Name:

BTEC Level 3 National Extended Certificate in Applied Science TRANSITION WORK

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# Course Overview

## Course Structure

Your course is broken down into 4 units:

* Unit 1: Principles and Applications of Science 1
* Unit 2: Practical Scientific Procedures and Techniques
* Unit 3: Science Investigation Skills
* Unit 10: Biological Molecules and Metabolic Pathways

These units are a mixture of internal and external assessment.

## How are you assessed?

Unit 1: Principles and Applications of Science

This unit is equally divided into biology, chemistry and physics, and works to give a foundation for the rest of the course content. Students are required to sit 3 external 40 minute written exams which are worth 90 marks total; the exams are split into three equal 30 mark sections (Biology, Chemistry and Physics). The exams will include a range of question types including multiple choice, calculation, short answer and open response.

Unit 2: Practical Scientific Procedures and Techniques Level

This is internally assessed and students will be introduced to quantitative laboratory techniques, calibration, chromatography, calorimetry and laboratory safety, which are relevant to the chemical and life science industries.

Unit 3: Science Investigation Skills

This unit focuses exclusively on laboratory skills applied to specific scientific procedure. At the end of the unit, students are set a two-part task (set externally), where they have to complete an experiment under timed conditions, and then complete a written task based on their findings along with further detailed analysis. The task aims to test the student's ability to plan, record, process, analyse and evaluate scientific findings.

Unit 10: Biological Molecules and Metabolic Pathways

This is an internally assessed unit comprising three assignments, looking at the makeup of biological molecules such as proteins and nucleic acids, and applying this knowledge to the key processes of respiration and photosynthesis.

## Resources

You will need (minimum) the following things to complete this course:

* A folder with at least 4 sections (one for each unit).
* A scientific calculator
* The textbook (available on ParentPay from September- see details below)
* Access to a computer (available in the sixth form centre)

The textbook for this course is available through ParentPay at the start of the year. There are also revision guides and workbooks available which we recommend you purchase however are not a requirement for the course.

* REQUIRED: BTEC Applied Science Textbook Student Book 1 **ISBN**: 9781292134093
* Revise BTEC National Applied Science Revision Guide **ISBN**: 9781292150048
* Revise BTEC National Applied Science Revision Workbook **ISBN**: 9781292150031


# Essential Content

As the course consists of biology, chemistry and physics, below are a series of checklists for each unit for you to complete based on your GCSE knowledge which will help you to see what you are aiming for and what you already know. After these are a series of exam style questions to get you thinking ready for the course.

