

General Certificate of Education
Ordinary Level

AGRICULTURE 5038

For examination in June and November 2011



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AGRICULTURE

5038

GCE Ordinary Level/School Certificate

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Information for Teachers

This booklet relates to examinations taken in the year printed on the cover. It is the normal practice of CIE to print and distribute a new version of this booklet each year. Centres should receive copies well in advance of them being required for teaching purposes.

Teachers who are about to teach syllabuses in this booklet for the first time should obtain and study the relevant past examination papers and Subject Reports.

Any queries relating to this booklet should be addressed to CIE Customer Services.

Nomenclature

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. Reference should be made to the joint statement on chemical nomenclature issued by the GCE boards. In particular, the traditional names sulfate, sulfite, nitrate, nitrite, sulfurous and nitrous acids will be used in question papers.

It is intended that, in order to avoid difficulties arising out of the use of l as the symbol for litre, use of dm^3 in place of l or litre will be made.

Units, significant figures

Candidates should be aware that misuse of units and/or significant figures, i.e. failure to quote units where necessary, the inclusion of units in quantities defined as ratios or quoting answers to an inappropriate number of significant figures, is liable to be penalised.

Exclusions

This syllabus must not be offered in the same session with the following syllabus:

0600 Agriculture

0500 Agriculture (Practical)

INTRODUCTION

It is expected that the subject matter will be treated practically as far as is possible. Some of the practical work will be in the form of experiments, demonstrations and visits to places of agricultural interest, but candidates will also be expected to have carried out individual and group practical work in agriculture; at least on a small scale, such as in a school garden.

AIMS

The syllabus aims to:

1. promote an appreciation of agriculture as an applied science;
2. stimulate an interest in, and create an awareness of, existing problems and opportunities in agricultural and rural development;
3. stimulate positive attitudes by showing that efficient farming can be both a profitable and a rewarding occupation;
4. develop positive attitudes towards the country's natural resources so as to conserve and use them wisely;
5. demonstrate the value of agriculture to the family and community, so as to show how improved agriculture can contribute to the worldwide campaign for freedom from hunger;
6. encourage the teaching, in a practical manner, of basic principles and skills in agriculture and of efficient farm business management;
7. ensure that schools take an active part in rural development by integration of agricultural activities into the school curriculum;
8. encourage the development of a school farm, ensuring that students actively participate in the farming events throughout the course, including at weekends and during school holidays;
9. develop initiative, problem-solving abilities, scientific methods and self-education so as to encourage resourcefulness and self-reliance;
10. provide a basis, together with the basic sciences and mathematics, for more advanced studies in agriculture.

ASSESSMENT OBJECTIVES

There are three assessment objectives that describe the knowledge, skills and abilities that candidates are expected to demonstrate at the end of the course. They reflect those aspects of the aims that will be assessed.

A Knowledge with understanding

Students should be able to demonstrate agricultural knowledge and understanding in relation to the correct use of:

1. facts, concepts, principles, patterns, models and theories;
2. terms, symbols, quantities and units;
3. the techniques, procedures and principles of safe agricultural practice.

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

B Handling information and solving problems

Students should be able – using oral, written, symbolic, graphical and numerical forms of presentation – to:

1. locate, select, organise and present information from a variety of sources;
2. translate information from one form to another;
3. use information to identify patterns, report trends and draw inferences;
4. present reasoned explanations for phenomena, patterns and relationships;
5. make predictions and propose hypotheses;
6. solve problems, including some of a quantitative nature.

These assessment objectives cannot be precisely specified in the subject 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* or *determine*. (See the glossary of terms at the back of this booklet.)

C Experimental skills and investigations

Students should be able to:

1. use and organise techniques, apparatus and material;
2. observe, measure and record;
3. interpret and evaluate experimental observations and data;
4. plan and carry out investigations (and, where appropriate, make predictions and propose hypotheses);
5. suggest improvements to their planned investigations.

Weighting of Assessment Objectives**Theory Paper (Paper 1)**

A Knowledge with understanding, approximately 45% of the marks.

B Handling information and solving problems, approximately 55% of the marks.

Practical Assessment (Papers 2 and 3)

This is designed to test appropriate skills in Assessment Objective C, *Experimental skills and investigations*.

SCHEME OF ASSESSMENT

Candidates are required to enter for Paper 1 and either *Paper 2 or Paper 3.

