

Required practicals summary

Practical work is at the heart of science – that’s why we have placed it at the heart of each of our GCSE science specifications. By carrying out carefully considered practical work, students will enhance their investigative thinking, improve their mastery of techniques and consolidate their understanding of key scientific concepts.

This document contains a summary of all the draft practicals which students need to carry out as part of their GCSE science qualifications. These lists have been updated to show explicitly how each practical meets the specific elements of the relevant apparatus and techniques that each student must use. A student who has completed all of the practicals will have had the opportunity to experience all of the apparatus and techniques required for the specification. Opportunities for developing mathematical skills and working scientifically skills have also been signposted.

The practicals that have been selected will be familiar, using apparatus and materials that are readily available in most schools. This summary shows the practicals required for all the science qualifications (combined and separate) and are grouped according to the subjects biology, chemistry and physics.

Please note:

- where a required practical is listed that is for a separate science *only* and not for the combined science specifications, it will be indicated, eg physics only
- there are 10 required practicals for biology, including the three needed for the standalone GCSE Biology qualification
- there are 8 required practicals for chemistry, including the two needed for the standalone GCSE Chemistry qualification
- there are 10 required practicals for physics, including the two needed for the standalone GCSE Physics qualification.

The specific *Apparatus and Techniques* skills that must be covered in each practical are indicated by the AT reference. The opportunities that these practicals offer for developing *Working scientifically* skills and *Mathematical skills* are indicated as WS and MS respectively. Further details about these skills are explained in the draft specifications.

Biology required practicals

Microscopy	Spec ref.	Skills
Use a light microscope to observe, draw and label a selection of plant and animal cells. A magnification scale must be included.	Biology 4.1.1.5 Trilogy 4.1.1.5 Synergy 4.1.3.2	AT 1 – use appropriate apparatus to record length and area. AT 7 – use a microscope to make observations of biological specimens and produce labelled scientific drawings. MS 1d, 3a
Microbiology (Biology only)	Spec ref.	Skills
Investigate the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition.	Biology 4.1.1.6	AT 1 – use appropriate apparatus to record length and area. AT 3 – use appropriate apparatus and techniques to observe and measure the process of bacterial growth. AT 4 – safe and ethical use of bacteria to measure physiological function and response to antibiotics and antiseptics in the environment. AT 8 – the use of appropriate techniques and qualitative reagents in problem-solving contexts to find the best antibiotic to use or the best concentration of antiseptic to use. MS 5c WS 2.1, WS 2.2, WS 2.4
Osmosis	Spec ref.	Skills
Investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue.	Biology 4.1.3.2 Trilogy 4.1.3.2 Synergy 4.1.3.3	AT 1 - use appropriate apparatus to record mass and time. AT 3 - use appropriate apparatus and techniques to observe and measure the process of osmosis. AT 5 - measure the rate of osmosis by water uptake. MS 1a, MS 1c, MS 2b, MS 4a, MS 4b, MS 4c, MS 4d WS 2.1, WS 2.2, WS 2.4, WS 2.6, WS 2.7 WS 3.1, WS 3.2

Enzymes	Spec ref.	Skills
<p>Investigate the effect of pH on the rate of reaction of amylase enzyme.</p> <p>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.</p>	<p>Biology 4.2.2.1</p> <p>Trilogy 4.2.2.1</p> <p>Synergy 4.2.1.5</p>	<p>AT 1 – use appropriate apparatus to record the volumes of liquids, time and pH.</p> <p>AT 2 – safe use of a water bath or electric heater.</p> <p>AT 5 – measure the rate of reaction by the colour change of iodine indicator.</p> <p>AT 8 – use of qualitative iodine reagent to identify starch by continuous sampling. (Biology only)</p> <p>MS 1a, MS 1c</p> <p>WS 2.1, WS 2.4, WS 2.5, WS 2.6.</p> <p>WS 3.1, WS 3.2</p>
Food Tests	Spec ref.	Skills
<p>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.</p>	<p>Biology 4.2.2.1</p> <p>Trilogy 4.2.2.1</p> <p>Synergy 4.2.1.5</p>	<p>AT 2 – safe use of a Bunsen burner and a boiling water bath.</p> <p>AT 8 – use of qualitative reagents to identify biological molecules. (Biology only)</p> <p>WS 2.4</p>
Photosynthesis	Spec ref.	Skills
<p>Investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.</p>	<p>Biology 4.4.1.2</p> <p>Trilogy 4.4.1.2</p> <p>Synergy 4.2.2.6</p>	<p>AT 1 – use appropriate apparatus to record the rate of production of oxygen gas produced; and to measure and control the temperature of the water in the 'heat shield' beaker.</p> <p>AT 2 – safe use of a thermometer to measure and control temperature of water bath.</p>

