INTEGRATED SCIENCE

1. PREAMBLE

This syllabus was evolved from the teaching syllabus for the Senior High School Integrated Science issued by the Ghana Education Service in September, 2010.

Integrated Science seeks to equip the individual with the integrated body of scientific knowledge and raise the level of scientific literacy of the individuals with comprehensive scientific skills that enable them to function in the present technological era. Education in science also provides opportunity for the development of positive attitudes and values.

2. AIMS AND OBJECTIVES OF THE SYLLABUS

This syllabus seeks to among other things, enable students to:

(1) acquire the skill to solve basic problems within their immediate environment through analysis and experimentation;

(2) keep a proper balance of the diversity of the living and non-living things based on their interconnectedness and repeated patterns of change;

(3) adopt sustainable habits for managing the natural environment for humankind and society;

(4) use appliances and gadgets effectively with clear understanding of their basic operations and underlying principles.

(5) explore, conserve and optimise the use of energy as an important resource for the living world;

(6) adopt a scientific way of life based on pragmatic observation and investigation of phenomena;

(7) search for solutions to problems of life recognizing the interaction of science, technology and other disciplines.

3. REQUIREMENTS

It is presumed that candidates taking the examination must have:

(1) carried out activities relating to rearing of at least one of the following groups of animals:
- (i) chickens/ducks/turkeys
- (ii) goats/sheep/cattle
- (iii) guinea pigs, rabbits

(2) paid visits to well established farms, and institutions related to agriculture, research or manufacturing to observe scientific work and application of science;

(3) kept practical notebooks on records of individual laboratory and field activities performed.

4. SCHEME OF EXAMINATION

There will be three papers, Papers 1, 2 and 3 all of which must be taken. Papers 1 and 2 will be a composite paper to be taken at one sitting.

PAPER 1: Will consist of fifty multiple-choice objective questions all of which must be answered within 1 hour for 50 marks.

PAPER 2: Will consist of six essay-type questions. Candidates will be required to answer four questions within 1 hour 30 minutes for 20 marks each.

PAPER 3: Will consist of four questions on test of practical work. Candidates will be required to answer all the questions within 2 hours for 60 marks.

5. DETAILED SYLLABUS

Questions will be asked on the topics set out in the column headed "CONTENTS". The "NOTES" are intended to indicate the scope of the questions but they are not to be as an exhaustive list of limitations and illustrations.

NOTE: The S.I units will be used for all calculations. However multiples or sub-multiples of the units may also be used.

CONTENTS	NOTES
A. DIVERSITY OF MATTER	
1. Introduction to Integrated Science	
1.1 Concept of Integrated Science	Explanation of Science as an interrelated body of knowledge. Carriers in science and technology.
1.2 The scientific Method	Identification of the problem. Hypothesis formulation. Experimentation. Data collection. Analysis and conclusion.
1.3 Safety precautions in the laboratory	Safety measures taken in the laboratory and reasons for them.

2. Measurement 2.1 Basic quantities, derived quantities and their units.	Basic quantities and units of scientific measurement: Length (m), Mass (kg),Time (s), Temperature (K), Current (A), Light intensity (cd), Amount of substance (mol).Derived quantities and their units: Volume (m^3), Density (kgm^{-3}), Velocity(ms^{-1}), Force (N), Work and Energy (J), Quantity of electricity (C), Electric resistance (&!), Potential difference (V), Power (W).
2.2 Measuring instruments	Identification and use of measuring instruments such as ruler, balances, stop watch, thermometer, measuring cylinder, callipers, hydrometer, pipette and burette to measure in various units. Necessity for measurement Sources of error
2.3 Measurement of density and relative density	Experiments to determine the density of equal volumes of water and salt solution. Comparison of densities of water and salt solution. Simple experiments of density of regular and irregular objects.
3. Diversity of living and non-living things	
3.1 Characteristics of living things	Differences between living and non-living things based on the life processes: movement, nutrition, growth, respiration, excretion, reproduction, irritability should be considered. Detailed treatment of the life processes NOT required. Explanation of biodiversity
3.2 Classification schemes of living and non-living things.	Importance of classification. Contribution of Aristotle, Linnaeus, and Mendeleev. Treatment to include the following levels or ranks: Living things-kingdom, division/ phylum, class, order, family, genus and species.

