Independent Schools
Examinations Board

## COMMON ENTRANCE EXAMINATION AT 11+ AND 13+

## COMMON ACADEMIC SCHOLARSHIP EXAMINATION AT 13+

# SCIENCE SYLLABUS

*(Revised Summer 2006 for first examination in Spring 2008)*



*N.B. Any change from the previous syllabus, published in September 2001, is indicated by a heavy line in the margin.*

### INTRODUCTION

The revised Common Entrance science syllabus for examination at 11+ and 13+ remains based upon the programme of study for key stage 2 and key stage 3 respectively of the National Curriculum. The syllabus content is presented in a two-column format. The first column presents in full each statement from the key stage 2 and key stage 3 programmes of study for attainment targets 2, 3 and 4. Because key stage 3 covers years 7-9, the Common Entrance syllabus does not include all key stage 3 topics; many of these will be taught at senior school level.

Where necessary, the syllabus for the Common Entrance examination at 11+ and 13+ is further amplified in the second column. These additional notes are designed to provide guidance with regard to the depth and breadth of each topic and teachers should follow this when formulating their schemes of work.

**Important note: Teachers should be aware of the health and safety statement on page 51 of the science booklet for *The National Curriculum for England,* 2004 and they should pay due regard to safety when planning and supervising practical activities. See also Appendix I.**

## AIMS

A course leading to this examination should:

(i) stimulate curiosity, interest in and enjoyment of science;

(ii) help candidates to acquire a systematic body of scientific knowledge and to develop an understanding of science, recognising connections between different areas of science;

(iii) enable candidates to use scientific ideas and models to explain phenomena and events and to understand applications of science;

(iv) develop an awareness of the impact of developments in technology on the environment and in other contexts;

(v) develop experimental and investigative abilities, paying due regard to safe practice;

(vi) develop an ability to evaluate and communicate scientific evidence, and understand the importance of experimental evidence in supporting scientific ideas.

## ASSESSMENT OBJECTIVES

Candidates should develop their knowledge, skills and understanding in the four attainment targets:

AO1 Scientific enquiry (Sc1);

AO2 Life processes and living things (Sc2);

AO3 Materials and their properties (Sc3);

AO4 Physical processes (Sc4).

The development of the practical and intellectual skills given in the level descriptions for Sc1 is an integral part of science education and some of the questions will be set to test investigation skills, including safety. Candidates will be expected to present and interpret data in a variety of ways, including bar charts and line graphs, and to have experienced the electronic capture of data. Teachers are encouraged to record candidates' progress in Sc1.

## SYLLABUS CONTENT

At 11+ it is expected that material in key stage 1 has already been fully covered. At 13+ it is expected that material in key stages 1 and 2 has already been fully covered.

The terminology used in the biology papers is based on *Biological Nomenclature*: *Standard Terms and Expressions used in the Teaching of Biology*, Institute of Biology, 2000.

# 11+

## Sc2: LIFE PROCESSES AND LIVING THINGS

| KS2 NC REQUIREMENT | 11+ AMPLIFICATION |
|---|---|
| **1. Life processes** | |
| Pupils should be taught: | Candidates should know: |
| a. that the life processes common to humans and other animals include nutrition, movement, growth and reproduction | the names and positions of the following related organs: **brain**, **heart**, **lungs**, **stomach**, **intestines**, **liver** and **kidneys** in humans, and the **root**, **stem**, **leaves** and **flower** of a flowering plant |
| b. that the life processes common to plants include growth, nutrition and reproduction | *For humans, this can be based on pictures and models; for flowering plants, real specimens should be examined.* |
| c. to make links between life processes in familiar animals and plants and the environments in which they are found. | how living things, e.g. pets, farm animals, wildlife found in parks and gardens and the associated plant life, carry out these life processes within their respective habitats. |
| **2. Humans and other animals** | |
| Pupils should be taught: | Candidates should know: |
| **Nutrition** | |
| a. about the functions and care of teeth | the main kinds of teeth **(incisors**, **canines**, **pre-molars** and **molars)** and their functions; the effect of **bacteria (plaque)**, fluoride and diet on dental decay; the importance of dental care and hygiene |
| b. about the need for food for activity and growth, and about the importance of an adequate and varied diet for health | the value of a balanced diet, composed of **carbohydrates**, **fats**, **proteins**, **vitamins**, **mineral salts**, **fibre** and **water**, in the maintenance of good health; how to carry out the iodine test for starch |
| **Circulation** | |
| c. that the heart acts as a pump to circulate the blood through vessels around the body, including through the lungs | the structure of the heart through the use of appropriate models or diagrams; that the heart forces blood around the body to the organs through **arteries** and that the blood returns to the heart through **veins** |

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|---|---|
| | *The names of the chambers and valves of the heart will not be examined.* |
| d. about the effect of exercise and rest on pulse rate | that during exercise the body needs more oxygen and food to provide the necessary energy, and that this can be demonstrated by comparing pulse rates at rest and after exercise; the effect of exercise on the body and the benefits to health, e.g. reducing obesity, increasing stamina<br><br>*The term* **respiration** *will not be used.* |
| **Movement** | |
| e. that humans and some other animals have skeletons and muscles to support and protect their bodies and to help them to move | that animals with internal skeletons are called **vertebrates**; the role of the skeleton in providing support, protection and movement; the location of the **skull**, **backbone (vertebral column)**, **rib cage**, **pelvis**, **collarbone** and **shoulder blade** |
| **Growth and reproduction** | |
| f. about the main stages of the human life cycle | *This topic will not be examined but should have been taught by the end of year 6.* |
| **Health** | |
| g. about the effects on the human body of tobacco, alcohol and other drugs, and how these relate to their personal health | examples of the harmful effects on the body of tobacco and alcohol; that other drugs can seriously affect health. |
| h. about the importance of exercise for good health. | *See 2d above.* |

