Discussion 2: teaching and learning of the required practicals

- Which practicals have been taught so far? Consider the positives and challenges.

- How have you approached the teaching and learning of AT and RPs?

  For example:
  - are the ATs the starting point?
  - are the ATs and RPs fully integrated into the teaching of WS and content?
  - are they taught separately from the teaching of WS and other content?

- How are learning outcomes determined by individual teachers?

- What conclusions have arisen as a result of department discussion about this?

- What are students recording for their ‘contemporaneous’ record?

Apparatus and Techniques – AQA specification

AT 1–7 are common with Combined Science. AT 8 is Biology only.

	Apparatus and techniques
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 (Biology only)	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).

AT 1–7 are common with Combined Science. AT 8 is Chemistry only.

	Apparatus and techniques
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 (Chemistry only)	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).

AT 1–7 are common with Combined Science. AT 8 is Physics only.

	Apparatus and techniques
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 and 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 (Physics only)	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 and j).

Opening up practical work: focus on aims and learning outcomes

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 shows how each required practical activity (RPA) 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 as MS and WS, respectively, on the table.

Our RPAs are deliberately familiar, using apparatus and materials that are readily available in most schools. This summary shows possible aims and learning outcomes for each of the RPAs and for convenience we have included our Entry Level Certificate (ELC) practical assignments too. All are grouped, for convenience, either as biology, chemistry or 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 ten required practical activities for biology, including the three needed for the standalone GCSE Biology qualification
- there are eight required practical activities for chemistry, including the two needed for the standalone GCSE Chemistry qualification
- there are ten required practical activities for physics, including the two needed for the standalone GCSE Physics qualification.

Making the most of your practical work

Biology required practical activities

Practical activities as described in specification	Spec ref.	Possible aims and learning outcomes
Microscopy 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 ELC Component 1	Aim: how big are cells? Are all cells the same size? Student is able to: • prepare slides of plant and animal cells and describe the procedure • correctly use a microscope to observe cells under different magnifications • make a clear drawing of a cell as observed under the microscope • calculate the magnification of a simple cell drawing • use a microscope with graticule to measure cells and calculate their real size (extension).
Microbiology Investigate the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition.	Biology only 4.1.1.6 ELC Component 3 Outcome 7	Aim: how do disinfectants or antibiotics affect the growth of bacteria? Student is able to: • plan and carry out a safe investigation into the effect of disinfectants or antibiotics on bacterial growth • calculate the cross-sectional areas of clear zones around disinfectant/ antibiotic discs using πr^2 • present and analyse results.

Osmosis 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	Aim: how does the concentration of a solution affect the size of potato chips? Student is able to: • suggest a hypothesis to explain changes in mass of potato chips • plan a procedure that provides evidence of changes in the size of potato chips when the concentration of solution changes • identify and control variables • read measurements off a scale and record in a table • make sufficient precise measurements.
Enzymes 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.	Biology 4.2.2.1 Trilogy 4.2.2.1 Synergy 4.2.1.5	Aim: how does pH affect the activity of the amylase enzyme? Student is able to: • work safely to produce repeatable results • record observations using correct units • describe patterns and trends in data • evaluate methods for quality of evidence • use a continuous sampling technique.
Food Tests 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.	Biology 4.2.2.1 Trilogy 4.2.2.1 Synergy 4.2.1.5 ELC Competency 1 Outcome 3	Possible aims: which molecules can diffuse through a semi-permeable membrane? (Test for starch or glucose). Or which urine samples suggest diabetes or kidney failure? (Test for sugars and protein). Or do red leaves carry out photosynthesis? (Test for starch). Or what's in the samples provided? Student is able to: • suggest a hypothesis • plan a procedure • make and record observations • describe patterns and trends in data and draw conclusions • evaluate quality of evidence.

Photosynthesis Investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.	Biology 4.4.1.2 Trilogy 4.4.1.2 Synergy 4.2.2.6 ELC Competency 2 or 3	Aim: how does light affect the rate of photosynthesis? Student is able to: • use appropriate apparatus and techniques to observe and measure oxygen gas production • record rate of production of oxygen gas • control temperature of water bath • describe patterns and trends in data and draw conclusions • evaluate quality of evidence.
Reaction time Plan and carry out an investigation into the effect of a factor on human reaction time.	Biology 4.5.2.1 Trilogy 4.5.2 Synergy 4.2.1.6 ELC Component 1 Outcome 8	Aim: how do external distractions affect reaction speed? Student is able to: • measure and record reaction times • work safely with others to measure reaction time and responses to a chosen factor • compare the speed of the catching reflex of two people.
Plant responses Investigate the effect of light or gravity on the growth of germinated seedlings.	Biology 4.5.4.1	Aim: does gravity affect the growth of plants? Or does light affect the growth of plants? Student is able to: • use plants safely and ethically to measure growth in response to light or gravity • make careful observations and produce labelled scientific drawings.

