary education (Form 4 and Form 5), learners will:

- be equipped to meet the changing needs of the Nation, and
- have attained internationally acceptable standards.

Eswatini's National Education Policy Directives

EGCSE syllabuses for studies in Form 4 and Form 5 will individually, and collectively, enable learners to develop **essential skills** and provide a broad **learning experience** which

- inculcates values and attitudes as well as knowledge and understanding,
- encourages respect for human rights and freedom of speech,
- respects the values and beliefs of others, relating to issues of gender, culture and religion,
- develops desirable attitudes and behaviour towards the environment,
- provides insight and understanding of global issues which affect quality of life in Eswatini and elsewhere, e.g., the AIDS pandemic; global warming; maldistribution of wealth; and technological advances.

The National Curriculum for Form 4 and Form 5

Learners will be given opportunities to develop essential skills which will overlap across the entire range of subjects studied. These skills are listed below.

- Communication and language skills
- Numeracy skills: mathematical ideas, techniques and applications
- Problem-solving skills
- Technological awareness and applications
- Critical thinking skills
- Work and study skills
- Independent learning
- Working with others

To develop these skills, learners must be offered five compulsory subjects and at least two elective subjects chosen from one or more Field of Study.

Compulsory Subjects

- SiSwati – either First Language or Second Language
- English Language
- Mathematics
- Science (Biology or Physical Science)
- Religious Education

Fields of Study

- Agriculture Field of Study
- Business Studies Field of Study
- Consumer Science Field of Study
- Social Sciences and Humanities Field of Study
- Technical Field of Study
- Science Field of Study

INTRODUCTION

The Eswatini General Certificate of Secondary Education (EGCSE) syllabuses are designed as two-year courses for examination in Form 5. Biology places considerable emphasis on understanding and use of scientific ideas and principles in a variety of situations, including those which are well-known to the learner and those which are new to them. It is anticipated that programmes of study based on this syllabus will feature a variety of learning experiences designed to enhance the development of skill and comprehension. This approach will focus teachers and learners on development of transferable life-long skills relevant to the increasingly technological environment in which people find themselves. It will also prepare candidates for an assessment that will, within familiar and unfamiliar contexts, test expertise, understanding and insight.

All EGCSE syllabuses follow a general pattern. The main sections are:

Aims

Assessment Objectives

Assessment

Curriculum Content

Biology falls into the Science Compulsory Subjects Group which includes Physical Science. It is also an Elective Subject in the following Field of Study Groups: Agriculture, Consumer Science and Science.

PURPOSE

The EGCSE syllabus prepares students for life, helping them develop an informed curiosity and a lasting passion for learning, by equipping them with problem solving skills useful in everyday life.

PRIOR KNOWLEDGE AND SKILLS

Learners beginning this course should normally have completed the junior secondary school science or its equivalent

PROGRESSION

EGCSE Biology qualification enables candidates to further their studies at tertiary institutions in Eswatini.

TEACHING HOURS

Appropriate teaching time for the Physical Science syllabus is Six (6) periods of forty (40) minutes each over a period of sixty weeks/cycles.

TEACHER SUPPORT MATERIAL

A wide range of materials and resources are available to support teachers in Eswatini schools. The resources suit a variety of teaching methods in the local context. Through targeted training forums, teachers can access the expert advice they need for teaching this syllabus.

EXAM PREPARATION RESOURCES

Examination reports, syllabuses, past papers and specimen papers are available on ECESWA website www.examscouncil.org.sz

SPECIAL REQUIREMENTS

Laboratories furnished with functional equipment for conducting practicals.

AVAILABLE GRADES

Candidates in this syllabus are eligible for Grades A* to G.

AIMS

The aims of the syllabus are the same for all learners. These aims are set out below and describe the educational purposes of a course in Biology for the EGCSE Examination. They are not listed in order of priority.

The aims are to:

1 provide, through well designed studies of experimental and practical science, a worthwhile educational experience for all students, whether or not they go on to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to:

- 1.1 become confident citizens in a technological world, to take or develop an informed interest in matters of scientific import;
- 1.2 recognise the usefulness, and limitations, of the scientific method and to appreciate its applicability in other disciplines and in everyday life;
- 1.3 be prepared for studies beyond EGCSE in pure sciences, in applied sciences or in science-dependent vocational courses;
- 1.4 develop an understanding of the scientific skills essential for both further study and everyday life.

2 develop abilities and skills that:

- 2.1 are relevant to the study and practice of Biology;
- 2.2 are useful in everyday life;
- 2.3 encourage efficient and safe practice;
- 2.4 encourage effective communication.

3 develop attitudes relevant to Biology such as:

- 3.1 concern for accuracy and precision;
- 3.2 objectivity;
- 3.3 integrity;
- 3.4 enquiry;
- 3.5 initiative;
- 3.6 inventiveness;
- 3.7 validity and reliability.

4 stimulate learner interest in, and care for, the environment.

5 promote an awareness that

- 5.1 scientific theories and methods have developed, and continue to do so, as a result of the co-operative activities of groups and individuals;
- 5.2 the study and practice of science is subject to social, economic, technological, ethical and cultural influences and limitations;
- 5.3 the applications of science may be both beneficial and detrimental to the individual, the community and the environment;
- 5.4 science transcends national boundaries and that the language of science, correctly and rigorously applied, is universal.

ASSESSMENT OBJECTIVES

Assessment Objectives in Biology are:

A Knowledge with Understanding

B Handling Information and Solving Problems

C Experimental Skills and Investigations

A description of each Assessment Objective follows.

A KNOWLEDGE WITH UNDERSTANDING

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

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

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

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

4 scientific quantities and their determination;

5 scientific and technological applications with their social, economic and environmental implications.

The Curriculum Content defines the factual material that candidates may need to recall and explain. Questions testing these objectives will often begin with one of the following words: define, state, describe, explain (using your Knowledge and Understanding) or outline. (see Appendix: Glossary of Terms at the back of the syllabus.)

B HANDLING INFORMATION AND SOLVING PROBLEMS

Learners should be able, in words or using other written forms of presentation (i.e., symbolic, graphical and numerical), to:

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

2 translate information from one form to another;

3 manipulate numerical and other data;

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

5 present reasoned explanations of phenomena, patterns and relationships;

6 make predictions and propose hypotheses;

7 solve problems, including some of a quantitative nature.

These assessment objectives cannot be precisely specified in the Curriculum Content because questions testing such skills may be based on information that 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: discuss, predict, suggest, calculate, explain or determine. (see Glossary of Terms at the back of the syllabus.)

C EXPERIMENTAL SKILLS AND INVESTIGATIONS

Learners should be able to:

1 demonstrate knowledge of how to safely use techniques, apparatus, and materials;

2 follow a sequence of instructions;

3 make predictions and propose hypotheses;

4 make and record observations and measurements;

5 interpret and evaluate experimental observations and data;

6 plan and carry out investigations, evaluate methods and suggest possible improvements (including the selection of techniques, controlling variables, apparatus and materials).