## Unit 1: Principles and Applications of Science

|  |
| --- |
| **Chemistry: Periodicity and properties of elements** |
| **A1 Structure and bonding in applications in science** |
| **Understand the electronic structure of atoms:** | **R** | **A** | **G** |
| o electronic orbitals |  |  |  |
| o Aufbau principle |  |  |  |
| o Bohr theory. |  |  |  |
| **Understand ionic bonding:** | **R** | **A** | **G** |
| o strong electrostatic attraction between oppositely charged ions |  |  |  |
| o effects ionic radius and ionic charge have on the strength of ionic bonding |  |  |  |
| o formation of ions in terms of electron loss or gain |  |  |  |
| o electronic configuration diagrams of cations and anions. |  |  |  |
| **Understand covalent bonding:** | **R** | **A** | **G** |
| o strong electrostatic attraction between two nuclei and the shared pair(s) of electrons between them |  |  |  |
| o dot and cross diagrams to show electrons in simple covalent molecules, including those with multiple bonds and dative covalent (coordinate) bonds |  |  |  |
| o the relationship between bond lengths and bond strengths in covalent bonds |  |  |  |
| o tetrahedral basis of organic chemistry. |  |  |  |
| **Understand metallic bonding:** | **R** | **A** | **G** |
| o de-localised electrons |  |  |  |
| o positive metal ions |  |  |  |
| o regular layer structure. |  |  |  |
| **Understand the following intermolecular forces:** | **R** | **A** | **G** |
| o van der Waals |  |  |  |
| o dipole-dipole |  |  |  |
| o hydrogen bonding. |  |  |  |
| **Understand the following:** | **R** | **A** | **G** |
| o balanced equations |  |  |  |
| o relative atomic mass |  |  |  |
| o atomic number and relative molecular mass |  |  |  |
| o moles, molar masses and molarities. |  |  |  |
| **Understand the quantities used in chemical reactions:** | **R** | **A** | **G** |
| o mass, volume of solution, concentration |  |  |  |
| o reacting quantities |  |  |  |
| o percentage yields. |  |  |  |
| **A2 Production and uses of substances in relation to properties** |
| **Understand the periodic table:** | **R** | **A** | **G** |
| o Periods 1, 2, 3 and 4 |  |  |  |
| o groups – s block, p block, d block |  |  |  |
| o layout of periodic table in relation to s, p, d notation |  |  |  |
| o electronic arrangement of elements using s, p, d notation. |  |  |  |
| **Understand the physical properties of elements:** | **R** | **A** | **G** |
| o first ionisation energy |  |  |  |
| o reasons for trends in ionisation energy across Periods 2–4 and down groups 1, 2 and 7 |  |  |  |
| o electron affinity |  |  |  |
| o atomic radius |  |  |  |
| o ionic radius |  |  |  |
| o electronegativity |  |  |  |
| o type of bonding in the element |  |  |  |
| o trends – melting point and boiling point |  |  |  |
| o physical properties of metals – electrical conductivity, thermal conductivity, malleability, ductility. |  |  |  |
| **Understand the chemical properties of elements:** | **R** | **A** | **G** |
| o products and reactivity of all Period 2 and 3 elements with oxygen |  |  |  |
| o products and reactivity of metals with oxygen, water, dilute hydrochloric acid and dilute sulfuric acid |  |  |  |
| o position of metals in the reactivity series in relation to position in the periodic table |  |  |  |
| o oxidation |  |  |  |
| o reduction |  |  |  |
| o variable oxidation states of transition metal ions |  |  |  |
| o displacement reactions of metals/halogens |  |  |  |
| o uses and applications of substances produced within this learning aim. |  |  |  |
| **Biology: Structure and functions of cells and tissues** |
| **B1 Cell structure and function**  | **R** | **A** | **G** |
| Know that cell theory is a unifying concept stating that cells are a fundamental unit of structure, function and organisation in all living organisms. |  |  |  |
| **Understand the ultrastructure and function of organelles in the following cells:**  | **R** | **A** | **G** |
| o prokaryote cells (bacterial cell) – nucleoid, plasmids, 70S ribosomes, capsule, cell wall |  |  |  |
| o eukaryotic cells (plant and animal cells) – plasma membrane, cytoplasm, nucleus, nucleolus, endoplasmic reticulum (smooth and rough), Golgi apparatus, vesicles, lysosomes, 80S ribosomes, mitochondria, centriole |  |  |  |
| o eukaryotic cells (plant-cell specific) – cell wall, chloroplasts, vacuole, tonoplast, amyloplasts, plasmodesmata, pits. |  |  |  |
| Recognise cell organelles from electron micrographs and the use of light microscopes. |  |  |  |
| Understand the similarities and differences between plant and animal cell structure and function. |  |  |  |
| Understand how to distinguish between gram-positive and gram-negative bacterial cell walls and why each type reacts differently to some antibiotics. |  |  |  |
