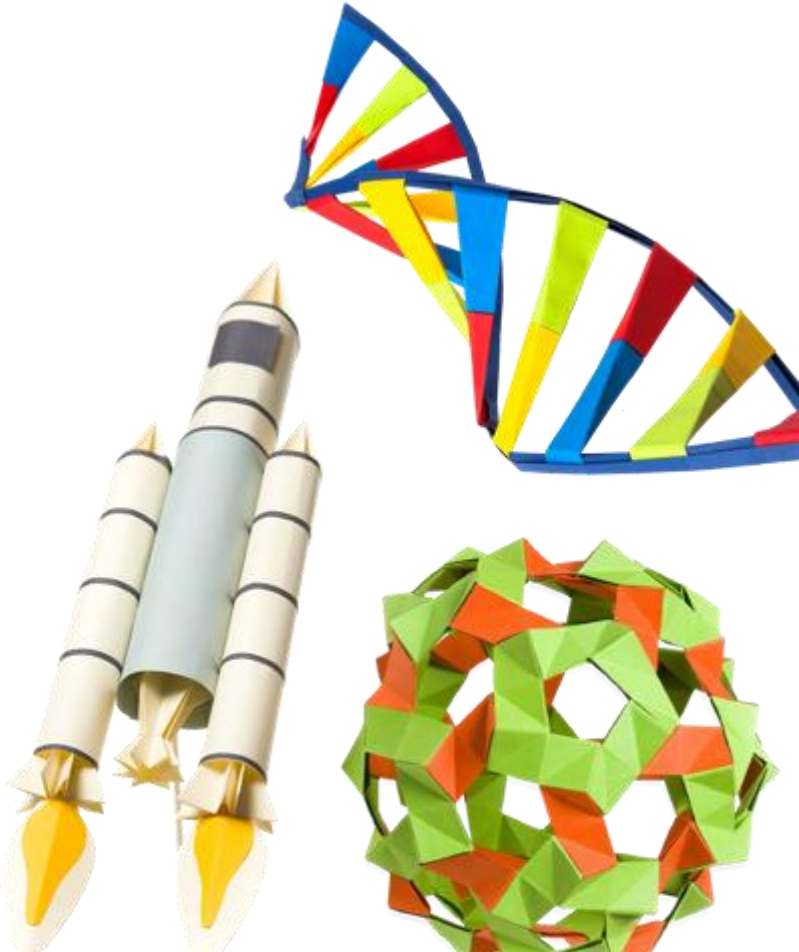
GCSE Combined Science

Impactful Practicals Summer Network



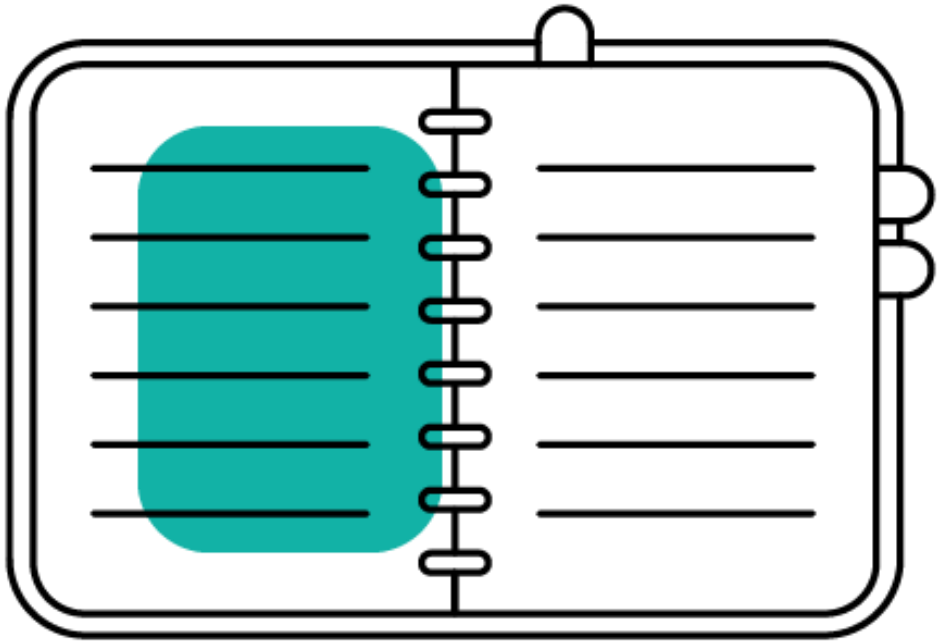
Impactful Practicals

Welcome and introductions

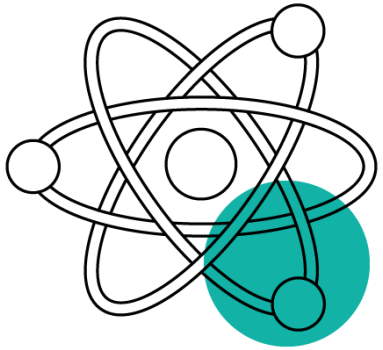
Agenda – Impactful Practicals

In this session we are going to:

- consider some of the barriers to effective practical work
- explore teaching and learning strategies to overcome these barriers and maximise learning from practical activities
- identify strategies to support SEND learners in science practicals
- share good practices with colleagues
- explore resources from Pearson Edexcel to support all learners in developing their practical skills.



What makes science great?



