IB Diploma Science 2023

Product Presenter

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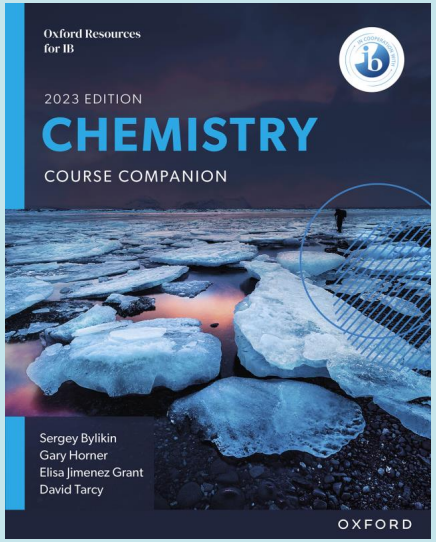
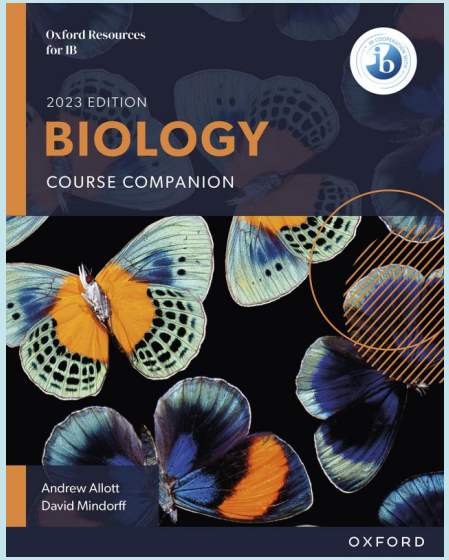
IB DP Science 2023

Oxford's 2023 IB DP Science resources are developed in cooperation with the IB, ensuring comprehensive coverage of all topics, structured according to the syllabus, and fully aligned to the latest subject guides for Biology and Chemistry.

The series brings together Oxford's extensive experience, the IB's approach to teaching and learning and future-facing functionality to provide the best blended teaching and learning experience, enabling success in DP and beyond.





[OUP Series Webpage]

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Curriculum Overview

IB Diploma Science 2023

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Curriculum information

- IB Diploma Programme
- 16 – 18 years
- Group 3 Sciences: Biology, Chemistry and Physics
- The courses can be studied at Standard or Higher Level (greater scope, challenge and teaching time +90hrs for HL)

Important dates:

- Final assessment current subject guides: November 2024
- First teaching new subject guides: 2023
- First Assessment new subject guides: 2025 (May for candidates starting DP in the 22/23 academic year)

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Curriculum changes

IB's vision for the new curriculum:

"A relevant and effective [Science] education needs to reflect societal change with **a greater focus on skills and the interconnectedness of concepts, contexts and content**, and facilitate deep learning and student understanding. Developments have taken place to address these needs."

Summary of the key changes to all three subjects:

- No more Options and content changes
- Conceptual framework changes
- Greater emphasis on skills development
- Changes to Practical work
- Changes to Nature of Science
- Changes to the assessment model

For concise, teacher-facing, details of the changes to each course, check out pages 2&3 of the Course Guides:

Biology & Chemistry

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Key differences in Syllabus: 2023 vs. 2014

- Introduction of concepts to help structure the learning
- Introduction of guiding and linking questions, to support the concept-based inquiry
- Increased emphasis on skills (3 tools & 3 inquiry process areas)
- More focused Nature of Science
- AHL content more integrated into the course
- No more options, but some options content retained as part of the core material or the AHL

- External assessment: only two papers for all students (SL and AHL)
- Internal assessment ('scientific investigation'): revised assessment criteria; student collaboration encouraged

DP Science 2023: Introduction to Curriculum changes

How is the syllabus changing?

Content changes

Conceptual structure

External assessment

Scientific Skills

Nature of Science

- Some topics removed
- No more options (but some of the content of the options still part of the course)
- No more prescribed practicals
- SL and HL content more integrated

DP Science 2023: Introduction to Curriculum changes

How is the syllabus changing?

Content changes

Conceptual structure

External assessment

Scientific Skills

Nature of Science

- Greater emphasis on conceptual T&L
- New conceptual approach / structure
- New Guiding Questions
- New Linking Questions

DP Science 2023: Introduction to Curriculum changes

How is the syllabus changing?

Content changes

Conceptual structure

External assessment

Scientific Skills

Nature of Science

- External Assessment: two papers, for both SL and HL = no more paper 3.
- Paper 1: MCQs and data-analysis/lab-based questions, using unseen data
- Paper 2: short answer questions and extended answer questions (conceptual, deep-dive questions that will bring together areas of a subject not commonly presented together)

DP Science 2023: Introduction to Curriculum changes

How is the syllabus changing?

Content changes

Conceptual structure

External assessment

Scientific Skills

Nature of Science

- Increased emphasis on scientific skills development
- Scientific skills are applied throughout the course
- They are in addition to ATLs

DP Science 2023: Introduction to Curriculum changes

Content changes

Conceptual structure

External assessment

Scientific Skills

Nature of Science

How is the syllabus changing?

- Nature of Science still present
- Greatly simplified
- Focuses on 11 aspects of NoS (shared between the three subjects)

Series Overview

IB Diploma Science 2023

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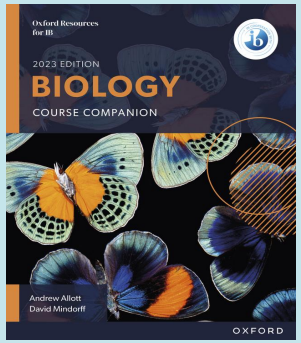
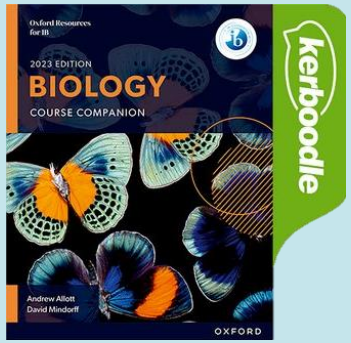
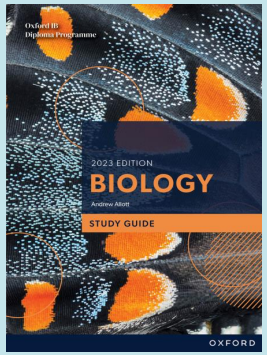
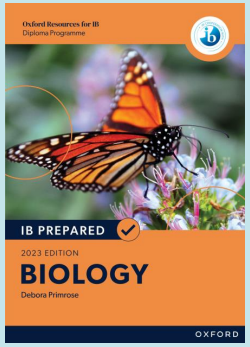
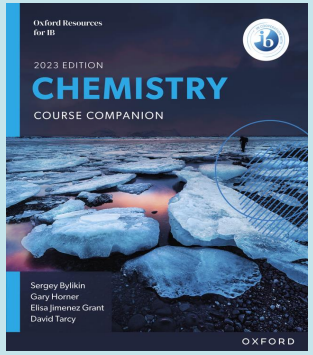
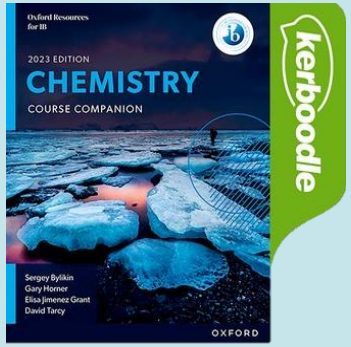
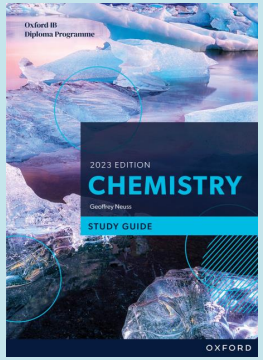
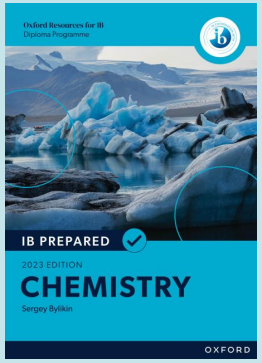
IB Diploma Programme	Print Course Books	Kerboodle Courses	Print Study Guides	IB Prepared Assessment Guides
Biology				
Chemistry				

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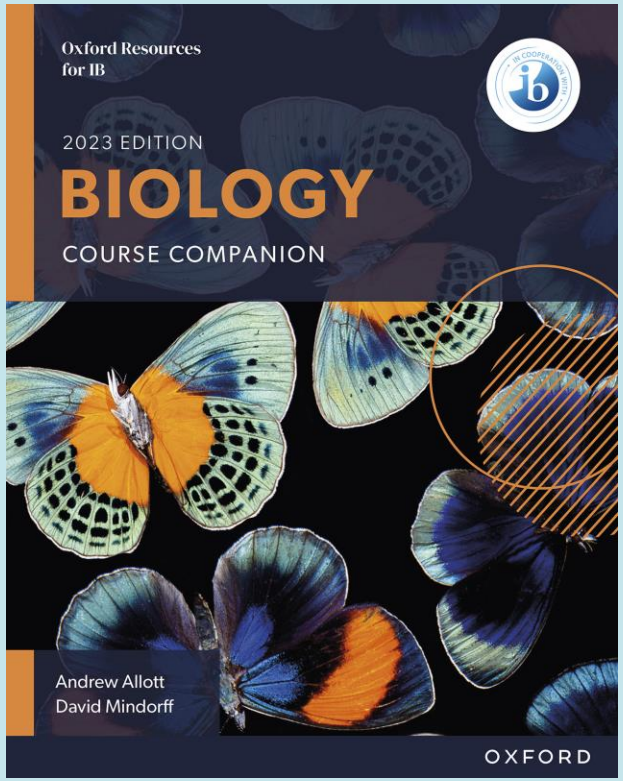
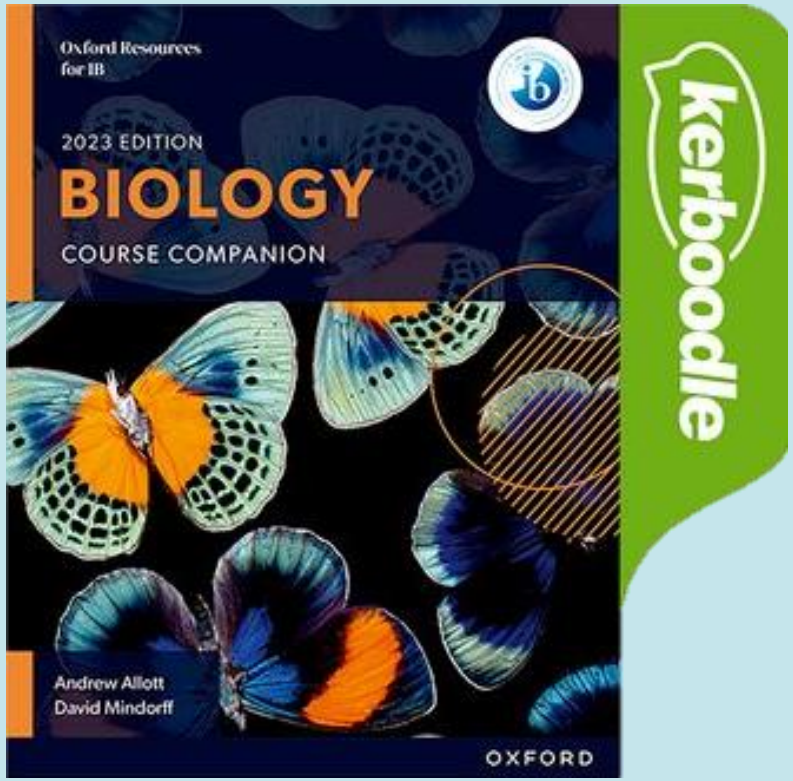
IB DP Biology 2023



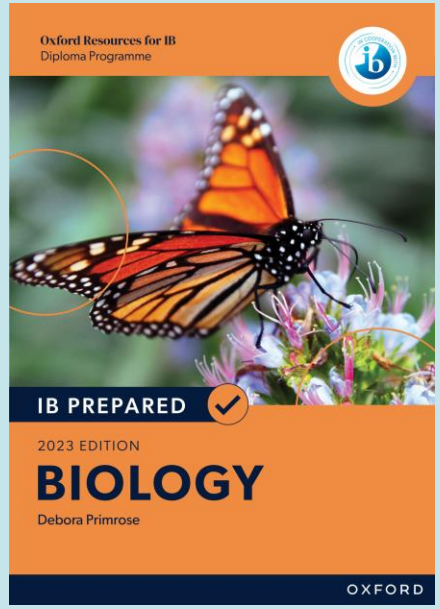
Course Companion

Format: print student coursebook – SL & HL
ISBN: 9781382016339
Extent: 816 pages



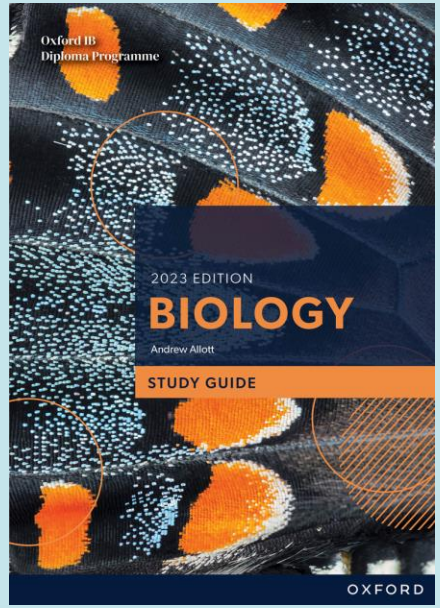
Kerboodle Online

Format: online teacher & student access, including online coursebooks
ISBN: subject to number of users



IB Prepared

Assessement support & guidance



Study Guide

Concise revision guidance

Format: print – SL & HL
ISBN: 9781382016438

Please refer to Order Forms for current prices.

