

Scheme of work – Unit F181 – Science in society

About this Scheme of work

Our new AAQ Cambridge Advanced National in Unit F181 – Science in society is for first teaching from September 2025.

This resource:

- is **unit-specific** and has a **lesson by lesson** approach by area of study and allocated guided learning hours (GLH)
- has a **simple** and **editable** Word format
- highlights each lesson's **key words/terms** and **learning outcomes**
- contains **ideas** for teaching and learning with useful **links**
- provides additional **subject knowledge support by area of study**.

Assumptions for teachers

- You will adapt the SOW and lesson content to match your own timetabling arrangements
- You are aware that this SOW is just one approach to how the specification could be taught and the use of any resources highlighted is optional
- Students can access some resources outside of lessons for any online homework or extension tasks
- You will refer to the [Cambridge Advanced National in Applied Science specification](#) as the key document for detailed insight into the qualification's content and assessment requirements.

In this scheme of work we have made suggestions for useful resources both for in class activities and for teacher subject knowledge enhancement. Where we have included a reference to endorsed products such as the Cambridge Advanced National textbook, this indicates that a resource is suitable to support delivery of an OCR specification, but it does not mean that the endorsed resource is the *only* suitable resource to support delivery, or that it is required or necessary to achieve the qualification. Unlike endorsed resources, the other listed resources have not been subject to review and so we cannot offer recommendations or guarantee the quality. We leave this to your professional judgment. These resources are suggestions and are not the only ones suitable to support delivery, neither are they required or necessary to achieve the qualification.

Performance objectives

Here is a reminder of the performance objectives in Unit F181 – Science in society

Performance Objectives	
PO1	Show knowledge and understanding
PO2	Apply knowledge and understanding
PO3	Analyse and evaluate knowledge, understanding and performance

Links to external resources

We make every effort to provide quality web links to external organisations for teacher support. While correct at publication, links may become obsolete. If a link is broken, we recommend visiting the organisation's website for a direct search as the content may still be available. We will continue to review our resources to check links remain current and up to date.

Further personal development support

For further training and professional development support, find out about our [upcoming training events](#). You'll be able to choose and book on to live online and face-to-face professional development.

Area of study: 1.1 The skills of scientists (Topic Area 1: What scientists do)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
1	1.1.1 The skills scientists use to carry out research into the natural world and developing new technologies: • Analysis • Communication • Problem solving • Creativity • Open-mindedness • Scepticism • Logic • Observation • Objectivity • Pragmatism • Curiosity	1	By the end of the lesson students should: • know what each skill involves. • understand how these skills are used by scientists. • know reasons why these skills are important in science. • understand how to recognise when scientists are employing these skills in their work.	Start the lesson by asking students to identify any skills that scientists may use. To help students with this, you could: • Show students one or more of the linked videos and ask what type of skills they may have to do those jobs. • You could also show slides 1-3 on the AAQ_Applied_Science_F181_1.1.1 Scientific skills PowerPoint with some job descriptions. • Ask what type of skills each of the jobs might have in common. Responses could be provided in a variety of ways (interactive Mentimeter , mini whiteboards, group discussion with answers brought together on the board). The slide of scientific investigations and image of scientist in a lab (AAQ_Applied_Science_F181_1.1.1 Scientific skills PowerPoint slides 4-6)	What is a scientist? video (youtube.com) Why is science important? video (youtube.com) What is science/scientists/types of scientists video (youtube.com) AAQ_Applied_Science_F181_1.1.1 Scientific skills PowerPoint (teachcambridge.org) Mentimeter word cloud generator (mentimeter.com) A free account needs creating. Students would need access to ICT for this task. There are some videos below which could be shown for	Students could complete summary notes (a mind map or flash cards) summarising the main skills required by scientists and where these are important. Students could also come up with a mnemonic to help them remember the names of each of the eleven skills. Students could also research a particular scientist and their associated discovery

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				could be displayed to prompt this discussion. Display the names of the skills. Discuss the meanings of each of these as a class. Students need to make a note of each of the definitions. Students could also then give an example of how scientists demonstrate each skill. You could model how they might do this, for example: communication – demonstrated by scientists sharing data with each other and sharing their results and conclusions with other members of the scientific community and eventually the public. Students can then spend time individually, as a pair or a group and then during class discussion ranking these as a diamond 9 lab (AAQ_Applied_Science_F181_1.1.1 Scientific skills PowerPoint slide 8) activity, justifying the reasons why each of these skills are important.	students to understand the role of research scientists. Career Talks: Research Scientist Day in the Life of a Research Scientist A day in the life of an Astrophysicist at Oxford University A week in the Life of a UK Biomedical Research Scientist King's College London A day in the life of a museum scientist Natural History Museum (youtube.com)	/invention and give examples of how each of the skills they have identified in this lesson would be used in that role.

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				Students choose an example of a scientific career from the slides (AAQ_Applied_Science_F181_1.1.1 Scientific skills PowerPoint They choose which skills are important and why they are particularly important for that career. Students could choose from the list of jobs available, research them and create their own career fact file - template available (AAQ_Applied_Science_F181_1.1.1 Scientific skills PowerPoint slides 16-18). Students could extend this by identifying which of the skills are transferrable to other STEM careers (non-research scientists) and/or which are the most common skills required across all the careers displayed.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	At the start of the lesson, students should already know that science involves a range of skills including creativity (designing experiments), observation (through experiments) and analysis (understanding and forming conclusions from experiments) as they will have practised these skills themselves throughout their school science lessons. These will then be built on within this unit of Applied Science where students will learn about the other skills involved such as problem solving and how these are required for the flexibility and adaptability of scientific investigation, as well as how scientists use logic and scepticism to form conclusions based on their own and others' work.
Common misconceptions	Students often think that a research scientist works alone, follows a method independently and achieves a successful result from which they can form an obvious conclusion. It is worth discussing the leap between results and the conclusions of new scientific knowledge). They might think that all science involves wet-practical work or field-work of some kind. Another misconception is that most scientific breakthroughs have arrived through serendipity or accidentally, and not through painstaking research based on the wealth of accrued knowledge over time.
Key concepts	Students should know the main skills that scientists require when carrying out research/new development careers. These include analysis, communication, problem solving, creativity, open mindedness, scepticism, logic, observation, objectivity, pragmatism, curiosity. Students also need to know how these might be presented within the role of a research scientist, for example, how scientists make observations and obtain results and from this, form a logical conclusion. Alternatively, that the scientists do not get the expected results and have to re-attempt their work having been creative and solved the problems that they faced. Specification point 1.1.1 links to 4.1.1 Communicating science to the public using the media and 4.1.2 Communicating science between experts, as well as 4.4.2 – Bias in science communication.
Subject knowledge enhancement for teachers	Read: Scientist Skills: Definition and Examples (indeed.com) Skills for a scientific career (embl.org) Research scientist (life sciences) job profile (prospects.ac.uk) Career Map: Research Scientist (energy.gov)

Area of study: 1.2 The scientific method (Topic Area 1: What scientists do)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
2	1.2.1 Steps in the scientific method - Defining the problem - Research - Formulating a hypothesis and making predictions - Undertaking experiments - Analysing the data - Drawing conclusions - Communicating results to others	1	By the end of the lesson students should: - understand key features of each step. - know the importance of each step. - understand the reasons for the order of the steps. - understand the role of inductive and deductive reasoning in the scientific method. - understand the approach to the scientific method varies in different	Introduce the steps in the scientific method by showing the flow chart (AAQ_Applied_Science_F181_1.2.1 Steps in a scientific method slides 1-4). As a class, discuss the car analogy and how the steps in the method are the same for the car breakdown as a scientific experiment. There is also an example of a scientific experiment (gummy bear) on the same slides to show how a scientific investigation can be applied to each step. Students could produce their own simple example to make a note for each step (e.g. how exercise affects heart rate). Students watch the scientific method video and make a list of the steps involved in the scientific method including what the steps are, what is involved and why it is important. Allow students to have thinking time to consider the steps in the order, asking questions such as:	AAQ_Applied_Science_F181_1.2.1 Steps in a scientific method PowerPoint (teachcambridge.org) The resources below provide useful information for steps in the scientific method. The scientific method (khanacademy.org) Understanding Scientific Inquiry (static.nsta.org)	Students could produce a summary paragraph or flow chart, naming the steps in the scientific method, what the step involves and why it is so important. Alternatively, there is a table provided that students could complete (1.2.1 Steps in a scientific method slide 5). Flipped learning - students could be given the task of identifying one accidental scientific

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			disciplines of science.	- What are the next steps if the results are not as expected? - Why is it important that the steps are in this order? - Can you ever put the experiment before the hypothesis and why? Possible short practical and demonstration to draw out idea of inductive and deductive reasoning (see link next column). Give students examples of different scientific conclusions and ask them to identify whether they are inductive or deductive conclusions and to justify their answers. Students could think-pair-share the different disciplines of science using mini whiteboards. Make a list of these on the board as a class. Question: How might the approach to the scientific method vary in the different disciplines of science? Class discussion to share ideas and make a list.	TOK Induction deduction activity (thinkib.net) This link provides the information for the practical/demonstration.	discovery and researching the date, scientist, what they were trying to do, what they actually ended up discovering and how this came about.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
3	1.2.2 The scientific method is a non-linear process • Iterative and cyclical nature of science research • The role of serendipity and intuition in discovery • Cross-disciplinary approaches Inductive reasoning that leads to hypotheses	2	By the end of the lesson students should: • understand how scientific inquiry can be cyclical and continuous. • understand the importance of flexibility and adaptability in scientific research. • understand accidental scientific discoveries occur occasionally in comparison to planned research. • understand scientific research often involves colleagues from	Students self-mark their flow chart produced for independent learning task (lesson 2) by comparing to a model answer. Students watch the Karl Popper video. As they watch, they make notes on the following: • How is scientific inquiry continuous and cyclical? • Why is science in principle ‘without end’? • What does a scientist need to do when their hypothesis is disproven or they find a different conclusion than expected? • Students could explain how the previous example in lesson 2 of a car break down analogy applies to these questions. An alternative analogy could be asking students how these questions apply to finding the best recipe for baking a cake. They could do this as a think-pair-share task.	Karl Popper "The game of science is, in principle, without end..." meaning (youtube.com) 5 Times That Science Got it Wrong (discovermagazine.com) This a starting point to show how science disprove hypothesis but this was important. The following links give examples of accidental discoveries.	Students could produce a flow chart or diagram summarising the cyclical nature of science. Students may also want to produce a key term glossary for themselves with key terminology such as inductive reasoning, deductive reasoning, cross-disciplinary, observations, theories, predictions and hypotheses. For more support, you could provide students with a match up activity for the key terminology or a ‘fill in the

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			multiple disciplines. understand observations and patterns can lead to theories that explain them and conclusions that are likely.	Students could then apply the same questions to the scientific discovery/invention that they researched as part of their independent learning task. Draw out the idea that scientists often need to go back and re-hypothesise and re-design their experiment, and that they need to be adaptable in their approach as the results don't always match the predicted outcome. Question: Can accidental discoveries ever be important? (Answer: Yes, scientific accidental discoveries have in many times led to important discoveries such as radiation and antibiotics.) Challenge: Students research how concluding that a hypothesis was incorrect was important in a scientific discovery. The linked article is a starting point. Accidental discovery Students either share their flipped learning on accidental discovery, or they can spend time researching	Ten major breakthroughs that were happy accidents (xprize.org) Great Accidental Discoveries (goethe.de) AAQ_Applied_Science_F181_1.2.2 Accidental scientific discoveries PowerPoint (teachcambridge.org) These videos are good for students to watch to investigate how collaboration and a cross-disciplinary approach was important in the COVID-19 pandemic.	blank' definitions style task. Use OCR ExamBuilder to generate exam questions assessing the learning of the unit so far. You will need to check the questions and mark schemes align with the AAQ specification and approach.