| Calculate magnification and size of cells and organelles from drawings or images. |  |  |  |
| **B2 Cell specialisation** |
| **Understand cell specialisation in terms of structure and function, to include:** | **R** | **A** | **G** |
| • palisade mesophyll cells in a leaf |  |  |  |
| • sperm and egg cells in reproduction |  |  |  |
| • root hair cells in plants |  |  |  |
| • white blood cells |  |  |  |
| • red blood cells. |  |  |  |
| **B3 Tissue structure and function** |  |  |  |
| **Understand the structure and function of epithelial tissue, to include:** | **R** | **A** | **G** |
| o squamous as illustrated by the role of alveolar epithelium in gas exchange to include the effect of chronic obstructive pulmonary disease (COPD) in smokers |  |  |  |
| o columnar as illustrated by goblet cells and ciliated cells in the lungs to include their role in protecting lungs from pathogens. |  |  |  |
| Understand the structure and function of endothelial tissue, as illustrated by blood vessels in the cardiovascular system, including the risk factors that damage endothelial cells and affect the development of atherosclerosis. |  |  |  |
| **Understand the structure and function of muscular tissue, to include:** | **R** | **A** | **G** |
| o the microscopic structure of a skeletal muscle fibre |  |  |  |
| o structural and physiological differences between fast- and slow-twitch muscle fibres and their relevance in sport. |  |  |  |
| **Understand the structure and function of nervous tissue, to include:** | **R** | **A** | **G** |
| o non-myelinated and myelinated neurones |  |  |  |
| o the conduction of a nerve impulse (action potential) along an axon, including changes in membrane permeability to sodium and potassium ions and the role of the myelination in saltatory conduction |  |  |  |
| o interpretation of graphical displays of a nerve impulse and electroencephalogram (ECG) recordings |  |  |  |
| o synaptic structure and the role of neurotransmitters, including acetylcholine |  |  |  |
| o how imbalances in certain, naturally occurring brain chemicals can contribute to ill health, including dopamine in Parkinson’s disease and serotonin in depression |  |  |  |
| o the effects of drugs on synaptic transmission, including the use of L-Dopa in the treatment of Parkinson’s disease. |  |  |  |
| **Physics: Waves in communication** |
| **C1 Working with waves** |
| **Understand the features common to all waves and use the following terms as applied to waves:** | **R** | **A** | **G** |
| o periodic time |  |  |  |
| o speed |  |  |  |
| o wavelength |  |  |  |
| o frequency |  |  |  |
| o amplitude |  |  |  |
| o oscillation. |  |  |  |
| Graphical representation of wave features. |  |  |  |
| **Understand the difference between the two main types of wave:** | **R** | **A** | **G** |
| o transverse |  |  |  |
| o longitudinal. |  |  |  |
| Understand concepts of displacement, coherence, path difference, phase difference, superposition as applied to diffraction gratings. |  |  |  |
| **Understand the industrial application of diffraction gratings, to include:** | **R** | **A** | **G** |
| o emission spectra |  |  |  |
| o identifying gases. |  |  |  |
| Be able to use the wave equation: v = f λ |  |  |  |
| Understand the concept and applications of stationary waves resonance. |  |  |  |
| o Musical instruments. |  |  |  |
| Be able to use the equation: calculation of speed v = √(T/µ) |  |  |  |
| **C2 Waves in communication** |
| **Understand the principles of fibre optics:** | **R** | **A** | **G** |
| o refractive index sin n = (c/v) = (sin i/ sinr) |  |  |  |
| o total internal reflection |  |  |  |
| o calculation of critical angles at a glass–air interface: sin c = 1/n |  |  |  |
| Understand the applications of fibre optics in medicine to include endoscopes. |  |  |  |
| **Understand the applications of fibre optics in communication, to include:** | **R** | **A** | **G** |
| o analogue and digital signals: analogue-to-digital conversion, broadband. |  |  |  |
| **C3 Use of electromagnetic waves in communication** | **R** | **A** | **G** |
| Understand that all electromagnetic waves travel with the same speed in a vacuum. |  |  |  |
| Be able to use the inverse square law in relation to the intensity of a wave: I = (k/r^2) |  |  |  |
| Understand how the regions of the electromagnetic spectrum are grouped according to the frequency. |  |  |  |
| **Understand how the applications of electromagnetic waves in communications are related to frequency, including:** | **R** | **A** | **G** |
| o satellite communication |  |  |  |
| o mobile phones |  |  |  |
| o Bluetooth® |  |  |  |
| o infrared |  |  |  |
| o Wi-Fi. |  |  |  |