4. Matter 4.1 Particulate nature of matter	Elements- metals and non metals (1^{st} to 20^{th} elements in the periodic table). Atoms, molecules, ions, atomic structure.
4.2 Elements, compound and mixtures	Differences between elements, compounds and mixtures.
4.3 Ionic and covalent compounds	Ionic and covalent bond formation. Characteristic properties of ionic and covalent compounds. IUPAC names of common compounds.
4.4 Atomic number, mass number, isotopes and relative atomic mass of given elements	Relative atomic masses should be explained using the periodic table. Carbon-12 isotope should be mentioned as reference scale.
4.5 Mole, molar mass and formula mass	The mole as unit of the physical quantity; amount of substance. Mention should be made of Avogadro's number. Calculation of formula mass and molar mass using relative atomic masses. Calculation of amount of substance in moles given its mass.
4.6 Preparation of solutions	Preparation of standard solution of NaOH, HCl, NaCl and sugar. Dilution of standard solution.
5. Cells 5.1 Plant and animal cells	Structure and function of plant and animal cells. Drawing and labelling required.
5.2 Types of plant and animal cells (Specialised cells)	Red blood cell, nerve cell, leaf epidermal cell, sperm cell, leaf palisade cells, lymphocyte and phagocyte. Functions of cell organelles required.

6. Rocks 6.1 Types, formation and characteristics of rocks.	Formation of igneous, sedimentary and metamorphic rocks and their characteristics.
6.2 Weathering of rocks	Physical, biological and chemical weathering of rocks. Explanation of the effect of hydration, hydrolysis, carbonation and oxidation on rocks is required.
7. Acids, bases, and salts 7.1 Simple definition of acids, bases, salts	Definition of acids and bases in terms of Proton transfer (Bronsted- Lowry concept).
7.2 Physical and chemical properties of acids, bases and salts	Properties and uses of acids, bases and salts. Description of laboratory preparation of hydrogen, carbon dioxide and ammonia gases. Test for hydrogen, carbon dioxide and ammonia gases.
7.3 Examples of chemical substances classified as acids, bases or salts	Simple chemical tests to classify chemical substances as acids, bases, or salts.
7.4 Methods of preparation of salts	Preparation of salts using the following methods: neutralization, precipitation, acid + salt, and acid + metal.
7.5 Acid-base indicators	Description of the colours developed by phenolphthalein, litmus and methyl orange in dilute acids and dilute bases.
7.6 Determination of pH of a given solutions.	The nature and use of the universal indicator and pH metre. Determination of soil pH is required.
8. Soil conservation 8.1 Principles of soil and water conservation	Explanation of the concept of soil conservation. Description of activities to conserve soil water and maintain soil fertility; irrigation, mulching, addition of organic matter or crop rotation. Macro (major) nutrients; nitrogen (N),

8.2 Classification of soil nutrients	potassium (K), phosphorus (P), calcium (Ca), magnesium (Mg), sulphur (S). Micro (minor) nutrients: boron(B), zinc(Zn) molybdenum(Mo), manganese(Mn), copper(Cu), chlorine(Cl), iron(Fe).
8.3 Functions and deficiency symptoms of nutrients	Description of the deficiency symptoms of the following nutrients in plants: nitrogen, potassium, phosphorus, mangenese and iron.
8.4 Maintenance of soil fertility	Application of organic and inorganic manures/ fertilizers, crop rotation, cover cropping, liming, and green manuring.
8.5 Organic and inorganic fertilizers	Identification and classification of organic and inorganic fertilizers. Methods of applying fertilizers.
8.6 Depletion of soil resources	Factors which lead to the depletion of soil resources: erosion, overgrazing, poor farming methods, dumping of non-biodegradable waste on land, improper irrigation and drainage practices, surface mining and quarrying, deforestation, and excessive use of fertilizer.
9. Water 9.1 Physical and chemical properties of water	Experiments to determine/ demonstrate: (i) boiling point of water. (ii) the solvent action of water on a variety of substances. (iii) presence of dissolved substances (iv) polar nature of water. Uses of water.
9.2 Hardness and softness of water.	Advantages and disadvantages of hard and soft water. Causes of hardness of water (Ca^{++}, Mg^{++}, Fe^{++} ions). Softening hard water (addition of washing soda, ion exchange, boiling and distillation). Steps involved in the treatment of water