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				some examples of accidental discovery in science. There are some ready-made slides (AAQ_Applied_Science_F181_1.2.2 Accidental scientific discoveries) but students may require more detail, in which case further research is required. Students produce a table summarising the intention of the experiment was, the observation made, the inductive reasoning/ conclusion formed and what the scientist would have done next to test their findings. Ask students to summarise generally why flexibility and adaptability is required by scientists, and why this demonstrates science is continuous and cyclical. The cross-disciplinary approach As a review of the disciplines of science which has previously been covered, students could produce a mind map of the different disciplines of science, or it could be turned into	Inside The Unprecedented Collaboration To Create The COVID-19 Vaccine Inter-professional collaboration for COVID-19 vaccinations: The Immunization Neighborhood (youtube.com) Links for students to use in their research: Human Brain Project (humanbrainproject.eu) The Human Genome Project (genome.gov) Mars Exploration Rovers: Spirit and Opportunity (science.nasa.gov)	

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				a game with clues to identify the different disciplines (e.g. bingo, splat). Students make a table of the benefits and challenges of a cross-disciplinary approach to scientific investigations. A good example to draw out the idea of collaboration is the race to produce the COVID-19 vaccine – watch the videos. Ask students which disciplines may be involved and what the importance of this is. Students can also research a different example of a large scientific project and share with the class how this used a cross-disciplinary approach. This could be done as a small group activity. For more support, students could use the following points as guidance for what to include in their research: 1. Summarise the main aims of the project 2. List five different disciplines that are involved in the project		

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				3. For each of the disciplines identified, describe their contribution to the project. 4. List five benefits and five challenges encountered throughout the project. 5. Identify some ways that the challenges have been overcome to achieve the aims of the project. Students can add to their list of benefits and challenges of cross-disciplinary approach, as well as any additional disciplines that may be involved. Students complete and mark a range of exam style questions provided.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Students should have some knowledge of what it means to formulate a hypothesis and to make a prediction . They need to understand that a scientist would design a specific experiment to test this hypothesis and analyse the data in order to

Subject knowledge enhancement	Details
	form a conclusion. Students need to be aware that while this is a linear process, scientists often form conclusions that they don't expect and further research is needed to develop understanding, and therefore the earlier stages in the process may be revisited depending on the observations made and conclusions drawn. Students need to have an understanding that there are different disciplines of science and they each have a different focus and role. They need to have understanding that working together can have benefits for both producing high quality work but also accessing resources, funds, and sharing expertise allowing for more advanced and rapid developments. They also need to understand that it is not just research scientists that work together, but also between industrial scientists and academic scientists.
Common misconceptions	Students may think that hypothesis and prediction are effectively one and the same; a hypothesis is an idea about how something works that can be tested experimentally, whereas a prediction suggests what will happen in an experiment if the hypothesis is correct. Students may think that scientists always form a positive result from their experimental data and from this, can form a conclusion. They may not realise that sometimes positive scientific results are accidental and often scientific experiments result in incorrect hypotheses or inconclusive results.
Key concepts	Formulating a hypothesis and making predictions – a hypothesis is an idea about how something works that can be tested experimentally, whereas a prediction says what will happen should the hypothesis be correct. For instance, a hypothesis might be that adding water to a plant will help it to grow. A prediction might be the more water I add to a plant, the bigger it will grow. Analysing the data – data analysis can take place with qualitative or quantitative techniques. Analysing the data is used to prove or disprove the prediction and hypothesis. Communicating results to others – results must be communicated with other scientists for peer review and to have the work extended. Conclusions must also be communicated in an appropriate way (tone, clarity of explanation) to members of the non-scientific community so that the conclusions can be understood. Inductive reasoning – this is a form of logical thinking using specific observations to form a general conclusion; drawing conclusions from evidence. A scientist collects data and interprets it. Deductive reasoning – this is finding evidence to support or disprove a conclusion. This approach follows the scientific method of having an idea or question and then testing to see whether this is correct.

Subject knowledge enhancement	Details
	Cyclical nature of scientific enquiry – scientific enquiry is cyclical and continual in nature which means the enquiry is unending; either conclusions form which can be explored in more detail based on new hypotheses, or a hypothesis is disproven and a scientist can go back to the start of the scientific research method and form a new hypothesis and amend or design a new experiment to test this. Scientific disciplines – there are a range of scientific disciplines which can be branched into life sciences (the study of living systems, such as biology, microbiology, biochemistry, natural sciences) and physical sciences (the study of non-living systems, such as Earth science, physics, chemistry). Specification point 1.2.1 links to 3.1.1 Hypothesis, theory and law Specification point 1.2.1 links to 2.1 Types of scientific data, 2.3 Storage and presentation of scientific data and 2.4.1 Identifying patterns and relationships. Specification point 1.2.2 links to 3.3.2 Contemporary issues that science will need to solve in the future (what scientific disciplines will be needed to solve these issues). Specification point 1.1.1 links to 4.1.1 Communicating science to the public using the media and 4.1.2 Communicating science between experts, as well as 4.4.2 Bias in science communication
Subject knowledge enhancement for teachers	Read: The OCR guide to research (ocr.org.uk) Writing a hypothesis and prediction (bbc.co.uk) Scientific principles and process (thealevelbiologist.co.uk)

Area of study: 1.3 The scientific community (Topic Area 1: What scientists do)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
4	1.3.1 Scientists can work: • alone • in a team • collaboratively in an international community.	2.5	By the end of the lesson students should: • understand the advantages and disadvantages of each type of working. • understand the reasons why collaboration is important in scientific research. • know ways that scientists collaborate. • understand the importance of diversity and inclusivity in a team.	Begin the lesson by reviewing exam questions set for independent learning, allowing students to familiarise themselves with the mark scheme make any improvements to their work and seek out additional support if required. Show students the Human Brain Project video clip. While watching the clip, students produce a list of when scientists may work alone, together and across an international community. Think-pair-share task: students consider real life examples of when they have worked alone and when they've worked in a team. Students could suggest why each of these approaches was the most appropriate at the time and the benefits of working alone/in a team on these examples. Students could also describe any disadvantages of working alone/in a team on their	Human Brain Project (humanbrainproject.eu) Information about one example of a collaboration between scientists. How Do Scientists Work Together? (calacademy.org) Information on the role of different scientists as they work together.	Use OCR ExamBuilder to generate exam questions assessing the learning of the unit so far. Students could choose one more scientific research project that is currently ongoing and identify ways that scientists may work alone and collaboratively and explain how this is helping to advance the project.

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				chosen example and suggest how changing their strategy might have improved this. Students should then be able to apply their understanding of working alone and/or in a team to scientific work in the next task. Students produce a table summarising the advantages and disadvantages of working alone, in a team and collaboratively across an international community. This could focus on key concepts such as sharing expertise, funding, safety, access to resources, speed of development due to team size, peer review for accuracy of work. Students could identify (such as by highlighting) their strongest and weakest advantages and disadvantages, justifying their choices, Question: why can't scientists achieve big discoveries alone? The How Do Scientists Work Together? video demonstrates the idea of collaboration. As students watch, they can make a bullet point list of the different skillsets involved	The following links can be used by students as a starting point for their research. Human Cell Atlas (humancellatlas.org) Kew: Seed Collection (kew.org) Examples of inclusivity policies can be found at the following websites.	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				in this project that require collaboration in order for the project to be successful. Draw out the idea that each scientist is a specialist and focuses on one area of science and that they need to share expertise and skills. Suggest a different example to students, such as the Kew Millenium Seed Bank or the Human Cell Atlas. Students think, pair and share where scientists may work individually in this project and where they may work collaboratively, and the advantages of both of these approaches. Students could study a specific example of a scientific project such as the Human Cell Atlas or Kew Millenium Seed Bank or alternative that they wish to learn about. Students could either: • Take on the role of CEO and produce a written statement for the website. • Take on the role of a journalist interviewing a scientist who works for the project and video this.	Human Brain Project (humanbrainproject.eu) Royal Society of Biology: Diversity, Equality and Inclusion (rsb.org.uk)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				In order to answer some of the following questions about their chosen project: 1. What is the project about? 2. What are the aims of the project? 3. Who is working on the project? 4. What are the skill requirements of people working on the project? 5. Give some examples of collaboration within the project and why this is important. Challenge: Research the COVID-19 collaboration across the world and explain the impact this had on ending the pandemic. Diversity and inclusivity Show students examples from websites where large scientific projects or companies, e.g. Human Brain Project, Royal Society of Biology, have a team that is responsible for diversity and inclusivity. Discuss what it looks like for a company to be diverse and inclusive and why it is important. Students could take on the role of		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				company director and write a pledge for how their company would ensure inclusivity and diversity and why this is so important for the company and its employees. Students can complete exam style questions assessing their understanding of collaboration, inclusivity and diversity.		
5	1.3.2 Successful collaborations in science	1.5	By the end of the lesson students should: - understand what was accomplished and how. - understand the necessity for collaboration in these successes. - understand why it is important to have scientists from different disciplines working together.	Begin the lesson by reviewing exam questions set for independent learning, allowing students to familiarise themselves with the mark scheme make any improvements to their work and seek out additional support if required. Successful collaborations Ask students what it means to collaborate and to think of where we collaborate in everyday life. Students make a list of the advantages of collaboration and suggest how this can be applied to scientific discoveries.	The following links can be used by students as a starting point for their research. The Human Genome Project (genome.gov) ATLAS Experiment (atlas.cern) International Space Station (nasa.gov) Global Climate Observing System (GCOS) (gcos.wmo.int) Collaborative Partnership on	Students produce a key terminology glossary of the key words that they have learnt so far in the topic. These could include collaboration, community, cross-disciplinary approach, scientific discipline, hypothesis, prediction, analysis, conclusion. Students should also spend time learning

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			Examples of successful collaborations in science may include: - Human Genome Project - ATLAS Experiment - International Space Station - Global Climate Observing System - Collaborative Partnership on Sustainable Wildlife Management.	Students become 'experts'; each student chooses one successful collaboration to research. They present their findings to their 'home groups' who produce a summary table for each of the collaborations presented (what was accomplished, how it was accomplished, why collaboration was important). Students produce a paragraph to explain why collaboration is important in science with common benefits that they have learnt from each of the specific examples.	Sustainable Wildlife Management (fao.org)	these answers in preparation for a quiz to assess knowledge.
6	1.3.3 International Scientific Organisations	2	By the end of the lesson students should: - understand the role of international organisations in developments in science. - know why it is an advantage to have these organisations.	Begin the lesson with a Kahoot! style quiz assessing the learning of definitions of key terminology. This could be multiple choice, open-answer or a correct the text style activity. Question: What would be the impact if organisations like the WHO and WWF no longer existed?	Kahoot! quiz link (free sign up required) (kahoot.com) The following links can be used by students as a starting point for their research. World Health Organization (who.int)	Possible flipped learning opportunity – to bring a list of different science disciplines in preparation for next lesson. Students write a paragraph summarising why

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			Examples of international scientific organisations may include: • WHO • UNESCO • IUCN • WWF • CERN • IPCC.	Students choose a scientific organisation from the list (lots of weblinks available in resources column as a starting point). They will need to spend time researching the organisation including the role of the organisation and its importance in society and scientific developments. They could take on the role of spokesperson for the company and produce a leaflet or poster summarising the role of the organisation and the important work that they do. Students can then complete a 'learning walk' reviewing other students' leaflets, completing their own summary table (name of organisation, role of organisation, importance). Students could be allowed to ask one question to the person who made the leaflet. Once their summary is completed, students produce a bullet point list of the roles of organisations such as these, and the advantages to having these organisations, and the possible impact if these organisations no longer existed.	UNESCO (unesco.org) IUCN (iucn.org) The Intergovernmental Panel on Climate Change (ipcc.ch) WWF (worldwildlife.org) ATLAS Experiment (atlas.cern)	these organisations are so important and the possible impact of not having these organisations on the scientific community and society as a whole.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Students can complete exam style questions assessing their understanding of the role and importance of such organisations.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Students may have heard of some of these organisations before and have some idea of their role within science. Most likely they will have heard of the World Health Organization and their role in promoting health and keeping the population of the world safe. Students may not be aware of how organisations such as the WHO do this. Students may have prior knowledge of the idea of collaboration, perhaps outside of the context of scientific investigation (through the idea of team work). This could be brought in with reference to an example they are more familiar with such as team sports. Students may have some prior knowledge of inclusivity and diversity; what this means and why it is important. Students may also have some prior knowledge of some of the key scientific discoveries such as the Human Genome Project; they may have some knowledge of what the genome is, what it means to sequence a gene and how this might be relevant to scientific advancements. However, there are lots of examples where students may be less than familiar and so the research theme to these lessons will enable students to increase their knowledge accordingly.
Common misconceptions	Students may have the misconception that diversity and inclusivity are the same thing; diversity is the presence of different identities, but this does not automatically lead to inclusion. Inclusivity brings in the idea that employees with diverse

Subject knowledge enhancement	Details
	identities feel valued and supported. It may be worthwhile reminding students of the need to include those with disabilities and neurodivergences when we think about inclusion, too. Students may think that collaboration happens between scientists of the same discipline, or from the same organisation. For instance, students may think that lots of different geneticists from one organisation worked on the Human Genome Project, and may not realise that scientists from different disciplines and countries, as well as a mixture of industrial and academic scientists, were required to make the project effective. Occasionally, students may pick up the idea of competition between scientists rather than collaboration (owing to scientific advancements such as the 'space race' and more recently, the apparent competition between organisations to produce the COVID-19 vaccine). This can be discussed and steered in the direction of scientific advancements benefitting from collaboration and healthy competition.
Key concepts	Collaboration – the collaborative approach is used alongside working independently and as part of a team. Collaboration can be between scientists of the same discipline and/or institution, or across different disciplines and across different industries, organisations, companies; this can be across a global network, depending on the scale of the project and the collaborative skills and resources required. Inclusivity – inclusivity is ensuring that all people are valued and supported. Diversity – diversity is the range of identifies of individuals. Scientific organisations – there are a range of global scientific organisations which work to advance science in a safe and effective way. These include UNICEF, WHO and WWF to name a few. Links to other parts of the specification Specification point 1.3.1 and 1.3.2 links to 3.3.1 Considerations for scientific developments and 3.3.2 Contemporary issues that science will need to solve in the future.
Subject knowledge enhancement for teachers	Read: OCR's STEM contributors resource (ocr.org.uk/blog) What is Collaborative Science? Benefits of Scientific Collaboration (lasernetus.org) Why is collaboration important? (wi.mit.edu) International collaboration in science (oecd.org)