		<p>AT 3 – use appropriate apparatus and techniques to observe and measure the process of oxygen gas production</p> <p>AT 4 – safe and ethical use and disposal of living pondweed to measure physiological functions and responses to light.</p> <p>AT5 – measuring rate of reaction by oxygen gas production.</p> <p>MS 1a, MS 1c, MS 4a, MS 4c, MS 3a, MS 3d (HT)</p> <p>WS 2.1, WS 2.2, WS 2.5, WS 2.6</p> <p>WS 3.1, WS 3.2</p>
Reaction time	Spec ref.	Skills
Plan and carry out an investigation into the effect of a factor on human reaction time.	<p>Biology 4.5.2.1</p> <p>Trilogy 4.5.2</p> <p>Synergy 4.2.1.6</p>	<p>AT 1 – use appropriate apparatus to record</p> <p>AT 3 – selecting appropriate apparatus and techniques to measure the process of reaction time.</p> <p>AT 4 – safe and ethical use of humans to measure physiological function of reaction time and responses to a chosen factor.</p> <p>MS 4a</p>
Plant responses	Spec ref.	Skills
Investigate the effect of light or gravity on the growth of germinated seedlings.	Biology 4.5.4.1	<p>AT 1 – use appropriate apparatus to record length and time.</p> <p>AT 3 – selecting appropriate apparatus and techniques to measure the growth of shoots or roots.</p> <p>AT 4 – safe and ethical use of plants to measure physiological function of growth in response to light or gravity.</p> <p>AT 7 – observations of biological specimens to produce labelled scientific drawings.</p> <p>WS 2.2, WS 2.3, WS 2.6, WS 2.7</p> <p>WS 3.1</p>

Field investigations	Spec ref.	Skills
Measure the population size of a common species in a habitat.	Biology 4.7.2.1	AT 1 - use appropriate apparatus to record length and area AT 3 - use transect lines and quadrats to measure distribution of a species
Use sampling techniques to investigate the effect of a factor on the distribution of this species.	Trilogy 4.7.2.1 Synergy 4.4.2.4	AT 4 - safe and ethical use of organisms and response to a factor in the environment AT 6 - application of appropriate sampling techniques to investigate the distribution and abundance of organisms in an ecosystem via direct use in the field AT 8 - use of appropriate techniques in more complex contexts including continuous sampling in an investigation (Biology only). MS 1d, MS 2b, MS 2d, MS 2f, MS 3a, MS 4c WS 2.1, WS 2.2, WS 2.3.
Decay (Biology only)	Spec ref.	Skills
Investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change.	Biology 4.7.2.3	AT 1 - use appropriate apparatus to record temperature and pH. AT 3 - the use of appropriate apparatus to measure anaerobic decay. AT 4 - safe use of microorganisms. AT 5 - measurement of rate of decay by pH change. MS 1c, MS 4a, MS 4c WS 2.1, WS 2.4, WS 2.6, WS 2.7

Chemistry required practicals

Making salts	Spec ref.	Skills
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.	Chemistry 4.4.2.3 Trilogy 5.4.2.3 Synergy 4.7.3.2	AT 2– Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater. AT 3 – Use of appropriate apparatus and techniques for conducting chemical reactions, including appropriate reagents. AT 4 – Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, filtration, crystallisation. AT 6 – Safe use and careful handling of liquids and solids, including careful mixing of reagents under controlled conditions. WS 2.3, WS 2.4
Neutralisation (Chemistry only)	Spec ref.	Skills
Determination of the reacting volumes of solutions of a strong acid and a strong alkali by titration. (HT only) Determination of the concentration of one of the solutions in mol/dm ³ and g/dm ³ from the reacting volumes and the known concentration of the other solution.	Chemistry 4.4.2.4	AT 1- Use of appropriate apparatus to make and record a range of measurements accurately, including volume of liquids. AT 8 – The determination of concentrations of strong acids and strong alkalis. MS 1a, MS 1c, MS 2a, WS 2.4, WS 2.6

Electrolysis	Spec ref.	Skills
<p>Investigate what happens when aqueous solutions are electrolysed using inert electrodes.</p> <p>This should be an investigation involving developing a hypothesis.</p>	<p>Chemistry 4.4.3.4</p> <p>Trilogy 5.4.3.4</p> <p>Synergy 4.7.5.3</p>	<p>AT 3 – Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions.</p> <p>AT 7 – Use of appropriate apparatus and techniques to draw, set up and use electrochemical cells for separation and production of elements and compounds.</p> <p>AT 8 – Use of appropriate qualitative reagents and techniques to analyse and identify unknown samples or products including gas tests for hydrogen, oxygen and chlorine (Chemistry only).</p> <p>WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.6</p>
Temperature changes	Spec ref.	Skills
<p>Investigate the variables that affect temperature changes in reacting solutions, eg acid plus metals, acid plus carbonates, neutralisations, displacement of metals.</p>	<p>Chemistry 4.5.1.1</p> <p>Trilogy 5.5.1.1</p> <p>Synergy 4.7.3.3</p>	<p>AT 1 – Use of appropriate apparatus to make and record a range of measurements accurately, including mass, temperature, and volume of liquids.</p> <p>AT 3 – Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions.</p> <p>AT 5 – Making and recording of appropriate observations during chemical reactions including changes in temperature.</p> <p>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.</p> <p>MS 1a, MS 2a, MS 2b, MS 4a, MS 4c</p> <p>WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.6, WS 2.7</p>

