edexcel

INTERNATIONAL GCSE Science (Double Award)

Specification and Sample Assessment Material

Edexcel International GCSE in Science (Double Award) (4SC0)

First examination June 2013

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This specification is Issue 6. Key changes are sidelined. We will inform centres of any changes to this issue. The latest issue can be found on our website: www.edexcel.com

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An internationally recognised option within Edexcel's learning pathways for students

Depending on the learning approach that suits them, and the progression route that they wish to follow, different learning pathways can suit different students. For many, especially those capable of progression to further academic study in science-related subjects, this International GCSE qualification forms an ideal grounding in scientific theory.

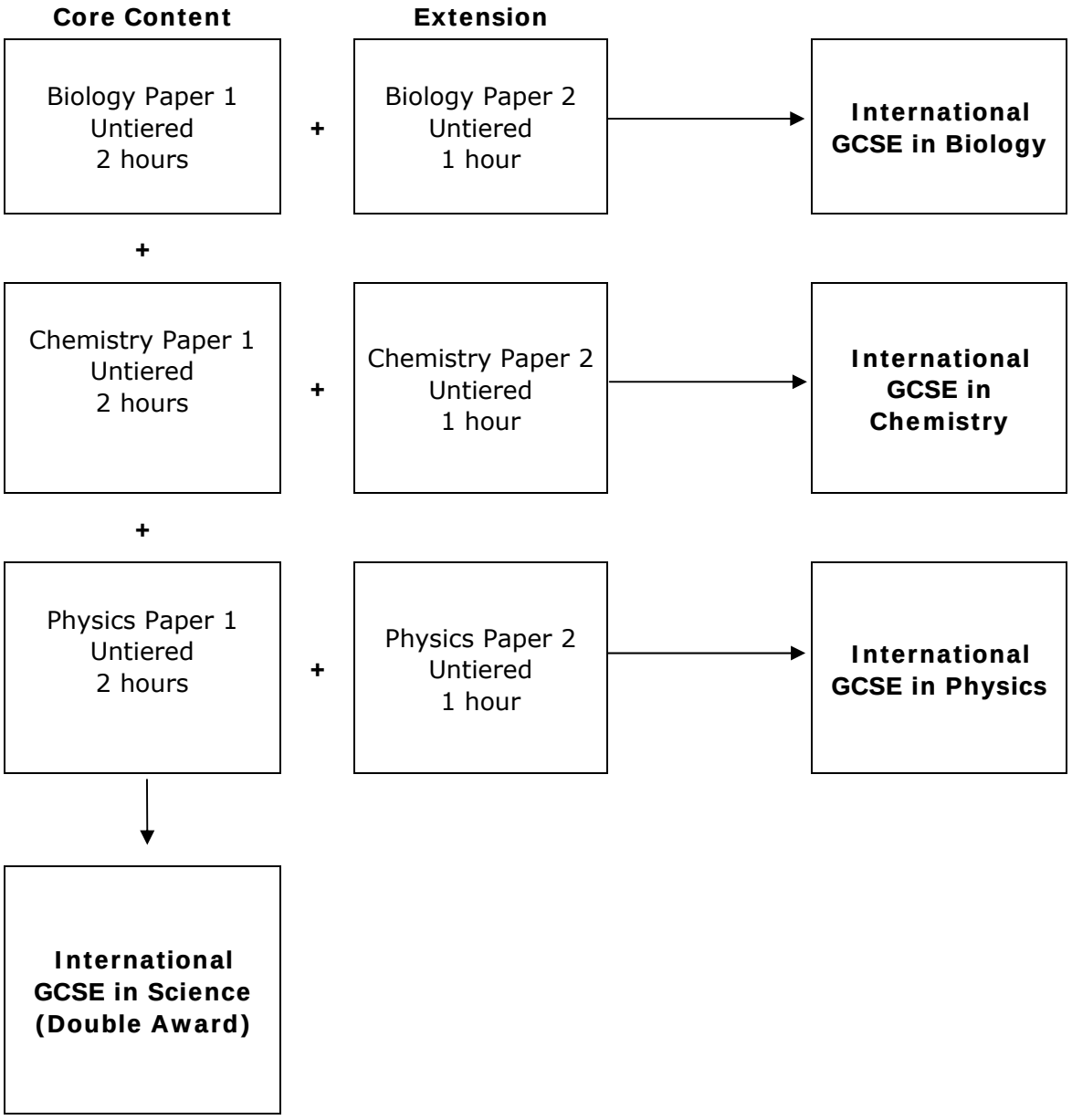
Used by many UK independent schools as well as renowned international schools, the content of International GCSE is:

- examined terminally to ensure secure acquisition of knowledge
- examined externally – controlled assessment is not required
- focused on the key theory that all students need to consider further study in Science.

Introduction

The Edexcel International GCSE 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 International GCSEs in single sciences (Biology, Chemistry and Physics), and combines them into an International GCSE in Science (Double Award) worth two GCSEs. 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.



National Qualifications Framework (NQF) criteria

This specification complies with the requirements of the common criteria which are prescribed by the regulatory authorities.

About this specification

Key subject aims

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

- acquire 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 and reporting as scientific methods
- form hypotheses and design experiments to test them
- sustain and develop an enjoyment of, and interest in, the scientific world
- evaluate, in terms of their scientific knowledge and understanding, the benefits and drawbacks of real-life applications of science, including their everyday, industrial and environmental aspects
- 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.

Key features and benefits of the specification

Key features and benefits are:

- students are awarded two grades, reflecting study of the prescribed amount of subject content
- clear, detailed and comprehensive subject content
- the specification includes aspects of science appropriate for the 21st century
- straightforward linear assessment
- it requires less curriculum time than teaching the three sciences individually
- single untiered assessment
- assessment of experimental skills through the examinations
- it provides a sound foundation for progression to Edexcel's GCE Advanced Subsidiary and Advanced Level science specifications.

Contents

Specification at a glance

This Edexcel International GCSE 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 2013	**33.3% of the total Double Award GCSE 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. • Grades A*–G available.	

Chemistry Paper 1	**Paper code: 4SC0/1C**
• Externally assessed • Availability: January and June series • First assessment: June 2013	**33.4% of the total Double Award GCSE 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 industry	
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. • Grades A*–G available.	

Physics Paper 1	**Paper code: 4SC0/1P**
• Externally assessed • Availability: January and June series • First assessment: June 2013	**33.3% of the total Double Award GCSE 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 • Grades A*–G available	

Practicals

The best way to develop practical and investigative skills is to embed practical activities in your teaching of theory. The development of knowledge and skills can then happen together, leading to secure acquisition of knowledge and skills.

There are some practicals in the specification content, which students need to describe. Knowledge of these practicals, and the ability to interpret the resulting data, is required for the examinations.

The teachers' guide materials contain additional suggested practicals.

Appendix 5 also contains some suggestions of practical activities.

Qualification content

Biology

This Edexcel International GCSE in Science (Double Award) requires students to demonstrate an understanding of:

- the nature and variety of living organisms
- structures and functions in living organisms
- reproduction and inheritance
- ecology and the environment
- use of biological resources.

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 understand that living organisms share the following 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; their cells contain chloroplasts and are able to carry out photosynthesis; their cells 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; their cells 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; their cells have 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 describe 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 compare the structures of plant and animal cells.

c) Biological molecules

Students will be assessed on their ability to:

2.5 identify 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, including those due to change in active site

2.10 describe experiments to investigate 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 understand 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 experiments to investigate 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 write the word equation and the balanced chemical symbol equation for photosynthesis

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

2.18 describe the structure of a leaf and explain how it is adapted for photosynthesis

2.19 understand 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 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 identify 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 describe the structures of the human alimentary canal and describe 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 understand 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 describe the structure of a villus and explain how this helps absorption of the products of digestion in the small intestine.

f) Respiration

Students will be assessed on their ability to:

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

2.29 describe the differences between aerobic and anaerobic respiration

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

2.31 write 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, including coronary heart disease

2.40 describe experiments 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 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 understand 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 to investigate the role of environmental factors in determining the rate of transpiration from a leafy shoot

Humans

2.48 describe 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 explain how adaptations of red blood cells, including shape, structure and the presence of haemoglobin, make them suitable for the transport of oxygen

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 explain how 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 understand the general structure 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 understand the origin of carbon dioxide and oxygen as waste products of metabolism and their loss from the stomata of a leaf

Humans

2.57 understand 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 understand 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 understand 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 understand 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 describe the structure and explain the function of the male and female reproductive systems

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

3.8 understand 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 understand 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 and that a gene codes for a specific protein

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 understand 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 understand 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 know 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 understand 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 that resistance to antibiotics can increase in bacterial populations, and appreciate how such an increase can lead to infections being difficult to control.

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 explain how quadrats can be used to estimate the population size of an organism in two different areas

4.3 explain how quadrats can be used to sample the distribution of organisms in their habitats.

b) Feeding relationships

Students will be assessed on their ability to:

4.4 explain 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 only about 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 understand 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 (genetic engineering)

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

Micro-organisms

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

Fish farming

5.7 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:

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

5.9 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:

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

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

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

5.13 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:

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

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

5.16 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

This Edexcel Level 1/Level 2 Certificate in Science (Double Award) requires students to demonstrate understanding of:

- principles of chemistry
- chemistry of the elements
- organic chemistry
- physical chemistry
- chemistry in industry

Section 1: Principles of chemistry

a) States of matter

b) Atoms

c) Atomic structure

d) Relative formula masses and molar volumes of gases

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

1.3 explain 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 and explain experiments to investigate 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 experimental techniques for the separation of mixtures, including simple distillation, fractional distillation, filtration, crystallisation and paper chromatography

1.8 explain how information from chromatograms can be used to identify the composition of a mixture.

c) Atomic structure

Students will be assessed on their ability to:

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

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

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

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

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

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

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

d) Relative formula masses and molar volumes of gases

Students will be assessed on their ability to:

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

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

1.18 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:

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

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

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

1.22 calculate empirical and molecular formulae from experimental data

1.23 calculate reacting masses using experimental data and chemical equations

1.24 carry out mole calculations using volumes and molar concentrations.

f) Ionic compounds

Students will be assessed on their ability to:

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

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

1.27 recall the charges of common ions in this specification

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

1.29 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

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

1.31 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:

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

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

1.34 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

1.35 understand that substances with simple molecular structures are gases or liquids, or solids with low melting points

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

1.37 explain the high melting and boiling 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:

1.38 understand that a metal can be described as a giant structure of positive ions surrounded by a sea of delocalised electrons

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

i) Electrolysis

Students will be assessed on their ability to:

1.40 understand that an electric current is a flow of electrons or ions

1.41 understand why covalent compounds do not conduct electricity

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

1.43 describe experiments to distinguish between electrolytes and non-electrolytes

1.44 understand that electrolysis involves the formation of new substances when ionic compounds conduct electricity

1.45 describe experiments to investigate electrolysis, using inert electrodes, of molten salts such as lead(II) bromide and predict the products

1.46 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 understand that the noble gases (Group 0) are 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 describe 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 describe the relative reactivities of the elements in Group 7

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

2.17 describe the laboratory preparation of oxygen from hydrogen peroxide, using manganese(IV) oxide as a catalyst

2.18 describe the reactions of magnesium, carbon and sulfur with oxygen in air, 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 describe 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 understand that carbon dioxide is a greenhouse gas and may contribute to climate change.

e) Hydrogen and water

Students will be assessed on their ability to:

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

2.25 describe the combustion of hydrogen

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

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

f) Reactivity series

Students will be assessed on their ability to:

2.28 understand 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

2.29 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

2.30 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

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

2.32 understand the terms redox, oxidising agent and reducing agent

2.33 describe the conditions under which iron rusts

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

2.35 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:

2.36 describe 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

2.37 describe 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

2.38 describe 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 describe the substitution 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 (knowledge of cis- and trans-isomers is not required)

3.8 describe the addition reaction of alkenes with bromine, including the decolourising 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 understand 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 experiments to prepare soluble salts from acids

4.8 describe experiments to prepare insoluble salts using precipitation reactions

4.9 describe experiments to carry out acid-alkali titrations.

b) Energetics

Students will be assessed on their ability to:

4.10 understand 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 enthalpy change for exothermic and endothermic reactions

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

4.14 understand 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 explain 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 understand 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 industry

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 understand that crude oil is a mixture of hydrocarbons

5.7 describe and explain 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 understand 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 understand that, in car engines, the temperature reached is high enough to allow nitrogen and oxygen from air to react, forming nitrogen oxides

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

5.13 understand that fractional distillation of crude oil produces more long-chain hydrocarbons than can be used directly and fewer short-chain hydrocarbons than required and explain why this makes cracking necessary

5.14 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:

5.15 understand that an addition polymer is formed by joining up many small molecules called monomers

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

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

5.18 describe some uses for polymers, including poly(ethene) and poly(propene).

5.19 explain that addition polymers are hard to dispose of as their inertness means that they do not easily biodegrade

d) The industrial manufacture of chemicals

Students will be assessed on their ability to:

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

5.21 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

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

5.23 describe the use of ammonia in the manufacture of nitric acid and fertilisers.

Physics

This Edexcel Level 1/Level 2 Certificate in Science (Double Award) requires students to demonstrate understanding of:

- forces and motion
- electricity
- waves
- energy resources and energy transfer
- solids, liquids and gases
- magnetism and electromagnetism
- radioactivity and particles

Section 1: Forces and motion

a) Units

b) Movement and position

c) Forces, movement, shape and momentum

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 plot and interpret distance-time graphs

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

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

1.4 describe experiments to investigate the motion of everyday objects such as toy cars or tennis balls

1.5 know and use the relationship between acceleration, velocity and time:

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

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

1.6 plot and interpret velocity-time graphs

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

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

c) Forces, movement, shape and momentum

Students will be assessed on their ability to:

1.9 describe the effects of forces between bodies such as changes in speed, shape or direction

1.10 identify different types of force such as gravitational or electrostatic

1.11 understand that friction is a force that opposes motion

1.12 know and use the relationship between unbalanced force, mass and acceleration:

force = mass × acceleration

$F = m \times a$

1.13 know and use the relationship between weight, mass and g:

weight = mass × g

$W = m \times g$

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

1.15 describe experiments to investigate the forces acting on falling objects such as sycamore seeds or parachutes

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

1.17 know and use the relationship between the moment of a force and its distance from the pivot:

moment = force × perpendicular distance from the pivot

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

1.19 describe experiments to investigate how extension varies with applied force for helical springs, metal wires and rubber bands

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

1.21 describe elastic behaviour as 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:

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

1.23 explain that gravitational force:

- causes moons to orbit planets
- causes the planets to orbit the sun
- causes artificial satellites to orbit the Earth
- causes comets to orbit the sun

1.24 describe the differences in the orbits of comets, moons and planets

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

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

$$v = \frac{2 \times \pi \times r}{T}$$

1.26 understand that:

- the universe is a large collection of billions of galaxies
- a galaxy is a large collection of billions of stars
- our solar system is in the Milky Way galaxy

Section 2: Electricity

a) Units

b) Mains electricity

c) Energy and potential difference in circuits

d) Electric charge

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

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

2.4 understand that a current in a resistor results in the electrical transfer of energy and an increase in temperature, and how this can be used in a variety of domestic contexts

2.5 know and use the relationship:

power = current × voltage

$P = I \times V$

and apply the relationship to the selection of appropriate fuses

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

energy transferred = current × voltage × time

$E = I \times V \times t$

2.7 understand the difference between mains electricity being alternating current (a.c.) and direct current (d.c.) being supplied by a cell or battery.

c) Energy and potential difference in circuits

Students will be assessed on their ability to:

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

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

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

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

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

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

2.14 know and use the relationship between voltage, current and resistance:

voltage = current × resistance

$V = I \times R$

2.15 understand that current is the rate of flow of charge

2.16 know and use the relationship between charge, current and time:

charge = current × time

$Q = I \times t$

2.17 know that electric current in solid metallic conductors is a flow of negatively charged electrons.

d) Electric charge

Students will be assessed on their ability to:

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

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 understand the difference between longitudinal and transverse waves and describe experiments to show longitudinal and transverse waves in, for example, ropes, springs and water

3.3 define amplitude, frequency, wavelength and period of a wave

3.4 understand that waves transfer energy and information without transferring matter

3.5 know 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 identify the order of the electromagnetic spectrum in terms of decreasing wavelength and increasing frequency, including the colours of the visible spectrum

3.10 explain 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 understand 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
- and describe simple protective measures against the risks.

d) Light and sound

Students will be assessed on their ability to:

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

3.13 use the law of reflection (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 know 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 explain the meaning of critical angle *c*

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

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

3.21 understand that sound waves are longitudinal waves and how they can be reflected and refracted

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

3.23 describe an experiment 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 know 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 describe how energy transfer may take place by conduction, convection and radiation

4.7 explain the role of convection in everyday phenomena

4.8 explain 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 know 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 know and use the relationship:

gravitational potential energy = mass × g × height

GPE = $m \times g \times h$

4.12 know and use the relationship:

kinetic energy = $\frac{1}{2}$ × mass × speed^2

KE = $\frac{1}{2} \times m \times v^2$

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 describe 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 know and use the relationship between density, mass and volume:

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

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

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

5.4 know 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 know and use the relationship for pressure difference:

pressure difference = height × density × 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, as supporting evidence for particle theory

5.8 understand 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 why there is an absolute zero of temperature which is –273°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 average 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

e) 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 describe experiments to investigate the magnetic field pattern for a permanent bar magnet and that between two bar magnets

6.4 describe 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 understand that an electric current in a conductor produces a magnetic field round it

6.6 understand 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 describe how 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 understand 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 and describe 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 and 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 $^{14}_{6}\mathrm{C}$ 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 explain 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 understand 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
- and describe how the associated risks can be reduced.

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 understand 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

Paper 1 Biology is externally assessed through an examination paper lasting 2 hours.

Paper 1 Chemistry is externally assessed through an examination paper lasting 2 hours.

Paper 1 Physics is externally assessed through an examination paper lasting 2 hours.

The assessment for this qualification is linear, and all papers must be taken in the same series.

There will be a range of compulsory, short-answer structured questions in all papers 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 scientific 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 scientific principles to unfamiliar situations. 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.

Summary of table of assessment

Biology Paper 1	**Paper code: 4SC0/1B**
• Externally assessed • Availability: January and June series • First assessment: June 2013 • Assesses all Assessment Objectives • Maximum mark 120 • 2-hour examination • Grades A*–G available	**33.3% of the total qualification**
Chemistry Paper 1	**Paper code: 4SC0/1C**
• Externally assessed • Availability: January and June series • First assessment: June 2013 • Assesses all Assessment Objectives • Maximum mark 120 • 2-hour examination • Grades A*–G available	**33.4% of the total qualification**
Physics Paper 1	**Paper code: 4SC0/1P**
• Externally assessed • Availability: January and June series • First assessment: June 2013 • Assesses all Assessment Objectives • Maximum mark 120 • 2-hour examination • Grades A*–G available	**33.3% of the total qualification**

Assessment Objectives and weightings

In the examination, students will be tested on the following areas:

- AO1 Knowledge and understanding
- AO2 Application of knowledge and understanding, analysis and evaluation
- AO3 Experimental skills, analysis and evaluation of data and methods

Assessment Objectives weightings

	% in Certificate
AO1: Knowledge and understanding*	45–50%
AO2: Application of knowledge and understanding, analysis and evaluation	27.5–32.5%
AO3: Experimental skills, analysis and evaluation of data and methods	20–25%
TOTAL	**100%**

Relationship of Assessment Objectives to Papers for Certificate

Paper number	Assessment Objectives			
	AO1*	AO2	AO3	Total marks for AO1, AO2 and AO3
Biology Paper 1	54 – 60 marks	33-39 marks	24 – 30 marks	120 marks
Chemistry Paper 1	54 – 60 marks	33-39 marks	24 – 30 marks	120 marks
Physics Paper 1	54 – 60 marks	33-39 marks	24 – 30 marks	120 marks
Percentage of Certificate	45–50%	27.5–32.5%	20–25%	100%

* No more than 50% of the AO1 marks **for the International GCSE** will be for recall of knowledge

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 are sent to all active Edexcel centres. The information can also be found on Edexcel's website.

Forbidden combinations

It is forbidden for students to take this qualification at the same time as following:

- Edexcel Level 1/Level 2 Certificate in Science (Double Award) (KSC0)
- Edexcel Level 1/Level 2 Certificate in Biology (KBI0)
- Edexcel Level 1/Level 2 Certificate in Chemistry (KCH0)
- Edexcel Level 1/Level 2 Certificate in Physics (KPH0)
- Edexcel International GCSE in Biology (4BI0)
- Edexcel International GCSE in Chemistry (4CH0)
- Edexcel International GCSE in Physics (4PH0)

Classification code

Centres should be aware that students who enter for more than one qualification with the same classification code will have only one grade (the highest) counted for the purpose of the school and college performance tables.