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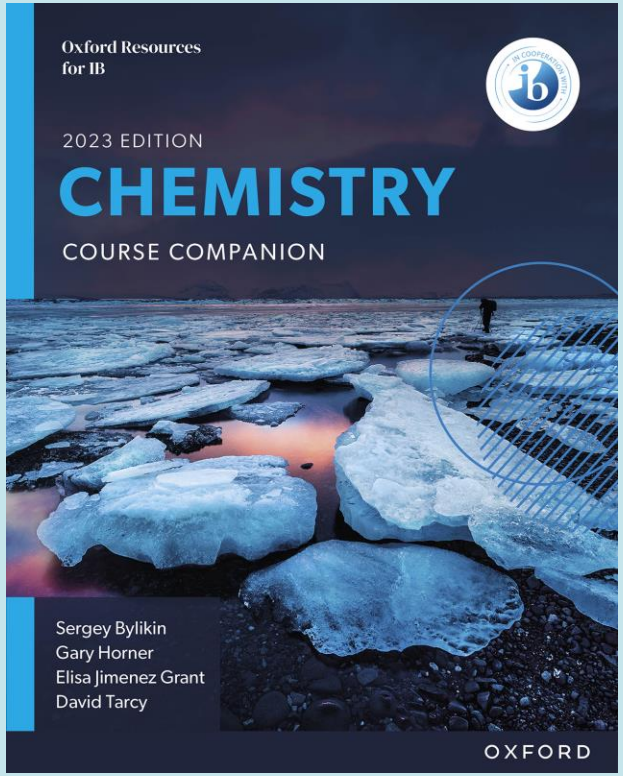
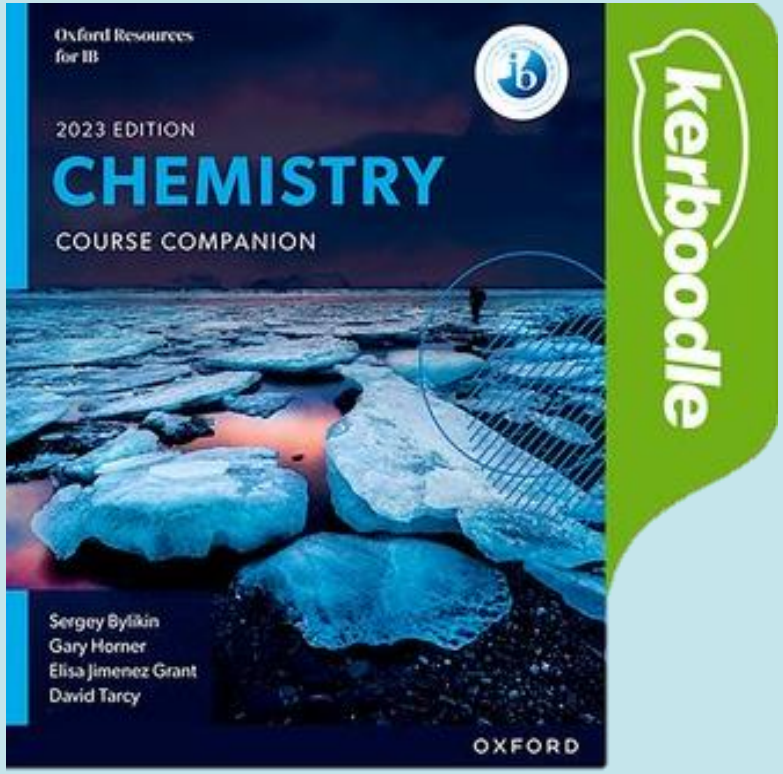
IB DP Chemistry 2023



Course Companion

Format: print student coursebook – SL & HL
ISBN: 9781382016469
Extent: 720 pages



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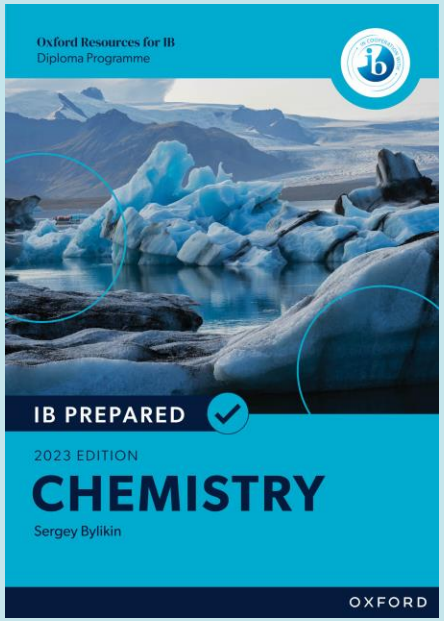
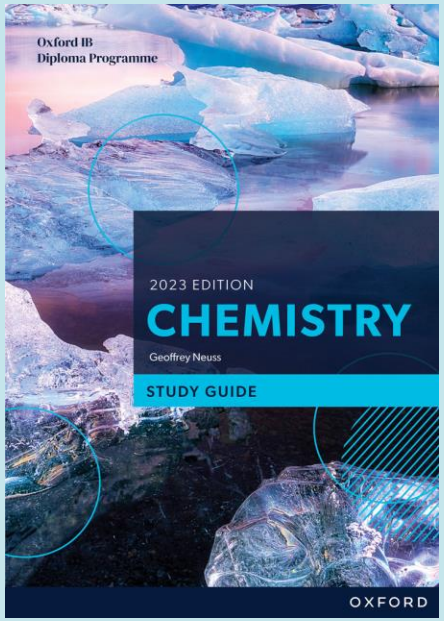


IB Prepared

Assessement support & guidance



Study Guide

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Format: print – SL & HL
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Key messages

IB Diploma Science 2023

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Oxford working "In Cooperation With" IB

- Aligned fully with current IB curriculum Frameworks
- Passed the IB's rigorous quality-assurance process
- Reviewed by IB subject matter experts
- Appropriate for IB World Schools

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Key messages

•**Provide comprehensive coverage** of all topics, structured according to the syllabus, and fully aligned to the 2023 subject guides for Biology, Chemistry and Physics

•**Support independent learning and progression** with adaptive technology that provides a fully personalized journey so students can self-assign auto-marked assessments, get real-time results and are offered next steps

Deepen understanding with intervention and extension support, and spaced repetition, where students are asked follow-up questions on completed topics at regular intervals to encourage knowledge retention

•**Help students to develop conceptual understanding** by easily integrating subject knowledge, the Nature of Science and Theory of Knowledge into your teaching

•**Focus on both knowledge and skills** with high-quality resources created by experienced IB authors, examiners, and teachers (NB: author team remains the same as previous edition)

•**Motivate students** with a variety of engaging content including interactive activities, vocabulary exercises, animations, and videos

•**Deliver responsive teaching** supported by enhanced reporting and rich data, to show progress at individual and class level

•**Enable learning anywhere** with mobile-optimized onscreen access to all resources and offline access to the digital Course Book via Kerboodle, plus print Course Book components

•**Ease the transition to the new specification** with professional development support to increase your confidence

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Product Features and benefits

IB Diploma Science 2023

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Table of Content review: DP Biology

Theme	Level of organization			
	1. Molecules	2. Cells	3. Organisms	4. Ecosystems
A **Unity and diversity**	Common ancestry has given living organisms many shared features while evolution has resulted in the rich biodiversity of life on Earth.			
	A1.1 Water **A1.2** Nucleic acids	**A2.1** Origins of cells *[HL only]* **A2.2** Cell structure **A2.3** Viruses *[HL only]*	**A3.1** Diversity of organisms **A3.2** Classification and cladistics *[HL only]*	**A4.1** Evolution and speciation **A4.2** Conservation of biodiversity
B **Form and function**	Adaptations are forms that correspond to function. These adaptations persist from generation to generation because they increase the chances of survival.			
	B1.1 Carbohydrates and lipids **B1.2** Proteins	**B2.1** Membranes and membrane transport **B2.2** Organelles and compartmentalization **B2.3** Cell specialization	**B3.1** Gas exchange **B3.2** Transport **B3.3** Muscle and motility *[HL only]*	**B4.1** Adaptation to environment **B4.2** Ecological niches
C **Interaction and interdependence**	Systems are based on interactions, interdependence and integration of components. Systems result in emergence of new properties at each level of biological organization.			
	C1.1 Enzymes and metabolism **C1.2** Cell respiration **C1.3** Photosynthesis	**C2.1** Chemical signalling *[HL only]* **C2.2** Neural signalling	**C3.1** Integration of body systems **C3.2** Defence against disease	**C4.1** Populations and communities **C4.2** Transfers of energy and matter
D **Continuity and change**	Living things have mechanisms for maintaining equilibrium and for bringing about transformation. Environmental change is a driver of evolution by natural selection.			
	D1.1 DNA replication **D1.2** Protein synthesis **D1.3** Mutations and gene editing	**D2.1** Cell and nuclear division **D2.2** Gene expression *[HL only]* **D2.3** Water potential	**D3.1** Reproduction **D3.2** Inheritance **D3.3** Homeostasis	**D4.1** Natural selection **D4.2** Stability and change **D4.3** Climate change

2023 Subject Guide

2023 Course Book

Contents

Table of Content review: DP Chemistry

Skills in the study of chemistry			
Structure Structure refers to the nature of matter from simple to more complex forms		**Reactivity** Reactivity refers to how and why chemical reactions occur	
Structure determines reactivity, which in turn transforms structure			
Structure 1. **Models of the particulate nature of matter**	Structure 1.1—Introduction to the particulate nature of matter	**Reactivity 1.** **What drives chemical reactions?**	Reactivity 1.1—Measuring enthalpy changes
	Structure 1.2—The nuclear atom		Reactivity 1.2—Energy cycles in reactions
	Structure 1.3—Electron configurations		
	Structure 1.4—Counting particles by mass: The mole		Reactivity 1.3—Energy from fuels
	Structure 1.5—Ideal gases		Reactivity 1.4—Entropy and spontaneity (Additional higher level)
Structure 2. **Models of bonding and structure**	Structure 2.1—The ionic model	**Reactivity 2.** **How much, how fast and how far?**	Reactivity 2.1—How much? The amount of chemical change
	Structure 2.2—The covalent model		Reactivity 2.2—How fast? The rate of chemical change
	Structure 2.3—The metallic model		Reactivity 2.3—How far? The extent of chemical change
	Structure 2.4—From models to materials		
Structure 3. **Classification of matter**	Structure 3.1—The periodic table: Classification of elements	**Reactivity 3.** **What are the mechanisms of chemical change?**	Reactivity 3.1—Proton transfer reactions
	Structure 3.2—Functional groups: Classification of organic compounds		Reactivity 3.2—Electron transfer reactions
			Reactivity 3.3—Electron sharing reactions
			Reactivity 3.4—Electron-pair sharing reactions

2023 Subject Guide

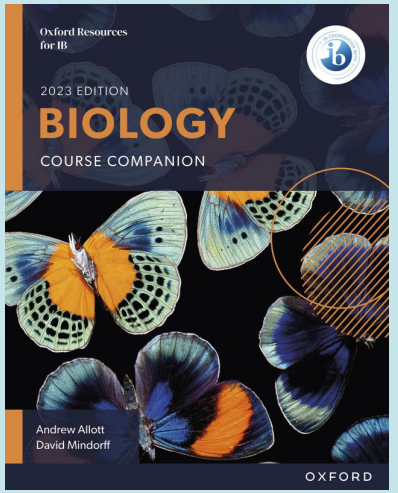
2023 Course Book

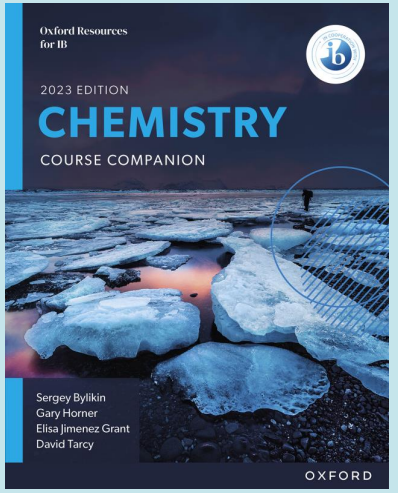
Contents

Key Course Book features

Top features of our upcoming DP Biology, Chemistry & Physics Course Books:

1. Understandings boxes
2. Guiding Questions
3. Linking Questions
4. Nature of Science boxes
5. TOK support
6. Data-based questions
7. Worked examples
8. Skills & experiment boxes
9. ATL boxes
10. End of topic questions
11. Full Chapter support for the Internal Assessment





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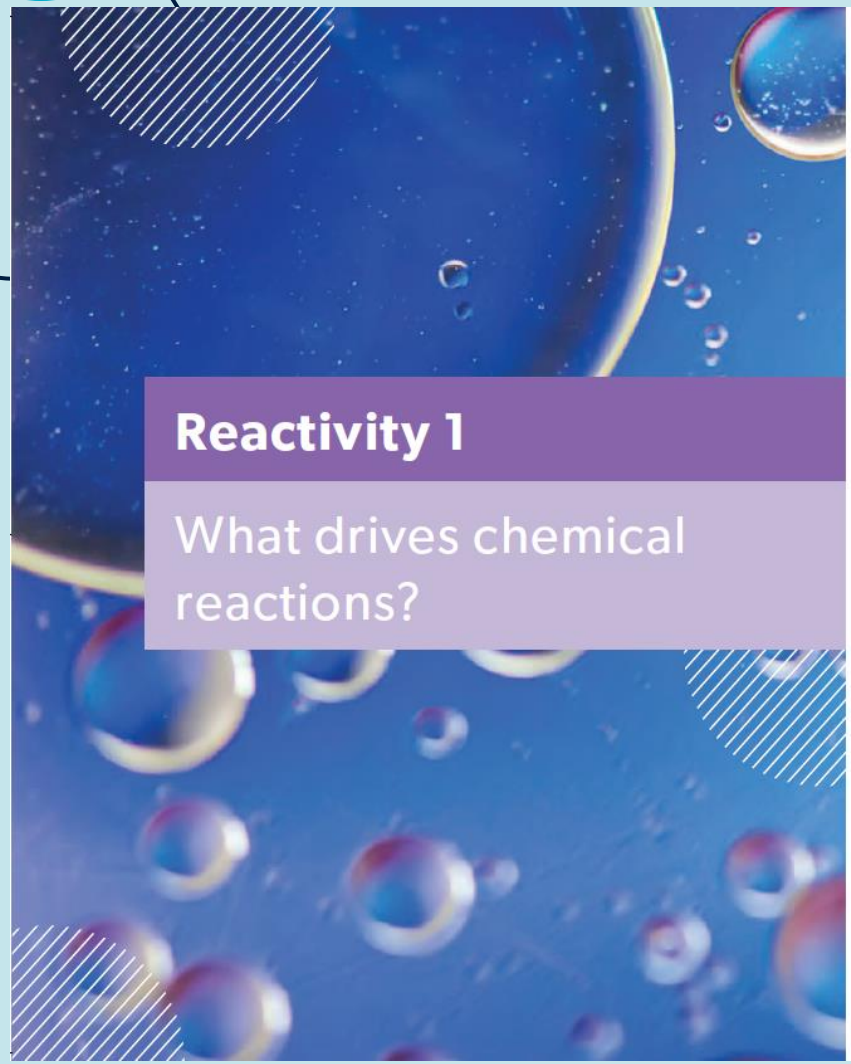
1. Understandings



Reactivity 1.1 Measuring enthalpy changes

What can be deduced from the temperature change that accompanies chemical or physical change?

