

## Doing better in GCSE science

This guidance is for teachers working with students who are predicted to be grade D/C on the GCSE exams. It is intended to support teachers in helping these students to achieve a grade C. The advice offered may also be useful to other teachers and in turn to many other students.

By the time students come to revise for their GCSEs they have covered most of the syllabus in lessons. Revision is not about doing those lessons again but about reminding students of what they have covered and learned and revisiting any aspects which remain unclear in their minds.

An important element of subject revision lessons is to provide students with the opportunity to learn, practise and refine revision techniques. In this way individual students will discover for themselves those techniques which are personally most effective. In addition, you can provide focused feedback, not just on the subject material, but also on the techniques. Using lessons just to complete or review past test papers is unlikely to be an effective strategy for helping D/C students to improve. Neither is giving students unstructured lesson time 'to revise' since many of these students are not very good at revising although they may well give the impression of industriously getting on with their work.

Remember to link your planned science revision with any whole-school programme and with advice that students may be receiving in their other subjects.

Further information and advice on helping these students revise and prepare for their exams can be found towards the beginning of the *GCSE booster pack* in the section 'GCSE booster: guidance for teachers and school leaders on using the materials'.

### Using the subject guidance leaflets

There are two leaflets for science. One is for you, the teacher; the other is for students.

It is envisaged that you will use these flexibly to suit your own circumstances. The student's leaflet can be photocopied and given to targeted students. Go through the leaflet with them. Encourage them to annotate it, and explain how your subject revision programme will fit with and support the students' own revision programmes and the advice on their leaflet.

Use the teacher's leaflet to plan your revision programme, covering those topics and aspects which you have identified as most relevant to the students. Encourage the students, at intervals during the revision programme, to use the traffic light system on their leaflet to assess their confidence in each aspect and to check with you those which remain difficult.

A number of revision activities are suggested in the teacher's leaflet, but plan your revision programme to suit your own students. Using specific revision activities is less important than planning to use a range to ensure that your lessons retain variety and that you offer students opportunities to work in their preferred ways.

## Doing better in GCSE science

To achieve a grade C in GCSE science your students need to be able to show that they can do all of the following, not just by chance, but because they understand and are confident in what they are doing.

What students need to be able to do	What this means to them	How you can help them improve
<p><b>1</b> Remember important information from all the areas of science</p>	<ul style="list-style-type: none"> <li>• Knowing the big ideas in biology, chemistry, physics, and earth science, e.g. cells and organisms; health; photosynthesis and respiration; genetics and inheritance; interdependence and ecology; particles, elements and compounds; equations and reactions; energy, electricity; forces and motion; waves; earth and space; rocks and metals</li> </ul>	<ul style="list-style-type: none"> <li>• Make sure all students have a complete set of notes, either their own or from a revision guide</li> <li>• Show students how to read each topic and to record the main points briefly on cards</li> <li>• Use lesson time to practise this skill</li> <li>• Use these cards for revision later</li> </ul>
<p><b>2</b> Talk about and describe science using the correct words, symbols and, where necessary, remembering the units for quantities</p>	<ul style="list-style-type: none"> <li>• Taking time to learn key words and their meanings</li> <li>• When describing something, making sure what they write is exactly what they mean</li> <li>• Remembering that in science numbers usually have units, e.g. mm, g, N, A</li> </ul>	<ul style="list-style-type: none"> <li>• Help students make a list of <b>key words</b> for each topic and write meanings for any they are unsure of</li> <li>• Use paired work in which students test one another on the meanings and spellings of some of the words</li> <li>• Have a periodic table on display and check chemical symbols every time you or students read or write the name of an element</li> <li>• Organise some paired work in which one partner names a compound and the other writes down its chemical formula</li> <li>• Make and play a loop card game from scientific quantities and their units</li> </ul>
<p><b>3</b> Explain how things work and why they are important</p>	<ul style="list-style-type: none"> <li>• Going beyond describing things by giving a scientific reason; using the word <b>because</b> If the question is: <i>Use what you know about particles and rates of reaction to explain why thin chips cook faster than thick ones</i> – the answer could be: <i>Thin chips cook faster because for every 1g of chip, thin chips have a greater surface area than thick ones. This means that for every 1g of chip more particles of oil can collide with the surface of the chip and transfer energy by heating it. Being thinner, the energy has less distance to travel through the chip to cook the inside.</i></li> </ul>	<ul style="list-style-type: none"> <li>• Show students how to draw flow charts that link structures to what they do and why</li> <li>• Ensure they write the name of the structure or substances in the first box, what it does or is used for in the second and why in the third; make sure that they include the word <b>because</b> between boxes two and three</li> </ul>

