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IGCSE

Science (Double Award)

Specification

Edexcel IGCSE in Science (Double Award) (4SC0)

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This specification is Issue 3. Key changes are sidelined. The latest issue can be found on the Edexcel website: www.edexcel.com

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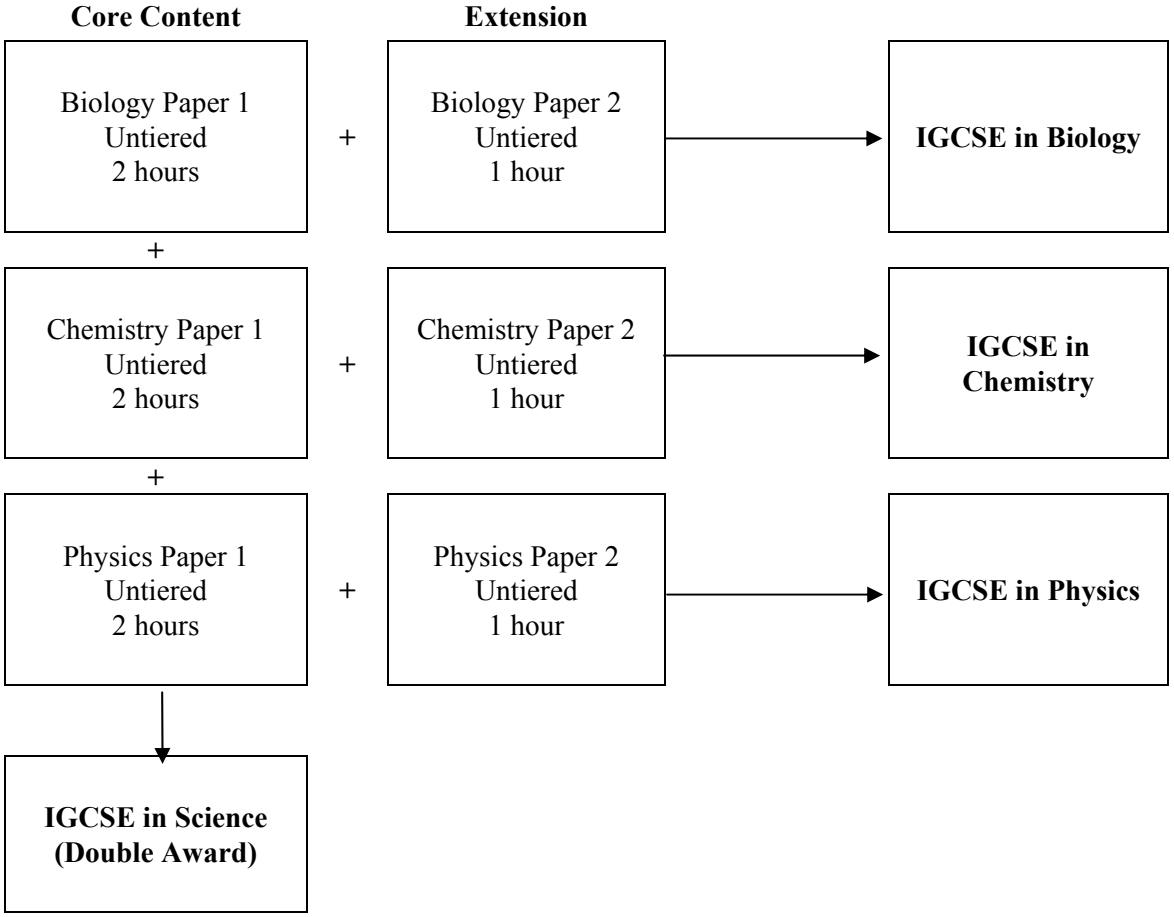
Introduction

The Edexcel International General Certificate of Secondary Education (IGCSE) in Science (Double Award) is designed as a two-year course of study. It takes approximately two-thirds of the subject content of each of the Edexcel IGCSE single sciences (Biology, Chemistry and Physics), and combines them into an IGCSE in Science (Double Award) specification worth two IGCSEs. It is designed to be an interesting and inspiring modern specification. The course offers opportunity for students to experience science within the context of their general education. In terms of progression, the design of the course provides a base to further study in GCE Advanced Subsidiary and Advanced Level Biology, Chemistry and Physics.

The relationship of assessment to the qualifications available is shown below.



About this specification

Key features and benefits of the specification

Key features and benefits are:

- students are awarded two IGCSE grades, reflecting study of the prescribed amount of subject content
- clear, detailed and comprehensive subject content with straightforward linear assessment
- it requires less curriculum time than teaching the three sciences individually
- there are no tiered papers
- it has assessment of investigative skills integrated within the examinations
- it provides a sound foundation for progression to Edexcel's GCE Advanced Subsidiary and Advanced level science specifications.

Key subject aims

The Edexcel IGCSE in Science (Double Award) enables students to:

- acquire a systematic body of scientific knowledge and facts, and an understanding of scientific concepts, principles, themes and patterns
- appreciate the practical nature of science, acquiring experimental skills based on correct and safe laboratory techniques
- appreciate the importance of accurate experimental work to scientific method and reporting
- form hypotheses and design experiments to test them
- sustain and develop an enjoyment of, and interest in, the scientific world
- appreciate the significance of science in wider personal, social, environmental, economic and technological contexts, and consider ethical issues
- select, organise and present information clearly and logically, using appropriate scientific terms and conventions
- prepare for more advanced courses in each of the three scientific disciplines which comprise this specification.

Contents

Specification at a glance

This Edexcel IGCSE in Science (Double Award) comprises three externally assessed papers:

- Biology Paper 1
- Chemistry Paper 1
- Physics Paper 1.

Biology paper 1	**Paper code: 4SC0/1B**
• Externally assessed • Availability: January and June series • First assessment: June 2011	**33.3% of the total Double Award IGCSE marks**
Overview of content: • Section 1: The nature and variety of living organisms • Section 2: Structures and functions in living organisms • Section 3: Reproduction and inheritance • Section 4: Ecology and the environment • Section 5: Use of biological resources.	
Overview of assessment: • The paper is assessed through a 2-hour examination paper set and marked by Edexcel. • The total number of marks is 120.	

Chemistry paper 1	**Paper code: 4SC0/1C**
• Externally assessed • Availability: January and June series • First assessment: June 2011.	**33.3% of the total Double Award IGCSE marks**
Overview of content: • Section 1: Principles of chemistry • Section 2: Chemistry of the elements • Section 3: Organic chemistry • Section 4: Physical chemistry • Section 5: Chemistry in society.	
Overview of assessment: • The paper is assessed through a 2-hour examination paper set and marked by Edexcel. • The total number of marks is 120.	

Physics paper 1	**Paper code: 4SC0/1P**
• Externally assessed • Availability: January and June series • First assessment: June 2011	**33.3% of the total Double Award IGCSE marks**
Overview of content: • Section 1: Forces and motion • Section 2: Electricity • Section 3: Waves • Section 4: Energy resources and energy transfer • Section 5: Solids, liquids and gases • Section 6: Magnetism and electromagnetism • Section 7: Radioactivity and particles	
Overview of assessment: • The paper is assessed through a 2-hour examination paper set and marked by Edexcel. • The total number of marks is 120.	

Qualification content

Biology

Section 1: The nature and variety of living organisms

a) Characteristics of living organisms

b) Variety of living organisms

a) Characteristics of living organisms

Students will be assessed on their ability to:

1.1 recall that living organisms share the following basic characteristics:

- they require nutrition
- they respire
- they excrete their waste
- they respond to their surroundings
- they move
- they control their internal conditions
- they reproduce
- they grow and develop.

b) Variety of living organisms

Students will be assessed on their ability to:

1.2 describe the common features shared by organisms within the following main groups, plants, animals, fungi, bacteria, protoctists and viruses, and for each group describe examples and their features as follows (details of life cycle and economic importance are **not** required).

Plants: These are multicellular organisms; they contain chloroplasts and are able to carry out photosynthesis; they have cellulose cell walls; they store carbohydrates as starch or sucrose.

Examples include flowering plants, such as a cereal (for example maize) and a herbaceous legume (for example peas or beans).

Animals: These are multicellular organisms; they do not contain chloroplasts and are not able to carry out photosynthesis; they have no cell walls; they usually have nervous coordination and are able to move from one place to another; they often store carbohydrate as glycogen.

Examples include mammals (for example humans) and insects (for example housefly and mosquito).

Fungi: These are organisms that are not able to carry out photosynthesis; their body is usually organised into a mycelium made from thread-like structures called hyphae, which contain many nuclei; some examples are single-celled; they have cell walls made of chitin; they feed by extracellular secretion of digestive enzymes onto food material and absorption of the organic products; this is known as saprotrophic nutrition; they may store carbohydrate as glycogen.

Examples include *Mucor*, which has the typical fungal hyphal structure, and yeast which is single-celled.

Bacteria: These are microscopic single-celled organisms; they have a cell wall, cell membrane, cytoplasm and plasmids; they lack a nucleus but contain a circular chromosome of DNA; some bacteria can carry out photosynthesis but most feed off other living or dead organisms.