Chemistry involves the study of chemical reactions and physical changes of state of the elements and their compounds. Conservation of energy is a fundamental principle of science, which is examined through observation and experimentation. The use of models, empirical or experimental data, the language of mathematics and scientific terminology, all contribute to our understanding of energy changes associated with chemical reactions.

An understanding of the relationships that exist between chemistry and energy involves understanding how energy is transferred between a chemical system and the surroundings. This information can in turn be used to develop an understanding of the relative stability of reactants and products, leading to better control over the progress of the reaction being studied.

Understandings

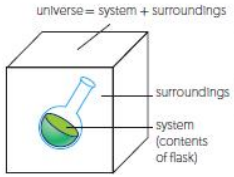
Reactivity 1.1.1—Chemical reactions involve a transfer of energy between the system and the surroundings, while total energy is conserved.

Reactivity 1.1.2—Reactions are described as endothermic or exothermic, depending on the direction of energy transfer between the system and the surroundings.

Reactivity 1.1.3—The relative stability of reactants and products determines whether reactions are endothermic or exothermic.

Reactivity 1.1.4—The standard enthalpy change for a chemical reaction, $\Delta H^{\ominus}$, refers to the heat transferred at constant pressure under standard conditions and states. It can be determined from the change in temperature of a pure substance.

Energy transfer in chemical reactions (*Reactivity 1.1.1*)



▲ Figure 1 The universe is the combination of the system and its surroundings

In a chemical reaction, total energy is conserved. Chemical potential energy is stored in the chemical bonds of **reactants** and **products**, while the temperature of the reaction mixture is a function of the kinetic energy of the atoms, ions and molecules present.

All chemical reactions involve energy changes. Energy may be released into the **surroundings** from the **reaction system** or it may be absorbed by the reaction system from the surroundings. Most commonly, the energy is transferred in the form of heat, but it may also be in the form of sound or light.

In an **open system**, the transfer of matter and energy is possible across its boundary (for example, matter can be added to a beaker, and energy can be transferred through its sides). A **closed system** allows no transfer of matter, though energy may be transferred across the boundary. In an **isolated system**, matter and energy can neither enter nor exit, but can only move around inside.

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Understandings boxes, outlining the content of the syllabus, demonstrate comprehensive coverage of all topics in the 2023 Subject Guides

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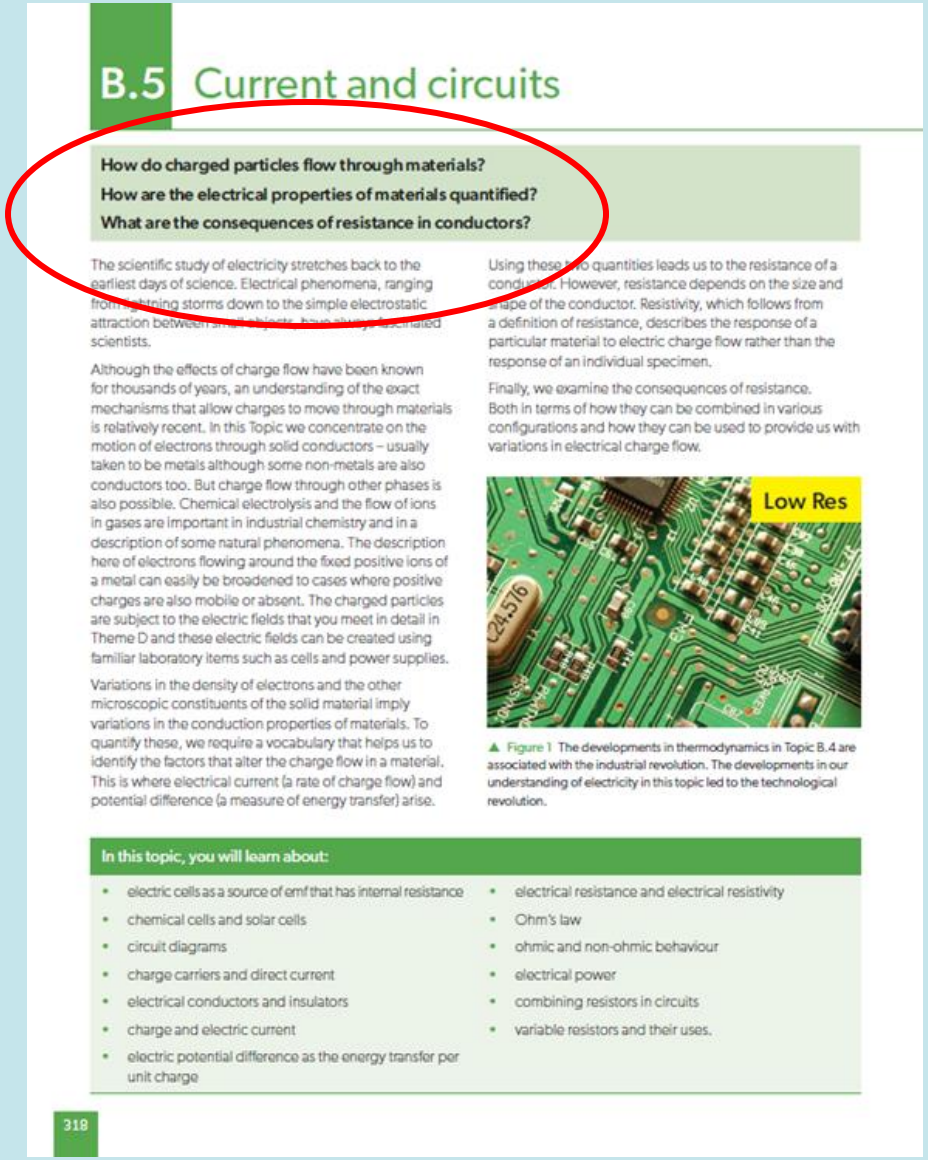
2. Guiding Questions

What can be deduced from the temperature change that accompanies chemical or physical change?

Chemistry involves the study of chemical reactions and physical changes of state of the elements and their compounds. Conservation of energy is a fundamental principle of science, which is examined through observation and experimentation. The use of models, empirical or experimental data, the language of mathematics and scientific terminology, all contribute to our understanding of energy changes associated with chemical reactions.

An understanding of the relationships that exist between chemistry and energy involves understanding how energy is transferred between a chemical system and the surroundings. This information can in turn be used to develop an understanding of the relative stability of reactants and products, leading to better control over the progress of the reaction being studied.

Guiding questions and a discussion of the guiding questions introduce and direct the inquiry, supporting the new conceptual understanding approach of the Subject Guides



B.5 Current and circuits

How do charged particles flow through materials?
How are the electrical properties of materials quantified?
What are the consequences of resistance in conductors?

The scientific study of electricity stretches back to the earliest days of science. Electrical phenomena, ranging from lightning storms down to the simple electrostatic attraction between small objects, have always fascinated scientists.

Although the effects of charge flow have been known for thousands of years, an understanding of the exact mechanisms that allow charges to move through materials is relatively recent. In this Topic we concentrate on the motion of electrons through solid conductors – usually taken to be metals although some non-metals are also conductors too. But charge flow through other phases is also possible. Chemical electrolysis and the flow of ions in gases are important in industrial chemistry and in a description of some natural phenomena. The description here of electrons flowing around the fixed positive ions of a metal can easily be broadened to cases where positive charges are also mobile or absent. The charged particles are subject to the electric fields that you meet in detail in Theme D and these electric fields can be created using familiar laboratory items such as cells and power supplies.

Variations in the density of electrons and the other microscopic constituents of the solid material imply variations in the conduction properties of materials. To quantify these, we require a vocabulary that helps us to identify the factors that alter the charge flow in a material. This is where electrical current (a rate of charge flow) and potential difference (a measure of energy transfer) arise.

Using these two quantities leads us to the resistance of a conductor. However, resistance depends on the size and shape of the conductor. Resistivity, which follows from a definition of resistance, describes the response of a particular material to electric charge flow rather than the response of an individual specimen.

Finally, we examine the consequences of resistance. Both in terms of how they can be combined in various configurations and how they can be used to provide us with variations in electrical charge flow.

▲ Figure 1 The developments in thermodynamics in Topic B.4 are associated with the industrial revolution. The developments in our understanding of electricity in this topic led to the technological revolution.

In this topic, you will learn about:

- electric cells as a source of emf that has internal resistance
- chemical cells and solar cells
- circuit diagrams
- charge carriers and direct current
- electrical conductors and insulators
- charge and electric current
- electric potential difference as the energy transfer per unit charge
- electrical resistance and electrical resistivity
- Ohm's law
- ohmic and non-ohmic behaviour
- electrical power
- combining resistors in circuits
- variable resistors and their uses.

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3. Linking Questions

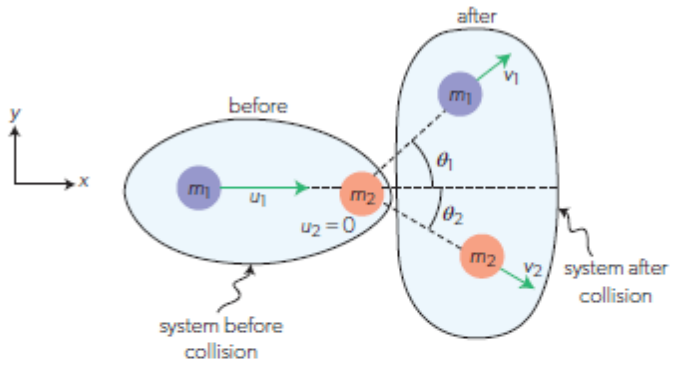
Linking Questions, found throughout, connect topics from different areas of the syllabus, helping to integrate and connect knowledge and further develop a conceptual understanding

AHL

What assumptions about the forces between molecules of gas allow for ideal gas behaviour? (NOS)

In Topic B.3, there is an important microscopic analysis of the particles in a gas that links the motion of these particles to the macroscopic measurements that we can make of the gas. This analysis relies heavily on the ideas of force and momentum conservation that are introduced in this topic.

To carry out the analysis, assumptions are required. Collisions between the gas particles and the wall are assumed to be elastic, for example. When you have studied the mechanics used in the kinetic theory of Topic B.3, review this topic, and link the ideas there to those here. Cross-linking topics in this way will improve your understanding of both areas of the subject.



▲ Figure 47 Momentum conservation in two dimensions. A moving object collides off-centre with a stationary object. After the elastic collision the objects move apart with an angle of $\theta_1 + \theta_2$ between them.

The centres of the pucks are not in line with the direction of motion of the first puck and so the pucks move off in different directions as shown. We assume that the pucks do not rotate either before or after the motion. Otherwise, we would have to allow for the rotational energy and rotational momentum of the pucks; this is left for Topic A.4.

Immediately before the collision, the first puck which has a mass m_1 is moving with speed u_1. The pucks move as shown in Figure 47 immediately after the collision with speeds v_1 and v_2 at angles θ_1 and θ_2.

In problems such as this, a good tip is to choose two axes at right angles that make the subsequent analysis as straightforward as possible. For the example here, one axis is in the same direction as u_1 and the other axis is at right angles to it.