9.3 Treatment of water for public consumption	for public consumption.
10. Metals and non-metals 10.1 Classification of materials	Classification of materials into metals, semi-metals (metalloids), and non-metals. Physical properties of metals, semi-metals and non-metals under conductivity, luster, malleability, ductility, sonority, density, melting point and tensile strength.
10.2 Uses of metals, semi-metals and non-metals	Uses of the following elements: Al, Cu, Fe, Au, C, O_2, N_2. Application of semi-metals.
10.3 Alloys	Examples of alloys and their constituent elements (steel, bronze, brass).Uses of alloys. Advantages of alloys in manufacture of certain household items.
11. Exploitation of minerals	Exploitation of the following minerals in Ghana: Bauxite, diamond, gold, crude oil and kaolin. Negative impact of exploitation of minerals mentioned and how to minimize the effect.
12. Rusting 12.1 Process of rusting	Conditions necessary for rusting. Experiments to show that air and water are necessary for rusting. Experiments to show that salt, dilute acid, dilute base and heat affect the rate of rusting in iron.
12.2 Prevention of rusting	Methods of preventing rusting: oiling/ greasing, painting, galvanizing, tin-coating, electroplating, cathode protection and keeping the metal dry. Effectiveness of the various methods of preventing rusting. Items in the home that undergo rusting.
	Hydrocarbons (first four members in

13. Organic and inorganic compounds	each group), alkanols (methanol, ethanol, propanol), alkanoic acids (first two members), alkanoates (first two members), fats and oils. Functional groups, properties and uses of organic compounds.
13.1 Classification of chemicals as organic and inorganic	Differences between organic and inorganic compounds. Importance of organic chemistry in industrialization.
13.2 Neutralization and esterterification	Differences between neutralization and esterification. Equations representing neutralization and esterification reactions.
13.3 Petrochemicals	Sources, application and effects of petrochemicals on the environment. The refinery of crude oil. Uses of petrochemical such as plastics, pharmaceuticals and agrochemicals.
B. <u>CYCLES</u>	
1. Air movement 1.1 Land and sea breeze	Explanation of formation of land and sea breezes. Demonstration of convectional currents using smoke-box and heated water with crystals of $KMnO_4$.
1.2 Types of air masses and their movement	Trade winds: Easterlies and Westerlies. Description of the direction of movement of major air masses on the earth's surface.
1.3 Effect of moving air masses	Differences between air masses and storm. Effect of moving air masses: spread of pollutants and effect on climate. Precautions against effects of storms. Use of the future's wheel to trace effects of spread of pollutants by air masses required. Tornados, hurricanes, typhoons should be mentioned.

2. Nitrogen cycle 2.1 Importance	Drawing and description of the nitrogen cycle Importance of the nitrogen cycle to plants and animals.
3. Hydrological cycle 3.1 Distribution of earth's water	Location of earth's water (groundwater and surface water) and how much of it is available for human use. Percentage distribution of water on the earth's surface to be mentioned.
3.2 Hydrological cycle	Processes involved in the hydrological cycle using appropriate diagrams. Relevance of hydrological cycle to plants and animals.
3.3 Sources of water contamination	Main sources of water contamination: domestic waste, trade waste, industrial waste, radioactive waste, and 'special' waste such as waste from hospital.
3.4 Effects of water contamination	Water-washed, water-based and insect-based carrier diseases
3.5 Water conservation methods	Household water treatment, waste water treatment, safe water storage, modern and traditional rainwater harvesting systems.
4. Life cycles of pests and parasites 4.1 Types of pests and parasites	Distinguish between pests and parasites. Common pests of humans and farm animals (cockroach, housefly, tsetsefly, and mosquito) common endoparasites, tapeworm, liver fluke and round worm), common ectoparasites (tick, bed bug louse, flea, mite). Common pests and parasites of plants (rice and maize weevils, mistletoe, dodder and cassytha beetle and stem borers.
4.2 Life cycles of some pests and parasites of human, plants and farm animals	Life cycles of the following: an endoparasite (tape worm, and guinea worm), pest of humans [Anopheles mosquito] malaria parasite