Examples include *Lactobacillus bulgaricus*, a rod-shaped bacterium used in the production of yoghurt from milk, and *Pneumococcus*, a spherical bacterium that acts as the pathogen causing pneumonia.

Protoctists: These are microscopic single-celled organisms. Some, like *Amoeba,* that live in pond water, have features like an animal cell, while others, like *Chlorella*, have chloroplasts and are more like plants. A pathogenic example is *Plasmodium*, responsible for causing malaria.

Viruses: These are small particles, smaller than bacteria; they are parasitic and can reproduce only inside living cells; they infect every type of living organism. They have a wide variety of shapes and sizes; they have no cellular structure but have a protein coat and contain one type of nucleic acid, either DNA or RNA.

Examples include the tobacco mosaic virus that causes discolouring of the leaves of tobacco plants by preventing the formation of chloroplasts, the influenza virus that causes 'flu' and the HIV virus that causes AIDS.

1.3 Recall the term 'pathogen' and know that pathogens may be fungi, bacteria, protoctists or viruses.

Section 2: Structures and functions in living organisms

a) Levels of organisation

b) Cell structure

c) Biological molecules

d) Movement of substances into and out of cells

e) Nutrition

f) Respiration

g) Gas exchange

h) Transport

i) Excretion

j) Coordination and response

a) Levels of organisation

Students will be assessed on their ability to:

2.1 describe the levels of organisation within organisms: organelles, cells, tissues, organs and systems.

b) Cell structure

Students will be assessed on their ability to:

2.2 recognise cell structures, including the nucleus, cytoplasm, cell membrane, cell wall, chloroplast and vacuole

2.3 describe the functions of the nucleus, cytoplasm, cell membrane, cell wall, chloroplast and vacuole

2.4 describe the differences between plant and animal cells.

c) Biological molecules

Students will be assessed on their ability to:

2.5 recall the chemical elements present in carbohydrates, proteins and lipids (fats and oils)

2.6 describe the structure of carbohydrates, proteins and lipids as large molecules made up from smaller basic units: starch and glycogen from simple sugar; protein from amino acids; lipid from fatty acids and glycerol

2.7 describe the tests for glucose and starch

2.8 understand the role of enzymes as biological catalysts in metabolic reactions

2.9 understand how the functioning of enzymes can be affected by changes in temperature

2.10 describe how to carry out simple controlled experiments to illustrate how enzyme activity can be affected by changes in temperature.

d) Movement of substances into and out of cells

Students will be assessed on their ability to:

2.11 recall simple definitions of diffusion, osmosis and active transport

2.12 understand that movement of substances into and out of cells can be by diffusion, osmosis and active transport

2.13 understand the factors that affect the rate of movement of substances into and out of cells, to include the effects of surface area to volume ratio, temperature and concentration gradient

2.14 describe simple experiments on diffusion and osmosis using living and non-living systems.

e) Nutrition

Students will be assessed on their ability to:

Flowering plants

2.15 describe the process of photosynthesis and understand its importance in the conversion of light energy to chemical energy

2.16 recall the word equation and the balanced chemical symbol equation for photosynthesis

2.17 understand how carbon dioxide concentration, light intensity and temperature affect the rate of photosynthesis

2.18 explain how the structure of the leaf is adapted for photosynthesis

2.19 recall that plants require mineral ions for growth and that magnesium ions are needed for chlorophyll and nitrate ions are needed for amino acids

2.20 describe simple controlled experiments to investigate photosynthesis, showing the evolution of oxygen from a water plant, the production of starch and the requirements of light, carbon dioxide and chlorophyll

Humans

2.21 recall sources and describe functions of carbohydrate, protein, lipid (fats and oils), vitamins A, C and D, the mineral ions calcium and iron, water and dietary fibre as components of the diet

2.22 recognise of the structures of the human alimentary canal and describe in outline the functions of the mouth, oesophagus, stomach, small intestine, large intestine and pancreas

2.23 understand the processes of ingestion, digestion, absorption, assimilation and egestion

2.24 explain how and why food is moved through the gut by peristalsis

2.25 understand the role of digestive enzymes, to include the digestion of starch to glucose by amylase and maltase, the digestion of proteins to amino acids by proteases and the digestion of lipids to fatty acids and glycerol by lipases

2.26 recall that bile is produced by the liver and stored in the gall bladder, and understand the role of bile in neutralising stomach acid and emulsifying lipids

2.27 explain how the structure of a villus helps absorption of the products of digestion in the small intestine.

f) Respiration

Students will be assessed on their ability to:

2.28 recall that the process of respiration releases energy in living organisms

2.29 describe the differences between aerobic and anaerobic respiration

2.30 recall the word equation and the balanced chemical symbol equation for aerobic respiration in living organisms

2.31 recall the word equation for anaerobic respiration in plants and in animals.

g) Gas exchange

Students will be assessed on their ability to:

2.32 understand the role of diffusion in gas exchange

Flowering plants

2.33 understand gas exchange (of carbon dioxide and oxygen) in relation to respiration and photosynthesis

2.34 explain how the structure of the leaf is adapted for gas exchange

2.35 describe the role of stomata in gas exchange

Humans

2.36 describe the structure of the thorax, including the ribs, intercostal muscles, diaphragm, trachea, bronchi, bronchioles, alveoli and pleural membranes

2.37 understand the role of the intercostal muscles and the diaphragm in ventilation

2.38 explain how alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries

2.39 understand the biological consequences of smoking in relation to the lungs and the circulatory system

2.40 describe a simple experiment to investigate the effect of exercise on breathing in humans.

h) Transport

Students will be assessed on their ability to:

2.41 understand why simple, unicellular organisms can rely on diffusion for movement of substances in and out of the cell

2.42 understand the need for a transport system in multicellular organisms

Flowering plants

2.43 describe the role of the xylem in transporting water and mineral salts from the roots to other parts of the plant

2.44 explain how water is absorbed by root hair cells

2.45 recall that transpiration is the evaporation of water from the surface of a plant

2.46 explain how the rate of transpiration is affected by changes in humidity, wind speed, temperature and light intensity

2.47 describe experiments that investigate the role of environmental factors in determining the rate of transpiration from a leafy shoot

Humans

2.48 recall the composition of the blood: red blood cells, white blood cells, platelets and plasma

2.49 understand the role of plasma in the transport of carbon dioxide, digested food, urea, hormones and heat energy

2.50 describe the adaptations of red blood cells for the transport of oxygen, including shape, structure and the presence of haemoglobin

2.51 describe how the immune system responds to disease using white blood cells, illustrated by phagocytes ingesting pathogens and lymphocytes releasing antibodies specific to the pathogen

2.52 describe the structure of the heart and how it functions

2.53 understand that the heart rate changes during exercise and under the influence of adrenaline

2.54 describe the structure of arteries, veins and capillaries and understand their roles

2.55 recall the general plan of the circulation system to include the blood vessels to and from the heart, the lungs, the liver and the kidneys.

i) Excretion

Flowering plants

Students will be assessed on their ability to:

2.56 recall the origin of carbon dioxide and oxygen as waste products of metabolism and their loss from the stomata of a leaf

Humans

2.57 recall that the lungs, kidneys and skin are organs of excretion

2.58 understand how the kidney carries out its roles of excretion and of osmoregulation

2.59 describe the structure of the urinary system, including the kidneys, ureters, bladder and urethra

2.60 describe the structure of a nephron, to include Bowman's capsule and glomerulus, convoluted tubules, loop of Henlé and collecting duct

2.61 describe ultrafiltration in the Bowman's capsule and the composition of the glomerular filtrate

2.62 understand that water is reabsorbed into the blood from the collecting duct

2.63 understand that selective reabsorption of glucose occurs at the proximal convoluted tubule

2.64 describe the role of ADH in regulating the water content of the blood

2.65 recall that urine contains water, urea and salts.

j) Coordination and response

Students will be assessed on their ability to:

2.66 understand that organisms are able to respond to changes in their environment

2.67 understand that homeostasis is the maintenance of a constant internal environment and that body water content and body temperature are both examples of homeostasis

2.68 understand that a coordinated response requires a stimulus, a receptor and an effector

Flowering plants

2.69 understand that plants respond to stimuli

2.70 describe the geotropic responses of roots and stems

2.71 describe positive phototropism of stems

Humans

2.72 describe how responses can be controlled by nervous or by hormonal communication and understand the differences between the two systems

2.73 recall that the central nervous system consists of the brain and spinal cord and is linked to sense organs by nerves

2.74 understand that stimulation of receptors in the sense organs sends electrical impulses along nerves into and out of the central nervous system, resulting in rapid responses

2.75 describe the structure and functioning of a simple reflex arc illustrated by the withdrawal of a finger from a hot object

2.76 describe the structure and function of the eye as a receptor

2.77 understand the sources, roles and effects of the following hormones: ADH, adrenaline, insulin, testosterone, progesterone and oestrogen.