For the axis in the same direction as u_1 (horizontally along the page), applying

Linking questions

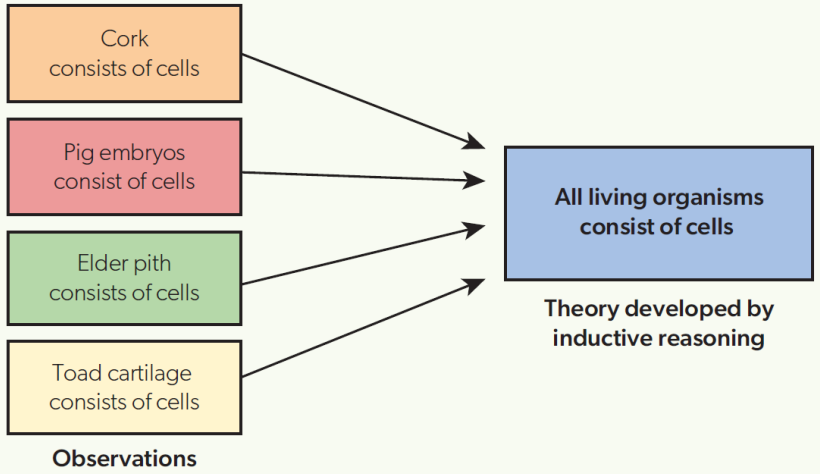
1. What are the benefits of models in studying biology?
   a. Construct a diagram of a food web using species from your local environment. (C4.2.4)
   b. Describe the fluid mosaic model of membrane structure. (B2.1.10)
   c. Outline an example of an experimental setup that is meant to model a biological system. (D4.2.4)
2. What factors can limit capacity in biological systems?
   a. Outline one example of sexual selection. (D4.1.7)
   b. Distinguish between top-down and bottom-up limiting factors. (C4.1.17)
   c. Explain the relationship between substrate concentration and reaction rate. (C1.1.8, C1.1.15)

4. Nature of Science support

Nature of Science boxes found throughout will offer support for the 11 aspects outlines by the new Subject Guides

Observations, theories and inductive reasoning

Biologists are interested in the natural world and look carefully at it—they act as observers and make observations. Sometimes biologists notice a trend or pattern in their observations and from this they develop a general theory. Theories developed from specific observations are an example of inductive reasoning—going from the specific to the general. In the case of the cell theory, the specific discovery that parts of diverse organisms consisted of cells led to the generalization that all organisms consist of cells.



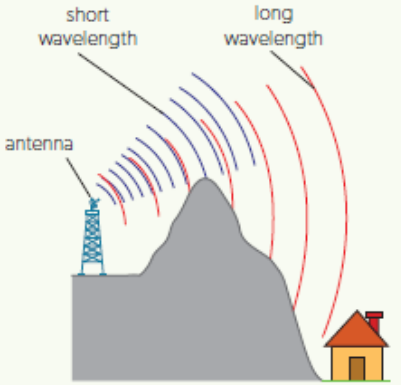
▲ Figure 4 The cell theory was developed by inductive reasoning

Global impact of science—Diffraction by a mountain

Diffraction is of importance beyond the confines of the physics lab. It has real-world implications. One of these is in radio and television reception.

The waves used in some radio transmission have long wavelengths, of the order of kilometres. These waves will be diffracted by objects of about the same size as the wavelength, in other words, something of the size a hill. It is common for a radio signal to be detected in a valley on the other side of a mountain, even though there is no line of sight to the transmitting antenna from the radio (Figure 18). Shorten the wavelength and there is no reception because the diffraction at this frequency does not allow the waves to reach the valley floor.

The effect can also be observed with sound. Every time you hear sound "around a corner" the waves must have diffracted at the edge of the building or feature to reach your ear.



▲ Figure 18 Diffraction by a natural feature. In this case a mountain top.

supporting the development of a deep understanding of the aspects of science and helps students towards thinking and acting scientifically

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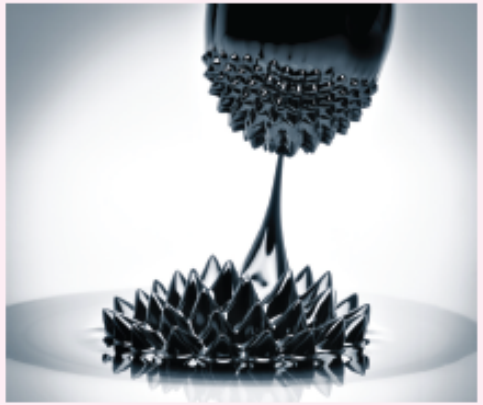
5. TOK support

End-of-chapter page-spread laid out in the style of an actual TOK Exhibition (Biology CB only)

Thought-provoking TOK boxes found throughout the Chemistry and Physics course books

Field lines



Magnetic flux density can be thought of as being the number of field lines (lines of flux) passing through a unit area.

However, field lines are not real. They are a visualization of the magnetic field introduced by Faraday. Strictly, there is an infinite number of field lines for a magnetic field, although we only draw a small number of them to illustrate a situation.

Although there are an infinite number of field lines in a given area for any particular field strength, different flux densities lead to different numbers of field lines over the same area. Infinities can be larger or smaller than each other!

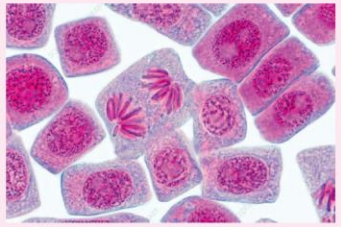
Are field lines a helpful model?

▲ Figure 7 A magnetic liquid forms shapes which seem to show field lines.

TOK

How important are material tools in the production or acquisition of knowledge?

Scientific tools can extend the range of human perception beyond the range that our senses can normally detect. Electron microscopes extend the range of resolution further.



▲ Figure 1 Our eyes can distinguish between two objects that are 0.1 mm apart. A light microscope enables us to distinguish objects that are 0.0002 mm apart

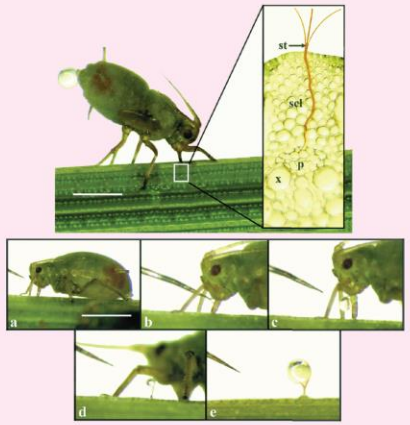
New tools can open the possibility of what can be known. An example is the use of radioactive isotopes in biological research. As the United States Atomic Energy Commission (AEC) report put it in 1948, radioisotopes enabled "a new mode of perception".

Carbon-14 is an isotope of carbon that is radioactive. Radioactively labelled carbon within carbon dioxide can be fixed by plants during photosynthesis. It will release radiation that can be detected using either film or radiation detectors. As the carbon is metabolized, it will be found in different molecules within the plant. In other words, both the formation and movement of radioactive molecules can be traced.

▲ Figure 2 A Geiger counter, measuring radiation levels in a crop of sunflowers. The sunflowers are being used for bioremediation of soil contaminated with radiation

A consideration with respect to the use of tools is what ethical issues might be raised. For example, aphid stylets in combination with radioactivity labelled molecules have been used to study the movement of sugars within plants. This raises certain ethical questions.

Aphids penetrate plant tissues to reach the phloem (p in the first picture in Figure 3) using mouth parts called stylets (st in the first picture). If the aphid is anaesthetized and the stylet severed (process about to occur in the middle picture), phloem will continue to flow out of the stylet (final picture). Both the rate of flow and the composition of the sap can be analysed. The closer the stylet is to the sink (the place where sugars in the sap are stored), the slower the rate at which the phloem sap will come out.



▲ Figure 3 An experiment with aphids that raises ethical issues

You would be guided to avoid this type of experiment because of the harm that would come to the aphid and the use of radioisotopes that would persist in the environment after the experiment.

6. Skills and experiment support

Kinetic energy equation

There is a subtle piece of notation here. When we talk about a value of kinetic energy, we write E_k, but when we are talking about a change in kinetic energy from one value to another then we should write ΔE_k where "Δ", as usual, means "the change in".

This equation for ΔE_k is one that needs a little care. Notice where the powers are; they are attached to each individual speed. This equation $\Delta E_k = \frac{1}{2}m(v^2 - u^2)$ is not the same as $\Delta E_k = \frac{1}{2}m(v - u)^2$.

Kinetic energy can also easily be linked to linear momentum p. Remember that $p = mv$ and that $E_k = \frac{1}{2}mv^2$. Therefore, E_k can be written as $E_k = \frac{1}{2}\frac{(mv)^2}{m} = \frac{p^2}{2m}$.

Skills and Experiment boxes provide opportunities for activities to cover the 'Tools' or 'Inquiry process' skills as outlined in the new subject guide. These offer direct support for the Assessment Objectives 1, 2 & 4 that assess skills, techniques and methodologies

Applying techniques: Using a potometer to measure rates of transpiration

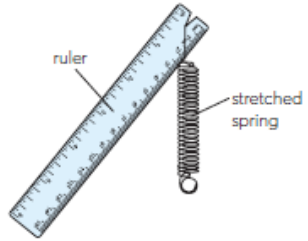
Mechanisms involved in water transport in the xylem can be investigated using apparatus and materials that show similarities in structure to plant tissues. Figure 20 shows a potometer. This is a device used to measure water uptake in plants. The apparatus consists of a leafy shoot in a tube (right), a reservoir (left of shoot), and a graduated capillary tube (horizontal). A bubble in the capillary tube marks the zero point. As the plant takes up water through its roots, the bubble will move along the capillary tube. The distance the bubble travels and the time taken are measured. The tap below the reservoir allows the bubble to be reset to carry out new measurements.

▲ Figure 20 A potometer

Measuring the spring constant

You must wear safety glasses for this experiment and ensure that your flying spring will not hit anyone.

- Get a spring and a length of wood (a wooden ruler would do).
- Make a notch in the top of the length of wood so that the end of the spring does not slip off (Figure 13).
- Mark the natural (unextended) length of the spring on the wood.
- Pull the spring so that it extends by 2 cm. Release it so that it flies vertically into the air.
- Measure the maximum height of the spring's motion. You should repeat this measurement three times.
- Repeat for five different extensions of the spring.
- Tabulate your values of extension and height. Take averages of the heights.
- By considering energy transfer, consider what you should plot on the x- or y-axes to give a linear graph. Plot this graph (use a computer spreadsheet to do it quickly). Is your graph linear?
- Use the variation in your repeats and the uncertainties to add error bars to your graph.
- Is it possible to draw a line of best fit that passes within the error bars?
- What does the gradient of your linear graph represent? How could you deduce the spring constant k of the spring from your gradient?
- What is the uncertainty of your gradient? Can you deduce the uncertainty in your measurement of k?
- Measure the spring constant in a different way (e.g. by considering Hooke's law). Try to evaluate the uncertainty in this measurement. Do your two values of k agree?



▲ Figure 13 Fire the spring vertically and estimate the maximum height reached.

7. ATL support

Approaches to Learning skill boxes can be found throughout the Course Books

ATL Drafting, revising and improving academic work

Joseph Fourier was a French mathematician and physicist who lived from 1768 to 1830. In 1807, he read a paper to the Paris Institute "*On the Propagation of Heat in Solid Bodies*". In it he used a mathematical method to reduce a complicated oscillation to a series of sine waves.

You can try this for yourself. Use a graphical calculator or a spreadsheet to help plot the function $y = \sin x + \frac{1}{3}\sin 3x + \frac{1}{5}\sin 5x + \cdots$. You can add further terms of $\frac{1}{n}\sin nx$ for odd values of the integer n. It does not require very many terms in the series to show that the series approaches a square-wave. You could also try the even terms to see what happens.

Fourier's paper did not convince everyone in the audience, however. He had relied on intuition in places and there were some gaps in his logic. His mathematical method also contradicted some of the work of one of the examiners in the audience—Joseph-Louis Lagrange.

To settle the matter, a prize problem was set in 1810 and Fourier submitted his original paper along with some new work. There was only one other paper, and Fourier won the competition. But the feedback (possibly from Lagrange) was not entirely favourable, and the result was that Fourier's work was not published until 1822.

Fourier's method of splitting a signal into sinusoidal waves of different frequencies is widely used today and is the principle behind the spectral analysis of sound.

ATL Research skills: Using search engines effectively

Your task is to research the connection between *Clostridium botulinum* and cosmetic facial injections. What cellular processes are affected?

Your primary purpose is to use web-based sources to find information. You should use precise language in your search terms, including scientific language. For example, you might search "*Clostridium botulinum*" and "cosmetic facial injections". However, this is likely to return results for businesses offering cosmetic treatments. These will be sites with domain names ending in ".com". For this task, you want information from organizations whose primary purpose is education. Such sites have domains ending in ".edu". To filter your search results, include the search term "site: edu".

Enter the following terms in your search engine. Compare the results of the different searches.

a. Botox® treatment

b. *Clostridium botulinum* and cosmetic facial injections

c *Clostridium botulinum* and cosmetic facial injections site:edu

Which search terms enabled you to answer the questions: "What is the connection between *Clostridium botulinum* and cosmetic facial injections?" and "What cellular processes are affected by *Clostridium botulinum*?"

▲ Figure 27 Injecting Botox®

These activities are designed to get students to develop their "critical thinking skills" and help to embed the ATL into SOW

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8. Data-based questions

Data-based questions allow students to apply knowledge to larger data sets and provide opportunities for practice with modelling and simulation questions, helping them prepare for these types of questions, which appear in Paper 1B and Paper 2

Data-based questions: Phosphate absorption in barley roots

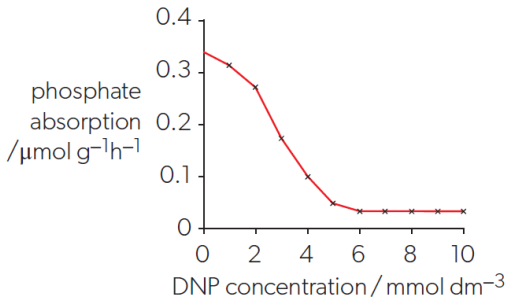
Roots were cut off from barley plants and used to investigate phosphate absorption. Roots were placed in phosphate solutions and air was bubbled through. The phosphate concentration was the same in each case, but the percentages of oxygen and nitrogen were varied in the air bubbled through. The rate of phosphate absorption was measured. Table 1 shows the results.