SPECIFICATION GRID

The approximate weightings allocated to each of the Assessment Objectives in the assessment model are summarised in the table below.

Assessment Objectives	**Paper 1 (marks)**	**Paper 2 (marks)**	**Papers 3 and 4 (marks)**	**Weighting of assessment objectives in overall qualification**
A Knowledge with understanding	25-30	48-53	0	50% (not more than 25% recall)
B Handling information and solving problems	10-15	27-32	0	30%
C Experimental skills and investigations	0	0	40	20%
Weighting of paper qualification	27%	53%	20%	

Teachers should take note that there is an equal weighting of 50% for skills (including handling information, solving problems, practical, experimental and investigative skills) and for knowledge and understanding. Teachers', schemes of work, and the sequence of learning activities should reflect this balance, so that the aims of the syllabus may be met, and the candidates prepared for the assessment.

SCHEME OF ASSESSMENT

All candidates must enter for three papers. These will be Paper 1, Paper 2 and one from the practical assessment Papers 3 (Practical Test) or 4 (Alternative to Practical).

A description of each paper follows.

Paper 1 (1 hour)

Compulsory short answer paper consisting of 40 marks. The paper will test skills mainly in Assessment Objectives A and B.

This paper will be weighted at 27% of the final total available marks.

Paper 2 (1 hour 15 minutes)

Compulsory theory paper consisting of 80 marks of structured questions.

The questions will be based on all material and will test skills mainly in Assessment Objectives A and B.

This paper will be weighted at 53% of the final total available marks.

Practical Assessment

The purpose of this component is to test appropriate skills in Assessment Objective **C**. Candidates must be entered for one of the following:

Either

Paper 3 Practical Test (1 hour 15 minutes)

consisting of 40 marks, with questions covering experimental skills and investigations. (See Appendix: Assessment Criteria for Practicals.)

Or

Paper 4 Alternative to Practical (1 hour)

consisting of 40 marks. This is a written paper designed to test familiarity with laboratory based procedures. (See Appendix: Assessment Criteria for Practicals.)

The practical assessment will be weighted at 20% of the final total available marks.

EXPERIMENTAL WORK

Experimental work is an essential component of all sciences. Experimental work within science education:

- gives candidates first-hand experience of phenomena
- enables candidates to acquire practical skills
- provides candidates with the opportunity to plan and carry out investigations
- promotes mastery of concepts.

This can be achieved by individual or group experimental work, or by demonstrations which actively involve the candidates.

Throughout the Curriculum Content section of this syllabus some clear indications are given of opportunities to use practical work, using the command words, for example '*describe*' 'perform *experiments* to…' and *'investigate*…' These instructions mean that such statements may be examined in terms of practical skills in Paper 3 or Paper 4, but also in terms of other skills (Assessment Objectives A and B) in Papers 1 and 2 covering such skills as planning, prediction, recall, explanation, handling data (including calculations) and interpretation of results.

CURRICULUM CONTENT

Notes:

(i) The Curriculum Content outlined below is designed to provide guidance to teachers as to what will be assessed in the overall evaluation of the learner. Throughout the course, attention should be drawn to the relevance of the concepts to the learner's everyday life and to the natural and man-made world. The specified content of the syllabus has been limited in order to encourage this approach and to permit flexibility in teaching programmes.

(ii) Due to the spiral nature of the curriculum, it is assumed that the elementary concepts of the syllabus have been covered during study at Junior Secondary level.

(iii) The main topic areas and concepts are indicated in **bold**.

(iv) Learners will be expected to give biologically correct definitions of any of the terms printed in *italic*.

(v) To avoid any confusion concerning the symbol for litre, dm^3 will be used in place of *l* or litre.

Duration of course

Appropriate teaching time for the Biology syllabus should be equivalent to six (6) periods of forty (40) minutes each over a period of sixty (60) weeks/cycles.

SECTION I - CHARACTERISTICS AND CLASSIFICATION OF LIVING ORGANISMS (5% of teaching time)
All learners should be able to:
1.0 Characteristics of living organisms
(a) list and describe the characteristics of living organisms (b) define the terms: (i) *nutrition* as obtaining the organic substances and mineral ions from which organisms gain their energy and the raw materials for growth and tissue repair (ii) *excretion* as the removal of toxic materials and the waste products of metabolism from organisms (iii) *respiration* as the release of energy from food substances in all living cells (iv) *sensitivity* as the ability to sense and respond to changes in the surroundings (v) *reproduction* as producing offspring, preventing extinction of the species (vi) *growth* as an increase in size, mass and complexity of an organism (vii) *movement* as a change in position of the whole body or any part of the organism

2.0 Classification and diversity of living organisms

(a) List the seven levels of classification of organisms in hierarchical order (taxa) as: kingdom, phylum, class, order, family, genus and species

(b) describe the *binomial system* as the system of naming organisms using two names, genus and species

(c) describe the main characteristics of the five kingdoms of organisms as: plantae, animalia, fungi, prokaryotae and protoctista

(d) state that animals are classified into vertebrates and invertebrates

(e) classify, using visible, external characteristic features:

(i) vertebrates into the classes: fishes, amphibians, reptiles, birds and mammals

(ii) invertebrates into arthropods, annelids, nematodes and molluscs

(iii) arthropods into the classes: insects, crustaceans, arachnids and myriapods

(iv) flowering plants into monocotyledons and dicotyledons

(Local examples to be studied as appropriate)

(f) list the main features used in the classification of the following groups: viruses, bacteria and fungi, and their adaptation to the environment, as appropriate

(g) construct and use simple dichotomous keys based on easily identifiable features

SECTION II - ORGANISATION AND MAINTENANCE OF THE ORGANISM (50% of teaching time)

All learners should be able to:

1.0 Cell structure and organisation: the cellular nature of all living organisms

(a) identify and describe the structure of a plant cell (palisade cell) and an animal cell (liver cell), as seen under the light microscope and other parts seen from images from the electron microscope, and state their functions (cell membrane, cytoplasm, nucleus, cell wall, vacuole, chloroplast, ribosome, mitochondrion)

(b) relate the structures of parts of the cell to their functions (cell membrane, chloroplast, mitochondrion)

(c) describe the differences in structure between typical animal and plant cells

2.0 Levels of organisation

(a) define development as an increase in complexity through the differentiation of cells

(b) define *tissue* as a group of cells of similar structure that work together to perform a special function

(c) relate the structure of the following to their functions:

(i) palisade mesophyll cells – photosynthesis

(ii) ciliated cells in respiratory tract – movement of mucus

(iii) goblet cell- secreting mucus which traps dust and other substances

(iv) root hair cells – absorption

(v) xylem vessels – conduction and support

(vi) muscle cells – contraction

(vii) red blood cells – transport

(d) define:

