UTC Swindon

Course Outline

Faculty (Science)	• **GCSE Biology** • **GCSE Chemistry** • **GCSE Physics**

The science curriculum aims to develop scientific knowledge and conceptual understanding through the specific disciplines of biology, chemistry and physics. Developing an understanding of the nature, processes and methods of science through different modes of inquiry helps students to answer scientific questions about the world around them.

Science is a set of ideas about the material world whether it be investigating, observing, experimenting or testing ideas and then thinking about them. The content allows scientific ideas to flow through the curriculum allowing students to build a deep understanding. This will involve students verbally communicating, reading and writing about science plus the actual doing as well as representing science in its many forms both mathematically and visually through modelling key scientific ideas.

The science curriculum encourages the development of knowledge and understanding in science through opportunities for working scientifically (the summation of all the activities that scientists do) and this is woven through the courses that the students study.

Science is delivered using the TEEP model and aims to make science relevant by demonstrating its purpose and application in industry and the real world.

The core of the science curriculum deals with science in our everyday lives. We aim for our students to see science all around them; from the nutrients in the food they had at breakfast being digested, to understanding the large-scale implications of climate change science. The curriculum also aims to develop students who are equipped with the scientific knowledge required to understand the uses and implications of science, today and for the future, by engaging them in practical activities throughout the academic year. The science curriculum is not just focused on exams but using science to understand the world around us, cross-linking topics across disciplines, seeing its applicability in our own lives and the future we have ahead of us.

The curriculum offers key opportunities for the following skills to be developed: WS refers to Working scientifically, MR refers to Mathematical requirements and AT refers to use of apparatus and techniques. Science staff are encouraged to introduce all of these skills where appropriate throughout the course.

Working Scientifically (WS)

1. **Development of scientific thinking**:
   - I. Understand how scientific methods and theories develop over time.
   - II. Use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.
   - III. Appreciate the power and limitations of science and consider any ethical issues which may arise.
   - IV. Explain every day and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments.
   - V. Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences.

VI. Recognise the importance of peer review of results and of communicating results to a range of audiences.

2. Development of experimental skills and strategies:

I. Use scientific theories and explanations to develop hypotheses.
II. Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena.
III. Apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment.
IV. Carry out experiments appropriately having due regard for the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.
V. Recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative.
VI. Make and record observations and measurements using a range of apparatus and methods.
VII. Evaluate methods and suggest possible improvements and further investigations.

3. Development of analysis and evaluation

I. Presenting observations and other data using appropriate methods.
II. Translating data from one form to another.
III. Carrying out and represent mathematical and statistical analysis.
IV. Representing distributions of results and make estimations of uncertainty.
V. Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions.
VI. Presenting reasoned explanations including relating data to hypotheses.
VII. Being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.
VIII. Communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms.

4. Development of Scientific vocabulary, quantities, units, symbols and nomenclature

I. Use scientific vocabulary, terminology and definitions.
II. Recognise the importance of scientific quantities and understand how they are determined.
III. Use SI units (e.g. kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate.
IV. Use prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano).
V. Interconvert units.
VI. Use an appropriate number of significant figures in calculation.

In addition to the development of scientific thinking and skills development, a range of mathematical skills will also be developed.

Mathematical Requirements (MR)

This matrix identifies the key mathematical skills students will need to develop and apply throughout science.