Oxygen /%	Nitrogen /%	Phosphate absorption/ $\mu mol\ g^{-1}\ h^{-1}$
0.1	99.9	0.07
0.3	99.7	0.15
0.9	99.1	0.27
2.1	97.1	0.32
21.0	79.0	0.33

▲ Table 1

1. Describe the effect of reducing the oxygen concentration below 21.0% on the rate of phosphate absorption by roots. You should only use information from Table 1 in your answer. [3]
2. Explain the effect of reducing the oxygen concentration from 21.0% to 0.1% on phosphate absorption. In your answer, you should use as much biological understanding as possible of how cells absorb mineral ions. [3]

An experiment was done to test which method of membrane transport was used by the roots to absorb phosphate. Roots were placed in the phosphate solution as before, with 21.0% oxygen bubbling through. Varying concentrations of a substance called DNP were added. DNP blocks the production of ATP by aerobic cell respiration. Figure 13 shows the results of the experiment.



▲ Figure 13 Effect of DNP concentration on phosphate absorption

3. Deduce, with a reason, whether the roots absorbed the phosphate by diffusion or by active transport. [2]
4. Discuss the conclusions that can be drawn from the data in the graph about the method of membrane transport used by the roots to absorb phosphate. [2]

9. Worked examples

Worked example 3

A high efficiency LED lamp is lit for 2 hours. Calculate the energy transfer to the lamp when the pd across it is 240 V and the current in it is 50 mA.

Solution

2 hours is $2 \times 60 \times 60 = 7200$ s

The charge transferred, $\Delta q = I\Delta t = 7.2 \times 10^{3} \times 50 \times 10^{-3} = 360$ C

Work done = charge × pd = $360 \times 240 = 86\,400$ J

Worked example 4

A cell has a terminal voltage of 1.5 V and can deliver a charge of 460 C before it becomes discharged.

a. Calculate the maximum energy the cell can deliver.
b. The current in the cell never exceeds 5 mA. Estimate the lifetime of the cell.

Solution

a. Potential difference, $V = \frac{W}{q}$, so $W = qV = 460 \times 1.5 = 690$ J

b. The current of 5 mA means that no more than 5 mC flows through the cell at any time. So $\frac{460}{0.005} = 92\,000$ s, which is about 25 hours.

Step-by-step worked examples on how to answer questions or complete calculations are found throughout, as new concepts are introduced. These help students with comprehension and exam skills and saves teachers time and effort writing their own model questions/answers

Worked example 2

A coffee-cup calorimeter was used to measure the temperature change for the reaction between zinc powder and a 1.0 mol dm^{-3} solution of copper(II) sulfate. The following results were recorded:

Mass of copper(II) sulfate solution / g	28.8
Mass of zinc / g	1.37
ΔT / °C	39.0

Determine the amount of heat released and the enthalpy change for this reaction.

Solution

First, use $Q = mc\Delta T$ to determine the amount of heat released:

$Q = 0.0288 \text{ kg} \times 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1} \times 39.0 \text{ K}$

$= 4.69$ kJ

Then, determine the limiting reactant for the reaction.

Number of moles of zinc, $n(\text{Zn}) = \frac{m}{M_r}$

$= \frac{1.37 \text{ g}}{65.38 \text{ g mol}^{-1}}$

$= 0.0210$ mol

Number of moles of copper(II) sulfate, $n(CuSO_4) = c \times v$

$= 1.00 \text{ mol dm}^{-3} \times 0.0288 \text{ dm}^{3}$

$= 0.0288$ mol

Zinc is present in a smaller amount, so it is the limiting reactant. You can calculate the enthalpy change of reaction from $\Delta H = -\frac{Q}{n}$:

$\Delta H = -\frac{4.69 \text{ kJ}}{0.0210 \text{ mol}} = -223 \text{ kJ mol}^{-1}$

10. End of topic questions

End of topic questions

1. Using your knowledge from the *Reactivity 1.1* topic, answer the guiding question as fully as possible:

   What can be deduced from the temperature change that accompanies chemical or physical change?

Multiple-choice questions

2. Which is correct for the following reaction?

   $2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$
   $\Delta H = -1049\ kJ\ mol^{-1}$

   A Reactants are less stable than products and the reaction is endothermic.
   B Reactants are more stable than products and the reaction is endothermic.
   C Reactants are more stable than products and the reaction is exothermic.
   D Reactants are less stable than products and the reaction is exothermic.

3. Which statement is correct?

   A In an exothermic reaction, the products have more energy than the reactants.
   B In an exothermic reversible reaction, the activation energy of the forward reaction is greater than that of the reverse reaction.
   C In an endothermic reaction, the products are more stable than the reactants.
   D In an endothermic reversible reaction, the activation energy of the forward reaction is greater than that of the reverse reaction.

4. Which statement is correct for this reaction?

   $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$
   $\Delta H = -26.6\ kJ\ mol^{-1}$

   A 13.3 kJ are released for every mole of Fe produced.
   B 26.6 kJ are absorbed for every mole of Fe produced.
   C 53.2 kJ are released for every mole of Fe produced.
   D 26.6 kJ are released for every mole of Fe produced.

5. In which reaction do the reactants have a lower energy than the products?

   A $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
   B $HBr(g) \rightarrow H(g) + Br(g)$
   C $Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$
   D $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

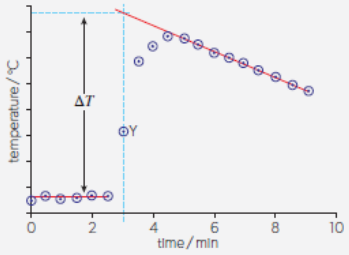
Extended-response questions

6. Nitrogen dioxide and carbon monoxide react according to the following equation:

   $NO_2(g) + CO(g) \rightarrow NO(g) + CO_2(g)$
   $\Delta H = -226\ kJ\ mol^{-1}$

   a. Calculate the enthalpy change for the reverse reaction.
   b. State the equation for the reaction of NO_2 in the atmosphere to produce acid deposition.

7. Powdered zinc was reacted with 25.00 cm^3 of 1.000 mol dm^{-3} copper(II) sulfate solution in an insulated beaker. Temperature was plotted against time.



   a. Estimate the time at which the powdered zinc was placed in the beaker.
   b. State what point **Y** on the graph represents.

      The maximum temperature used to calculate the enthalpy of reaction was chosen at a point on the extrapolated (red) line.

   c. State the maximum temperature that should be used, and outline **one** assumption made in choosing this temperature on the extrapolated line.
   d. To determine the enthalpy of reaction, the experiment was carried out five times. The same volume and concentration of copper(II) sulfate was used but the mass of zinc was different each time. Suggest, with a reason, if zinc or copper(II) sulfate should be in excess for each trial.

      The formula $q = mc\Delta T$ was used to calculate the amount of energy released. The values used in the calculation were $m = 25.00$ g and $c = 4.18\ J\ g^{-1}\ K^{-1}$.
   e. State an assumption made when using these values for m and c.
   f. Predict, giving a reason, how the final enthalpy of reaction calculated from this experiment would compare with the theoretical value.

8. A potato chip (crisp) was ignited, and the flame was used to heat a test tube containing water.

Mass of water/g	7.8
Mass of chip/g	1.2
Initial temperature/°C	21.3
Final temperature/°C	22.6

   a. Calculate the heat required, in kJ, to raise the temperature of the water, using data in the table above and from section 2 of the data booklet.
   b. Determine the enthalpy of combustion of the potato chip, in kJ g^{-1}.

End of topic questions covering each topic, including both past IB exam questions and new questions, help students prepare for their exam with realistic practice opportunities and saves teachers time and effort writing their own questions

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11. Full chapter support for the Internal Assessment

The internal assessment (IA)

Introduction

The internal assessment (IA) is an opportunity to apply the skills and tools you have learned during the DP chemistry course. In your IA, you are expected to spend ten hours carrying out a scientific investigation to produce a written report. The maximum word count of the report is 3000 words, but this word count does not include charts, diagrams, equations, formulas, calculations, tables, references, bibliography, or headers.

The IA is an inquiry process. Collaboration between up to three students is allowed, and your group must be established before the scientific investigation begins. Even if you collaborate in your IA, you must ensure that you produce an individual and unique research question or title.

The IA is assessed by four criteria, each worth six points and 25% of your final mark (table 1).

Criterion	Number of marks	Weighting
Research design	6	25%
Data analysis	6	25%
Conclusion	6	25%
Evaluation	6	25%

▲ Table 1 Assessment criteria for the IA

Any source used in your scientific investigation should be properly cited as required by the IB's academic integrity policy. However, correct citation is not assessed by the criteria in table 1.

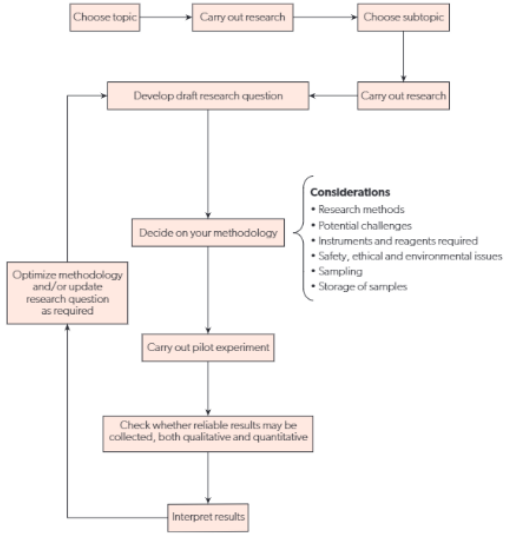
In the research design for your scientific investigation, you are required to

- produce a focused research question or title
- identify the best methodology to answer it
- clearly detail the steps of the chosen methodology
- carry out sufficient research to meet the requirements of each step and be able to justify every decision taken.

Research design

The research question should provide specific and appropriate context for your investigation. In your methodological considerations, you should describe how the chosen data collection methods allow you to answer the research question. The methodology used should be realistic in terms of the time and resources available. It must also be possible to effectively control variables that impact your results. You should present the description of the methodology clearly such that it could be easily reproduced.

You should also make sure that your overall research design allows you to explore the skills detailed in the inquiry process. Two different investigations will rarely follow the same path, but some of the following steps may be involved in developing your research design:



▲ Figure 1 Possible steps in developing your research design

A full chapter at the end of the Course Book is dedicated to step-by-step guidance to the Internal Assessment element of the courses, including examples with commentary for each of the 4 criteria that are assessed.

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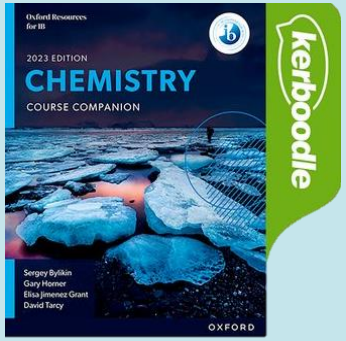
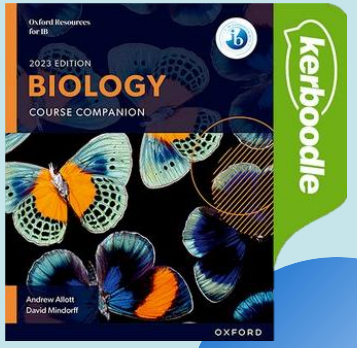
Key Kerboodle features





Top features of our upcoming DP Biology, Chemistry & Physics Kerboodles:

1. Formative Assessment with adaptive Next Steps (excl. Biologia)
2. Reactivates
3. Reporting, data and insights
4. Vocabulary activities
5. Interactive activities
6. Animations with comprehension questions
7. How-to videos
8. Professional development
9. Course Book resolution
10. Device optimisation & accessibility

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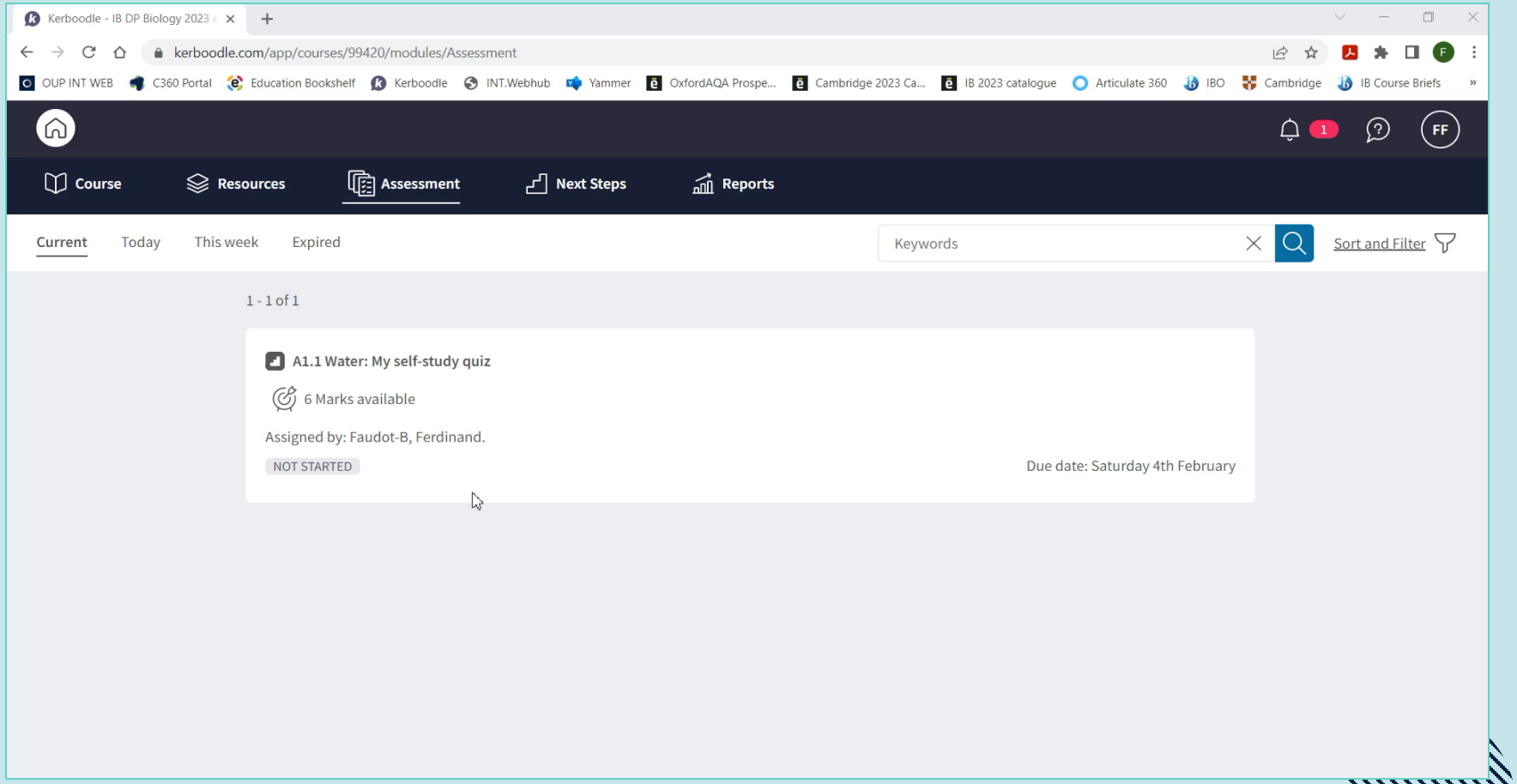
1. Formative Assessment and Adaptive Next Steps

Self-study quizzes (student-assigned) or formative tests (teacher-assigned) with adaptive next steps (level up) for every syllabus topic strengthen or extend learning in the core areas of the curriculum, tailored specifically to each student's needs.