Section 3: Reproduction and inheritance

a) Reproduction

b) Inheritance

a) Reproduction

Students will be assessed on their ability to:

3.1 describe the differences between sexual and asexual reproduction

3.2 understand that fertilisation involves the fusion of a male and female gamete to produce a zygote that undergoes cell division and develops into an embryo

Flowering plants

3.3 describe the structures of an insect-pollinated and a wind-pollinated flower and explain how each is adapted for pollination

3.4 understand that the growth of the pollen tube followed by fertilisation leads to seed and fruit formation

3.5 understand that plants can reproduce asexually by natural methods (illustrated by runners) and by artificial methods (illustrated by cuttings)

Humans

3.6 recall the structure and function of the male and female reproductive systems

3.7 understand the roles of oestrogen and progesterone in the menstrual cycle

3.8 recall the roles of oestrogen and testosterone in the development of secondary sexual characteristics.

b) Inheritance

Students will be assessed on their ability to:

3.9 recall that the nucleus of a cell contains chromosomes on which genes are located

3.10 understand that a gene is a section of a molecule of DNA

3.11 describe a DNA molecule as two strands coiled to form a double helix, the strands being linked by a series of paired bases: adenine (A) with thymine (T), and cytosine (C) with guanine (G)

3.12 understand that genes exist in alternative forms called alleles which give rise to differences in inherited characteristics

3.13 recall the meaning of the terms dominant, recessive, homozygous, heterozygous, phenotype and genotype

3.14 describe patterns of monohybrid inheritance using a genetic diagram

3.15 understand how to interpret family pedigrees

3.16 predict probabilities of outcomes from monohybrid crosses

3.17 recall that the sex of a person is controlled by one pair of chromosomes, XX in a female and XY in a male

3.18 describe the determination of the sex of offspring at fertilisation, using a genetic diagram

3.19 understand that division of a diploid cell by mitosis produces two cells which contain identical sets of chromosomes

3.20 understand that mitosis occurs during growth, repair, cloning and asexual reproduction

3.21 understand that division of a cell by meiosis produces four cells, each with half the number of chromosomes, and that this results in the formation of genetically different haploid gametes

3.22 understand that random fertilisation produces genetic variation of offspring

3.23 recall that in human cells the diploid number of chromosomes is 46 and the haploid number is 23

3.24 understand that variation within a species can be genetic, environmental, or a combination of both

3.25 recall that mutation is a rare, random change in genetic material that can be inherited

3.26 describe the process of evolution by means of natural selection

3.27 understand that many mutations are harmful but some are neutral and a few are beneficial

3.28 understand how resistance to antibiotics can increase in bacterial populations.

Section 4: Ecology and the environment

a) The organism in the environment

b) Feeding relationships

c) Cycles within ecosystems

d) Human influences on the environment

a) The organism in the environment

Students will be assessed on their ability to:

4.1 understand the terms population, community, habitat and ecosystem

4.2 recall the use of quadrats to estimate the population size of an organism in two different areas

4.3 describe the use of quadrats as a technique for sampling the distribution of organisms in their habitats.

b) Feeding relationships

Students will be assessed on their ability to:

4.4 recall the names given to different trophic levels to include producers, primary, secondary and tertiary consumers and decomposers

4.5 understand the concepts of food chains, food webs, pyramids of number, pyramids of biomass and pyramids of energy transfer

4.6 understand the transfer of substances and of energy along a food chain

4.7 explain why about only 10% of energy is transferred from one trophic level to the next.

c) Cycles within ecosystems

Students will be assessed on their ability to:

4.8 describe the stages in the carbon cycle, including respiration, photosynthesis, decomposition and combustion.

d) Human influences on the environment

Students will be assessed on their ability to:

4.9 understand the biological consequences of pollution of air by sulfur dioxide and by carbon monoxide

4.10 recall that water vapour, carbon dioxide, nitrous oxide, methane and CFCs are greenhouse gases

4.11 understand how human activities contribute to greenhouse gases

4.12 understand how an increase in greenhouse gases results in an enhanced greenhouse effect and that this may lead to global warming and its consequences

4.13 understand that eutrophication can result from leached minerals from fertiliser

4.14 understand the effects of deforestation, including leaching, soil erosion, disturbance of the water cycle and of the balance in atmospheric oxygen and carbon dioxide.

Section 5: Use of biological resources

a) Food production

b) Selective breeding

c) Genetic modification

d) Cloning

a) Food production

Students will be assessed on their ability to:

Crop plants

5.1 describe how glasshouses and polythene tunnels can be used to increase the yield of certain crops

5.2 understand the effects on crop yield of increased carbon dioxide and increased temperature in glasshouses

5.3 understand the use of fertiliser to increase crop yield

5.4 understand the reasons for pest control and the advantages and disadvantages of using pesticides and biological control with crop plants

Microorganisms

5.5 understand the role of yeast in the production of beer

5.6 describe a simple experiment to investigate carbon dioxide production by yeast, in different conditions

5.7 interpret and label a diagram of an industrial fermenter and explain the need to provide suitable conditions in the fermenter, including aseptic precautions, nutrients, optimum temperature and pH, oxygenation and agitation, for the growth of microorganisms

Fish farming

5.8 explain the methods which are used to farm large numbers of fish to provide a source of protein, including maintenance of water quality, control of intraspecific and interspecific predation, control of disease, removal of waste products, quality and frequency of feeding and the use of selective breeding.

b) Selective breeding

Students will be assessed on their ability to:

5.9 understand that plants with desired characteristics can be developed by selective breeding

5.10 understand that animals with desired characteristics can be developed by selective breeding.

c) Genetic Modification (genetic engineering)

Students will be assessed on their ability to:

5.11 describe the use of restriction enzymes to cut DNA at specific sites and ligase enzymes to join pieces of DNA together

5.12 describe how plasmids and viruses can act as vectors, which take up pieces of DNA, then insert this recombinant DNA into other cells

5.13 understand that large amounts of human insulin can be manufactured from genetically modified bacteria that are grown in a fermenter

5.14 evaluate the potential for using genetically modified plants to improve food production (illustrated by plants with improved resistance to pests).

d) Cloning

Students will be assessed on their ability to:

5.15 describe the process of micropropagation (tissue culture) in which small pieces of plants (explants) are grown *in vitro* using nutrient media

5.16 understand how micropropagation can be used to produce commercial quantities of identical plants (clones) with desirable characteristics

5.17 describe the stages in the production of cloned mammals involving the introduction of a diploid nucleus from a mature cell into an enucleated egg cell, illustrated by Dolly the sheep.

Chemistry

Section 1: Principles of chemistry

a) States of matter

b) Atoms

c) Atomic structure

d) Relative formula masses

e) Chemical formulae and chemical equations

f) Ionic compounds

g) Covalent substances

h) Metallic crystals

i) Electrolysis

a) States of matter

Students will be assessed on their ability to:

1.1 understand the arrangement, movement and energy of the particles in each of the three states of matter: solid, liquid and gas

1.2 describe how the interconversion of solids, liquids and gases are achieved and recall the names used for these interconversions

1.3 describe the changes in arrangement, movement and energy of particles during these interconversions.

b) Atoms

Students will be assessed on their ability to:

1.4 describe simple experiments leading to the idea of the small size of particles and their movement including:

- i dilution of coloured solutions
- ii diffusion experiments

1.5 understand the terms atom and molecule

1.6 understand the differences between elements, compounds and mixtures

1.7 describe techniques for the separation of mixtures, including simple distillation, fractional distillation, filtration, crystallisation and paper chromatography.

c) Atomic structure

Students will be assessed on their ability to:

1.8 recall that atoms consist of a central nucleus, composed of protons and neutrons, surrounded by electrons, orbiting in shells

1.9 recall the relative mass and relative charge of a proton, neutron and electron

1.10 understand the terms atomic number, mass number, isotopes and relative atomic mass (A_r)

1.11 calculate the relative atomic mass of an element from the relative abundances of its isotopes

1.12 understand that the Periodic Table is an arrangement of elements in order of atomic number

1.13 deduce the electronic configurations of the first 20 elements from their positions in the Periodic Table

1.14 deduce the number of outer electrons in a main group element from its position in the Periodic Table.

d) Relative formula masses

Students will be assessed on their ability to:

1.15 calculate relative formula masses (M_r) from relative atomic masses (A_r)

1.16 understand the use of the term mole to represent the amount of substance

1.17 carry out mole calculations using relative atomic mass (A_r) and relative formula mass (M_r).

e) Chemical formulae and chemical equations

Students will be assessed on their ability to:

1.18 write word equations and balanced chemical equations to represent the reactions studied in this specification

1.19 use the state symbols (s), (l), (g) and (aq) in chemical equations to represent solids, liquids, gases and aqueous solutions respectively

1.20 understand how the formulae of simple compounds can be obtained experimentally, including metal oxides, water and salts containing water of crystallisation

1.21 calculate empirical and molecular formulae from experimental data

1.22 calculate reacting masses using experimental data and chemical equations

1.23 carry out mole calculations using volumes and molar concentrations.

f) Ionic compounds

Students will be assessed on their ability to:

1.24 describe the formation of ions by the gain or loss of electrons

1.25 understand oxidation as the loss of electrons and reduction as the gain of electrons

1.26 recall the charges of common ions in this specification

1.27 deduce the charge of an ion from the electronic configuration of the atom from which the ion is formed

