The new science GCSE at Sands School (Double award)

Subject Content

Biology

B1 exam
1 Cell biology
2 Organisation
3 Infection and response
4 Bioenergetics

B2 exam
5 Homeostasis and response
6 Inheritance, variation and evolution
7 Ecology

Chemistry

C1 exam
9 Atomic structure and the periodic table
10 Bonding, structure, and the properties of matter
11 Quantitative chemistry
12 Chemical changes
13 Energy changes

C2 exam
14 The rate and extent of chemical change
15 Organic chemistry
16 Chemical analysis
17 Chemistry of the atmosphere
18 Using resources

Physics

P1 exam
20 Energy
21 Electricity
22 Particle model of matter
23 Atomic structure

P2 exam
24 Forces
25 Waves
26 Magnetism and electromagnetism

Structure of the course

All exams are in the final year as part of the May/June exam session. There are a total of 6 exams, each worth 70 marks, with an allowed time of 1 hour 15 minutes. This means each exam is worth 16.7% of the GCSE which is a double award (worth 2 GCSEs). Types of question will be; Multiple choice, structured, closed short answer, and open response. Biology papers will have 10% mathematics questions, Chemistry 20%, and Physics 30%.

There are 21 "required practicals" as part of this course, which will be carried out at regular intervals throughout at the end of each topic. Though in themselves they don't count for any marks towards the GCSE itself, the experience of doing them is tested in written form in their respective exams at the end.

The required practicals are a valuable opportunity for students to learn what are called "working scientifically" skills. As such, a few days before each practical, students will be given a homework to use the internet and their textbooks to learn about the equipment and techniques they will use in the practical. While doing this, they will be given a standardised form each time into which they will make notes on how they are going to carry out the practical, the equipment they will need, what they will measure, how to keep a 'fair test', and health and safety considerations.

For each student, a folder will be kept that will hold all of their 'practical homework sheets', the results of their practical, mock tests, and anything else relevant to recording their progress.

Standard route (3 lessons per week)
Exam units will be taught in the following order with a mock test at the end of each;

Year one (O3)
Autumn term B1
Spring term C1
Summer term P1

Year two (O2)
Autumn term B2
Spring term C2
Summer term P2

Other routes
Students wishing to study Triple Science will not take the exams at the end of year two (O2), but will study a further 3rd unit in each area to be examined in their third year (O1), or second year (O2) if leaving the school early.

Those students who don't want to take the Double award as most will, will follow a convoluted route. If, for example, a student only wanted to study Biology, they would attend classes in the terms when that content is being taught in class. When Chemistry or Physics was being taught, they would carry out guided individual learning on the B3 content, or during other spare time if leaving in O2.

At present, the plan is for all those wanting to follow these other routes to study for the relevant Unit 3(s) largely independently as a useful opportunity for them to develop some very important skills. As already stated, this would be under the guidance of both the subject teacher, and the tutor. Any required practicals would of course be arranged as and when needed.

Content of the course

The full syllabus can be found here. Below is a summary.

Biology unit 1

Cell Biology

Cell structure

- Animal and Plant cells
- ***Required practical activity 1****: use a light microscope to observe, draw and label a selection of plant and animal cells. A magnification scale must be included.*
- Cell specialisation
- Cell differentiation
- Microscopy

Cell division

- Chromosomes
- Mitosis and the cell cycle
- Stem cells

Transport in cells

- Diffusion
- Osmosis
- ***Required practical activity 2****: investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue.*
- Active transport

Organisation

Principles of organisation

Animal tissues, organs and organ systems

- The human digestive system
- ***Required practical activity 3****: use qualitative reagents to test for a range of carbohydrates, lipids and proteins. To include: Benedict's test for sugars; iodine test for starch; and Biuret reagent for protein.*
- ***Required practical activity 4****: investigate the effect of pH on the rate of reaction of amylase enzyme. Students should use a continuous sampling technique to determine the time taken to completely digest a starch solution at a range of pH values. Iodine reagent is to be used to test for starch every 30 seconds. Temperature must be controlled by use of a water bath or electric heater*.
- The heart and blood vessels
- Blood
- Coronary heart disease: a noncommunicable disease
- Health issues
- The effect of lifestyle on some non-communicable diseases
- Cancer

Plant tissues, organs and systems

- Plant tissues
- Plant organ systems

Infection and response

Communicable diseases

- Communicable (infectious) diseases
- Viral diseases
- Bacterial diseases
- Fungal diseases
- Protist diseases
- Human defence systems
- Vaccination
- Antibiotics and painkillers
- Discovery and development of drugs