(i) *organ* as several tissues grouped together to make a structure with a special function

(ii) *organ system* as a group of organs with closely related functions

(Use examples of organs and organ systems, as illustrated by examples covered in Sections II and III)

(e) identify the different levels of organisation in drawings, diagrams and images

3.0 Size of specimens

calculate magnification and size of biological specimens using millimetres as units

4.0 Movement in and out of cells

4.1 Diffusion

(a) define *diffusion* as the movement of particles from a region of their higher concentration to a region of their lower concentration, down a concentration gradient

(b) describe the importance of diffusion of gases and solutes to living organisms

(c) investigate the factors that influence diffusion (surface area, temperature, concentration gradient, distance)

4.2 Osmosis

(a) describe *osmosis* as the net movement of water molecules from a region of their higher concentration (higher water potential) to a region of their lower concentration (lower water potential), through a partially permeable membrane

(b) investigate the effect of osmosis on animal and plant tissues in solutions of different concentrations

(c) explain the effect of osmosis on plant and animal tissues using the terms plasmolysis, turgid, flaccid, turgor pressure, isotonic, hypertonic, hypotonic

(d) explain the importance of a water potential gradient in the uptake of water by plants

4.3 Active transport

(a) define *active transport* as the movement of particles through a cell membrane from a region of their lower concentration to a region of their higher concentration using energy from respiration

(b) discuss the importance of active transport as a process for movement across membranes e.g. mineral ion uptake in root hair cells, uptake of glucose by epithelial cells of villi and in kidney tubules

5.0 Enzymes

(a) define *enzymes* as proteins that function as biological catalysts

(b) investigate and describe the effect of changes in temperature and pH on enzyme activity

(c) explain enzyme action in terms of the ‘lock and key’ hypothesis

6.0 Nutrition

6.1 Nutrients

(a) list the main chemical elements that make up: carbohydrates, fats and proteins

(b) describe the synthesis of large molecules from smaller basic units: simple sugars to starch and glycogen, amino acids to proteins, fatty acids and glycerol to fats and oils

(c) describe and carry out tests for:

(i) starch using iodine solution

(ii) reducing sugars using Benedict's solution

(iii) vitamin C using DCPIP

(iv) protein using the biuret test

(v) fats using ethanol

(d) list the principal sources and describe the importance of carbohydrates, fats, proteins, vitamins (C and D only), mineral salts (calcium, iodine and iron only), fibre or roughage and water

(e) describe the deficiency symptoms for: vitamins (C and D only) and mineral salts (calcium, iodine and iron only)

6.2 Plant nutrition

6.2.1 Photosynthesis

(a) define *photosynthesis* as the fundamental process by which plants manufacture simple sugars from carbon dioxide and water in the presence of light energy and chlorophyll

(b) state the equation for photosynthesis in words and in symbols

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2$$

(c) describe the intake of the raw materials for photosynthesis and the trapping and storing of energy (conversion of light energy into chemical energy)

(d) state the uses of glucose in the formation of other food substances and their subsequent storage

(e) perform the starch test on a leaf

(f) investigate the necessity for chlorophyll, light and carbon dioxide for photosynthesis, using appropriate controls

(g) define the term *limiting factor* as the external factor which restricts the effects of others (when a number of factors are needed, it is the one in shortest supply)

(h) investigate and describe the effects of varying light intensity and carbon dioxide concentration in the rate of photosynthesis

(i) identify and explain the limiting factors of photosynthesis in different environmental conditions

(j) explain the use of carbon dioxide enrichment, optimum light and optimum temperatures in greenhouse systems

6.2.2 Leaf structure

(a) identify the cellular and tissue structure of a dicotyledonous leaf, as seen in cross-section

(b) describe and explain the significance of these features in terms of functions:

(i) distribution of chloroplasts - photosynthesis

(ii) stomata and mesophyll cells - gaseous exchange

(iii) vascular bundles (xylem and phloem) - transport

6.2.3 Mineral requirements

(a) describe the importance of:

(i) nitrate ions for protein synthesis

(ii) magnesium ions for chlorophyll synthesis

(b) investigate the effects of nitrate ion and magnesium ion deficiency on plant growth

(c) describe the uses of nitrogen fertilisers and local alternatives (e.g. kraal manure)

6.3 Human nutrition

6.3.1 Diet

(a) describe a balanced diet as a diet containing all the nutrients in correct amounts and proportions to sustain a healthy life

(b) explain

(i) how age, gender, and activity affect the dietary needs of humans

(ii) the effects of malnutrition in relation to starvation, coronary heart disease, constipation and obesity

(c) discuss the special dietary needs for people living with:

(i) high blood pressure in relation to salt and fat intake

(ii) sugar diabetes in relation to carbohydrate, fruit and vegetable intake

6.3.2 Human alimentary canal

(a) define:

(i) *ingestion* as the intake of food into the mouth

(ii) mechanical digestion as the breakdown of food into smaller pieces without chemical change to food molecules

(iii) *chemical digestion as the* breakdown of large, insoluble food molecules into smaller, soluble ones using enzymes

(iv) *absorption* as the process by which digested food molecules pass across the wall of the intestine into the blood or lymph

(v) *assimilation* as use of food molecules by cells in the processes of growth, reproduction and repair (i.e. building up the cell/incorporating into the cell)

(vi) *egestion* as the passing out of undigested food, in the form of faeces, through the anus

(b) identify the main regions of the alimentary canal and associated organs: mouth, salivary glands, oesophagus, stomach, small intestine (duodenum and ileum), large intestine (colon and rectum), anus, pancreas, liver, gall bladder

(c) describe the functions of the alimentary canal's various parts in relation to ingestion, digestion, absorption, assimilation and egestion of food

(d) describe diarrhoea and outline its treatment using oral rehydration therapy

6.3.3 Mechanical digestion

(a) identify the types of human teeth and relate their structure to their functions

(b) identify and describe parts of a human tooth (enamel, dentine, pulp cavity, nerves, blood vessels,

gums, cement)

(c) describe dental decay stating its causes and ways of prevention

(d) explain the probable action of fluoride in reducing dental decay

(e) describe the disadvantage of excess fluoride in natural water sources

(f) describe and explain mechanical digestion

(g) describe and explain the process of peristalsis

6.3.4 Chemical digestion

(a) describe digestion along the alimentary canal

(b) describe the functions of a typical amylase, protease (pepsin and trypsin) and lipase, listing the substrate and end-products

(c) describe and explain the role of bile in fat digestion

6.3.5 Absorption

(a) identify the ileum as the region for the absorption of digested food

(b) describe the adaptations of the ileum for absorption

(c) describe and explain:

(i) the significance of villi and microvilli in increasing the internal surface area