Access arrangements and special requirements

Edexcel's policy on access arrangements and special considerations for GCE, GCSE, International GCSE 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) for:

- the Joint Council for Qualifications (JCQ) policy Access Arrangements, Reasonable Adjustments and Special Considerations 2010–2011
- 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

Equality Act 2010

Please see the Edexcel website (www.edexcel.com) for information on the Equality Act 2010

Health and safety

Students must follow the Health and Safety rules which normally operate in their laboratories.

Responsibility for safety during practical activities rests with the centre.

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 2013 series and in each January and June series thereafter for the lifetime of the specification.

Your student assessment opportunities

	June 2012	January 2013	June 2013	January 2014
Certificate in Science (Double Award)			✓	✓

Awarding and reporting

The grading, awarding and certification of this qualification will comply with the requirements of the current GCSE/GCE Code of Practice, which is published by the Office of Qualifications and Examinations Regulation (Ofqual). The international GCSE qualification will be graded and certificated on a 15-grade scale: A*A*(a*a*), A*A(a*a), AA(aa), AB(ab), …FG(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 International GCSE in Science (Double Award) will be 2013.

Language of assessment

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

Malpractice and plagiarism

For up-to-date advice on malpractice and plagiarism, please refer to the JCQ's *Suspected Malpractice in Examinations and Assessments: 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.

Guided learning hours

The number of guided learning hours required for this qualification is 260.

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 can 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 can use many different relationships between physical quantities to carry out calculations effectively
- 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 describe an appropriate method for a practical task, identifying the key factors to be considered. They can recall or describe a range of apparatus required for the task. They can select a method of presenting data which is appropriate to the task; they can select information from a range of sources where it is appropriate to do so. They can 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 can 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 can 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 can describe how a leaf is adapted to its functions; they can use simple balanced equations and they can 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 practical scenario. For example, they can identify key factors to vary and control; they can recall or describe a range of apparatus required for the task; they can present data systematically, in graphs where appropriate, and use lines of best fit; they can identify and explain patterns within data and draw conclusions consistent with the evidence. They can 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 can state the main functions of organs of the human body; they know that plants need light for photosynthesis; they can state some uses of materials obtained from oil; they can suggest ways in which insulation is used in domestic contexts
- use and apply knowledge and understanding in some specific everyday contexts. For example, they can describe how the heart rate increases with exercise; they can suggest a way of speeding up a particular chemical reaction; they can 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 can recall or describe simple apparatus appropriate for the task. They can obtain information from simple tables, charts and graphs and identify simple patterns in information and observations. They can 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 with 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 – To make it easier for you to raise a query with us online, we have merged our **Ask Edexcel** and **Ask the Expert** services.

There is now one easy-to-use web query form that will allow you to ask any question about the delivery or teaching of Edexcel qualifications. You will receive a personal response, from one of our administrative or teaching experts, sent to the email address you provide.

We'll also be doing lots of work to improve the quantity and quality of information in our FAQ database where you'll be able to find answers to many questions.

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 of the Elements

1	2											3	4	5	6	7	0
							1 H hydrogen 1										4 He helium 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
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
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
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] 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
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 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	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key: relative atomic mass / atomic symbol / name / atomic (proton) number

** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.*

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Appendix 2: Physics formulae for relationships

The relationships listed below will **not** be provided for Certificate students either in the form given or in rearranged 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

(v) the energy relationships:

energy transferred = work done

kinetic energy = $\frac{1}{2}$ × 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) $$\frac{\text{input (primary) voltage}}{\text{output (secondary) voltage}} = \frac{\text{primary turns}}{\text{secondary turns}}$$

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

$$n = \left(\frac{\sin i}{\sin r}\right)$$

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

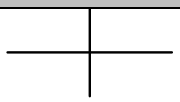
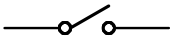
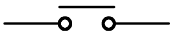
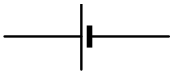
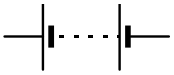
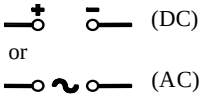
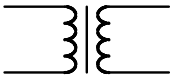
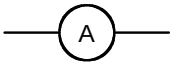
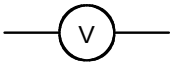
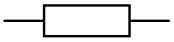
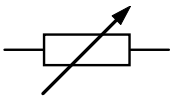
$$\sin c = \frac{1}{n}$$

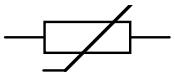
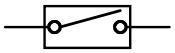
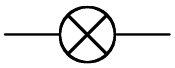
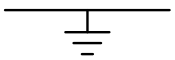
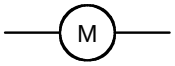
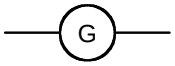
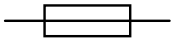
(xiv) the relationship for pressure difference:

pressure difference = height × density × g

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

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	

Appendix 4: Wider curriculum

Signposting and development suggestions

Issue	Paper	Opportunities for development
Spiritual	None	
Moral	All	Biology 4d, 5 Chemistry 5b Physics 3c
Ethical	All	Biology 4d, 5 Physics 3c
Social	All	Biology 2.47, 2.56, 3.28, 4d, 5 Chemistry 2.24, 5b Physics 2.2, 3c, 7.14
Legislative	All	Biology 4d, 5 Chemistry 5b Physics 2.2, 3c
Economic	All	Biology 4d, 5 Chemistry 5.2, 5b Physics 3c
Cultural	All	Biology 3.26, 5 Physics 3c

Issue	Paper	Opportunities for development
Sustainable	All	Biology 2.47, 4d, 5 Chemistry 2.23, 5b Physics 3c, 4.8, 7.14
Health and safety	All	Practical work Chemistry 5b Physics 1.16, 2.2. 7.14
European initiatives	All	Biology 4d Chemistry 2.23 Physics 1.16, 7.14

Appendix 5: Suggested practicals

The following suggestions for practical investigations exemplify the scientific process and can support students' understanding of the subjects.

Biology

- Investigate human responses to external stimuli.
- Investigate reaction times.
- Investigate the effects of antiseptics or antibiotics on microbial cultures
- Investigate the effect of pollutants on plant germination and plant growth
- Investigate inheritance using suitable organisms or models
- Investigate the speed of transmission of electrical impulses in the nervous system
- Investigate the presence of sugar in simulated urine/body fluids
- Investigate the effect of light and/or gravity on plant growth
- Investigate how indicator species can be used to assess levels of pollution in water or the atmosphere
- Investigate the factors that affect enzyme activity.
- Investigate the effect of exercise on breathing rate and heart rate.
- Investigate how factors, including light intensity, CO_2 concentration or temperature, affect the rate of photosynthesis.
- Investigate osmosis
- Investigate the relationship between organisms and their environment using fieldwork techniques.
- Investigate the distribution of organisms in an ecosystem, using sampling techniques including:

  a pooters

  b sweep nets/pond nets

  c pitfall traps

  d quadrats

  and measure environmental factors including:

  e temperature

  f light intensity

  g pH
- Investigate the effect of different concentrations of digestive enzymes, using and evaluating models of the alimentary canal.
- Investigate plant and animal cells with a light microscope
- Investigate the effect of concentration on rate of diffusion
- Investigate the effect of glucose concentration on rate of anaerobic respiration in yeast

- Investigate how the structure of the leaf is adapted for photosynthesis
- Investigate how the loss of water vapour from leaves drives transpiration
- Investigate the conditions affecting growth of micro-organisms (using resazurin dye)
- Investigate the effect of different factors on yogurt making
- Investigate the use of immobilised lactase to produce lactose-free milk
- Investigate the use of enzymes in food production
- Investigate the importance of photoperiodicity in plants
- Investigate different behaviours exhibited by animals
- Investigate the use of chymosin in the manufacture of vegetarian cheese
- Investigate the use of invertase (sucrase) produced by *Saccharomyces cerevisiae*(yeast) in the manufacture of sweets
- Investigate the use of enzymes in washing powders

Chemistry

- Investigate the proportion of oxygen in the atmosphere
- Investigate the ease of thermal decomposition of carbonates, including calcium carbonate, zinc carbonate and copper carbonate
- Compare the temperature rise produced when the same volume of water is heated by different fuels
- Investigate the presence of water vapour and carbon dioxide in the atmosphere
- Investigate the volume of air used up and products formed when candles are burned
- Investigate the reactions of calcium compounds: the decomposition of calcium carbonate and the reaction of calcium oxide with water; the reaction of calcium carbonate with acid
- Investigate mass changes before and after the reaction of eg copper sulfate and sodium chloride
- Carry out simple neutralisation reactions of acids, using metal oxides, hydroxides and/or carbonates
- Carry out tests for hydrogen, chlorine and oxygen
- Carry out electrolysis of sea water/acidified water
- Investigate the rusting of iron
- Investigate simple oxidation and reduction reactions, such as burning elements in oxygen or competition reactions between metals and metal oxides
- Investigate the properties of a metal, such as electrical conductivity
- Investigate the fractional distillation of synthetic crude oil and the ease of ignition and viscosity of the fractions
- Investigate the products produced from the complete combustion of a hydrocarbon
- Investigate the cracking of paraffin oil
- Prepare an insoluble salt by precipitation
- Classify different types of elements and compounds by investigating their melting points and boiling points, solubility in water and electrical conductivity (as solids and in solution) including sodium chloride, magnesium sulfate, hexane, liquid paraffin, silicon(IV) oxide, copper sulphate
- Compare the temperature rise produced when the same volume of water is heated by different fuels
- Investigate the presence of water vapour and carbon dioxide in the atmosphere
- Investigate the volume of air used up and products formed when candles are burned
- Investigate the reactions of calcium compounds: the decomposition of calcium carbonate and the reaction of calcium oxide with water; the reaction of calcium carbonate with acid

- Investigate mass changes before and after the reaction of eg copper sulfate and sodium chloride
- Carry out simple neutralisation reactions of acids, using metal oxides, hydroxides and/or carbonates
- Carry out tests for hydrogen, chlorine and oxygen
- Carry out electrolysis of sea water/acidified water
- Investigate the rusting of iron
- Investigate simple oxidation and reduction reactions, such as burning elements in oxygen or competition reactions between metals and metal oxides
- Investigate the properties of a metal, such as electrical conductivity
- Investigate the fractional distillation of synthetic crude oil and the ease of ignition and viscosity of the fractions
- Investigate the products produced from the complete combustion of a hydrocarbon
- Investigate the cracking of paraffin oil
- Prepare an insoluble salt by precipitation and sucrose (sugar)
- Investigate the effect of temperature, concentration and surface area of a solid on the rate of a reaction such as hydrochloric acid and marble chips
- Determine the empirical formula of a simple compound, such as magnesium oxide
- Investigate the properties of a group of elements, eg Group 2
- Investigate the properties of typical ionic compounds
- Test predictions of whether a precipitate forms when soluble salts are combined
- Carry out a series of ion tests to identify unknown compounds
- Build models of simple covalent molecules
- Investigate the typical properties of simple and giant covalent compounds
- Use paper chromatography to separate inks, food dyes etc
- Investigate the properties of metals
- Carry out an activity to show that transition metal salts have a variety of colours
- Investigate heat energy changes in neutralisation and/or displacement reactions
- Investigate the rate of reactions, such as magnesium and hydrochloric acid; or sodium thiosulfate and hydrochloric acid
- Investigate the effect of potential catalysts on the rate of decomposition of hydrogen peroxide.
- Determine the formula of copper oxide by reduction of the oxide to copper
- Determine the formula of a hydrated salt such as barium chloride or copper sulfate by heating to drive off water of crystallisation
- Prepare a substance and calculate the % yield, given the theoretical yield
- Evaporate a solution to dryness to determine the mass of solute in a given mass of solution

- Investigate the mass changes at the electrodes during the electrolysis of copper sulfate solution using copper electrodes
- Investigate the migration of ions in eg potassium manganate (VII) solution
- Electroplate a metal object
- Determine the volume of one mole of hydrogen gas by using the reaction of magnesium with hydrochloric acid
- Determine the molar volume by measuring the volume and mass of a gas using a heavier gas (eg carbon dioxide)
- Investigate simple reversible reactions, such as the decomposition of ammonium chloride

Physics

- Investigate the power consumption of low-voltage electrical items
- Investigate factors affecting the generation of electric current by induction
- Investigate how the nature of a surface affects the amount of energy radiated or absorbed
- Investigate models to show refraction, such as toy cars travelling into a region of sand
- Investigate the areas beyond the visible spectrum, such as those found by Herschel and Ritter who discovered infrared and ultraviolet (UV) respectively
- Investigate the relationship between potential difference (voltage), current and resistance
- Investigate the relationship between force, mass and acceleration
- Investigate the forces required to slide blocks along different surfaces, with differing amounts of friction
- Investigate how crumple zones can be used to reduce the forces in collisions
- Investigate forces between charges
- Conduct experiments to show the relationship between potential difference (voltage), current and resistance, for a component whose resistance varies with a given factor, such as temperature, light intensity and pressure
- Investigate the motion of falling
- Investigate momentum during collisions
- Investigate power by running up the stairs or lifting objects of different weights
- Investigate the critical angle for perspex/air or glass/air or water/air boundaries
- Investigate factors affecting the height of rebound of bouncing balls
- Investigate the temperature and volume relationship for a gas
- Investigate the volume and pressure relationship for a gas
- Investigate the absorption of light by translucent materials in order to simulate x-rays' absorption.

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edexcel

International GCSE

Science (Double Award) (4SC0)

Sample Assessment Material

First examination June 2013

ALWAYS LEARNING

PEARSON

Contents

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, ie if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Write your name here

Surname	Other names

Edexcel
International GCSE

Centre Number | Candidate Number

Biology

Paper: 1B

Sample Assessment Material
Time: 2 hours

Paper Reference
4BI0/1B

You must have:
Ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.

Information

- The total mark for this paper is 120.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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S 4 1 6 4 4 A 0 1 2 9

PEARSON

Answer ALL questions.

1 Organisms can be classified into groups, depending on some of their features.

(a) Some scientists were working in the rainforest in Indonesia.
They found two organisms living in the water in a pond.

Organism A was visible by eye, had fins for swimming and a mouth for feeding.
Organism B was a single-celled organism. This cell had a nucleus but no chitin cell wall.

animals	bacteria	fungi	plants	protoctists	viruses

Use a word from the box to complete each of the following sentences.

(i) Organism A belongs to the group called .....

(1)

(ii) Organism B belongs to the group called .....

(1)

(b) Give **three** structural differences between plant cells and animal cells.

(3)

.....

.....

.....

(c) Explain how fungi obtain their food.

(3)

.....

.....

.....

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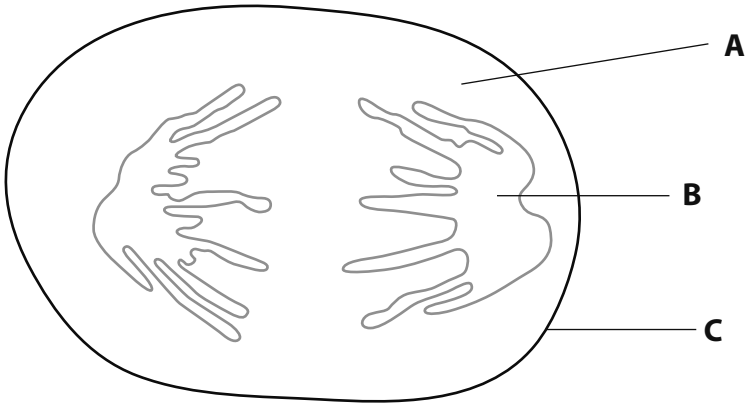
.....

(Total for Question 1 = 8 marks)

2 The animal cell below has a diploid number of eight. The cell is dividing by mitosis.



(a) Name the parts labelled **A**, **B** and **C**.

(3)

A .....

B .....

C .....

(b) A student wrote this passage describing mitosis. There are two mistakes.

> The diploid number of this cell is 8. It will divide into four daughter cells, each with a diploid number of 8. Mitosis is a very important type of cell division for growth, repair, cloning and sexual reproduction.

Identify the **two** mistakes in the passage.

(2)

1 .....

.....

2 .....

.....

(c) What is the diploid number in a human body cell?

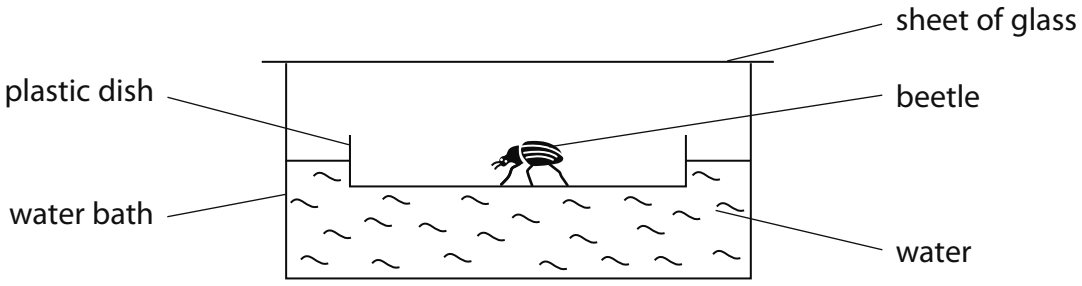
(1)

.....

(Total for Question 2 = 6 marks)

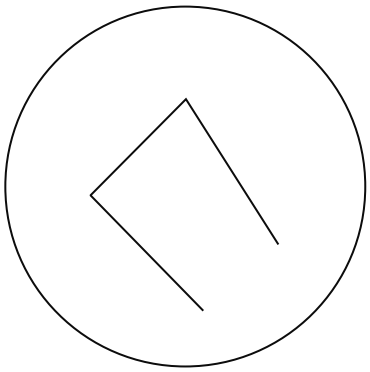
3 A student carried out an investigation to find out how temperature affects movement in beetles. The student placed a beetle in a plastic dish, which was allowed to float on water in a water bath. The water bath was set at a temperature of 15 °C.

The apparatus the student used is shown in the diagram below.

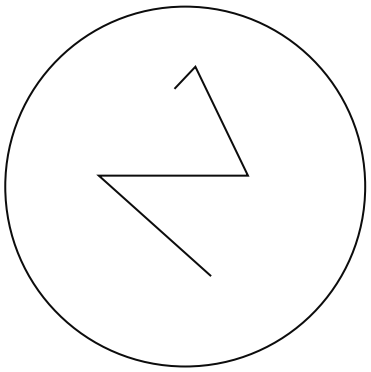


The student wanted to measure the distance moved in cm by the beetle in one minute. To do this, the student looked down from the top and recorded the movement of the beetle on the sheet of glass using a pen. The student did this four times (trials).
The whole procedure was carried out at five different temperatures using the same beetle.

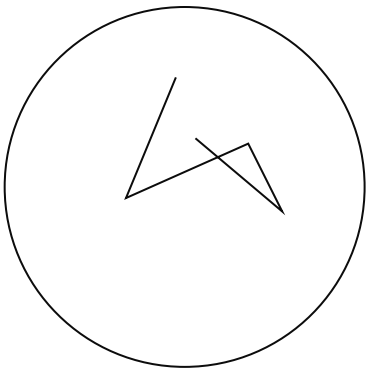
The diagrams show the pen recordings for the beetle's movement during one minute at 25 °C.



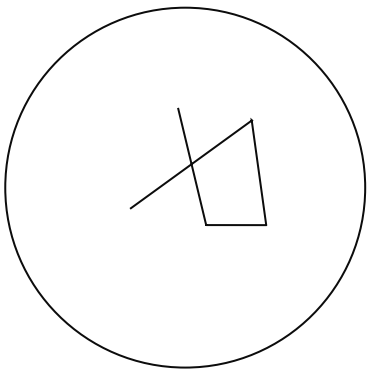
Trial 1



Trial 2



Trial 3



Trial 4

(a) Table 1 shows the results obtained for all trials at 15 °C, 20 °C, 30 °C and 35 °C.

(i) Measure the distance moved in cm by the beetle during trial 4 at 25 °C.
Write your answer in the empty box in Table 1.

(1)

Table 1

Temperature in °C	Distance moved in cm in one minute			
	Trial 1	Trial 2	Trial 3	Trial 4
15	2.4	2.1	1.8	1.7
20	4.3	4.1	4.4	4.0
25	6.2	6.0	6.0	
30	7.0	6.7	6.9	6.6
35	8.3	8.4	8.1	8.0

(ii) Calculate the average distance moved in cm by the beetle at 35 °C.
Show your working.

(2)

Answer ..... cm

(b) Describe and explain the results shown in the table.

(2)

.....

.....

.....

.....

(c) (i) Suggest how you could adapt this apparatus to obtain results at a temperature of 5 °C.

(1)

.....

.....

(ii) Suggest **one** reason why the student should not collect results above 35 °C.

(1)

.....

.....

(d) Suggest **one** way in which the student could modify the investigation to improve the accuracy of the results.

(1)

.....

.....