Bioenergetics

Photosynthesis

- Photosynthetic reaction
- Rate of photosynthesis
- ***Required practical activity 5****: investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.*
- Uses of glucose from photosynthesis

Respiration

- Aerobic and anaerobic respiration
- Response to exercise
- Metabolism

Biology unit 2

Homeostasis and response

Homeostasis

The human nervous system

- ***Required practical activity 6****: plan and carry out an investigation into the effect of a factor on human reaction time.*

Hormonal coordination in humans

- Human endocrine system
- Control of blood glucose concentration
- Hormones in human reproduction
- Contraception
- The use of hormones to treat infertility (Higher Tier only)
- Negative feedback (Higher Tier only)

Inheritance, variation and evolution

Reproduction

- Sexual and asexual reproduction
- Meiosis
- DNA and the genome
- Genetic inheritance
- Inherited disorders
- Sexual determination

Variation and evolution

- Variation
- Evolution
- Selective breeding
- Genetic engineering

The development of understanding of genetics and evolution

- Evidence for evolution
- Fossils
- Extinction
- Resistant bacteria

Classification of living organisms

Ecology

Adaptations, interdependence and competition

- Communities
- Abiotic factors
- Biotic factors
- Adaptations

Organisation of an ecosystem

- Levels of organisation
- ***Required practical activity 7****: measure the population size of a common species in a habitat. Use sampling techniques to investigate the effect of a factor on the distribution of this species.*
- How materials are cycled

Biodiversity and the effect of human interaction on ecosystems

- Biodiversity
- Waste management
- Land use
- Deforestation
- Global warming
- Maintaining biodiversity

Chemistry unit 1

Atomic structure and the periodic table

A simple model of the atom, symbols, relative atomic mass, electric charge and isotopes

- Atoms, elements and compounds
- Mixtures
- The development of the model of the atom (common content with physics)
- Relative electrical charges of subatomic particles
- Size and mass of atoms
- Relative atomic mass
- Electronic structure

The periodic table

- The periodic table
- Development of the periodic table
- Metals and non-metals
- Group 0
- Group 1
- Group 7

Bonding, structure, and the properties of matter

Chemical bonds, ionic, covalent and metallic

- Chemical bonds
- Ionic bonding
- Ionic compounds
- Covalent bonding
- Metallic bonding

How bonding and structure are related to the properties of substances

- The three states of matter
- State symbols
- Properties of ionic compounds
- Properties of small molecules
- Polymers
- Giant covalent structures
- Properties of metals and alloys
- Metals as conductors

Structure and bonding of carbon

- Diamond
- Graphite
- Graphene and fullerenes

Quantitative chemistry

Chemical measurements, conservation of mass and the quantitative interpretation of chemical equations

- Conservation of mass and balanced chemical equations
- Relative formula mass
- Mass changes when a reactant or product is a gas
- Chemical measurements

Use of amount of substance in relation to masses of pure substances

- Moles (HT only)
- Amounts of substances in equations (HT only)
- Using moles to balance equations (HT only)
- Limiting reactants (HT only)
- Concentration of solutions

Chemical changes

Reactivity of metals

- Metal oxides
- The reactivity series
- Extraction of metals and reduction
- Oxidation and reduction in terms of electrons (HT only)

Reactions of acids

- Reactions of acids with metals
- Neutralisation of acids and salt production
- Soluble salts
- ***Required practical activity 8****: preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate, using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution.*
- The pH scale and neutralisation
- Strong and weak acids (HT only)

Electrolysis

- The process of electrolysis
- Electrolysis of molten ionic compounds
- Using electrolysis to extract metals
- Electrolysis of aqueous solutions
- ***Required practical activity 9****: investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis.*
- Representation of reactions at electrodes as half equations (HT only)

Energy changes

Exothermic and endothermic reactions

- Energy transfer during exothermic and endothermic reactions
- ***Required practical activity 10****: investigate the variables that affect temperature changes in reacting solutions such as, eg acid plus metals, acid plus carbonates, neutralisations, displacement of metals.*
- Reaction profiles
- The energy change of reactions (HT only)

Chemistry unit 2

The rate and extent of chemical change

Rate of reaction

- Calculating rates of reactions
- Factors which affect the rates of chemical reactions
- ***Required practical activity 11****: investigate how changes in concentration affect the rates of reactions by a method involving measuring the volume of a gas produced and a method involving a change in colour or turbidity.*
- Collision theory and activation energy
- Catalysts