	(*Plasmodium*), a crop pest (weevil). Control methods of the pests and parasites are required.
5. Crop production 5.1 General principles of crop production	Selection of appropriate varieties, site selection and land preparation, methods of propagation and planting methods, cultural practices, pest and disease control, harvesting, processing, storage and marketing.
5.2 Production of crops	Application of all crop production mentioned in 5.1 to produce a crop, harvest, generate new planting materials, keep records and market. Precautions against post harvest losses. Production should be limited to the following crops: vegetables (okro/lettuce/carrot); cereals (maize/millet); legumes (cowpea/groundnut); root crop (cassava); stem tuber (yam).
6. General principles of farm animal production: 6.1 Main activities involved in farm animal production	Selection of suitable breeds, choice of management system, breeding systems and care of the young, management practices including animal health care and feeding, finishing, processing and marketing of produce.
6.2 Ruminant production	Types of breeds and their characteristics, management practices, breeding systems, common pests and diseases and marketing of products. Production should be limited to cattle, goats and sheep.
6.3 Production of non-ruminant	Main activities outlined in 6.1 to produce a non-ruminant farm animal. Production limited to poultry, pigs and rabbits.

C. SYSTEMS	
1. Skeletal system 1.1 The mammalian skeleton	Major parts and functions of the mammalian skeleton. Axial skeleton: skull and vertebral column. Appendicular skeleton: limbs and the limb girdles. Types of joints. Detailed treatment of the individual bones not required.
2. Reproduction and growth in plants 2.1 Structure of flowers	Parts of a flower and variation in flower structure. Examination of complete flower and half flower with free parts. Bi-sexual flower (Flamboyant or Pride of Barbados or *Hibiscus sp*.). Uni-sexual flower with free parts (water melon, gourd and pawpaw). Drawing and labelling of complete and half flower required.
2.2 Pollination and fertilization	Processes of pollination and fertilization. Adaptations of flowers for pollination required. Formation of fruits and seeds.
2.3 Fruits	Classification of fruits into dry fruits and fleshy or succulent fruits.
2.4 Seeds	Seed structure: endospermous (monocotyledon) and non-endospermous (dicotyledon)seeds. Functions of parts of seeds.
2.5 Seeds and fruits dispersal	Structure of seeds/ fruits and how they are adapted to their mode of dispersal. Agents of dispersal. Explosive mechanism in fruits of Balsam and Pride of Barbados. Advantages and disadvantages of seed and fruit dispersal.
2.6 Seed germination	The process and conditions for germination. Types of germination: hypogeal and

2.7 Vegetative (Asexual) reproduction in plants	epigeal. Formation of new plants from corms, bulbs, setts, rhizomes, cuttings, stolons, runners. Distinction between budding and grafting. Importance of the methods of vegetative propagation.
3. Respiratory system	Explanation of respiration and how energy is released from food substances for living organisms. Importance of respiration to living organisms.
3.1 Aerobic and anaerobic respiration	Distinction between aerobic and anaerobic respiration.
3.2 Structure and functions of the respiratory system in mammals	Identification of the respiratory organs of the respiratory system. Functions of the trachea, lungs, ribs, intercostal muscles and diaphragm.
3.3 Inhalation and exhalation	Mechanisms of inhalation and exhalation.
3.4 Problems and disorders of the respiratory system	Lung cancer, asthma, tuberculosis, whooping cough and pneumonia. Prevention and control of these problems and disorders.
3.5 Exchange of respiratory gases in plants.	Description of how respiratory gases [oxygen and carbon (IV) oxide] are taken in and out of plants. Importance of cell (tissue) respiration. Glycolysis and Kreb's cycle NOT required.
4. Food and nutrition 4.1 Classes of food and food substances	Classes of food and food substance and their importance: carbohydrates, proteins, lipids, vitamins, mineral salts and water. Importance of balanced diet. Food test for starch protein and lipids.
4.2 Malnutrition	Explanation of malnutrition and its effects. Relationship between diet and certain diseases – night blindness, high blood

	pressure, diabetes, obesity, lactose intolerance, and Kwashiorkor. Importance of roughage.
4.3 Food fortification and enrichment	The essence of food fortification and enrichment. Determination of body mass index (BMI)
4.4 Health benefits of water	The importance of water to the human body.
5. Dentition, feeding and digestion in mammals	
5.1 Structure of different types of teeth in relation to their functions	Structure and functions of the teeth. Drawing and labelling of a vertical section of a typical tooth. Differences in dentition in humans and other mammals in relation to diet.
5.2 Care of teeth in humans	Proper ways of caring for the teeth to prevent dental problems.
5.3 Digestive system of human	Structure and functions of digestive systems in humans.
6. Transport: Diffusion, osmosis and plasmolysis.	Explanation of diffusion, osmosis, and plasmolysis. Simple experiments to demonstrate diffusion in air and in liquids; osmosis in living tissue and in non-living tissue. Examples of diffusion and osmosis in nature.
7. Excretory system	Explanation of excretion. Distinction between excretion and egestion.
7.1 Excretory organs	Excretory organs (lungs, skin, liver and kidney). Elimination of products from the body. Structure of the skin and the kidneys.
7.2 Disorders of urinary systems in humans	Bed wetting, urine retention, kidney stone prostate and their remedies.