1.28 explain, using dot and cross diagrams, the formation of ionic compounds by electron transfer, limited to combinations of elements from Groups 1, 2, 3, and 5, 6, 7

1.29 understand ionic bonding as a strong electrostatic attraction between oppositely charged ions

1.30 understand that ionic compounds have high melting and boiling points because of strong electrostatic forces between oppositely charged ions.

g) Covalent substances

Students will be assessed on their ability to:

1.31 describe the formation of a covalent bond by the sharing of a pair of electrons between two atoms

1.32 understand covalent bonding as a strong attraction between the bonding pair of electrons and the nuclei of the atoms involved in the bond

1.33 explain, using dot and cross diagrams, the formation of covalent compounds by electron sharing for the following substances:

- i hydrogen
- ii chlorine
- iii hydrogen chloride
- iv water
- v methane
- vi ammonia
- vii oxygen
- viii nitrogen
- ix carbon dioxide
- x ethane
- xi ethene

1.34 recall that substances with simple molecular structures are gases or liquids, or solids with low melting points

1.35 explain why substances with simple molecular structures have low melting points in terms of the relatively weak forces between the molecules

1.36 explain the high melting points of substances with giant covalent structures in terms of the breaking of many strong covalent bonds.

h) Metallic crystals

Students will be assessed on their ability to:

1.37 describe a metal as a giant structure of positive ions surrounded by a sea of delocalised electrons

1.38 explain the malleability and electrical conductivity of a metal in terms of its structure and bonding.

i) Electrolysis

Students will be assessed on their ability to:

1.39 understand an electric current as a flow of electrons or ions

1.40 understand why covalent compounds do not conduct electricity

1.41 understand why ionic compounds conduct electricity only when molten or in solution

1.42 describe simple experiments to distinguish between electrolytes and non-electrolytes

1.43 recall that electrolysis involves the formation of new substances when ionic compounds conduct electricity

1.44 describe simple experiments for the electrolysis, using inert electrodes, of molten salts such as lead(II) bromide

1.45 write ionic half-equations representing the reactions at the electrodes during electrolysis.

Section 2: Chemistry of the elements

a) The Periodic Table

b) Group 1 elements – lithium, sodium and potassium

c) Group 7 elements – chlorine, bromine and iodine

d) Oxygen and oxides

e) Hydrogen and water

f) Reactivity series

g) Tests for ions and gases

a) The Periodic Table

Students will be assessed on their ability to:

2.1 understand the terms group and period

2.2 recall the positions of metals and non-metals in the Periodic Table

2.3 explain the classification of elements as metals or non-metals on the basis of their electrical conductivity and the acid-base character of their oxides

2.4 understand why elements in the same group of the Periodic Table have similar chemical properties

2.5 recall the noble gases (Group 0) as a family of inert gases and explain their lack of reactivity in terms of their electronic configurations.

b) Group 1 elements – lithium, sodium and potassium

Students will be assessed on their ability to:

2.6 describe the reactions of these elements with water and understand that the reactions provide a basis for their recognition as a family of elements

2.7 recall the relative reactivities of the elements in Group 1.

c) Group 7 elements – chlorine, bromine and iodine

Students will be assessed on their ability to:

2.8 recall the colours and physical states of the elements at room temperature

2.9 make predictions about the properties of other halogens in this group

2.10 understand the difference between hydrogen chloride gas and hydrochloric acid

2.11 explain, in terms of dissociation, why hydrogen chloride is acidic in water but not in methylbenzene

2.12 recall the relative reactivities of the elements in Group 7

2.13 describe experiments to show that a more reactive halogen will displace a less reactive halogen from a solution of one of its salts

2.14 understand these displacement reactions as redox reactions.

d) Oxygen and oxides

Students will be assessed on their ability to:

2.15 recall the gases present in air and their approximate percentage by volume

2.16 describe how experiments involving the reactions of elements such as copper, iron and phosphorus with air can be used to determine the percentage by volume of oxygen in air

2.17 describe the laboratory preparation of oxygen from hydrogen peroxide

2.18 describe the reactions with oxygen in air of magnesium, carbon and sulfur, and the acid-base character of the oxides produced

2.19 describe the laboratory preparation of carbon dioxide from calcium carbonate and dilute hydrochloric acid

2.20 describe the formation of carbon dioxide from the thermal decomposition of metal carbonates such as copper(II) carbonate

2.21 recall the properties of carbon dioxide, limited to its solubility and density

2.22 explain the use of carbon dioxide in carbonating drinks and in fire extinguishers, in terms of its solubility and density

2.23 recall the reactions of carbon dioxide and sulfur dioxide with water to produce acidic solutions

2.24 recall that sulfur dioxide and nitrogen oxides are pollutant gases which contribute to acid rain, and describe the problems caused by acid rain.

e) Hydrogen and water

Students will be assessed on their ability to:

2.25 describe the reactions of dilute hydrochloric and dilute sulfuric acids with magnesium, aluminium, zinc and iron

2.26 describe the combustion of hydrogen

2.27 describe the use of anhydrous copper(II) sulfate in the chemical test for water

2.28 describe a physical test to show whether water is pure.

f) Reactivity series

Students will be assessed on their ability to:

2.29 recall that metals can be arranged in a reactivity series based on the reactions of the metals and their compounds: potassium, sodium, lithium, calcium, magnesium, aluminium, zinc, iron, copper, silver and gold

2.30 describe how reactions with water and dilute acids can be used to deduce the following order of reactivity: potassium, sodium, lithium, calcium, magnesium, zinc, iron, and copper

2.31 deduce the position of a metal within the reactivity series using displacement reactions between metals and their oxides, and between metals and their salts in aqueous solutions

2.32 understand oxidation and reduction as the addition and removal of oxygen respectively

2.33 understand the terms redox, oxidising agent and reducing agent

2.34 recall the conditions under which iron rusts

2.35 describe how the rusting of iron may be prevented by grease, oil, paint, plastic and galvanising

2.36 understand the sacrificial protection of iron in terms of the reactivity series.

g) Tests for ions and gases

Students will be assessed on their ability to:

2.37 describe simple tests for the cations:

- i Li^+, Na^+, K^+, Ca^{2+} using flame tests
- ii NH_4^+ using sodium hydroxide solution and identifying the ammonia evolved
- iii Cu^{2+}, Fe^{2+} and Fe^{3+} using sodium hydroxide solution

2.38 describe simple tests for the anions:

- i Cl^-, Br^- and I^- using dilute nitric acid and silver nitrate solution
- ii SO_4^{2-} using dilute hydrochloric acid and barium chloride solution
- iii CO_3^{2-} using dilute hydrochloric acid and identifying the carbon dioxide evolved

2.39 describe simple tests for the gases:

- i hydrogen
- ii oxygen
- iii carbon dioxide
- iv ammonia
- v chlorine.

Section 3: Organic chemistry

a) Introduction

b) Alkanes

c) Alkenes

a) Introduction

Students will be assessed on their ability to:

3.1 explain the terms homologous series, hydrocarbon, saturated, unsaturated, general formula and isomerism.

b) Alkanes

Students will be assessed on their ability to:

3.2 recall that alkanes have the general formula C_nH_{2n+2}

3.3 draw displayed formulae for alkanes with up to five carbon atoms in a molecule, and name the straight-chain isomers

3.4 recall the products of the complete and incomplete combustion of alkanes

3.5 recall the reaction of methane with bromine to form bromomethane in the presence of UV light.

c) Alkenes

Students will be assessed on their ability to:

3.6 recall that alkenes have the general formula C_nH_{2n}

3.7 draw displayed formulae for alkenes with up to four carbon atoms in a molecule, and name the straight-chain isomers

3.8 describe the addition reaction of alkenes with bromine, including the decolorising of bromine water as a test for alkenes.

Section 4: Physical chemistry

a) Acids, alkalis and salts

b) Energetics

c) Rates of reaction

d) Equilibria

a) Acids, alkalis and salts

Students will be assessed on their ability to:

4.1 describe the use of the indicators litmus, phenolphthalein and methyl orange to distinguish between acidic and alkaline solutions

4.2 understand how the pH scale, from 0-14, can be used to classify solutions as strongly acidic, weakly acidic, neutral, weakly alkaline or strongly alkaline

4.3 describe the use of universal indicator to measure the approximate pH value of a solution

4.4 define acids as sources of hydrogen ions, H^+, and alkalis as sources of hydroxide ions, OH^-

4.5 predict the products of reactions between dilute hydrochloric, nitric and sulfuric acids; and metals, metal oxides and metal carbonates (excluding the reactions between nitric acid and metals)

4.6 recall the general rules for predicting the solubility of salts in water:

- i all common sodium, potassium and ammonium salts are soluble
- ii all nitrates are soluble
- iii common chlorides are soluble, except silver chloride
- iv common sulfates are soluble, except those of barium and calcium
- v common carbonates are insoluble, except those of sodium, potassium and ammonium

4.7 describe how to prepare soluble salts from acids

4.8 describe how to prepare insoluble salts using precipitation reactions

4.9 describe how to carry out acid-alkali titrations.

b) Energetics

Students will be assessed on their ability to:

4.10 recall that chemical reactions in which heat energy is given out are described as exothermic and those in which heat energy is taken in are endothermic