Reversible reactions and dynamic equilibrium

- Reversible reactions
- Energy changes and reversible reactions
- Equilibrium
- The effect of changing conditions on equilibrium (HT only)
- The effect of changing concentration (HT only)
- The effect of temperature changes on equilibrium (HT only)
- The effect of pressure changes on equilibrium (HT only)

Organic chemistry

Carbon compounds as fuels and feedstock

- Crude oil, hydrocarbons and alkanes
- Fractional distillation and petrochemicals
- Properties of hydrocarbons
- Cracking and alkenes

Chemical analysis

Purity, formulations and chromatography

- Pure substances
- Formulations
- Chromatography
- ***Required practical activity 12****: investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.*

Identification of common gases

- Test for hydrogen
- Test for oxygen
- Test for carbon dioxide
- Test for chlorine

Chemistry of the atmosphere

The composition and evolution of the Earth's atmosphere

- The proportions of different gases in the atmosphere
- The Earth's early atmosphere
- How oxygen increased
- How carbon dioxide decreased

Carbon dioxide and methane as greenhouse gases

- Greenhouse gases
- Human activities which contribute to an increase in greenhouse gases in the atmosphere
- Global climate change
- The carbon footprint and its reduction

Common atmospheric pollutants and their sources

- Atmospheric pollutants from fuels
- Properties and effects of atmospheric pollutants

Using resources

Using the Earth's resources and obtaining potable water

- Using the Earth's resources and sustainable development
- Potable water
- ***Required practical activity 13****: analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.*
- Waste water treatment
- Alternative methods of extracting metals (HT only)

Life cycle assessment and recycling

- Life cycle assessment
- Ways of reducing the use of resources

Physics unit 1

Energy

Energy changes in a system, and the ways energy is stored before and after such changes

- Energy stores and systems
- Changes in energy
- Energy changes in systems
- ***Required practical activity 14****: an investigation to determine the specific heat capacity of one or more materials. The investigation will involve linking the decrease of one energy store (or work done) to the increase in temperature and subsequent increase in thermal energy stored.*
- Power

Conservation and dissipation of energy

- Energy transfers in a system
- Efficiency

National and global energy resources

- National and global energy resources

Electricity

Current, potential difference and resistance

- Standard circuit diagram symbols
- Electrical charge and current
- Current, resistance and potential difference
- ***Required practical activity 15****: use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits. This should include: • the length of a wire at constant temperature • combinations of resistors in series and parallel.*
- Resistors
- ***Required practical activity 16****: use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements, including a filament lamp, a diode and a resistor at constant temperature.*

Series and parallel circuits

- Series
- Parallel

Domestic uses and safety

- Direct and alternating potential difference
- Mains electricity

Energy transfers

- Power
- Energy transfers in everyday appliances
- The National Grid

Particle model of matter

Changes of state and the particle model

- Density of materials
- ***Required practical activity 17****: use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids. Volume should be determined from the dimensions of regularly shaped objects, and by a displacement technique for irregularly shaped objects. Dimensions to be measured using appropriate apparatus such as a ruler, micrometer or Vernier callipers.*
- Changes of state

Internal energy and energy transfers

- Internal energy
- Temperature changes in a system and specific heat capacity
- Changes of heat and specific latent heat

Particle model and pressure

- Particle motion in gases

Atomic structure

Atoms and isotopes

- The structure of an atom
- Mass number, atomic number and isotopes
- The development of the model of the atom (common content with chemistry)

Atoms and nuclear radiation

- Radioactive decay and nuclear radiation
- Nuclear equations
- Half-lives and the random nature of radioactive decay
- Radioactive contamination

Physics unit 2

Forces

Forces and their interactions

- Scalar and vector quantities
- Contact and non-contact forces
- Gravity
- Resultant forces

Work done and energy transfer

- Work done and energy transfer

Forces and elasticity

- Forces and elasticity
- ***Required practical activity 18****: investigate the relationship between force and extension for a spring.*

Forces and motion

- Describing motion along a line
    - Distance and displacement
    - Speed
    - Velocity
    - The distance–time relationship
    - Acceleration
- Forces, accelerations and Newton's Laws of motion
    - Newton's First Law
    - Newton's Second Law
    - ***Required practical activity 19****: investigate the effect of varying the force on the acceleration of an object of constant mass, and the effect of varying the mass of an object on the acceleration produced by a constant force.*
    - Newton's Third Law
- Forces and braking
    - Stopping distance
    - Reaction time
    - Factors affecting braking distance 1
    - Factors affecting braking distance 2