Practical work is the top motivator for studying science

- Language development
- Collaboration
- Communication
- Engagement
- Knowledge Retention

Purpose of practical work

To teach the principles of scientific inquiry	**Disciplinary knowledge**
To improve understanding of theory through practical experience	**Substantive knowledge**
To teach specific practical skills, such as measurement and observation	**Science-specific skills**
To motivate and engage students	**Enjoyment / engagement**
To develop higher level skills such as communication, teamwork and perseverance	**Wider skills**

Identify the skills or knowledge you are trying to develop

Practical work – insights from 2024 GCSEs

Positives…

In biology particularly, candidates were more familiar with the core practicals

Challenges…

- In chemistry and physics, students didn’t seem familiar with all core practicals
- Students were not always confident in names and uses of apparatus
- Even where the core practical method was described, the purpose of steps was unclear
- Not understanding the difference between control variables and dependent/ independent variables
- Describing controlling variables when asked to identify a control (test)
- Not responding to the context/question given, sometimes using different apparatus.

Securing the basics

What? How? Why?

Considering three of these challenges:

- Students not confident in names and uses of apparatus
- Even where the method was described, the purpose of steps was unclear
- Difference between control variables and dependent/ independent variables

We could take it back to basics and focus questions on:

What?

How?

Why?

Before progressing to more challenging questions such as novel contexts or improvements

Include a focus on disciplinary knowledge, such as variables.

Planning What? How? Why?

Consider **one** of the Core Practicals below:

1. Biology – Investigate the effect of pH on enzyme activity.
2. Chemistry – Investigate the preparation of pure, dry hydrated copper sulfate crystals starting from copper oxide including the use of a water bath.
3. Physics – Investigate the suitability of equipment to measure the speed, frequency and wavelength of a wave in a solid and a fluid.

Design at least one ‘what?’ ‘why?’ and ‘how?’ question.

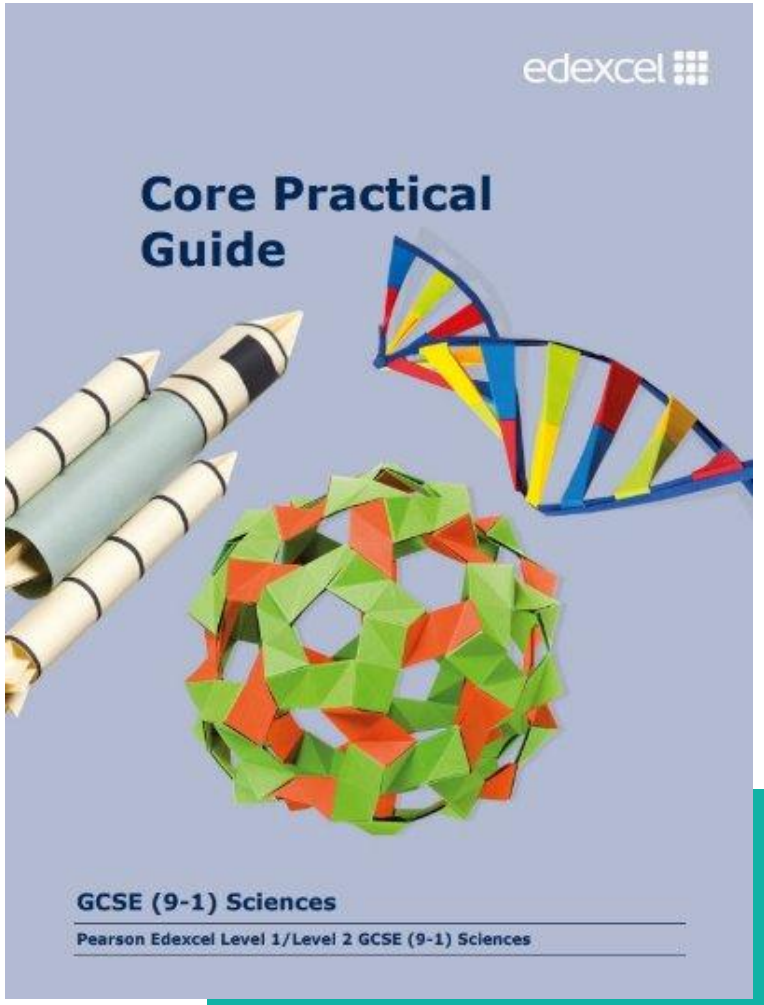
Share question ideas in chat, start your response with B, C or P.

Core Practical Guide

Free Core Practical Guide with Teacher, Technician and Student worksheets for every core practical.

Videos of all core practicals, which can be used in lessons to support students.

[Edexcel GCSE Sciences (2016) | Pearson qualifications]



Core Practical – Teacher Guides

Contents

Key

PRACTICAL SHOWN IN BOLD IS THE ADDITIONAL PRACTICAL REQUIRED FOR GCSE PHYSICS.

Icons

Short Videos | Long Videos | Key Questions | Student sheets | Exam-style questions

Core Practical – Student Guides

Light intensity and Photosynthesis

Questions you could ask to enhance learning and focus your students on important aspects of the practical:

- How can light intensity be measured?
- How can light intensity be calculated?
- What is the optimum temperature for this investigation?
- When should the algal balls be added to the indicator solution?
- What are the other variables that need to be controlled during the investigation?
- Why does algae work better than pondweed in this type of investigation?
- What are the benefits of using immobilised algae?
- Why does the rate of photosynthesis lead to a colour change in the indicator solution?
- Why is a tube of water placed between the light source and the tubes of indicator containing the algal balls?

Pearson Edexcel (9-1) |SHORTS | Investigating Photosynthesis | GCSE Combined Science | GCSE Biology

Questions to enhance learning – Biology

- Why is iodine solution used?
- Why are syringes used to measure the volumes of the solutions?
- Why does the mixture need to be stirred?
- Why are the solutions added in the order stated? (amylase solution, pH solution and starch solution)
- Why is the timer started after the starch solution is added?
- Why must the syringes be used in the same solutions when the investigation is repeated?
- What are the main errors in this procedure?
- How can you improve the procedure?
- What other factors could have affected the results?