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4 Follow simple balanced equations for reactions	<ul style="list-style-type: none"> <li>Writing equations in both words and as chemical formulae, perhaps filling in the names of any chemicals missing from an equation they are given</li> </ul>	<ul style="list-style-type: none"> <li>Organise paired work in which one of the pair gives the other word and chemical symbol equations with one or more substances missing</li> </ul>
5 Perform simple calculations	<ul style="list-style-type: none"> <li>Working out things like the speed of an object if given the time and the distance it moved, or calculating the current in a circuit if the voltage and resistance are given</li> </ul>	<ul style="list-style-type: none"> <li>Provide opportunities for students to work on familiar calculations and play with the numbers to see what happens</li> <li>Try the following example: <i>Calculate the speed of a car which covers 1 km in 30 seconds. Write the answer as metres per second. How does the speed change if the time is 45 seconds, or the distance falls to 0.75 km?</i></li> <li>Spend time building a list of the most common formulae covered in science</li> <li>Show students how to write down what each symbol means next to each formula, e.g. <math>V = I \times R</math>; <math>V</math> = voltage in volts (V); <math>I</math> = current in amps (A); <math>R</math> = resistance in ohms (<math>\Omega</math>)</li> </ul>
6 Describe links between related aspects of science	<ul style="list-style-type: none"> <li>Seeing the bigger science picture rather than just remembering scientific facts For instance, if given some information about a person with short sight, using what they know about lenses to work out what sort of lens is needed to correct the person's vision. If told about what an unfamiliar animal eats, fitting it into a food web and explaining how introducing this animal could affect other animals and plants in that web.</li> <li>Seeing science as a whole and as more than a number of unrelated topics</li> </ul>	<ul style="list-style-type: none"> <li>Demonstrate and help students practise drawing concept maps of big science ideas they have studied, e.g. industrial pollution; using enzymes in industry; generating electricity; atoms, ions, elements and compounds; waves</li> <li>Explain how to write main ideas in boxes and join boxes with lines to show links; write a word or two on each line to explain the nature of the link, e.g. 'is made from', 'can be converted into', 'feeds on', 'is the same as'</li> </ul>
7 Use diagrams	<ul style="list-style-type: none"> <li>Drawing accurate diagrams</li> <li>Knowing what sort of information can be communicated through a diagram</li> <li>Looking at diagrams carefully and noticing every detail</li> </ul>	<ul style="list-style-type: none"> <li>Provide opportunities for students to look closely at a diagram, cover it up and either redraw it to show the main features or write some brief words or notes on what the main features are</li> <li>Over time include as many as possible of the familiar diagrams</li> </ul>
8 Use charts and graphs	<ul style="list-style-type: none"> <li>Knowing how to draw charts and graphs from numbers and, conversely, how to get numbers from charts and graphs</li> <li>Drawing a line of best fit in a line graph</li> <li>Taking readings from line graphs, interpreting them to identify patterns and predicting what might happen if the graph continued</li> </ul>	<ul style="list-style-type: none"> <li>Demonstrate how to sketch line graphs and to explain the shape of the line, e.g. a cup of tea cooling down on a normal day, the same cup of tea cooling in a fridge</li> <li>Provide opportunities for students to practise this in pairs or large groups</li> </ul>