Momentum (HT only)

- Momentum is a property of moving objects
- Conservation of momentum

Waves

Waves in air, fluids and solids

- Transverse and longitudinal waves
- Properties of waves
- ***Required practical activity 20****: make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements.*

Electromagnetic waves

- Types of electromagnetic waves
- Properties of electromagnetic waves 1
- ***Required practical activity 21****: investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface.*
- Properties of electromagnetic waves 2
- Uses and applications of electromagnetic waves

Magnetism and electromagnetism

Permanent and induced magnetism, magnetic forces and fields

- Poles of a magnet
- Magnetic fields

The motor effect

- Electromagnetism
- Fleming's left-hand rule (HT only)
- Electric motors (HT only)

Monitoring progress and grading

Monitoring progress

It is well known that learning and progress are two separate things. Learning is what happens over the course of a lesson, whereas progress takes weeks/months/years.

Learning is not guaranteed each lesson as not only are students living, breathing creatures that have good days and bad days, but they also have preferences for certain topics. This is evidenced in the non-linear rise of the grades recorded in each student's academic reports. Any drop in grade is not necessarily due to a drop in teaching quality and vice versa, as while some students grades move one way, others move the other way. So, any monitoring must always be honest, and any feedback must be useful. That is, it must allow the student to feel noticed and valued, like they are making progress, and not be overly critical in areas where they are not. It must be provided sensitively so that students don't become disheartened, but still firmly enough to encourage them to challenge themselves.

To give this feedback I rarely mark students work with a pen. That only normally happens if they ask for it as most students don't bother reading/considering it which means it's just a waste of my time. Instead, I try to speak to absolutely every student in every lesson directly on some aspect of the lesson, at least once, and in a positive way. If I have something less positive to say, I try to say it privately. This goes for assessment of verbal, written, skills based, or any other work. By making feedback a dialogue rather than a monologue it is much more effective.

I have produced a chart for each student to use to monitor their progress in each topic area. It also has a space for them to give more general feedback, including comments on the teaching they have received. The idea is that it shows them how well they are doing relative to other topics, subjects, students, and themselves over time as they improve. It highlights areas for most improvement. I will also bring in a similar chart to monitor other things such as practical and social skills in good time.

To write academic tutorials and reports for parents my first stop is to look over what the group has covered since the last report. From this I can then make a set of general comments on the achievement and behaviour of the group as a whole. Then, I look over each student's work and comment on aspects of it from handwriting to calculator skills. When I write a report, I also look at previous ones so that I can tie them together to show progression rather than treating them as a point in time snapshot.

At the end of it all, I am monitoring and giving feedback for one reason, and that is NOT to meet a set of grades requirements. I firmly believe that the best student is the one who has been guided how to learn and is then self-motivated to the grade they achieve. If a student is capable of a B, but they only get a D because they didn't work well enough to get the B then only the student is to blame. I expose the knowledge and encourage students to take it, but I will not put it in their hands for free. If a student who could get a D works hard enough to get that D, it is no less valuable *to them* than the A* for a student who could always get it.

We are not all natural sportsmen, actresses, singers or artists, nor is everyone naturally interested in science, so an honest approach will produce honest grades. No performance enhancing drugs in my lab!

Grading

This course will follow the government's new system using numbers, not letters. As it's a double award, students will get two numbers. Using the old system, the best students would get 2A*s, where the new system will show 9-9. Unfortunately it's more complicated than that, because the new numbers don't align with the old letter system. E.g. 9 is actually above A*.

On the new system, a 4 is like the old C, but the government wants all students to aim for at least a 5 as a 'good pass'. E.g. 5-5.

A student taking Foundation Tier assessments will be awarded a grade within the range of 1–1 to 5–5. Students who fail to reach the minimum standard for grade 1–1 will be recorded as U (unclassified) and will not receive a qualification certificate.

A student taking Higher Tier assessments will be awarded a grade within the range of 4–4 to 9–9. A student sitting the Higher Tier who just fails to achieve grade 4–4 will be awarded an allowed grade 4–3. Students who fail to reach the minimum standard for the allowed grade 4–3 will be recorded as U (unclassified) and will not receive a qualification certificate.