**3. Green plants**

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Growth and nutrition** | |
| a. the effect of light, air, water and temperature on plant growth | how to demonstrate the effect of variation in light, temperature and water on plant growth; that the air supplies a plant with **carbon dioxide** for making food; that plants also need **oxygen**<br><br>*Respiration will not be examined.* |

| | |
|---|---|
| b. the role of the leaf in producing new material for growth | that green plants use energy from the Sun to produce food **(photosynthesis)**; the role of the green pigment **(chlorophyll)** in the leaf and stem in capturing this light energy; that nearly all food chains start with green plants. |
| c. that the root anchors the plant, and that water and minerals are taken in through the root and transported through the stem to other parts of the plant | that mineral salts are **nutrients** which are needed for healthy growth |
| **Reproduction** | |
| d. about the parts of the flower *[e.g. stigma, stamen, petal, sepal]* and their role in the life cycle of flowering plants, including pollination, seed formation, seed dispersal and germination. | how sexual reproduction occurs in flowering plants, including details of flower structure; the terms **carpel (stigma**, **style**, **ovary**, **ovule)**, **stamen (anther**, **filament)**, **petal**, **sepal**; that **pollination** is the transfer of pollen from an anther to a stigma; that **fertilisation** is the fusing together of the male and female sex cells which produces a fertilised egg leading to the formation of a **seed**; about fruit formation and seed dispersal; about the **germination** of seeds; the main parts of a germinating seed: **embryo shoot**, **embryo root**, **food store** and **seed coat.** |

## 4. Variation and classification

| Pupils should be taught: | Candidates should know: |
|---|---|
| a. to make and use keys | how to make and use simple keys based on observable external features to help them to identify and group living things systematically |
| b. how locally occurring animals and plants can be identified and assigned to groups | the terms **vertebrate** and **invertebrate**; how to distinguish between insects and spiders; that there are flowering and non-flowering groups of plants. |
| c. that the variety of plants and animals makes it important to identify them and assign them to groups. | *Taxonomic groups will not be examined.* |

## 5. Living things in their environment

| Pupils should be taught: | Candidates should know: |
|---|---|
| a. about ways in which living things and the environment need protection | about the need to protect and conserve living things and their environment, e.g. endangered species, effects of pollution, habitat destruction etc. |
| **Adaptation** | |
| b. about the different plants and animals found in different habitats<br><br>c. how animals and plants in two different habitats are suited to their environment | the features of animals and plants in **one** chosen habitat (these should include size, shape, colour and, where possible, methods of movement, feeding and protection); the wide variety of responses which animals have developed to living in different situations; that some animals are **nocturnal**; that the activity of living things can be related to the time of day and season of the year; the terms **hibernation** and **migration** |
| **Feeding relationships** | |
| d. to use food chains to show feeding relationships in a habitat | how to place organisms in order in a food chain; the terms **producer**, **consumer (herbivore**, **carnivore** and **omnivore)**; the relationship between **predator** and **prey**. |
| e. about how nearly all food chains start with a green plant | |
| **Micro-organisms** | |
| f. that micro-organisms are living organisms that are often too small to be seen, and that they may be beneficial *[e.g. in the breakdown of waste, in making bread]* or harmful *[e.g. in causing disease, in causing food to go mouldy].* | *This topic will not be examined but should have been taught by the end of year 6.* |

## Sc3: MATERIALS AND THEIR PROPERTIES

| KS2 NC REQUIREMENT | 11+ AMPLIFICATION |
|---|---|
| **6. Grouping and classifying materials** | |
| Pupils should be taught: | Candidates should know: |
| a. to compare everyday materials and objects on the basis of their material properties, including hardness, strength, flexibility and magnetic behaviour, and to relate these properties to everyday uses of the materials | the terms **metal**, **non-metal**, **magnetic** and **non-magnetic**<br><br>*A wide range of materials should be tested and included in as many practical situations as possible (see Appendix II).* |
| b. that some materials are better thermal insulators than others | that air is a good **insulator**; examples of situations where trapped air is used for insulation in everyday life, e.g. winter clothing, sleeping-bags, expanded polystyrene for cups |
| c. that some materials are better electrical conductors than others | that metals and carbon (graphite) are **conductors** of electricity, e.g. copper for household wiring; that most other materials are **insulators,** e.g. plastic for plug covers |
| d. to describe and group rocks and soils on the basis of their characteristics, including appearance, texture and permeability | about different kinds of soils, e.g. sand, clay, loam; how particle size affects drainage; the term **humus** and how this enriches the soil<br><br>*Rocks will not be examined but should have been taught by the end of year 6.* |
| e. to recognise differences between solids, liquids and gases, in terms of ease of flow and maintenance of shape and volume. | how to use simple particle theory to describe the arrangement of particles in solids, liquids and gases.<br><br>*The use of technical terms such as* viscosity *is not expected.* |
| **7. Changing materials** | |
| Pupils should be taught: | Candidates should know: |
| a. to describe changes that occur when materials are mixed *[e.g. adding salt to water]* | how to carry out simple dissolving experiments |

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|---|---|
| b. to describe changes that occur when materials *[e.g. water, clay, dough]* are heated or cooled | that heating or cooling can cause a change of state; the names given to these changes, i.e. **melting**, **boiling**, **condensing**, **evaporating, freezing / solidifying**; that water expands on freezing, causing pipes to burst and rocks to crack; how to compare different temperatures by feel and by the use of a thermometer; how to read a thermometer scale including values below 0 ºC; the boiling point and freezing point of water and the temperature of a healthy human |
| c. that temperature is a measure of how hot or cold things are | |
| d. about reversible changes, including dissolving, melting, boiling, condensing, freezing and evaporating | |
| e. the part played by evaporation and condensation in the water cycle | how to carry out simple experiments on **evaporation** and **condensation**; how these processes relate to the **water cycle** |
| f. that non-reversible changes *[e.g. vinegar reacting with bicarbonate of soda, plaster of Paris with water]* result in the formation of new materials that may be useful | examples of useful non-reversible changes, e.g. making concrete, baking; that air and water are both needed for rusting to occur; simple methods of preventing rusting, e.g. oiling, painting, galvanising, coating with plastic |
| g. that burning materials *[e.g. wood, wax, natural gas]* results in the formation of new materials and that this change is not usually reversible. | simple burning experiments to demonstrate that burning is not reversible; the term **fuel**; the term **fossil fuel** and examples of solid, liquid and gaseous fossil fuels.<br><br>*Knowledge of the formation of fossil fuels will not be examined.* |

**8. Separating mixtures of materials**

| Pupils should be taught: | Candidates should know: |
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| a. how to separate solid particles of different sizes by sieving *[e.g. those in soil]* | how to carry out simple experiments to separate solid particles of different sizes |