What students need to be able to do	What this means to them	How you can help them improve
<p><b>9</b> Describe how scientists test predictions by looking for evidence</p>	<ul style="list-style-type: none"> <li>• Identifying what evidence is useful and what is not</li> <li>• Identifying whether any useful evidence is enough to support a prediction</li> <li>• Making this kind of judgement about evidence provided even if the investigation is not one the student has performed</li> <li>• Seeing how different people might have different views and being able to explain their own views using evidence</li> </ul>	<ul style="list-style-type: none"> <li>• Provide a range of newspaper or magazine articles on a scientific topic</li> <li>• Model underlining or highlighting words or phrases which describe evidence, not opinion or conclusion, and provide opportunities for students to do this</li> <li>• Organise students to work in groups, drawing their own conclusions and comparing them with those in the articles</li> </ul>
<p><b>10</b> Describe how different people may have different views on the value of evidence and what it might mean</p>	<ul style="list-style-type: none"> <li>• Saying how two people can look at similar sets of results but emphasise different aspects of them and so draw different conclusions or interpret them in different ways</li> </ul>	<ul style="list-style-type: none"> <li>• Provide completed tables of results done by this or any group of students and, in each case, a parallel table where the results have been altered slightly to make them a little ambiguous</li> <li>• Ask students to work in small groups to draw and compare conclusions from both sets of results</li> </ul>
<p><b>11</b> Identify how to plan an investigation to answer a question, including identifying all the variables and explaining how they can be controlled</p>	<ul style="list-style-type: none"> <li>• Applying what they have learned from their own investigations to other, less familiar investigations</li> <li>• Recognising that the skills needed to plan and carry out an investigation are the same no matter what the investigation</li> </ul>	<ul style="list-style-type: none"> <li>• Work through the planning process for an investigation with groups of students and help them appreciate how each of the stages links to the others</li> <li>• Provide opportunities for students to practise writing out instructions for an investigation; ensure they record the factor they are investigating and those that need to be kept the same</li> <li>• Ask pairs of students to work together, questioning their partner about any aspects of the plan they don't understand</li> </ul>
<p><b>12</b> Know how to use scientific apparatus appropriately so that measurements and observations are as accurate as possible</p>	<ul style="list-style-type: none"> <li>• Answering an exam question on practical work using what they remember from a similar activity they have done and how they obtained accurate results</li> </ul>	<ul style="list-style-type: none"> <li>• Provide opportunities for students to work in pairs in which one draws a quick simple sketch of some scientific apparatus and shows it to their partner, who then asks questions about, e.g., what the apparatus is used for, what is an example of an investigation where it might be used</li> </ul>

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<p><b>13</b> Know when to repeat measurements or observations</p>	<ul style="list-style-type: none"> <li>Explaining that repeating measurements or observations helps increase confidence in them</li> <li>Explaining that repeating increases their reliability, which allows scientists to be more certain of their conclusion</li> <li>Appreciating that taking measurements again does not make their results more accurate</li> </ul>	<ul style="list-style-type: none"> <li>Ask students to use their watches to time how long it takes to do a familiar task such as typing their name in a text message or eating a crisp; do the task three times; work out the average of each set of results</li> <li>Provide examples of data with no repeat readings, then one repeat, then two, and ask students to work out average values in each case to show the increase in reliability of the final results</li> </ul>
<p><b>14</b> Identify important information from graphs and data, explain patterns in results and draw conclusions which match the evidence</p>	<ul style="list-style-type: none"> <li>Looking for patterns in tables, charts and graphs</li> <li>Identifying any anomalous results</li> <li>Identifying features of a line graph such as the highest, lowest or fastest points</li> <li>Taking data from a graph</li> <li>Making reasoned predictions of what would happen next, what results are likely if the line graph is extrapolated beyond existing data</li> </ul>	<ul style="list-style-type: none"> <li>Provide tables of results from any investigation, and ask students to 'tell the story of the data', describing in words any patterns they see</li> <li>Provide line graphs, or get students to plot some from given data; ask them to take data from the graph, to explain patterns, to predict beyond the data and to explain their reasoning</li> </ul>
<p><b>15</b> Use science knowledge and understanding to explain conclusions</p>	<ul style="list-style-type: none"> <li><b>Explaining</b> why things have happened and not just <b>describing</b> what has happened, e.g. <i>The water warmed up fastest in the dull black cup because dull black is a better absorber of infra-red radiation</i></li> </ul>	<ul style="list-style-type: none"> <li>Provide a number of explanations or conclusions based on a common set of data, and ask students to say which they think is the best answer and why</li> <li>Encourage students to try asking themselves <b>why</b> questions about everything they see, e.g. <i>Why isn't there any grass under that tree? Why is the car radiator painted black? Why shouldn't I put metal objects in the microwave?</i></li> </ul>
<p><b>16</b> Evaluate how good any evidence is and how strongly it supports a conclusion</p>	<ul style="list-style-type: none"> <li>Asking the questions: <i>How sure am I about this? Do I really have enough evidence to be certain? What extra experiments do I need to do?</i></li> </ul>	<ul style="list-style-type: none"> <li>Provide scientific 'stories' from sources outside the classroom, e.g. television, radio, magazines or newspapers</li> <li>Ask students to provide some scientific 'stories' themselves, perhaps things they hear from friends, e.g. <i>Hey, Mick, did you know mobile phones fry your brain?</i></li> <li>Model with students asking questions about the 'stories', e.g. <i>How does he know? What evidence does he have?</i></li> </ul>