Rates of reaction	Spec ref.	Skills
<p>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.</p> <p>This should be an investigation involving developing a hypothesis.</p>	<p>Chemistry 4.6.1.2</p> <p>Trilogy 5.6.1.2</p> <p>Synergy 4.7.4.3</p>	<p>AT 1 – Use of appropriate apparatus to make and record a range of measurements accurately, including mass, temperature, and volume of liquids.</p> <p>AT 3 – Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions.</p> <p>AT 5 – Making and recording of appropriate observations during chemical reactions including changes in temperature.</p> <p>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.</p> <p>MS 1a, MS 1c, MS 1d, MS 2a, MS 2b, MS 4a, MS 4b, MS 4c, MS 4d, MS 4e</p> <p>WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.6, WS 2.7</p>
Chromatography	Spec ref.	Skills
<p>Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate R_f values.</p>	<p>Chemistry 4.8.1.3</p> <p>Trilogy 5.8.1.3</p> <p>Synergy 4.2.2.4</p>	<p>AT 1 – Use of appropriate apparatus to make and record a range of measurements accurately.</p> <p>AT 4 – Safe use of a range of equipment to purify and/or separate chemical mixtures including chromatography.</p> <p>WS 2.4, WS 2.6</p>

Identifying ions (Chemistry only)	Spec ref.	Skills
Use of chemical tests to identify the ions in unknown single ionic compounds covering the ions from sections 4.8.3.1 to 4.8.3.5	Chemistry 4.8.3.7	<p>AT 1 - Safe use of a Bunsen burner.</p> <p>AT 8 - Use of appropriate qualitative reagents and techniques to analyse and identify unknown samples or products including gas tests, flame tests, precipitation reactions.</p> <p>WS 2.4, WS 2.6</p>
Water purification	Spec ref.	Skills
Analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.	Chemistry 4.10.1.2 Trilogy 5.10.1.2 Synergy 4.4.1.8	<p>AT 2 - Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater.</p> <p>AT 3 - Use of appropriate apparatus and techniques for the measurement of pH in different situations.</p> <p>AT 4 - Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, distillation.</p> <p>WS 2.3, WS 2.4, WS 2.5, WS 2.6, WS 2.7</p>

Physics required practicals

Specific heat capacity	Spec ref.	Skills
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.	Physics 4.1.1.3 Trilogy 6.1.1.3 Synergy 4.1.1.4	AT 1 - use appropriate apparatus to make and record measurements of mass, time and temperature accurately. AT 5 – use, in a safe manner, appropriate apparatus to measure energy changes/transfers and associated values such as work done. MS 2a, MS 2b, MS 3b, MS 3c WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.6, WS 2.7 WS 3.1, WS 3.2, WS 3.3, WS 3.4, WS 3.5, WS 3.6, WS 3.7, WS 3.8 WS 4.2, WS 4.3, WS 4.6
Thermal Insulation (Physics only)	Spec ref.	Skills
Investigate the effectiveness of different materials as thermal insulators and the factors that may affect the thermal insulation properties of a material.	Physics 4.1.2.1	AT 1 - use appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, volume and temperature. AT 5 – use, in a safe manner, appropriate apparatus to measure energy changes/transfers. MS 2a, MS 2c, MS 4c, MS 5c WS 1.2 WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.6, WS 2.7 WS 3.1, WS 3.3, WS 3.4, WS 3.5, WS 3.6, WS 3.8 WS 4.2, WS 4.3, WS 4.6
Resistance	Spec ref.	Skills
Use circuit diagrams to set up and check appropriate circuits to investigate the	Physics 4.2.1.3 Trilogy 6.2.1.3	AT 1 - use appropriate apparatus to measure and record length accurately. AT 6 - use appropriate apparatus to measure current, potential difference and resistance