1. Arithmetic and numerical computation		BIOLOGY	CHEMISTRY	PHYSICS
1a	Recognise and use expressions in decimal form	✓	✓	✓
1b	Recognise and use expressions in standard form	✓	✓	✓
1c	Use ratios, fractions and percentages	✓	✓	✓
1d	Make estimates of the results of simple calculations	✓	✓	✓

2. Handling data				
2a	Use an appropriate number of significant figures	✓	✓	✓
2b	Find arithmetic means	✓	✓	✓
2c	Construct and interpret frequency tables and diagrams, bar charts and histograms	✓	✓	✓
2d	Understand the principles of sampling as applied to scientific data	✓		
2e	Understand simple probability	✓		
2f	Understand the terms mean, mode and median	✓		✓
2g	Use a scatter diagram to identify a correlation between two variables	✓		✓
2h	Make order of magnitude calculations	✓	✓	✓

3. Algebra				
3a	Understand and use the symbols: =, <, <<, >>, >, ∝ , ~	✓	✓	✓
3b	Solve simple algebraic equations		✓	✓
3c	Substitute numerical values into algebraic equations using appropriate units for physical quantities		✓	✓
3d	Solve simple algebraic equations	✓		✓

4. Graphs				
4a	Translate information between graphical and numeric form	✓	✓	✓
4b	Understand that y = mx + c represents a linear relationship	✓	✓	✓
4c	Plot two variables from experimental or other data	✓	✓	✓
4d	Determine the slope and intercept of a linear graph	✓	✓	✓
4e	Draw and use the slope of a tangent to a curve as a measure of rate of change		✓	✓
4f	Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate			✓

5. Geometry and trigonometry				
5a	Use angular measures in degrees			✓
5b	Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects		✓	✓
5c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes	✓	✓	✓

Apparatus & Techniques

Practical work is at the heart of science, so we have placed it at the heart of our curriculum. There are three interconnected, but separate reasons for doing practical work at UTC Swindon. They are:

1. To support and consolidate scientific concepts (knowledge and understanding). This is done by applying and developing what is known and understood of abstract ideas and models. Through practical work we are able to make sense of new information and observations, and provide insights into the development of scientific thinking.

2. To develop investigative skills. These transferable skills include:
   I. devising and investigating testable questions
   II. identifying and controlling variables
   III. analysing, interpreting and evaluating data.

3. To build and master practical skills such as:
   I. using specialist equipment to take measurements
   II. handling and manipulating equipment with confidence and fluency
   III. recognising hazards and planning how to minimise risk.

By focusing on the reasons for carrying out a particular practical, teachers will help their students understand the subject better, to develop the skills of a scientist and to master the manipulative skills required for further study or jobs in STEM subjects.

Questions in the written exams will draw on the knowledge and understanding students have gained by carrying out the practical activities listed below. These questions will count for at least 15 % of the overall marks for the qualification. Practical work will focus on investigative skills and how well students can apply what they know to practical situations to help prepare for application in exams which often set novel contexts.

Teachers are encouraged to further develop students' abilities by providing other opportunities for practical work throughout the course.

Biology AT Skills

AT-1	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH (links to A-level AT a).
AT-2	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater (links to A-level AT a).
AT-3	Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes.
AT-4	Safe and ethical use of living organisms (plants or animals) to measure physiological functions and responses to the environment (links to A-level AT h).
AT-5	Measurement of rates of reaction by a variety of methods including production of gas, uptake of water and colour change of indicator.
AT-6	Application of appropriate sampling techniques to investigate the distribution and abundance of organisms in an ecosystem via direct use in the field (links to A-level AT k).
AT-7	Use of appropriate apparatus, techniques and magnification, including microscopes, to make observations of biological specimens and produce labelled scientific drawings (links to A-level AT d and e).
AT-8	Use of appropriate techniques and qualitative reagents to identify biological molecules and processes in more complex and problem-solving contexts including continuous sampling in an investigation (links to A-level AT f).