Paper	Type of Paper	Duration	Marks	Weighting
1	Theory	2 h	100	77%
2	*Teacher-assessed Coursework	-	30	23%
3	Practical Test	1 h 15 min	30	23%

Paper 1 Theory (2 h, 100 marks), consisting of two sections

Section A will carry 55 marks and will contain a number of compulsory, short, structured questions.

Section B will carry 45 marks and will contain five free response questions, each of 15 marks. Candidates are required to answer any three questions.

***Paper 2** Teacher-assessed Coursework (30 marks)

This is a Coursework assessment, marked by the teacher and moderated by the Ministries. Detailed instructions for teacher assessment are available from the Ministries of Education. ***This component is only available to those countries with whom a prior arrangement has been made with CIE.**

Paper 3 Practical Test (1 hr 15 min, 30 marks)

This will consist of a practical examination marked by CIE. Questions will cover experimental and observational skills based mainly on Assessment Objective C.

Candidates may be asked to carry out exercises that involve:

- following a sequence of instructions;
- the use of familiar and unfamiliar techniques to record observations and make deductions from them;
- performing simple physiological experiments (e.g. tests for food substances and use of litmus and Universal Indicator);
- the use of a hand lens of not less than x6 magnification for the recognition, observation and recording of familiar and unfamiliar specimens;
- making clear line drawings of specimens provided, giving an indication of the magnification of the drawings and labelling as required.

It is expected that glassware and instruments normally found in a laboratory (e.g. beakers, test-tubes, test-tube rack or other holder, funnels, thermometers, specimen tubes, Petri dishes, syringes, droppers, glass rods, a means of heating the equipment referred to above, hand lens (at least x6), will be available for these experiments, along with reagents (e.g. for food tests), litmus paper and Universal Indicator (liquid and paper).

When planning practical work, teachers should make sure that they do not contravene any school, education authority or government regulations.

SUBJECT CONTENT

Asterisks (*) placed alongside learning outcomes indicate areas of the syllabus that present opportunities for practical work.

1. General Agriculture

Content

- 1.1 General principles of land use
- 1.2 National agricultural programmes

Learning Outcomes

Candidates should be able to:

- (a) describe different forms of land use, including different agricultural systems and farming practices (rotations, mixed farming and monoculture), forestry and wildlife management in game parks;
- (b) describe and explain the ways in which the uses of land in different areas may be limited by topographical, climatic and other environmental factors;
- (c) understand that population growth leads to a need for efficient use of land and farm planning;
- (d) explain the value of national agricultural programmes and of research.

2. Soil

Content

- 2.1 Soil formation
- 2.2 Soil types, structure and texture
- 2.3 Soil temperature
- 2.4 Soil fertility
- 2.5 Soil erosion
- 2.6 Water cycle

Learning Outcomes

Candidates should be able to:

- (a) explain soil formation from parent material by physical, chemical and biological agents of weathering;
- (b) describe soil profile in terms of top soil, sub-soil and underlying materials;
- (c) *describe soil texture in terms of different sizes of soil particles, sand, silt and clay, and also carry out a practical assessment of texture of soils;
- (d) understand soil structure including the importance of forming and maintaining a good crumb structure, the effects of humus and maintenance of organic matter in the soil, oxidation of organic matter and the loss of soil structure causing capping and soil pans;
- (e) *describe different soil types (sandy soils, loam soils and clay soils) and their properties, including water-holding capacity and drainage;
- (f) outline soil constituents in terms of mineral matter, organic matter, air, water (free or gravitational water, capillary and hygroscopic water) and living organisms (bacteria, nematodes, fungi and earthworms);

- (g) *understand the influence of soil temperature on the rate of plant growth, the danger of excessive heat to young seedlings and the danger of frost to some crops, and the methods of reducing the effect of extreme temperatures by mulching of seed beds and shading of transplanted seedlings;
- (h) *explain the importance of the following nutrients to soil fertility and describe the signs and effects of their deficiency in plants:
 - major nutrients – compounds of nitrogen, phosphorus, potassium, calcium, magnesium and sulfur;
 - minor nutrients – iron, manganese, boron and molybdenum;
- (i) *carry out practical soil sampling and tests for soil pH;
- (j) *carry out wet tests to determine the presence of the following ions: ammonium, calcium, carbonate, nitrate and sulfate.