Questions to enhance learning – Chemistry

- What safety precautions should you take when carrying out this experiment and why?
- Why was it necessary to warm the sulfuric acid?
- What colour was the copper sulfate solution that formed?
- Why was it necessary to add copper oxide until it was present in excess?
- How did you know when the copper oxide was present in excess?
- How did you separate the excess copper oxide from the copper sulfate solution?
- What is meant by the filtrate?
- What is meant by the residue?
- What is the filtrate in this experiment?
- What is the residue in this experiment?
- Why is a water bath used to evaporate the water from the copper sulfate solution instead of heating the evaporating basin directly with a Bunsen burner?
- Why should you not evaporate all of the water from the copper sulfate solution?

Questions to enhance learning – Physics

- Waves can be transverse or longitudinal. What type of wave is
  (a) a water wave on the surface of the water in a ripple tank?
  (b) a sound wave in a metal rod?
- How would you measure the speed of sound in air?
- How would you measure the speed of water waves in a ripple tank?
- Why can you not measure the speed of sound waves in a metal rod in the same way?
- Is it possible to measure the speed of light?

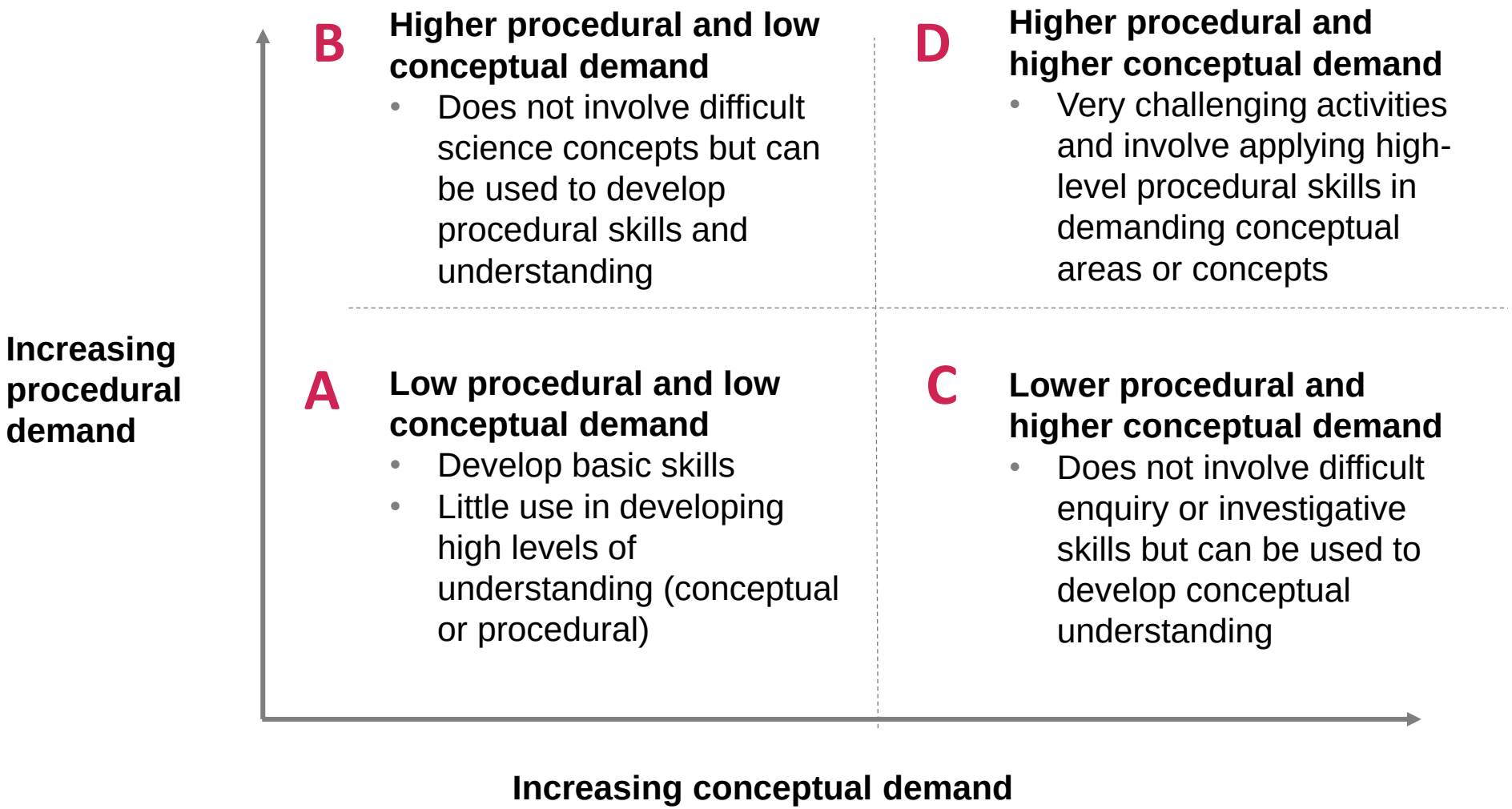
Supporting diverse learners in practical work

Supporting diverse learners

- We have diverse learners with a broad spectrum of learning styles and cognitive abilities.
- To maximise learning from practical work, we need to consider how to:

engage and motivate	hook learners in, spark interest, make the science relevant
present instructions	Considering cognitive load
embed the practical activities into the learning sequence	
scaffold practical activities and analysis	

Cognitive load



Discussion task 1 – supporting SEND and lower prior attaining learners in practical work

In breakout rooms discuss strategies used to support SEND and lower attaining learners in practical work.