Video example:



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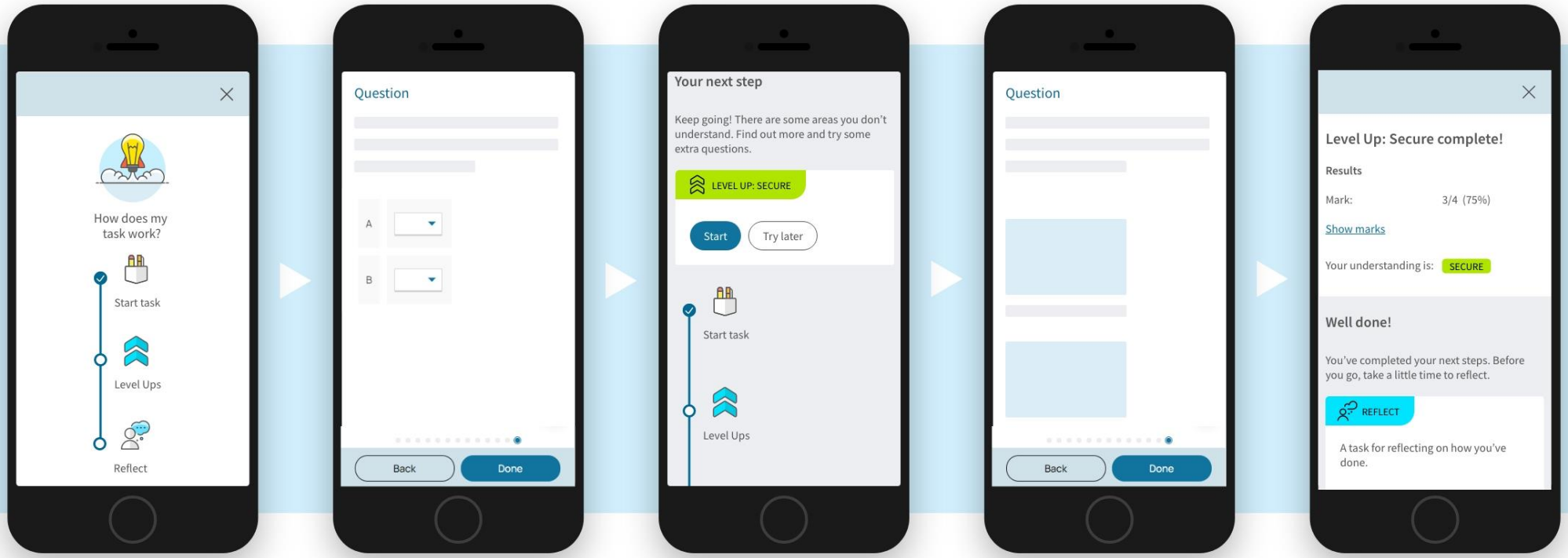
1. Formative Assessment and Adaptive Next Steps



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1. Formative Assessment and Adaptive Next Steps

Level Up: Secure complete!

Results

Mark	5 / 6 (83%)	Show marks
Sub-theme(s):	None added	
Your understanding is:	SECURE	

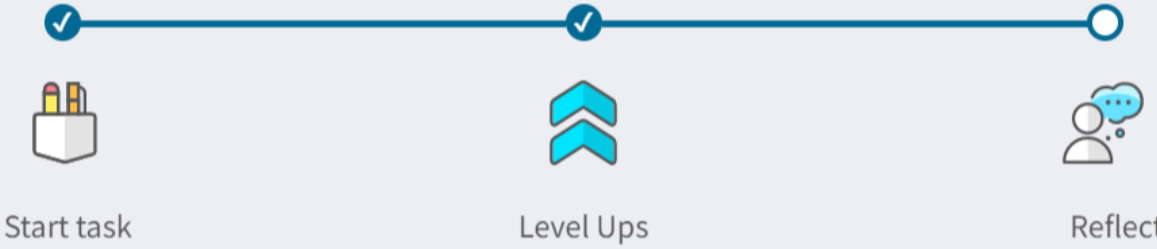
Your next step

Fantastic! Now see if you can challenge yourself and try some harder questions.

LEVEL UP: EXTEND

Sub-theme(s): None added

Start | Try later



1. Formative Assessment and Adaptive Next Steps

Level Up: Secure complete!

Results

Mark	0 / 8 (0%)	Show marks
Sub-theme(s):	None added	
Your understanding is:	DEVELOPING	

Well done!

You've completed your next steps. Before you go, take a little time to reflect.

REFLECT

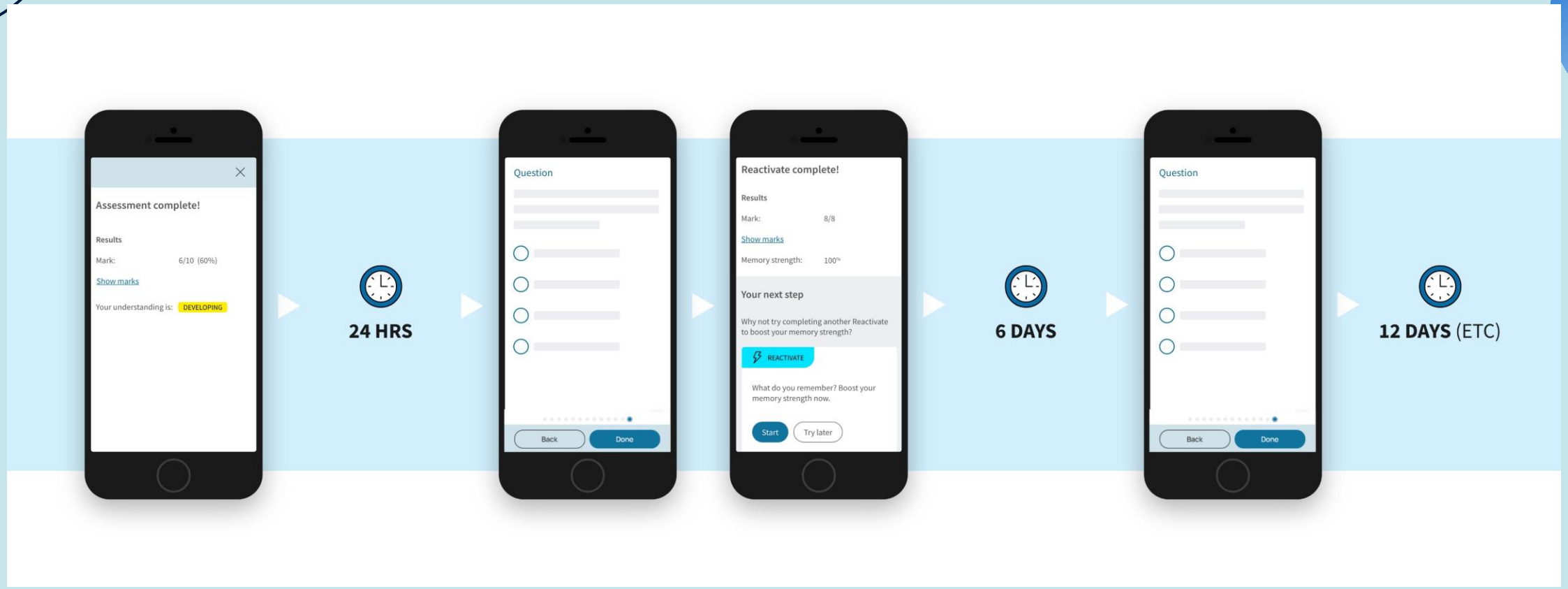
A task for reflecting on how you've done.

Start

Start task | Level Ups | Reflect

2. Reactivates

Automatically generated quizzes that will become available to students at time intervals to prompt them to revisit topics and continuously test their knowledge



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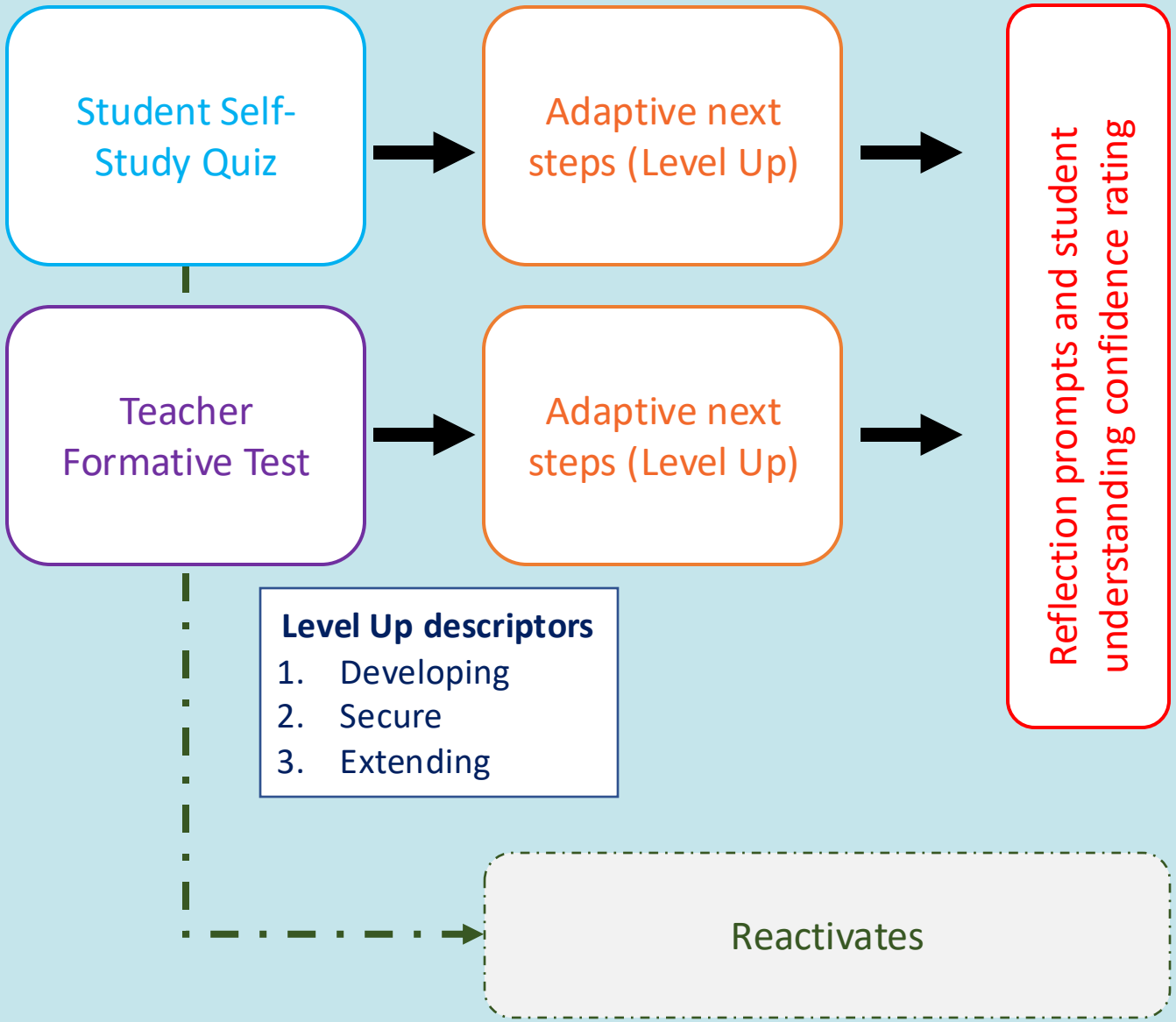
Adaptive Pathway overview



Adaptive next steps (Level Up):