8. Reproductive system and growth in mammals	
8.1 Mammalian reproductive system	Structure and function of male and female reproductive systems.
8.2 Male and female Circumcision	Advantages and disadvantages circumcision.
8.3 Fertilization, development of the zygote and birth in humans.	The process of fertilization, development of zygote (pregnancy) and birth. Formation of twins: identical, fraternal, and siamese. Details of cell division and anatomy of the embryo NOT required.
8.4 The process of birth and care for the young	The process of birth in mammals, including pre-natal, post-natal and parental care.
8.5 Problems associated with reproduction in humans	Causes and effects of miscarriage, ectopic pregnancy, infertility, impotence, fibroid, disease infections and ovarian cyst.
8.6 Sexually transmitted infections (STI's)	Types: HIV/ AIDS, gonorrhea, syphilis, candidiasis, herpes, chlamydia and their mode of transmission. Effects of STI's on the health and reproduction in humans.
8.7 Phases of growth and development	Physical and behavioural changes associated with each phase of human development: losing milk teeth and development of permanent teeth, increase in mass, height, development of secondary sexual characters, e.g. menstruation in girls (pre-menstrual syndrome in some women- accompanied by violent moods or depression), wet dreams in boys. Changes in old age should include menopause and its

	associated problems.
9. The circulatory system 9.1 The structure and functions of the circulatory system of humans	The flow of blood through the heart, the lungs and the body of humans. Functions of the heart, the veins and the arteries in the circulatory system . Detailed structure of cellular components of the blood vessels NOT required.
9.2 Composition and functions of blood	The structure of blood cells. Functions of blood and blood circulatory system.
9.3 Disorders associated with the blood and the blood circulatory system	High blood pressure, low blood pressure and hole-in- heart, leukemia, anaemia.
10. Nervous system 10.1 Structure and the function of nervous system	Parts of the brain and their functions: fore-brain (cerebrum), mid-brain (cerebellum), hind-brain (medulla oblongata). The spinal cord as part of the central nervous system. Details of electrical and chemical nature of impulse transmission not required.
10.2 Causes and effects of damage to the central nervous system	Accidents, diseases, drug abuse and depression.
10.3 Voluntary and involuntary actions	Distinction between voluntary and involuntary actions. Importance of reflex action. The reflex arc.
10.4 Endocrine system and its functions	Glands producing hormones, normal functions of hormones and its effects of overproduction and underproduction. The role of thyroxin, adrenaline, testosterone, oestrogen and insulin. Importance of iodated salt.

D. ENERGY	
1. Forms of energy and energy transformation	Illustrations with flow charts to show the following energy transformations: solar energy to chemical in photosynthesis, Chemical energy to electrical energy in voltaic cells, solar energy to electrical energy in solar cells, chemical energy in fossil fuel into thermal energy/ electrical energy, potential energy to kinetic energy in falling object, electrical energy to light energy in bulbs, chemical energy is released from glucose during cellular respiration.
1.1 Conservation of energy and efficiency of energy conversion	Explanation of the principle of conservation of energy. Demonstration of the principle of transformation by considering the transformation of potential energy to kinetic energy using a falling object. Explanation of efficiency using the expression: $E = \frac{\text{energy output}}{\text{energy input}} \times 100\%$
2. Solar energy 2.1 Uses of solar energy	The main applications of solar energy: generating electricity, drying materials and heating substances.
2.2 Application of solar energy	Practical activities to demonstrate the application of solar energy to: dry clothes, heat water for bathing, dry crops for preservation, cook (boil an egg). Advantages of solar energy over the use of fossil fuels as source of energy.
3. Photosynthesis 3.1 The process of photosynthesis	Conditions of photosynthesis: light, chlorophyll, carbon dioxide and water. Experiments to show the necessity of light, chlorophyll and carbon dioxide for photosynthesis.
3.2 Conversion of light energy to chemical	Equations to show how light energy is trapped during the process of photosynthesis and converted to glucose.