15 minutes

For each example, identify whether this strategy is used to:

1. *engage and motivate*
2. *reduce cognitive load*
3. *other?*

Please nominate a spokesperson who is willing to feed back to the whole group

Examples of approaches

- Use of Assistive technology
- Multi-Sensory Approach
- Visual Aids
- Collaborative Learning
- Technology Integration
- Scaffolding
- Interactive Experiment

Multisensory approaches

Presenting practical instructions

Visually – using diagrams, videos, and visual aids

Auditory – discussion, teaching others, reading aloud, repetition, use of audio materials

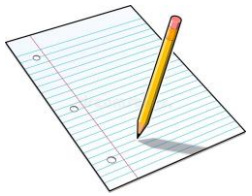
Kinaesthetic – through hands-on activities and experiments

Visual aids – integrated Instructions

1

50cm^3 of hydrochloric acid

2



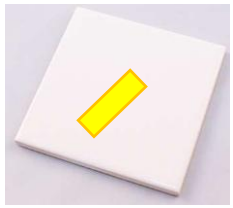
Estimate the pH

3

Amount of Calcium Hydroxide (g)	Estimated pH	Actual pH
0		
0.3		
0.6		
0.9		
1.2		
1.5		
1.8		
2.1		
2.4		

Draw table and record table next to ‘0’

4

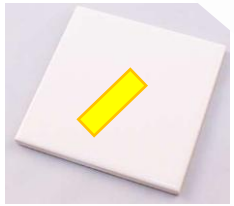


Place universal indicator paper on tile

5

Glass rod into acid

6



Drip on indicator paper and wait 30 seconds

7

Check against pH scale

8

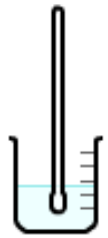
Rinse

9

Balance

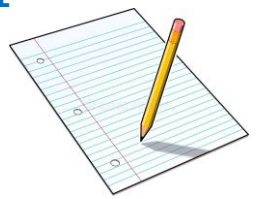
Measure calcium hydroxide on piece of paper

10



Add to beaker and stir

11



Estimate the pH and dip indicator into solution to find actual pH

12

Repeat stages 5 to 10 until 2.4g in total of calcium hydroxide has been added

Scaffolding – I do, we do…

Scaffolding – slow practicals

this involves slowing a hands-on practical activity down, teacher leading students through each step

well planned dialogue supports at each step, as in demonstration

reduces cognitive load as students are taught in chunks and can focus on the directed learning

used regularly in practical subjects such as technology

Interactive demonstrations

Virtual experiments and simulations – students can explore scientific concepts in a virtual environment using digital tools.

Multimedia resources – videos, animations, and interactive presentations can help illustrate complex scientific concepts.

Connect to real-world situations – use case studies, videos, and news stories to show how scientific knowledge is used in real-world situations.

Field trips – field trips to research facilities, parks, or museums can give students first-hand experiences.

Invite STEM professionals – invite STEM professionals to interact with students live or remotely.

Use games – Games like ChemEscape can help students apply their knowledge to new settings and strengthen teamwork and problem-solving skills.

Provide effective commentary and questioning – support demonstrations with effective commentary and questioning.

Interactive demonstrations

Stacked ball drop – energy & thermal physics

Reversing arrows – light, sound and waves

Kettle power – energy & thermal physics

Quick parallels – electricity and magnetism

Dancing sprinkles – light, sound and waves

Slink-o-scope – light, sound and waves

Ice, water, oil – properties of matter

Static crate – forces & motion

Steady spoon – forces & motion

Toppling bottles – forces & motion

Exploding jelly babies – chemistry

Digestion – body systems

Pigs lungs – body systems

Leaf blower – body systems

Illusions, reaction times – body systems

Magic writing – chemical reactions

Exploding can – reactions & synthesis

Determining molecular mass – Quantitative chemistry

Links to some demonstrations

- https://spark.iop.org/quick
- https://www.stem.org.uk/resources/elibrary/resource/30906/demonstrating-biology-eight-demonstrations
- https://www.stem.org.uk/resources/community/collection/10493/biology-demonstrations-and-practical-work
- https://edu.rsc.org/resources/collections/classic-chemistry-demonstrations

Planning for progression into core practicals

Planning for progression into core practicals

Consider the core practical:

Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:

a measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)

Skills that are covered in the practical:

- Use appropriate apparatus to make and record measurements of mass, volume of solutions, time, temperature and volume of gas
- Safe use of a water bath to investigate the effect of temperature on the rate of a reaction
- Use appropriate apparatus and techniques for monitoring chemical reactions, for example, a gas syringe or collecting gas over water in an upturned measuring cylinder
- Make and record observations and measurements of rate of reaction when a gas is produced or there is a colour change
- Safe use and careful handling of hydrochloric acid, marble chips and sodium thiosulfate solution

What do students need to know?