<p>factors affecting the resistance of electrical circuits.</p> <p>This should include: the length of a wire at constant temperature; combinations of resistors in series and parallel.</p>	<p>Synergy 4.7.2.2</p>	<p>AT 7 - use circuit diagrams to construct and check series and parallel circuits</p> <p>MS 2a, MS 2b, MS 4b, MS 4c, MS 4d</p> <p>WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.5, WS 2.6, WS 2.7</p> <p>WS 3.1, WS 3.2, WS 3.3, WS 3.4, WS 3.5, WS 3.6,</p> <p>WS 3.7, WS 3.8</p> <p>WS 4.2, WS 4.3, WS 4.6</p>
<p>I-V characteristics</p>	<p>Spec ref.</p>	<p>Skills</p>
<p>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.</p>	<p>Physics 4.2.1.4</p> <p>Trilogy 6.2.1.4</p> <p>Synergy 4.7.2.2</p>	<p>AT 6 - use appropriate apparatus to measure current and potential difference and to explore the characteristics of a variety of circuit elements</p> <p>AT 7 - use circuit diagrams to construct and check series and parallel circuits including a variety of common circuit elements</p> <p>MS 2a, MS 2g, MS 4b, MS 4c</p> <p>WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.5, WS 2.6, WS 2.7</p> <p>WS 3.1, WS 3.4, WS 3.5, WS 3.6, WS 3.8</p> <p>WS 4.2, WS 4.3 , WS 4.6</p>
<p>Density</p>	<p>Spec ref.</p>	<p>Skills</p>
<p>Use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids.</p>	<p>Physics 4.3.1.1</p> <p>Trilogy 6.3.1.1</p>	<p>AT 1 - use appropriate apparatus to make and record measurements of length, area, mass and volume accurately. Use such measurements to determine the density of solid objects and liquids.</p>

<p>Volume should be determined from the dimensions of regularly shaped objects and by a displacement technique for irregularly shaped objects.</p> <p>Dimensions to be measured using appropriate apparatus such as a ruler, micrometer or Vernier callipers.</p>	<p>Synergy 4.1.1.2</p>	<p>MS 2a, MS 2b, MS 5c</p> <p>WS 1.2 , WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.6, WS 2.7</p> <p>WS 3.1, WS 3.5, WS 3.8</p> <p>WS 4.2, WS 4.3, WS 4.6</p>
<p>Light (Physics only)</p>	<p>Spec ref.</p>	<p>Skills</p>
<p>Investigate the reflection of light by different types of surface and the refraction of light by different substances.</p>	<p>Physics 4.6.1.3</p>	<p>AT 4 - make observations of the effects of the interaction of electromagnetic waves (light) with matter.</p> <p>AT 8 - make observations of waves in fluids and solids to identify the suitability of apparatus to measure the effects of the interaction of waves with matter.</p> <p>MS 2g, MS 4c, MS 5a, MS 5b</p>
<p>Force and Extension</p>	<p>Spec ref.</p>	<p>Skills</p>
<p>Investigate the relationship between force and extension for a spring.</p>	<p>Physics 4.5.3</p> <p>Trilogy 6.5.3</p> <p>Synergy 4.6.1.6</p>	<p>AT 1 - use appropriate apparatus to make and record length accurately.</p> <p>AT 2 - use appropriate apparatus to measure and observe the effect of force on the extension of springs and collect the data required to plot a force-extension graph.</p> <p>MS 2a, MS 2b, MS 4a, MS 4b, MS 4c</p> <p>WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.6</p> <p>WS 3.1, WS 3.2, WS 3.3, WS 3.5, WS 3.8</p> <p>WS 4.6</p>

Acceleration	Spec ref.	Skills
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.	Physics 4.5.6.2.2 Trilogy 6.5.4.2.2 Synergy 4.7.1.6	AT 1 - use appropriate apparatus to make and record measurements of length, mass and time accurately. AT 2 - use appropriate apparatus to measure and observe the effect of force. AT 3 - use appropriate apparatus and techniques for measuring motion, including determination of speed and rate of change of speed (acceleration/deceleration) MS 2a, MS 2b, MS 2g, MS 4a, MS 4b, MS 4c WS 2.1, WS 2.2, WS 2.3, WS 2.4, WS 2.6, WS 2.7 WS 3.1, WS 3.2, WS 3.3, WS 3.4, WS 3.5, WS 3.6, WS 3.7 WS 4.2, WS 4.3, WS 4.6
Waves	Spec ref.	Skills
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.	Physics 4.6.1.2 Trilogy 6.6.1.2 Synergy 4.1.4.1	AT 4 – make observations of waves in fluids and solids to identify the suitability of apparatus to measure speed, frequency and wavelength. WS 2.3, WS 2.6 WS 3.8 WS 4.2, WS 4.3
Radiation and absorption	Spec ref.	Skills
Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface.	Physics 4.6.2.2 Trilogy 6.6.2.2 Synergy 4.1.4.3	AT 1 - use appropriate apparatus to make and record temperature accurately. AT 4 – make observations of the effects of the interaction of electromagnetic waves with matter. MS 2c WS 3.8