## Unit 2: Practical Scientific Procedures and Techniques Level

|  |
| --- |
| **Learning aim A: Undertake titration and colorimetry to determine the concentration of solutions** |
| **A1 Laboratory equipment and its calibration** | **R** | **A** | **G** |
| Equipment and glassware used in titration and colorimetry and the importance and processes involved in calibration of measuring equipment. |   |   |   |
| **Use of pH meters and probes:** |   |   |   |
| o calibration according to the manufacturer’s instructions. |   |   |   |
| **Use of balances and weighing:** |   |   |   |
| o electronic balances – rough balances (two decimal places), analytical balances (four decimal places) |   |   |   |
| o checking calibration with certified weights |   |   |   |
| o measurement of mass using increasingly accurate balances |   |   |   |
| o suitable containers for weighing liquids and solids |   |   |   |
| o density of water at different temperatures. |   |   |   |
| **Safe use of volumetric glassware:** |   |   |   |
| o bulb, graduated, automated and teat pipettes |   |   |   |
| o burettes |   |   |   |
| o glass and plastic filter funnels |   |   |   |
| o volumetric flasks |   |   |   |
| o accurate dilution |   |   |   |
| o use of water as a standard for calibrating volumetric glassware. |   |   |   |
| **A2 Preparation and standardisation of solutions using titration** | **R** | **A** | **G** |
| Processes involved in the preparation and standardisation of solutions using titration. |   |   |   |
| **Accurate determination of the end-point of titrations from:** |   |   |   |
| o the colour change of a suitable indicator |   |   |   |
| o plots of pH versus volume |   |   |   |
| o ΔpH/Δvolume versus volume. |   |   |   |
| **Calculation of concentrations:** |   |   |   |
| o use of molecular mass from periodic table. |   |   |   |
| Use of primary and secondary titrimetric standards. |   |   |   |
| **A3 Colorimetry** | **R** | **A** | **G** |
| Understanding and practical application of colorimetry techniques. |   |   |   |
| Selection and use of a colorimeter or visible spectrometer – selection of filter (colorimeter) or fixed wavelength (spectrometer). |   |   |   |
| Measurement and use of absorbance readings. |   |   |   |
| Use of Beer-Lambert law to determine the concentration of a transition metal ion solution. |   |   |   |
| Accurate dilution of stock solutions to prepare a range of calibration standards with absorbance in the range 0 to 1. |   |   |   |
| Use of blank solutions. |   |   |   |
| Calibration plot. |   |   |   |
| Determination of unknown solution concentration from reading from graph (graph paper) or from the equation of a linear trend line through the origin (Microsoft Excel). |   |   |   |
| **Learning aim B: Undertake calorimetry to study cooling curves** |
| **B1 Thermometers** | **R** | **A** | **G** |
| Types of thermometer, appropriate use and practical application of measurements of heat. |   |   |   |
| The relationship between temperature and heat energy. |   |   |   |
| **Types of thermometer and how they are used to gain accurate readings:** |   |   |   |
| o electronic thermometers/temperature probes |   |   |   |
| o liquid-filled thermometers. |   |   |   |
| Checking the calibration of thermometers by using ice and boiling water. |   |   |   |
| Accuracy of thermometers and temperature probes at different temperatures. |   |   |   |
| **B2 Cooling curves** | **R** | **A** | **G** |
| **Construction and interpretation of cooling curves:** |  |  |  |
| • temperature as a function of time |   |   |   |
| • rate of cooling from the gradient of the tangent to the cooling curve |   |   |   |
| • determination of melting point from the shape of a curve for a substance freezing |   |   |   |
| • super cooling |   |   |   |
| • shape of the curve and rate of cooling in relation to intermolecular forces and the state (solid or liquid) of the substance. |   |   |   |
| **Learning aim C: Undertake chromatographic techniques to identify components in mixtures** |
| **C1 Chromatographic techniques** | **R** | **A** | **G** |
| Theory, equipment and procedures used in chromatography. |   |   |   |
| **Terminology:** |   |   |   |
| o mobile and stationary phases |   |   |   |
| o adsorption. |   |   |   |
| Principles of paper chromatography. |   |   |   |
| **Principles of thin-layer chromatography (TLC):** |   |   |   |
| o nature of a TLC plate – glass, metal or plastic sheet with solid adsorbent layer. |   |   |   |
| Use of capillary tubes to apply mixtures to paper or TLC plates. |   |   |   |
|  Choice of developing solvent and vessel. |   |   |   |
| **Preparative methods for samples:** |   |   |   |
| o solvent extraction |   |   |   |
| o filtration |   |   |   |
| o concentration by evaporation. |   |   |   |
| The use of locating agents. |   |   |   |
| **C2 Application of chromatography** | **R** | **A** | **G** |
| Separation of components of a mixture, to include plant pigments extracted from leaves/herbs with propanone (paper chromatography and TLC). |   |   |   |
| Identification of unknown mixtures and pure substances using chromatography, to include amino acids (paper chromatography). |   |   |   |
| Awareness of other types of chromatography – e.g. gas chromatography, ion-exchange chromatography – and that procedures and chromatogram interpretations are very different. |   |   |   |
| **C3 Interpretation of a chromatogram** | **R** | **A** | **G** |
| Polarity of molecules/intermolecular forces in relation to solubility in the mobile phase. |   |   |   |
| Polarity of molecules/intermolecular forces in relation to retention of molecules in the stationary phase. |   |   |   |
| Size of molecules in relation to solubility and mobility. |   |   |   |
| Calculation of Rf value. |   |   |   |
| Interpretation of chromatograms in terms of the number of substances present and the Rf values of components. |   |   |   |
| Awareness of common problems in technique resulting in difficulty interpreting a chromatogram, e.g. overloading samples, disturbing plate/paper during development or contamination of plate/paper. |   |   |   |
| **Learning aim D: Review personal development of scientific skills for laboratory work** |
| **D1 Personal responsibility** | **R** | **A** | **G** |
| Understanding of the personal responsibilities that must be accepted for successful work in science. |   |   |   |
| Work to appropriate standards and protocols. |   |   |   |
| Application of safe working practices. |   |   |   |
| Accept responsibility for the quality of own work. |   |   |   |
| Take responsibility for completing tasks and procedures as well as using judgements within defined parameters. |   |   |   |
| **D2 Interpersonal skills** | **R** | **A** | **G** |
| **Understanding and development of skills for effective and efficient working with others:** |   |   |   |
| • communication and co-operation in the scientific working environment |   |   |   |
| • give and receive constructive feedback |   |   |   |
| • behaviour for safe and efficient working in science. |   |   |   |
| **D3 Professional practice** | **R** | **A** | **G** |
| **Understanding and personal development of standard practices applicable to working as a professional scientist:** |   |   |   |
| • recognise problems and apply appropriate scientific methods to identify causes and achieve solutions |   |   |   |
| • identify, organise and use resources effectively to complete tasks |   |   |   |
| • maintain and enhance competence. |   |   |   |