- Help students revisit areas of the topic they might not be so confident in yet or need to improve in (based on results)
- Consists of content (such as a short explanation of the topic, or a prompt to help the student avoid frequent misconceptions associated with that topic) and further comprehension questions
- The content and number (up to 3) of Level Ups that a student will be shown is dependent on the result of the trigger quiz they took to unlock the next steps path

Reflection:

- Questions to prompt the student to think about not only what they learnt and what else they need to do next, but also how they have learnt

Reactivates:

- Automatically generated quizzes (at time intervals) to help students revisit their knowledge & learning

https://support.kerboodle.com/teacher-support/assessment-and-markbook/next-steps-student-experience/

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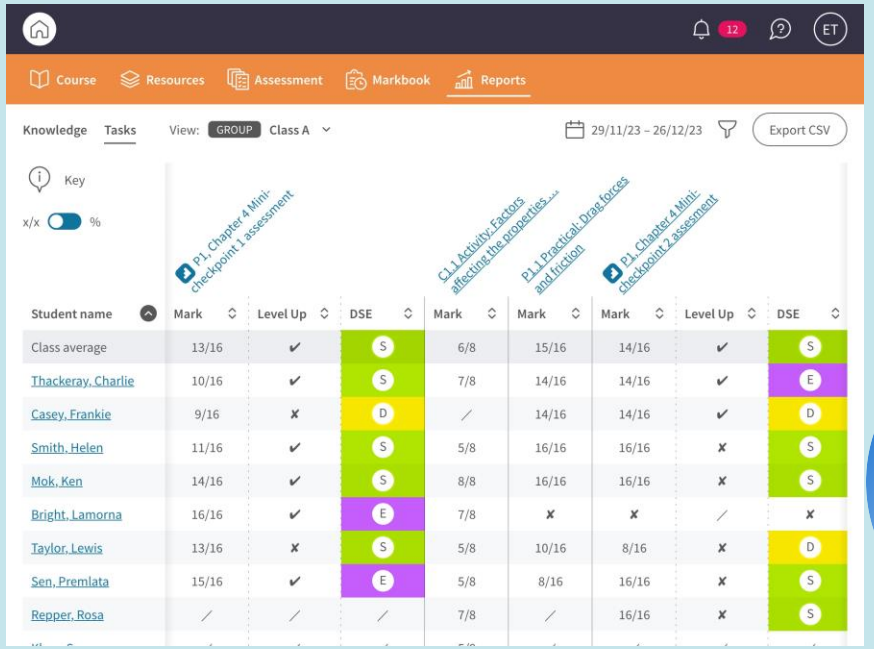
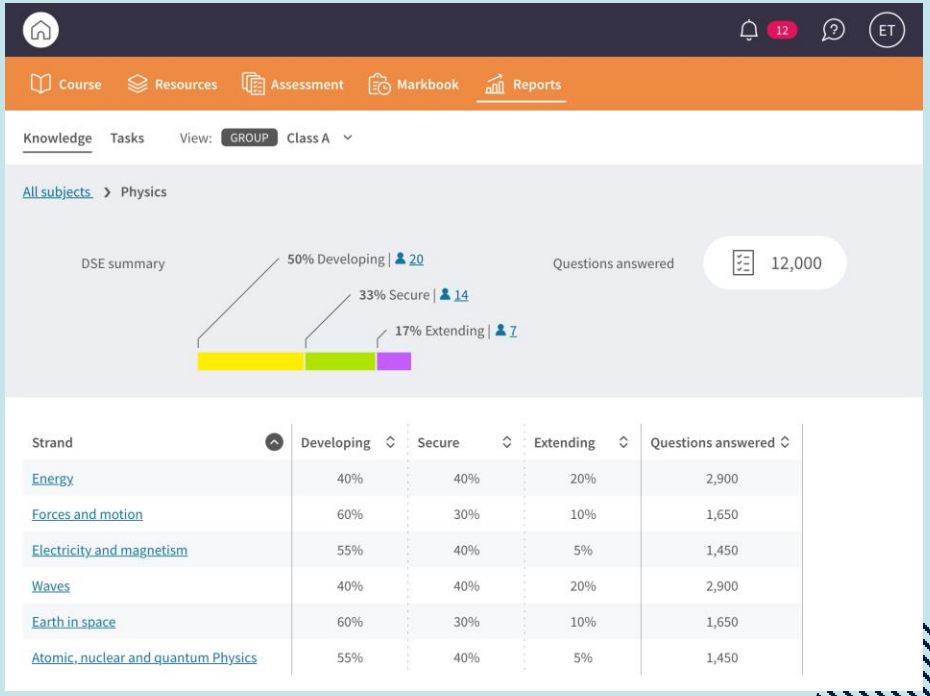
3. Reporting, data and insights

Gather rich **data with enhanced reporting** on attainment, progression, student feedback and next steps activity at student and class level.

Encourages **responsive teaching**, allows for targeted **intervention**, is user-friendly and saves administration time





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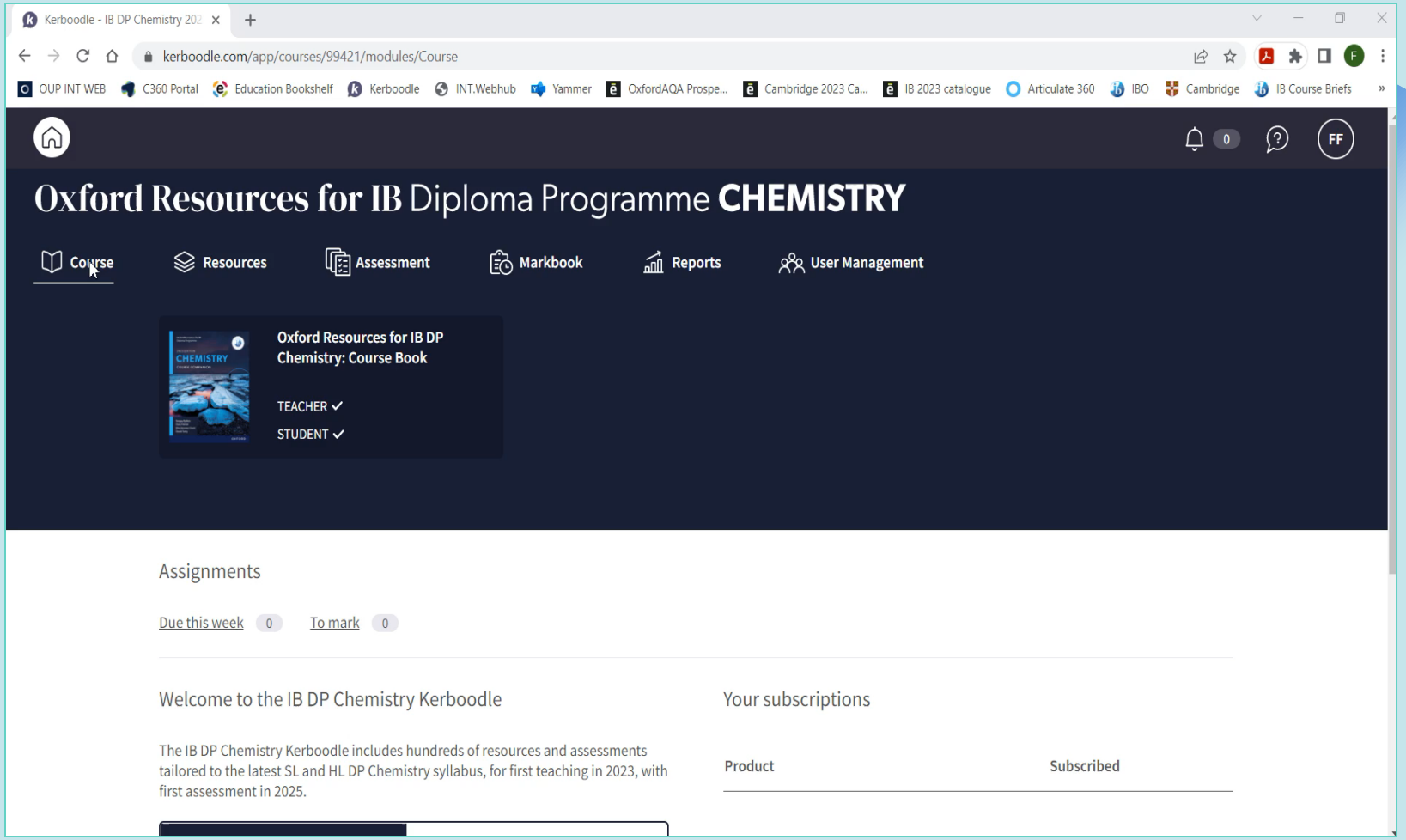
4. Vocabulary activities

Video example:

Engaging **vocabulary exercises** consisting of questions that allow students to **practice scientific terminology**, all aligned with the IB DP Assessment Objectives

- 1st question – AO1 demonstrate knowledge
- 2nd question – AO2 understand and apply knowledge
- 3rd question – AO3 show conceptual understanding



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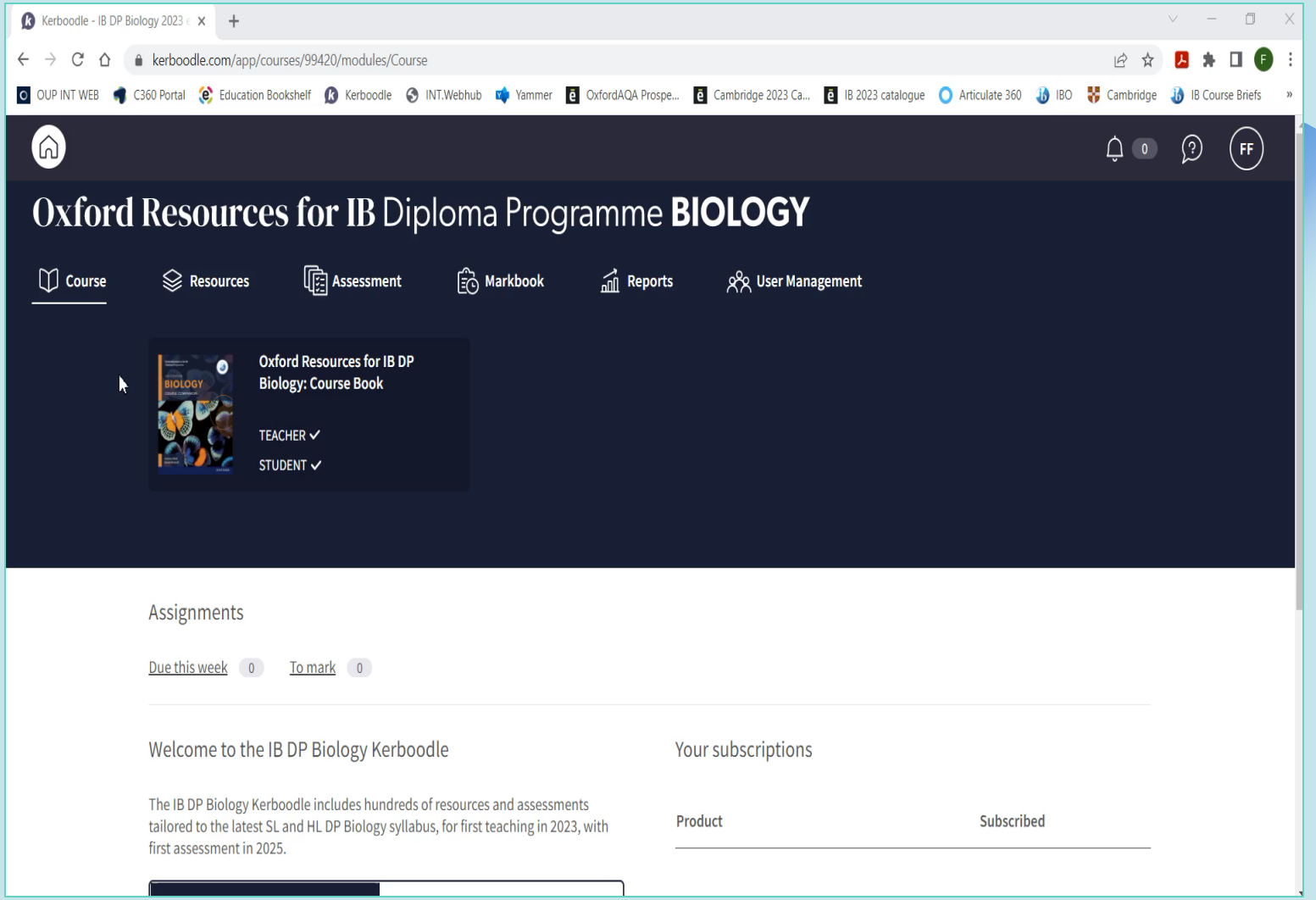
5. Interactive activities

Video example:

Interactive worksheet activities focused on three categories aligned with the IB DP subject guides:

- **Skills** – support the mathematical tools, experimental techniques and technology tools requirements
- **Inquiry** – supports the inquiry process
- **Thinking about Science** (TAS) – supports TOK and NOS requirements