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| b. | that some solids *[e.g. salt, sugar]* dissolve in water to give solutions but some *[e.g. sand, chalk]* do not | the terms **soluble**, **insoluble**, **solute**, **solvent**, **solution**; factors affecting the rate of dissolving everyday substances in water, i.e. the temperature of the solvent, particle size of the solute and stirring; the concept of fair testing to compare rates of dissolving in water; that a solution contains at least two substances: water and the dissolved substance; how to draw and interpret bar charts and line graphs using data from dissolving experiments |
| c. | how to separate insoluble solids from liquids by filtering | how to carry out simple **filtration** experiments and **decanting** as another simple method of separating a solid from a liquid; the terms **filtrate** and **residue** |
| d. | how to recover dissolved solids by evaporating the liquid from the solution | how to carry out simple evaporation experiments, e.g. evaporation of a salt solution; that salt solutions should not be dried completely when heated |
| e. | to use knowledge of solids, liquids and gases to decide how mixtures might be separated. | how to take an investigative approach to separate a variety of mixtures. |

## Sc4: PHYSICAL PROCESSES

| KS2 NC REQUIREMENT | | 11+ AMPLIFICATION |
|---|---|---|
| **9. Electricity** | | |
| Pupils should be taught: | | Candidates should know: |
| **Simple circuits** | | |
| a. | to construct circuits, incorporating a battery or power supply and a range of switches, to make electrical devices work *[e.g. buzzers, motors]* | how to construct series circuits involving up to 3 cells, up to 3 bulbs, a motor, a buzzer and a switch; that electrical devices will only work if they are part of a complete circuit between the terminals of an electrical supply, and that each part of the circuit must be a conductor of electricity; the term **in series** |
| b. | how changing the number or type of components *[e.g. batteries, bulbs, wires]* in a series circuit can make bulbs brighter or dimmer | the relative brightness of bulbs in series circuits<br><br>*It is recommended that normal brightness describes one bulb lit by one cell. Other circuits can be compared with this.* |

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| c. how to represent series circuits by drawings and conventional symbols, and how to construct series circuits on the basis of drawings and diagrams using conventional symbols. | the electrical symbols for all the components mentioned above *(see Appendix III)*; how to interpret and draw circuit diagrams where the components are connected in series; how to recognise a short circuit and be aware of the safety implications. |

## 10. Forces and motion

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Types of force** | |
| a. about the forces of attraction and repulsion between magnets, and about the forces of attraction between magnets and magnetic materials | how to classify materials into **magnetic** and **non-magnetic** groups; that magnetic materials such as iron and steel are attracted to a magnet; how to carry out experiments to discover that a magnet exerts a force on another magnet or any piece of magnetic material which is placed close to it; that a magnet has **north-seeking** and **south-seeking poles** and why they are so called; that a freely suspended bar magnet comes to rest in a north-south direction and acts as a compass; that like poles **repel** and unlike poles **attract** each other; that magnetic effects will pass through some materials; how to compare the strength of two or more magnets |
| b. that objects are pulled downwards because of the gravitational attraction between them and the Earth | *The distinction between mass and weight will not be examined.* |
| c. about friction, including air resistance, as a force that slows moving objects and may prevent objects from starting to move | about the concept of **friction** as a force which opposes the relative movement of surfaces, with reference to everyday situations, e.g. the effect of friction between the wheels of a bicycle and the road, the effect of air resistance on the cyclist; how to carry out investigations involving friction, e.g. a toy car running over different surfaces |
| d. that when objects *[e.g. a spring, a table]* are pushed or pulled, an opposing pull or push can be felt | how to carry out simple experiments to experience these opposing forces |

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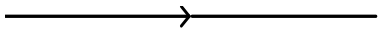
|---|---|
| e. how to measure forces and identify the direction in which they act. | different types of force: **push**, **pull**, **frictional** (including **air resistance**), **magnetic**, **gravitational**, **support (reaction)** and **upthrust**; how to use arrows to show the direction in which these forces are acting on an object; that the **newton (N)** is the unit of force; how to use a force meter (newton spring balance) to investigate the force required to do various jobs. |

## 11. Light and sound

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Everyday effects of light** | |
| a. that light travels from a source | that a **luminous** source gives out light; examples of luminous sources; that light travels in straight lines; how to indicate a ray of light like this:  |
| b. that light cannot pass through some materials, and how this leads to the formation of shadows | the terms **opaque**, **translucent** and **transparent;** how shadows are formed by opaque objects, investigating the effect of different distances between source, object and screen |
| c. that light is reflected from surfaces *[e.g. mirrors, polished metals]* | *Quantitative experiments with mirrors will not be examined.* |
| **Seeing** | |
| d. that we see things only when light from them enters our eyes | how we see luminous objects; how to draw simple diagrams to show that light rays, travelling in straight lines, enter the eye(s) directly from the luminous object<br><br>*Details of the structure of the eye will not be examined.* |
| **Vibration and sound** | |
| e. that sounds are made when objects *[e.g. strings on musical instruments]* vibrate but that vibrations are not always directly visible | the terms **vibrate** and **vibration**; that sound is emitted when an object vibrates, e.g. a stringed instrument, a tuning fork, a rubber band, a ruler or when the air inside an object vibrates, e.g. a recorder, a milk bottle; how to demonstrate that vibrations are not always visible, e.g. vibrations in a drum skin shown by using rice grains |

| | |
|---|---|
| f. how to change the pitch and loudness of sounds produced by some vibrating objects *[e.g. a drum skin, a plucked string]* | the term **pitch**; how the properties of sound such as pitch and **loudness** can be changed; that an increase / decrease in the size of the vibration produces a louder / quieter sound, and a faster / slower vibration produces a higher / lower-pitched sound; that on a stringed instrument, changing the length, tightness and thickness of a string will affect the pitch of a note<br><br>*The terms **frequency** and **amplitude** are not required.* |
| g. that vibrations from sound sources require a medium *[e.g. metal, wood, glass, air]* through which to travel to the ear. | that sound travels through solids, liquids and gases but not through a **vacuum**; these vibrations are detected by the ear.<br><br>*The ear and hearing will not be examined.* |

## 12. The Earth and beyond

| Pupils should be taught: | Candidates should know: |
|---|---|
| **The Sun, Earth and Moon** | |
| a. that the Sun, Earth and Moon are approximately spherical | |
| **Periodic changes** | |
| b. how the position of the Sun appears to change during the day, and how shadows change as this happens | how to use a globe and lamp representing the Earth and Sun in order to show how day and night arise; about practical examples relating to the apparent movement of the Sun, e.g. sundials. |
| c. how day and night are related to the spin of the Earth on its own axis | |
| d. that the Earth orbits the Sun once each year, and that the Moon takes approximately 28 days to orbit the Earth. | *A small ball representing the Moon should be added to the model.* |