Subject knowledge enhancement	Details
	Listen: Research Culture (research-culture.captivate.fm) Celebrating 70 years of protecting the world: combating influenza now and in the future (tdr.who.int) The future of global health is through diversity and dignity (tdr.who.int)

Area of study: 1.4 The role of scientists (Topic Area 1: What scientists do)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
7	1.4 The role of scientists - Scientists have many varied roles across different disciplines of natural sciences. - Applied science uses scientific knowledge to achieve practical goals. - Solve real-world problems. - Develop useful technologies.	2	By the end of the lesson students should: - understand how to recognise the different disciplines of science and the roles of scientists in them. - know why it is useful to think of science as different disciplines. - understand why it is important to consider the interconnectivity and overlap between the disciplines. - understand that the role of 'pure' and applied science and their dependence on each other.	Students make a list of the different scientific disciplines that exist using their flipped independent learning from lesson 6. Any that they don't understand, they should research what the discipline involves. Students could do a matching activity of scientific disciplines and example(s) of what each discipline involves. Students produce a glossary of the different types of science (pure, applied, earth science, natural science, physical science). Students then produce a fact file of some of the different disciplines of science (you could use some of the career fact file examples in AAQ_Applied_Science_F181_1.1.1 Scientific skills PowerPoint). Content might include: - Name of discipline. - Description of what the discipline involves.	The Pontifical Academy of Sciences (pas.va) This site provides information on different scientific disciplines. Branches of Science (slideshare.net) This site provides information on different branches of science.	Use OCR ExamBuilder to generate exam questions assessing the learning of the unit so far. Students can ensure that they have a full and completed glossary of all key terms from across the unit by adding definitions of new key terminology such as pure science, applied science, natural science, earth science, physical science. An alternative task could be to watch this Public Lecture – The Stegosaurian

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				- Whether it overlaps with any other discipline. - Examples of where this discipline has been used in scientific discoveries or inventions. - Specific skillsets essential for each discipline. Using examples such as ones previously researched (Human Genome Project, ATLAS Experiment, Human Brain Project, etc.), students write a summary explaining the importance of interconnectivity and overlap between the disciplines. For students to do this successfully, you could: - Show one or both of the linked videos asking students to summarise key points on why collaboration and overlap of skills/ disciplines is important. - Model an answer to show an example for how interconnectivity between scientific disciplines is successful, for example for a large organisation such as NASA.	The weblinks below can be used by students as a starting point for their research. Britannica: Science (britannica.com) ATLAS Experiment (atlas.cern) The Human Genome Project (genome.gov) International Space Station (nasa.gov) Global Climate Observing System (GCOS) (gcos.wmo.int)	Dinosaurs (The Geological Society, Youtube) and ask students to pick out all of the key themes studied so far.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				3. Students could then choose an example of an organisation or project they have studied and identify some of the different scientific disciplines involved in this, describe the roles of these disciplines within the organisation and explain how collaboration between these disciplines is essential to the project/organisation, giving examples. Provide students with the definitions of pure and applied science with a couple of examples of each. Provide students with a list of scientific careers and disciplines and ask students to sort them by colour coding or producing a table to identify which would belong to pure science and which would belong to applied science. Alternatively, students could each write as many scientific disciplines as they can remember on Post-it notes and stick them on the board under the correct column (pure or applied).	Collaborative Partnership on Sustainable Wildlife Management (fao.org) Collaboration: the critical skill for future researchers (youtube.com) TEDx Talks – The Power of Multidisciplinary Learning and Collaboration (youtube.com)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Students consolidate their knowledge of the cross-disciplinary approach to science by producing an information handout for a college or university course (e.g. applied science, biology – each student could be given a specific course to research). In their information handout, students should include: 1. A list of the modules included. 2. Types of study included, e.g. lab work, theoretical work. 3. Examples of content studied, e.g. organic molecules, biological systems. 4. Careers it may be linked to. The teacher could then have a summary table displayed to collate common features across each course, e.g. which courses have lab work, which study organic molecules or biological systems.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Students will likely be aware from previous lessons (e.g. lesson covering specification point 1.3.1) that there are different disciplines of science, some of which work well together in collaboration on major scientific projects and breakthroughs.
Common misconceptions	Students may have the misconception that all science is research based, and not that it is used in application careers which are equally useful and important to society.
Key concepts	Disciplines of science – science can be divided into different disciplines or branches based on the subject of study. For instance there are physical sciences (astronomy, physics, earth sciences, chemistry), biological sciences (medicine, immunology) and social sciences (anthropology). Each discipline largely follows the same scientific method but what they specifically study varies across disciplines. In some examples such as the Human Genome Project, scientists from various disciplines work collaboratively (through interconnectivity) to share their expertise, improve understanding and make scientific developments together. Applied science – this is the application of scientific theories and methodology to practical and real-world problems such as through medicine, engineering, pharmacology. Pure science – if you search online, this sometimes appears under the term ‘basic science’ or ‘natural science’ and involves the broader subjects such as chemistry, biology and physics. This is the study of the universe through the development of scientific theories and predictions. It is commonly thought of as research that is conducted in a lab. Pure science does not consider how theories can be applied but aims to answer questions and understand phenomena.
Subject knowledge enhancement for teachers	Read: Science and Technology Basic vs Applied Science: Understanding the Differences (mindthegraph.com) Differences Between Basic Research and Applied Research0 (youtube.com)

Area of study: 2.1 Types of scientific data (Topic Area 2: Handling scientific data)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
8	2.1 Types of scientific data Qualitative and quantitative data Continuous and discrete data Data from observations and measurements Primary and secondary data	1.5	By the end of the lesson students should: - know what each type of data looks like. - understand how to classify data into these types. - understand how to represent these different types of data appropriately.	Begin the lesson by reviewing exam questions set for independent learning from lesson 7, allowing students to familiarise themselves with the mark scheme make any improvements to their work and seek out additional support if required. Students could watch the video on qualitative and quantitative data and while they do this, they make notes on the differences between qualitative and quantitative, discrete and continuous data. Task for checking understanding: provide students with a range of sets of data and ask them to identify whether they are qualitative, quantitative, discrete or continuous. Students could watch the video on primary and secondary data.	Qualitative and Quantitative Data (youtube.com) Primary and Secondary Data (youtube.com) Primary and Secondary Data (studysmarter.co.uk) This site gives information on primary and secondary data.	Students produce a glossary of the key terminology from the lesson including: continuous data, discrete data, qualitative, quantitative, observation, primary data and secondary data. Flipped learning – students could revise the method of sampling that they have previously studied, e.g. by watching the video below and come to the lesson with summary notes on sampling, random, estimation, systematic, observation and

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Students produce a table summarising the advantages and disadvantages of primary and secondary data. Challenge question: How would scientific investigations and breakthroughs be impacted if secondary data was not available? (Student responses may be along the lines of results not being replicated, lack of confidence in results, unable to identify areas to further investigate from previous experiments and therefore not actually make the breakthrough.)		measurements from experiments. A Level Biology Revision "Sampling Techniques used in Biology" (youtube.com)

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Types of data: Students may have prior knowledge about the difference between quantitative and qualitative data, as well as some examples of continuous and discrete data. They may also be aware of how continuous data can be plotted on a graph such as a scatter graph but a bar chart would be required for discrete data where the independent variable is presented in categories (blood type, for example). Students may also have some prior knowledge and understanding that for data to be considered good quality, the results have to be repeatable and a small standard deviation from the mean, or possibly a small range of results.
Common misconceptions	Students may misunderstand the terms primary and secondary data as first and second data collections as opposed to their true meanings of data they have collected themselves versus data gathered by someone else that is used to inform a person's new research. Students may also have an understanding of the difference between a <i>primary</i> and <i>secondary</i> source from history lessons. i.e. a first-person account of an event versus a commentary provided by someone who wasn't present at the event. This may impact their understanding of primary and secondary data in science. It is possible that students have the misconception that quantitative data is better than qualitative data, that it is inherently more scientific and accurate if it is numerical. They may also consider quantitative data as being free from bias or interpretation, and that qualitative data is easier to collect.
Key concepts	Types of scientific data: Students should know that data can be categorised into different types and how to do this. They should know how to appropriately represent this data including a range of types of graphical representations. Links to other parts of the specification Specification point 2.3.1 Scientific data links to Unit F182 1.2.1 Designing a scientific investigation.
Subject knowledge enhancement for teachers	Read: Presenting Experimental Data (savemyexams.com)

Area of study: 2.2 Collecting scientific data (Topic Area 2: Handling scientific data)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources										
9	2.2 Collecting scientific data Observation and measurement from experiments Surveys Sampling Random Systematic Estimation Cohort studies Meta-studies Computer modelling	3	By the end of the lesson students should: - understand key concepts and uses of each collection method - understand the types of scientific disciplines that use these methods - understand the advantages and disadvantages of each	Question: How do scientists gather the data that they have for their conclusions and discoveries? (Student answers might include: experiments, observations, measurements, take surveys, estimate results, collect results from other scientists.) Teacher-led discussion or student-led research to gather knowledge on each method for collecting data and produce a table similar to the one below: <table><tr><td>Method of data collection</td><td>Describe the method</td><td>Example of where it may be used</td><td>Advantages</td><td>Disadvantages</td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></table> Question: When is it appropriate to use estimation rather than a full data sample? (Answer: If you can take samples and it is representative of the full area, for example if testing several samples of water and you can be confident the water is of similar quality throughout.)	Method of data collection	Describe the method	Example of where it may be used	Advantages	Disadvantages						Cohort and Case Control Studies (youtube.com) A quick guide to survey research (pmc.ncbi.nlm.nih.gov) Page summarising survey pros and cons. A Level Biology Revision "Sampling Techniques used in Biology" (youtube.com) Meta-Analysis (guides.himmelfarb.gwu.e) AAQ_Applied_Science_F181_2.2 Collecting data PowerPoint	Use OCR ExamBuilder to produce a range of exam questions assessing understanding of this topic. Students could produce a glossary of the key terminology in this lesson.
Method of data collection	Describe the method	Example of where it may be used	Advantages	Disadvantages												

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			collection method • know the impact of bias in data collection methods • understand the importance of diversity and inclusivity, where appropriate.	Challenge: What are the differences between prospective, retrospective, concurrent and nested case control studies? What are the advantages of having a range of types of study? Find an example of each type of case control study and explain why it was an appropriate method. Students could be given the statements from the AAQ_Applied_Science_F181_2.2 Collecting data PowerPoint slides and they match up the correct method to the example of method. Think-pair-share question: Use the following examples to summarise the importance of inclusivity and diversity in collecting data: 1. The symptoms of COVID-19 presented significantly differently in males and females 2. The symptoms of COVID-19 tended to present more severely in individuals of black and Asian ethnicity compared to white individuals 3. Children are excluded from clinical trials studying the effectiveness of antidepressants 4. Pregnant women were excluded from the clinical trials of the thalidomide drug	These two videos describe the importance of diversity in clinical trials. The Importance of Diversity in Clinical Trials Why inclusion matters in clinical research (youtube.com) Interactive Simulations for Science and Math (phet.colorado.edu) This is a useful interactive website for students to use to generate computer models.	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				5. People with low socioeconomic status have a higher risk of cardiovascular disease Students can also watch the linked videos to aid their suggestions. (Students should come up with suggestions that data needs to be collected as a representation across males and females, ages, ethnicities, socioeconomic backgrounds in order to ensure scientific advancements are effective and appropriate for everyone). Students write a paragraph summarising the importance of diversity and inclusion in data collection (e.g. clinical trials, alongside their own examples where relevant). Question: The Framingham Heart study was originally mostly people of white European decent in the first cohort. As data has been collected from second, third and fourth generations, a wider range of ethnic groups was included. Explain the importance of this. Answer: Students may suggest answers such as ensuring inclusivity and diversity, taking a wider range of factors that can lead to cardiovascular disease into account which can vary across cultures and ethnicities, ensuring data is representative of a whole population rather than just one sample.	Interactive Simulations (grc.nasa.gov) This site has useful interactive modelling activities.	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Computer modelling Question: when is computer modelling useful in science? Answer: it is useful when studying complex systems or systems that are impractical or impossible to explore in real time. Students produce a list of advantages and disadvantages of computer modelling in science. Students can then spend some time exploring the free Phet modelling, NASA modelling (or an alternative science modelling website) generating computer models. Provide students with exam style questions that assess their understanding of the techniques of random sampling, estimations, systematic sampling and observations and measurements within scientific experiments.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Collecting data: students will have spent a considerable amount of their time during scientific investigations making observations and measurements. They have previously studied systematic and random sampling in terms of field investigations and may have even covered estimation in terms of estimating the population of a species across a field based on their samples collected. Plotting graphs: students are likely to have experience with plotting graphs; the most common ones they will have had the most practice on being scatter graphs, line graphs, bar charts and pie charts.
Common misconceptions	Students may think that scientific studies have to always be carried out first-hand, in that scientific results are only valid if they are the result of a practical experiment. Students are not always aware that collecting data as a meta-study or using surveys is an equally valid method of investigating something. Students may conflate gender with sex and use identities interchangeably. Where gender is socially constructed and interpreted differently by different communities, it is important to use sex and define what this means. Race is also a socially constructed concept, and not a scientific one. Students may hold the misconception that someone's race can impact their biological outcomes, but in reality, cultural and socioeconomic differences between communities are more important for health outcomes than their ancestry.
Key concepts	Collecting scientific data: Students should know that scientific data can be collected using a variety of methods and that this should be done in such a way as to avoid bias. Students should know that there are advantages and disadvantages to different methods of collecting data and these should be considered when scientists are trying to collect good quality data. Links to other parts of the specification Specification point 2.2 Collecting scientific data links to Unit F180 4.2 Sampling and Unit F185 5.3 Sampling techniques.
Subject knowledge enhancement for teachers	Read: Types of Scientific Studies: The Basics (somos.org) A Guide to Understanding Meta-analysis (jospt.org) NCI Dictionary of Cancer Terms: prospective cohort study (cancer.gov) Read about race and biology: Race, Racism, and Genetics (fredhutch.org)