(ii) the structure of a villus, including the role of capillaries and lacteals

6.3.6 Assimilation

(a) state the role of the hepatic portal vein in the transport of absorbed food to the liver

(b) describe:

(i) the role of the liver in the metabolism of glucose

(ii) the role of fat as a storage substance

(c) describe and explain deamination

7.0 Transportation

7.1 Transport in plants

7.1.1 Water uptake

(a) identify root hair cells, as seen under the light microscope, and describe their functions

(b) investigate the passage of water through root, stem and leaf

(c) identify the tissue structure of a dicotyledonous root and stem as seen in a cross section (xylem, phloem, epidermis, cortex, pith)

7.1.2 Transpiration

(a) describe *transpiration*

(b) describe how transpiration rate is related to cell surfaces, air spaces and stomata

(c) investigate and explain the effects of variation of temperature, humidity, light intensity and air movement on transpiration rate using a potometer

(d) explain the mechanism of water uptake and movement in terms of transpiration pull creating a

water potential gradient in the xylem, drawing cohesive water molecules up the plant

(e) explain how and why wilting occurs

(f) discuss the adaptations of the leaf, stem and root to different environments, with emphasis on local examples

7.1.3 Translocation

(a) define *translocation* as the movement of sucrose and amino acids from regions of production or of storage to regions of utilisation in respiration or growth

(b) describe translocation of applied chemicals, including systemic pesticides, throughout the plant

(c) compare the role of transpiration and translocation in the transport of materials

7.2 Transport in humans

7.2.1 Blood circulation

(a) describe the circulatory system as a system of blood vessels with a pump and valves to ensure one way flow of blood

(b) describe the double circulation in terms of a low pressure circulation to the lungs and a high pressure circulation to the body tissues and relate these differences to the different functions of the two circuits

7.2.2 Heart

(a) identify and describe the structure and function of the heart, including chambers, septum, different valves (tricuspid, bicuspid, semi - lunar) and its associated major blood vessels

(b) investigate and explain the effect of exercise on heartbeat

(c) state the function of the coronary blood vessels

(d) describe the causes, effects, preventive measures and control of high blood pressure

(e) describe coronary heart disease in terms of the blockage of coronary arteries and state the possible risk factors as diet, smoking, stress, genetic disposition and age

(f) discuss the roles of diet and exercise in the prevention of coronary heart disease

7.2.3 Arteries, veins and capillaries

(a) describe the structure and functions of arteries, veins and capillaries

(b) explain how structure and function are related in arteries, veins and capillaries

7.2.4 Blood

(a) identify red blood cells, phagocytes, lymphocytes and platelets as seen under a light microscope from prepared slides, diagrams and photomicrographs

(b) describe:

(i) the components of blood (red blood cells, platelets, plasma, phagocytes and lymphocytes) and relate them to their functions

(ii) blood clotting in terms of conversion of fibrinogen to fibrin only

(c) describe the transfer of materials between capillaries and tissue fluid

7.2.5 Immunity

(a) describe the immune system in terms of antibody production and phagocytosis

(b) define pathogen as a disease-causing organism

(c) describe active and passive immunity

(d) describe and explain the process of vaccination

(e) describe tissue rejection and how it is prevented

(f) outline the lymphatic system in terms of lymphatic vessels and lymph nodes

(g) describe the function of the lymphatic system in circulation of body fluids and the production of lymphocytes.

8.0 Respiration

8.1 Aerobic respiration

(a) define *aerobic respiration* as the breakdown of glucose in the presence of oxygen to release energy in cells.

(b) state the equation for aerobic respiration in words and in symbols:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy

(c) describe the uses of energy in the human body i.e. muscle contraction, protein synthesis, cell division, active transport, growth, passage of nerve impulses and maintenance of constant body temperature

(d) investigate the uptake of oxygen by respiring organisms, such as arthropods and germinating seeds

8.2 Anaerobic respiration

(a) define *anaerobic respiration* as the breakdown of glucose in the absence of oxygen to release energy in cells

(b) state the equation for anaerobic respiration in muscles ($C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$), and in yeast ($C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$) using words and symbols

(c) describe the production and effect of lactic acid in muscles during exercise

(d) describe the role of anaerobic respiration in brewing and in bread-making using yeast

(e) compare aerobic respiration and anaerobic respiration in terms of relative amounts of energy released

8.3 Gaseous exchange

(a) identify and name the trachea, bronchi, bronchioles, alveoli, lungs, diaphragm, ribs, external and internal intercostal muscles and associated capillaries

(b) list the features of gas exchange surfaces in humans in terms of large surface area, thin epithilia, good blood supply and good ventilation with air

(c) describe and explain gaseous exchange in the alveoli

(d) describe the role of the ribs, the internal and external intercostal muscles and the diaphragm in producing volume and pressure changes leading to the ventilation of the lungs

(e) investigate and explain the link between physical activity and rate and depth of breathing in terms of changes in respiratory rate

(f) use limewater or hydrogen carbonate indicator as a test for carbon dioxide to investigate and explain the differences in composition between inspired and expired air

(g) describe the effects of tobacco smoke and its major toxic components on the respiratory system in relation to emphysema, chronic bronchitis and lung cancer

9.0 Excretion in humans

(a) identify and state the functions of the different parts of the human urinary system (kidneys and associated blood vessels, ureters, bladder and urethra)

(b) describe the structure of the kidney in terms of cortex, medulla and pelvis

(c) describe the function of the kidney simply in terms of the removal of urea, formed through deamination, excess water, and hormones and drugs broken down by liver

(d) describe the structure of a nephron (glomerulus, renal capsule, tubule, loop of Henle, collecting duct) and relate it to the kidney function

(e) explain dialysis and discuss its application in kidney machines

(f) discuss the advantages and disadvantages of kidney transplants, compared with dialysis

10.0 Coordination and response

10.1 Hormones

(a) define a *hormone* as a chemical secreted by an endocrine gland, transported in the bloodstream and affecting a target organ

(b) describe the chemical control of metabolic activity by adrenaline, stating its source, target organs and effects

(c) discuss the use of chemicals in food production; auxins (growth regulation and ripening of fruits) and hormones (growth regulation)

10.2 Tropic responses

(a) define:

  (i) *gravitropism* as a response in which parts of a plant grows towards or away from gravity

  (ii) *phototropism* as plant growth in response to light

(b) investigate and explain:

  (i) negative and positive phototropism

  (ii) negative and positive gravitropism

(c) explain the chemical control of plant growth by auxins including gravitropism and phototropism in terms of auxins regulating differential growth

(d) describe the use of synthetic plant hormones as weed killers

10.3 Nervous control in humans

(a) describe the human nervous system in terms of the central nervous system (brain and spinal cord) and the peripheral nervous system

(b) identify and state the functions of parts of the human central nervous system i.e. cerebral hemispheres, hypothalamus, pituitary gland, medulla, cerebellum and spinal cord