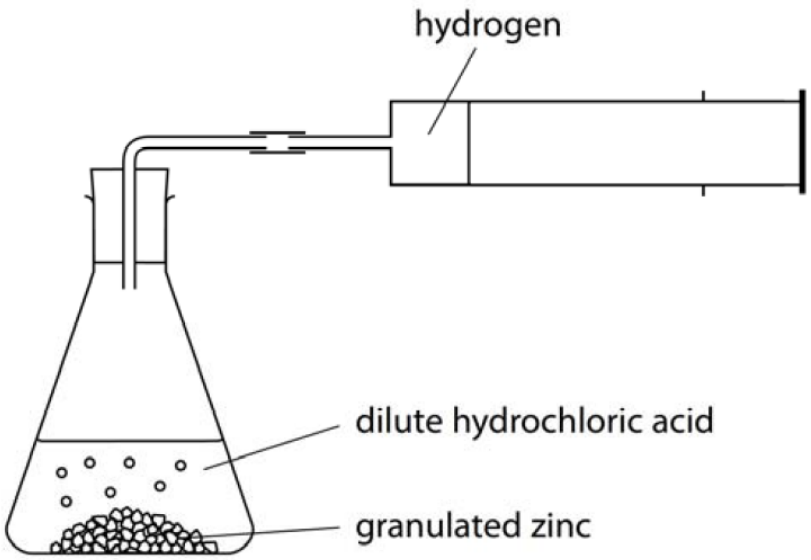
- The signs of a chemical reaction (KS3)
- Particle theory
- Factors affecting the rate of reaction – temperature, concentration, surface area
- Definition of rate
- Why a reaction stops
- ….

Where have students met rate before?

Metals reacting with acid – to determine reactivity (qualitatively) – how could we make this quantitative?

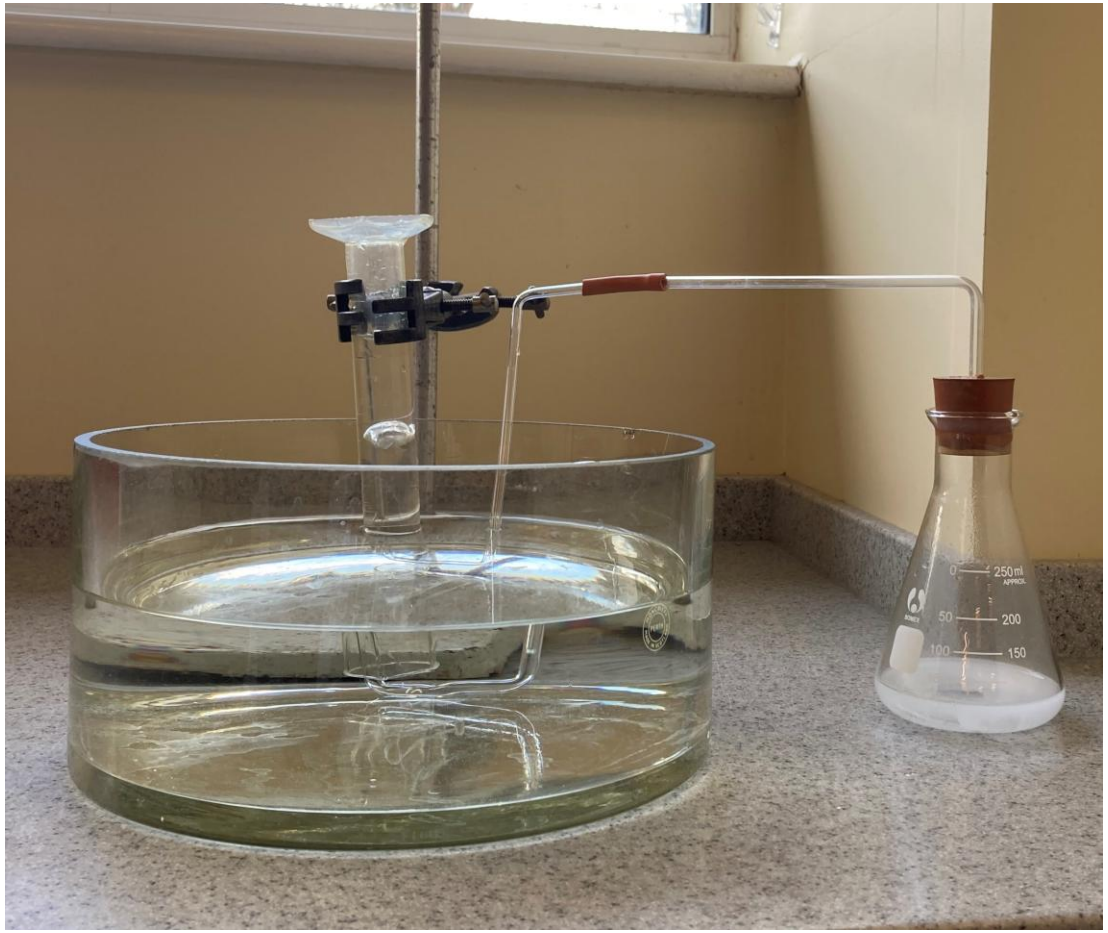
Measuring rate (1)

Method 1



Measuring rate (2)