(Total for Question 3 = 8 marks)

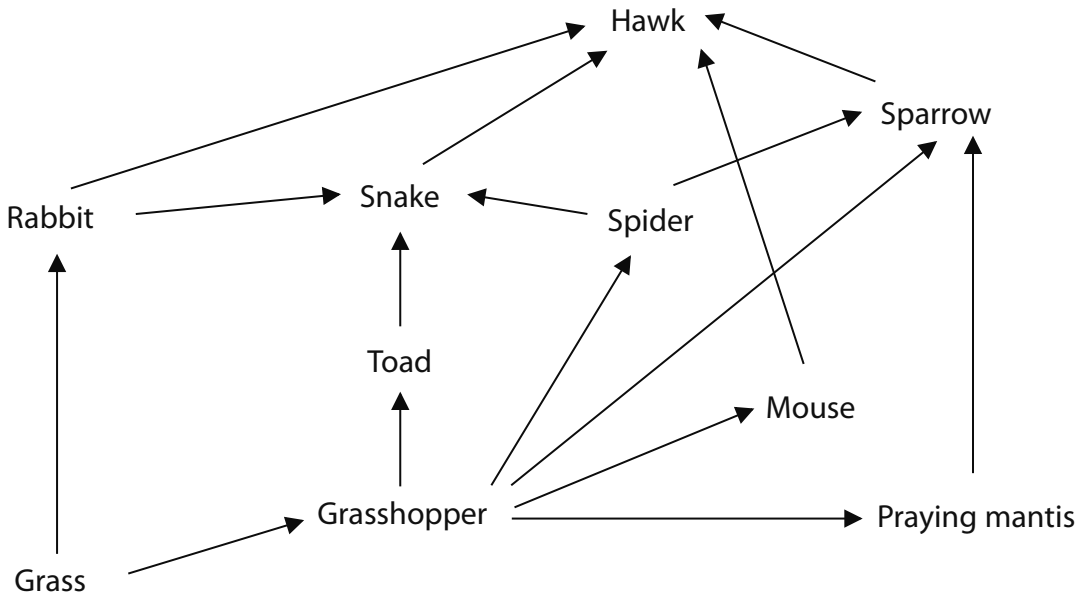
4 Many endurance athletes train at high altitude (height above sea level) before a major sporting event. They do this because they think that training at high altitude changes the number of red blood cells in their body.

Describe an investigation to find out if training at high altitude does change the number of red blood cells in the human body.

(6)

(Total for Question 4 = 6 marks)

5 The diagram shows a food web from a grassland ecosystem.



(a) From the food web, name an organism that is

(i) a producer

(1)

.....

(ii) a primary consumer

(1)

.....

(iii) a tertiary consumer

(1)

.....

(b) How many different organisms feed on the grasshopper in the food web?

(1)

.....

(c) From the food web, draw a food chain that contains 5 levels and includes the spider.

(2)

(d) A land owner wanted to reduce the number of rabbits feeding on his grass, so he killed a large number of rabbits.

Suggest an explanation for the effect this would have on the hawk population.

(2)

.....

.....

.....

.....

(Total for Question 5 = 8 marks)

6 As part of an investigation into biological cycles, Ome buried a dead mouse in some soil outside her classroom.

Explain what would happen to the body of the mouse over the next six months.

(5)

(Total for Question 6 = 5 marks)

7 The kidney contains many nephrons and is involved in excretion.

(a) Ultrafiltration occurs at the glomerulus. Describe how the blood leaving the glomerulus will differ from blood entering the glomerulus.

(3)

.....

.....

.....

.....

.....

.....

(b) In part of the nephron, selective reabsorption occurs.

What is meant by the term selective reabsorption?

(2)

.....

.....

.....

.....

(c) The following passage describes part of the role of the kidney. Complete the sentences in the passage by writing a suitable word or words on each dotted line.

(5)

The amount of water returning to the blood is controlled by the hormone

..... which is released from the ..... gland.

The solution containing waste products from the kidney is called

..... and passes down a tube called the ..... .

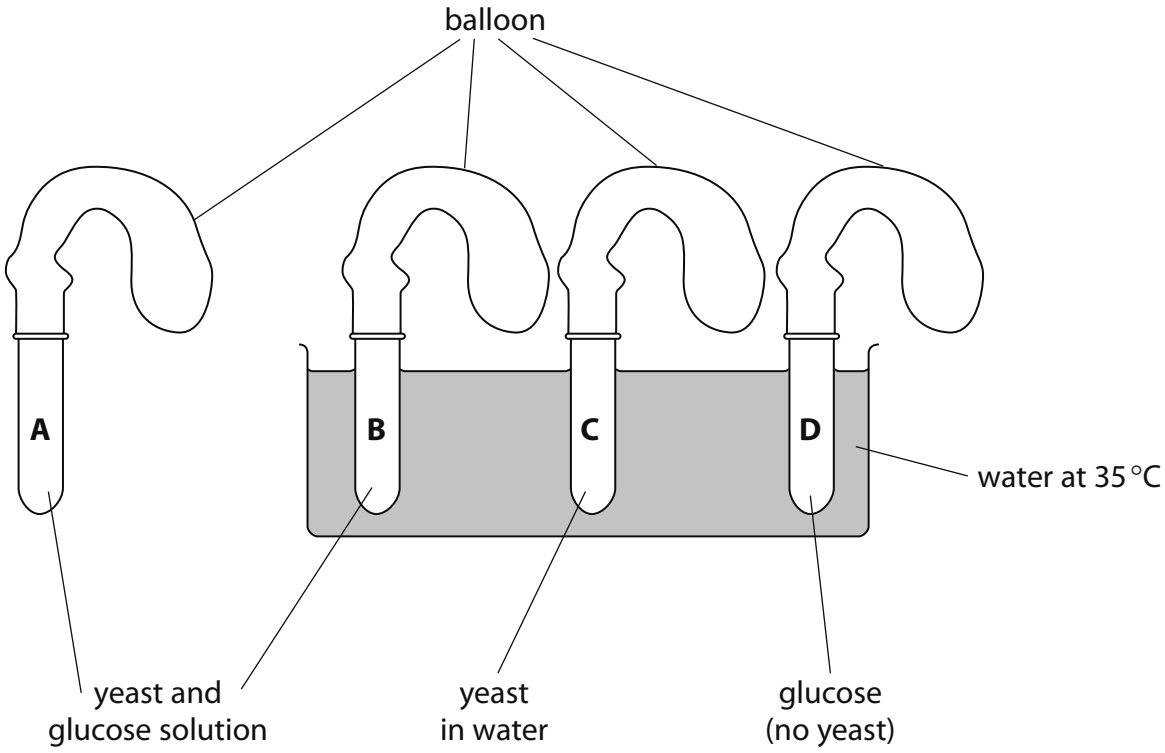
It is stored in the ..... before being passed from the body down the urethra.

(Total for Question 7 = 10 marks)

8 A student investigated how much gas was given off under different conditions in the production of beer. The diagram shows the apparatus she used.

Test tubes A and B each contained the same volume of yeast mixed with glucose solution.
Test tube C contained yeast in water, but no glucose.
Test tube D contained glucose solution, but no yeast.

Test tube A was placed in room temperature at 20 °C. The other test tubes were placed in a warm water bath at 35 °C. A balloon was put over the opening of each tube.



The table describes the appearance of the balloons after 15 minutes.
Some inflate (fill up with gas), others do not.

Tube	Appearance of balloon after 15 minutes
A	slightly inflated
B	very inflated
C	no change
D	

(a) (i) Explain why the balloons on tubes **A** and **B** inflated.

(2)

(ii) Explain why being in a higher temperature caused the balloon on tube **B** to inflate more than the balloon on tube **A**.

(2)

(b) Why did the balloon on tube **C** not show any change?

(1)

(c) Describe the appearance you would expect the balloon on tube **D** to have at the end of the experiment.

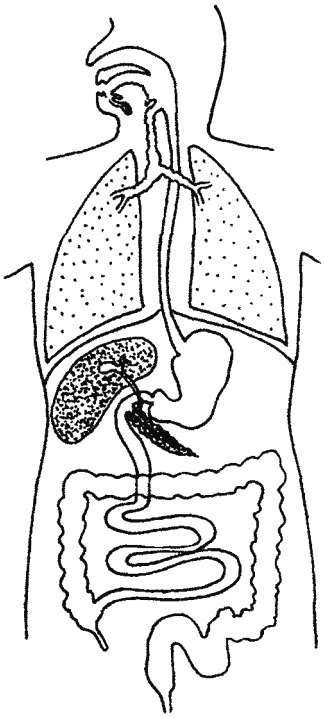
(1)

(Total for Question 8 = 6 marks)

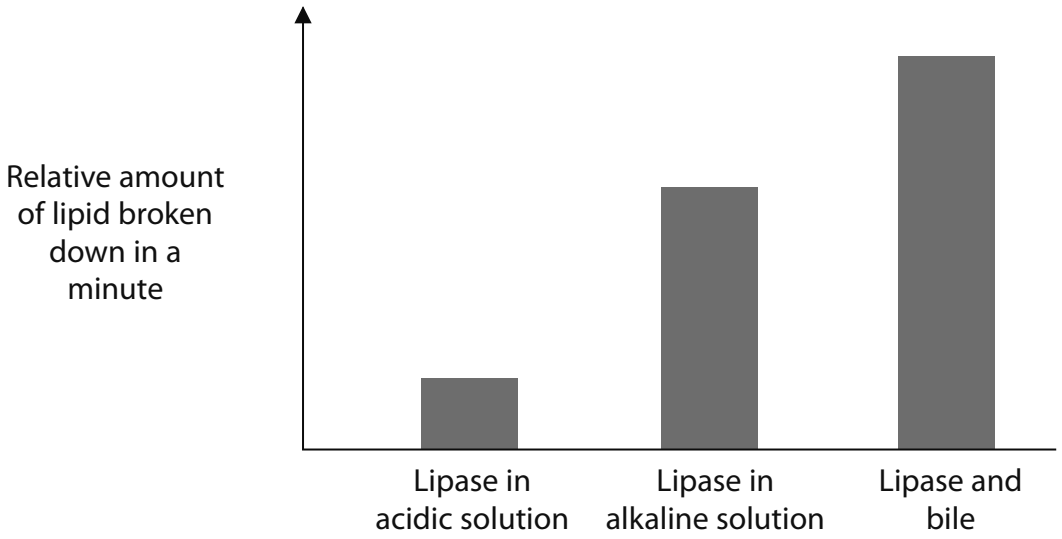
9 Lipase is an enzyme that breaks down lipids (fats) to fatty acids and glycerol. Lipase is produced in the pancreas and acts in the small intestine.

(a) On the diagram, label the pancreas and the small intestine.

(2)



(b) The graph shows the relative amount of lipid broken down by lipase under different conditions.



(i) Describe and explain the results shown by the graph.

(4)

(ii) Name the **three** chemical elements present in lipids.

(1)

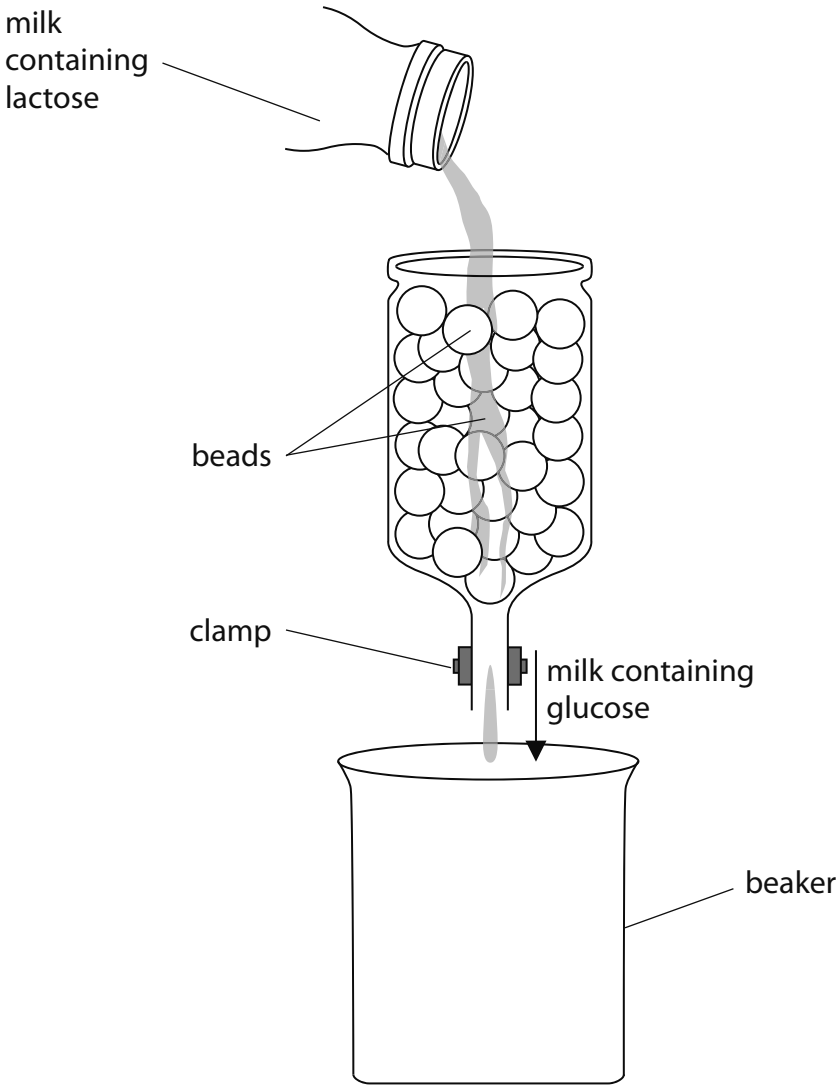
(c) Describe how the structure of the small intestine is adapted for the efficient absorption of the products of digestion.

(5)

(Total for Question 9 = 12 marks)

10 Nicola investigated the digestion of lactose, a substance found in milk.

The diagram shows the apparatus she used.

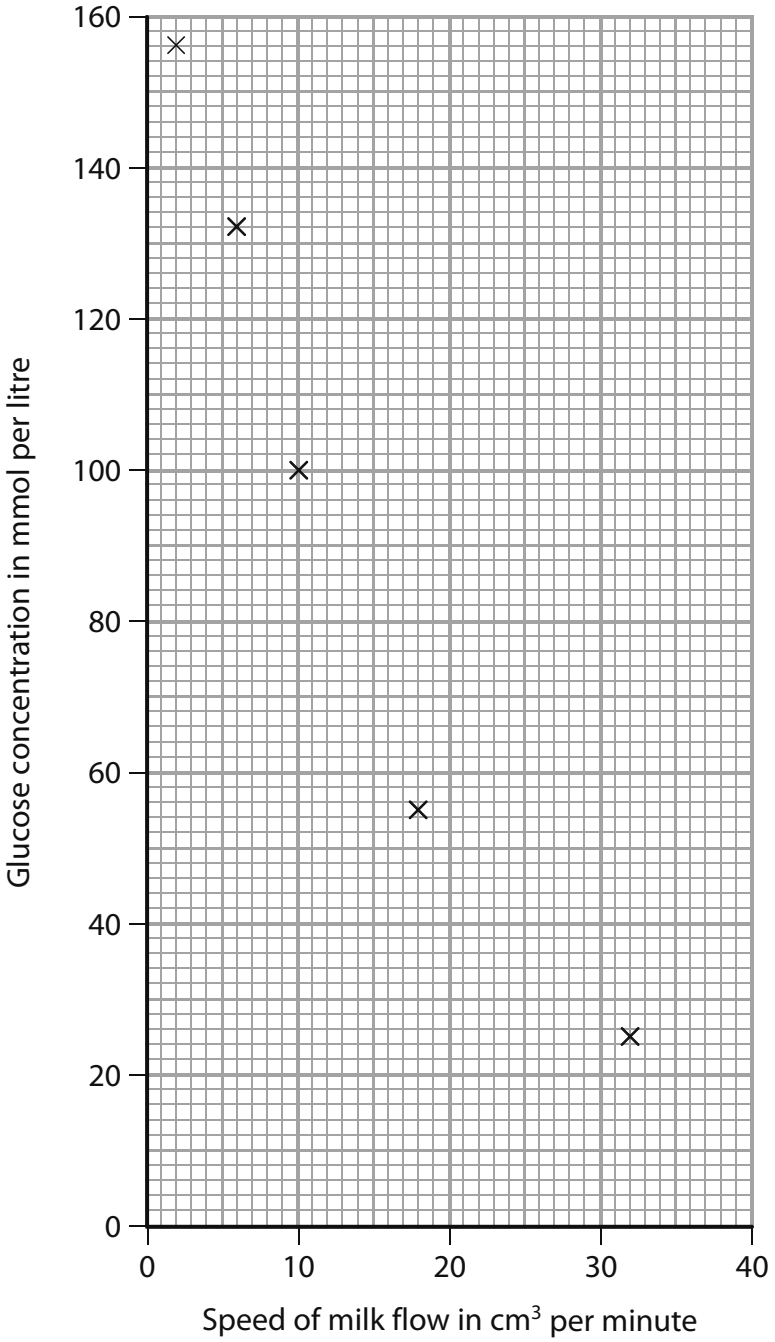


The beads contained an enzyme called lactase. This enzyme digests lactose into two sugars called glucose and galactose.

The outer coat of the beads allows milk to enter and sugars to leave. The outer coat also prevents the enzyme from leaving.

An experiment was carried out in which milk was allowed to flow through the apparatus at different speeds. The speed of flow was changed using the clamp on the exit tube.

The milk collected in the beaker was tested for the concentration of glucose it contained at each flow speed. The graph shows the results.



Speed of milk flow through apparatus in cm^3 per minute	Glucose concentration in beaker milk in mmol per litre
4	156
6	132
10	100
18	55
32	25

(a) (i) Describe the relationship between the speed of flow and the concentration of glucose.

(1)

.....

.....

(ii) Suggest an explanation for the relationship between the speed of flow and the concentration of glucose.

(2)

.....

.....

.....

.....

(b) The investigation was carried out at 20 °C.

(i) Name **two** variables, apart from temperature, that need to be kept the same during this investigation.

(2)

1 .....

2 .....

(ii) Suggest how the results would be different if the investigations had been carried out at 25 °C.

Explain your answer.

(2)

.....

.....

.....

.....

(c) How would the concentration of glucose in the beaker be different if the beads used were bigger in size?

(1)

.....

.....

(d) Give **one** way in which the results in this investigation could be made more reliable.

(1)

.....

.....

(Total for Question 10 = 9 marks)

11 Angela carried out an experiment to investigate how breathing rate changes during exercise.

She worked with a partner who counted the number of breaths she took during

- three periods of 20 seconds at rest
- three periods of 20 seconds immediately after 5 minutes of exercise
- three periods of 20 seconds immediately after 10 minutes of exercise.

The results that Angela collected from her experiment are given in the table.

Situation when breaths counted	Number of breaths in 20 seconds 1st period	Number of breaths in 20 seconds 2nd period	Number of breaths in 20 seconds 3rd period	Average breathing rate in breaths per minute
At rest	5	6	5	16
After 5 minutes of exercise	15	16	14	45
After 10 minutes of exercise	18	20	18	56

(a) Give **two** variables that Angela should have controlled in her experiment. For each variable describe how she could control it.

(4)

Variable 1 .....

.....

.....

.....

Variable 2 .....

.....

.....

.....

(b) (i) State how Angela's breathing rate changed with exercise.

(1)

.....

.....

(ii) Explain why Angela's breathing rate changed during exercise.

(4)

(Total for Question 11 = 9 marks)

12 The oil seed plant is an important crop plant grown by farmers.

(a) The stages below are used to insert a gene for herbicide resistance into crops such as oil seed plant.

Place the stages in the correct order by writing the order (1, 2, 3, 4 and 5) in the table.

(4)

Stage	Order
Recombinant DNA inserted into the crop plant cell using a vector.	
Desired gene for herbicide resistance inserted into recipient DNA using an enzyme.	
Desired gene for herbicide resistance removed from donor cell using an enzyme.	
The plant is herbicide resistant.	
Desired gene for herbicide resistance identified.	

(b) Give **one** example of a vector used in genetic modification.

(1)

(c) State the role of restriction enzymes and ligase enzymes in genetic modification.

(2)

restriction enzymes .....

ligase enzymes .....

(d) (i) What is meant by the term **herbicide**?

(1)

(ii) Give a reason why a farmer would want his crop plants to be resistant to a herbicide.

(1)

(e) Suggest why some people are concerned about genetically modified (GM) crops.