WET TESTS FOR THE PRESENCE OF IONS

ion	Test	test result
ammonium (NH ₄ ⁺)	add aqueous sodium hydroxide; warm carefully	ammonia produced
calcium (Ca ²⁺)	add aqueous sodium hydroxide	white precipitate
carbonate (CO ₃ ²⁻)	add dilute acid	effervescence, carbon dioxide produced
nitrate (NO ₃ ⁻) [in solution]	add aqueous sodium hydroxide then aluminium foil; warm carefully	ammonia produced
sulfate (SO ₄ ²⁻) [in solution]	acidify with dilute nitric acid then add aqueous barium nitrate	white precipitate

- (k) describe the nitrogen cycle and its importance to soil fertility;
- (l) explain the importance of legumes, the use of inorganic fertilisers (limited to **one** example each of a fertiliser containing predominantly nitrogen, predominantly phosphorus and predominantly potassium and **one** example of a compound fertiliser), fertilising practices, the influence of soil pH, lime and liming, on soil fertility;
- (m) describe types of soil erosion, their causes, agents, prevention and control;
- (n) describe drainage as movement of gravitational water down through the soil and understand the drainage of waterlogged land by means of ditches and the loss of plant nutrients due to leaching;
- (o) understand the effects of poor drainage on soil organisms and root respiration;
- (p) explain the need for irrigation and describe methods of irrigation with its effects on crop yield and quality (details of irrigation programmes for individual crops and of equipment specification are **not** required);
- (q) describe and understand the significance of the water cycle and ground water resources.

3. Principles of Plant Growth

Content

- 3.1 Movement of materials through plants
- 3.2 Carbon cycle
- 3.3 Reproduction in plants
- 3.4 Germination

Learning Outcomes

Candidates should be able to:

- (a) describe the distribution and function of root tissues and the structure and function of root hairs;
- (b) *explain the absorption of plant requirements from the soil, including the principles of diffusion, osmosis, the passage of water and dissolved mineral salts through vascular tissues;
- (c) *explain how the structure of a leaf is related to function (cellular detail is **not** required);
- (d) outline gas exchange by diffusion through the stomata;
- (e) describe photosynthesis in terms of carbon dioxide, water, light and chlorophyll leading to the synthesis of carbohydrates and the production of oxygen;
- (f) describe the distribution and function of tissues in a stem (dicotyledon only);
- (g) define *translocation* in terms of the movement of synthesised food to storage organs and explain the principles of modification of different parts of plants to form food storage organs and the types of food materials stored;
- (h) explain transpiration in terms of the transpiration stream, loss of water by evaporation and diffusion of water vapour through stomata;
- (i) describe the effects of temperature, humidity, wind and light intensity on the rate of transpiration;
- (j) describe the carbon cycle;
- (k) define *sexual reproduction*;
- (l) describe the structure and functions of the flowers of a maize plant and of a bean plant;
- (m) define *pollination*;
- (n) describe the process of fertilization;
- (o) describe the formation of seed and fruit;
- (p) describe how seeds and fruits are dispersed and explain the importance of dispersal in relation to weed control;
- (q) *describe asexual reproduction from stem tubers (e.g. Irish potato and yam) and from stem cuttings (e.g. sweet potato, cassava and sugar cane);
- (r) *describe seed structure and the germination of maize and bean (or other legume) and understand the conditions required for germination.

4. Crop Production**Content**

4.1 Land preparation

4.2 Cultivation of cash crops

Learning Outcomes

Candidates should be able to:

- (a) describe land preparation by stumping and clearing and soil preparation by primary and secondary cultivations by hand or machine (e.g. ploughing or digging, harrowing or raking);
- (b) name the main types of crop found locally (legumes, roots and tubers, edible fruits and cereals) and their products;
- (c) *describe in detail the cultivation of **one** crop of local importance in relation to soil and climatic requirements, soil preparation, sowing or planting time and method, choice of suitable cultivars, seed rate and spacing, rates of application of fertiliser and manure, prevention and control of common pests, weeds and diseases, recognition of crop maturity, harvesting, yield and storage, marketing, uses of byproducts, relevant legislation and record keeping (including a diary of events, production and financial records).