Area of study: 2.3 Storage and presentation of scientific data (Topic Area 2: Handling scientific data)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
10	2.3 Storage and presentation of scientific data 2.3.1 Scientific data can be stored on: • Personal database • National database • International database	1	By the end of the lesson students should: • know key features and uses of each type of database. • understand when it is appropriate to use one database type rather than another. • understand examples of the type of data stored in each way and why. • understand advantages and disadvantages of each type of database.	Begin the lesson by reviewing exam questions set for independent learning from lesson 9, allowing students to familiarise themselves with the mark scheme make any improvements to their work and seek out additional support if required. Expert groups: each student carries out research into one type of scientific database to answer the following questions: 1. What are the key features of the database? 2. When should this database be used? 3. What are some examples of data stored in this database? 4. Why is this database suitable to store this particular data you have identified? 5. What are the advantages of this database?	Data Repository Guidance (nature.com) This article provides information on how data is stored. Publishing your research findings (ukri.org) This article provides information on what data is stored when scientists publish their research Examples of databases students could research are: UK Biobank (ukbiobank.ac.uk) National Geoscience Data Centre (bgs.ac.uk)	Students could write a short paragraph to be sent to employees of a scientific organisation summarising how their data will be stored, why it will be stored in that way, how the data will be used and how it will be kept safe.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				6. What are the disadvantages of this database? Students can present their findings in groups of three. Each group would end up with a full set of notes for personal, national and international databases, either set out as questions and answers, or a summary table to answer questions 1 to 6. As a further challenge, students could rank their advantages and disadvantages from strongest to weakest and justify this. They would work in pairs and their partner play 'devil's advocate' to the justifications.	Physical Sciences Data-Science Service (psds.ac.uk) Committee on Data International Science Council (codata.org) PubMed (pubmed.ncbi.nlm.nih.gov)	
11	2.3.2 Scientific data can be represented in different graphical forms: • Scatter and line graph • Bar chart • Histogram • Pie chart	2	By the end of the lesson students should: • know key features and uses of each. • understand why different graphs may be used to communicate to different audiences	Begin the lesson with students comparing their answers from their independent learning to model answers. Depending on the class, you could either use examples to describe the key features of each type of graph and examples of when they may be	Using graphs (bbc.co.uk/bitesize) Types of graphs and when to use them (youtube.com) Representing data (khanacademy.org)	Use OCR ExamBuilder to provide students with a range of mathematical exam questions in which they practise plotting a range of types of graph.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources			
	• Kite diagram • Cumulative graph • Box and whisker plots		or for different purposes. • understand how to represent data in these graphical forms with accuracy.	used, or students may research this themselves. Question: Why are different types of graphs used? (Answer: it depends on the data set, so for example bar charts are used for discrete data as the x axis would be categories, whereas a pie chart is used to show proportions). Question: Why are graphs used to communicate scientific information? (Answer: universal meaning, simple to understand, represents a lot of data in a simple way). Students could complete a summary table for each type of graph listed which includes: <table><tr><td>Name of graph type</td><td>Key features and a sketch</td><td>When is it used?</td></tr></table>	Name of graph type	Key features and a sketch	When is it used?	Graphs (castlerock.org.uk) This presentation has some key information on types of graphs. Do you struggle on graph exam questions? Modelled answers & tips in this question walk-through (youtube.com) This video will be useful in supporting students with graph tasks.	Preparation for next lesson: students could be given graphs or simple datasets and asked to describe the graph and/or perform simple calculations to bring to next lesson. In the starter, this could be marked and shared to assess prior knowledge.
Name of graph type	Key features and a sketch	When is it used?							

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				'Which graph when?' Provide students with a range of sets of data (to cover each type of graph) and they choose the correct type of graph to draw and attempt to draw the correct one for each. Students could complete a verbal or written justification for why they have chosen to use each one. You could also show a range of poor examples of graphs/graphs with errors and students spend time identifying where graphs are incorrect. Extension – use the data provided by RSC for students to practice using the data shown on graphs, e.g. to work out the gradient. (This is free to sign up to). Provide students with exam questions that involve plotting graphs. They produce a 'how to' guide for other students to learn how to draw graphs in science with the correct type of graph identified and why, top tips on	Graph drawing teaching resources is	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				how to draw the graph and correct plotting of the graph.	(thescienceteacher.co.uk) An example of a website with incorrect graphs for students to correct. Examples of graph exam questions can be found on the websites below: A-Level Biology past paper questions with Graphs (alevelbiologytutor.com) OCR ExamBuilder How to teach pupils to choose the right graph (edu.rsc.org) This web page provides extension activities.	

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Students are likely to have prior knowledge of plotting a range of types of graphs from their studies in maths and science.
Common misconceptions	Students may have misconceptions in relation to which types of data are suitable to be used on which types of graphs. They may also have misconceptions on how to correctly produce graphs, such as how to correctly convert numbers into an angle to produce a pie chart. Students may have the misconception that all data on line graphs must have a straight line of best fit to show a linear relationship, that the line must pass through the origin, and that it must touch every data point. There may be some misconceptions on storing data on national and international database. For example, there may be misconceptions in relation to the use of the data, who has access to the data and how long it is allowed to be stored for.
Key concepts	Storing and presenting scientific data: Students should know that there are different ways of storing data. They should be able to identify examples of data stored by each of the three methods (personal, national or international databases) and the pros and cons of this. Links to other parts of the specification Specification point 2.3.2 Scientific data can be represented in different graphical forms links to Unit F182 3.1.1 Analysing data.
Subject knowledge enhancement for teachers	Read: Graphical Techniques (ccea.org.uk) Tips for Drawing Graphs in Biology (thebiologyjotterbook.com) Collect, Record and Present Data (pmt.physicsandmathstutor.com) Tables and Graphs Guide (static1.squarespace.com) Which graph when? (edu.rsc.org)

Area of study: 2.4 Interpreting data (Topic Area 2: Handling scientific data)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
12	2.4 Interpreting data 2.4.1 Identifying patterns and relationships to: - Draw conclusions - Accept or reject a hypothesis - Inform further scientific investigation	5	By the end of the lesson students should: - understand patterns from data and graphs. - understand use of mathematical skills when determining patterns from data and graphs. - understand conclusions from data or graphs. - understand decisions about further investigation.	Begin the lesson by reviewing exam questions set for independent learning from lesson 11, allowing students to familiarise themselves with the mark scheme make any improvements to their work and seek out additional support if required. Determine the prior knowledge of students either by reviewing the independent learning set last lesson or by providing a simple graph (such as an enzyme shape graph) and ask them to describe the pattern shown by the graph independently. Ask for students to contribute their answers as a class discussion; students could initially write their answers on a mini whiteboard during thinking time and then add detail during paired	Enzymes: Rates of Reaction (studymind.co.uk) This website has an example of an enzyme graph you could ask students to describe. A-Level Biology - How to describe a graph? (youtube.com) Graph drawing teaching resources is (thescienceteacher.co.uk) An example of a website that	Use OCR ExamBuilder to produce exam questions for students to assess their understanding, or alternatively provide a worksheet for students to continue to practise their mathematical skills. Students could alternatively produce a mind map, flash card or summary table of the main skills learnt in this lesson including the describing a graph, each individual mathematical skill

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				discussion time. Use this as a way to model to the class how to describe a graph particularly well; students should annotate their own copies of the graph. You could impose a suggested rule to help improve scientific descriptions of replacing any 'they', 'them' or 'it' with a noun (e.g. 'as the concentration of enzyme increases, it also increases' would be replaced with 'as the concentration of enzyme increases, the rate of reaction also increases'. Key questions: • Describe each part of the graph. • Where is the line steepest? • How much higher is the peak of the line of best fit compared to the lowest point? • What is the correlation? • Can you improve your answer to use X word?	shows how to describe a graph well. Describing Graphs (academic-englishuk.com) This presentation provides lots of graphs that students can describe. They are not scientific graphs but are still excellent for practicing graph describing skills. Save My Exams This revision website is free to sign up to. Do you struggle on graph exam questions? Modelled answers & tips in this question walk-through (youtube.com) This video will be useful in supporting students with graph tasks.	and suggestions on how to extend scientific investigations from information given. Calculating Rates from Graphs A Level Biology Revision (youtube.com) Students could watch this video to consolidate their knowledge. OCR Mathematical Skills Handbook Students could work through the examples in the handbook and check their own answers (for the relevant pages of the examples you choose to teach).

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Provide students with exemplar answers describing graphs achieving a range of marks. Students rank the answers from best to worst, justify their answers and suggest improvements to the graph explanations. Students could make their own 'how to' guide for how to describe a graph well as a simple bullet point list. Give students further examples of graphs to describe. Provide model answers for students to compare their answers to. For each of the following mathematical skills: 1. Model how to carry out mathematical interpretations of data and graphs.	<u>Transition Booklet from iGCSE Physics to A Level Physics</u> (strichardreynolds.org.uk) This resource has questions and answers for identifying graphs, plotting graphs, describing and explaining graphs task. <u>Science Investigation Skills Transition</u> (elizabethan.notts.sch.uk) This resource also has questions and answers for the identifying graphs, plotting graphs, describing and explaining graphs task. <u>Interpreting graphs</u> (youtube.com)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				2. Provide students with time to practice the skills using the linked resources. 3. Students mark each other's answers using available mark schemes and model answers. 4. Students make corrections; any that they are struggling with they either seek help from the teacher or produce an independent revision resource and re-attempt further questions for consolidation. Mathematical skills include: - Determining the intercept and/or gradient using $y = mx + c$. - Calculating the rate of change from a graph with a linear relationship (e.g. rate of transpiration). - Drawing a tangent to a curve on a graph to calculate the rate of change (e.g. amount of product produced against	Although this example is about rates, students can follow this video link to practice describing the trend a graph shows as it shows different gradients, calculations for working out the gradient and how this can be used to suggest explanations of observations. OCR guide: Draw and use the slope of a tangent to a curve as a measure of rate of change (ocr.org.uk) Examples of resources you could use to teach students mathematical skills in relation to graphs: OCR A Level exemplar candidate work Chemistry A and	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				time, at a fixed concentration of enzyme). - Calculate the standard deviation of a set of data. - Calculate the mean, median, mode, range (e.g. height of group of organisms, number of stomata in a plant). Provide questions to students in which they can practice these skills and for each set of data, accept or reject the hypothesis that precedes it. Question: How can we use scientific data to produce a scientific conclusion? Does it always tell us everything we need to know? (You could provide examples of experimental results and ask if the conclusion would always be true). (Answer: The data tells us whether our hypothesis was right. But it might not tell us everything, for example, if studying the effect	B (Salters) (ocr.org.uk) Exemplar work on working out the rate using a tangent. A Level Biology A Question Set 5 (pmt.physicsandmathstutor.com) Standard deviation questions provided step-by-step. New A-Level Biology Statistics booklet (uhs.org.uk) A range of mathematical questions including standard deviation. OCR guide: Understanding measures of dispersion including standard deviation and range (ocr.org.uk) Shows how to calculate standard deviation. Maths for A Level Biology (mmerevise.co.uk)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				of light intensity on pondweed, the same conclusion may not be applicable to all plants.) Share some examples of experimental data. Students could work in pairs to identify gaps in the conclusion. Hints/prompts could be provided, such as: • Would their result be true for all acids/animals for example, and how could they investigate further? • Do different conditions affect the results? • Have they used a large sample size or do they need to change this to represent a wider range of results? • Could they change their range of measurements, e.g. bigger or smaller increments, a bigger or smaller range?	This has a range of activities relating to graph calculations. A Level Biology Revision "Continuous Variation and Standard Deviation" (youtube.com) Shows how to calculate standard deviation. Key Concepts: Independent and Dependent Variables (alevelbiologytutor.com) Provides a range of exam questions on standard deviation and graph calculations. Using standard deviation to analyse data in A-Level Biology. Help with evaluate the conclusion Qs (youtube.com) provides information on how to calculate and interpret standard deviation. OCR guide: Draw and use the slope of a tangent to a curve as a measure of rate of change	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				If it is an experiment on a live organism: is it only one species, are they all of the same age, have they all been exposed to the same conditions? Students can work through a pack of questions (either exam questions or practice questions such as the ones linked) to consolidate their knowledge of practising graphs, identifying the correct type of graph, describing graphs and explaining graphs.	(ocr.org.uk) Shows how to draw a tangent on a graph and use it to work out the rate of change. Rate of Reaction using Graphs and Tangents (api.thenational.academy) Worksheet providing information and questions on calculating rate of change using a tangent on a graph Notes and Example Calculations (pmt.physicsandmathstutor.com) Worksheet providing questions on calculating rate of change from a tangent on a graph. Rates of Reaction Mastery Booklet (hartismere.com) Booklet providing information including some challenging questions on calculating rate of change from a graph y=mx+c Revision (mmerevise.co.uk)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
					Videos, examples and questions for calculating $y = mx + c$. Evaluating experiments worksheet (edu.rsc.org) Free sign up and allows students to evaluate experimental design and data. Evaluate this conclusion... Exam skills for A Level Biology How to answer Evaluate exam questions. Evaluate the method, data and conclusion in A Level Biology (youtube.com) These videos show how to draw conclusions and evaluate them. Evaluating Existing Experimental Designs (teaching.betterlesson.com) Examples of experimental design to be evaluated. OCR ExamBuilder	