(2)

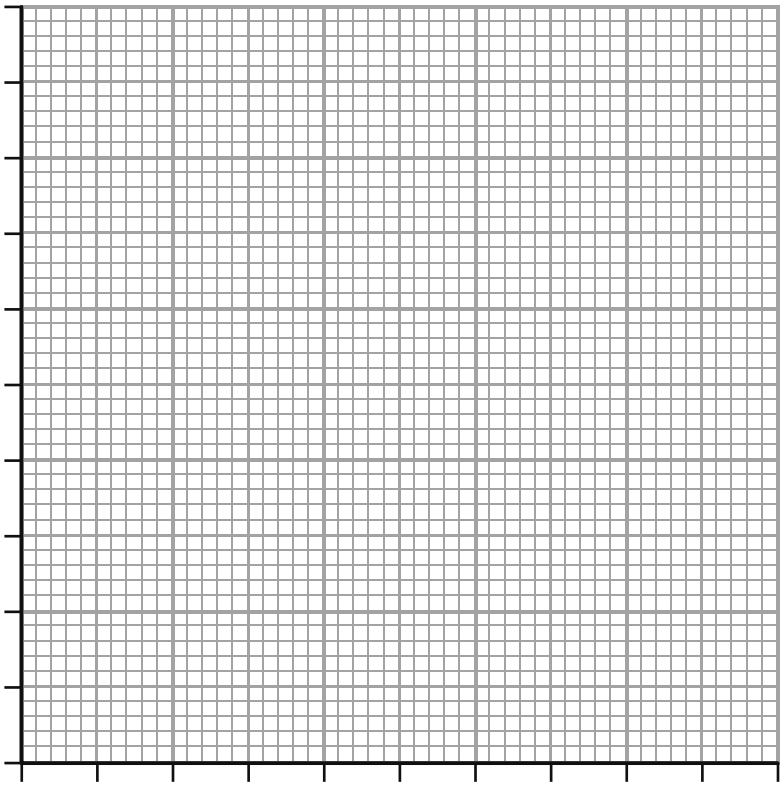
(Total for Question 12 = 11 marks)

13 The table shows data taken from dairy farms in the UK. It shows changes in milk yield and dairy herd size (number of cows) between the years 2000 and 2008.

Year	Average milk yield in dm^3 per cow per year	Average size of dairy herd in thousands
2000	6,048	2,330
2001	6,449	2,229
2002	6,450	2,224
2003	6,631	2,185
2004	6,886	2,060
2005	6,999	2,003
2006	6,963	1,989
2007	6,924	1,961
2008	6,945	1,902

(a) On the grid, plot the data to show how average milk yield changed during the years 2000 to 2008. Join your points using straight lines.

(5)



(b) Describe how the average milk yield per cow changes over the time period.

(2)

(c) Suggest why the average size of dairy herds changed between 2000 and 2008.

(1)

(d) Describe how a selective breeding programme could be used to produce an improvement in milk yield.

(3)

(e) Improvement in milk yield can be affected by factors other than selective breeding.

Suggest **two** factors that a farmer may change that could lead to an improvement in milk yield. For **each factor**, give a reason why it would improve milk yield.

(4)

Factor 1 .....

.....

Reason .....

.....

.....

.....

Factor 2 .....

.....

Reason .....

.....

.....

.....

(Total for Question 13 = 15 marks)

14 Batten's disease is caused by a recessive allele. Symptoms include loss of vision, epilepsy and difficulty in walking and talking.

The mutation causes lipofuscins to build-up in the body's tissues. Lipofuscins consist of fats and proteins and form distinctive deposits that cause the symptoms.

(a) Name **one** system in the body affected by Batten's disease.

(1)

.....

(b) Two adults who had never shown any symptoms married and had a child who developed Batten's disease.

Deduce the genotypes of the parents and show how the gametes formed by these parents can give rise to a child who has the genotype and phenotype for Batten's disease.

Use **B** to show the normal allele and **b** to show the recessive allele responsible for Batten's disease.

(4)

(c) Recessive conditions, like Batten's disease, are usually very rare in populations.

However, if someone who comes from a family with a history of the disease marries a cousin then the likelihood of inheriting the condition changes.

Suggest why this is the case.

(2)

.....

.....

.....

.....

.....

(Total for Question 14 = 7 marks)

TOTAL FOR PAPER = 120 MARKS

Sample Mark Scheme

Paper 1B

Question number	Answer	Notes	Marks
1 (a) (i)	animals	ACCEPT fish	1
(i)	protoctists		1
(b)	Any three of the following statements about plant cells: • plant cells have a (cellulose) cell wall • plants cells contain chloroplasts • plant cells store carbohydrate as starch (or sucrose) • plant cells contain a vacuole	ACCEPT converse statements about the animal cell	3
(c)	An explanation linking three of the following points: • mycelium / hyphae • feed on dead material / saprophytic • secrete extracellular enzymes onto food / eq • which breaks it down / digest • so that breakdown products can be absorbed by fungus		3
			Total: 8

Question number	Answer	Notes	Marks
2 (a)	**A** = cytoplasm **B** = chromosome / DNA **C** = cell membrane		3
(b)	not four cells / two daughter cells not sexual / asexual	ACCEPT either a correction **or** an identification of a wrong statement	2
(c)	46		1
			Total: 6

Question number	Answer	Notes	Marks
3 (a) (i)	5.8	ALLOW ±1 mm	1
(ii)	(8.3 + 8.4 + 8.1 + 8.0) ÷ 4 = 8.2	ALLOW 1 in working for division by 4	2
(b)	increase in temperature leads to an increase in distance moved enzymes work better / more energy / more respiration		2
(c) (i)	ice	IGNORE fridge	1
(ii)	cruel / unethical / cause harm / kill beetle / eq IGNORE denatured	ACCEPT beetle moves too quickly to trace its path accurately	1
(d)	any modification that forces movement in a straight line		1
			Total: 8

Question number	Answer	Notes	Marks
4	C : two or more altitudes O : same person / people / gender / age R : repeat at each altitude / several samples M1 : count (number of red blood cells) M2 : use microscope S1 : same diet S2 : other controlled variable eg training intensity		6 max
			Total: 6

Question number	Answer	Notes	Marks
5 (a) (i) (ii) (iii)	grass rabbit/grasshopper hawk/snake/sparrow		1 1 1
(b)	5		1
(c)	grass --> grasshopper --> spider --> snake --> hawk OR grass --> grasshopper --> spider --> sparrow --> hawk	1 mark for 5 organisms including spider 1 mark for correct arrows	2
(d)	An explanation linking the following points: • hawk numbers decrease / drop / go down • (because) less food / rabbits for them to eat	ACCEPT could stay the same, as hawks eat more of other (named) prey instead	2
			Total: 8

Question number	Answer	Notes	Marks
6	An explanation linking five of the following: • bacteria / fungi / decomposers / a named example • digest / break down • body tissue / proteins / compounds / eq • (because they contain) enzymes • (leading to) loss of mass / dead mouse getting smaller / decays • release of carbon dioxide / water • release of mineral ions / named mineral ion • ref to speed depending on environmental temperature / season	ACCEPT reference to insects/invertebrates/scavenger	5
			Total: 5

Question number	Answer	Notes	Marks
7 (a)	A description including three of the following: • less glucose • less water • fewer amino acids • less urea • fewer ions	ACCEPT converse arguments for blood entering the glomerulus	3
(b)	some substances / eq absorbed/eq into the blood		2
(c)	ADH pituitary urine ureter bladder		5
			Total: 10

Question number	Answer	Notes	Marks
8 (a) (i)	An explanation linking the following points: • respiration (of the yeast) • (produces) carbon dioxide (gas)		2
(ii)	An explanation linking the following points: • increased enzyme/yeast activity / eq • increased chemical reactions / kinetic energy / eq	ACCEPT warmer gas takes up larger volume	2
(b)	no glucose / eq	IGNORE no respiration ACCEPT no gas/carbon dioxide produced	1
(c)	no change / same as **C** / does not inflate		1
			Total: 6

Question number	Answer	Notes	Marks
9 (a)	both correctly labelled		2
(b) (i)	An explanation linking four of the following points: • lipase works best with bile • (and works) least well in acidic / better in alkaline • bile is alkaline / neutralises (stomach acid) / optimum pH /eq • bile emulsifies lipid • (therefore) larger surface area (for lipase)		4 max
(ii)	carbon, hydrogen and oxygen	Allow C, H, O	1
(c)	A description including five of the following: • villi • microvilli • (have a) large surface area • (and have) thin walls / epithelium • (rich) capillary network • (to allow maximum rate of) diffusion • to carry away molecules / maintain gradient • (into) lacteals • named product of digestion		5 max
			Total :12

Question number	Answer	Notes	Marks
10 (a) (i)	faster flow, lower glucose concentration / less glucose		1
(ii)	An explanation linking the following: • if speed of flow high, then less time in bead • (so less time) to digest / in contact with enzyme/lactase	ACCEPT converse argument	2
(b) (i)	Any two from: • concentration of enzyme/lactase • type of milk • size of beads • number of beads		2 max
(ii)	An explanation linking two of the following: • more glucose / more digestion • (because) faster enzyme activity / optimum temperature • (and) higher kinetic energy / more collisions / eq	ACCEPT less glucose milk flows faster (at a higher temp) less time in contact with enzyme	2 max
(c)	lower / less glucose		1
(d)	more experiments / eq		1
			Total: 9

Question number	Answer	Notes	Marks
11 (a)	amount of exercise / type of exercise (controlled by having) same number of exercise type temperature of room (controlled by) using thermostat / air conditioning	ACCEPT other reasonable controls	4
(b) (i)	increases		1
(ii)	An explanation linking four of the following: • muscles • (need) more oxygen • (because of) increased respiration • (to provide) more energy • (increase breathing also) removes more CO_2 • (as) waste product of respiration	ACCEPT ref to heat	max 4
			Total: 9

<table>
<tr><th>Question number</th><th>Answer</th><th>Accept</th><th>Marks</th></tr>
<tr><td>12 (a)</td><td>
<table>
<tr><th>Stage</th><th>Order</th></tr>
<tr><td>Recombinant DNA inserted into the crop plant cell using a vector</td><td>4</td></tr>
<tr><td>Desired gene for herbicide resistance inserted into recipient DNA using an enzyme</td><td>3</td></tr>
<tr><td>Desired gene for herbicide resistance removed from donor cell using an enzyme</td><td>2</td></tr>
<tr><td>The plant is herbicide resistant</td><td>5</td></tr>
<tr><td>Desired gene for herbicide resistance identified</td><td>1</td></tr>
</table>
</td><td>1 mark for 1st statement correct
1 mark for last statement correct
1 marks for statement 2 before statement 3
1 mark for statement 3 before statement 4</td><td>4</td></tr>
<tr><td>(b)</td><td>virus / plasmid / gene gun</td><td></td><td>1</td></tr>
<tr><td>(c)</td><td>restriction enzyme: to cut DNA / chop DNA

ligase enzymes: to join / stick DNA</td><td></td><td>2</td></tr>
<tr><td>(d) (i)</td><td>(substance that) kills plants</td><td></td><td>1</td></tr>
<tr><td>(ii)</td><td>to spray / kill weeds without killing crop</td><td></td><td>1</td></tr>
<tr><td>(e)</td><td>Any two from:
• crops could alter food chains/webs
• lack of control on gene transfer
• GM crops could take over ecosystems
• might be effects on health</td><td>ACCEPT
gene gets into wild plants/weeds
(so) weeds now resistant to herbicide / herbicide now non-functional</td><td>max 2</td></tr>
<tr><td></td><td></td><td></td><td>Total: 11</td></tr>
</table>

Question number	Answer	Accept	Marks
13 (a)	size suitable ; line joining points ; axes correct way round and labelled ; points correctly plotted ;;	Note: 2 marks for points, penalise 1 mark for each incorrect plot	5
(b)	A description that includes the following: • increases • up to 2005 / then levels off / plateaus	ACCEPT by 897 dm^3 per cow	2
(c)	each cow producing more milk, so fewer cows needed / total yield for the herd stays constant / less demand from consumers for milk	ACCEPT due to diversification	1
(d)	A description that includes three of: • select bulls • that produce female calves with high milk yield / eq • choose high milk-yielding cows • and then repeat with offspring		max 3
(e)	Any **two** from: nutrition / eq greater fat/lipid in diet to increase milk yield / eq keep indoors (so) more energy available for milk production sex hormones larger udders to increase milk production	ALLOW any other suitable answers	4
			Total: 15

Question number	Answer	Notes	Marks
14 (a)	nervous system	ACCEPT skeletal system	1
(b)	parents: Bb Bb gametes of parents: B b B b genotype of children: (BB Bb Bb) bb phenotype of children: (normal normal normal) affected	ALLOW Bb appearing once ALLOW only bb shown as Batten's phenotype	4
(c)	cousin may (also) carry recessive allele / they share a common ancestor (therefore) increased chance of these combining / reference to inbreeding		2
			Total: 7

Write your name here

Surname	Other names

Edexcel
International GCSE

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Paper: 1C

Sample Assessment Material
Time: 2 hours

Paper Reference
4CH0/1C

You must have:
Ruler
Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.

Information

- The total mark for this paper is **120**.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

S41646A

S 4 1 6 4 6 A 0 1 2 8

PEARSON

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 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
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
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
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **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
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **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	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The Lanthanides (atomic numbers 58-71) and the Actinides(atomic numbers 90-103) have been omitted.***

Cu and Cl have not been rounded to the nearest whole number.

Answer ALL questions.

1 The table shows the properties of four substances.

Use the information in the table to answer the following questions.

Substance	Melting point in °C	Boiling point in °C	Conducts electricity when	
			solid	liquid
A	1650	2230	no	no
B	1538	2862	yes	yes
C	– 7	59	no	no
D	801	1413	no	yes

Place a cross (☒) in the appropriate box to indicate your answer.

Choose from **A** to **D** a substance that could be:

(5)

(a) a metal

A ☒ **B** ☒ **C** ☒ **D** ☒

(b) a giant covalent structure

A ☒ **B** ☒ **C** ☒ **D** ☒

(c) an ionic compound

A ☒ **B** ☒ **C** ☒ **D** ☒

(d) a liquid at 25 °C

A ☒ **B** ☒ **C** ☒ **D** ☒

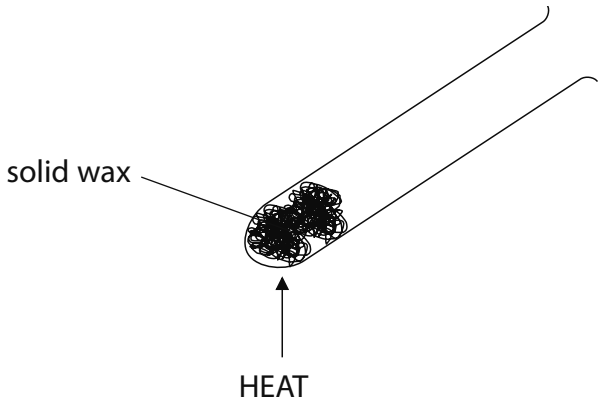
(e) a solid at 1600 °C

A ☒ **B** ☒ **C** ☒ **D** ☒

(Total for Question 1 = 5 marks)

2 A student investigated what happened when a sample of wax was heated using a Bunsen burner.

He set up the apparatus as shown in the diagram.



The student heated the solid wax strongly with a Bunsen burner until it turned into a liquid.

(a) Give the name of the process that occurs when a solid turns into a liquid.

(1)

.....

(b) Explain **one** change needed to make the experiment safer.

(2)

.....

.....

.....

.....

(c) Describe the changes in arrangement, movement and energy of the particles when the liquid wax cools to become a solid.

(3)

.....

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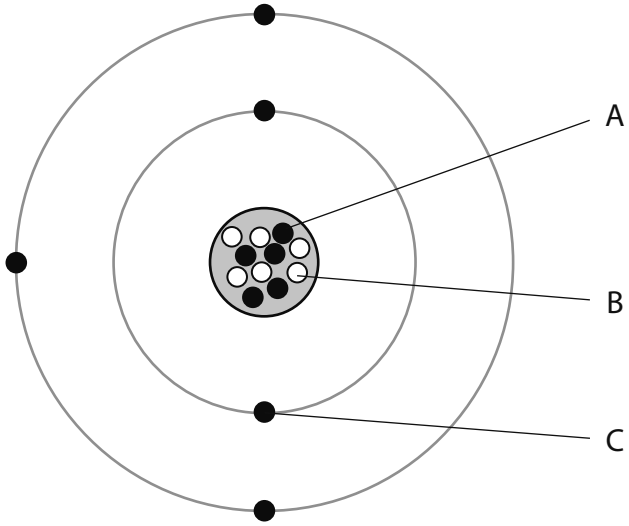
.....

.....

.....

(Total for Question 2 = 6 marks)

3 The diagram represents an atom of an element.



(a) The diagram shows that there are equal numbers of particles **A** and **C**.

(i) State the name of each of the particles **A** and **B**.

(2)

A .....

B .....

(ii) State the atomic number and mass number of this atom.

(2)

Atomic number .....

Mass number .....

(b) (i) State the **name** of this element.

(1)

.....

(ii) State the electronic configuration of this element.

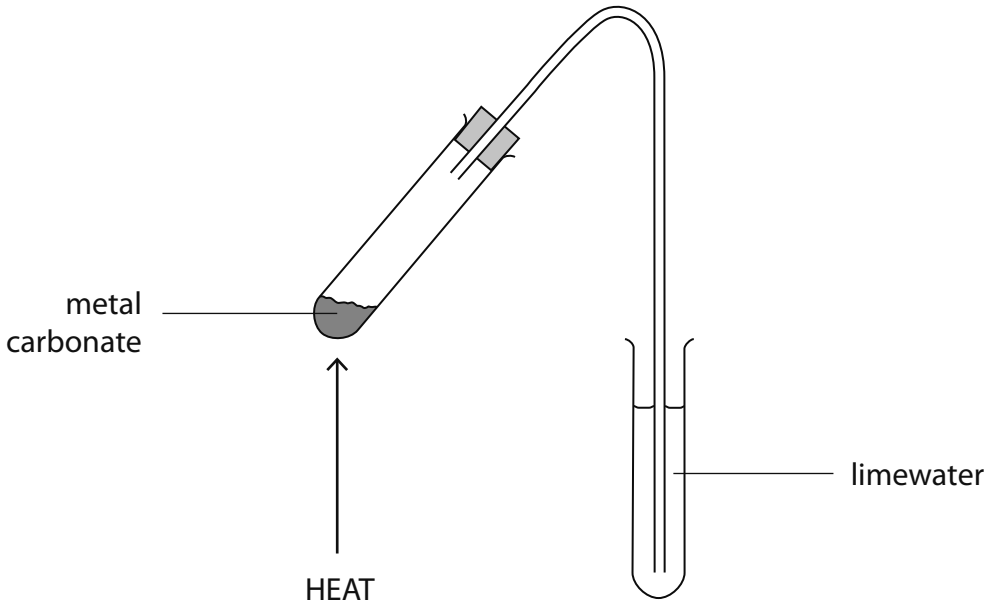
(1)

.....

(Total for Question 3 = 6 marks)

4 A student wanted to find out how easily different metal carbonates decomposed on heating.

She placed a sample of a metal carbonate into a test tube and heated it, passing the gas given off through limewater using the apparatus shown in the diagram.



She heated three other metal carbonates in turn and measured the time taken for the limewater to turn milky.

Her results are given in the table.

Metal carbonate	Time taken in seconds
copper(II) carbonate	5
magnesium carbonate	25
lead(II) carbonate	15
sodium carbonate	does not turn milky

(a) State the name of the gas that causes the limewater to turn milky.

(1)

.....

(b) Use the results to identify, with a reason, which metal carbonate decomposed most easily.

(2)

.....

.....

.....

(c) What do the results suggest about the effect of heat on sodium carbonate?

(1)

.....

(d) State **two** things that the student must do to make sure the experiment is valid (a fair test).

(2)

1 .....

.....

2 .....

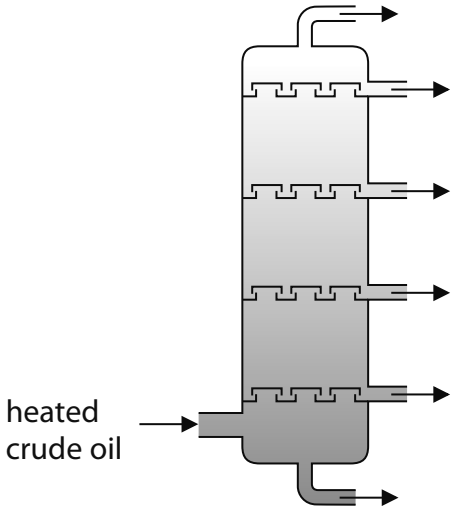
.....

(Total for Question 4 = 6 marks)

5 Fractional distillation is an important process in the oil industry.

In this process, the crude oil is separated into a number of fractions. Each fraction is a mixture of hydrocarbons.

The diagram shows the column used for fractional distillation.



(a) What is meant by the term **hydrocarbon**?

(2)

.....

.....

(b) Bitumen, diesel, gasoline and refinery gases are three of the fractions obtained from crude oil.

(i) Which one of these three fractions has the lowest boiling point?

(1)

.....

(ii) Which one of these three fractions is the most viscous?

(1)

.....

(c) Explain how the separation of crude oil into fractions takes place in the fractionating column.