# 13+

## Sc2: LIFE PROCESSES AND LIVING THINGS

| KS3 NC REQUIREMENT | 13+ AMPLIFICATION |
|---|---|
| **13. Cells and cell functions** | |
| Pupils should be taught: | Candidates should know: |
| a. that animal and plant cells can form tissues, and tissues can form organs | that in multicellular organisms cells are massed together to form tissues and tissues can be massed together to form organs |
| b. the functions of chloroplasts and cell walls in plant cells and the functions of the cell membrane, cytoplasm and nucleus in both plant and animal cells | that a typical animal or plant cell has a **nucleus**, **cytoplasm** and **cell surface membrane**; the function of each component, stated very briefly; that the nucleus contains **genes** which control the production of protein in the cell; that genes are made of **DNA** which determines an organism's characteristics; how to use a microscope to observe plant and animal cells and how to prepare a temporary microscope slide, e.g. using methylene blue as a stain for nuclei |
| c. ways in which some cells, including ciliated epithelial cells, sperm, ova, and root-hair cells, are adapted to their functions | *This section can be taught in the context of other parts of the syllabus. Candidates will not be expected to draw these cells in an examination.* |
| d. about fertilisation in humans and flowering plants as the fusion of a male and female cell | that fertilisation in humans occurs when the head of a **sperm** (a male cell) enters the **ovum** (a female cell) and the nuclei fuse together<br><br>*See also 2g.*<br><br>that fertilisation in flowering plants occurs when a male nucleus in a pollen tube fuses with a nucleus in a female egg cell (ovum) in an ovule. |
| e. to relate cells and cell functions to life processes in a variety of organisms. | *Questions will be restricted to animal and plant cells only.* |

## 14. Humans as organisms

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Nutrition** | |
| a. about the need for a balanced diet containing carbohydrates, proteins, fats, minerals, vitamins, fibre and water, and about foods that are sources of these | that **glucose** and **starch** are examples of carbohydrates, **vitamin C** is an example of a vitamin, and **calcium salts** are an example of a mineral; the effects on humans of lack of vitamin C and calcium; the dangers of an excessive intake of animal fats; one good source of each food component; how to carry out the iodine test for starch<br><br>*No other food tests will be examined.* |
| b. the principles of digestion, including the role of enzymes in breaking down large molecules into smaller ones | that digestive **enzymes** in the gut break down food substances into soluble substances capable of being absorbed across the lining of the intestine into the bloodstream<br><br>*Names, sources and actions of particular enzymes will not be examined.* |
| c. that the products of digestion are absorbed into the bloodstream and transported throughout the body, and that waste material is egested | that the products of digestion are absorbed through the gut into the bloodstream and the waste products are **egested** (not excreted) |
| d. that food is used as a fuel during respiration to maintain the body's activity and as a raw material for growth and repair | that carbohydrates are energy-containing foods, proteins are needed for growth and repair, fats are an energy source and are also needed for insulation |
| **Movement** | |
| e. the role of the skeleton and joints and the principle of antagonistic muscle pairs *[e.g. biceps and triceps]* in movement | that the skeleton protects delicate organs, supports the body and provides attachment for muscles; that muscles can contract and are pulled back to their original length by the contraction of antagonistic muscles; that muscles usually operate across moveable joints |

**Reproduction**

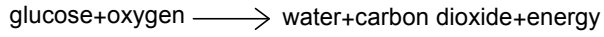
| | | |
|---|---|---|
| f. | about the physical and emotional changes that take place during adolescence | the principal changes which occur at adolescence<br><br>*Emotional changes should be addressed but will not be examined.* |
| g. | about the human reproductive system, including the menstrual cycle and fertilisation | the terms **gamete** and **zygote**; the relative sizes and numbers of **eggs** and **sperm** and their roles; that fertilisation is the union of a sperm with an egg, bringing together through the genes some of the characteristics of both parents; the structure and functions of the human reproductive system and how sperm and egg are brought together; the menstrual cycle in outline only<br><br>*Hormonal control will not be examined.* |
| h. | how the fetus develops in the uterus, including the role of the placenta | how the **fetus** is protected and nourished in the uterus and how its waste materials are eliminated |

**Breathing**

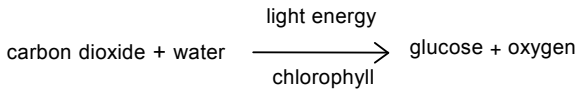
| | | |
|---|---|---|
| i. | the role of lung structure in gas exchange, including the effect of smoking | the structure of the lungs in outline only, i.e. the lung surface is greatly folded, creating a large surface area for gaseous exchange; that oxygen is taken into the lungs by breathing, and transported to the tissues by the circulatory system; that smoking is one of the causes of lung cancer and heart disease; that smoking reduces the surface area of the lungs, leading to severe breathing difficulties |

**Respiration**

| | | |
|---|---|---|
| j. | that aerobic respiration involves a reaction in cells between oxygen and food, in which glucose is broken down to carbon dioxide and water | the difference between breathing and respiration |

| | |
|---|---|
| k. to summarise aerobic respiration in a word equation | that energy is made available by **aerobic respiration**, summarised by the word equation:<br>  <br><br>how to test exhaled air for carbon dioxide using limewater |
| l. that the reactants and products of respiration are transported throughout the body in the bloodstream | that oxygen and carbon dioxide are carried in the blood and exchanged with the atmosphere through the lungs |
| **Health** | |
| m. that the abuse of alcohol, solvents and other drugs affects health | the positive effects of exercise and healthy eating |
| n. how the growth and reproduction of bacteria and the replication of viruses can affect health, and how the body's natural defences may be enhanced by immunisation and medicines. | one example of a bacterial disease and one example of a viral disease; the importance of cleanliness at the personal and community levels as a defence against disease; that the body's natural defences can be supplemented by artificial methods.<br><br>*Immunisation will not be examined.* |