energy	Test for starch in food and leaf.
4. Electronics 4.1 Claasification of solid materials into conductors, semiconductors and insulators	Classify solid materials into conductors, semiconductors and insulators. P-type and N-type semiconductors. Behaviour of P.N junction diode in a d.c and a.c electronic circuit. Explanation of rectification.
4.2 Behaviour of discrete electronic components	A simple electronic circuit comprising a.c and d.c. source, a resistor and a Light Emitting Diode (*LED*) in series. Behaviour of the *LED* when: the switch is closed, switch is opened, resistor is replaced with capacitor, capacitor is replaced with inductor or coil. Repetition of experiment by replacing the d.c. source wih an a.c. source.
4.3 Transistor and its uses	Observe an NPN or PNP Transistor and identify the emitter, the base and the collector. The use of transistor as a switch. Behaviourof *NPN* transistor in circuit with the base at the junction of two resisitors,its collector at the battery and an *LED* connected to the emitter.
4.4 Amplifer	Application of transistor as an amplifier.
5. Electrical energy 5.1 Nature and source of static and current electricity	Explanation of the formation of lighting based on electrostatics. Protection of buildings and installations with lightning arrestors. Sources of static and current electricity. Difference between a.c and d.c and their limitations.
5.2 Electric circuits	Drawing of electric circuit and the functions of each component. Advantages and disadvantages of the components ofcircuit in series and parallel.

5.3 Resistance(R), current (I), potential difference (V), and power (P).	Simple calculation of resistance, current, potential difference using the Ohm's law. Simple calculation for electric power. Importance of power ratings and power rationing. Efficient use of electric appliances.
5.4 Electric power generation	Sources of electric power generation: Hydro, thermal, nuclear, solar, wind, tidal and biogas. Basic principles underlying the production of electricity e.g. relative motion between a coil and a magnet.
5.5 Power transmission	The gadgets and processes involved in the transmission of power: step-up and step-down transformers, wiring a plug, household wiring, stabilizers, fuses and earthing.
6. Sound energy 6.1 Sources of sound	Production of sound from different instruments(pipes, rods or strings and percussions). Nature of sound: velocity, reflection and refraction. Differences in velocity of sound in different media (gas, liquid, solid, and vacuum). Formation of echoes. Determination of the velocity of sound is NOT required.
6.2 Musical notes and noise	Classification of different sounds as noise or musical notes (Distinction between musical notes and noise). Explanation of pitch, loudness and quality of musical notes.
6.3 The human ear	Identification of parts of the human ear and description of their functions. The importance of ear muffs.
7. Light energy 7.1 Reflection and refraction of	Explanation of reflection and refraction of light. Characteristics of images formed

light	by plane mirror.
7.2 The mammalian eye	Structure and functions of the parts of the mammalian eye. Eye defects, causes and their correction using the appropriate lenses.
7.3 Dispersion of light	Explanation of dispersion of light. Formation of rainbow.
7.4 Primary and secondary colours	Distinction between primary (red, green, blue) and secondary (yellow, violet, indigo, orange) colours. Demonstration of the behaviour of objects under different coloured lights.
7.5 Electromagnetic spectrum	Explanation of electromagnetic spectrum. Application of each component in the spectrum. Calculation and detailed treatment NOT required.
8. Heat energy 8.1 Nature and sources of heat energy	Explanation of why heat is a form of energy. Sources of heat energy.
8.2 Modes of heat transfer	Demonstration of the rate of flow of heat in a metal bar of different materials. Applications of conduction, convection, and radiation (e.g. vacuum flask and ventilation).
8.3 Temperature	Definition of temperature. Concept of thermal equilibrium between bodies. Units: degree Celsius(^{o}C) and kelvin(K) in which temperature is expressed. Fahrenheit should be mentioned. Uses and limitations of different types of thermometers e.g. liquid-in-glass (alcohol and mercury), gas, resistance thermometers. Advantages and disadvantages of mercury and alcohol as thermometric liquids. Clinical thermometer. Thermostat and how it works. The ball and ring experiment to show