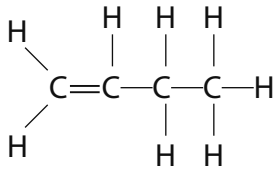
(4)

(Total for Question 5 = 8 marks)

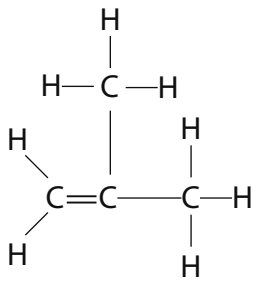
6 (a) Isomers are compounds that have the same molecular formula but different displayed formulae.

The molecular formula C_4H_8 represents several isomers.

The displayed formulae and names for two of these isomers are



but-1-ene



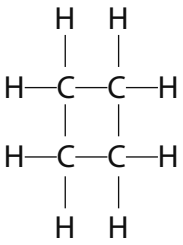
methylpropene

(i) Draw the displayed formula and give the name for another alkene with the molecular formula C_4H_8

(2)

Name .....

(ii) The displayed formula of another isomer of C_4H_8 is



cyclobutane

The general formula of cyclobutane is also C_nH_{2n}

State why cyclobutane is not an alkene.

(1)

.....

.....

(iii) Cyclobutane can be distinguished from but-1-ene by adding bromine water and shaking. Bromine water is orange.

State what you would see when bromine water is shaken separately with each compound.

(2)

Observation with cyclobutane

.....

Observation with but-1-ene

.....

(b) Cracking is used to break long alkane molecules into shorter alkanes and alkenes.

Explain why this process is of such importance in the petrochemical industry.

(2)

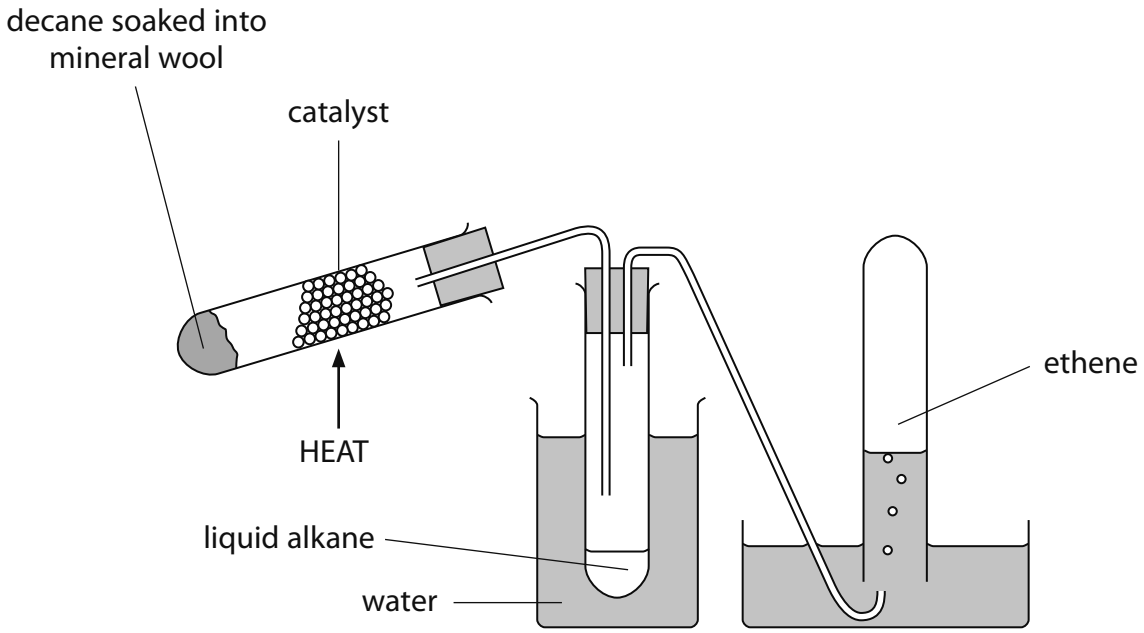
.....

.....

.....

.....

(c) Cracking can be carried out in the laboratory by passing the vapour of an alkane over a heated catalyst using the apparatus shown.



When decane ($C_{10}H_{22}$) is cracked, a shorter chain alkane and ethene (C_2H_4) can be produced.

(i) Write a chemical equation for the cracking of decane.

(2)

.....

(ii) The alkane produced can be used as a fuel for cars.

When this fuel is burned in a car engine, some incomplete combustion occurs. This produces carbon monoxide, which is dangerous to humans.

Explain why carbon monoxide is dangerous to humans.

(2)

.....

.....

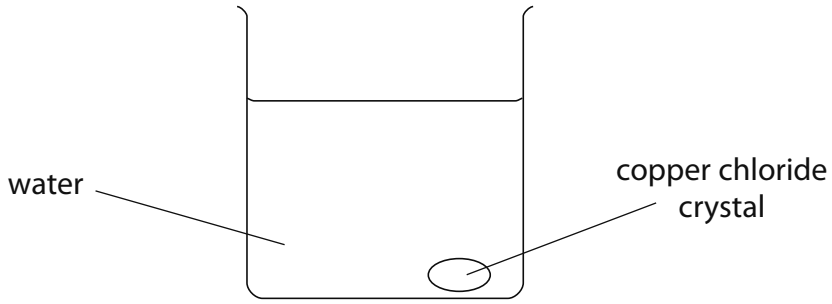
.....

.....

(Total for Question 6 = 11 marks)

7 Copper chloride is a soluble ionic compound. Solid copper chloride is green.

(a) A crystal of copper chloride was placed in a beaker containing water. It was left for several days.



Explain how the appearance of the liquid in the beaker changes after several days.

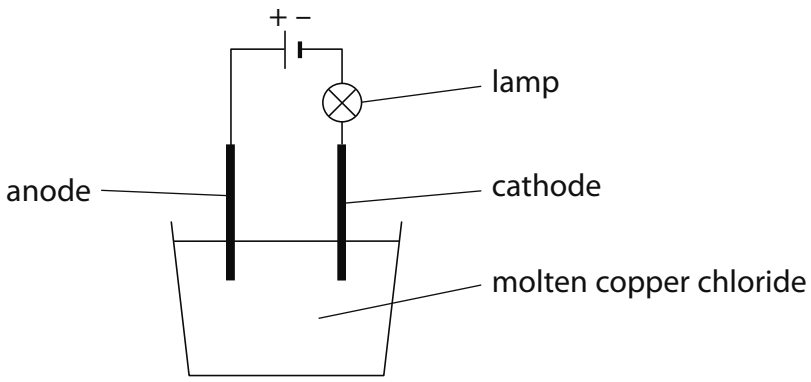
(2)

.....

.....

.....

(b) A chemist electrolyses a sample of molten copper chloride, $CuCl_2$.



Name the products formed at the electrodes.

(2)

Anode .....

Cathode .....

(c) Write an equation to show the formation of the product at the negative electrode.

(2)

.....

(Total for Question 7 = 6 marks)

8 Equal masses of iron, magnesium and zinc were placed in separate beakers, each containing 50 cm^3 of copper(II) sulfate solution.

The mass of copper displaced in each case was found and each experiment was performed three times. The results obtained are given in the table.

Metal	Mass of copper produced in grams		
	Experiment 1	Experiment 2	Experiment 3
iron	1.1	1.3	1.2
magnesium	2.3	3.2	2.2
zinc	0.9	0.8	1.10

(a) How can you tell that one of the results has been recorded to a greater precision than the others?

(1)

.....

.....

(b) Write a chemical equation for the reaction taking place between magnesium and copper(II) sulfate.

(2)

.....

.....

(c) (i) State, in terms of electrons, what happens when a copper ion becomes a copper atom.

(1)

.....

(ii) What name is given to the type of change occurring in (c)(i)?

(1)

.....

(iii) State **two** observations you would expect to make when magnesium is added to copper(II) sulfate solution.

(2)

.....

.....

(Total for Question 8 = 7 marks)

9 (a) An aqueous solution of hydrogen peroxide (H_2O_2) decomposes very slowly into water (H_2O) and oxygen (O_2) according to the following equation:

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

The reaction is faster when manganese(IV) oxide (MnO_2) is added. The manganese(IV) oxide remains chemically unchanged at the end of the reaction.

A student investigated the reaction in the presence of manganese(IV) oxide. He collected the oxygen gas produced and recorded its volume every five minutes. His results are shown in the table.

Time in minutes	0	5	10	15	20	25	30	35	40
Volume in cm^3	0	20	32	42	50	55	58	60	60

(i) The volume of gas given off between 5 and 10 minutes is 12 cm^3.

Calculate the volume of gas given off between 30 and 35 minutes.

(1)

Answer ..... cm^3

(ii) Explain, in terms of the changes in the rate of the reaction and collisions between particles, why your calculated volume is less than 12 cm^3.

(3)

.....

.....

.....

.....

.....

(iii) After how many minutes did the reaction finish?

(1)

.....

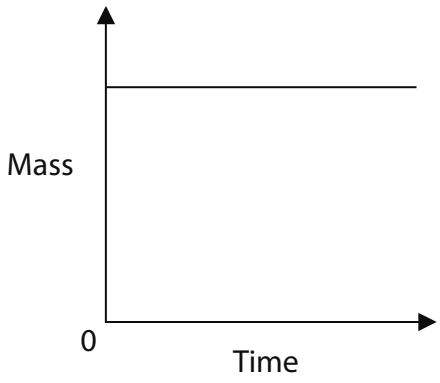
(b) What type of substance is manganese(IV) oxide in this experiment?

(1)

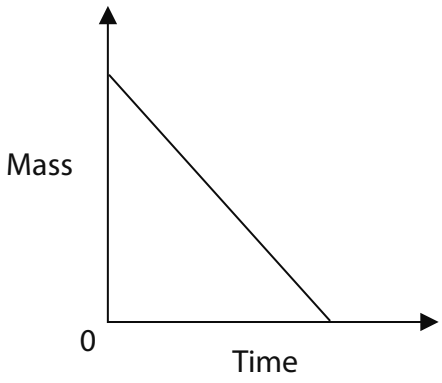
.....

(c) Some of the graphs **A** to **F** below could represent changes occuring during the decomposition of hydrogen peroxide.

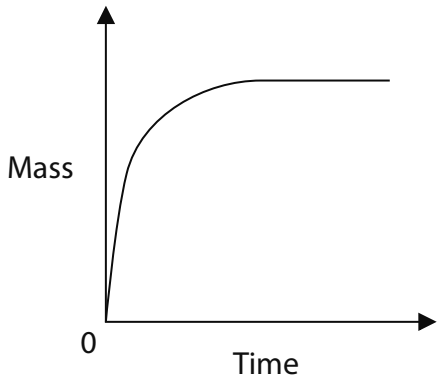
A



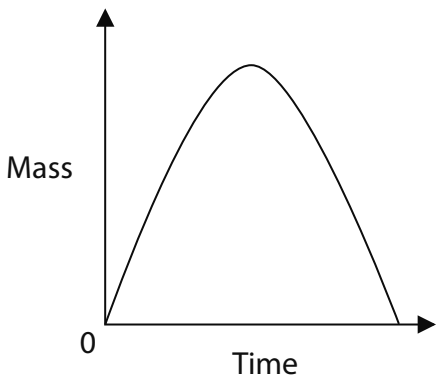
B



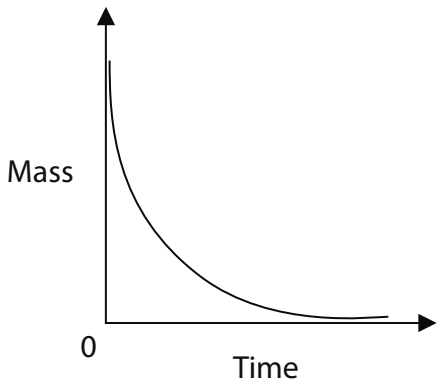
C



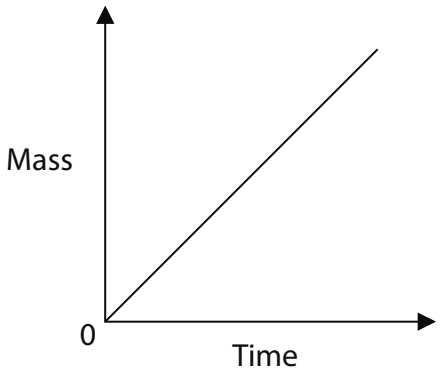
D



E



F



Answer the questions below by placing a cross (☒) in the appropriate box to indicate your answer.

Which graph could represent

(i) the total mass of oxygen given off as the experiment in (a) proceeds?

(1)

☒ **A** ☒ **B** ☒ **C** ☒ **D** ☒ **E** ☒ **F**

(ii) the mass of hydrogen peroxide remaining as the experiment in (a) proceeds?

(1)

☒ **A** ☒ **B** ☒ **C** ☒ **D** ☒ **E** ☒ **F**

(iii) the mass of the manganese(IV) oxide as the experiment in (a) proceeds?

(1)

☒ **A** ☒ **B** ☒ **C** ☒ **D** ☒ **E** ☒ **F**

(Total for Question 9 = 9 marks)

10 When potassium iodide solution is mixed with lead(II) nitrate solution, a reaction occurs to form the insoluble salt, lead(II) iodide.

The equation for this reaction is:

$$2KI(aq) + Pb(NO_3)_2(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$$

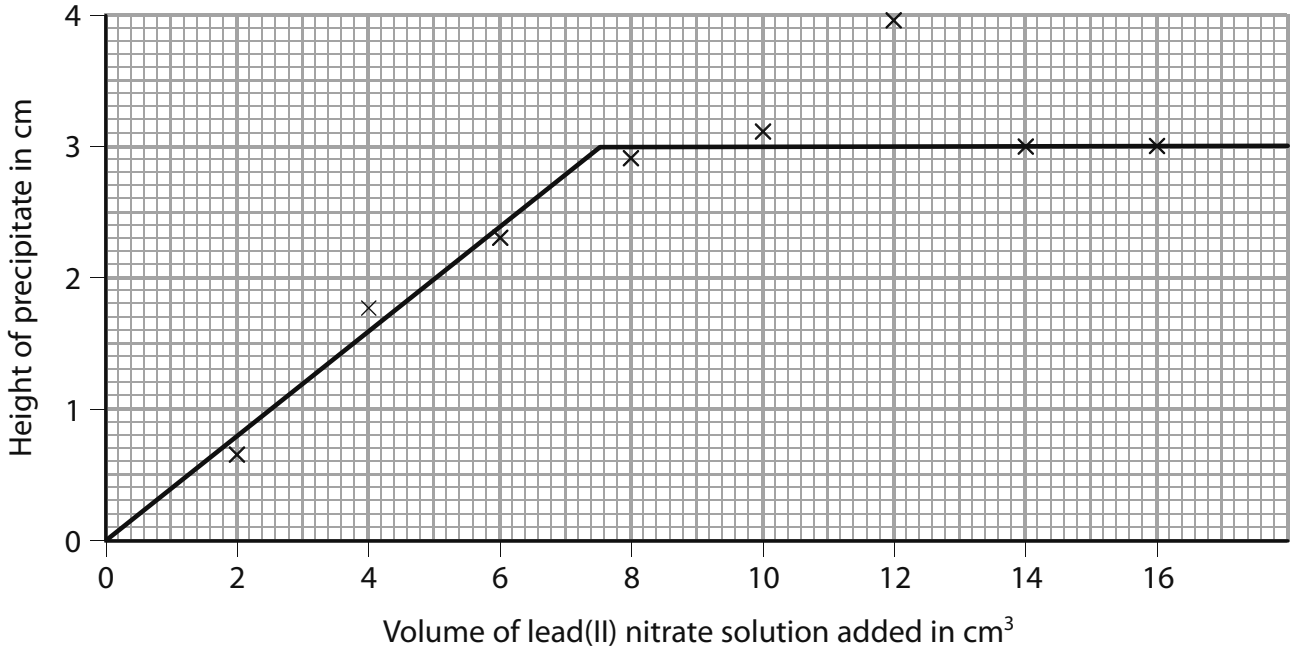
A student carried out an investigation to find how much precipitate was formed with different volumes of lead(II) nitrate solution.

- He used a measuring cylinder to transfer 15 cm^3 of potassium iodide solution into a clean boiling tube.
- Using a different measuring cylinder, he measured out 2 cm^3 of lead(II) nitrate solution and added this to the potassium iodide solution in the boiling tube.
- A yellow precipitate formed in the tube and was allowed to settle.
- The student then measured the height (in cm) of the precipitate using a ruler.

He repeated the experiment using different volumes of lead(II) nitrate solution.

In each experiment, the potassium iodide solution and lead(II) nitrate solution he used were of the same concentration.

The graph shows the results he obtained.



(a) Explain why the line on the graph rises to a maximum level, but then does not change.

(2)

.....

.....

.....

.....

(b) (i) On the graph, circle the point which seems to be anomalous.

(1)

(ii) Explain **two** things that the student may have done in the experiment to give this anomalous result.

(4)

1 .....

.....

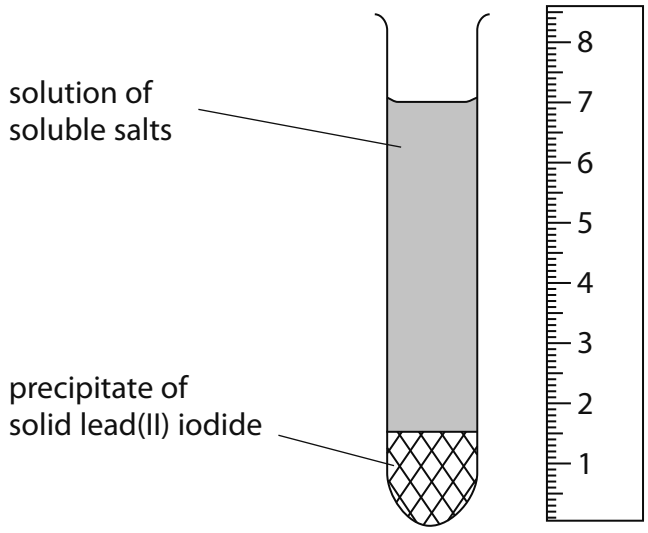
.....

2 .....

.....

.....

(c) The diagram shows a result of an identical experiment.



(i) How much precipitate has been made in the tube?

(1)

..... cm

(ii) Use the graph to find the voume of lead(II) nitrate solution needed to make this amount of precipitate.

(1)

..... cm^3

(Total for Question 10 = 9 marks)

11 Fluorine and chlorine are two elements in Group 7 of the Periodic Table.

Fluorine reacts with most elements in the Periodic Table, but it does not react with neon.

Neon is in Group 0 of the Periodic Table.

(a) Explain, in terms of the arrangement of electrons in its atoms, why neon is very unreactive.

(2)

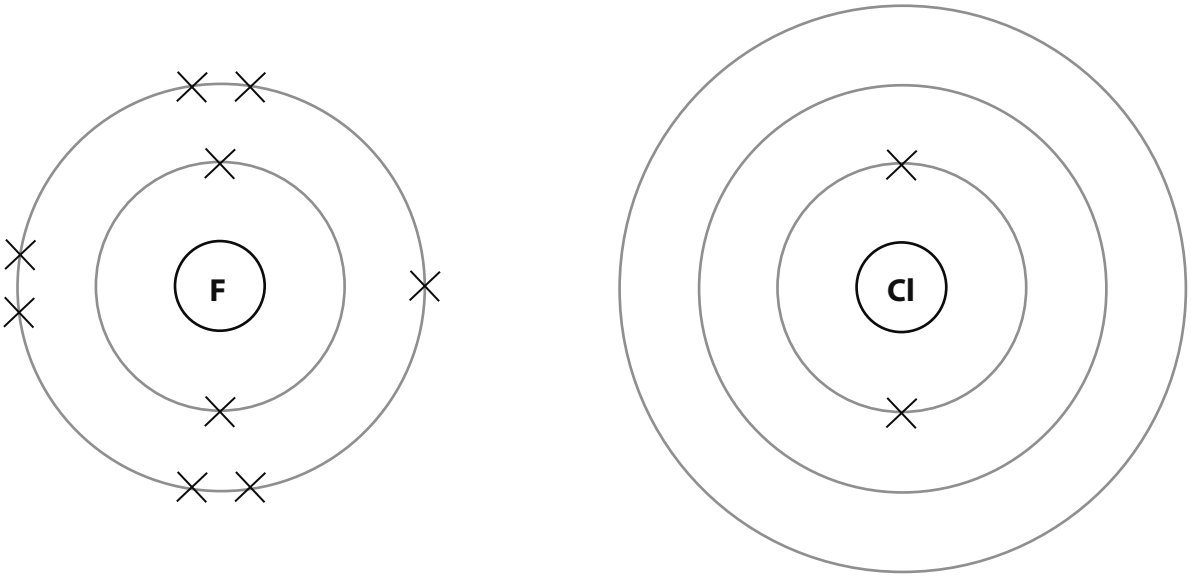
.....