(c) define *sense organs* as groups of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals

(d) identify the component parts of the eye and state their functions

(e) distinguish between rods and cones, in terms of function and distribution

(f) describe and explain accommodation and pupil reflex

(g) identify motor, relay and sensory neurones from diagrams and state their functions

(h) describe the structure of a synapse

(i) describe effectors in terms of muscles (biceps and triceps) and glands

(j) describe a simple reflex arc in terms of receptor, sensory neurone, relay neurone, motor neurone and effector

(k) describe a reflex action as a means of automatically and rapidly integrating and coordinating stimuli with responses

(l) distinguish between voluntary and involuntary actions

(m) compare hormonal and nervous control systems in terms of speed and longevity of action

10.4 Homeostasis

(a) define *homeostasis* as the maintenance of a constant internal environment

(b) identify and name on a diagram of the skin: hairs, sweat glands, sweat ducts, temperature receptors, blood vessels and fatty tissue

(c) describe temperature regulation in terms of

- (i) insulation
- (ii) the role of temperature receptors
- (iii) sweating
- (iv) shivering
- (v) vasodilation
- (vi) vasoconstriction

(d) describe the control of the glucose concentration of the blood by the liver, and the roles of insulin and glucagon from the pancreas

(e) describe sugar diabetes (Type 1 and 2) in relation to:

- (i) the causes, signs and symptoms
- (ii) effects
- (iii) preventive measures
- (iv) control and treatment

10.5 Drugs

(a) define a *drug* as any substance taken into the body that modifies or affects chemical reactions

(b) describe the medicinal use of drugs (penicillin and paracetamol)

(c) describe the short term and long term effects of alcohol, tobacco, cannabis (dagga), solvents (petrol, benzene, and some glues), heroin, and the dangers of their misuse

(d) discuss the personal and social problems arising from drug abuse, such as alcohol and heroin

(e) discuss the effects of performance-enhancing drugs in sports

SECTION III THE DEVELOPMENT OF THE ORGANISM AND THE CONTINUITY OF LIFE (25% of teaching time)

All learners should be able to:

1.0 Reproduction

1.1 Asexual reproduction

(a) define *asexual reproduction* as the process resulting in the production of genetically identical offspring from one parent
(b) describe asexual reproduction in:
  (i) bacteria
  (ii) fungi (spore production)
  (iii) potatoes (tuber formation)
  (iv) sugar cane
(c) discuss the advantages and disadvantages of asexual reproduction to the species

1.2 Sexual reproduction

(a) define *sexual reproduction* as a process involving the fusion of the nuclei of male and female gametes resulting in the production of offspring that are genetically different
(b) discuss the advantages and disadvantages of sexual reproduction to the species

1.2.1 Sexual reproduction in plants

(a) identify and name the parts of a dicotyledonous flower (e.g. hibiscus) and a monocotyledonous flower (e.g. grass)
(b) state the functions of parts of the dicotyledonous and grass flowers
(c) define *pollination* as the transfer of pollen grains from the anther to the stigma
(d) name the agents of pollination
(e) describe self-pollination and cross-pollination, and discuss their implications to a species
(f) compare the different structural adaptations of insect-pollinated and wind-pollinated flowers
(g) describe:
  (i) the growth of the pollen tube and the process of fertilisation
  (ii) the formation of seed and fruit
(h) identify and name the parts of a non-endospermic seed
(i) state the functions of parts a non-endospermic seed
(j) define *dispersal* as a means of moving fruits or seeds away from the parent plant
(k) describe the structural adaptations of seeds/fruit for wind, animal and explosive dispersal
(l) investigate and describe the environmental conditions affecting germination (suitable temperature, oxygen and water)
(m) describe the role of enzymes in seed germination

1.2.2 Sexual reproduction in humans

(a) identify and state the functions of the different parts of the human male and female reproductive systems
(b) describe the structural differences between the sperm and ovum and relate their structures to their functions
(c) describe:
  (i) the roles of testosterone and oestrogen (sex hormones) in the development and regulation of secondary sexual characteristics at puberty
  (ii) the menstrual cycle in terms of the physical changes, and the roles and the sites of production of the hormones: oestrogen, progesterone, FSH (follicle stimulating hormone) and LH (luteinising hormone)
  (iii) sexual intercourse, fertilisation and implantation
  (iv) the development of the foetus in terms of:
    - the placenta
    - maternal and foetal blood supplies and exchange of materials

- amniotic sac and amniotic fluid

(v) the roles of hormones in pregnancy
(vi) ante-natal care in terms of dietary requirements (calcium, iron, folic acid, carbohydrates and proteins) and maintaining good health in relation to alcohol intake and smoking
(vii) The main stages of birth (labour, delivery and after birth)

(d) describe the advantages and disadvantages of breast-feeding compared with bottle-feeding

1.3 Methods of birth control

(a) name and describe the following methods of birth control:
(i) natural (abstinence, rhythm, withdrawal)
(ii) chemical (spermicides, contraceptive pills, injectables, hormonal implant)
(iii) mechanical (intra uterine device, condom)
(iv) surgical (vasectomy and tubal ligation)

(b) discuss:
(i) the social aspects of artificial insemination (gamete donation and surrogacy)
(ii) the use of hormones in fertility drugs

1.4 HIV and sexually transmissible infections (STIs)

(a) state the causative agent for gonorrhoea

(b) describe the symptoms, signs, effects and treatment of gonorrhoea

(c) state the causative agent for Acquired Immuno Deficiency Syndrome (AIDS) as Human Immuno-deficiency Virus (HIV)

(d) describe the methods of transmission of HIV, and the ways in which it can be prevented from spreading, such as early testing for everyone, use of condoms, anti-retroviral drugs.

(e) outline how HIV affects the immune system

(f) discuss the control and treatment of HIV/AIDS such as male circumcision and prevention of mother to child transmission (PMTCT)

2.0 Inheritance

Define *inheritance* as the transmission of genetic information from generation to generation, leading to continuity of, and variation within, the species

2.1 Chromosomes

(a) define the terms:
(i) *chromosome* as a thread of DNA, made up of genes
(ii) *gene* as a section of DNA, which codes for the formation of a protein, controlling a specific characteristic of the organism
(iii) *allele* as an alternative form of a gene
(iv) *haploid nucleus* as one containing a single set of unpaired chromosomes e.g. in sperm and ovum
(v) *diploid nucleus* as one containing pairs of chromosomes e.g. in somatic (body) cells

(b) describe the structure of DNA with reference to double strand, nucleotides and pairing of the bases (A with T and C with G)

2.2 Mitosis

describe mitosis simply, in terms of the exact duplication of chromosomes resulting in identical daughter nuclei (details of stages are **not** required)

2.3 Meiosis

describe the production of gametes by meiosis simply, in terms of halving of chromosome number

leading to variation (details of stages are **not** required)

2.4 Monohybrid inheritance

(a) define the terms:
  (i) *genotype* as the genetic make-up of an organism
  (ii) *phenotype* as the characteristics visible in an organism controlled by the genotype and the environment
  (iii) *homozygous* as having a pair of identical alleles controlling the same characteristic
  (iv) *heterozygous* as having a pair of dissimilar alleles for a characteristic
  (v) *dominant* as a gene that always shows in the phenotype of an organism whether the organism is heterozygous or homozygous
  (vi) *recessive* as a gene that only has an effect on the phenotype when the organism is homozygous.