4.11 describe simple calorimetry experiments for reactions such as combustion, displacement, dissolving and neutralisation in which heat energy changes can be calculated from measured temperature changes

4.12 understand the use of ΔH to represent molar enthalpy change for exothermic and endothermic reactions

4.13 represent exothermic and endothermic reactions on a simple energy level diagram

4.14 recall that the breaking of bonds is endothermic and that the making of bonds is exothermic.

c) Rates of reaction

Students will be assessed on their ability to:

4.15 describe experiments to investigate the effects of changes in surface area of a solid, concentration of solutions, temperature and the use of a catalyst on the rate of a reaction

4.16 describe the effects of changes in surface area of a solid, concentration of solutions, pressure of gases, temperature and the use of a catalyst on the rate of a reaction

4.17 understand the term activation energy and represent it on a reaction profile

4.18 explain the effects of changes in surface area of a solid, concentration of solutions, pressure of gases and temperature on the rate of a reaction in terms of particle collision theory

4.19 understand that a catalyst speeds up a reaction by providing an alternative pathway with lower activation energy.

d) Equilibria

Students will be assessed on their ability to:

4.20 recall that some reactions are reversible and are indicated by the symbol ⇌ in equations

4.21 describe reversible reactions such as the dehydration of hydrated copper(II) sulfate and the effect of heat on ammonium chloride

4.22 understand the concept of dynamic equilibrium

4.23 predict the effects of changing the pressure and temperature on the equilibrium position in reversible reactions.

Section 5: Chemistry in society

a) Extraction and uses of metals

b) Crude oil

c) Synthetic polymers

d) The industrial manufacture of chemicals

a) Extraction and uses of metals

Students will be assessed on their ability to:

5.1 explain how the methods of extraction of the metals in this section are related to their positions in the reactivity series

5.2 describe and explain the extraction of aluminium from purified aluminium oxide by electrolysis, including:

- i the use of molten cryolite as a solvent and to decrease the required operating temperature
- ii the need to replace the positive electrodes
- iii the cost of the electricity as a major factor

5.3 write ionic half-equations for the reactions at the electrodes in aluminium extraction

5.4 describe and explain the main reactions involved in the extraction of iron from iron ore (haematite), using coke, limestone and air in a blast furnace

5.5 explain the uses of aluminium and iron, in terms of their properties.

b) Crude oil

Students will be assessed on their ability to:

5.6 recall that crude oil is a mixture of hydrocarbons

5.7 describe how the industrial process of fractional distillation separates crude oil into fractions

5.8 recall the names and uses of the main fractions obtained from crude oil: refinery gases, gasoline, kerosene, diesel, fuel oil and bitumen

5.9 describe the trend in boiling point and viscosity of the main fractions

5.10 recall that incomplete combustion of fuels may produce carbon monoxide and explain that carbon monoxide is poisonous because it reduces the capacity of the blood to carry oxygen

5.11 recall that, in car engines, the temperature reached is high enough to allow nitrogen and oxygen from air to react, forming nitrogen oxides

5.12 recall that fractional distillation of crude oil produces more long-chain hydrocarbons than can be used directly and fewer short-chain hydrocarbons than required

5.13 describe how long-chain alkanes are converted to alkenes and shorter-chain alkanes by catalytic cracking, using silica or alumina as the catalyst and a temperature in the range of 600-700 °C.

c) Synthetic polymers

Students will be assessed on their ability to:

5.14 recall that an addition polymer is formed by joining up many small molecules called monomers

5.15 draw the repeat unit of addition polymers, including poly(ethene), poly(propene) and poly(chloroethene)

5.16 deduce the structure of a monomer from the repeat unit of an addition polymer.

d) The industrial manufacture of chemicals

Students will be assessed on their ability to:

5.17 recall that nitrogen from air, and hydrogen from natural gas or the cracking of hydrocarbons, are used in the manufacture of ammonia

5.18 describe the manufacture of ammonia by the Haber process, including the essential conditions:

- i a temperature of about 450 °C
- ii a pressure of about 200 atmospheres
- iii an iron catalyst

5.19 understand how the cooling of the reaction mixture liquefies the ammonia produced and allows the unused hydrogen and nitrogen to be recirculated

5.20 recall the use of ammonia in the manufacture of nitric acid and fertilisers.

Physics

Section 1: Forces and motion

a) Units

b) Movement and position

c) Forces, movement and shape

d) Astronomy

a) Units

Students will be assessed on their ability to:

1.1 use the following units: kilogram (kg), metre (m), metre/second (m/s), metre/second^2 (m/s^2), newton (N), second (s), newton per kilogram (N/kg).

b) Movement and position

Students will be assessed on their ability to:

1.2 understand and use distance-time graphs

1.3 recall and use the relationship between average speed, distance moved and time:

$$\text{average speed} = \frac{\text{distance moved}}{\text{time taken}}$$

1.4 recall and use the relationship between acceleration, velocity and time:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

$$a = \frac{(v-u)}{t}$$

1.5 interpret velocity-time graphs

1.6 determine acceleration from the gradient of a velocity-time graph

1.7 determine the distance travelled from the area between a velocity-time graph and the time axis.

c) Forces, movement and shape

Students will be assessed on their ability to:

1.8 express a force as a push or pull of one body on another

1.9 identify various types of force (for example gravitational, electrostatic etc)

1.10 understand that friction is a force that opposes motion

1.11 recall and use the relationship between unbalanced force, mass and acceleration:

force = mass × acceleration

$F = m \times a$

1.12 recall and use the relationship between weight, mass and g:

weight = mass × g

$W = m \times g$

1.13 describe the forces acting on falling objects and explain why falling objects reach a terminal velocity

1.14 describe the factors affecting vehicle stopping distance including speed, mass, road condition and reaction time

1.15 recall and use the relationship between the moment of a force and its distance from the pivot:

moment = force × perpendicular distance from the pivot

1.16 recall that the weight of a body acts through its centre of gravity

1.17 describe how extension varies with applied force for helical springs, metal wires and rubber bands

1.18 recall that the initial linear region of a force-extension graph is associated with Hooke's law

1.19 associate elastic behaviour with the ability of a material to recover its original shape after the forces causing deformation have been removed.

d) Astronomy

Students will be assessed on their ability to:

1.20 recall that the moon orbits the Earth and that some planets also have moons

1.21 understand gravitational field strength, g, and recall that it is different on other planets and the moon from that on the Earth

1.22 explain that gravitational force:

- causes the planets to orbit the sun
- causes the moon and artificial satellites to orbit the earth
- causes comets to orbit the sun

1.23 use the relationship between orbital speed, orbital radius and time period:

$$\text{orbital speed} = \frac{2 \text{ x } \pi \text{ x orbital radius}}{\text{time period}}$$

$$v = \frac{2 \text{ x } \pi \text{ x } r}{T}$$

1.24 describe how the orbit of a comet differs from that of a planet

1.25 recall that the solar system is part of the Milky Way galaxy:

- describe a galaxy as a large collection of billions of stars
- state that the universe is a large collection of billions of galaxies.

Section 2: Electricity

a) Units

b) Mains electricity

c) Energy and potential difference in circuits

a) Units

Students will be assessed on their ability to:

2.1 use the following units: ampere (A), coulomb (C), joule (J), ohm (Ω), second (s), volt (V), watt (W).

b) Mains electricity

Students will be assessed on their ability to:

2.2 recall the hazards of electricity including frayed cables, long cables, damaged plugs, water around sockets, and pushing metal objects into sockets

2.3 describe the uses of insulation, double insulation, earthing, fuses and circuit breakers in a range of domestic appliances

2.4 know some of the different ways in which electrical heating is used in a variety of domestic contexts

2.5 understand that a current in a resistor results in the electrical transfer of energy and an increase in temperature

2.6 recall and use the relationship:

power = current × voltage

$P = I \times V$

and apply the relationship to the selection of appropriate fuses

2.7 use the relationship between energy transferred, current, voltage and time:

energy transferred = current × voltage × time

$E = I \times V \times t$

2.8 recall that mains electricity is alternating current (a.c.) and understand the difference between this and the direct current (d.c.) supplied by a cell or battery.

c) Energy and potential difference in circuits

Students will be assessed on their ability to:

2.9 explain why a series or parallel circuit is more appropriate for particular applications, including domestic lighting

2.10 understand that the current in a series circuit depends on the applied voltage and the number and nature of other components

2.11 describe how current varies with voltage in wires, resistors, metal filament lamps and diodes, and how this can be investigated experimentally

2.12 describe the qualitative effect of changing resistance on the current in a circuit

2.13 describe the qualitative variation of resistance of LDRs with illumination and of thermistors with temperature

2.14 know that lamps and LEDs can be used to indicate the presence of a current in a circuit

2.15 recall and use the relationship between voltage, current and resistance:

voltage = current × resistance

$V = I \times R$

2.16 understand that current is the rate of flow of charge

2.17 recall and use the relationship between charge, current and time:

charge = current × time

$Q = I \times t$

2.18 identify common materials which are electrical conductors or insulators, including metals and plastics

2.19 recall that electric current in solid metallic conductors is a flow of negatively charged electrons.