5. Crop Protection**Content**

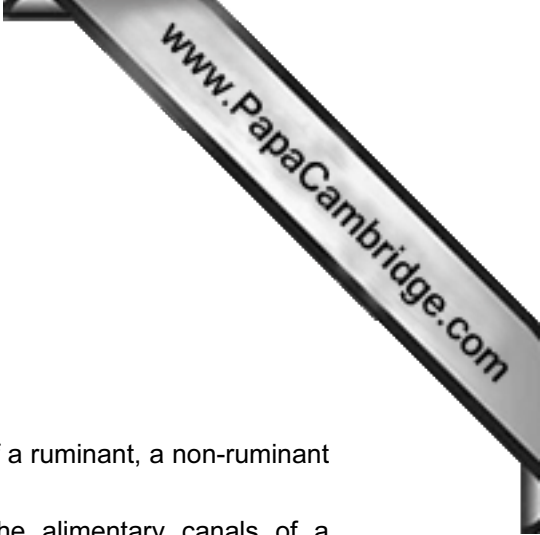
5.1 Chemical and biological control of pests

5.2 Safe handling of farm chemicals

Learning Outcomes

Candidates should be able to:

- (a) describe the life cycle, effect and method of spread of **one** pest from **each** of the following:
 - biting and chewing pests (e.g. grasshoppers, locusts, termites, leaf miners and beetles);
 - piercing and sucking pests (e.g. aphids, Bagrada bugs, mealy bugs and scale insects);
 - boring pests (e.g. weevils, stalk borer and American bollworm (*Heliothus spp.*));
- (b) name and describe the mode of action of chemical controls for pests including contact pesticides and systemic pesticides (either chemical or brand names are acceptable) and understand the appropriate use of these pesticides in controlling pests in the groups listed above;
- (c) outline biological and biotechnical methods of controlling pests;
- (d) describe methods of cultural pest control including rotation and catch cropping;
- (e) describe the mode of infection, harmful effects, prevention and control of **one named** plant disease from each of the following groups:
 - bacterial diseases, fungal diseases and viral diseases;
- (f) *explain the importance and methods of safe handling and storage of farm chemicals, including the use of specifically designed protective clothing, correct dilution and mixing, precautions before, during and after application and avoidance of pollution when cleaning spraying equipment.



6. Livestock Anatomy and Physiology

Content

- 6.1 Digestion in ruminants, non-ruminants and poultry
- 6.2 Sexual reproduction in mammals

Learning Outcomes

Candidates should be able to:

- (a) describe the structure and function of the digestive system of a ruminant, a non-ruminant and poultry;
- (b) describe the processes of digestion and absorption in the alimentary canals of a ruminant and a non-ruminant (reference to specific enzymes is **not** required);
- (c) describe the reproductive systems (male and female) of a **named** mammalian farm animal;
- (d) describe the processes of fertilisation and birth in a **named** mammalian farm animal;
- (e) define *weaning* and *lactation* and understand the importance of colostrum.

7. Livestock Production and Health

Content

- 7.1 Livestock housing
- 7.2 Livestock nutrition
- 7.3 Livestock health
- 7.4 Study of **one** ruminant and **one** non-ruminant animal (may be poultry) with particular reference to (a) to (h) below

Learning Outcomes

Candidates should be able to:

- (a) describe suitable housing and living conditions for livestock;
- (b) describe the care and rearing of young stock;
- (c) describe the nutritional requirements (including food materials, their nutritional content and signs of deficiency) and feeding practices (including the importance of a balanced ration suited to the age and the stage of development of the livestock);
- (d) carry out food tests to determine the presence of the following substances: protein, reducing sugar and starch;

FOOD TESTS

substance	test	result
protein	add aqueous sodium hydroxide and aqueous copper sulfate	purple
reducing sugar	warm with Benedict's solution	orange
starch	add iodine solution	blue/black

- (e) outline the meaning of the terms *maintenance ration* and *production ration*;
- (f) explain the importance of an adequate, clean water supply;
- (g) *demonstrate stockmanship, including care in the handling of animals, record keeping, including a diary of events, production and financial records;
- (h) describe the storage, processing and uses of livestock products;
- (i) recognise the signs of health and of ill-health in livestock;

- (j) explain the ways in which infectious and contagious diseases are spread;
- (k) explain the problems caused by parasites;
- (l) explain what is meant by the terms *notifiable/scheduled diseases*;
- (m) explain the importance of livestock hygiene and the isolation of sick animals.