(b) calculate and predict, using a genetic diagram or Punnet square, the results of monohybrid crosses

(c) describe the inheritance of sex in humans (XX, XY)

(d) explain codominance e.g. inheritance of A, B, AB and O blood groups using the alleles I^A, I^B and I^o

(e) define a *sex linked characteristic* as a characteristic in which the gene responsible is located on a sex chromosome and that this makes it more common in one sex than in the other

(f) describe colour blindness and haemophilia as examples of sex linkage

(g) calculate and predict using a genetic diagram or Punnet square, the results of monohybrid crosses involving sex linkage

2.5 Variation

(a) define variation as observable differences within a species, stating examples

(b) describe continuous and discontinuous variation as influenced by the environment and genes, illustrated by examples such as height and blood groups in humans

(c) describe *mutation* as a spontaneous change in a gene or a chromosome using albinism and Down's syndrome as examples

(d) state that mutation is the way in which new alleles are formed leading to variation within species

(e) state that ionising radiation and some chemicals increase the rate of mutation

(f) describe cancer in relation to the causes, preventive measures and treatment using cervical and prostate cancer as examples

(g) describe sickle cell anaemia, and explain its incidence in relation to that of malaria

(h) describe how variation and competition leads to differential survival of, and reproduction by, those organisms best fitted to the environment

2.6 Selection

(a) describe the role of artificial selection in the production of varieties of animals and plants with increased economic importance

(b) describe natural selection

(c) discuss the importance of natural selection as a possible mechanism for evolution

(d) describe the development of strains of antibiotic resistant bacteria such as Multiple Drug Resistant (MDR) tuberculosis as an example of evolution by natural selection

(e) describe the importance of completing the full course of antibiotics medication

3.0 Biotechnology and Genetic engineering

3.1 Biotechnology

(a) describe biotechnology

(b) describe:
  (i) the role of enzymes and their uses in biological washing products and in the food industry with reference to the extraction of fruit juices
  (ii) the use of microorganisms and fermenters to manufacture enzymes for use in biological washing powders
  (iii) the use of microorganisms in the food industry, with reference to yoghurt, bread and brewing
(c) Describe cloning as an example of biotechnology
(d) Discuss the social aspects of cloning

3.2 Genetic Engineering

(a) define *genetic engineering* as changing the genetic material of an organism by removing, changing or inserting individual genes
(b) outline and explain the use genetic engineering in the production of human insulin using bacteria
(c) explain why bacteria are used in genetic engineering
(d) discuss potential advantages and disadvantages of genetic engineering with reference to genetically modified organisms (GMOs)

SECTION IV BIODIVERSITY AND ECOSYSTEMS (20% of teaching time)

All learners should be able to:

1.0 Biodiversity

(a) define biodiversity as the existence of many different species of plants and animals in an environment, and differences within a species
(b) discuss the importance of biodiversity such as medicinal purposes and ecological roles
(c) discuss threats to biodiversity (habitat change, alien invasive species, unsustainable resource extraction, wild fires, climate change and soil erosion).

2. 0 Ecosystems

2.1 Energy flow

(a) state that the Sun is the principal source of energy input to biological systems.
(b) describe the non-cyclical nature of energy flow.

2.2 Food chains and food webs

(a) define the terms:
  (i) *food chain* as a way of showing linear feeding relationships between organisms and the direction of energy flow
  (ii) *food web* as a group of interlinking food chains that shows the feeding relationship between them
  (iii) *producer* as an organism that makes its own food using energy from sunlight through the process of photosynthesis
  (iv) *consumer* as an organism that feeds on other organisms
  (v) *herbivore* (primary consumer) as an animal that eats plants
  (vi) *carnivore* (secondary consumer or tertiary consumer) as an animal that eats other animals
  (vii) *decomposer* as an organism that obtains its food by breaking down dead organisms
  (viii) *habitat* as the place where an organism lives, feeds and breeds
  (ix) *environment* as all conditions in the surroundings of an organism that may affect it
  (x) *ecosystem* as a community of interdependent organisms and their environment

(xi) *trophic level* as an organism's position in a food chain, food web or pyramid

(b) construct food chains and food webs using examples of local plants and animals

(c) describe and explain:
(i) energy losses between trophic levels
(ii) the advantages of short food chains in terms of energy loss
(iii) why there is a greater efficiency in supplying plants as human food and that there is a relative inefficiency in feeding crop plants to livestock that will be used as food

(d) draw, describe and interpret pyramids of biomass, numbers and energy

2.3 Nutrient cycles

(a) describe the carbon cycle

(b) discuss the effects of the combustion of fossil fuels and deforestation on the balance between oxygen and carbon dioxide and the implications on global warming

(c) describe the nitrogen cycle in terms of:
(i) the role of micro-organisms in providing usable nitrogen containing substances by decomposition and by nitrogen fixation in roots
(ii) the absorption of nitrogen containing substances by plants and their conversion to protein
(iii) the passage through food chains, death, decay, nitrification and denitrification and
(iv) the return of nitrogen to the soil or the atmosphere (names of individual bacteria are not required)

3.0 Pollution

(a) define *pollution* as a build-up of substances such as chemicals, which damage the environment, due to human activities

(b) describe the undesirable effects of:
(i) water pollution by sewage and chemical waste
(ii) air pollution by sulfur dioxide and oxides of nitrogen
(iii) pollution due to pesticides and herbicides
(iv) nuclear fall-out

(c) discuss the causes and apparent effects on the environment of acid rain, and the measures that might be taken to reduce its incidence

(d) describe eutrophication

(e) explain the effects of eutrophication due to excessive fertilisers and untreated sewage on aquatic life

4.0 Conservation

(a) define the term *sustainable development* as the development providing for the needs of an increasing human population without harming the environment

(b) explain the need to conserve non-renewable resources, limited to fossil fuels

(c) state that products can be re-used or recycled, limited to paper, glass and plastic

(d) describe how endangered species can be conserved, limited to monitoring and protecting species and habitats, education, captive breeding programmes and seed banks

(e) explain reasons for conservation programmes

GRADE DESCRIPTIONS

The scheme of assessment is intended to encourage positive achievement by all candidates. Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The grade awarded will depend on the extent to which the candidate has met the assessment objectives overall and may conceal weakness in one aspect of the examination that is balanced by above-average performance on some other.