8.4 Thermal expansion	that a body expands when heated. Applications of expansion e.g. thermostats, sagging of electric cable, bursting of inflated hot lorry tyres.
8.5 Change of state of matter	Explanation of how heat causes change of state of matter. Latent heat. Distinction between latent heat of fusion and latent heat of vaporization. Evaporation; Application of principles of evaporation in heat reduction e.g. regulation of body temperature by the skin, and cooling of water in local clay water pots.
9. Nuclear energy 9.1 Radioactivity	Causes of nuclear instability and how they emit radiation to become stable. Types of radiation (alpha and beta particles, and gamma rays).
9.2 Radioisotopes	The nature, production and use of radioisotopes: food preservation, sterilization of equipment, treatment of diseases, pest control and crop improvement.
9.3 Uses of nuclear energy	Uses of nuclear energy e.g. in the production of electricity.
9.4 Protection from the effects of radioactivity	Harmful effects of radioactivity and how to protect people from the effects e.g. atomic bombs.
9.5 Nuclear waste disposal	Problems associated with the disposal of nuclear waste.
E. <u>INTERACTIONS OF MATTER</u>	
1. Ecosystem 1.1 Basic ecological terms	Explanation of ecological terms: ecosystem, species, population, ecology, ecosphere and community.
1.2 Types of ecosystem and their components	Natural ecosystem: fresh water, marine, estuarine, lake, rainforest, savanna and

	desert. Artificial ecosystem: farmland,man-made lake, roads. Components of ecosystem: biotic/ living (plants and animals) and abiotic/ non-living(soil, air, and water). Effects of the components on each other. Ecological factors: biotic (predation and competition) and abiotic (climatic factors, salinity, altitude and slope of land) Appropriateness of instruments used to measure abiotic factors.
1.3 Food chain and food web	Explanation of food chain and food web. Identification of components of food chain and food web: producers (green plants), primary consumers (herbivores), secondary consumers (carnivores). Decomposers should be mentioned.
2. Atmosphere and climate change 2.1 Regions of atmosphere	Layers of the atmosphere: troposphere, stratosphere, mesosphere, and thermosphere. Description of the characteristics of each layer in terms of thickness, temperature, air quality and composition, pressure and support for human activities.
2.2 Human activities and their effects on the atmosphere	Effects of human activities on the atmosphere: air transport, defence, industrialization and agriculture.
2.3 Atmospheric pollutants	Sources and effects of the following major pollutants: oxides of lead, nitrogen and sulphur; ozone, halons (carbon and halogen compounds).
2.4 Green house effect	Explanation of 'greenhouse' and its effect: Global warming and climate change. Possible factors to address the problem of global warming. Greenhouse gases e.g. carbon (IV)oxide and methane.
2.5 Ozone layer	Ozone layer and how it protects living organisms. Causes and effects of the

	depletion of the ozone layer. Sources and effects of CFCs on the ozone layer.
2.6 Acid rain	Identification of acidic pollutants which cause acid rain. The effects of acid rain on the environment (damage to buildings, paints forests etc).
3. Infection and diseases 3.1 Causes of Diseases	Pathogenic: bacteria, virus, fungi, protozoa and rickettsia. Non-pathogenic: nutritional, genetic, stress conditions, and poor sanitation.
3.2 Common diseases	Modes of transmission, symptoms, methods of prevention and control of common diseases (air borne, water related, insect borne, food contaminated, nutrition, sexually transmitted, communicable, zoonotic diseases).
4. Magnetism 4.1 Magnetic and non-magnetic materials	Classification of various kinds of materials as magnetic and non-magnetic. Permanent and temporary magnets. The use of magnetism the following gadgets: telephone earpiece, loud speakers, microphones, magnetic compass, generation of electricity, fridge doors, etc.
4.2 Magnetic field	Explanation of magnetic field. Demonstration of magnetic fields around a bar magnet using compressor or iron fillings.
4.3 Magnetization and demagnetization	Processes of magnetization and demagnetization. The production and use of electromagnets. Complete demagnetization of permanent magnet.
5. Force, motion, and pressure 5.1 Force	Explanation of the various types of forces: frictional, viscous, gravitational, weight, electrostatic, magnetic, upthrust, tension and push / pull.