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To get a grade C in GCSE science you need to be confident in these areas.

(Use the code in the second column to say how well you think you are doing: G - green, very confident; O - orange, not fully sure; and R - red, not very confident. Ask your teacher about anything you colour red.)

Can I?		What can I do to improve?
<p><b>Describe and explain the important ideas</b> in biology, chemistry, physics and earth science.</p>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">R</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">O</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">G</div> </div>	<ul style="list-style-type: none"> <li>• <b>Make sure I have a complete set of notes</b>, either my own notes or a revision guide.</li> <li>• Read each topic and then <b>write the main points on cards</b>.</li> <li>• <b>Use these cards for further revision later</b>.</li> </ul>
<p><b>Use correct scientific words</b> to write exactly what I mean; and, when I write numbers, I <b>always include the units</b> - for example, millimetres (mm), grams (g) or newtons (N).</p>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">R</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">O</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">G</div> </div>	<ul style="list-style-type: none"> <li>• <b>Every time I read or write the name of an element, check its symbol using a periodic table</b>. Work with a friend: Take turns to name a compound; the other person writes down its chemical formula. Use a periodic table if this helps.</li> <li>• <b>Make a list of key words and their meanings for each topic</b>. Work with a friend: Test each other on meanings. Test each other on spellings.</li> </ul>
<p><b>Explain how things work</b> and not just describe what they do - <b>use the word because</b>. For example: Q. Explain how a red blood cell is adapted for what it does (its function). A. A red blood cell is adapted to be good at carrying oxygen <b>because</b>:</p> <ul style="list-style-type: none"> <li>• it is small, so more cells can be packed into the blood;</li> <li>• it has no nucleus, so there is more space for the haemoglobin which carries the oxygen around the body.</li> </ul>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">R</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">O</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">G</div> </div>	<ul style="list-style-type: none"> <li>• <b>Use flow charts to link structures to what they do and how they do it</b>. Write the name of the structure or substances in the first box, what it does or is used for in the second and <b>how</b> or <b>why</b> in the third.</li> <li>• <b>Make sure to include the word because</b> between boxes two and three.</li> </ul> <div style="text-align: center; margin-top: 10px;"> <pre> graph LR     A[Red blood cell] --&gt; B[good at carrying oxygen]     B -- because --&gt; C["Small - so many can fit into vessels No nucleus - full of haemoglobin"]     </pre> </div>
<p><b>Join different aspects of science together and see the bigger scientific picture</b>. Don't just remember scientific facts. For example: I am told about what an animal I have not heard of eats. Can I:</p> <ul style="list-style-type: none"> <li>• fit it into a food web;</li> <li>• explain how introducing this animal could affect other animals and plants in that web?</li> </ul>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">R</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">O</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; margin: 2px; text-align: center; line-height: 20px;">G</div> </div>	<ul style="list-style-type: none"> <li>• <b>Draw concept maps of some important topics I have studied in science</b> - for example, industrial pollution; using enzymes in industry; generating electricity; atoms, ions, elements and compounds; waves.</li> <li>• <b>Write the main ideas in boxes and join the boxes with lines to show the links</b>.</li> <li>• <b>Write a word or two on each line to explain the link</b> - for example, 'is made from', 'can be converted into', 'feeds on', 'is the same as'.</li> <li>• <b>Make a list of all the topics I have studied</b>. Sort out the ones I am less sure about and work on these first.</li> </ul>