Method 2



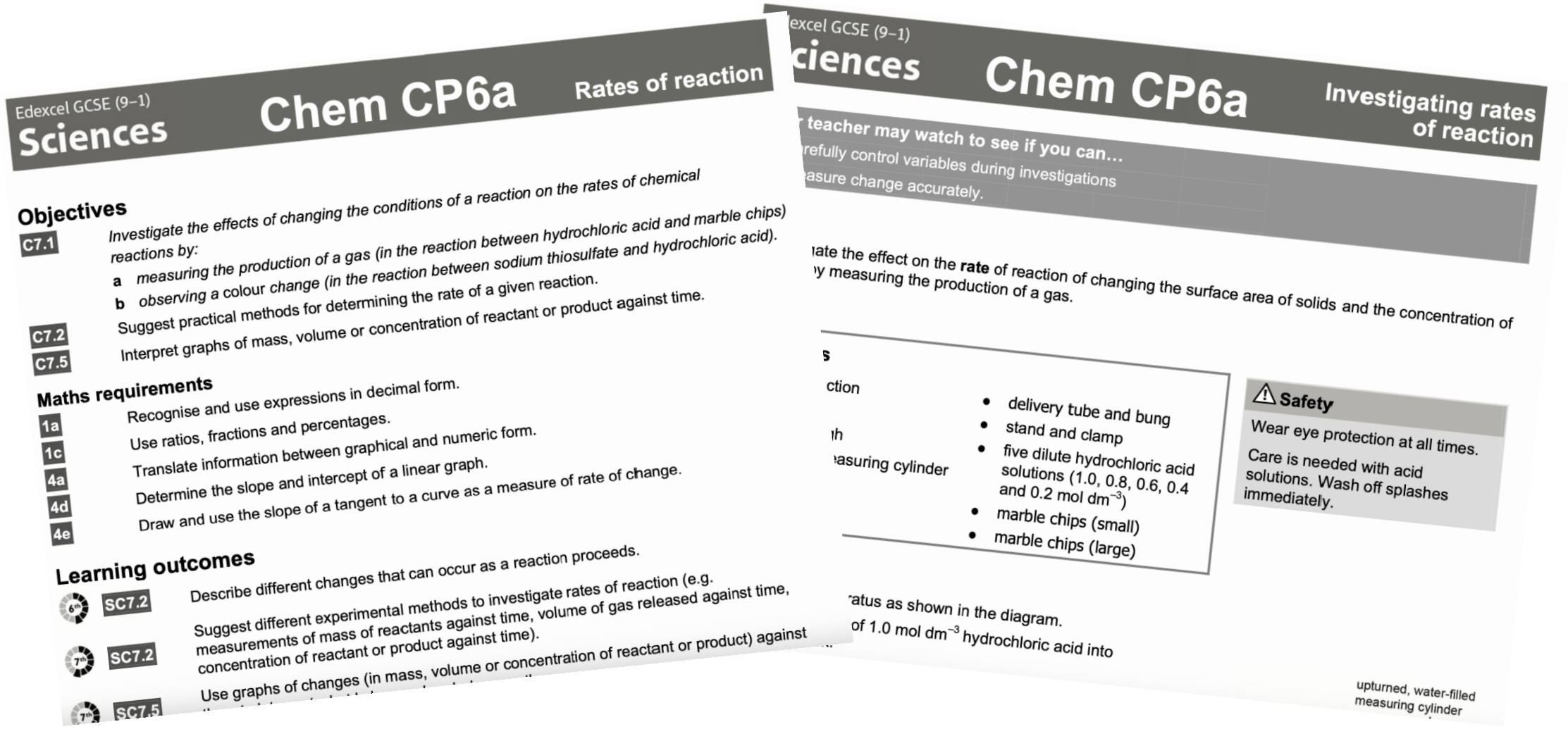
A possible teaching sequence

- Recap signs of a reaction – perhaps link to an equation
- Demonstrate a reaction and discuss how to measure rate
- Carry out a practical – such as the reaction of marble chips and acid and collect the gas, using an inverted measuring cylinder; or could record the loss of mass in a given time
- Recap what's happening in terms of collision theory (linking to the equation)
- Investigate the effect of changing a variable
- Process results
- Describe the graph
- Evaluate the method
- …

Alternative practicals

- Rate and rhubarb
- Effervescent tablets
- Glo sticks

Teacher and student sheets



Edexcel GCSE (9–1)
Sciences

Chem CP6a

Rates of reaction

Objectives

C7.1 *Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:*

a *measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)*

b *observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid).*

C7.2 Suggest practical methods for determining the rate of a given reaction.

C7.5 Interpret graphs of mass, volume or concentration of reactant or product against time.

Maths requirements

1a Recognise and use expressions in decimal form.

1c Use ratios, fractions and percentages.

4a Translate information between graphical and numeric form.

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.

Learning outcomes

SC7.2 Describe different changes that can occur as a reaction proceeds.

SC7.2 Suggest different experimental methods to investigate rates of reaction (e.g. measurements of mass of reactants against time, volume of gas released against time, concentration of reactant or product against time).

SC7.5 Use graphs of changes (in mass, volume or concentration of reactant or product) against

Edexcel GCSE (9–1)
ciences

Chem CP6a

Investigating rates of reaction

teacher may watch to see if you can…
refully control variables during investigations
asure change accurately.

ate the effect on the **rate** of reaction of changing the surface area of solids and the concentration of
y measuring the production of a gas.

ction

h

asuring cylinder

- delivery tube and bung
- stand and clamp
- five dilute hydrochloric acid solutions (1.0, 0.8, 0.6, 0.4 and 0.2 mol dm^{-3})
- marble chips (small)
- marble chips (large)

⚠ Safety

Wear eye protection at all times.

Care is needed with acid solutions. Wash off splashes immediately.

atus as shown in the diagram.

of 1.0 mol dm^{-3} hydrochloric acid into

upturned, water-filled measuring cylinder

Discussion task 2

Consider one of the core practicals and the skills it is intended to develop:

- B – Using microscopes
- C – Investigating composition of inks
- P – Investigating density

In breakout rooms, discuss:

a) Prior knowledge needed

b) An opportunity to lead into this practical activity at KS3

c) An alternative (additional) practical activity at KS4

Optional – Handout 3 provides a template to record ideas (one for each of B, C and P)

15 minutes

In summary

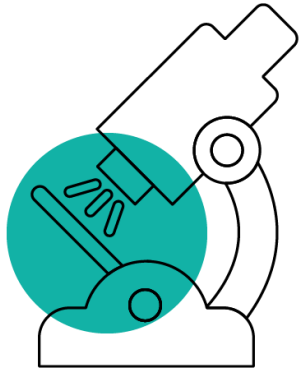
- Identify the purpose of all practical work
- Reflect these purposes in lesson outcomes and assessment
- Consider cognitive load linked with practical activities and adapt where needed, for example, **develop** demonstration skills (especially out of specialism)
- Consider the diverse needs of your learners and plan varying approaches
- Ensure the basics are secure (what, how, why?)
- Plan the journey through KS3 and 4 to support progression and application
- Plan in retrieval of core practicals; use homework/ independent learning as a means of revisiting methods
- Focus on variables wherever relevant.