## 15. Green plants as organisms

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Nutrition and growth** | |
| a. that plants need carbon dioxide, water and light for photosynthesis, and produce biomass and oxygen | the global importance of photosynthesis in producing food and maintaining the composition of the atmosphere; about gas production during photosynthesis in, e.g. *Elodea*; how to perform a controlled experiment to show that light is needed for starch production by a potted plant, e.g. *Pelargonium* |
| b. to summarise photosynthesis in a word equation | that photosynthesis is summarised by the word equation:<br>  <br><br>that in most plants the glucose is then converted into starch which can be tested, using iodine solution |

| | |
|---|---|
| c. that nitrogen and other elements, in addition to carbon, oxygen and hydrogen are required for plant growth | *Knowledge of mineral nutrients will not be examined.* |
| d. the role of root hairs in absorbing water and minerals from the soil | that root hairs increase the surface area for absorption of water and minerals such as nitrates |
| **Respiration** | |
| e. that plants carry out aerobic respiration. | that animals and plants respire and plants photosynthesise; how the **carbon cycle** maintains a balance between respiration and photosynthesis and the effect of this on the atmosphere. |

## 16. Variation, classification and inheritance

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Variation** | |
| a. about environmental and inherited causes of variation within a species | how to detect and describe variation within and between species and suggest possible causes |
| **Classification** | |
| b. to classify living things into the major taxonomic groups | how to use a simple key to identify the group to which a specimen belongs; that **animals** and **plants** are classified into separate kingdoms; that **bacteria**, **fungi** and **single-celled organisms** are placed in other kingdoms; the characteristic features of the animal and plant kingdoms and why fungi are not included with plants; the diagnostic features of: single-celled organisms, fungi, arthropods (knowing the difference between insects and spiders), fish, amphibians, reptiles, birds, mammals and flowering plants.<br><br>*Candidates will not be asked to make their own keys.* |
| **Inheritance** | |
| c. that selective breeding can lead to new varieties. | *This will not be examined.* |

## 17. Living things in their environment

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Adaptation and competition** | |
| a. about ways in which living things and the environment can be protected, and the importance of sustainable development | the importance of conserving local habitats, that the resources of the Earth are limited and need to be managed |
| b. that habitats support a diversity of plants and animals that are interdependent | at least one habitat, e.g. a freshwater pond or a hedgerow |
| c. how some organisms are adapted to survive daily and seasonal changes in their habitats | about the habitat of at least **one** animal and **one** plant, understanding how they are adapted to the conditions in their natural habitats at different times of the day, and in different seasons of the year; measure at least one physical factor, e.g. temperature, light intensity in the habitat |
| d. how predation and competition for resources affect the size of populations *[e.g. bacteria, growth of vegetation]* | simple methods of estimating the population size of one type of organism by means of a quadrat; that population size is affected by **predation** and **competition** |
| **Feeding relationships** | |
| e. about food webs composed of several food chains, and how food chains can be quantified using pyramids of number | about one simple food chain in one of the habitats studied; the difference between a **food chain** and a **food web**.<br><br>*Pyramids of number, biomass and energy will not be examined.* |
| f. how toxic materials can accumulate in food chains. | *Questions will be restricted to data interpretation.* |

## Sc3: MATERIALS AND THEIR PROPERTIES

| KS3 NC REQUIREMENT | 13+ AMPLIFICATION |
|---|---|
| **18. Classifying materials** | |
| Pupils should be taught: | Candidates should know: |
| **Solids, liquids and gases** | |
| a. how materials can be characterised by melting point, boiling point and density | *Measurement of the mass and volume and calculation of the density of regularly-shaped solids and of irregularly-shaped solids (using the displacement of water to find the volume) and of liquids will usually be examined in the physics section of the Common Entrance examination. So too will the fact that air has mass and that it is possible to measure its density.* |
| b. how the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of state, gas pressure and diffusion | the meaning of the words **atom** and **molecule**<br><br>*A knowledge of ions and of diffusion will not be examined.* |
| **Elements, compounds and mixtures** | |
| c. that elements are shown in the periodic table and consist of atoms which can be represented by symbols | the term **element** as used in chemistry and the idea that samples of the same element contain the same type of atom; that the elements are organised in the periodic table<br><br>*A knowledge of chemical symbols, formulae and details of the periodic table will not be examined.* |
| d. how elements vary widely in their physical properties, including appearance, state at room temperature, magnetic properties and thermal and electrical conductivity, and to use these properties to classify elements as metals or non-metals | the terms **conductor** and **insulator** in both electrical and thermal contexts; the grouping of elements into metals and non-metals according to physical characteristics such as electrical conductivity, shininess, malleability and according to whether they give acidic or basic oxides<br><br>*Carbon, copper, iron, magnesium, sulphur and zinc are suitable examples for experiments on burning the elements in air and testing the oxides. Calcium and sodium, if included, must be handled only by the teacher.* |

| | |
|---|---|
| e. how elements combine through chemical reactions to form compounds *[e.g. water, carbon dioxide, magnesium oxide, sodium chloride, most minerals]* with definite composition | the idea that elements combine to give **compounds** whose properties differ from those of the constituent elements; what happens when some elements are burned in oxygen, e.g. carbon, sulphur, iron, magnesium the reaction between pairs of elements, e.g. iron + sulphur, copper + sulphur, aluminium + iodine (in fume cupboard or outside)<br><br>*Knowledge of the reaction of sodium with chlorine will not be examined.* |
| f. to represent compounds by formulae and to summarise reactions by word equations | *Representation by formulae will not be examined.* |
| g. that mixtures *[e.g. air, sea water and most rocks]* are composed of constituents that are not combined | that air is a mixture of gases; the approximate percentages of nitrogen, oxygen and the relatively small proportion of other gases in the air; the uses of oxygen; that carbon dioxide is a product of respiration and a raw material for photosynthesis |
| h. how to separate mixtures into their constituents using distillation and chromatography and other appropriate methods. | the following methods of separation: evaporation to recover a solute and the testing of water purity by measurement of its boiling point and freezing point; simple distillation to recover a solvent from a solution, e.g. how to obtain a sample of pure water from sea water or washable ink; of the need to prevent suck-back of the distilled sample if simple apparatus is used, and how to prevent it; fractional distillation to recover ethanol (alcohol) from wine or beer; use of the Liebig condenser; paper chromatography to separate a mixture of two or more coloured solutes from a solution, e.g. coloured inks, food dyes, Smartie-type sweets; how to interpret simple chromatograms; about filtration to remove insoluble solids from a suspension; the terms **filtrate** and **residue**; how to purify rock salt.<br><br>*Distillation of crude oil will not be examined.* |