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Describing graphs: students will have some experience of describing graphs at GCSE, particularly in the context of common examples such as enzyme activity at different temperatures or pH or how different variables affect the rate of reaction. Students may well be familiar with including data in their answer, describing each section of the graph, reading data off the line of best fit of a linear graph and using key terminology such as steep, rapid, shallow, slow, stops, correlation, increase, decrease, optimum, peak and plateau. As well as this, students may have prior knowledge of how to calculate the gradient of a line, draw a tangent, interpolate off a line of best fit and calculate the mean, mode, median and range.
Common misconceptions	Reading off the line of best fit: Students may think that reading off a line of best fit can be done in the same way whether the line is curved or straight. It may need explaining clearly that where the line of best fit is a curve, a tangent needs to be drawn at the steepest part of the line of best fit.
Key concepts	Interpreting data: Students should know how to analyse data using a variety of methods including reading off graphs with linear relationships, drawing tangents and carrying out calculations such as the mean. Students should be able to describe graphs in detail and use this to form conclusions about data they are presented with, accepting or rejecting given hypotheses. Links to other parts of the specification Specification point 2.4 Interpreting data links to Unit F182 1.1.1 Researching the topic.
Subject knowledge enhancement for teachers	Read: OCR A Level Mathematical Skills Handbook Biology A Biology B Save My Exams: Mathematical Analysis of Results (OCR A Level Biology) (savemyexams.com) Evaluating Experiments (studyrocket.co.uk) Elewise (elewise.co.uk) Watch: Struggling with maths questions in biology? Watch me go through 5 maths exam questions to help you A-Level Biology - How to describe a graph (youtube.com)

Area of study: 3.1 Hypothesis, theory and law (Topic Area 3: Scientific developments)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
13	3.1.1 Scientific uses of terms: - Hypothesis - Prediction - Theory - Law	2	By the end of the lesson students should: - know definitions of the terms. - know how to write a hypothesis and predictions. - understand how a hypothesis may become a theory. - understand how the term theory is used in science and in everyday language. - understand the role of assumptions, estimations and approximations in science.	Students could watch one of the linked videos or read the information from a website (see useful resources column). Using what they have learnt from the videos, students could complete a match up activity of key terms and their definitions. Students could then match these up with provided examples of each of the key terms. For further challenge, students could be given a theme or question and produce their own examples. Key terms include hypothesis, prediction, theory, law. Students could be then given a range of investigation titles with some background information and they attempt to produce a hypothesis and a prediction from this. This could be extended for further challenge to produce null hypotheses for each. There is an example on	Applied Science Unit 3: Writing a hypothesis The Scientific Method, Part 3: Writing a Hypothesis (youtube.com) Definitions (ncse.ngo) AAQ_Applied_Science_F181_3.1.1 Hypothesis and prediction PowerPoint (teachcambridge.org) Experimental Design of a Controlled Experiment (bpb-ap-se2.wpmucdn.com) This resource allows students to practice writing hypotheses. Holmes Classrooms (holmesclassrooms.weebly.com) This website has a video, an example and questions for students to write their own hypotheses.	Students could produce a 'how-to' guide for how to write a prediction and hypothesis. Students add key terminology to their glossary including hypothesis, prediction, theory, law, approximation, estimation and assumption. Students can spend time learning these definitions.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				AAQ_Applied_Science_F181_3.1.1 Hypothesis and prediction PowerPoint slide 1. Students could work through the experimental design resource where they practice writing hypotheses. Provide students with one or more exam style questions where they practice writing a hypothesis in exam conditions. Alternatively, a range of hypotheses and predictions could be given and students determine whether they are adequate, and if not, amend them accordingly to make them 'good' hypotheses and predictions. This could be extended further as part of a challenge activity for students to carry out a statistical test and accept or reject a hypothesis based on the results from this. Think-pair-share task on what is meant by the terms 'theory' and	These live science articles describe theory and law: What is a scientific theory? What is a scientific hypothesis? (livescience.com) These websites are good starting points for learning about assumptions and estimations. Save My Exams (savemyexams.com)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				'scientific theory'. Draw out the idea that scientific theories are the explanations of phenomenon based on scientific observations/experiments compared to untested hunches in everyday life. Students write a definition. Question: Is it always possible to collect a full set of data to prove or disprove a hypothesis? Answer: No, sometimes it is not feasible to do this, such as if you are studying a huge sample of water or fieldwork where organisms move around. In this case you need to make estimates. Question: What are the flaws of making estimates? You have to also make assumptions so that the estimate is true for the whole population or sample being studied.	This revision website is free to sign up to. Save My Exams Estimates (savemyexams.com) (free sign up required) Making assumptions (undsci.berkeley.edu) Capture - Recapture Revision (mmerevise.co.uk) Save My Exams Capture Mark Recapture (savemyexams.com) (free sign up required) Capture Recapture Practice Questions (corbettmaths.com) Capture-mark-recapture method with video and questions and answers. Epidemiological Background and Design: The Framingham Heart Study (framinghamheartstudy.org) This web page explains assumptions and estimations that were made.	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Students research examples of where assumptions and estimations are used in science, alternatively provide some examples using the links. One specific example students may already be familiar with is the capture-mark-recapture technique. You could talk through this technique or show the linked video and then get students to estimate the population size and suggest any assumptions they might make. Question: Why is estimation important in studying disease prevalence? Answer: Not everyone will declare they have a disease for a range of reasons, some people will have the infection but are not showing symptoms so you don't actually know for certain how many people have it, the population is too big to take data from everyone.		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Bring in the Framingham Heart Study which students may have looked at in the cohort study lesson. Students can read the article and identify assumptions and estimations made during this study and explain why they were important. Challenge: Explain the complications of making assumptions within living populations Answer: There are so many variables, for example with diseases there are multiple causes and you do not know which one it is due to and therefore it does weaken the evidence of a causal link. Students could produce a correct the text, fill in the blank word, flashcard or five sentence summary of their learning across these lessons.		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
14	3.1.2 Scientific theory versus scientific law	2	By the end of the lesson students should: - know how a law is different from a theory. - understand both theories and laws require evidence and can be open to change and revision. Examples of scientific theories may include: Theory of evolution Theory of relativity Atomic theory. Examples of scientific laws may include: Newton's Laws of motion Periodic Law Laws of thermodynamics	Begin the lesson by assessing students' knowledge of their key words (previous independent learning task was to learn definitions in their glossary). Give students a quiz or get students to generate their own quiz to assess each other's knowledge. Show students the videos and use the information available on the websites (linked) to make a bullet point list summarising the key features of scientific laws and theories. Students can then produce a Venn diagram comparing the similarities and differences between the two. (Supported: provide statements for students to sort into the correct area of the Venn diagram, Challenge: students create their own statements to put in the correct area of the Venn diagram). Provide students with a list of scientific theories and laws. Students choose one law and one	What's the difference between a scientific law and theory? Fact vs. Theory vs. Hypothesis vs. Law (youtube.com) Video: Theory vs. Hypothesis vs. Law Difference & Examples (study.com) NASA worksheet (nasa.gov) This worksheet can consolidate	Provide exam questions put together using OCR ExamBuilder. As a lot of content has been covered so far in this topic, now might be a good time to set a consolidation independent learning/homework task such as reviewing notes, making revision resources such as flashcards or mind maps, bringing written questions to lesson that students need clarification on.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			Does not include detailed information on each law or theory.	theory and research in order to answer some comprehension questions including (but not limited to): State your law/theory and provide a very brief description of what it is. Is this a law or theory? Give three reasons. Summarise some evidence to support the law/theory you have chosen. Challenge question - Is this law/theory likely to change? What would be required to make this change? Students share their learning with other students who have studied different examples, for example by presenting their findings to the class and then the class voting on whether the presentation is based on a theory or a law and why.	students' understanding of theory and law. Kahoot! (kahoot.com) (free sign up required)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Give students a series of statements and students decide if they are theory, law or hypothesis, such as the NASA worksheet. This could be done using a Kahoot! quiz.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Students may well be familiar with hypotheses and predictions, having produced them previously and/or determined whether a set of results allow the hypothesis or prediction to be accepted or rejected. Students have been taught laws previously such as Ohm's Law but may not be familiar with the definition of a scientific law. Similarly, students may have previously learnt about scientific theories such as the theory of evolution and so may be able to name examples but may not be able to define the term theory. Students may have some general knowledge of the impact and risks of using modern technology such as artificial intelligence.
Common misconceptions	Hypothesis, prediction, theory and law – students may have the misconception that a prediction and theory are the same thing. Similarly they may think a theory and law is the same thing. Due to the use of the word theory in every day language, they often believe a theory is not proven or is only an idea without evidence.
Key concepts	Hypothesis, prediction, theory and law – here students will learn about the definitions of these terms, how to write a hypothesis and prediction and identify examples of each. Students will learn about the definitions of these terms in the context of everyday language and in the scientific context. Students will learn about examples of laws and theories and what makes them a law, without having to go into detailed information on any particular laws or theories. Links to other parts of the specification Specification point 3.1.1 Scientific use of the terms hypothesis and prediction links to Unit F182 1.1.1 Researching the topic. Specification point 3.1.2 Scientific theory and law could link to several parts of the topic depending on the examples used in teaching such as Unit F180 P1 1.1.2 Ohm's Law, Unit F180 P1 1.1.4 Kirchoff's Laws, P2 2.1.2 Work and energy, P2 2.1.5 Newton's first, second and third laws of motion, P3 3.2.2 Decay law, B1 1.1.1 Cell structure and function, C4 4.1.1 Factors which affect reaction rate, P3 3.2.1 Fundamentals of radioactivity.
Subject knowledge enhancement for teachers	Watch: The Scientific Method: Steps, Examples, Tips, and Exercise (youtube.com) Formulating a Viable Scientific Hypothesis (study.com) Hypothesis and Prediction (youtube.com) Read: Hypotheses and Predictions (biologyforlife.com) Mark, Release and Recapture (field-studies-council.org)

Area of study: 3.2 Using new technologies in science (Topic Area 3: Scientific developments)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
15	3.2.1 New technologies play an important part in continuing scientific development: • Robotics and automation • Computer aided design (CAD) • Artificial intelligence and machine learning • Quantum computing • Big data analytics • Smart technologies • Advanced imaging technologies Augmented and virtual reality	3	By the end of the lesson students should: • understand key concepts of each type of new technology. • understand advantages of the new technologies to further scientific development. • understand how scientific disciplines might be supported by these technologies. Does not include detailed descriptions of how each technology works.	Begin the lesson by reviewing exam questions set for independent learning, allowing students to familiarise themselves with the mark scheme make any improvements to their work and seek out additional support if required. Show images of modern technology such as the watch that buzzes in a boring conversation, smartphone apps that help to catch fish, GM rice, drones, virtual reality. Ask students which they think are real or fake news and why (they should all be real). Think-pair-share question task: 1. What is science? 2. What is technology? 3. What is the difference between them? 4. What links them?	Students could ask their older relatives: 1. How has technology changed as they have grown up? 2. What impact has this change in technology had? 3. What has enabled the change? 4. What are the advantages of the change?	Students could choose the technology type(s) they find the most challenging to understand or the most interesting. From their choice they could produce an information guide aimed at younger students with an FAQ section to help them with their understanding (such as what it is, examples of use, pros and cons, who might disagree with the technology and why). For areas that students found most challenging on their exam questions,