.....

(b) The diagram on the left shows the arrangement of the electrons in a fluorine atom.

Use the Periodic Table to help you to complete the diagram on the right to show the arrangement of electrons in a chlorine atom.

(2)



(c) When chlorine gas is bubbled into an aqueous solution of potassium iodide, the colourless solution turns brown.

(i) Complete the following ionic equation for the reaction that takes place.

(2)

$Cl_2(g)$ + ...$I^-(aq)$ → ..... (aq) + ... (aq)

(ii) What is the name given to this type of reaction?

(1)

.....

(iii) Why does the solution turn brown?

(1)

.....

(d) When chlorine reacts with concentrated sodium hydroxide solution, a compound is formed that contains 21.6% by mass of sodium and 33.3% by mass of chlorine. The rest is oxygen.

Calculate the empirical formula of this compound.

(4)

.....

.....

.....

.....

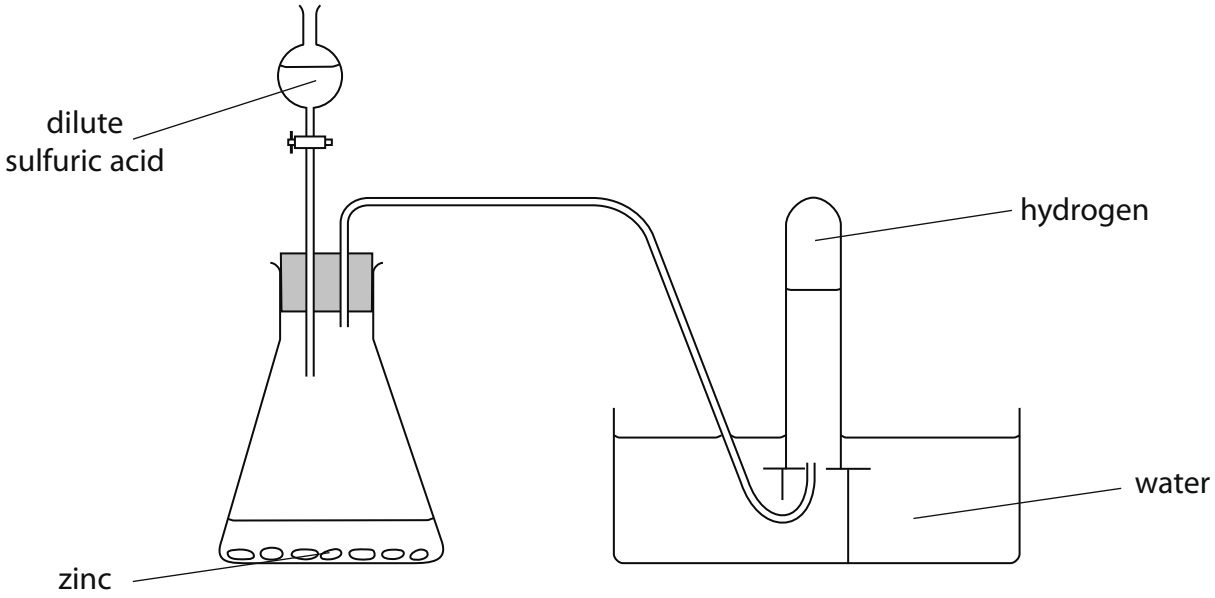
.....

.....

.....

(Total for Question 11 = 12 marks)

12 Hydrogen can be prepared in the laboratory by reacting zinc with dilute sulfuric acid using the apparatus shown.



The equation for the reaction is:

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

The reaction is fairly slow but, when copper(II) sulfate solution is added, bubbles of hydrogen form much more quickly.

A student decided to investigate how copper(II) sulfate solution increased the rate of this reaction.

She set up the apparatus as shown, without copper(II) sulfate present, and counted the number of bubbles of hydrogen produced every 15 seconds.

She then repeated the experiment with copper(II) sulfate present.

(a) Explain why her method of counting the number of bubbles of hydrogen might not give accurate results in her second experiment, with copper(II) sulfate present.

(2)

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(b) Describe how she should change the experiment to allow the collection of more precise results.

(2)

The student then decided that she wanted to show that the gas collected was hydrogen. She burned a sample in oxygen and collected the colourless liquid that formed on cooling. If the gas were hydrogen then the colourless liquid should be pure water.

(c) Describe a **physical** test that she could perform to show that the colourless liquid is pure water.

(2)

The student's teacher said that even if the colourless liquid were pure water then it does not necessarily mean that the gas was hydrogen.

(d) Suggest the name of another **gas** that produces water when it is burned in oxygen.

(1)

(Total for Question 12 = 7 marks)

13 Ammonia (NH_3) is manufactured in the exothermic reaction between nitrogen gas (N_2) and hydrogen gas (H_2) in the presence of an iron catalyst.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ/mol}$$

The nitrogen and hydrogen mixture is passed into a reaction chamber at a pressure of 200 atmospheres and a temperature of 450 °C.

The reaction is reversible and, if left for long enough, can reach a position of dynamic equilibrium.

(a) Why is a catalyst needed in this reaction?

(1)

.....

(b) What is meant by the term **dynamic equilibrium**?

(2)

.....

.....

(c) A scientist working in the factory making ammonia suggested changing the reaction conditions to a pressure of 1000 atmospheres and a temperature of 250 °C.

Use your knowledge of equilibrium reactions and reaction rates to explain whether the scientist's suggestion was a good one.

(4)

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(d) The mixture of gases leaving the reaction chamber contains unreacted nitrogen and hydrogen as well as ammonia.

(i) Explain how the ammonia can be separated from the unreacted nitrogen and hydrogen after the mixture has left the reaction chamber.

(2)

(ii) What happens to the unreacted nitrogen and hydrogen after it has been separated from the ammonia?

(1)

(e) Ammonia is used to make the fertiliser ammonium nitrate (NH_4NO_3) by reacting ammonia with nitric acid.

Write a chemical equation for the reaction between ammonia and nitric acid.

(1)

(f) Describe a chemical test that you could perform to show that ammonium nitrate contains ammonium ions.

(3)

(Total for Question 13 = 14 marks)

14 Zinc phosphide (Zn_3P_2) is found in some rat poisons. It is an ionic compound manufactured by heating zinc and phosphorus together.

(a) (i) The formula of the zinc ion is Zn^{2+}.

Deduce the formula of the phosphide ion.

(1)

.....

(ii) Explain why zinc phosphide does **not** conduct electricity when solid, but **does** when molten.

(2)

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.....

(b) Calculate the relative formula mass (M_r) of zinc phosphide.

(2)

Relative formula mass = ...

(c) A bag containing 51.4 kg (51 400 g) of zinc phosphide stored in a factory warehouse was accidentally contaminated with water.

Zinc phosphide reacts with water to form zinc hydroxide and phosphine gas, PH_3.

The equation for the reaction is:

$$Zn_3P_2(s) + 6H_2O(l) \rightarrow 3Zn(OH)_2(s) + 2PH_3(g)$$

(i) Calculate the minimum mass of water, in kg, needed to react with all of the zinc phosphide in the bag.

(3)

Mass of water needed = ... kg

(ii) The factory was evacuated because phosphine can burst into flames immediately when it comes into contact with oxygen in the air.

What does this suggest about the activation energy for the reaction between phosphine and oxygen?

(1)

.....

(iii) Is the reaction between phosphine and oxygen endothermic or exothermic? Use information from part (ii) to justify your answer.

(1)

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.....

(d) (i) Phosphine is similar to ammonia (NH_3) in the way its atoms are bonded.

Draw a dot and cross diagram to show the arrangement of electrons in a molecule of phosphine. You should show only the outer electrons of each atom.

(2)

(ii) Explain why phosphine has a low boiling point.

(2)

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(Total for Question 14 = 14 marks)

TOTAL FOR PAPER = 120 MARKS

Sample Mark Scheme

Paper 1C

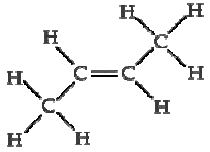
Question number	Answer	Notes	Marks
1 (a)	B		1
(b)	A		1
(c)	D		1
(d)	C		1
(e)	A		1
			Total: 5

Question number	Answer	Notes	Marks
2 (a)	melting		1
(b)	An explanation linking the following : • heat with electric heater / in water bath / sand bath • because wax may catch fire / prevent liquid wax boiling over or spitting	ACCEPT • use test tube holder / clamp • to prevent being burned by hot test tube	2
(c)	A description including the following: • (becomes) regular arrangement / pattern (of particles) • particles slow down / vibrate (in fixed positions) • particles lose (kinetic) energy	ACCEPT closer together ACCEPT stop moving around (freely)	3
			Total: 6

Question number	Answer	Notes	Marks
3 (a) (i)	A = proton(s) B = neutron(s)	Award 1 mark for two correct particles in the wrong order	2
(ii)	atomic number = 5 mass number = 11	No mark for two numbers transposed	2
(b) (i)	boron		1
(ii)	2, 3	ACCEPT any other punctuation marks, such as '.' '/' '-' or no punctuation	1
			Total: 6

Question number	Answer	Notes	Marks
4 (a)	carbon dioxide	ALLOW CO_2	1
(b)	copper(II) / copper (carbonate) (because) limewater turned milky in **least** time / **most** quickly		2
(c)	(sodium carbonate / it) does not decompose	ALLOW no carbon dioxide / gas given off	1
(d)	Any **two** from: • same volume / concentration of limewater • same flame e.g. "always roaring flame" • same amount of solid • same distance of flame to tube • same form / state of division of solid e.g. "all powders"	ACCEPT: • same amount of limewater • same temperature / Bunsen setting • same mass of solid	max 2
			Total: 6

Question number	Answer	Notes	Marks
5 (a)	compounds / substances containing hydrogen and carbon <u>only</u>	DO NOT ACCEPT atoms/elements in place of compounds/substances	2
(b) (i)	refinery gases		1
(ii)	bitumen		1
(c)	An explanation linking any **four** of the following: • crude oil / vapour rises through the (fractionating) column • idea of temperature gradient in column e.g. hotter at the bottom than the top • different fractions have different boiling point • condense when they get to part of the column that has lower temperature than their boiling point • vapour passes through bubble caps / one-way valves OR idea that liquid fractions cannot trickle back down because of bubble caps	ALLOW vaporising point / condensing temperature	max 4
			Total: 8

Question number	Answer	Notes	Marks
6 (a) (i)	 but-2-ene	1 mark for formula 1 mark for name	2
(ii)	no double bond / saturated		1
(iii)	cyclobutane: no change / remains orange but-1-ene: (bromine) turns (from orange to) colourless / decolourised	 IGNORE starting colour of bromine	2
(b)	An explanation linking the following points: • crude oil contains too many long chain hydrocarbons • which are economically less useful / need converting to more economically useful smaller hydrocarbons	ACCEPT • alkenes need in polymer industry • to make useful plastics	2
(c) (i)	$C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$ 1 mark for correct formula for alkane 1 mark for balanced equation	ALLOW equations which finish: $\rightarrow C_6H_{14} + 2C_2H_4$ $\rightarrow C_4H_{10} + 3C_2H_4$ $\rightarrow C_2H_6 + 4C_2H_4$	2
(ii)	An explanation linking the following points: • toxic / poisonous • (because) it restricts blood carrying oxygen	ACCEPT comments about binding to haemoglobin / forming carboxyhaemoglobin	2
			Total: 11

Question number	Answer	Notes	Marks
7 (a)	An explanation linking the following points: • green colour spreads throughout liquid • (because of) diffusion	ACCEPT dark green at bottom and light green at top	2
(b)	Anode = copper Cathode = chlorine	Award 1 mark for both correct products, but at incorrect electrodes	2
(c)	$2Cl^- \rightarrow Cl_2 + 2e$ 1 mark for correct species 1 mark for balance	ALLOW $2Cl^- - 2e \rightarrow Cl_2$	2
			Total: 6

Question number	Answer	Notes	Marks
8 (a)	extra decimal place / trailing zero / to 0.01 g		1
(b)	$Mg + CuSO_4 \rightarrow MgSO_4 + Cu$	1 mark for reactants 1 mark for products	2
(c) (i)	gains (two) electrons		1
(ii)	reduction		1
(iii)	Any **two** from: • (blue) colour of solution fades /solution turns colourless • brown/pink/pink(y)-brown solid forms • gets warm/hot	NOT solution turns clear ALLOW precipitate ALLOW fizzing / bubbles	max 2
			Total: 7

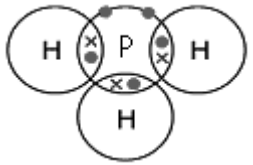
Question number	Answer	Notes	Marks
9 (a) (i)	2 (cm^3)		1
(ii)	An explanation linking the following points: • reaction rate slows down • (because there are) fewer **hydrogen peroxide** particles • (therefore) less **frequent** collisions/fewer collisions **per second**	ACCEPT hydrogen peroxide is less concentrated	3
(iii)	35 (minutes)	ACCEPT any number **between** 30 and 35	1
(b)	catalyst		1
(c) (i)	C		1
(ii)	E		1
(iii)	A		1
			Total: 9

Question number	Answer	Notes	Marks
10 (a)	An explanation linking the following points: • more precipitate as more lead(II) nitrate present (to react with potassium iodide) • but eventually all potassium iodide used up / lead(II) nitrate becomes in excess / the reaction finishes		2
(b) (i)	correct point circled (at 12cm^3 of lead(II) nitrate added)	ACCEPT any way in which this point is indicated	1
(ii)	Any **two** of the following pairs of statements: • not left long enough • therefore precipitate / solid not fully settled **OR** • too much potassium iodide added • so more precipitate made **OR** • tube not vertical when precipitate was settling • so precipitate not level in the tube	ACCEPT reasonable alternatives, as long as they explain why the height is **too high**	max 4
(c) (i)	1.5 ± 0.1 (cm)	ACCEPT 0.8 cm (for candidates who use their own ruler)	1
(ii)	3.7 – 3.8 (cm^3)	ALLOW consequential on answer to (c)(i)	1
			Total: 9

Question number	Answer	Notes	Marks
11 (a)	An explanation linking the following points: • 8 electrons in **outer(most)** shell • does not **easily/readily** gain or lose electrons	ACCEPT full **outer(most)** shell ACCEPT argument based on energy required	2
(b)	8 electrons in middle shell 7 electrons in outer shell	ACCEPT dots, circles, crosses or e to represent electrons	2
(c) (i)	$2(I^-)$ and $2\ Cl^- + I_2$	1 mark – correct formulae 1 mark – correct balancing	2
(ii)	displacement / redox	ACCEPT oxidation **and** reduction	1
(iii)	iodine (formed, and it is brown in solution)	I_2	1
(d)	calculation of % O = 45.1 dividing by A_r values: Na 21.6/23 Cl = 33.3/35.5 O = 45.1/16 simplest whole number ratio = 1:1:3 translating this ratio to a formula = $NaClO_3$	If division by atomic number, neither 2nd nor 3rd mark can be scored – although 4th mark can (probably $NaClO_3$ or $Na_8Cl_8O_{23}$) Final answer consequential on slips in calculation above	4
			Total: 12

Question number	Answer	Notes	Marks
12 (a)	An explanation linking the following points: • reaction rate is faster • (therefore) counting bubbles is more difficult / bubbles may form continuous stream	ACCEPT: • bubbles may be different size • so not valid / poor comparison with first experiment	2
(b)	A description linking the following points: • measure the volume of gas produced • using a graduated test-tube / gas syringe / inverted measuring cylinder	ACCEPT: answers which lead to decreased rate to allow bubble counting to work e.g. • reduced concentration of acid / larger pieces of zinc • to slow rate / make bubbles smaller	2
(c)	measure the boiling point / freezing point 100°C / 0°C	boils at 100°C OR freezes at 0°C are worth 2 marks	2
(d)	any named **gas** that burns in oxygen to form water as a product e.g. methane, ethane	ACCEPT correct formula for gas	1
			Total: 7

Question number	Answer	Notes	Marks
13 (a)	to speed up the reaction **OR** to allow a lower temperature to be used but still have a reasonably / acceptably fast reaction	ACCEPT to lower the activation energy / achieve a better balance of yield and rate	1
(b)	forward and reverse reactions **are** occurring at same rate/speed	ACCEPT amounts of reactants / products / macroscopic properties remain constant	2
(c)	An explanation linking **four** of the following points: • increased pressure favours forward reaction / increases yield • increased pressure also increases rate • decreased temperature favours forward reaction / increases yield • decreased temperature decreases rate • concluding comment e.g. greater yield, but probably at reduced rate / increase in rate due to pressure cancels decrease in rate due to temperature change **Concluding comment must be present to score full 4 marks, but can be agreement or disagreement with scientist's idea.**	ACCEPT moves equilibrium to right ACCEPT moves equilibrium to right ACCEPT good idea but increased pressure increases cost	max 4
(d) (i)	An explanation linking the following points: • ammonia has low boiling point / liquefies • (therefore) mixture is cooled		2
(ii)	recirculated / recycled / re-used / returned to reaction chamber / used to make more ammonia		1
(e)	$NH_3 + HNO_3 \rightarrow NH_4NO_3$		1
(f)	A description linking the following points: • add aqueous sodium hydroxide (and warm) • gas / ammonia (given off) • turns (damp) red litmus blue	ACCEPT forms white smoke with HCl	3
			Total: 14

Question number	Answer	Notes	Marks
14 (a) (i)	P^{3-}	ACCEPT P^{-3}	1
(ii)	An explanation linking the following points: • ions are not free to move in solid (IGNORE ref to electrons) • (however) ions are free to move when molten	REJECT any mention of electron movement	2
(b)	(65 × 3) + (31 × 2) = 257	Award 1 mark for correct use of Mr of Zn and P	2
(c) (i)	• moles phosphine = 51400 / 257 • moles water = moles phosphine × 6 • mass water = moles water × 18 = 21600 g / 21.6 kg **OR** • 6 × 18 = 108 • 257 / 108 = 51.4 / mass water • mass water = 21.6 kg	Mark consequentially on (b) ACCEPT answer in g or kg, as long as unit matches value	3
(ii)	low / small		1
(iii)	exothermic, because it burst into flames	NOT just 'exothermic'	1
(d) (i)		1 mark for 3 bonding pairs 1 mark for non-bonding pair	2
(ii)	An explanation linking any **two** of the following points: • small molecules • weak (attractive) forces between molecules • (therefore) little energy required to overcome forces / separate molecules	ACCEPT "weak bonds", but not "weak covalent bonds"	max 2
			Total: 14

Write your name here

Surname	Other names

Edexcel
International GCSE

Centre Number | | | | | |

Candidate Number | | | | |

Physics

Paper: 1P

Sample Assessment Material
Time: 2 hours

Paper Reference
4PH0/1P

You must have:
Ruler, protractor, calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- Show all the steps in any calculations and state the units.

Information

- The total mark for this paper is **120**.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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S 4 1 6 4 8 A 0 1 3 0

PEARSON

EQUATIONS

You may find the following equations useful.

energy transferred = current × voltage × time $E = I \times V \times t$

pressure × volume = constant $p_1 \times V_1 = p_2 \times V_2$

$$\frac{\text{pressure}}{\text{kelvin temperature}} = \text{constant} \qquad \frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$$\text{frequency} = \frac{1}{\text{time period}} \qquad f = \frac{1}{T}$$

$$\text{power} = \frac{\text{work done}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}} \qquad v = \frac{2 \times \pi \times r}{T}$$

Where necessary, assume the acceleration of free fall, $g = 10\ \text{m/s}^2$.

Answer ALL questions.

1 The Solar System contains planets, comets and satellites.

(a) Answer the following questions by placing a cross (☒) in the appropriate box.

(i) When one object goes around another in space, it follows a path called

(1)

☒ **A** a circle

☒ **B** an equator

☒ **C** an orbit

☒ **D** an oval

(ii) Which force is responsible for planets following their paths around the Sun?

(1)

☒ **A** friction

☒ **B** gravity

☒ **C** magnetism

☒ **D** upthrust

(iii) Which force is responsible for artificial satellites following their paths around the Earth?

(1)

☒ **A** friction

☒ **B** gravity

☒ **C** magnetism

☒ **D** upthrust

(iv) Moons are natural satellites of

(1)

☒ **A** asteroids

☒ **B** comets

☒ **C** planets

☒ **D** stars

(b) State **one** similarity in the movement of planets and comets.

(1)

.....

.....

(c) State **one** difference between the movement of planets and comets.

(1)

.....

.....

(d) Explain how the speed of a comet changes as it moves.