Section 3: Waves

a) Units

b) Properties of waves

c) The electromagnetic spectrum

d) Light and sound

a) Units

Students will be assessed on their ability to:

3.1 use the following units: degree (˚), hertz (Hz), metre (m), metre/second (m/s), second (s).

b) Properties of waves

Students will be assessed on their ability to:

3.2 describe longitudinal and transverse waves in ropes, springs and water where appropriate

3.3 state the meaning of amplitude, frequency, wavelength and period of a wave

3.4 recall that waves transfer energy and information without transferring matter

3.5 recall and use the relationship between the speed, frequency and wavelength of a wave:

wave speed = frequency × wavelength

$v = f \times \lambda$

3.6 use the relationship between frequency and time period:

$$\text{frequency} = \frac{1}{\text{time period}}$$

$$f = \frac{1}{T}$$

3.7 use the above relationships in different contexts including sound waves and electromagnetic waves.

c) The electromagnetic spectrum

Students will be assessed on their ability to:

3.8 understand that light is part of a continuous electromagnetic spectrum which includes radio, microwave, infrared, visible, ultraviolet, x-ray and gamma ray radiations and that all these waves travel at the same speed in free space

3.9 recall the order of the electromagnetic spectrum in decreasing wavelength and increasing frequency, including the colours of the visible spectrum

3.10 recall some of the uses of electromagnetic radiations, including:

- radio waves: broadcasting and communications
- microwaves: cooking and satellite transmissions
- infrared: heaters and night vision equipment
- visible light: optical fibres and photography
- ultraviolet: fluorescent lamps
- x-rays: observing the internal structure of objects and materials and medical applications
- gamma rays: sterilising food and medical equipment

3.11 recall the detrimental effects of excessive exposure of the human body to electromagnetic waves, including

- microwaves: internal heating of body tissue
- infrared: skin burns
- ultraviolet: damage to surface cells and blindness
- gamma rays: cancer, mutation.

d) Light and sound

Students will be assessed on their ability to:

3.12 recall that light waves are transverse waves which can be reflected and refracted

3.13 recall that the angle of incidence equals the angle of reflection

3.14 construct ray diagrams to illustrate the formation of a virtual image in a plane mirror

3.15 describe experiments to investigate the refraction of light, using rectangular blocks, semicircular blocks and triangular prisms

3.16 recall and use the relationship between refractive index, angle of incidence and angle of refraction:

$$n = \frac{\sin i}{\sin r}$$

3.17 describe an experiment to determine the refractive index of glass, using a glass block

3.18 describe the role of total internal reflection in transmitting information along optical fibres and in prisms

3.19 recall the meaning of critical angle *c*

3.20 recall and use the relationship between critical angle and refractive index:

$$\sin c = \frac{1}{n}$$

3.21 recall that sound waves are longitudinal waves which can be reflected and refracted

3.22 recall that the frequency range for human hearing is 20 Hz – 20 000 Hz

3.23 describe how to measure the speed of sound in air.

Section 4: Energy resources and energy transfer

a) Units

b) Energy transfer

c) Work and power

d) Energy resources and electricity generation

a) Units

Students will be assessed on their ability to:

4.1 use the following units: kilogram (kg), joule (J), metre (m), metre/second (m/s), metre/second^2 (m/s^2), newton (N), second (s), watt (W).

b) Energy transfer

Students will be assessed on their ability to:

4.2 describe energy transfers involving the following forms of energy: thermal (heat), light, electrical, sound, kinetic, chemical, nuclear and potential (elastic and gravitational)

4.3 understand that energy is conserved

4.4 recall and use the relationship:

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

4.5 describe a variety of everyday and scientific devices and situations, explaining the fate of the input energy in terms of the above relationship, including their representation by Sankey diagrams

4.6 recall that energy transfer may take place by conduction, convection and radiation

4.7 describe the role of convection in everyday phenomena

4.8 describe how insulation is used to reduce energy transfers from buildings and the human body.

c) Work and power

Students will be assessed on their ability to:

4.9 recall and use the relationship between work, force and distance moved in the direction of the force:

work done = force × distance moved

$W = F \times d$

4.10 understand that work done is equal to energy transferred

4.11 recall and use the relationship:

gravitational potential energy = mass × g × height

GPE = $m \times g \times h$

4.12 recall and use the relationship:

kinetic energy = ½ × mass × speed^2

KE = ½ × $m \times v^2$

4.13 understand how conservation of energy produces a link between gravitational potential energy, kinetic energy and work

4.14 describe power as the rate of transfer of energy or the rate of doing work

4.15 use the relationship between power, work done (energy transferred) and time taken:

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

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

d) Energy resources and electricity generation

Students will be assessed on their ability to:

4.16 understand the energy transfers involved in generating electricity using:

- wind
- water
- geothermal resources
- solar heating systems
- solar cells
- fossil fuels
- nuclear power.

Section 5: Solids, liquids and gases

a) Units

b) Density and pressure

c) Ideal gas molecules

a) Units

Students will be assessed on their ability to:

5.1 use the following units: degrees Celsius (^{o}C), kelvin (K), joule (J), kilogram (kg), kilogram/metre^3 (kg/m^3), metre (m), metre^2 (m^2), metre^3 (m^3), metre/second (m/s), metre/second^2 (m/s^2), newton (N), pascal (Pa).

b) Density and pressure

Students will be assessed on their ability to:

5.2 recall and use the relationship between density, mass and volume:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\rho = \frac{m}{V}$$

5.3 describe how to determine density using direct measurements of mass and volume

5.4 recall and use the relationship between pressure, force and area:

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

$$p = \frac{F}{A}$$

5.5 understand that the pressure at a point in a gas or liquid which is at rest acts equally in all directions

5.6 recall and use the relationship for pressure difference:

$$\text{pressure difference} = \text{height} \times \text{density} \times g$$

$$p = h \times \rho \times g$$

c) Ideal gas molecules

Students will be assessed on their ability to:

5.7 understand the significance of Brownian motion

5.8 recall that molecules in a gas have a random motion and that they exert a force and hence a pressure on the walls of the container

5.9 understand that there is an absolute zero of temperature which is – 273 ^{o}C

5.10 describe the Kelvin scale of temperature and be able to convert between the Kelvin and Celsius scales

5.11 understand that an increase in temperature results in an increase in the speed of gas molecules

5.12 describe the qualitative relationship between pressure and Kelvin temperature for a gas in a sealed container

5.13 use the relationship between the pressure and volume of a fixed mass of gas at constant temperature:

$$p_1V_1 = p_2V_2$$

Section 6: Magnetism and electromagnetism

a) Units

b) Magnetism

c) Electromagnetism

d) Electromagnetic induction

a) Units

Students will be assessed on their ability to:

6.1 use the following units: ampere (A), volt (V), watt (W).

b) Magnetism

Students will be assessed on their ability to:

6.2 understand the term 'magnetic field line'

6.3 sketch and recognise the magnetic field pattern for a permanent bar magnet and that between two bar magnets

6.4 know how to use two permanent magnets to produce a uniform magnetic field pattern.

c) Electromagnetism

Students will be assessed on their ability to:

6.5 recall that an electric current in a conductor produces a magnetic field round it

6.6 recall that a force is exerted on a current-carrying wire in a magnetic field, and how this effect is applied in simple d.c. electric motors and loudspeakers

6.7 use the left hand rule to predict the direction of the resulting force when a wire carries a current perpendicular to a magnetic field

6.8 recall that the force on a current-carrying conductor in a magnetic field increases with the strength of the field and with the current.

d) Electromagnetic induction

Students will be assessed on their ability to:

6.9 recall that a voltage is induced in a conductor or a coil when it moves through a magnetic field or when a magnetic field changes through it; also recall the factors which affect the size of the induced voltage

6.10 describe the generation of electricity by the rotation of a magnet within a coil of wire and of a coil of wire within a magnetic field; also describe the factors which affect the size of the induced voltage.

Section 7: Radioactivity and particles

a) Units

b) Radioactivity

c) Particles

a) Units

Students will be assessed on their ability to:

7.1 use the following units: becquerel (Bq), centimetre (cm), hour (h), minute (min), second (s).

b) Radioactivity

Students will be assessed on their ability to:

7.2 describe the structure of an atom in terms of protons, neutrons and electrons and use symbols such as $^{14}_{6}C$ to describe particular nuclei

7.3 understand the terms atomic (proton) number, mass (nucleon) number and isotope

7.4 understand that alpha and beta particles and gamma rays are ionising radiations emitted from unstable nuclei in a random process

7.5 describe the nature of alpha and beta particles and gamma rays and recall that they may be distinguished in terms of penetrating power

7.6 describe the effects on the atomic and mass numbers of a nucleus of the emission of each of the three main types of radiation

7.7 understand how to complete balanced nuclear equations

7.8 understand that ionising radiations can be detected using a photographic film or a Geiger-Muller detector

7.9 recall the sources of background radiation

7.10 understand that the activity of a radioactive source decreases over a period of time and is measured in becquerels

7.11 recall the term 'half-life' and understand that it is different for different radioactive isotopes

7.12 use the concept of half-life to carry out simple calculations on activity

7.13 describe the uses of radioactivity in medical and non-medical tracers, in radiotherapy and in the radioactive dating of archaeological specimens and rocks

7.14 describe the dangers of ionising radiations, including:

- radiation can cause mutations in living organisms
- radiation can damage cells and tissue
- the problems arising in the disposal of radioactive waste.

c) Particles

Students will be assessed on their ability to:

7.15 describe the results of Geiger and Marsden's experiments with gold foil and alpha particles

7.16 describe Rutherford's nuclear model of the atom and how it accounts for the results of Geiger and Marsden's experiment and understand the factors (charge and speed) which affect the deflection of alpha particles by a nucleus

7.17 understand that a nucleus of U-235 can be split (the process of fission) by collision with a neutron, and that this process releases energy in the form of kinetic energy of the fission products

7.18 recall that the fission of U-235 produces two daughter nuclei and a small number of neutrons

7.19 understand that a chain reaction can be set up if the neutrons produced by one fission strike other U-235 nuclei

7.20 understand the role played by the control rods and moderator when the fission process is used as an energy source to generate electricity.