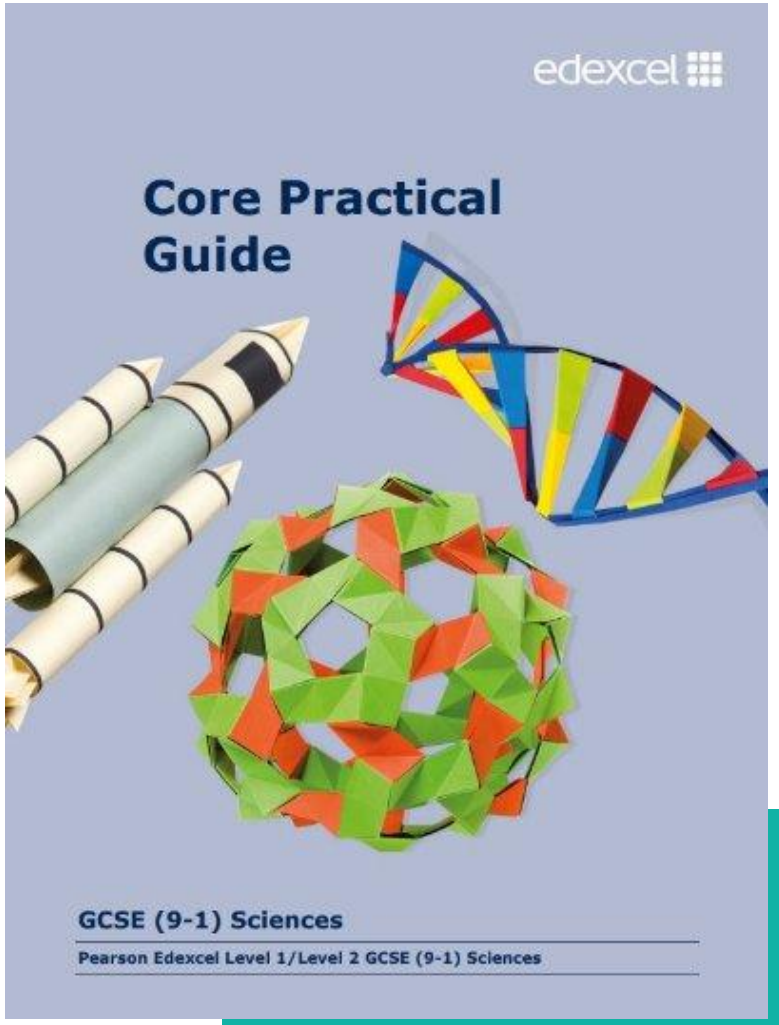
Core Practical Guide

Free Core Practical Guide with Teacher, Technician and Student worksheets for every core practical.

Videos of all core practicals, which can be used in lessons to support students.

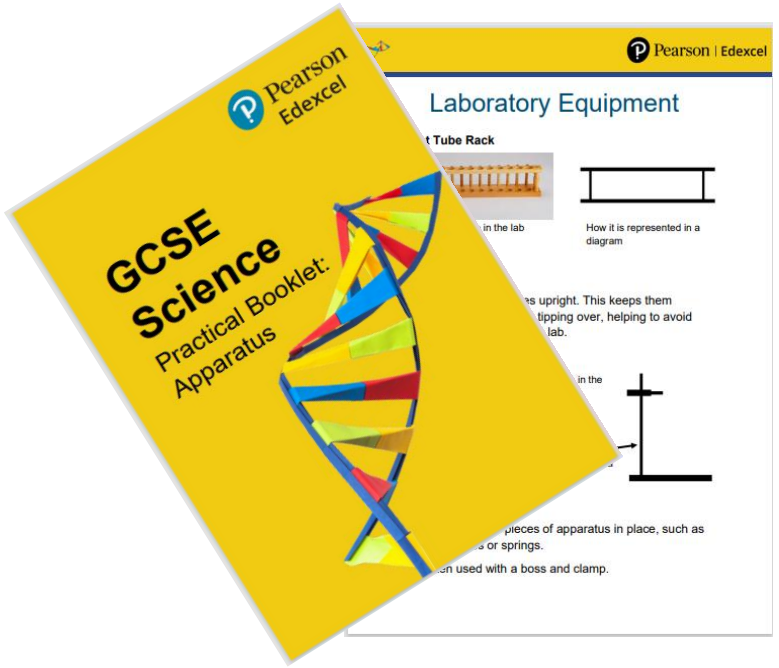
[Edexcel GCSE Sciences (2016) | Pearson qualifications]