8. Pasture Management

Content

8.1 Extensive pasture management

8.2 Intensive pasture management

Learning Outcomes

Candidates should be able to:

- (a) describe the vegetation of grazing lands, including grasses and legumes for grazing and bush for browsing;
- (b) describe how improved pastures can be established;
- (c) explain what is meant by *rotational grazing, paddock* and *zero grazing, unenclosed* and *enclosed grazing systems* and *intensive* and *extensive grazing*;
- (d) describe extensive management methods, including the importance of stocking rates, carrying capacity and the dangers of overstocking, bush control and the use and misuse of fire;
- (e) explain how pasture utilisation can be improved by fencing and rotational grazing.

9. Crop and Livestock Breeding

Content

9.1 Monohybrid inheritance

9.2 Selective breeding in animals and plants

Learning Outcomes

Candidates should be able to:

- (a) define the terms *chromosome, gene, allele, homozygous, heterozygous, dominant* and *recessive*;
- (b) calculate and predict the results of simple genetic crosses involving 1:1 and 3:1 ratios;
- (c) explain the meaning of *genotype* and *phenotype* and assess their importance in animal and plant breeding;
- (d) describe how breeding can improve yield, disease resistance, hardiness and appearance in livestock and in crops;
- (e) understand the role of artificial selection in the production of improved varieties of animals and plants of economic importance;
- (f) understand the benefits of artificial insemination.

10. Farm Structures and Tools

Content

10.1 Fencing

10.2 Farm buildings

10.3 Farm water supplies

10.4 Farm tools

Learning Outcomes:

Candidates should be able to:

- (a) describe the treatment of fencing posts, methods of fence construction, types of fence suitable for different purposes, the use of hedges and windbreaks;
- (b) outline the properties and uses of wood, concrete blocks, metal, stone, brick, earth and thatch in the construction of farm buildings;
- (c) list suitable sources of water for human consumption, for livestock and for irrigation;
- (d) outline methods of water treatment by settling and filtration;
- (e) outline suitable methods of construction of storage dams to resist water pressure, which increases with depth;
- (f) describe the use of storage tanks, the distribution of water through pipe systems and simple plumbing, sufficient for maintaining a plastic pipe system, including pipe-joining and fitting of tap washers;
- (g) *describe the use and maintenance of saw, hammer, screwdriver, file, spanner, sprayer and hand tools for cultivation.

11. Farm Machinery

Content

11.1 Engines

11.2 Machinery

Learning Outcomes

Candidates should be able to:

- (a) *identify the parts of an engine and state their functions, including cylinders, pistons, connecting rods, crankshaft, camshaft, valves and spark plugs (only in sufficient detail to show how the four-stroke cycle operates);
- (b) explain the differences between petrol and diesel engines;
- (c) explain the advantages and disadvantages of farm mechanization;
- (d) describe the use and maintenance of mould-board plough, cultivator, harrow, planter and ridger (either ox- or donkey- or tractor-drawn);
- (e) *demonstrate understanding and practical application of *centre of gravity*;
- (f) outline safety precautions in handling and storing inflammable fuels and in checking batteries.

RESOURCE LIST – 5038

Teachers may find reference to the following textbooks helpful.

- | | |
|---|--|
| O. Akinsanmi | <i>Senior Secondary Agricultural Science</i> (1990)
Pearson Education 0582003407 |
| A. King | <i>Agriculture: An Introduction for Southern Africa</i> (1985)
Cambridge University Press 052127317X |
| M. F. Komolafe, A. A. Adegbola,
L. A. Are & T. I. Ashaye | <i>Agricultural Science for West African Schools and Colleges</i>
(2 nd Ed. 1985) Oxford University Press (Nigeria)
0195754921 |
| M. F. Komolafe & D. C. Joy | <i>Agricultural Science for Senior Secondary Schools:</i>
Books 1-3 (1990-92) University Press, Ibadan, Nigeria
9781545860, 9781549684, 9782490806 |
| J. Kwarteng & M. Towler | <i>West African Agriculture</i> (1994)
Macmillan Education 0333470303 |
| J. Okorie | <i>Junior Tropical Agriculture for West Africa: Books 2-3</i>
(1985–91) Macmillan Heinemann Educational Publishing
(Book 1 not in print at present) 0333359909, 0333326466 |
| I. C. Onwueme (Ed.) | <i>Cassell's Tropical Agriculture: Books 1-3</i>
Cassell plc 030430 – 2090 – 2082 – 2074 |
| G. Owen | <i>O Level Agriculture for Central Africa</i> (1984)
Pearson Education 0582651034 |
| Scheckman et al | <i>Focus on Agriculture (Zimbabwe): Books 1-3</i>
College Press 08692 – 57633 – 54081 – 55908 |
| I. Scoones (Ed.) | <i>Dynamics and Diversity – Soil Fertility and Farming
Livelihoods in Africa</i> (2001) Earthscan Publications
(www.earthscan.co.uk) 1853838209 |
| Sibanda | <i>Agriculture for Botswana</i> (1983)
Macmillan Heinemann Educational Publishing 0333351258
(out of print) |