(2)

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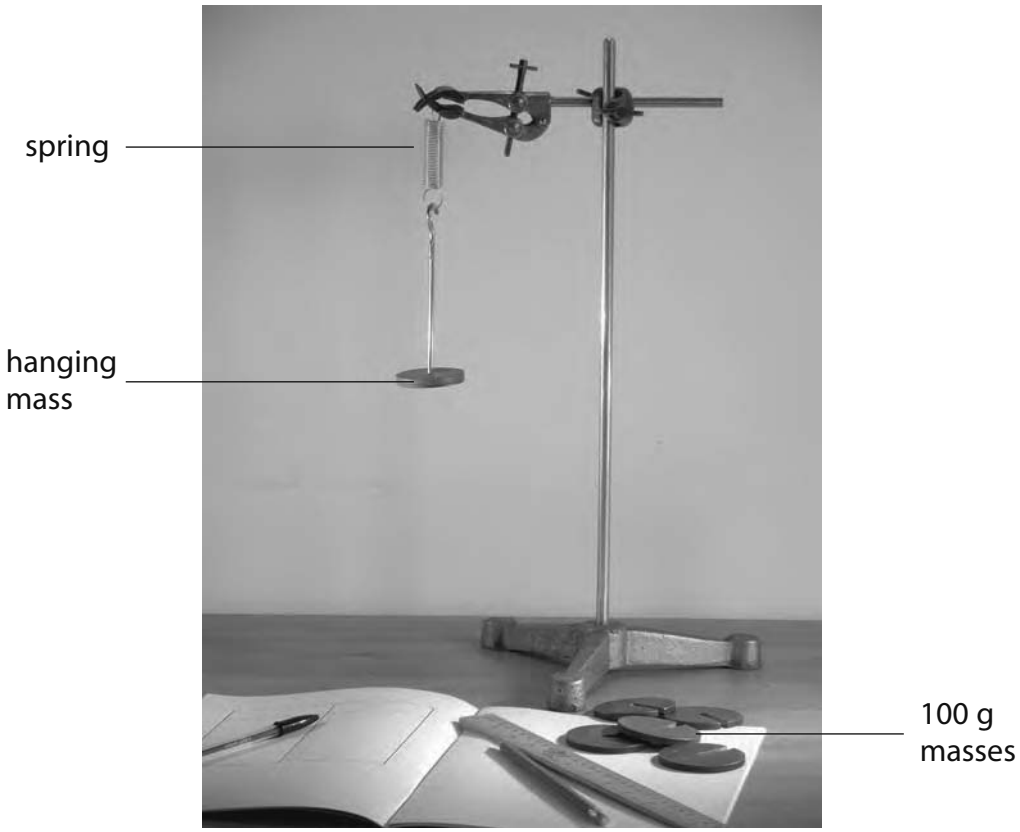
(Total for Question 1 = 8 marks)

2 A student is investigating how the extension of a spring varies when she changes the force stretching it.

The photograph shows how she sets up her experiment.



The student has a ruler marked in centimetres.

Each mass is marked '100 g'.

The student writes the following plan:

- I will hang 100 g on the spring.
- I will hold the ruler next to the spring and measure the length of the spring.
- I will add another mass and measure the length again.
- I will repeat this process until I have enough measurements.

(a) Explain how the student could improve her plan to make her measurements more accurate.

(5)

(b) State, with a reason, a suitable safety precaution the student should take when carrying out her experiment.

(1)

(c) Describe how the student should convert her measurements of mass into forces.

(2)

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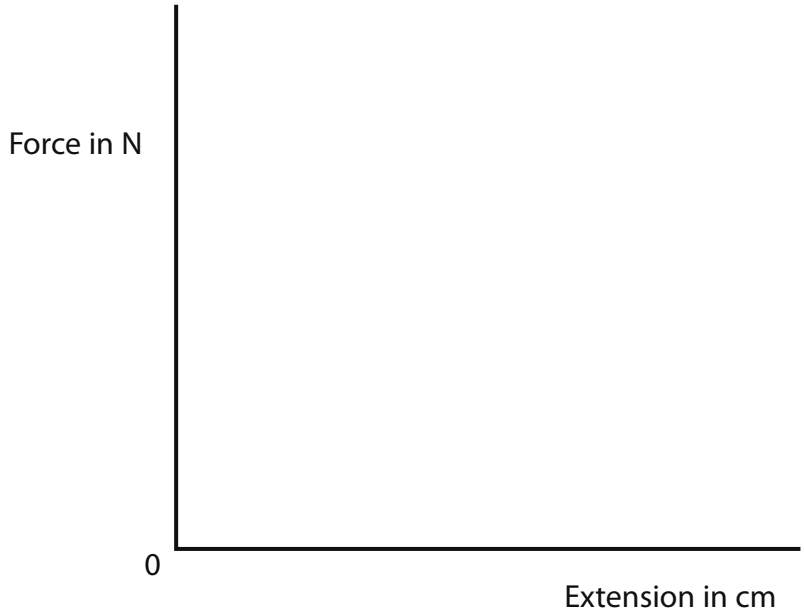
(d) The student plots a graph of force against extension.

She finds that the spring obeys Hooke's law.

On the axes below, sketch the line she gets.

(2)



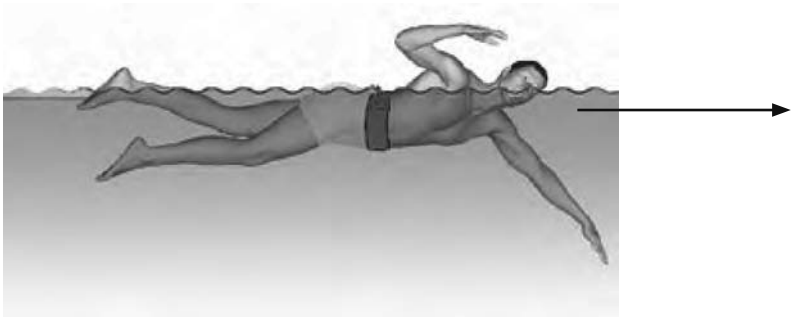
(Total for Question 2 = 10 marks)

3 A triathlon race has three parts: swimming, riding a bicycle and running.

(a) The diagram shows the force responsible for the forward movement of an athlete in the swimming part of the race.

Label the diagram to show **two** other forces acting on the athlete.

(2)



(b) The table shows the distance of each part of a triathlon race and the time an athlete takes for each part.

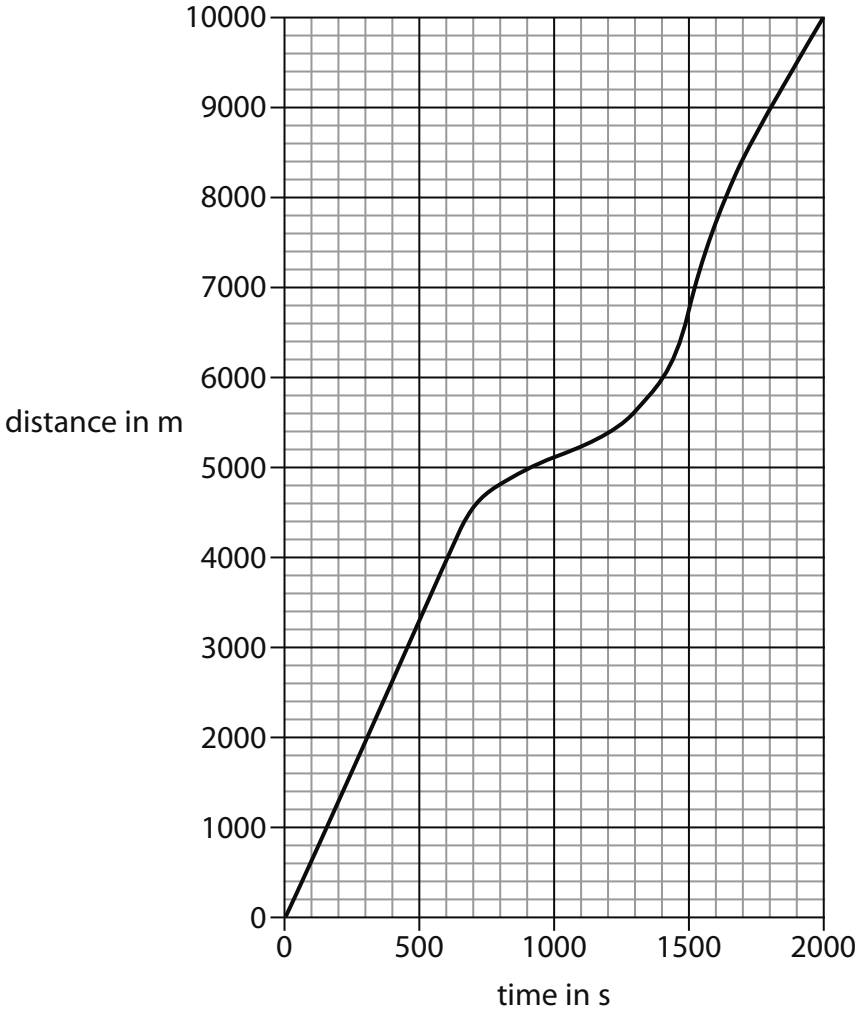
Part of race	Distance in m	Time in s
swimming	1 500	1 200
riding a bicycle	40 000	3 600
running	10 000	2 000

(i) Calculate the athlete's average speed for the whole race.

(2)

Average speed = ... m/s

(ii) The graph shows how the distance varied with time for the running part of the race.



Describe how the athlete's speed changed during this part of the race.

(3)

(Total for Question 3 = 7 marks)

4 Using mains electricity can be dangerous.

(a) Suggest **two** safety precautions you should take when putting a plug into a mains socket.

(2)

1 .....

.....

.....

2 .....

.....

.....

(b) Mains electricity provides an alternating current (a.c.)

A battery provides direct current (d.c.)

Describe the difference between a.c. and d.c.

(2)

.....

.....

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.....

(c) The photograph shows two mains plugs.

Mains plug A has a connection for an earth wire.
Mains plug B does not have an earth connection.

(i) Describe how the earth wire can act together with a fuse as a safety device.

(2)

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(ii) Explain why mains plug B can be safe to use even though it has no earth connection.

(2)

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.....

(d) A fuse is rated at 13 A.

The mains voltage is 230 V.

Calculate the maximum power that can be supplied using this fuse.

State the correct unit in your answer.

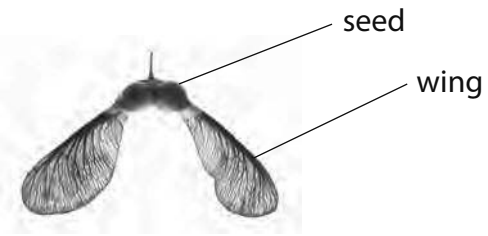
(3)

Maximum power = ... Unit .....

(Total for Question 4 = 11 marks)

5 Two students notice some small objects falling from a tree.

The objects have wings that make them spin around and fall slowly.



The students find out that this is the way that the tree spreads its seeds.

They decide to use these 'winged seeds' for an investigation.

They drop several seeds from a window and collect the data shown in the table.

Average mass of a winged seed	0.25 g
Vertical distance fallen	5 m
Average time taken for a winged seed to fall	12 s

(a) Explain why it is a good idea to use a distance of 5 m in this experiment.

(2)

(b) Describe how the students should find the average mass of a winged seed.

(2)

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.....

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.....

(c) (i) State the equation linking gravitational potential energy, mass, *g* and height.

(1)

(ii) Calculate the average gravitational potential energy lost by one winged seed as it falls a vertical distance of 5 m.

(2)

Gravitational potential energy = ... J

(iii) Describe what happens to this energy.

(2)

.....

.....

.....

.....

(Total for Question 5 = 9 marks)

6 Electromagnetic waves called T-rays (short for tera-rays) are used in some airport security scanners.

T-rays:

- pass through clothes
- bounce off the human body
- do not pass through or bounce off metal.

(a) Put a cross (✖) in the appropriate box to indicate the correct ending for each sentence.

(i) T-rays are absorbed by

(1)

clothes	
the human body	
metal	

(ii) T-rays are reflected by

(1)

clothes	
the human body	
metal	

(b) (i) State the equation linking wave speed, frequency and wavelength.

(1)

(ii) T-rays have a wavelength of 3×10^{-4} m and travel at a speed of 3×10^{8} m/s.

Calculate the frequency of T-rays.

State the correct unit in your answer.

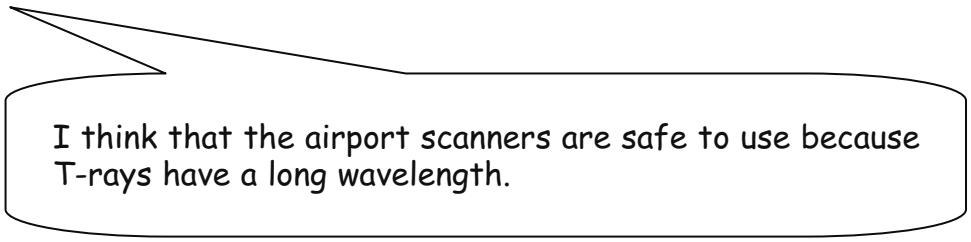
(3)

Frequency = ... Unit .....

(iii) The table shows data for some waves in the electromagnetic spectrum.

Type of wave	Radio waves	Microwaves	T-rays	Infrared waves
Typical wavelength	30 m	3×10^{-2} m	3×10^{-4} m	3×10^{-6} m

A student concludes:



Evaluate the student's conclusion.

(2)

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(Total for Question 6 = 8 marks)

7 Radioactive materials emit different types of ionising radiation.

(a) Complete this table for ionising radiations.

(3)

Type of radiation	Nature of radiation	Charge
alpha	two neutrons and two protons	
beta		negative
	an electromagnetic wave	zero

(b) A nucleus decays and emits an alpha particle.

State the result of this decay on the atomic (proton) number and mass (nucleon) number of the nucleus.

(2)

atomic (proton) number

.....

.....

mass (nucleon) number

.....

.....

(c) Describe how radioactivity can be used to estimate the age of archaeological discoveries such as wooden boats and animal bones.

(4)

(Total for Question 7 = 9 marks)

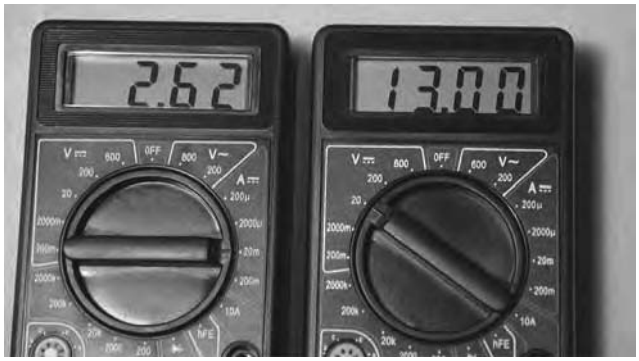
8 A student is investigating the relationship between voltage and current.

(a) State the equation linking voltage, current and resistance.

(1)

(b) The meters show the current in a resistor and the voltage across it.

Current in mA Voltage in V



(i) Complete this table by recording the readings shown on the meters.

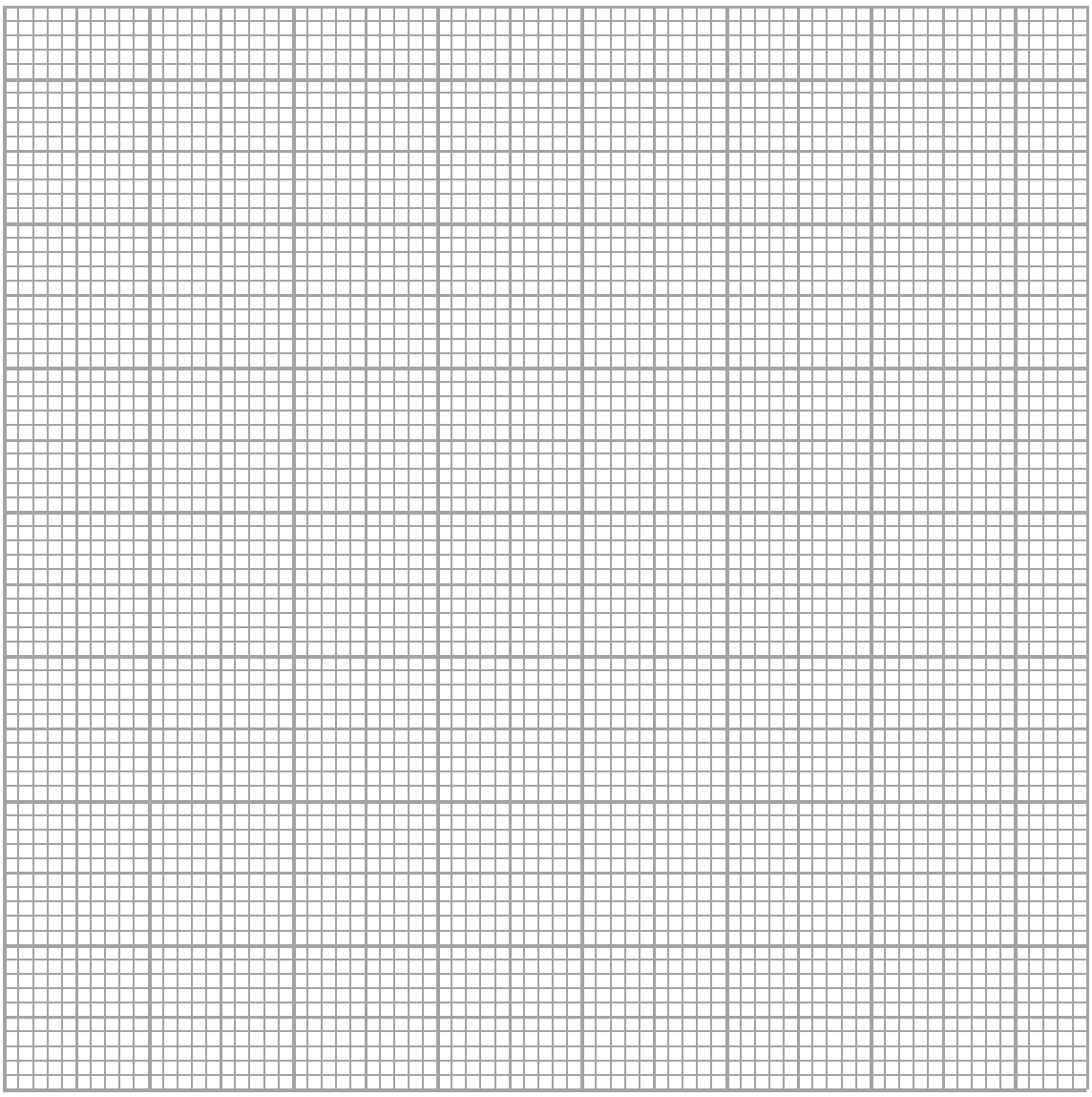
Give your values to an appropriate precision.

(1)

Current in mA	0.20	0.60	1.01	1.14	1.81	2.22	
Voltage in V	1.0	3.0	5.0	7.0	9.0	11.0	

(ii) Use the data in the table to draw a graph of current against voltage.

(5)



(iii) Circle the anomalous point on the graph.

(1)

(iv) How did you decide that this point was anomalous?

(1)

.....

.....

.....

(v) Use your graph, or the table, to find the resistance of the resistor that the student used.

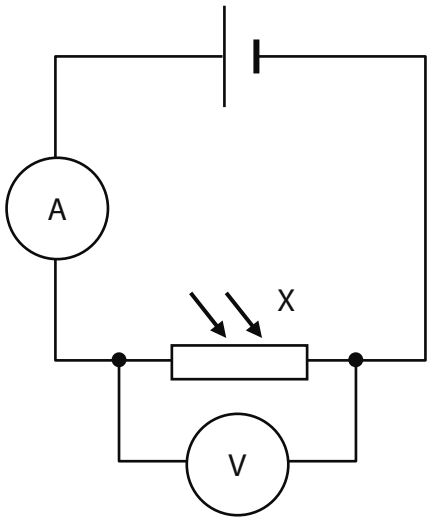
(2)

Resistance = ... Ω

(c) The student wants to investigate the effect of changing light intensity on a circuit.

The student sets up equipment outside in a garden for an experiment lasting 24 hours.

The student uses the circuit shown below.



(i) Give the name of the component labelled X.

(1)

.....

(ii) List the variables that the student should measure.

(2)

.....

.....

.....

(iii) Explain why the student might need help to take all the readings for this investigation.

(2)

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(iv) The graph below shows some results of the student's investigation.

Label both axes with appropriate quantities and units.