Grade A	Candidate must show mastery of the curriculum
	A candidate should be able to: • relate facts to principles and theories and vice versa; • state why particular techniques are preferred for a procedure or operation; • select and collate information from a number of sources and present it in a clear logical form; • solve problems in situations which may involve a wide range of variables; • process data from a number of sources to identify any patterns or trends; • generate a hypothesis to explain facts, or find facts to support an hypothesis.
Grade C	Candidate must show a high level of competence in the curriculum.
	A candidate should be able to: • link facts to situations not specified in the syllabus; • describe the correct procedure(s) for a multi-stage operation; • select a range of information from a given source and present it in a clear logical form; • identify patterns or trends in given information; • solve problems involving more than one step, but with a limited range of variables; • generate a hypothesis to explain a given set of facts or data.
Grade G	Candidate must show competence in the curriculum.
	A candidate should be able to: • recall facts contained in the syllabus • indicate the correct procedure for a single operation • select and present a single piece of information from a given source • solve a problem involving one step, or more than one step if structured help is given • identify a pattern or trend where only a minor manipulation of data is needed • recognise which of two given hypotheses explains a set of facts or data

APPENDIX 1: ASSESSMENT CRITERIA FOR PRACTICALS

Practical Assessment

Scientific subjects are, by their nature, experimental. It is, accordingly, important that an assessment of a learner's knowledge and understanding of Biology should contain a component relating to practical work and experimental skills (as identified by Assessment Objective C). In order to accommodate, within EGCSE, differing circumstances - such as the availability of resources - two alternative means of assessing Assessment Objective C are provided, namely, a formal practical test and a written alternative to practical paper, as outlined in the scheme of assessment.

Paper 3, Practical Test

Questions may be set requiring the candidates to:

- follow carefully a sequence of instructions
- use familiar and unfamiliar techniques to record observations and make deductions from them
- perform simple physiological experiments, e.g. tests for food substances and the use of hydrogen carbonate indicator, litmus and Universal Indicator paper
- use a scalpel or a razor blade, forceps, scissors and mounted needles skilfully
- use a hand lens of not less than x6 magnification to recognise, observe and record familiar, and unfamiliar, biological specimens
- make a clear line drawing of a specimen provided, indicate the magnification of the drawing and label, as required
- perform simple arithmetical calculations
- make predictions and hypotheses
- control variables
- plot graphs and /or interpret graphical information
- identify sources of error and suggest possible improvement in procedures
- describe and explain, or comment on experimental arrangements and techniques
- improve validity and reliability of experiments

It is expected that glassware and instruments normally found in a laboratory, e.g., beakers, test tubes, test-tube racks or other holders, funnels, thermometers, specimen tubes, Petri dishes, syringes, droppers, glass rods, means of heating the equipment referred to above, x6 (at least) hand lenses and so on, should be available for these experiments, along with reagents (e.g., for food tests), hydrogen carbonate indicator, litmus paper and Universal Indicator paper. When planning practical work, teachers should make sure that they do not contravene any school, Examinations Council of Eswatini or government regulations that restrict the sampling, in educational establishments, of saliva, blood, urine or other bodily secretions and tissues.

Paper 4, Alternative to Practical

This paper is designed to test candidates' familiarity with laboratory practical procedures.

Questions may be set requiring the candidates to:

- follow carefully a sequence of instructions
- use familiar and unfamiliar techniques to record observations and make deductions from them
- recall simple physiological experiments, e.g., tests for food substances, the use of a potometer and the use of hydrogen carbonate indicator, litmus and Universal Indicator paper
- recognise, observe and record, familiar and unfamiliar biological specimens
- a clear line drawing from a photograph (or other visual representation) of a specimen, indicate the magnification of the drawing and label, as required
- perform simple arithmetical calculations
- make predictions and hypothesis
- control variables
- plot graphs and /or interpret graphical information
- identify sources of error and suggest possible improvement in procedures
- describe and explain, or comment on experimental arrangements and techniques
- improve validity and reliability of experiments

APPENDIX 2: TERMINOLOGY, UNITS, SYMBOLS AND PRESENTATION OF DATA

These terms will be used on question papers and learners should be made aware of the terminology during teaching and practical work.

1. Numbers

- The decimal point will be placed on the line, e.g., 52.35
- Numbers from 1000 to 9999 will be printed without commas or spaces
- Numbers greater than or equal to 10 000 will be printed without commas. A space will be left between each group of three whole numbers, e.g., 4 256 789
- Decimal numbers should be rounded off to two decimal places e.g. 36.7666 written as 36.77

2. Units

The International System of units will be used (SI units). Units will be indicated in the singular not in the plural, e.g., 28 kg.

(a) Units commonly used in Biology are listed below.

N.B. Care should be taken in the use of *mass* and *weight.* In most biological contexts, the term mass is correct, e.g., dry mass, biomass.

Quantity	*Name of unit*	*Symbol for unit*
length	kilometre	km
	metre	m
	centimetre	cm
	millimetre	mm
	micrometre	μm
mass	tonne (1000 kg)	(no symbol)
	kilogram	kg
	gram	G
	milligram	Mg
	microgram	Mg
temperature	Degree Celsius	^{0}C
time	year	Y
	day	D
	hour	H
	minute	Min
	second	S
amount of substance	mole	Mol

(b) Derived units are listed below.

energy	kilojoule	kJ
	joule	J
	(calorie is obsolete)	

(c) Recommended units for area, volume and density are listed below.

area	hectare = 10^4 m^2		ha
	square metre		m^2
	square decimetre		dm^2
	square centimetre		cm^2
	square millimetre		mm^2
volume	cubic kilometre		km^3
	cubic metre		m^3
	cubic decimetre (preferred to litre)		dm^3
	litre		
	cubic centimetre		cm^3 (**not** ml)
	cubic millimetre		mm^3
density	kilogram per cubic metre	*or*	kg m^{-3}
	gram per cubic centimetre	*or*	g cm^{-3}

(d) Use of solidus

The solidus (/) will **not** be used for a quotient, e.g., m / s for metres per second.

3. Presentation of data

The solidus (/) is to be used for separating the quantity and the unit in tables, graphs and charts, e.g., time/s for time in seconds.

(a) Tables

(i) Each column of a table will be headed with the physical quantity and the appropriate unit, e.g., time/s.

There are three acceptable methods of stating units, e.g., metres per sec or m per s or m s^{-1}.

(ii) The column headings of the table can then be directly transferred to the axes of a constructed graph.

(b) Graphs

(i) The independent variable should be plotted on the x-axis (horizontal axis) and the dependent variable plotted on the y-axis (vertical axis).

(ii) Each axis will be labelled with the physical quantity and the appropriate unit, e.g. time / s.

(iii) The graph is the whole diagrammatic presentation. It may have one or several curves plotted on it.