Some helpful websites available at the time of writing

<http://www.saps.plantsci.cam.ac.uk/> SAPS (Science and Plants for Schools)

<http://www.bbc.co.uk/schools/gcsebitesize/biology/> GCSE BITESIZE revision in biology

<http://www.nationalacademies.org/webextra/crops> Technology to Feed the World

http://www.learnagriculture.org/html/classroom_activities.cfm Minnesota Department of Agriculture
– lots of different agriculture education materials

<http://www.michiganfarmbureau.com/php-toolkit/aglinks.php/> links to agriculture education and
other sites

www.soilassociation.org/sa/saweb.nsf/library?openform soil association online library with many
different resources on organic farming

<http://www.newforestsproject.com/> New Forests Project

www.unl.edu/nac/afnotes/ff-1 notes on forestry farming

GLOSSARY OF TERMS USED IN BIOLOGICAL SCIENCES PAPERS

During the moderation of a question paper, care is taken to ensure that the paper and its individual questions are, in relation to the syllabus, fair as regards balance, overall difficulty and suitability. Attention is also paid to the wording of questions to ensure that it is as concise and as unambiguous as possible. In many instances, Examiners are able to make appropriate allowance for an interpretation that differs, but acceptably so, from the one intended.

It is hoped that the glossary (which is relevant only to biology, human and social biology and agriculture) will prove helpful to candidates as a guide (i.e. it is neither exhaustive nor definitive). The glossary has been deliberately kept brief not only 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.

1. *Define* (the term(s)...) is intended literally, only a formal statement or equivalent paraphrase being required.
2. *What is meant by* (the term(s)...) normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.
3. *State* implies a concise answer with little or no supporting argument (e.g. a numerical answer that can readily be obtained 'by inspection').
4. *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.
5. (a) *Explain* may imply reasoning or some reference to theory, depending on the context. It is another way of asking candidates to give reasons for. The candidate needs to leave the examiner in no doubt **why** something happens.
(b) *Give a reason/Give reasons* is another way of asking candidates to explain **why** something happens.
6. (a) *Describe*, the data or information given in a graph, table or diagram, requires the candidate to state the key points that can be seen in the stimulus material. Where possible, reference should be made to numbers drawn from the stimulus material.
(b) *Describe*, a process, requires the candidate to give a step by step written statement of what happens during the process.
Describe and *explain* may be coupled, as may *state* and *explain*.
7. *Discuss* requires the candidate to give a critical account of the points involved in the topic.
8. *Outline* implies brevity (i.e. restricting the answer to giving essentials).
9. *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.
10. *Deduce* is 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).
11. *Suggest* is used in two main contexts (i.e. either to imply that there is no unique answer (e.g. in chemistry, two or more substances may satisfy the given conditions describing an 'unknown') 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').
12. *Find* is a general term that may variously be interpreted as *calculate*, *measure*, *determine*, etc.

13. *Calculate* is used when a numerical answer is required. In general, working should be shown, especially where two or more steps are involved.
14. *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).
15. *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. the Young modulus, relative molecular mass).
16. *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.
17. *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, asymptote or discontinuity at a particular value).

In diagrams, *sketch* implies that a simple, freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.

In all questions, the number of marks allocated are shown on the examination paper and should be used as a guide by candidates to how much detail to give. 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 how many reasons to give, or how much detail to give for each reason.