Field investigation Measure the population size of a common species in a habitat.	Biology 4.7.2.1 Trilogy 4.7.2.1 Synergy 4.4.2.4	How many plantain (daisies etc) grow on the field? Student is able to: • record length and area • use transect lines and quadrats to measure distribution of a species.
Field investigation Use sampling techniques to investigate the effect of a factor on the distribution of this species.	ELC Component 2 Outcome 6	Aim: does light affect the amount of moss/pleurococcus growing on a tree/wall? Student is able to: • use organisms safely and ethically • use sampling techniques to measure area of moss/pleurococcus cover. Aim: does trampling affect populations of plants? Student is able to: • suggest a hypothesis • plan a procedure • make and record observations • describe patterns and trends in data and draw conclusions • evaluate quality of evidence.

Decay Investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change.	Biology 4.7.2.3	Aim: which yoghurt is well past its sell by date? Will your yoghurt decay quicker if left out of the fridge? Student is able to: • suggest a hypothesis • plan a procedure • make and record observations • describe patterns and trends in data and draw conclusions • evaluate quality of evidence (use live yoghurt).

Chemistry required practical activities

Practical activities as described in specification	Spec ref.	Possible aims and learning outcomes
Making salts 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	Aim: who can make a pure sample of a salt? Student is able to: • use appropriate equipment to purify and separate chemical mixtures • use techniques including evaporation, filtration and crystallization • use indicators to measure pH of mixture • work safely. Handling liquids and solids carefully, including the mixing and heating of reagents.
Neutralisation (Chemistry only) 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/dm3 and g/dm3 from the reacting volumes and known concentration of the other solution.	Chemistry 4.4.2.4	Aim: how can titration using an indicator be used to measure the concentration of bottle X of sodium hydroxide solution? Student is able to: • measure reacting volumes of acids and alkalis accurately using a burette • use indicators to establish neutralization point • make and record accurate observations • process data to work out the concentration of the alkali • use ratios, fractions and percentages • substitute numerical values into equations using SI units g and dm3.

Electrolysis Investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis.	Chemistry 4.4.3.4 Trilogy 5.4.3.4 Synergy 4.7.5.3	Aim: is it possible to use electrolysis to help identify mystery salt solutions? Student is able to: • suggest a hypothesis • devise a plan • make & record detailed observations of the reactions at each electrode • collect & identify gases produced • justify findings based on evidence.
Temperature changes Investigate the variables that affect temperature changes in reacting solutions, eg acid plus metals, acid plus carbonates, neutralisations, displacement of metals.	Chemistry 4.5.1.1 Trilogy 5.5.1.1 Synergy 4.7.3.3 ELC Component 4 Outcomes 1, 2 and 3	Aim: athletes often use hot or cold packs to ease muscular aches and pains. Investigate which reactants would be most suitable for this purpose. Student is able to: • work safely. Handling liquids and solids carefully, including the mixing of reagents • use a thermometer to record observations carefully • record observations accurately • use evidence as the basis of conclusions • evaluate and suggest refinement of procedure.

Rates of reaction Investigate how changes in concentration affect the rates of reactions by a method involving measuring the volume of a gas produced (this should be an investigation involving developing a hypothesis). Investigate how changes in concentration affect the rates of reactions by a method involving a change in colour or turbidity.	Chemistry 4.6.1.2 Trilogy 5.6.1.2 Synergy 4.7.4.3 ELC Component 4 Outcome 4	Aim: how does the concentration of the acid affect the rate of reaction? Student is able to: • suggest a hypothesis • devise a plan • make and record accurate measurements of gas released • work safely when handling acids. Aim: how does the concentration of the acid affect the time it takes for the cross to disappear? Student is able to: • make and record accurate measurements of time • work safely when handling and mixing reagents • use models to explain observations in terms of the interactions between particles.
Chromatography Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.	Chemistry 4.8.1.3 Trilogy 5.8.1.3 Synergy 4.2.2.4 ELC Component 3 Outcome 6	Aim: do red leaves contain chlorophyll? Student is able to: • extract chloroplast chemicals from green and red plant leaves • use thin layer chromatography TLC • interpret chromatogram including rf values • reach a conclusion based on quantitative evidence.