**19. Changing materials**

| Pupils should be taught: | Candidates should know: |
|---|---|

**Physical changes**

| | | |
|---|---|---|
| a. | that when physical changes *[e.g. changes of state, formation of solutions]* take place, mass is conserved | the terms **solution**, **solvent**, **solute**, **soluble**, **insoluble** and **dissolving** |
| b. | about the variation of solubility with temperature, the formation of saturated solutions and the differences in solubility of solutes in different solvents | that when soluble solids form a solution, a chemical change is not involved; that a solution is a mixture which may be separated using physical techniques; about the abundance of water in nature, including its existence as vapour in the air; the water cycle; about the use of anhydrous copper sulphate and anhydrous cobalt chloride to test for the presence of water vapour in the air; the effect of air flow and temperature changes on evaporation from oceans or in laboratory experiments; how to make predictions about the amount of water lost; the need for filtration; the differences between sea, tap and distilled water, demonstrated by evaporation; the importance of water as a solvent; that ethanol and propanone are alternative solvents to water<br><br>*Chlorinated hydrocarbons must not be used.* |
| c. | to relate changes of state to energy transfers | the terms **melting**, **freezing**, **boiling**, **condensation**, **evaporation** and **sublimation;** that most solids, liquids and gases expand on heating and contract on cooling, e.g. the use of mercury or alcohol in thermometers; that evaporation can occur at any temperature but boiling occurs at a specific temperature for a particular substance |

**Geological changes**

| | | |
|---|---|---|
| d. | how the forces of expansion, contraction and the freezing of water can lead to the physical weathering of rocks | *This will not be examined.* |
| e. | about the formation of rocks by processes that take place over different time-scales and that the mode of formation determines their texture and the minerals contained | *This will not be examined.* |
| f. | how igneous rocks are formed by the cooling of magma, sedimentary rocks by the deposition of rock fragments and organic material or by evaporation, and metamorphic rocks by the action of heat and pressure on existing rocks | *This will not be examined.* |

**Chemical reactions**

| | | |
|---|---|---|
| g. | how mass is conserved when chemical reactions take place because the same atoms are present, although combined in different ways | how to use the Bunsen burner for gentle warming, vigorous heating etc.; about the effect of air supply on the flame and relative temperatures of different parts of the roaring flame; about the experiment to demonstrate the conservation of mass in which lead iodide, or another suitable solid, is produced by mixing two solutions in a stoppered conical flask; how to construct word equations for simple chemical reactions; about recognising chemical change by the new substances which are formed |
| h. | that virtually all materials, including those in living systems, are made through chemical reactions, and to recognise the importance of chemical change in everyday situations, *[e.g. ripening fruit, setting superglue, cooking food]* | *Many examples of such reactions are given in other sections. Copper oxide, zinc oxide and magnesium oxide (previously dried in an oven) may be used to illustrate that some substances do not change chemically when heated.*<br><br>that chemical reactions are needed for the extraction of copper, iron and aluminium from their ores |

| | |
|---|---|
| i. about possible effects of the burning of fossil fuels on the environment *[e.g. production of acid rain, carbon dioxide and solid particles]* and how these effects can be minimised. | that when things burn in air they react with oxygen; the glowing splint test for oxygen and the limewater test for carbon dioxide; how to identify the products of combustion, e.g. of a candle; the importance of oxygen as a reactant in respiration; the effect of burning fossil fuels, that air is often polluted by sulphur dioxide and carbon monoxide and the sources of these pollutants.<br><br>*Production and effects of ozone and oxides of nitrogen will not be examined.* |

**20. Patterns of behaviour**

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Metals** | |
| a. how metals react with oxygen, water and acids and oxides of other metals, and what the products of these reactions are | how to apply the lighted splint test for hydrogen; about the rusting of iron; that oxygen in the air is involved in the rusting process<br><br>*Simple rusting experiments should be extended to show that air contains 20% oxygen. Copper, iron, magnesium and zinc are suitable examples for experiments.* |
| b. about the displacement reactions that take place between metals and solutions of salts of other metals | about displacement reactions between metals and solutions of the sulphates of other metals |
| c. how a reactivity series of metals can be determined by considering these reactions, and used to make predictions about other reactions | how to use the reactivity series of metals to deduce that those higher in the series might burn more vigorously in air, react faster with water and dilute acids, and replace a lower metal from its oxide; about the uses of metals low down the series, such as lead and copper, for roofing and piping; about the need for methods of covering the surface when the more reactive iron is used; about the exceptional lack of reactivity of silver and gold which makes them useful for jewellery and electrical contacts<br><br>*Reference should be made to the fact that most metals are not found in their free state and that chemical reactions are necessary to extract metals from their ores.* |

**Acids and bases**

| | | |
|---|---|---|
| d. | to use indicators to classify solutions as acidic, neutral or alkaline and to use the pH scale as a measure of the acidity of a solution | about experiments which test substances with different indicators, including litmus paper and Universal Indicator; that substances can be acidic, alkaline or neutral; about the use of plant extracts, e.g. red cabbage as indicators; colour changes for litmus; the pH scale; pH numbers for strong and weak acids and alkalis and a neutral solution |
| e. | how metals and bases, including carbonates, react with acids and the products of these reactions | about neutralisation and salt formation; about the addition of dilute sodium hydroxide solution to dilute hydrochloric acid and evaporation of the neutral solution, to illustrate neutralisation and salt formation<br><br>*Alternatively, salt formation could be illustrated by adding copper oxide or copper carbonate to warm dilute sulphuric acid and evaporating gently.*<br><br>*Titration will not be examined.* |
| f. | about some everyday applications of neutralisations *[e.g. the treatment of acid indigestion, the treatment of acid soil, the manufacture of fertilizer]* | about medical and agricultural applications of neutralisation |
| g. | how acids in the environment can lead to corrosion of metal and chemical weathering of rock *[e.g. limestone]* | that carbon dioxide dissolves in water to form an acid and that rain is slightly acidic; about limestone: its chemical composition, its decomposition when heated, its reaction with dilute hydrochloric acid, its uses as a building material and for the production of agricultural lime; about the weathering effect of acid rain on limestone |
| h. | to identify patterns in chemical reactions. | the terms **oxidation**, **reduction**, **neutralisation** and **decomposition**; about the use of carbon to illustrate reduction; about the action of heat on copper and magnesium in air to illustrate oxidation; about the combustion of methane and similar fuels; about hydrated copper sulphate, hydrated cobalt chloride, copper carbonate and potassium permanganate to illustrate thermal decomposition. |