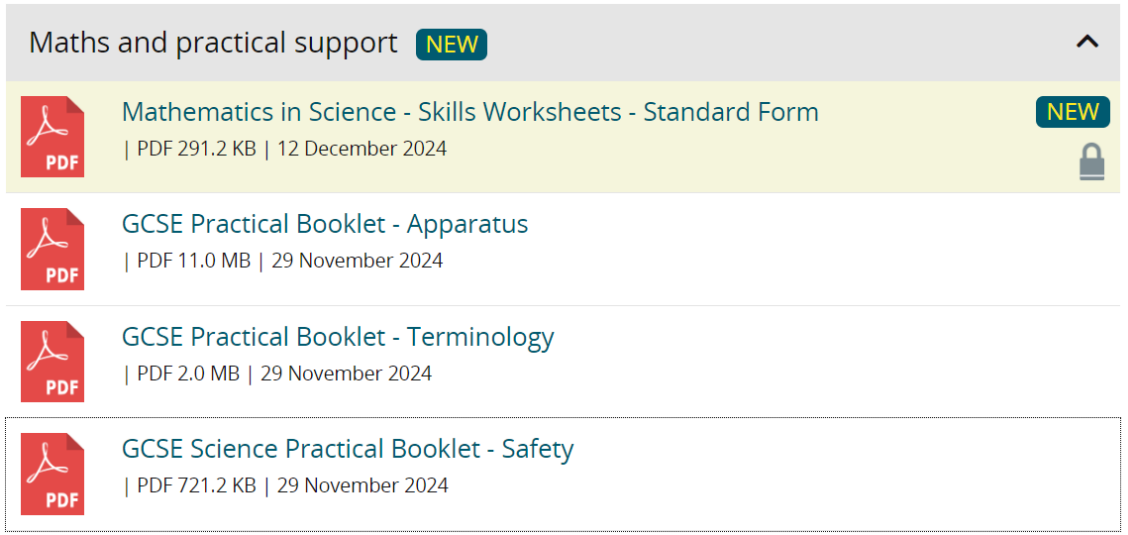




GCSE Practical Booklets

- GCSE Practical Booklets available for download from our Science qualifications page.
- [Edexcel GCSE Sciences (2016) | Pearson qualifications]





Gatsby Good Practical Science Report

Authored by Sir John Holman and published in 2017, the Gatsby Good Practical Science Report outlines a framework for effective practical science in schools. It was developed through international visits, research, surveys, and literature reviews, resulting in 10 benchmark recommendations to help schools assess their own practices.

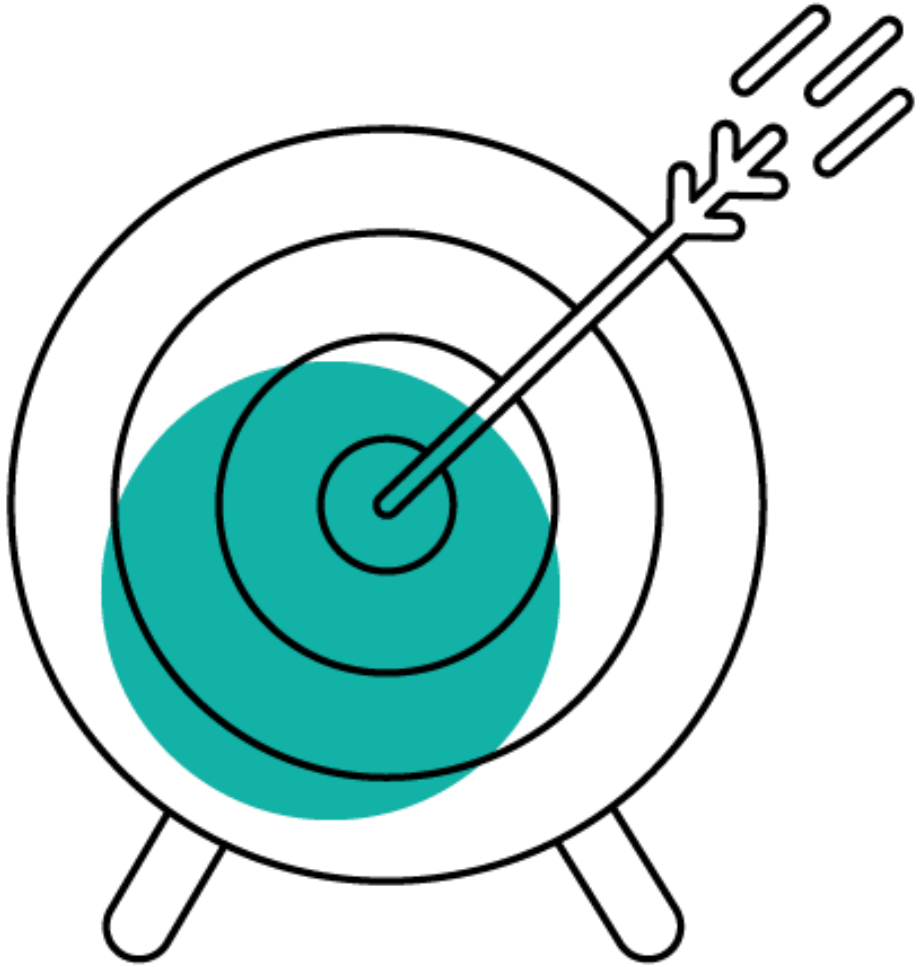
You can access the report by following this link:

https://www.gatsby.org.uk/education/programmes/support-for-practical-science-in-schools

Planning ahead

In this session we:

- consider some of the barriers to effective practical work
- explored teaching and learning strategies to overcome these barriers and maximise learning from practical activities
- delved into strategies to support SEND learners in science practicals
- shared good practice with colleagues
- explored resources from Pearson Edexcel to support all learners in developing their practical skills.



Identify any actions that you will take away from the session.

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Following this event, you will receive an invitation to share your thoughts about the session. Your feedback is invaluable to us, as it helps us tailor our professional development materials to better meet your needs. Please don’t hesitate to let us know what you’d like to see more of and what areas you think could be improved.

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