(2)

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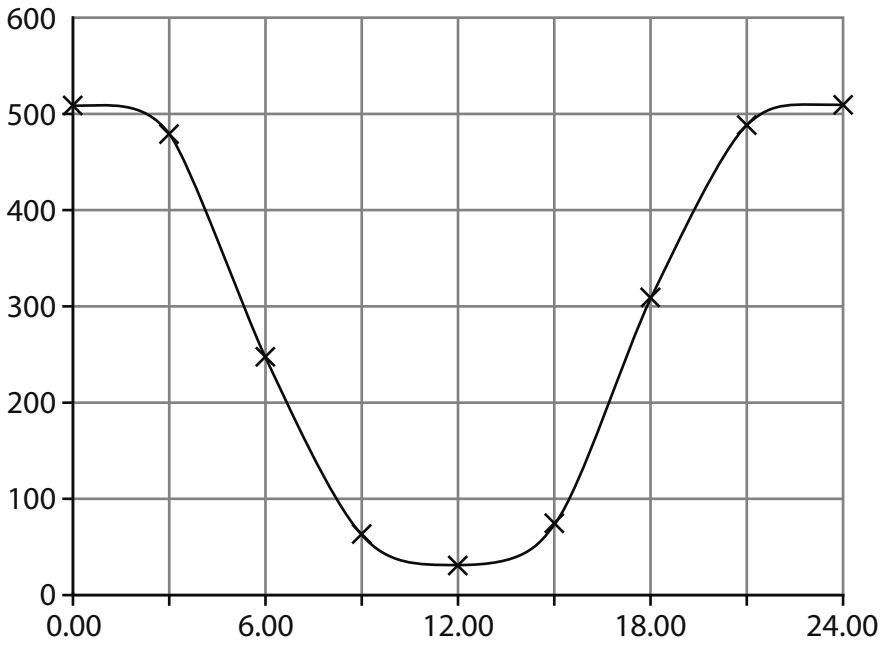
.....

.....

.....



.....

(Total for Question 8 = 18 marks)

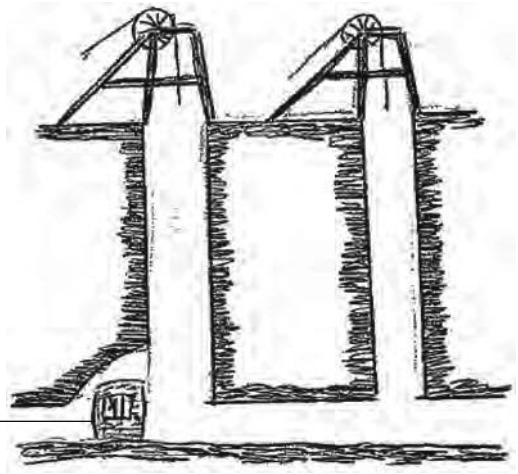
9 Energy can be transferred by radiation, conduction or convection.

(a) Compare the processes of transferring energy by conduction and transferring energy by convection.

(3)

(b) Convection was used in the past to ensure that miners who worked underground had a fresh air supply to breathe.

The diagram shows a mine. A fire has been lit in a furnace at the bottom of one shaft.

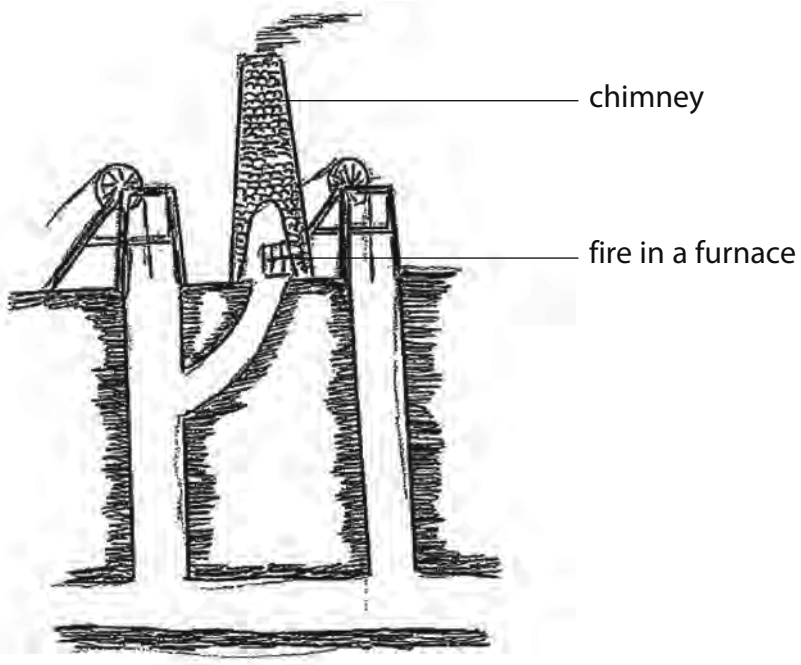


(i) Explain how lighting a fire in this way helped to keep a supply of fresh air moving through the mine.

You may draw on the diagram above to help illustrate your answer.

(3)

(ii) In an earlier system, the fire was lit at the surface of the mine.



This system was less effective at keeping fresh air moving through the mine.

Suggest why.

(2)

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(Total for Question 9 = 8 marks)

10 A student compares two electric lamps.

The lamps have the same brightness.

Type of lamp	filament lamp 	energy-saving lamp 
Electrical energy transferred in J/s	100	20
Useful light energy emitted in J/s	5	5

(a) Both lamps waste energy.

(i) How much energy does the filament lamp waste each second?

(1)

..... J

(ii) Describe what happens to the energy wasted by the filament lamp.

(2)

.....

.....

.....

.....

.....

(b) (i) Calculate the efficiency of the energy-saving lamp.

(2)

Efficiency = ...

(ii) Sketch a labelled Sankey diagram to show the energy transfers in the energy-saving lamp.

(3)

(c) The lamps in the student's house are connected in parallel.

State **two** benefits of connecting lamps in parallel.

(2)

1 .....

.....

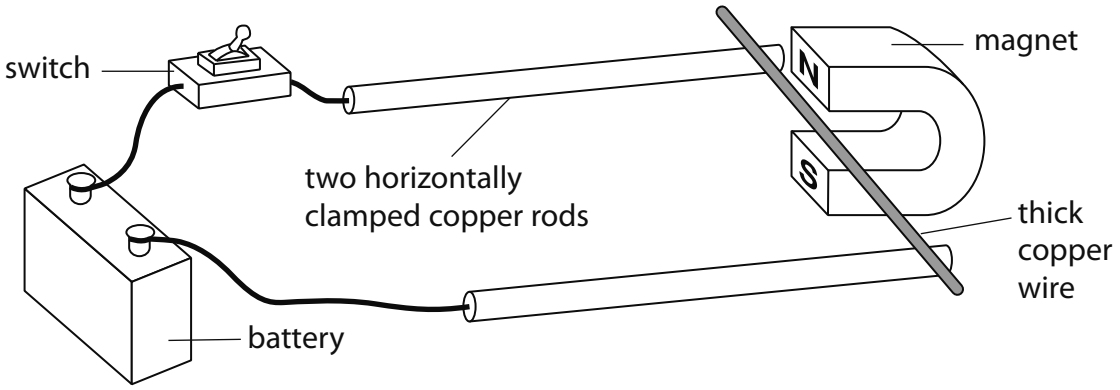
2 .....

.....

(Total for Question 10 = 10 marks)

11 A student investigates electromagnetic effects.

(a) Firstly, he tests this circuit.



When he presses the switch, the thick copper wire rolls along the clamped copper rods, away from the magnet.

(i) Explain why this happens.

(3)

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.....

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.....

(ii) On the diagram, draw an arrow to show the direction of the current in the circuit when the switch is pressed.

(1)

(iii) State **two** changes the student could make so that the copper wire moved away more quickly when he pressed the switch.

(2)

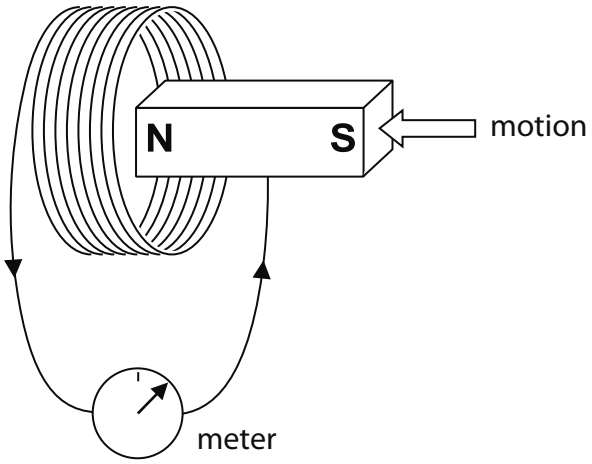
1 .....

.....

2 .....

.....

(b) The student investigates another effect using a coil of wire, a sensitive meter and a magnet.



When he moves the magnet towards the coil, the meter gives a reading to the right.

(i) What is the name of this effect?

(1)

.....

(ii) State **two** changes the student could make so that the meter gives a larger reading to the right.

(2)

1 .....

.....

2 .....

.....

(iii) How could the student make the meter give a reading to the left?

(1)

.....

.....

(Total for Question 11 = 10 marks)

12 The human eye contains liquid.

The liquid exerts a pressure on the inside of the eye.

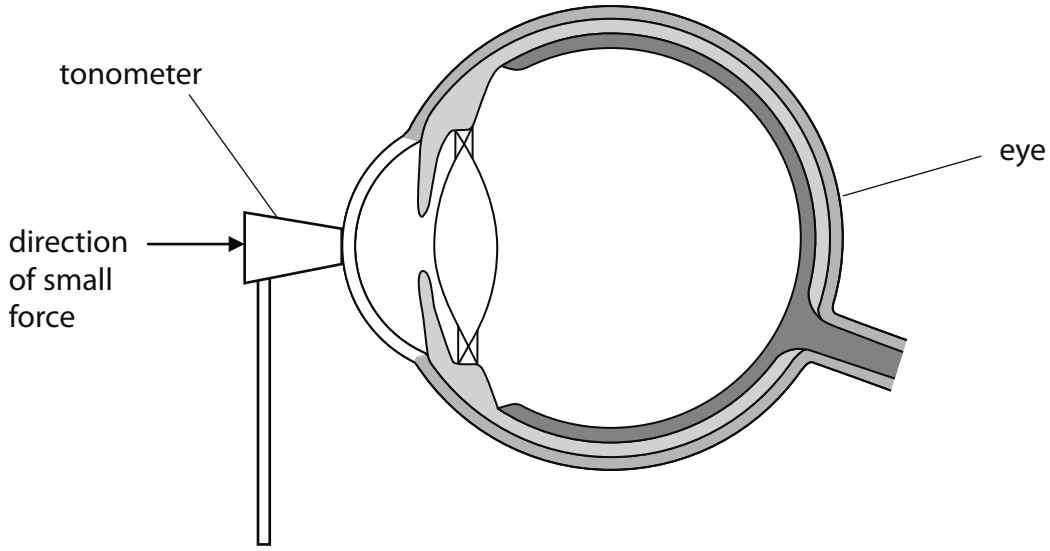
This pressure is higher than atmospheric pressure from the air on the outside of the eye.

(a) Explain, in terms of molecular motion, how the air exerts a pressure on the outside of the eye.

(4)

(b) A doctor uses a tonometer to measure the excess pressure (how much higher the pressure is than atmospheric pressure) of the liquid in the eye.

The tonometer pushes on the person's eye with a very small force.



The tonometer pushes on the eye with a force of 0.015 N.

The tonometer touches an area of 7.35×10^{-6} m^2.

Show that the pressure that the tonometer exerts is about 2 kPa.

(3)

(c) Doctors think that a healthy excess pressure in the eye is 'about 15 mm Hg'.

This equals the pressure difference produced by a 0.015 m column of mercury.

The density of mercury is 13 600 kg/m^3.

Explain whether or not the excess pressure of 2 kPa in part (b) is healthy for the eye.

Use a suitable calculation to support your answer.

(5)

(Total for Question 12 = 12 marks)

TOTAL FOR PAPER = 120 MARKS

Sample Mark Scheme

Paper 1P

Question number	Answer	Notes	Marks
1 (a) (i)	**C**		1
(ii)	**B**		1
(iii)	**B**		1
(iv)	**C**		1
(b)	both orbit Sun		1
(c)	shape of orbit	ACCEPT period of orbit	1
(d)	An explanation linking the following: • the comet travels faster when it is nearer the Sun / the comet is travelling at 2πr/T • (because) the gravitation attraction from the Sun is stronger when the comet is close / the force of gravity from the Sun is stronger when the comet is closer	ACCEPT a reasonable alternative	2
			Total: 8

Question number	Answer	Notes	Marks
2 (a)	An explanation linking **five** of the following: • check each mass on scales/balance • use a ruler marked in mm / smaller division • fix ruler in clamp (next to the spring), with the zero next to start of the spring • check the ruler is vertical with a suitable device eg set square • attach marker/pin to top/bottom of spring • measure at eye level to avoid parallax		max 5
(b)	wear eye protection (as there is a) risk of spring 'flying back' into face **OR** care against tipping over / clamp the stand (with a G clamp) (as there is a) risk of falling onto feet /sending spring flying **OR** protection on floor/desk / use as low a height as possible (as there is a) risk of damage to feet	Precaution must be relevant to the experiment Reason given must match the precaution	1
(c)	the force she needs is the <u>weight</u> of the masses and $W = mg$ **OR** convert mass to kg multiply by g	 REJECT "multiply by 10" unless it is clear that this is g	2
(d)	straight line through the origin		2
			Total: 10

Question number	Answer	Notes	Marks
3 (a)	Any **two** forces correctly shown on diagram from: • drag • gravity • upthrust	Each force arrow must be in the correct direction	max 2
(b) (i)	total distance (51 500) and total time (6800) seen 51500 ÷ 6800 = 7.57 (m/s)	 ACCEPT 7.6 (m/s)	2
(ii)	A description including **three** from: • starts with constant speed • slows down • speeds up again • correct ref to slope • correct ref to coordinates		max 3
			Total: 7

Question number	Answer	Notes	Marks
4 (a)	Any **two** of: • beware of frayed cable • beware of damaged plug • beware of water	ALLOW: turn socket off keep metal objects away from pins	max 2
(b)	d.c. – electrons/current motion only in one direction a.c. – electron/current motion reverses (regularly)		2
(c) (i)	A description including **two** from: • large current in earth wire / charge flows to earth • large current in fuse • fuse melts / blows / breaks circuit • stopping electrocution		max 2
(ii)	An explanation linking **two** of the following: • term <u>double insulation</u> (applied to plug, cable or appliance) • idea that insulation stops current / does not conduct • idea that electric shocks are currents • idea of a second insulation layer in case the first fails		max 2
(d)	statement of P = IV or 13 × 230 seen answer = 2990 unit (W or J/s)	 ACCEPT 2.99 kW / 3000 W / 3 kW Unit mark independent of answer	 3
			Total: 11

Question number	Answer	Notes	Marks
5 (a)	An explanation linking the following: • improves accuracy / reduces % uncertainty • (because) allows longer time measurement / reduces impact of reaction time		2
(b)	A description including: • method of measuring mass e.g. scales / balance • with **EITHER** idea of Σn **OR** idea of repeated readings		2
(c) (i)	GPE = m × g × h	if left blank, can credit correct statement of equation seen in (ii)	1
(ii)	substitution (0.00025 × 10 × 5) answer = 0.0125 (J)	ecf on equation in (i) ALLOW 1 mark if 0.25g used, giving 12.5J	2
(iii)	(transferred to) kinetic energy (of the seed) (transferred to) thermal (heat) energy in the surroundings	 ACCEPT sound	2
			Total: 9

Question number	Answer	Notes	Marks
6 (a) (i)	metal		1
(ii)	the human body		1
(b) (i)	$v = f \lambda$	if left blank, can credit correct statement of equation seen in (ii)	1
(ii)	rearrangement / substitution : $f = 3 \times 10^8 \div 3 \times 10^{-4}$ answer = 1×10^{12} unit = Hz / s^{-1}	ecf for omitted equation in (i) Unit mark independent of answer	3
(iii)	An explanation linking the following: <u>Disagreement with the conclusion:</u> • T-rays have shorter wavelength / higher frequency / more energy (than radio / microwave) or appropriate correct reference to wavelengths • (likely to) cause increase of named detrimental effect (e.g. skin burns) **OR** <u>Agreement with the conclusion:</u> • T-rays do not penetrate the human body • (because) T-rays are reflected / bounce off	NB there is no mark for stating agreement / disagreement with the conclusion	2
			Total: 8

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>7 (a)</td><td>
<table>
<tr><th>Type of radiation</th><th>Nature of radiation</th><th>Charge</th></tr>
<tr><td></td><td></td><td>positive</td></tr>
<tr><td></td><td>electron / e</td><td></td></tr>
<tr><td>gamma / γ</td><td></td><td></td></tr>
</table>
</td><td>ACCEPT +ve / 2+ / +2</td><td>3</td></tr>
<tr><td>(b)</td><td>atomic number: decreases by two

mass number: decreases by four</td><td></td><td>2</td></tr>
<tr><td>(c)</td><td>A description including any four from:
• (living things contain) carbon (14)
• C^{14} is a radioactive isotope / beta emitter
• (radio)activity decreases (over time)
• (estimate) half-lives (since material was alive)
• compare activity (of sample now with living tissue) / ratio of C^{14} to C^{12} is fixed in living material</td><td></td><td>max 4</td></tr>
<tr><td></td><td></td><td></td><td>Total: 9</td></tr>
</table>

Question number	Answer	Notes	Marks
8 (a)	voltage = current × resistance	ACCEPT V = IR or rearrangement	1
(b) (i)	2.62 and 13.0	NOT 13.00	1
(ii)	suitable scale chosen (>50% of grid used) ; line of best fit acceptable ; axes labelled with scales and units ; plotting to nearest half square (minus one for each error) ;;	 deduct 1 mark for each incorrect plot	1 1 1 2
(iii)	1.14, 7.0 identified / circled		1
(iv)	does not fit with the pattern of the others / well away from the line		1
(v)	conversion of reading from graph from mA to A answer = 4950 ± 50 (Ω)	4.95 (± 0.05) scores 2nd mark only 4.95 (± 0.05) **kΩ** scores both marks	 2

(c) (i)	light dependent resistor	ACCEPT LDR	1
(ii)	time voltage and current	ACCEPT "time of day" for time ACCEPT resistance	2
(iii)	An explanation linking **two** of the following: • difficulty in taking readings over long time • difficulty in taking two or more readings simultaneously • appropriate named simultaneous readings (e.g. time and resistance; voltage and current; time, voltage and current) • idea that second person / datalogger could assist with above		max 2
(iv)	resistance in ohms time in hours / time of day / clock time	both quantities but no units – 1 mark, both units but no quantities – 1 mark	2
			Total: 18

Question number	Answer	Notes	Marks
9 (a)	Any **three** from: CONDUCTION: • from particle to particle • by collision CONVECTION: • particles able to move • transfer the energy by their movement / kinetic energy		max 3
(b) (i)	A explanation linking the following: • heated air expands / becomes less dense • (therefore) rises (up the shaft) • (this) sets up convection current so fresh air moves down other shaft		3
(ii)	heated air only rises from surface air in shaft only 'drawn up', not rising itself **OR** convection currents are not set up as efficiently		2
			Total: 8

Question number	Answer	Notes	Marks
10 (a) (i)	95 (J)		1
(ii)	A description including **two** from: • converted / transformed • into thermal energy • dissipated to surroundings	ALLOW heat for thermal energy	max 2
(b) (i)	equation / substitution of values = 5 ÷ 20 answer = 0.25	 ALLOW 25 %	 2
(ii)	recognisable Sankey diagram widths of arrows in proportion at least 2 correct labels		 3
(c)	independent control failure of one allows others to continue working	Points in either order, and could be explained with a diagram ALLOW reverse arguments based on problems with series connection	 2
			Total: 10

Question number	Answer	Notes	Marks
11 (a) (i)	An explanation linking **three** of the following: • current in the (thick) copper wire • sets up a magnetic field (around it) • which interacts (OWTTE) with the field of the magnet • there is a force on the wire		max 3
(ii)	arrow indicating anticlockwise direction somewhere in or near the electric circuit		1
(iii)	Any **two** from: • higher current / higher voltage • lower resistance wires • stronger magnet	NOT bigger magnet	max 2
(b) (i)	electromagnetic induction	ALLOW generator effect	1
(ii)	Any **two** from: • stronger magnet • more turns (on coil) • move faster (towards coil) • lower resistance wire	NOT bigger magnet NOT more coils	max 2
(iii)	move magnet away from coil / turn the magnet round / reverse connections on the meter		1
			Total: 10

Question number	Answer	Notes	Marks
12 (a)	An explanation linking **four** of the following: • random motion (or air molecules) • (create(impact(s) on outside of eye • (particle's) momentum/direction changes • (therefore) force produced • on the area outside (the eye) • reference to pressure = force/area		max 4
(b)	equation (pressure = force ÷ area) / substitution = $0.015 \div 7.35 \times 10^{-6}$ answer = 2041 Pa conversion to 2 kPa		3
(c)	An explanation linking the following: • uses formula : P = hρg • conversion of 15mm into m i.e. 0.015 m • substitution : $0.015 \times 13600 \times 10$ • answer = 2040 Pa • appropriate comment about pressure being healthy	ACCEPT similar reverse argument: • uses formula : P = hρg • substitution : $2000 = h \times 13600 \times 10$ • answer : h = 0.0147 m • conversion of answer to mm i.e. 14.7 mm • appropriate comment about pressure being healthy	5
			Total: 12

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