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Research task: Students choose a minimum of three types of technology to research the following points: 1. How does the technology work? 2. How might this technology impact education, giving examples? Structure your answer so the points you make are sorted into advantages and disadvantages. 3. How might this technology impact medicine, giving examples? Structure your answer so the points you make are sorted into advantages and disadvantages. 4. How might this technology impact our understanding and actions in relation to the environment, giving examples? Structure your answer so the points you make are sorted into advantages and disadvantages. 5. Which scientific disciplines might benefit from your chosen technology and why? Students can spend some time presenting their findings to their	5. What are the disadvantages of the change? This could be done as a questionnaire that students design or one that is provided for more support. The following weblinks will be useful for students to start their research: What is the difference between automation and	they should produce a revision resource to bring to next lesson to demonstrate they are working on this skill / content.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				classmates either orally in small groups or as a peer review of each other's written work to ensure they have covered key content. 'Dragons' Den' task: Students can research some real-life applications of each of the technologies using some of the websites linked (they can choose from the list of technologies, and could do more than one if they wish). As a more challenging alternative, students could identify a first world problem and then design a possible solution to the problem (no limits on cost, challenges could be easily solved, using their imaginations) and pitch their invention. They become 'scientists' and are trying to convince investors to fund their research to develop their technology into a new product. They should produce an oral presentation (written notes as evidence) to describe their product/development and convince their classmates (Dragons) to fund their research because their product is going to change the world! The Dragons should play Devil's advocate as a challenge and can ask thought	robotics? (robotnik.eu) What is CAD? (ptc.com) Artificial Intelligence (ourworldindata.org) What is quantum computing? (ibm.com) How AI is Transforming Quantum Computing (analyticsinsight.net) What Is Big Data Analytics? Definition, Benefits, and More (coursera.org) What is smart technology and what are its benefits? (rezaid.co.uk) Advanced image technology promises	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				provoking questions to try and identify disadvantages or problems with the development. As an extension, students could then decide which of the technologies they have studied: 1. Has the widest range of useful applications. 2. Has the most potential to be dangerous/misused. 3. Is the most exciting or interesting. 4. Is the one that they think the public will be the most invested in using or seeing being used in scientific development.	greater diagnostic accuracy, less radiation (physics.unc.edu) Virtual Reality, the technology of the future (iberdrola.com) Real life application website links (students could find their own): Robotics (newscientist.com) Nature machine intelligence (nature.com) SciTech Daily (scitechdaily.com) The Scientific Teen (thescientificteen.org)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
16	3.2.2 Limitations and risks of new technologies in society	1	By the end of the lesson students should: - understand impacts on people, money, security and the environment. - understand how to identify the limitations and risks. - understand how judgements are made about the use of these new technologies.	Students could share the results of their questionnaire given for independent learning in the previous lesson. They could collate answers and identify common themes. Students produce a table listing advantages and disadvantages of developing technology. They could add to their list specific disadvantages from each specific technology that they studied in the previous lesson. (Lesson 15, specification point 3.2.1.) Students sort their list of disadvantages into what it will impact (money, security, the environment, any alternative categories they feel are relevant). Students could work in groups to choose one of the application tasks below: - Decide which technological development you would invest in, giving reasons for your answer. - You are the leader of a political party. Choose one technological	Advantages and disadvantages of using new technology for businesses (bbc.co.uk/bitesize)	Provide student with exam style questions which could start with command words such as 'evaluate', 'compare' or 'analyse' so that they can practice an open style question assessing their knowledge on this topic. An example of a modelled answer may help students to gauge the level of depth and breadth required.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				development that your political party would support as part of your manifesto. Communicate to your constituents why you and your party are backing that technology for their benefit. 3. You are a government think-tank and have five hundred million pounds to invest in one new technology. Create a press release that outlines why you are backing the technology for the benefit of the country and providing counter arguments that another political party might suggest to you.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	This content may well be new to students in terms of scientific advancements although they may have general knowledge of some of the technologies from everyday such as artificial intelligence.
Common misconceptions	Students may have the misconception that these technologies are solely beneficial or that risks can easily be overcome. They may also have other misconceptions about technology such as artificial intelligence is dangerous, will entirely replace the role of humans or that these technologies can be easily trained into being biased.

Subject knowledge enhancement	Details
Key concepts	Using new technologies in science – students will learn about a range of new and developing technologies that are being developed such as robotics and artificial intelligence. They will learn the key concepts around these new technologies, as well as their advantages and limitations and risks.
Subject knowledge enhancement for teachers	Read: The use of computer aided design and computer aided manufacture (bbc.co.uk/bitesize) Advantages And Disadvantages of Using Computer Aided Design (CAD) (arcvertex.com) Watch: What Are Robotics and Automation? It's Future And Impact on Various Industries (youtube.com) Listen: How AI is Transforming Science (youtube.com)

Area of study: 3.3 Implications and limitations of scientific development (Topic Area 3: Scientific developments)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
17	3.3.1 Considerations for scientific developments: - Monetary costs and funding - Social, ethical, and moral issues - Environmental issues Benefits and limitations to society	2	By the end of the lesson students should: - know the importance of funding in science. - understand the role of private companies, charitable foundations or governments in scientific research. - understand factors that affect research that is carried out. - understand how scientists receive funding for research. - understand what issues might arise and how they are classified as social,	Help students to self-mark their exam questions by providing model answers achieving different marks for the command words provided such as 'evaluate'. Ask students to rank the answers and award marks, suggesting improvements. Students can then self-assess their own exam questions and add improvements where relevant. Students could produce a flow chart outlining what happens when scientists apply for and are granted funding. Question: Only 20% of applications receive funding despite the majority being considered high quality applications. Suggest why this might be. (Students might suggest things such as limited funding, applications which are most relevant to current issues,	Types of research funding (imperial.ac.uk) What is Research Funding? (infonetica.net) Why fund research? (sciencebusiness.net) 'Bubble boy' treatments showing success in spite of funding challenges (capitolweekly.net) What are stem cells, and why are they important? (medicalnewstoday.com)	Provide student with exam style questions which could start with command words such as 'evaluate', 'compare' or 'analyse' so that they can practice an open style question assessing their knowledge on this topic. (If students completed a similar command question last lesson/for homework, provide a question with a different command word).

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			ethical or moral issues. Examples of scientific developments may include: • Stem cell therapies • Proton beam therapy • Electric vehicles • GM crops. Does not included detailed understanding of research grant applications or detailed information on examples of scientific developments.	applications which are deemed most likely to succeed/have positive results, applications which are deemed most likely to be a commercial success.) Look at examples of scientific developments such as recent news articles of stem cell therapy. For one or more of the developments, you could provide a list of challenges and issues that may arise, or for more challenge students could think of their own. These could then be grouped by students into social, moral, ethical or other issues. Challenge – if money was no object, can you think of ways to overcome these challenges? ‘What do you think?’ task -students suggest opinions of a range of people who may be invested in a particular scientific development and explain why they might hold that opinion (examples would depend on the context but some could be: parent of an ill child, scientist, environmental campaigner, sufferer	Cancer treatment underfunding Many of the deadliest cancers receive the least amount of research funding (news.northwestern.edu) GM Crops - The Human and Environmental Hazards (youtube.com)	Flipped learning: To prepare for next lesson, students could research one or more of the contemporary issues such as antibiotic resistance, self-driving cars, palm oil and nanotechnology.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				of an illness, family member, NHS worker, farmers, funding body, charity). Students could act as a chairperson of a funding body and write an email/letter response offering or rejecting funding for one of the scientific development examples discussed in the lesson.		
18	3.3.2 Contemporary issues that science will need to solve in the future: • Climate change • Sustainability of natural resources • Conservation • Public health • Energy sources • Transport • Manufactured products	3	By the end of the lesson students should: • know key concepts of these main issues. • understand what scientific disciplines will be necessary to solve these issues. • understand social, ethical, and moral issues arising. • understand economic and	Help students to self-mark their exam questions by providing model answers achieving different marks for the command words provided such as 'evaluate'. Ask students to rank the answers and award marks, suggesting improvements. Students can then self-assess their own exam questions and add improvements where relevant. Recap from earlier in the topic: think-pair-share what is a scientific discipline and give examples.	Students' revision might start at these links but they can then find their own links from here. Climate Change (thesciencehive.co.uk) GCSE Physics Revision "Renewable Sources of Energy" (youtube.com) A Level Biology Revision "Antibiotics and Antibiotic Resistance" (youtube.com)	Flipped learning – students could find several examples of scientific information passed to the public (e.g. podcasts, news articles, books) and bring them to next lesson to share. Consolidation task – provide students with a set of exam questions assessing the content so far of the unit. In one colour they complete the questions in

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			environmental considerations. Examples of contemporary issues may include: • Antibiotic resistance • Self-driving electric vehicles • Use of palm oil • Nanotechnology.	Question: what issues is science currently trying to develop solutions to? (Students may suggest ideas such as climate change, pandemics such as COVID-19, alternatives to fossil fuels, alternative fuel to using petrol for cars, no longer using single use plastics and finding alternatives.) Students research a minimum of three contemporary issues (from your suggested examples or their own ideas). Each of their examples need to be presented in different ways. Ideas include: a PowerPoint presentation, an information guide for a government's website, a neutral news article to be published to the public, a children's webpage news article or a debate script. The content they include is: 1. Key concepts of the issue.	How driverless cars will change our world (bbc.com) Understanding palm oil (icheme.org) Nanotechnology (edu.rsc.org) (This is free to sign up to). GCSE Chemistry - Nanoparticles (youtube.com) Solar power: your questions answered (nationalgrid.com) Single-Use Plastics 101 (nrdc.org) A new era for respiratory pathogen pandemic preparedness (who.int)	exam conditions, in a second colour they add further answers using their notes/the internet/revision resources. Anything they are still finding challenging, they could then produce a revision resource (e.g. further exam questions, notes, flashcards) to consolidate their knowledge.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				2. Who is involved in trying to develop technology to help address the issue (such as organisations, scientific disciplines, government or private)? 3. What problems are we facing due to the chosen issue (categorised into social, economic, ethical/moral and environmental)? 4. What is/are the cause(s)? 5. What are the current solution(s) that scientists are working on? Challenge: Produce some data to show evidence of the issue and whether any scientific advancements or advice based on scientific data is helping the issue Challenge: Explain why it is not simple to solve the contemporary issue, using knowledge of technology / processes involved, challenges that are arising and including data where possible.	Wildlife Conservation (worldwildlife.org)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Students can share their answers with each other and make summary notes as they listen to each other's presentations. Students complete exam style questions to assess their understanding.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Students may have some general knowledge of some well known scientific developments such as stem cell therapy and electric vehicles. Students may know some of the advantages and risks of these scientific developments. There may be underlying knowledge of what is meant by the terms ethical, social, economic, moral and environmental considerations. Students may be aware that scientific research is extremely expensive and requires funding. They may be aware that some scientific research is funded by external organisations, for example they may know that the COVID-19 vaccination was funded largely by the government and private companies to help the research and development of this vaccination.
Common misconceptions	Students may have the misconception that funding for scientific research is unlimited or that all scientists are eligible and receive the funding that they request. Students may think that the funding is provided by the scientific organisation carrying out the research and not that further contributions are made from government or charitable organisations, for example. Students may have the misconception that funding is provided regardless of any potential opposing points of view. For example, they may think that unlimited funding is provided to organisations researching stem cell therapy and that the opposed points of view do not impact this receipt of funding.

Subject knowledge enhancement	Details
Key concepts	Scientific developments - students will learn about a range of scientific developments; they will focus on the key concepts of some examples of developments and how these may benefit society. They will also learn about the limitations of some of these developments and therefore some of the disadvantages to society, of which can be placed into categories such as social, ethical, moral, economic and environmental considerations. Funding - students will also learn about the process of funding and how a range of different organisations provide funding to scientific research bodies. Detailed steps of research grant applications are not required but students will learn about the key steps in needing to apply for funding, why this is important and the issues that may arise with the funding application and receipt of funding. Links to other parts of the specification Specification point 3.3 considerations for scientific developments could link to a range of specification points in Unit F184 such as 2.1 impact of human activities, 4.1 environmental surveying, 4.2 environmental management.
Subject knowledge enhancement for teachers	Watch: What Are Research Grants? (youtube.com) Read: Research Grants: Tips for Overcoming the Funding Challenges in Academic Research (indeemo.com) What is climate change? (metoffice.gov.uk) What is antibiotic resistance? (khanacademy.org) Environmental Pros and Cons of Self-Driving Cars (earth.org) Industries: Palm oil (worldwildlife.org) What are potential harmful effects of nanoparticles? (ec.europa.eu/health) Risks of nanotechnology (centerforfoodsafety.org)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
19	4.1.1 Communicating science to the public using the media: - Popular science books - TV documentaries - Blogs and vlogs - Podcasts - Social media - Websites - National newspapers - Science magazines	3	By the end of the lesson students should: - know key features of each media. - understand advantages and disadvantages of communicating using each media. - know target audiences of each media. - understand language, structure, and images used for	Students' independent learning was to complete exam questions in two different colours (one for their own knowledge and one for use of resources). Take a poll to find out which areas students commonly found most challenging. This might be a good opportunity to re-teach some of the content with revision activities such as: - Talking them through examples of exam questions. - Providing them with relevant resources to allow them to produce their own revision materials while asking specific questions. - Working in small groups to work on key ideas together. - Provide additional exam questions using OCR ExamBuilder to work through areas of challenge in small groups, using resources or as a whole class. - Giving time for students to create their own model answers after you have demonstrated examples of how to do this.	AAQ_Applied_Science_F181_4. 1.1 Communicating science to the public using the media PowerPoint (teachcambridge.org) Examples of how science is communicated to the public: Newsround (bbc.co.uk) Science Podcasts (bbc.co.uk) Science Documentaries (youtube.com) Or other well known documentaries such as Planet Earth (bbc.co.uk).	Revision in preparation for next lesson: students make summary notes recapping prior learning on the different types of scientific discipline, and research definitions of reliability, validity, accuracy and peer review. Students could complete an exam style question

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources										
			engagement of target audience. - understand how to assess the effectiveness of a source of information in providing accurate information and being engaging. - know how to assess the validity of a source of information.	(This could take different lengths of time depending on the areas students are finding most challenging). Ask students to make a list of the different ways science is communicated to the public. You could print off articles, provide books, show video clips (linked in resources). Alternatively, students show their own scientific articles/podcasts/media that they researched for homework. As a class, for one of the media types, model how to identify the key features, target audience, advantages, disadvantages and how they use language/structure/images to engage the target audience. Students write down the example. Students could then work initially independently, then in groups to share and build on answers and then as a whole class discussion to produce a table that may look like the following: <table><tr><td>Media type and key features</td><td>Target audience</td><td>Advantages</td><td>Disadvantages</td><td>How do they engage the target audience? (language, structure, images).</td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></table>	Media type and key features	Target audience	Advantages	Disadvantages	How do they engage the target audience? (language, structure, images).						Science Books (goodreads.com) Social Media in Science: Best Practices for Navigating Social Media for Scientists (scitechedit.com) New Scientist (newscientist.com) The Guardian: Science (theguardian.com)	assessing the validity of a source of scientific information provided.
Media type and key features	Target audience	Advantages	Disadvantages	How do they engage the target audience? (language, structure, images).												