5.2 Archimedes Principle and law of flotation	Explanation of the Archimedes Principle and law of flotation. Explanation of the following phenomena: the flight of birds and flotation of boats.
5.3 Distance, displacement, speed, velocity, momentum, acceleration	Definition of the terms: distance, displacement, speed, velocity, acceleration, and momentum. Simple calculations required
5.4 Stability of objects	Explanation of centre of gravity. Determination of centre of gravity of rectangular, triangular, and irregular shaped cardboards using the knife edge. Types of equilibrium: stable, unstable, neutral equilibrium. Stability based on the following activities: Demonstration of the three types of stability using a cone on a flat surface. Effect of loading a vehicle on the top carrier or on the base carrier on the stability of the vehicle.
5.5 Pressure	Definition of pressure. Effects of pressure in solids, in liquids and in gases (use of bicycle pump, hydraulics, siphons and water pumps).
6. Safety in the community	
6.1 Safe use of appliances in the home	Proper use and handling of household appliances to prevent accidents at home: avoidance of overloading of electric sockets, extreme care in using the heating coil in metal/ plastic containers, use of gloves. Precautionary measures in preventing accidents in the home.
6.2 First aid methods	Demonstration of the following using models: mouth-to-mouth resuscitation method, methods of extinguishing different fires, treatment of burns, cuts and electric shocks.
6.3 Hazardous substances	Possible hazards that can occur in working environment e.g. dust, fumes,

6.4 Common hazards in the community	toxic substance, corrosive substances, fire, food contamination, harmful radiation (X-rays), poisonous substances from heated or frozen plastics. Effects of hazardous substances on human body, e.g. blindness, burns, nausea, vomiting, and allergies. Appraisal of the adequacy of the various hazards, warning labels on containers and other places. Techniques involved in preventing fire due to electrical and chemical causes, and bush fires. Community hazards: diseases, pests and parasites outbreak, insanitary conditions, traffic problems in towns and cities, pollution problems and waste generation.
6.5 Roles of health service organizations: (WHO, FAO, UNICEF, Foods and Drugs Board Ghana Health Service, Red Cross, Red Crescent, EPA, Ghana Standards Board, UNPFA, Blue Cross)	Functions of health organizations such as public health and sanitation, public health education, proper siting of refuse dumps, provision of waste disposal facilities, and provision of public toilets. Factors that promote public health. Importance of proper sanitation in diseases control. Efficient town planning and village planning systems, places of garbage disposal, good clean roads and street connections.
7. Variation and inheritance 7.1 Chromosomes and genes	Chromosomes as bearers of genes/ hereditary materials and recessive and dominant characters; genotype and phenotype. Inheritance of a single pair of contrasting characters e.g height (tallness and shortness) to second filial generation. Simple treatment of Mendel's first law of inheritance. Application of the sequence of inheritance with respect to cloning of stem cells. DNA Test. Heritable and non-heritable characteristics in human.

7.2 Variation	Explanation of variation. Causes and consequences of variation: Mutation should be mentioned as one of the causes of variation e.g. resistance of some organisms to drugs or chemicals, albinism in humans.
7.3 Sex determination and sex-linked characters	Explanation of sex determination at fertilization. Effects of sex preference on family relationship. Sex- linked characters.
7.4 Blood groups and Rhesus factor	Types of blood groups and Rhesus factor and their importance for marriage, blood transfusion and paternity test. Inheritance of blood groups and Rhesus factor. Problems in marriage due to incompatibility Rh-factor and how to avoid these problems.
7.5 Sickle cell gene and Sickle cell anaemia	Inheritance of sickle cell gene. Acquisition of sickle cell anaemia. Management of sickle cell anaemia.
8. Work and machines 8.1 Work, energy and power	Definition of work, energy and power. Simple calculations required.
8.2 Simple machines	Identification of simple machines such as levers, pulleys, wheels, and axle and inclined planes. Classes of levers should be mentioned. Explanation of mechanical advantage, velocity ratio and efficiency of machines. Simple calculations required.
8.3 Friction	Definition of friction, effects of friction and methods of reducing friction. Advantages and disadvantages of friction.
9. Endogenous technology	Explanation of endogenous technology. Effects of modern technology on the development of endogenous technolog.

		Inter-dependence of science and technology. Distinction between science and technology. Significance of science and technology to the development of society.
	9.1 Small scale industries	Small scale industries: raw materials and equipment. Scientific principles underlying the following small scale industries: soap production, salt making, palm oil production, bread making, and yogurt production.
	10. Biotechnology	Explanation of biotechnology. Examples of industries based on biotechnology.
10.1	Genetic engineering	Explanation of genetic engineering. Application in medicine, agriculture, food processing.
	10.2 Tissue culture	Explanation of tissue culture. Importance of tissue culture in agriculture.