## Sc4: PHYSICAL PROCESSES

| KS3 NC REQUIREMENT | 13+ AMPLIFICATION |
|---|---|
| **21. Electricity and magnetism** | |
| Pupils should be taught: | Candidates should know: |
| **Circuits** | |
| a. how to design and construct series and parallel circuits, and how to measure current and voltage | about parallel and series circuits, involving cells, lamps, switches (push button, SPST, reed switches), resistors, variable resistors, LDRs, LEDs, motors, buzzers, fuses, AND and OR circuits (as constructed using switches); about truth tables for these<br><br>*Logic gates, SPDT switches and the use of the voltmeter will not be examined.* |
| b. that the current in a series circuit depends on the number of cells and the number and nature of other components and that current is not 'used up' by components | how to use ammeters<br><br>*Knowledge of resistors should be qualitative and no formal statement of Ohm's Law or definition of resistance will be required.* |
| c. that energy is transferred from batteries and other sources to other components in electrical circuits | that electrical energy is converted into other forms in electrical components |
| **Magnetic fields** | |
| d. about magnetic fields as regions of space where magnetic materials experience forces, and that like magnetic poles repel and unlike magnetic poles attract | that like poles repel and unlike poles attract, and that both poles will attract unmagnetised iron, that the Earth has a magnetic field, and that a freely-suspended bar magnet will align itself north–south; the terms **north-seeking** and **south-seeking poles;** that lines showing the direction of the field should have arrows pointing away from the north-seeking pole; that repulsion by a known magnet is the only true test for another magnet |

**Electromagnets**

| | |
|---|---|
| e. that a current in a coil produces a magnetic field pattern similar to that of a bar magnet | how to use plotting compasses and / or iron filings to show that current in a coil produces a magnetic field |
| f. how electromagnets are constructed and used in devices *[e.g. lifting magnets, relays].* | how to construct a simple electromagnet using an iron core and insulated wire; how to use relays. |

## 22. Forces and motion

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Force and linear motion** | |
| a. how to determine the speed of a moving object and to use the quantitative relationship between speed, distance and time | about the timing of moving bodies to measure speed; the relationship between speed, distance and time; how to use this for simple quantitative work |
| b. that the weight of an object on Earth is the result of the gravitational attraction between its mass and that of the Earth | that there is a gravitational force of attraction between any two masses; that this force causes bodies to fall towards the centre of the Earth; that the **weight** of a body is the pull of gravity on it and that it can be measured with a newton spring balance (newton meter) |
| c. that unbalanced forces change the speed or direction of objects and that balanced forces produce no change in the movement of an object | the concept of constant speed and of speeding up and of slowing down, without a formal definition of acceleration; about the effects of forces on an object; that forces can act in different directions; about experiments and calculations with springs and combinations of springs<br><br>*Knowledge of elastic limit and limit of proportionality will not be examined.* |
| d. ways in which frictional forces, including air resistance, affect motion *[e.g. streamlining cars, friction between tyre and road]* | about the force of friction, including air resistance, and its applications; the different stopping distances as listed in the Highway Code<br><br>*Candidates do not have to memorise the different stopping distances.* |

**Force and rotation**

| | |
|---|---|
| e. that forces can cause objects to turn about a pivot | about the use of levers to change direction and magnitude of a force and their use in simple machines, e.g. crowbars, pliers, scissors |
| f. the principle of moments and its application to situations involving one pivot | about the action of levers, including simple quantitative examples involving moments about a single pivot |

**Force and pressure**

| | |
|---|---|
| g. the quantitative relationship between force, area and pressure and its application *[e.g. the use of skis and snowboards, the effect of sharp blades, hydraulic brakes].* | the relationship between force, area and pressure; how to use this for simple quantitative work. |

## 23. Light and sound

| Pupils should be taught: | Candidates should know: |
|---|---|
| **The behaviour of light** | |
| a. that light travels in a straight line at a finite speed in a uniform medium | that light comes from a luminous source and travels in straight lines |
| b. that non-luminous objects are seen because light scattered from them enters the eye | *Details of the structure of the eye will not be examined.* |
| c. how light is reflected at plane surfaces | how plane mirrors alter the path of a ray of light; how to recognise its practical applications, e.g. construction of a periscope |
| d. how light is refracted at the boundary between two different materials | that, on a qualitative basis, light changes direction when it reaches the boundary between two different materials and that this phenomenon is called **refraction**<br><br>*Snell's Law and knowledge of optical devices which require the use of lenses will not be examined.* |
| e. that white light can be dispersed to give a range of colours | how a prism disperses white light and that a similar effect occurs naturally in a rainbow |

| | |
|---|---|
| f. the effect of colour filters on white light and how coloured objects appear in white light and in other colours of light | *This will not be examined.* |

**Hearing**

| | |
|---|---|
| g. that sound causes the eardrum to vibrate and that different people have different audible ranges | *Questions will not be set which require candidates to have experienced the use of a signal generator.* |
| h. some effects of loud sounds on the ear *[e.g. temporary deafness]* | that loud sounds can cause temporary or permanent damage to hearing |

**Vibration and sound**

| | |
|---|---|
| i. that light can travel through a vacuum but sound cannot, and that light travels much faster than sound | that sound travels through solids, liquids and air, but not through a vacuum; that an event observed from a distance is seen before it is heard<br><br>*Candidates will not be expected to memorise the numerical values for the speeds of sound and light but merely the comparison between the two.* |
| j. the relationship between the loudness of a sound and the amplitude of the vibration causing it | that increasing amplitude increases the loudness of a sound |
| k. the relationship between the pitch of a sound and the frequency of the vibration causing it. | that increasing frequency increases pitch. |

## 24. The Earth and beyond

| Pupils should be taught: | Candidates should know: |
|---|---|

**The solar system**

| | |
|---|---|
| a. how the movement of the Earth causes the apparent daily and annual movement of the Sun and other stars | that the Earth is one of several planets which orbit the Sun; the reasons for the changes causing night and day, seasons and eclipses of the Sun and Moon |

| | |
|---|---|
| b. the relative positions of the Earth, Sun and planets in the solar system | the concept of a moon as a satellite, as shown by our Moon and the moons of other planets; that the solar system is part of the Milky Way galaxy, and that the Universe contains many such groups of stars or galaxies; about the scale of astronomical distances<br><br>*Planetary and stellar distances need not be remembered.* |
| c. about the movements of planets around the Sun and to relate these to gravitational forces | that it is gravitational forces which keep the Moon in orbit round the Earth and planets in orbit round the Sun |
| d. that the Sun and other stars are light sources and that the planets and other bodies are seen by reflected light | why the planets and our Moon are visible even though they are not light sources. |
| e. about the use of artificial satellites and probes to observe the Earth and to explore the solar system. | *Factual details about Man's exploration of space will not be examined, but candidates should have heard of the development of manned space flight and of the use of satellites for communication, for monitoring conditions on Earth and for exploration of the solar system.* |