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				To extend this task, students could rank the media types from most to least effective in providing accurate information in an engaging way. (Students may consider factors such as whether the source provides evidence, whether it is communicated appropriately for a target audience, whether engagement is deemed a priority over factual information.) Alternatively, provide students with some scientific information such as an interesting scientific investigation and ask them to produce a resource to communicate this to a specific target audience. This could be an oral news report for the general public, an engaging article that might appear on something like BBC Newsround aimed at children, for instance. You could show slide 2 of AAQ_Applied_Science_F181_4.1.1 Communicating science to the public using the media PowerPoint. Ask students which article they believe more and why? Questions: Which appear more 'valid'? Which may be showing bias and how does this affect how well you believe it?	Massive 'weak spot' in Earth's magnetic field is growing... and it could have huge consequences (dailymail.co.uk) Measles outbreak prompts call for vaccination uptake (bbc.co.uk) Breaking: Shell backs down in its lawsuit against Greenpeace (greenpeace.org.uk)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Is there any data that has been removed to make the graph appear different? Which sources are the most reliable? What else might you consider when evaluating validity? Talk through with students what it means for data / an article to be credible and peer reviewed, and the factors to look for when considering the strength of evidence of an article, e.g. date of publication, quality of data, publisher. Students think-pair-share a list of key features that they may look for in assessing the validity of a source of information. (Examples may include: purpose, author, credibility, peer review, strength of evidence, target audience, which media it was published in, accuracy, date of publication or bias). You could finally provide students with several sources of scientific publications (some examples you could use are linked). Students evaluate the validity of each of the articles they have chosen and justify their responses. This task could be extended for more challenge by students ranking the articles in order of validity and justifying their answer or identifying what further information could be gathered to improve the validity of the experiment.		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
20	4.1.2 Communicating science between experts: - Journals - Meetings and seminars - Conferences and symposia - Online platforms and forums - The process of peer review	2	By the end of the lesson students should: - know why it is important for experts within scientific disciplines to engage with each other. - know why it is important for experts across scientific disciplines to engage with each other. - understand key features of each type of communication. - know steps in the process of peer review.	Students mark their homework question assessing validity of a source by comparing to a peer's answer or a model answer. Question: Would you trust a scientific conclusion/breakthrough if only one person had worked on it? Why/why not? Answer: Hopefully not! Students should come up with the idea that scientific breakthroughs require collaboration and therefore communication. Question: Would you trust the breakthrough more if it had been published in a scientific journal or on the BBC? Answer: Hopefully yes, scientific journals are often peer reviewed and neutral in their communication, as well as the information going to other scientists who might look at it through a critical lens rather than just accepting the news like many people who don't fully understand the science might. Question: Would you trust the breakthrough more if scientists had used the internet to research secondary data and attempted to reproduce the data?	These links provide examples of where peer review has been	Students produce a page that could be used in a revision guide for other A Level students summarising the key points about scientific communication and peer review. Students could complete one or more of the activities available on Royal Society of Chemistry website. (edu.rsc.org)

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			- understand why peer review is important. - understand how the process of peer review increases reliability and validity of published information.	Answer: Hopefully yes, as reproducibility is key in showing results are valid and accurate. Think-pair-share task: - How might scientists communicate with each other? - What are the pros and cons of each type of scientific communication you have mentioned? - How would scientific discoveries be affected if scientists did not communicate with each other within and across disciplines? Use an example to support your answer. (Students have covered this in specification point 1.2 and therefore this is revision). You could show students some examples of where peer review has been important in a scientific breakthrough (see links). e.g. cold fusion paper 1989, arsenic life 2010 Students could complete a comprehension task about peer review using some of the links. Questions that could be asked include:	important in a scientific breakthrough: Cold fusion: A case study for scientific behavior (undsci.berkeley.edu) Scientists say NASA's 'new arsenic form of life' was untrue (phys.org) Alan Turing and DNA papers among historical peer review reports made public for first time (royalsociety.org) Peer review: the nuts and bolts (senseaboutscience.org) Peer Review (physicsandmathstutor.com) Open access research (khanacademy.org)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				1. What is peer review? 2. Produce a flow chart describing the process of peer review. 3. Describe the types of peer review. 4. What are the purposes of peer review? 5. How do new methods of peer review help to improve its effectiveness? 6. Why is it important that a peer review is anonymous? 7. How does being peer reviewed affect your trust in the information you read? Would you read information that has not been peer reviewed? Why? 8. Challenge: Is peer review ever a bad thing? Is it ever unnecessary? Explain your answer. (If students research this they will come across some articles where scientists are criticising the depth that peer review is required in now.) (Students might come up with the idea that peer review can be good for many reasons but may not be accurate or unnecessary in current society because: false positives may be obtained, companies are now sharing data as they collaborate more, a growth in science /		

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				number of scientists, there is a need for reproducibility but this could be obtained independently, the internet making results widely available, data dredging, publication bias, scientific errors.) Provide students with an exam style question which asks them to describe or evaluate the process of peer review.		
21	4.2 Plagiarism • Complete • Direct • Self • Source-based Accidental	2.5	By the end of the lesson students should: • know definition of each type of plagiarism. • understand when each type of plagiarism could occur. • understand why people plagiarise	Go through the answers to the Royal Society of Chemistry website independent learning activity. Teacher-led discussion (using linked resources where required) on types of plagiarism. Questions: • Why might people plagiarise? • Why is plagiarism a problem? • What might the consequences of plagiarism be? Students think-pair-share a list of ways to avoid plagiarism. Students could produce a plagiarism guide for a university course in one of various formats (information sheet, recorded video / audio with cue	What is peer review? (edu.rsc.org) Royal Society of Chemistry independent learning activity. These weblinks provide information on types of plagiarism: Plagiarism - Lesson presentation (turnitin.com)	Students could produce a range of questions (worth 1-3 marks, increasing by difficulty) with model answers for their classmates to answer in future lessons. Use OCR ExamBuilder

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			and why it matters. - understand how to avoid plagiarism. - understand potential consequences of plagiarism.	cards). This could be done independently or as part of a small group task. Students will need to include: - Types of plagiarism. - Why plagiarism is wrong. - How to avoid plagiarism. - How artificial intelligence can be used to produce work appropriately but carefully in order to avoid plagiarism. You could provide students with examples of work that are and are not plagiarised. Students identify whether they are plagiarised or not and if so, what type of plagiarism has occurred. (There is an example in the resource below but you may want to use more scientific examples). Identifying Plagiarism (readwritethink.org) Challenge: Students could produce their own 'is it plagiarised?' or not using their textbook or personal notes for other students to determine (as a mixture of a revision and plagiarism exercise).	What is Plagiarism and How Do I Avoid it? (youtube.com) Academic English UK (academic-englishuk.com) Plagiarism and Academic Misconduct: Artificial Intelligence (plagiarism.admin.cam.ac.uk) Plagiarism Worksheet (unbc.ca) This worksheet gives examples of work asking students if it is plagiarised. Mentimeter (mentimeter.com) This website could be used for students to complete or produce a quiz.	to produce a range of exam questions for students to complete which could be focused on either the content from this lesson or the content that they have learnt so far in this unit.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Students add to their glossary the key terminology from the lesson including: complete plagiarism, direct plagiarism, self plagiarism, source-based plagiarism, accidental plagiarism. Students could complete a quiz to assess their knowledge or use Mentimeter (or similar free website) to produce a quiz.		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Students will have general knowledge that science is communicated to the public in a range of ways such as through streaming services, news outlets, podcasts and social media. They are likely to have some underlying knowledge that depending on the source, the information may well be 'skewed'. For example, they may be aware that certain news outlets are supposed to provide impartial information, that organisations such as Greenpeace may be considered to provide information that would support and demonstrate their own viewpoint only. Students will also likely have underlying knowledge that information shared may be filtered or amended to put across a certain viewpoint and influence opinion and therefore know that the validity of sources should not be fully accepted without consideration. Students may have some prior knowledge of peer review and that feedback from peers, in this case other scientists, is important for assessing the validity of results. Students may have some prior knowledge that plagiarism is the reproduction of someone else's work and is not allowed. They may also have some knowledge of how to write a piece of work without plagiarising and the consequences of not doing so; however, they may not fully appreciate that there are different types of plagiarism or what they entail before this lesson.

Subject knowledge enhancement	Details
Common misconceptions	Communicating science – students may have the misconception that all science information communicated is factually accurate, unbiased and all of the relevant information is shared. They may not fully appreciate that information can be filtered in order to strengthen a particular message or influence public opinion. Peer review – students may have the misconception that peer review happens by scientists within the same organisation and not from other organisations such as other universities or companies from across the globe. Students may have the misconception that reproducibility and repeatability are the same and therefore think that peer review is as effective as being able to repeat one's own experiment and get the same results. They may be unaware that some scientific journals will publish articles without peer review and that some groups will pay for this opportunity. Plagiarism – students may have the misconception that plagiarism is always intentional and that there is only one type of plagiarism such as complete plagiarism. They may believe that re-writing in their own words, without indicating the source of the ideas, does not constitute plagiarism.
Key concepts	Methods of communication – students should know that there are a range of different methods used by scientists to communicate both with other scientists / experts and with the general public. Students should know that there are pros and cons to each method of communication and why communicating the scientific information is so important. Communicating science – students should know that communication between scientists is vital, especially when going through the process of peer review to increase validity of results by proving reproducibility of results. Plagiarism – students should gain knowledge of different types of plagiarism, why plagiarism is carried out and how to avoid plagiarising work. They should also gain an appreciation of potential consequences of each type of plagiarism. Links to other parts of the specification Specification point 4.1 Communicating science links to Unit F182 3.3 Communicating results and Unit F185 4.3.2 Communicating results of analysis Specification point 4.4.2 Bias links to Unit F185 3.4.1 Interpreting results of analyses.
Subject knowledge enhancement for teachers	Watch: Plagiarism: 6 different types of plagiarism to avoid (youtube.com) Listen: Science thrives on constructive and respectful peer review (physicsworld.com) Read: What is peer review?(edu.rsc.org)

Area of study: 4.3 Using science to inform decision making (Topic Area 4: Communicating science)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
22	4.3 Different organisations that use science to inform their decision making: - Government organisations - Non-governmental organisations - Private and commercial organisations - Pressure, voluntary and charitable groups	3	By the end of the lesson students should: - know how organisations use scientific information and data. - understand aims and objectives of these types of organisations. - understand the importance of these organisations in influencing public opinion. - understand the importance of these organisations in future scientific advancement. Examples of different organisations may include:	Begin the lesson by reviewing exam questions set for independent learning, allowing students to familiarise themselves with the mark scheme make any improvements to their work and seek out additional support if required. Question: what is the purpose of collecting scientific information/data? Students may suggest ideas such as to prove or disprove a hypothesis, to help with scientific developments (e.g. new technology), to help work towards solving problems (e.g. data on climate change could be used to identify some of the major causes). Provide students with a list of examples of organisations which use scientific information. Making sure they choose one of each of the types of organisations (government, non-government, private/commercial and	These weblinks are a good starting point for students to begin their research. They contain both information in written form and videos: Environment Agency (gov.uk)	Students could produce a revision resource to cover the content from this lesson (or include previous lessons' content). This could be: a revision guide style summary page, flashcards, a mind map, written notes or question and answers. Flipped learning – students could come prepared to the next lesson(s) with a list of definitions for key terms such as: misinformation, disinformation, bias, pre-bunking, debunking, peer review.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			- Environment Agency (EA) - Health and Safety Executive (HSE) - European Union (EU) - United Nations (UN) - Worldwide Fund for Nature (WWF) - Greenpeace.	charitable/voluntary), students research the following: - Role of the organisation. - Type of organisation (e.g. government, non-government, private, commercial, charity, voluntary). - How scientific information/data is used? - How important it is that the organisation communicates effectively with the public and why. - Why the organisation is important in scientific advancements. Students could then produce a resource for each of the organisations they have researched (for example: a blog, website home page addressing the general public, newsletter, notes for a podcast to fellow scientists, email to reassure a concerned client) to inform them of their role in using scientific data and why their findings and decisions	Health and Safety Executive (hse.gov.uk) European Commission (commission.europa.eu) United Nations (un.org) World Wide Fund for Nature (wwf.org.uk) Greenpeace (greenpeace.org) website How to write a science blog (blog.sintef.com) Example of blog: Croda (croda.com)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				based on the data need to be communicated with the public. Questions to answer based on their research between different types of organisations: 1. Are there any similarities between the organisations you have researched? 2. Are there any differences in how the data is used? 3. Are there any other differences in how the organisations you have researched operate? Why do you think they have these differences? 4. Are there any differences in the communication of information (e.g. method, target audience, style) Challenge: Are there any advantages to having a range of types of organisation (e.g. charity-run, government, private)? What are they, which is the most beneficial advantage and why?		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Students may have heard of some organisation such as the European Union, United Nations or Greenpeace. They may have some knowledge of their roles in making decisions and how science plays a role in informing their decision. They may also know that these organisations communicate information to the public.
Common misconceptions	There may be the misconception that all organisations are profit-making organisations or that they are all linked to the government and their role in making decisions and policies linked to scientific research. Students may not be as aware that there are organisations that are voluntary or charitable.
Key concepts	Using science to inform decision making – students should know that there are a range of organisations which have roles in decision making and base their decisions on scientific research on evidence. These organisations may be government or non-government, profitable or charitable organisations. Students should have some knowledge of examples of decisions that companies make, that they have a role in future scientific advancements and that they have to communicate this information to the public.
Subject knowledge enhancement for teachers	Read: Environment Agency (gov.uk) Health and Safety Executive (hse.gov.uk) European Commission's Joint Research Centre (joint-research-centre.ec.europa.eu) United Nations: Science, Technology and Innovation (un.org) Worldwide Fund for Nature (wwf.org.uk) Greenpeace (greenpeace.org)