## Unit 3: Science Investigation Skills

|  |
| --- |
| **A Planning a scientific investigation** |
| **A1 Developing a hypothesis for an investigation** | **R** | **A** | **G** |
| Be able to formulate a hypothesis or a null hypothesis based on relevant scientific ideas. |  |  |  |
| **A2 Selection of appropriate equipment, techniques and standard procedures** | **R** | **A** | **G** |
| Be able to select and justify the use of equipment/techniques/standard procedures for quantitative and/or qualitative investigations. |  |  |  |
| **A3 Health and safety associated with the investigation** | **R** | **A** | **G** |
| Understand risks and hazards associated with the investigation. |  |  |  |
| **A4 Variables in the investigation** | **R** | **A** | **G** |
| Independent. |  |  |  |
| Dependent. |  |  |  |
| Control. |  |  |  |
| **A5 Method for data collection and analysis** | **R** | **A** | **G** |
| Be able to produce a clear, logically ordered method to obtain results. |  |  |  |
| Be able to select relevant measurements and the range of measurements to be recorded. |  |  |  |
| Understand the importance of obtaining data accurately/reliably and to appropriate levels of precision. |  |  |  |
| Understand how variables can be controlled/measured/monitored. |  |  |  |
| Understand how the data/information can be analysed. |  |  |  |
| **B Data collection, processing and analysis/interpretation** |
| **B1 Collection of quantitative/qualitative data** | **R** | **A** | **G** |
| Be able to collect data accurately/reliably and to appropriate levels of precision. |  |  |  |
| Be able to tabulate data in a clear and logical format using correct headings with units where appropriate. |  |  |  |
| Be able to identify anomalous data and take appropriate action. |  |  |  |
| Be able to recognise when it is appropriate to take repeats. |  |  |  |
| Be able to make qualitative observations and draw inferences. |  |  |  |
| **B2 Processing data** | **R** | **A** | **G** |
| Be able to carry out relevant calculations where appropriate, involving: |  |  |  |
| o mean and standard deviation |  |  |  |
| o use and interpretation of error bars |  |  |  |
| o use of statistical tests, including t-test, chi-squared and correlation analysis |  |  |  |
| o use of formulae |  |  |  |
| o transposition of formulae |  |  |  |
| o conversion of units |  |  |  |
| o use of standard form |  |  |  |
| o percentage error of measuring equipment. |  |  |  |
| Be able to display data in an appropriate format, including: |  |  |  |
| o choosing an appropriate graph/chart/tables |  |  |  |
| o correct plotting/labelling/scales. |  |  |  |
| **C Drawing conclusions and evaluation** |
| **C1 Interpretation/analysis of data** | **R** | **A** | **G** |
| Be able to identify trends/patterns in data. |  |  |  |
| Be able to compare primary and secondary data. |  |  |  |
| Be able to use data to draw conclusions that are valid and relevant to the purpose of the investigation. |  |  |  |
| Interpretation of statistical tests using tables of critical values and a 5% significance level, with reference to the null hypothesis. |  |  |  |
| **C2 Evaluation** | **R** | **A** | **G** |
| Be able to make any recommendations for improvements to the investigation. |  |  |  |
| Be able to explain anomalous data. |  |  |  |
| Be able to determine quantitative and discuss qualitative sources of error. |  |  |  |
| Be able to discuss evidence of the reliability of the data collected during the investigation. |  |  |  |
| Be able to identify strengths and weaknesses within method/techniques/standard procedures/equipment used. |  |  |  |
| Be able to suggest improvements to an investigation. |  |  |  |
| **D Enzymes in action** |