Chemistry AT Skills

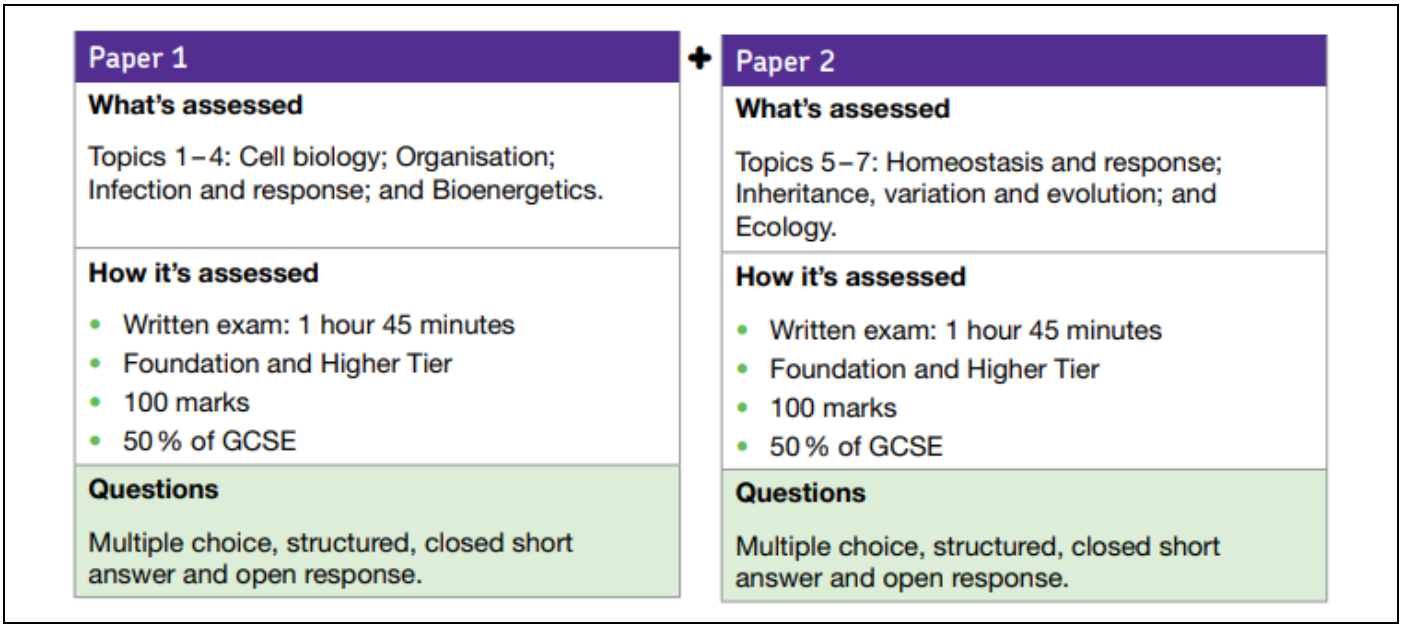
AT-1	Use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature, and volume of liquids and gases (links to A-level AT a).
AT-2	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater (links to A-level AT b).
AT-3	Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions, including appropriate reagents and/or techniques for the measurement of pH in different situations (links to A-level AT a and d).
AT-4	Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, filtration, crystallisation, chromatography and distillation (links to A-level AT d and g).
AT-5	Making and recording of appropriate observations during chemical reactions including changes in temperature and the measurement of rates of reaction by a variety of methods such as production of gas and colour change (links to A-level AT a and l).
AT-6	Safe use and careful handling of gases, liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes and/or products (links to A-level AT a and k).
AT-7	Use of appropriate apparatus and techniques to draw, set up and use electrochemical cells for separation and production of elements and compounds (links to A-level AT d and j).
AT-8	Use of appropriate qualitative reagents and techniques to analyse and identify unknown samples or products including gas tests, flame tests, precipitation reactions, and the determination of concentrations of strong acids and strong alkalis (links to A-level AT d).