Area of study: 4.4 Problems with communicating science (Topic Area 4: Communicating science)

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
23	4.4.1 Public trust in the scientific community and developments - Misinformation in science - Misinformation versus disinformation Ways of improving public trust in the scientific community and developments	2	By the end of the lesson students should: - know how to differentiate between misinformation and disinformation. - understand how to identify potential misinformation and disinformation in science. - understand why science might be misrepresented. - understand different ways science can be misrepresented. - understand possible causes of misinformation. - understand sources of misinformation.	Students watch the linked videos on misinformation and disinformation. Students answer questions such as: - What is meant by the terms misinformation and disinformation? - How can you identify misinformation and disinformation? - Why is misinformation spread? - How can misinformation be spread? - How can we reduce the amount of people who believe the 'fake news'? 'Help uncover fake news' task: Provide some examples of scientific misinformation and disinformation for students to identify which is which and justify their answers (use links).	Misinformation v disinformation: What's the difference? (bbc.co.uk/bitesize) What is misinformation? Let's break it down (youtube.com) What are climate misinformation and disinformation and what is their impact? (lse.ac.uk) Climate disinformation (climate.ec.europa.eu) Climate Disinformation	Students spend time learning the definition for the key terminology they have been learning. This could be assessed with a multiple choice or alternative quiz in the subsequent lesson. Use OCR ExamBuilder to provide a range of exam questions for students to attempt. Students could self-mark and then come to lesson with highlighted questions to seek clarification on.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
			• know definition of scientific literacy. • understand why it is important for all citizens in society to be scientifically literate. • understand how scientists can improve communication with citizens about developments and research.	Topics could include climate change, measles outbreak, pink salt. Challenge: What are the advantages of pre-bunking over debunking misinformation? Students write an open letter/email to the CEO of a social media company to express examples of misinformation and disinformation they have seen circulating. They explain a range of reasons as to why this is a problem, suggest ideas that the company could do to reduce the problem. Students could listen to the podcast (11 minutes) linked. Students produce a definition of scientific literacy, give examples of common themes that it is important for the public to understand and why this is so important. Think-pair-share question: How might scientists improve communication with the public?	Database (desmog.com) How misinformation is fuelling the current measles crisis (gavi.org) Fake news in chemistry and how to deal with it: The case of pink salt (scienceinschool.org) Can you trust the news? How to tell the difference between real and fake news (youtube.com) The Difference Between Misinformation and Disinformation (youtube.com) Podcast: Scientific literacy: What do we need to know to make	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Draw out the idea that scientists need to adapt their communication to meet the target audience. Students can then give examples of target audiences (school children, general public, specific group). Provide students with examples of scientific news articles (some are linked, but you might find different ones depending on current news and/or student interest and/or how you structure the task with variation of articles among students). They translate the article into different words (not plagiarised!) to communicate each article to a different target audience (e.g. fellow scientists, secondary school children, A Level students, general public).	informed choices? (the-ies.org) Examples of scientific news articles: Groundbreaking proton beam therapy cancer trial opens (leeds.ac.uk) Stem cell therapy to correct heart failure in children could 'transform lives' (foxnews.com) Spacecraft attempts closest-ever approach to Sun (bbc.co.uk)	
24	4.4.2 Bias in science communication • Confirmation bias • Publication bias • Reporting bias • Biased language	2	By the end of the lesson students should: • understand contrast in how the term bias is used in science and in everyday language.	Gather feedback from students on the areas of the exam questions set for independent learning that they feel they need more support with. Go back over the content either by: • Re-teaching.		Students spend time reviewing their notes and learning the content. They could use resource such as the following to

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
	Conclusions influenced by other factors		- understand key ideas about each type of bias in science communication. - understand possible consequences of bias in science communication. - know how to avoid bias in science communication	- Putting students into small groups with an 'expert' who feels they can teach the content confidently. - Answering specific questions that students ask. - Directing students to appropriate resources for independent or collaborative revision. Students write the first word that comes into their head when they hear the term 'bias' on a Post-it note. They could stick it on the board underneath the columns: 'everyday' bias and 'scientific' bias. Discuss the differences between these two and draw out the idea that there are lots of types of bias in science. Questions: - What are the differences between 'every day' bias and 'scientific bias'?	Bias in Science (senecalearning.com) How to avoid bias in scientific tests (youtube.com) New study shows typhoon season made worse by climate change: Greenpeace Philippines responds (greenpeace.org)	address any gaps in knowledge: Techniques for random sampling and avoiding bias (khanacademy.org) What is AI? (khanacademy.org) Save My Exams This revision website is free to sign up to. Provide a range of exam questions using OCR ExamBuilder.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				2. What is objectivity and why is this important? 3. How can you spot and avoid bias in science? Students research different types of bias and produce a list of definitions of each type of bias. This could be extended by students researching measurement bias and selection bias and re-arranging their rank order to include these types of bias. Question: how does peer review help to prevent publication bias? (Students may suggest ideas such as ensuring all data is incorporated and is not 'dredged' to find a story to fit the data.) Provide students with examples of scientific articles (such as the ones linked) and ask them to identify the types of bias involved and the impact this may have on the reporting of the data.	Report: Glaxo withheld critical data on antidepressant Seroxat (biopharmadive.com) Confirmation bias in science: how to avoid it - Water memories (arstechnica.com)	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
				Question: How can bias be avoided when communicating science? Students think-pair-share and make a bullet point list. (Students may suggest ideas such as using peer review or explaining assumptions that were made in analysing the dataset).		

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Underlying knowledge and understanding	Students may have prior knowledge of the term bias, especially from everyday life as opposed to the scientific context. Students may also have some understanding that it is usually best to minimise bias as much as possible.
Common misconceptions	Students may think that bias is mainly focusing on an inclination to or against a certain idea rather than being able to be biased in terms of collecting data (e.g. in sampling), and reporting data for example. They may also think that being biased is always intentional.
Key concepts	Bias – in this lesson, students will learn about the different types of bias that exist in terms of science. They will learn about how bias occurs and different strategies and/or techniques that can be used to minimise bias.
Subject knowledge enhancement for teachers	Read: Common sources of bias (understandinghealthresearch.org) Different Types of Bias in Research (casp-uk.net)

Subject knowledge enhancement	Details
	Confirmation Bias And the Power of Disconfirming Evidence (fs.blog) Watch: Is Confirmation Bias Good? (youtube.com) Example of undercoverage introducing bias (khanacademy.org)

Area of study: Revision and consolidation

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
25	All content from Unit F181 Science in society.	1	To revise the key content from the Unit F181 Science in society module.	Students should spend this lesson making use of the time revising for their end of topic assessment. Ideas for activities include: • Watching and making notes on some of the YouTube videos provided throughout this scheme of work. • Making notes from revision guides. • Producing and using flash cards or mind maps. • Completing past exam questions. • Working collaboratively with the teacher and/or students in small groups to clarify key ideas. Completing quiz questions or creating definition match up activities using resources from throughout this topic such as Physics and Maths Tutor or Khan Academy.	Linked throughout the topic	Students continue their preparation independently and bring to next lesson to be checked.
26	All content from Unit F181: Science in society.	1	To assess knowledge and understanding from the Unit F181: Science in society module.	Students should spend this lesson completing an end of topic assessment such as using past exam questions in exam conditions.	OCR ExamBuilder	

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
27	All content from Unit F181: Science in society.	2	By the end of the lesson students should: identify areas to improve and clarify areas of uncertainty from the Unit F181: Science in society module.	This lesson could be split into two parts. Part 1 Students use the mark scheme, revision materials, work collaboratively to identify areas to improve such as mistakes they have made or clear areas of content that they need to re-revise. Students identify areas of the content that they do not understand and cannot figure out independently. Part 2 You spend time re-teaching the content. Provide students time to improve their answers in exam conditions and they re-mark using the mark scheme or model answer. Provide students with similar versions of the same questions they are struggling with and allow them time to attempt to see if they now understand the question and have made progress in how to complete it.	Linked throughout the topic.	Students continue to revise independently the areas they struggled on the most and bring this to subsequent lessons.

Area of study: Pre-release article preparation

Lessons

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources
28	Relevant specification content from Unit F180, Unit F181 and Unit F182 (relevance seen when pre-release material is made available).	3	By the end of the lesson students should: prepare for the pre-release article questions in the examination.	Provide copies of the pre-release materials to students. Students should spend time reading the articles independently. As they read the articles, students could use several different highlighters (or alternative methods to produce a key) to demonstrate: • Areas that they are familiar with and recognise the content. • Areas that are unfamiliar/in a different context and need to research. • Key terminology. Students should then cross-reference each key point in the article with the relevant points on their specification, so that they know which area of content in their specification the article is referring to. Students could then spend the remainder of the lesson revising the relevant content of the	Pre-release material which will be released six weeks before the exam date on Teach Cambridge. A copy of the course specification (ocr.org.uk) Relevant resources provided throughout the scheme of work.	Students continue to revise the relevant key content of the specification points included in the pre-release article using the same strategies that they have been during lesson time. Students could be provided with recall questions (worth 1-2 marks) to help them consolidate their knowledge of the parts of the specification relevant to the article.

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources				
				specification, focusing on the areas they find the most challenging. This might be done by: • Watching YouTube or Khan Academy videos. • Using the resources linked throughout the provided schemes of work. • Producing their own revision materials such as revision guide style summary pages. • For students preferring the use of computers to study, they could produce a PowerPoint presentation of the key points. • Writing questions and answering them. • Orally presenting key information either by creating a podcast, explaining key ideas to peers. Students complete a range of questions that you provide in as much detail as possible. It might be useful to students to set it out with reference to the area of the pre-release material and cross-referenced to the specification (an example is shown below). <table><tr><td>Paragraph /line in article</td><td>Specification reference</td><td>Question</td><td>Answer</td></tr></table>	Paragraph /line in article	Specification reference	Question	Answer		Students could also be provided with relevant application exam questions to help them practice applying their knowledge to a range of contexts.
Paragraph /line in article	Specification reference	Question	Answer							

Lesson number	Specification coverage	GLH	Lesson aims and outcomes	Lesson ideas, key words and activities	Useful resources	Student independent learning – ideas and useful resources						
29	Relevant specification content from Unit F180, Unit F181 and Unit F182 (relevance seen when pre-release material is made available).	1	By the end of the lesson students should: prepare for the pre-release material questions in the examination.	Students review their application exam questions and knowledge recall questions that they have studied for homework either by comparing with their notes or other students work or by comparing to answers that you provide. Students should produce a glossary for the key terminology they have identified: a) Throughout the text. b) In their notes / study of the content. They may want to follow a format such as the table below to help them remain familiar with the pre-release article. <table><tr><th>Paragraph number from article</th><th>Key term</th><th>Definition / key points</th></tr><tr><td></td><td></td><td></td></tr></table> Students should then spend time learning these definitions in a way that suits them. For example they could work collaboratively to quiz other students, create photocopies of their glossary to make their own match up activity, create photocopies of their glossary and blank out some of the words to fill in themselves.	Paragraph number from article	Key term	Definition / key points				Relevant resources provided throughout the scheme of work.	Students should spend time learning the key terminology from their glossary.
Paragraph number from article	Key term	Definition / key points										

Subject knowledge support for this area of study

Subject knowledge enhancement	Details
Key concepts	The pre-release material is used to introduce novel contexts to the content that students have studied within this topic and allows students to develop skills including scientific literacy, research and scientific enquiry. Detailed explanations beyond the ones outlined in the specifications of Unit F180, Unit F181 and Unit F182 are not required. Students are recommended to spend 3-4 hours of detailed study on this material.

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