| **D1 Protein structure** | **R** | **A** | **G** |
| Peptide linkage. |  |  |  |
| Active sites. |  |  |  |
| Denaturation. |  |  |  |
| **D2 Enzymes as biological catalysts in chemical reactions** | **R** | **A** | **G** |
| Collision theory. |  |  |  |
| Formation of enzyme-substrate complex. |  |  |  |
| Specificity of enzymes brought about by the need for matching of substrate and active site. |  |  |  |
| Lowering of activation energy. |  |  |  |
| Changing substrate concentration changes the rate at which substrate molecules will join active sites. |  |  |  |
| Importance of measuring initial rates of reaction. |  |  |  |
| **D3 Factors that can affect enzyme activity** | **R** | **A** | **G** |
| Temperature. |  |  |  |
| pH. |  |  |  |
| Substrate and enzyme concentration. |  |  |  |
| **E Diffusion of molecules** |
| **E1 Factors affecting the rate of diffusion** | **R** | **A** | **G** |
| Concentration gradient. |  |  |  |
| Shape and size of molecules. |  |  |  |
| Temperature. |  |  |  |
| Distance. |  |  |  |
| Surface area. |  |  |  |
| **E2 Arrangement and movement of molecules** | **R** | **A** | **G** |
| Random movement of molecules in liquids and gases. |  |  |  |
| Diffusion takes place along a concentration gradient until dynamic equilibrium is reached. |  |  |  |
| **F Plants and their environment** |
| **F1 Factors that can affect plant growth and/or distribution** | **R** | **A** | **G** |
| Human effects – trampling. |  |  |  |
| Soil pH and aeration. |  |  |  |
| Light intensity – shaded and unshaded areas. |  |  |  |
| Temperature. |  |  |  |
| Presence of water – moisture and rainfall. |  |  |  |
| Mineral ions. |  |  |  |
| **F2 Sampling techniques** | **R** | **A** | **G** |
| Understand the importance of random sampling in collecting reliable and valid data for analysis. |  |  |  |
| Select appropriate ecological sampling techniques to investigate the effect of abiotic factors on plant populations, including: |  |  |  |
| o transects |  |  |  |
| o quadrats (open and gridded) |  |  |  |
| o point frames. |  |  |  |
| **F3 Sampling sizes** | **R** | **A** | **G** |
| Select sample sizes for investigation with regards to practical constraints and the need to collect sufficient data to make valid conclusions. |  |  |  |
| **G Energy content of fuels** |
| **G1 Fuels** | **R** | **A** | **G** |
| Petrol, paraffin, food, cooking oil, methanol, ethanol, propan-1-ol, butan-1-ol, pentan-1-ol, wax temperature. |  |  |  |
| **G2 Hazards associated with fuels** | **R** | **A** | **G** |
| Flammability. |  |  |  |
| Toxicity. |  |  |  |
| Risk of explosion. |  |  |  |
| Harmful effects of products of incomplete combustion. |  |  |  |
| Pollution from sulphur impurities. |  |  |  |
| **G3 Units of energy** | **R** | **A** | **G** |
| Define – joules, kJ, calories (1 g by 1 oC), kilocalories, kWh. |  |  |  |
| The heat capacity of water will be given if required. |  |  |  |
| Calculate heat energy supplied by a fuel to water using: |  |  |  |
| o heat energy = mass of water × specific heat capacity of water × temperature rise of water. |  |  |  |
| Calculate heat energy released from a fuel in kJ mol-1. |  |  |  |
| **H Electrical circuits** |
| **H1 Use of electrical symbols to design circuits** | **R** | **A** | **G** |
| Battery. |  |  |  |
| Ammeter. |  |  |  |
| Voltmeter. |  |  |  |
| Bulbs. |  |  |  |
| Resistors. |  |  |  |
| Diodes. |  |  |  |
| **H2 Equations** | **R** | **A** | **G** |
| Power = VI (voltage × current). |  |  |  |
| Power = work done/time |  |  |  |
| Work done = energy supplied or transformed. |  |  |  |
| **H3 Energy usage** | **R** | **A** | **G** |
| Consider different domestic appliances to calculate energy usage and relate fuse size to power. |  |  |  |