Can I?		What can I do to improve?
<p><b>Explain how scientists test predictions by looking for evidence.</b></p> <p><b>Decide:</b></p> <ul style="list-style-type: none"> <li>• what evidence is useful and what is not;</li> <li>• whether there is enough evidence to support a prediction.</li> </ul>	<div style="border: 1px solid black; padding: 5px; text-align: center;">       R O G     </div>	<ul style="list-style-type: none"> <li>• Take any newspaper or magazine article about a scientific topic.</li> <li>• Underline (or highlight) words or sentences that describe evidence and are not someone's opinion.</li> <li>• <b>Draw my own conclusion and compare it with the conclusion in the article.</b></li> </ul>
<p><b>Explain how two people can look at the same set of results and see different things</b> and so draw different conclusions.</p> <p><b>Explain my own view of the evidence.</b></p>	<div style="border: 1px solid black; padding: 5px; text-align: center;">       R O G     </div>	<ul style="list-style-type: none"> <li>• Find the results table for an investigation I have done.</li> <li>• Ask a friend to <b>draw a conclusion from the results and compare it with my conclusion.</b></li> </ul>
<p><b>Identify important information from graphs and data.</b> For example:</p> <ul style="list-style-type: none"> <li>• Look for patterns.</li> <li>• Identify any odd results that don't fit the pattern.</li> <li>• Find the highest, lowest or fastest part of a line graph.</li> <li>• Read a number off a graph.</li> <li>• Extend the best-fit line on a graph to predict what might happen next.</li> </ul>	<div style="border: 1px solid black; padding: 5px; text-align: center;">       R O G     </div>	<ul style="list-style-type: none"> <li>• Look at some results from an experiment. Try to spot any results which are unusual or don't fit the pattern (anomalous). Explain to a friend why I have chosen these results.</li> <li>• Work with a friend. Sketch the shape of the graph from some familiar experiments - for example, cooling, enzyme reactions, rates of chemical reactions, speed or acceleration.</li> <li>• <b>Extend the line further than the data I have and explain the new shape I have chosen.</b></li> </ul>
<p>Always try to <b>explain why things have happened</b> and not just describe what has happened.</p> <p><b>Use the science I have learnt to help me explain why.</b> For example: The water warmed up fastest in the dull black cup <b>because</b> dull black is a better absorber of infra-red radiation.</p>	<div style="border: 1px solid black; padding: 5px; text-align: center;">       R O G     </div>	<ul style="list-style-type: none"> <li>• Check that I have used the word <b>because</b> in my answers.</li> <li>• Ask myself: <b>What science have I used in this answer?</b></li> <li>• Ask myself <b>Why</b> questions about everyday things - for example:       <ul style="list-style-type: none"> <li>- <b>Why</b> isn't there any grass under that tree?</li> <li>- <b>Why</b> is the car radiator painted black?</li> <li>- <b>Why</b> shouldn't I put metal objects in the microwave?</li> </ul> </li> </ul>
<p><b>Do simple calculations.</b></p> <p>For example:</p> <ul style="list-style-type: none"> <li>• Work out the speed of an object if I am told the time and the distance it moved.</li> <li>• Calculate the current in a circuit if I am told the voltage and resistance.</li> </ul>	<div style="border: 1px solid black; padding: 5px; text-align: center;">       R O G     </div>	<ul style="list-style-type: none"> <li>• <b>Work on familiar calculations and change some of the numbers to see what happens</b> - for example:       <ul style="list-style-type: none"> <li>- Calculate the speed of a car which covers 1 km in 30 seconds. Write the answer in metres per second.</li> <li>- Change the distance to 0.75 km. Work out the speed now.</li> <li>- Change the time to 45 seconds. Work out the speed now.</li> </ul> </li> <li>• <b>Write a list of all the formulae I have come across in science.</b></li> <li>• <b>Write down what each symbol means next to each formula.</b></li> <li>• <b>Write down what unit I would use for each number.</b></li> </ul>