Assessment

Assessment summary

Biology paper 1

This paper will assess biology across all Assessment Objectives. The maximum mark for this paper will be 120.

There will be a range of compulsory short-answer structured questions which are ramped to ensure accessibility for less-able students, as well as to stretch more-able students.

Students may be required to perform calculations, draw graphs and describe, explain and interpret biological phenomena. Some of the question content will be unfamiliar to students; these questions are designed to assess data-handling skills and the ability to apply biological principles to unfamiliar information. Questions targeted at grades A* – B will include questions designed to test knowledge, understanding and skills at a higher level, including some questions requiring longer prose answers.

Chemistry paper 1

This paper will assess chemistry across all Assessment Objectives. The maximum mark for this paper will be 120.

There will be a range of compulsory short-answer structured questions which are ramped to ensure accessibility for less-able students, as well as to stretch more-able students.

Students may be required to perform calculations, draw graphs and describe, explain and interpret chemical phenomena. Students may be required to describe, explain and interpret chemical phenomena. Some of the question content will be unfamiliar to students; these questions are designed to assess simple data-processing skills and the ability to apply chemical principles to unfamiliar information.

Physics paper 1

This paper will assess physics across all Assessment Objectives. The maximum mark for this paper will be 120.

There will be a range of compulsory short-answer structured questions which are ramped to ensure accessibility for less-able students, as well as to stretch more-able students.

Students may be required to perform calculations, draw graphs and describe, explain and interpret physical phenomena. Students may be required to describe, explain and interpret physical phenomena. Some of the question content will be unfamiliar to students; these questions are designed to assess simple data-processing skills and the ability to apply physical principles to unfamiliar information.

Summary of table of assessment

Biology paper 1	**Paper code: 4SC0/1B**
• Externally assessed • Availability: January and June series • First assessment: June 2011	**33.3% of the total Double Award IGCSE marks**
Chemistry paper 1	**Paper code: 4SC0/1C**
• Externally assessed • Availability: January and June series • First assessment: June 2011	**33.3% of the total Double Award IGCSE marks**
Physics paper 1	**Paper code: 4SC0/1P**
• Externally assessed • Availability: January and June series • First assessment: June 2011	**33.3% of the total Double Award IGCSE marks**

Assessment Objectives and weightings

This specification requires that all students demonstrate the following Assessment Objectives in the context of the content and skills prescribed.

	% in Double Award IGCSE
AO1: Knowledge and understanding	45-55%
AO2: Application of knowledge and understanding, analysis and evaluation	25-35%
AO3: Experimental and investigative skills	20%
TOTAL	**100%**

AO1 Knowledge and understanding

In the examination, students will be tested on their ability to:

- recognise, recall and show understanding of specific scientific facts, terminology, principles, concepts and practical techniques, including aspects of safety
- draw on existing knowledge to show understanding of the social, economic, environmental and technological applications and implications of biology, chemistry and physics
- select, organise and present relevant information clearly and logically, using appropriate vocabulary.

AO2 Application of knowledge and understanding, analysis and evaluation

In the examination, students will be tested on their ability to:

- describe, explain and interpret phenomena, effects and ideas in terms of the principles and concepts of biology, chemistry and physics, presenting arguments and ideas clearly and logically
- interpret and translate, from one form into another, data presented as continuous prose or in tables, diagrams, drawings and graphs
- carry out relevant calculations
- apply the principles and concepts of biology, chemistry and physics to unfamiliar situations, including those related to applications of these sciences in ethical, social, economic and technological contexts
- assess the validity of scientific information and make informed judgements based on it.

AO3 Experimental and investigative skills

In the assessment of practical skills, students will be tested on their ability to:

- devise and plan investigations, selecting appropriate techniques
- demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- make observations and measurements with appropriate precision, record these methodically and present them in a suitable form
- analyse and interpret data from experimental activities to draw conclusions which are consistent with the evidence, using scientific knowledge and understanding, and communicate these findings using appropriate specialist vocabulary
- evaluate data and methods.

Relationship of Assessment Objectives to papers for IGCSE

	Assessment Objective			
Paper number	**AO1**	**AO2**	**AO3**	**Total for AO1, AO2 and AO3**
Biology paper 1	15-18 $\frac{1}{3}$ %	8 $\frac{1}{3}$ -11 $\frac{2}{3}$ %	6 $\frac{2}{3}$ %	33 $\frac{1}{3}$ %
Chemistry paper 1	15-18 $\frac{1}{3}$ %	8 $\frac{1}{3}$ -11 $\frac{2}{3}$ %	6 $\frac{2}{3}$ %	33 $\frac{1}{3}$ %
Physics paper 1	15-18 $\frac{1}{3}$ %	8 $\frac{1}{3}$ -11 $\frac{2}{3}$ %	6 $\frac{2}{3}$ %	33 $\frac{1}{3}$ %
Total for IGCSE (Double Award)	45-55%	25-35%	20%	100%

Entering your students for assessment

Student entry

Details of how to enter students for this qualification can be found in Edexcel's *International Information Manual*, copies of which (in CD format) are sent to all active Edexcel centres. The information can also be found on Edexcel's website.

Combinations of entry

Students entering for the Edexcel IGCSE in Science (Double Award) (4SC0) may not enter the following specifications in the same exam series:

- Edexcel IGCSE in Biology (4BI0)
- Edexcel IGCSE in Chemistry (4CH0)
- Edexcel IGCSE in Physics (4PH0).

Access arrangements and special requirements

Edexcel's policy on access arrangements and special considerations for GCE, GCSE, IGCSE, and Entry Level qualifications aims to enhance access to the qualifications for students with disabilities and other difficulties without compromising the assessment of skills, knowledge, understanding or competence.

Please see the Edexcel website (www.edexcel.com/iwantto/Pages/access-gq.aspx) for:

- the Joint Council for Qualifications (JCQ) policy *Access Arrangements and Special Considerations, Regulations and Guidance Relating to Students who are Eligible for Adjustments in Examinations*
- the forms to submit for requests for access arrangements and special considerations
- dates for submission of the forms.

Requests for access arrangements and special considerations must be addressed to:

Special Requirements
Edexcel
One90 High Holborn
London WC1V 7BH

Health and safety

Students must follow the health and safety rules which normally operate in their laboratories. This will include the following:

- eye protection must always be worn
- laboratory coats must always be worn
- plastic gloves must be worn when supplied for a particular exercise
- all substances should be regarded as being potentially toxic and hazardous

- HazChem labels (for example flammable) should be read and appropriate precautions (for example keep liquid away from flame) taken
- all substances spilled on the skin should be rinsed off immediately
- chemicals must never be tasted
- gases and vapours should never be smelt unless the question instructs the candidates to do so and then only with great care.

With all laboratory practicals it is essential that centres carry out a detailed risk assessment before allowing students to carry out the practical. For further information on risk assessments and chemical hazards please refer to the CLEAPSS website (www.cleapss.org.uk).

Assessing your students

The first assessment opportunity for all papers of this qualification will take place in the June 2011 series and in each January and June series thereafter for the lifetime of the specification.

Your student assessment opportunities

Paper	June 2011	January 2012	June 2012	January 2013
Biology paper 1	✓	✓	✓	✓
Chemistry paper 1	✓	✓	✓	✓
Physics paper 1	✓	✓	✓	✓

Awarding and reporting

The grading, awarding and certification of this qualification will follow the processes outlined in the current GCSE/GCE Code of Practice for courses starting in September 2009, which is published by the Qualifications and Curriculum Authority (QCA). The IGCSE (Double Award) will be graded and certificated on a 15-grade scale: A*A*(a*a*), A*A(a*a), AA(aa), AB(ab), …G(fg), GG(gg), of which Grade A*A*(a*a*) is the highest and Grade GG(gg) is the lowest.

Students whose level of achievement is below the minimum standard for Grade GG(gg) will receive an unclassified U(u). Where unclassified is received it will not be recorded on the certificate.

The first certification opportunity for the Edexcel IGCSE in Science (Double Award) will be June 2011.