## Unit 10: Biological Molecules and Metabolic Pathways

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| **Learning aim A: Understand the structure and function of biological molecules and their importance in maintaining biochemical processes** |
| **A1 Water** | **R** | **A** | **G** |
| **Structure:** |  |  |  |
| o contains hydrogen (H) and oxygen (O) atoms |   |   |   |
| o structural and chemical formulae. |   |   |   |
| **Bonding:** |  |  |  |
| o in water molecule (covalent bonding) |   |   |   |
| o between water molecules (hydrogen bonding). |   |   |   |
| **Importance:** |  |  |  |
| o as a solvent |   |   |   |
| o medium for chemical reactions |   |   |   |
| o pH regulation |   |   |   |
| o electrolyte balance |   |   |   |
| o temperature regulator |   |   |   |
| o cohesion-tension in transpiration. |   |   |   |
| **A2 Carbohydrates** | **R** | **A** | **G** |
| **Structure and features:** |  |  |  |
| o contain carbon (C), hydrogen and oxygen atoms |   |   |   |
| o monosaccharides, e.g. α and β glucose, galactose, fructose, ribose and deoxyribose |   |   |   |
| o disaccharides, e.g. lactose, maltose and sucrose |   |   |   |
| o polysaccharides, e.g. amylose, amylopectin, cellulose |   |   |   |
| o use of iodine and Benedicts’ solution as tests for presence of carbohydrates. |   |   |   |
| **Importance:** |  |  |  |
| o energy production |   |   |   |
| o energy storage |   |   |   |
| o structural/building |   |   |   |
| o lipid metabolism |   |   |   |
| o prevention of protein breakdown for energy in animals. |   |   |   |
| **A3 Proteins and nucleic acids** | **R** | **A** | **G** |
| **Structural features:** |   |   |   |
| **proteins:** |  |  |  |
| o primary structure, including peptide links to give polypeptides |   |   |   |
| o secondary structure, including α-helices and β-pleated sheets |   |   |   |
| o tertiary structure, to include ionic interaction, hydrogen bonding, sulphur bridges and van der Waal’s forces |   |   |   |
| o quaternary structure, e.g. haemoglobin |   |   |   |
| o classification as globular or fibrous |   |   |   |
| o use of Biuret solution as a test for presence of protein |   |   |   |
| **nucleic acids:** |  |  |  |
| o nucleotide structure (deoxyribose or ribose, phosphate and purine or pyrimidine base) |   |   |   |
| o polynucleotide structure with bonds made through condensation reactions |   |   |   |
| o formation of the DNA double helix through complementary base pairing |   |   |   |
| o importance of proteins and nucleic acids |   |   |   |
| o enzymes that control metabolism |   |   |   |
| o as neurotransmitters |   |   |   |
| o antibodies |   |   |   |
| o hormones |   |   |   |
| o for transport of other components |   |   |   |
| o body tissue growth and repair |   |   |   |
| o muscle contraction in animals (actin and myosin interaction: detailed knowledge of the sliding filament theory not required) |   |   |   |
| o blood clotting in animals |   |   |   |
| o role of nucleic acids in coding for genes and controlling gene expression. |   |   |   |
| **A4 Lipids** | **R** | **A** | **G** |
| **Structure:** |   |   |   |
| carbon, hydrogen and oxygen in fats, oils and waxes |   |   |   |
| saturated and unsaturated fats, and formation of diglycerides and triglycerides via esterification reactions |   |   |   |
| use of emulsion tests to identify presence of lipids |   |   |   |
| **importance of lipids in animals:** |   |   |   |
| o energy sources |   |   |   |
| o insulation and organ protection in animals |   |   |   |
| o phospholipids in membranes |   |   |   |
| o production of vitamins. |   |   |   |
| **A5 Disruption of biochemical processes in living organisms** | **R** | **A** | **G** |
| The causes and effects of disruption to biochemical processes, to include: |   |   |   |
| • porphyria |   |   |   |
| • lactose intolerance |   |   |   |
| • diabetes mellitus |   |   |   |
| • cystic fibrosis |   |   |   |
| • exposure to carcinogens |   |   |   |
| • interference in plant growth regulators, e.g. delaying or promoting fruit ripening using the effects of ethene and gibberellins; disruption of auxin transport; use of synthetic auxin. |   |   |   |
| **Learning aim B: Explore the effect of activity on respiration in humans and factors that can affect respiratory pathways** |
| **B1 Respiration** | **R** | **A** | **G** |
| Adenosine triphosphate (ATP) as the universal energy currency. |   |   |   |
| Stages and locations of aerobic and anaerobic respiratory pathways |   |   |   |
| Glycolysis: conversion of monosaccharides to pyruvate; production of lactic acid in anaerobic respiration and ethanol in yeast. |   |   |   |
| Link reaction. |   |   |   |
| **Krebs cycle:** |   |   |   |
| o conversion of molecules in the cycle from citric acid to oxaloacetate |   |   |   |
| o carbon dioxide (CO2) production. |   |   |   |
| **Electron transport chain in ATP production:** |   |   |   |
| o reduction of coenzymes |   |   |   |
| o cytochrome system and ATP synthase |   |   |   |
| o importance of oxygen as final electron acceptor and nicotinamide adenine dinucleotide (NAD) as hydrogen acceptor. |   |   |   |
| **B2 Effect of activity on requirements for oxygen and output of CO2** | **R** | **A** | **G** |
| Recovery rates after exercise as measured by breathing rate. |   |   |   |
| Short-term anaerobic respiration leading to oxygen debt. |   |   |   |
| Effect of exercise on carbon dioxide output; potential damaging effects of excess CO2 and lactic acid; bicarbonate buffering system of blood. |   |   |   |
| **B3 Factors that can affect respiration** | **R** | **A** | **G** |
| The causes and effects of the following on the ability of individuals to carry out processes leading to efficient respiration. |   |   |   |
| **Cigarettes:** |   |   |   |
| o inhalation of toxins |   |   |   |
| o tar |   |   |   |
| o nicotine. |   |   |   |
| **Drugs:** |   |   |   |
| o ketamine |   |   |   |
| o cocaine interferes with how the brain processes chemicals. |   |   |   |
| **Pollutants:** |   |   |   |
| o asbestos |   |   |   |
| o oxidants causing inflammation and metabolic damage to the cells. |   |   |   |
| Disease, e.g. asthma. |   |   |   |
| **Learning aim C: Explore the factors that can affect the pathways and the rate of photosynthesis in plants** |
| **C1 Pathways in photosynthesis** | **R** | **A** | **G** |
| **Light-dependent reaction:** |   |   |   |
| o stages in and location of photophosphorylation, including role of coenzymes, and photolysis |   |   |   |
| o light energy converted to chemical energy held in ATP. |   |   |   |
| **Light-independent reaction:** |   |   |   |
| o stages in and location of the Calvin cycle |   |   |   |
| o role of ribulose bisphosphate (RuBP) and ribulose bisphosphate carboxylase (RuBisCO) |   |   |   |
| o production of glucose. |   |   |   |
| **C2 Factors that can affect the pathways in photosynthesis** | **R** | **A** | **G** |
| Requirements for photosynthetic organisms, including sources and control of limiting factors, e.g. light intensity, CO2 concentration, temperature, water. |   |   |   |
| Role of photosynthetic pigments (chlorophylls and carotenoids) in absorbing different wavelengths of light. |   |   |   |