(iv) Curves and lines joining points on the graph should be referred to as 'curves'.

(v) Points on the curve should be clearly marked as crosses (x) or encircled dots (⊙). If a further curve is included, vertical crosses (+) may be used to mark the points.

(vi) A best-fit line (trend line) should be a single, thin, smooth straight line or curve.

(c) Pie charts

These should be drawn with the sectors in rank order, largest first, beginning at 'noon' and proceeding clockwise. Pie Charts should preferably contain no more than six sectors.

(d) Bar charts

These are drawn when one of the variables is not numerical, e.g., percentage of vitamin C in different fruits. They should be made up of narrow blocks of equal width that do **not** touch.

(e) Histograms

These are drawn when plotting frequency graphs with continuous data, e.g., frequency of occurrence of leaves of different lengths. The blocks should be drawn in order of increasing or decreasing magnitude and they **should** be touching.

4. Terminology

(a) Wherever possible, English terms should be used in preference to Latin or Greek terms, e.g., the term red blood cell should be used and **not** erythrocyte.

(b) Where no suitable English terms exist, latinised terms are unavoidable and will need to be used, e.g., atrium, bronchi, villi.

APPENDIX 3: MATHEMATICAL REQUIREMENTS

Calculators may be used in all parts of the Assessment.

Candidates should be able to:

1. add, subtract, multiply and divide;
2. understand and use averages, decimals, fractions, percentages, ratios and reciprocals;
3. recognise and use standard notation;
4. use direct and inverse proportion;
5. use positive, whole number indices;
6. draw charts and graphs from given data;
7. interpret charts and graphs;
8. select suitable scales and axes for graphs;
9. make approximate evaluations of numerical expressions;
10. recognise and use the relationship between length, surface area and volume and their units
11. use usual mathematical instruments e.g. ruler, compasses, protractor;
12. understand the meaning of radius, diameter, square, rectangle.

APPENDIX 4: GLOSSARY OF TERMS

It is hoped that the glossary will prove helpful to candidates as a guide i.e., it is neither exhaustive nor definitive. The glossary has been deliberately kept brief with respect to the number of terms included but also to the descriptions of their meanings. Candidates should appreciate that the meaning of a term must depend, in part, on its context.

In all questions, the number of marks allocated is shown on the examination paper, and should be used as a guide by candidates to how much detail to give or time to spend in answering. In describing a process, the mark allocation should guide the candidate about how many steps to include. In explaining why something happens, it guides the candidate on how many reasons to give, or how much detail to give for each reason.

CALCULATE Used when a numerical answer is required. In general, working should be shown, especially where two or more steps are involved.

DEDUCE Used in a similar way to "Predict" except that some supporting statement is required (e.g., reference to a law, principle, or the necessary reasoning is to be included in the answer).

DEFINE (the term(s) ...) is intended literally, only a formal statement or equivalent paraphrase being required.

DESCRIBE Requires the candidate to state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena. In other contexts, describe should be interpreted more generally (i.e., the candidate has greater discretion about the nature and the organisation of the material to be included in the answer). "Describe and explain" may be coupled, as may "State and explain".

DETERMINE Often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula (e.g., resistance, the formula of an ionic compound).

DISCUSS Requires the candidate to give a critical account of the points involved in the topic.

ESTIMATE Implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

EXPLAIN May imply reasoning or some reference to theory, depending on the context.

FIND Is a general term that may variously be interpreted as "Calculate", "Measure", "Determine", etc.

LIST Requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified this should **not** be exceeded.

MEASURE Implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g., length, using a rule, or mass, using a balance).

OUTLINE Implies brevity (i.e., restricting the answer to giving essentials).

PREDICT Implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question. Predict also implies a concise answer with no supporting statement required.

SKETCH When applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct, **but** candidates should be aware that, depending on the context, some quantitative aspects may be looked for (e.g., passing through the origin, having an intercept). In diagrams, sketch implies that simple, freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.

STATE Implies a concise answer with little or no supporting argument (e.g., a numerical answer that can readily be obtained 'by inspection').

SUGGEST Used in two main contexts (either to imply that there is no unique answer, or to imply that candidates are expected to apply their general knowledge to a 'novel' situation, one that may be formally 'not in the syllabus').

PERFORM Perform an experiment in the syllabus implies that the learners will gain great benefit from carrying out such an experiment themselves, and as a result will be able to recall and explain the procedures and the associated science knowledge and understanding, demonstrate how to handle and interpret data from the experiment, and draw conclusions.

INVESTIGATE Investigate in the syllabus implies that the learners will have planned the experiment themselves before carrying it out, and as a result will be able to use hypotheses to make predictions and so explain the experimental plan, as well as the issues included above.

APPENDIX 5: GENERIC APPARATUS LIST ACROSS THE SCIENCES

The list below details the apparatus expected to be generally available for both the teaching and the examination of Paper 3. The list is not exhaustive: in particular, some items that are commonly regarded as standard equipment in a science laboratory are not included.

The *Confidential Instruction*s, provided to Centres prior to the examination of Paper 3, will give the detailed requirements for each examination.

- rulers capable of measuring to 1 mm metre rule
- means of writing on glassware
- beakers, 100 cm^3, 250 cm^3
- a polystyrene or other plastic beaker of approximate capacity 150 cm^3
- test-tubes (Pyrex or hard glass), approximately 125 mm × 16 mm
- boiling tubes, approximately 150 mm × 25 mm
- delivery tubes
- conical flasks, within the range 100 cm^3 to 250 cm^3
- measuring cylinders, within the range 10 cm^3 to100 cm^3
- dropping pipettes
- white tiles
- large containers (e.g. plastic bowl) to hold cold water generic
- thermometers, –10 °C to +110 °C with 1 °C graduations
- stopclocks (or wall clock or wrist-watch), to measure to an accuracy of 1 s
- glass rods
- spatulas
- wooden splints
- indicators (e.g. litmus paper, Universal Indicator paper, full range Universal Indicator)
- common reagents for tests (e.g. limewater test)
- burettes, 50 cm^3
- pipettes, 25 cm^3
- pipette fillers
- filter funnels and filter paper
- wash bottle
- an ammeter FSD 1 A, 1.5A
- voltmeter FSD 1 V, 5 V
- electrical cells (batteries) and holders to enable several cells to be joined
- connecting leads and crocodile clips
- d.c. power supply, variable to 12 V
- low-voltage filament lamps in holders
- various resistors and resistance wire
- switches
- good supply of masses and holders
- 2 cm expendable springs

- clamps and stands
- pendulum bobs
- newton meters
- plasticine or modelling clay
- wooden boards
- converging lens with f = 15 cm
- glass or Perspex block, rectangular and semi-circular
- glass or Perspex prism, triangular
- optics pins
- plane mirrors
- ray box

Note: the standard concentration for laboratory stock solutions is usually 1 M.

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