**25. Energy resources and energy transfer**

| Pupils should be taught: | Candidates should know: |
|---|---|
| **Energy resources** | |
| a. about the variety of energy resources, including oil, gas, coal, biomass, food, wind, waves and batteries, and the distinction between renewable and non-renewable resources | that energy is a quantity which can be measured and that the unit of energy is the **joule**<br><br>*Calculations involving this unit in the context of 'work' will not be examined.* |
| b. about the Sun as the ultimate source of most of the Earth's energy resources and to relate this to how coal, oil and gas are formed | the role of the Sun as the ultimate source of the energy in fossil fuels; its part in the water cycle and formation of wind and waves |
| c. that electricity is generated using a variety of energy resources | that a variety of processes are used to generate electricity |

**Conservation of energy**

| | | |
|---|---|---|
| d. | the distinction between temperature and heat, and that differences in temperature can lead to transfer of energy | *This will not be examined.* |
| e. | ways in which energy can be usefully transferred and stored | that work is a process involving energy transfer; about different forms of energy: **chemical**, **electrical**, **gravitational**, **kinetic**, **light**, **sound**, **strain (elastic)**, and **internal thermal** |
| f. | how energy is transferred by the movement of particles in conduction, convection and evaporation, and that energy is transferred by radiation | *This will not be examined.* |
| g. | that although energy is always conserved, it may be dissipated, reducing its availability as a resource. | the significance of the Law of Conservation of Energy. |

## SCHEME OF ASSESSMENT

### 11+

The 11+ examination will consist of a single 60-minute paper, carrying 80 marks.

The paper will test Life Processes and Living Things, Materials and Their Properties and Physical Processes with approximately equal weighting. Questions will be included to enable candidates to demonstrate their developing skills in scientific enquiry. Each paper may contain a question giving candidates the opportunity for free writing to a maximum of 4 marks.

There will be no choice of questions. The use of calculators will be allowed in the examination.

### 13+

The 13+ examination will consist of three 40-minute papers in biology (Sc2), chemistry (Sc3) and physics (Sc4). Each paper will carry 60 marks.

In all three papers, approximately 25% of the marks will be targeted at Sc1. All three papers will contain a few short questions at the beginning which aim to examine the breadth of the syllabus; longer questions will follow, allowing a greater differentiation of candidates' abilities by examining fewer topics in greater depth. One question on each paper will give candidates the opportunity for free writing to a maximum of 4 marks.

There will be no choice of questions. The use of calculators and protractors will be allowed in the examination and, at times, may be required.

## SCHOLARSHIP

Scholarship papers are based on this syllabus. The Common Academic Scholarship examination (90 minutes, including 10 minutes' reading time) will be divided into three sections: A (Biology), B (Chemistry) and C (Physics). Each section will contain two questions. Candidates will be required to attempt three questions, one from each section. Each question will carry 20 marks. The use of calculators and protractors will be allowed in the examination.

# APPENDIX I

## HEALTH AND SAFETY GUIDANCE

| | | |
|---|---|---|
| (i) | *Be Safe! Primary Science,* 3rd Edition, 2001 | The Association for Science Education<br>College Lane<br>Hatfield<br>AL10 9AA<br><br>Tel: 01707 283000<br>http://www.ase.org.uk |
| (ii) | *Safeguards in the School Laboratory, 11-19 Science,* 11th Edition, 2006 | *see above* |
| (iii) | Other ASE materials | *see above* |
| (iv) | *Shorter Laboratory Handbook* | CLEAPSS School Science Service<br>Brunel University<br>Uxbridge<br>UB8 3PH<br><br>Tel: 01895 251496<br>http://www.cleapss.org.uk |

# APPENDIX II

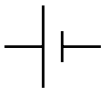
## SUGGESTED MATERIALS FOR GROUPING AND CLASSIFYING MATERIALS

aluminium
brass
bronze
carbon (graphite)
ceramic
chalk
clay
copper
cork
cotton cloth
expanded polystyrene
glass
granite
hard wood
iron
lead
leather
limestone
marble
nylon
paper
Perspex
polystyrene
polythene
PVC
rubber
slate
soft wood
steel
wool
zinc

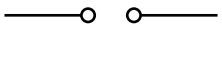
# APPENDIX III

## ELECTRICAL SYMBOLS
## WHICH MAY BE USED IN COMMON ENTRANCE PAPERS

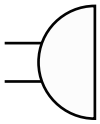
**11+**



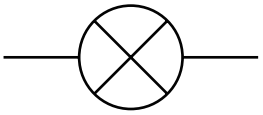
cell



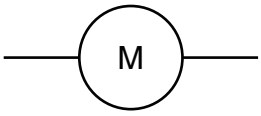
terminals



buzzer



lamp / bulb

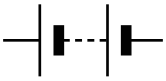



motor

switch
(open)

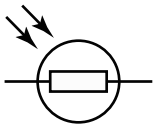
switch
(closed)

**Additional symbols required for 13+**

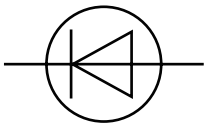


battery

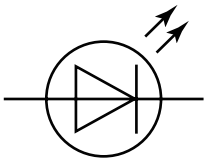
fuse



light dependent
resistor

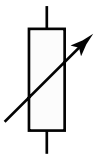


semiconductor
diode

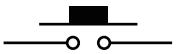


light emitting
diode

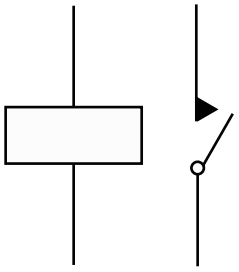
resistor



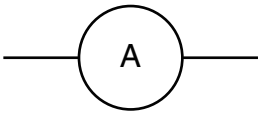
variable
resistor



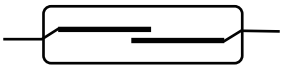
push-button
switch



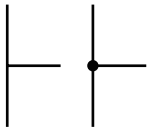
relay
(normally open)




ammeter



reed switch



junction of
conductors