# Exam-Style Questions

**Q1.** Scientists researching fertilisation in humans need to understand how sperm cells are adapted for their specific function.

The diagram shows a human sperm cell.

Complete the missing labels, X and Y, on the diagram.



**(Total for question = 2 marks)**

**Q2.** A microbiologist measures an electron micrograph image of a bacterium to be 4.5 cm in length.

The magnification used to view the bacterium was 22 500×.

Calculate the actual size of the bacterium.

Show your working.

 ........................................................... μm

**(Total for question = 3 marks)**

**Q3.** A palisade mesophyll cell is a specialised plant cell in the leaf.



Explain how the structure of the palisade mesophyll cells is specialised to support the process of photosynthesis.

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**(Total for question = 6 marks)**

**Q4.** Chemists use the periodic table to predict the chemical properties of elements based on their location in the table.

Part of the periodic table is shown.



The letters, A, B, C and D, represent four different elements.

Complete the electronic configuration for an atom of sodium.

 1s2 2s2 ............................................................................................................

**(Total for question = 1 mark)**

**Q5.** Iron is extracted from iron oxide in a blast furnace.

The balanced equation for the reaction is

Fe2O3 + 3CO → 2Fe + 3CO2

Calculate the relative formula mass of iron oxide.

Show your working.

Relative formula mass = ...........................................................

 **(Total for question = 2 marks)**

**Q6.** Magnesium chloride, MgCl2, is an important industrial chemical.

It can be made by reacting magnesium with dilute hydrochloric acid.

Calculate the number of moles of hydrochloric acid in 50 cm3 of 0.2 M hydrochloric acid.

Show your working.

 ........................................................... moles

**(Total for question = 3 marks)**

**Q7.** A flute is a musical instrument. It is used to play a note into a microphone connected to a cathode ray oscilloscope (CRO). The CRO displays the output of the note played. This is shown in diagram A.

A tuning fork is also used to produce the same note. The CRO display of this note is shown in diagram B.

The CRO display settings are the same for both.



Identify **two** differences between the note displayed in diagram A and the note displayed in diagram B.

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**(Total for question = 2 marks)**

**Q8.** A student uses a cathode ray oscilloscope (CRO) to investigate the properties of waves produced by a signal generator.

The student obtains the following output.



The student investigates a different water wave.

The wavelength is 0.05 m and the wave speed is 0.075 m/s.

Calculate the frequency of the water wave.

Show your working.

Frequency = ........................................................... Hz

**(Total for question = 3 marks)**

**Q9.** Various parts of the electromagnetic spectrum are used for communication.

An electromagnetic wave has a frequency of 4.5 × 109 Hz.

The speed of light is 3 × 108 m/s.

Discuss the advantages and disadvantages of using radio waves and microwaves in communication.

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**(Total for question = 6 marks)**