Identifying ions (Chemistry only) 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	Aim: identify the metals in the following solutions. Student is able to: • use flame tests to identify lithium, sodium, potassium, calcium and copper ions • carry out procedure that reduces contamination • justify decisions based on evidence.
Water purification 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 ELC Component 4 Outcome 10	Aims: which colourless liquid is water? How can we purify this sample of water? Which water sample is fit to drink? What is the best way to make water fit to drink? Student is able to: • heat a sample of water safely using a Bunsen burner • use equipment carefully to evaporate and distil water samples • use a microscope to look for single celled organisms • use filter paper to remove insoluble solids • inoculate agar plate with water sample to culture possible microbes.

Physics required practical activities

Practical activities as described in specification	Spec ref.	Possible aims and learning outcomes
Specific heat capacity 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	Aim: which small metal block is the best heat store? Student is able to: • work safely and carefully with small hot metal blocks • identify and control key variables • make and record measurements of mass, time and temperature accurately • compare energy released as a temperature change by different hot metal blocks when immersed in water • calculate the specific heat capacity for each of the metals.
Thermal Insulation (Physics only) 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 ELC Component 5 Outcome 2	Aim: how does the number of layers affect the energy released as a temperature change from the beaker of water? Student is able to: • suggest a hypothesis • identify and control key variables • devise a plan • select appropriate apparatus • make and record accurate measurements • process and interpret data • reach a conclusion based on quantitative evidence.

Resistance 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.	Physics 4.2.1.3 Trilogy 6.2.1.3 Synergy 4.7.2.2	Aim: how does the length of a wire affect the resistance of a wire? Student is able to: • select components and assemble a suitable circuit • measure and record length accurately • measure current, potential difference and resistance. Aim: how does the length of a wire affect the resistance of a wire? Student is able to: • use circuit diagrams provided to construct and check series and parallel circuits • add resistors (or variable resistor) to these different circuits • use ammeters and voltmeters to measure current and potential difference in these circuits • process data to represent patterns of resistance in series and parallel circuits.
I-V characteristics 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.	Physics 4.2.1.4 Trilogy 6.2.1.4 Synergy 4.7.2.2	Aim: how does resistance vary for the following components? A filament lamp, diode and resistor. Student is able to: • construct and check series and parallel circuits • use appropriate apparatus to measure current and potential difference • process data to represent patterns in data for each component • reach a conclusion based on quantitative evidence.

Density 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.	Physics 4.3.1.1 Trilogy 6.3.1.1 Synergy 4.1.1.2 ELC Component 3 Outcome 8	Aim: complete the circus of activities to find the density of different solids and liquids Student is able to: • measure length, mass and volume accurately using suitable equipment such as calipers or a micrometer • use direct measurements and displacement of water • process data to calculate density for all objects provided.
Force and Extension Investigate the relationship between force and extension for a spring.	Physics 4.5.3 Trilogy 6.5.3 Synergy 4.6.1.6	Aim: how does the quantity of force affect the extension of a spring? Student is able to: • make and record length accurately • collect the data required to plot a force-extension graph.
Acceleration 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 ELC Component 5 Outcome 6	Aims: how does the height of a ramp affect the acceleration of the trolley? How does the mass of the trolley affect its acceleration? Student is able to: • make and record measurements of length, mass and time accurately • measure distance and time and calculate speed • measure rate of change of speed substituting values into simple equation • use equation, change in velocity divided by time taken to calculate acceleration • use light gates to measure acceleration.

Waves 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	
Light (Physics only) Investigate the reflection of light by different types of surface and the refraction of light by different substances.	Physics 4.6.1.3	Aims: which material would be most suitable for a cyclist to wear? Which material refracts light the most? Glass or water? Student is able to: • devise a plan • select appropriate equipment such as a light meter, protractor and ray box • make and record measurements • represent observations using ray diagrams • justify decisions based on evidence • evaluate methods and suggest improvements.
Radiation and absorption 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	Aim: which surface, dull black or shiny is the best radiator of heat? Student is able to: • identify and control variables • use a heat sensor or thermometer or measure time for wax to melt • make and record observations accurately • justify decisions based on evidence • evaluate methods and suggest improvements.