Language of assessment

Assessment of this specification will be available in English only. Assessment materials will be published in English only and all work submitted for examination must be produced in English.

Malpractice and plagiarism

For up-to-date advice on malpractice and plagiarism, please refer to the Joint Council for Qualifications *Suspected Malpractice in Examinations: Policies and Procedures* document on the JCQ website www.jcq.org.uk.

Student recruitment

Edexcel's access policy concerning recruitment to our qualifications is that:

- they must be available to anyone who is capable of reaching the required standard
- they must be free from barriers that restrict access and progression
- equal opportunities exist for all students.

Progression

This qualification supports progression to:

- Edexcel GCE Advanced Subsidiary and Advanced Level in Biology
- Edexcel GCE Advanced Subsidiary and Advanced Level in Chemistry
- Edexcel GCE Advanced Subsidiary and Advanced Level in Physics
- Edexcel Level 3 BTEC National Award/Certificate/Diploma in Applied Science.

Grade descriptions

Grade A

Candidates can:

- recall a wide range of knowledge from all areas of the specification
- use detailed scientific knowledge and understanding in many different applications relating to scientific systems or phenomena. For example, they explain how temperature or water content is regulated in humans; they routinely use a range of balanced chemical equations and the particle model to explain variations in reaction rates; they use many different relationships between physical quantities to carry out calculations effectively. Candidates draw together and communicate knowledge from more than one area, routinely use scientific or mathematical conventions in support of arguments, and use a wide range of scientific and technical vocabulary throughout their work
- use scientific knowledge and understanding to select an appropriate strategy for a task, identifying the key factors to be considered. They make systematic observations in qualitative work and decide which observations are relevant to the task in hand. When making measurements they decide the level of precision needed and can recall or use a range of apparatus to make appropriately precise measurements. They select a method of presenting data which is appropriate to the task; they use information from a range of sources where it is appropriate to do so. They identify and explain anomalous observations and measurements and the salient features of graphs
- use scientific knowledge and understanding to identify and explain patterns and draw conclusions from the evidence by combining data of more than one kind or from more than one source. They identify shortcomings in the evidence, use scientific knowledge and understanding to draw conclusions from their evidence and suggest improvements to the methods used that would enable them to collect more reliable evidence.

Grade C

Candidates can:

- recall a range of scientific information from all areas of the specification. For example, they can explain how the lungs are ventilated; they recall simple chemical symbols and physics formulae, including use of correct units
- use and apply scientific knowledge and understanding in some general contexts. For example, they describe how a leaf is adapted to its functions; they use simple balanced equations and they use quantitative relationships to perform calculations
- describe links between related phenomena in different contexts; use diagrams, charts and graphs to support arguments; use appropriate scientific and technical vocabulary in a range of contexts
- use scientific knowledge and understanding to identify an approach to a question. For example, they identify key factors which can be varied and controlled; they recall or use a range of apparatus to make careful and precise measurements and systematic observations; they recognise when it is necessary to repeat measurements and observations; they present data systematically, in graphs where appropriate, and use lines of best fit; they identify and explain patterns within data and draw conclusions consistent with the evidence. They explain these conclusions on the basis of their scientific knowledge and understanding, and evaluate how strongly their evidence supports the conclusions.

Grade F

Candidates can:

- recall a limited range of information. For example, they state the main functions of organs of the human body; they know that plants need light for photosynthesis; they state some uses of materials obtained from oil; they suggest ways in which insulation is used in domestic contexts
- use and apply knowledge and understanding in some specific everyday contexts, for example, they describe how the heart rate increases with exercise; they suggest a way of speeding up a particular chemical reaction; they explain that fuels are energy resources
- make some use of scientific and technical vocabulary and make simple generalisations from information
- devise fair tests in contexts which involve only a few factors. They recall or use simple apparatus to make measurements appropriate to the task and record observations and measurements in tables and graphs; they obtain information from simple tables, charts and graphs and identify simple patterns in information and observations; they offer explanations consistent with the evidence obtained.

Support and training

Edexcel support services

Edexcel has a wide range of support services to help you implement this qualification successfully.

ResultsPlus – ResultsPlus is an application launched by Edexcel to help subject teachers, senior management teams, and students by providing detailed analysis of examination performance. Reports that compare performance between subjects, classes, your centre and similar centres can be generated in 'one-click'. Skills maps that show performance according to the specification topic being tested are available for some subjects. For further information about which subjects will be analysed through ResultsPlus, and for information on how to access and use the service, please visit www.edexcel.com/resultsplus

Ask the Expert – Ask the Expert is a new service, launched in 2007, that provides direct email access to senior subject specialists who will be able to answer any questions you might have about this or any other specification. All of our specialists are senior examiners, moderators or verifiers and they will answer your email personally. You can read a biography for all of them and learn more about this unique service on our website at www.edexcel.com/asktheexpert

Ask Edexcel – Ask Edexcel is Edexcel's online question and answer service. You can access it at www.edexcel.com/ask or by going to the main website and selecting the Ask Edexcel menu item on the left.

The service allows you to search through a database of thousands of questions and answers on everything Edexcel offers. If you don't find an answer to your question, you can choose to submit it straight to us. One of our customer services team will log your query, find an answer and send it to you. They'll also consider adding it to the database if appropriate. This way the volume of helpful information that can be accessed via the service is growing all the time.

Examzone – The Examzone site is aimed at students sitting external examinations and gives information on revision, advice from examiners and guidance on results, including re-marking, re-sitting and progression opportunities. Further services for students – many of which will also be of interest to parents – will be available in the near future. Links to this site can be found on the main homepage at www.examzone.co.uk

Training

A programme of professional development and training courses, covering various aspects of the specification and examination, will be arranged by Edexcel. Full details can be obtained from our website: www.edexcel.com

Appendices

Appendix 1: Periodic Table

THE PERIODIC TABLE

Period	Group 1	2										3	4	5	6	7	0
1	1 H Hydrogen 1																4 He Helium 2
2	7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
5	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

Relative atomic mass
Symbol
Name
Atomic number

Appendix 2: Physics formulae for relationships

The relationships listed below will **not** be provided for IGCSE students either in the form given or in re-arranged form.

(i) the relationship between average speed, distance and time:

$$\text{average speed} = \frac{\text{distance}}{\text{time}}$$

(ii) the relationship between force, mass and acceleration:

force = mass × acceleration

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

(iii) the relationship between density, mass and volume:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(iv) the relationship between force, distance and work:

work done = force × distance moved in direction of force

(v) the energy relationships:

energy transferred = work done

kinetic energy = ½ × mass × speed^2

gravitational potential energy = mass × g × height

(vi) the relationship between mass, weight and gravitational field strength:

weight = mass × gravitational field strength

(vii) the relationship between an applied force, the area over which it acts and the resulting pressure:

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

(viii) the relationship between the moment of a force and its distance from the pivot:

moment = force × perpendicular distance from the pivot

(ix) the relationships between charge, current, voltage, resistance and electrical power:

charge = current × time

voltage = current × resistance

electrical power = voltage × current

(x) the relationship between speed, frequency and wavelength:

wave speed = frequency × wavelength

(xi) $$\frac{\text{input (primary) voltage}}{\text{output (seconday) voltage}} = \frac{\text{primary turns}}{\text{secondary turns}}$$

(xii) the relationship between refractive index, angle of incidence and angle of refraction:

$$n = \frac{\sin i}{\sin r}$$

(xiii) the relationship between refractive index and critical angle:

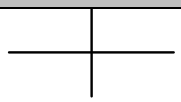
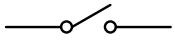
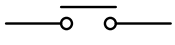
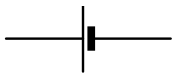
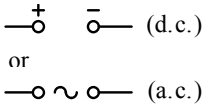
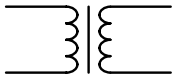
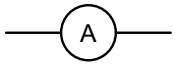
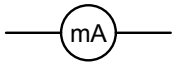
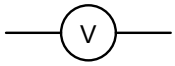
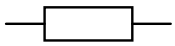
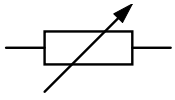
$$\sin c = \frac{1}{n}$$

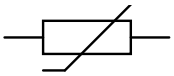
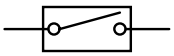
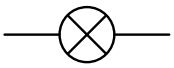
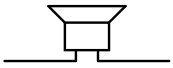
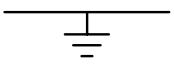
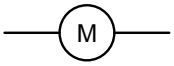
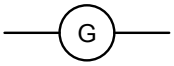
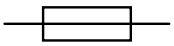
(xiv) the relationship for pressure difference:

pressure difference = height × density × g

$$p = h\rho g$$

Appendix 3: Electrical circuit symbols

Description	Symbol
conductors crossing with no connection	
junction of conductors	
open switch	
closed switch	
open push switch	
closed push switch	
cell	
battery of cells	
power supply	
transformer	
ammeter	
milliammeter	
voltmeter	
fixed resistor	
variable resistor	

Description	Symbol
heater	
thermistor	
light-dependent resistor (LDR)	
relay	
diode	
light-emitting diode (LED)	
lamp	
loudspeaker	
microphone	
electric bell	
earth or ground	
motor	
generator	
fuse/circuit breaker	

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