Physics AT Skills

AT-1	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, volume and temperature. Use of such measurements to determine densities of solid and liquid objects (links to A-level AT a and b).
AT-2	Use of appropriate apparatus to measure and observe the effects of forces including the extension of springs (links to A-level AT a).
AT-3	Use of appropriate apparatus and techniques for measuring motion, including determination of speed and rate of change of speed (acceleration/deceleration) (links to A-level AT a, b and d).
AT-4	Making observations of waves in fluids and solids to identify the suitability of apparatus to measure speed/frequency/wavelength. Making observations of the effects of the interaction of electromagnetic waves with matter (links to A-level AT i and j).
AT-5	Safe use of appropriate apparatus in a range of contexts to measure energy changes/ transfers and associated values such as work done (links to A-level AT a, b).
AT-6	Use of appropriate apparatus to measure current, potential difference (voltage) and resistance, and to explore the characteristics of a variety of circuit elements (links to A-level AT f).
AT-7	Use of circuit diagrams to construct and check series and parallel circuits including a variety of common circuit elements (links to A-level AT g).
AT-8	Making observations of waves in fluids and solids to identify the suitability of apparatus to measure the effects of the interaction of waves with matter (links to A-level AT h, j).

BIOLOGY Assessment

UNIT	Content
1	Cell biology
2	Organisation
3	Infection and response
4	Bioenergetics
5	Homeostasis and response
6	Inheritance, variation and evolution
7	Ecology
8	Key ideas



Paper 1

What's assessed

Topics 1–4: Cell biology; Organisation; Infection and response; and Bioenergetics.

How it's assessed

- Written exam: 1 hour 45 minutes
- Foundation and Higher Tier
- 100 marks
- 50 % of GCSE

Questions

Multiple choice, structured, closed short answer and open response.

Paper 2

What's assessed

Topics 5–7: Homeostasis and response; Inheritance, variation and evolution; and Ecology.

How it's assessed

- Written exam: 1 hour 45 minutes
- Foundation and Higher Tier
- 100 marks
- 50 % of GCSE

Questions

Multiple choice, structured, closed short answer and open response.

CHEMISTRY Assessment

UNIT	Content
1	Atomic structure and the periodic table
2	Bonding, structure, and the properties of matter
3	Quantitative chemistry
4	Chemical changes
5	Energy changes
6	The rate and extent of chemical change
7	Organic chemistry
8	Chemical analysis
9	Chemistry of the atmosphere
10	Using resources
11	Key ideas

Paper 1:

What's assessed

Topics 1–5: Atomic structure and the periodic table; Bonding, structure, and the properties of matter; Quantitative chemistry, Chemical changes; and Energy changes.

How it's assessed

- Written exam: 1 hour 45 minutes
- Foundation and Higher Tier
- 100 marks
- 50% of GCSE

Questions

Multiple choice, structured, closed short answer and open response.

Paper 2:

What's assessed

Topics 6–10: The rate and extent of chemical change; Organic chemistry; Chemical analysis, Chemistry of the atmosphere; and Using resources.

Questions in Paper 2 may draw on fundamental concepts and principles from sections 4.1 to 4.3.

How it's assessed

- Written exam: 1 hour 45 minutes
- Foundation and Higher Tier
- 100 marks
- 50% of GCSE

Questions

Multiple choice, structured, closed short answer and open response.

PHYSICS Assessment

UNIT	Content
1	Energy
2	Electricity
3	Particle model of matter
4	Atomic structure
5	Forces
6	Waves
7	Magnetism and electromagnetism
8	Space physics

Paper 1:

What's assessed

Topics 1-4: Energy; Electricity; Particle model of matter; and Atomic structure.

How it's assessed

- Written exam: 1 hour 45 minutes
- Foundation and Higher Tier
- 100 marks
- 50% of GCSE

Questions

- Multiple choice, structured, closed short answer and open response.

Paper 2:

What's assessed

Topics 5-8: Forces; Waves; Magnetism and electromagnetism; and Space physics.

Questions in paper 2 may draw on an understanding of energy changes and transfers due to heating, mechanical and electrical work and the concept of energy conservation from Energy (page 17) and Electricity (page 23).

How it's assessed

- Written exam: 1 hour 45 minutes
- Foundation and Higher Tier
- 100 marks
- 50% of GCSE

Questions

- Multiple choice, structured, closed short answer and open response.