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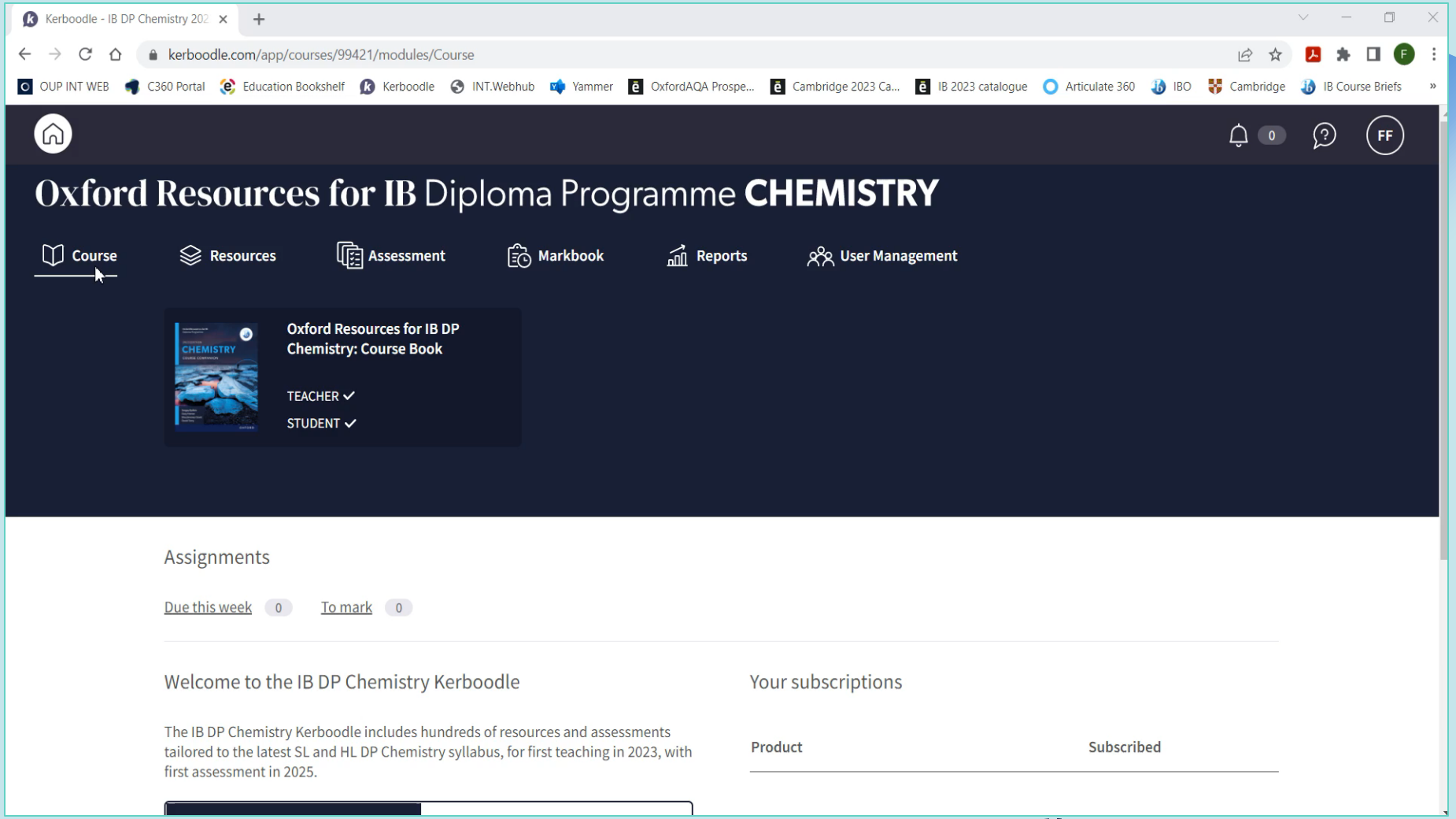
6. Animations with comprehension questions

Video example:

Subject-specific **animations** covering key topics, complemented by **comprehension questions** to test students' understanding of the content in the animation itself



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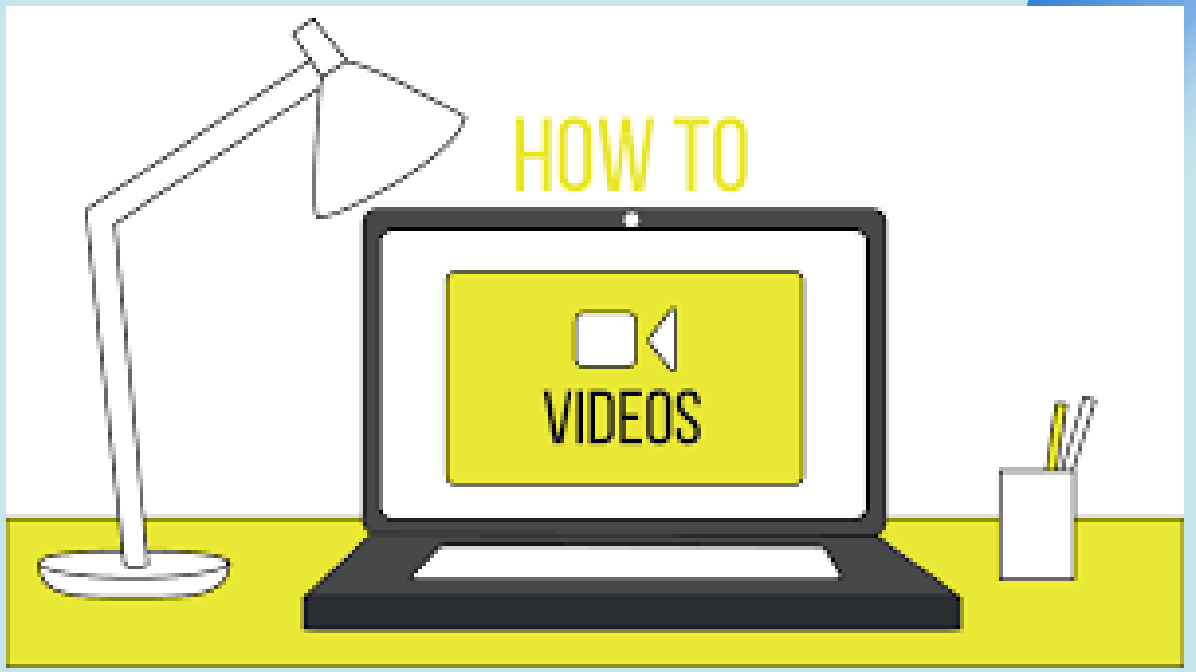
7. How-to videos

1. Videos supporting how to **approach and prepare for the Internal Assessment** (Scientific Investigation)

2. Videos containing explanations on how to **approach specific types of questions** that are common in the subject



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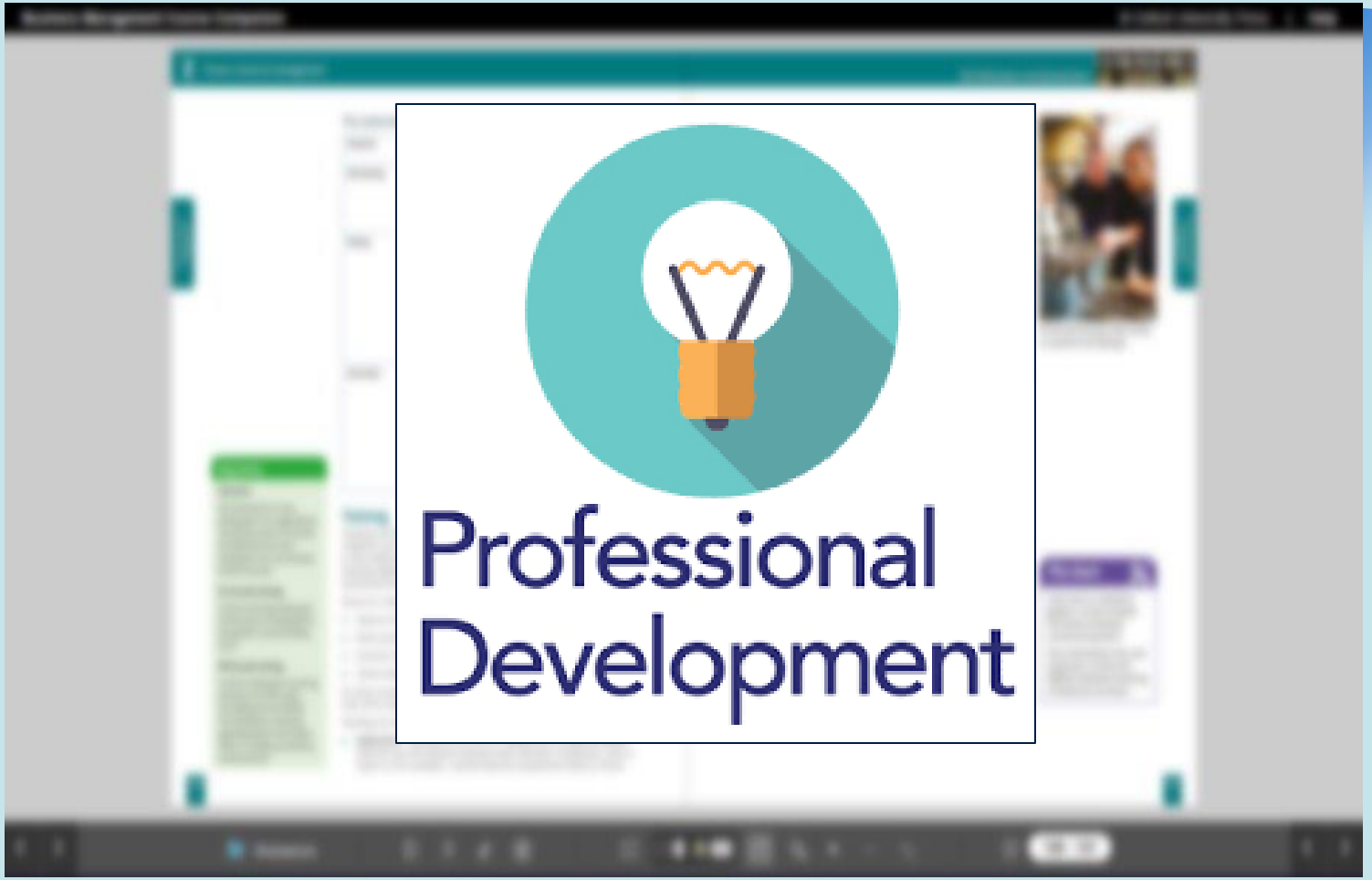
8. Professional Development

Integrated Professional Development support via:

video recordings, **webinar** recordings and helpful **documents**



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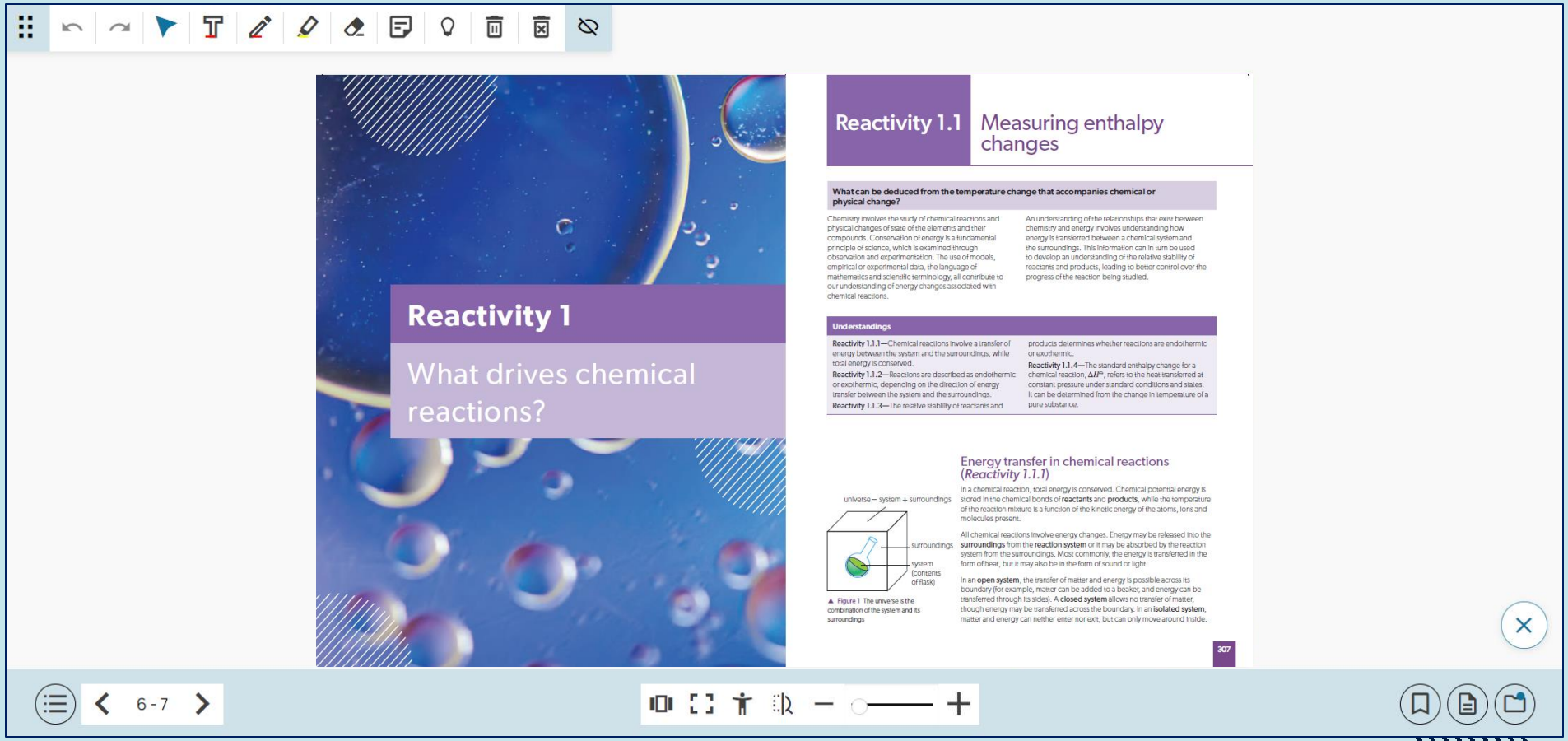
9. Course Book resolution

Our DP Science online Course Books will be the first to be fully optimized for any screen use – they will no longer be Jpeg but instead **PDF eBooks allowing for vastly improved visibility and adaptability across any screen-size**



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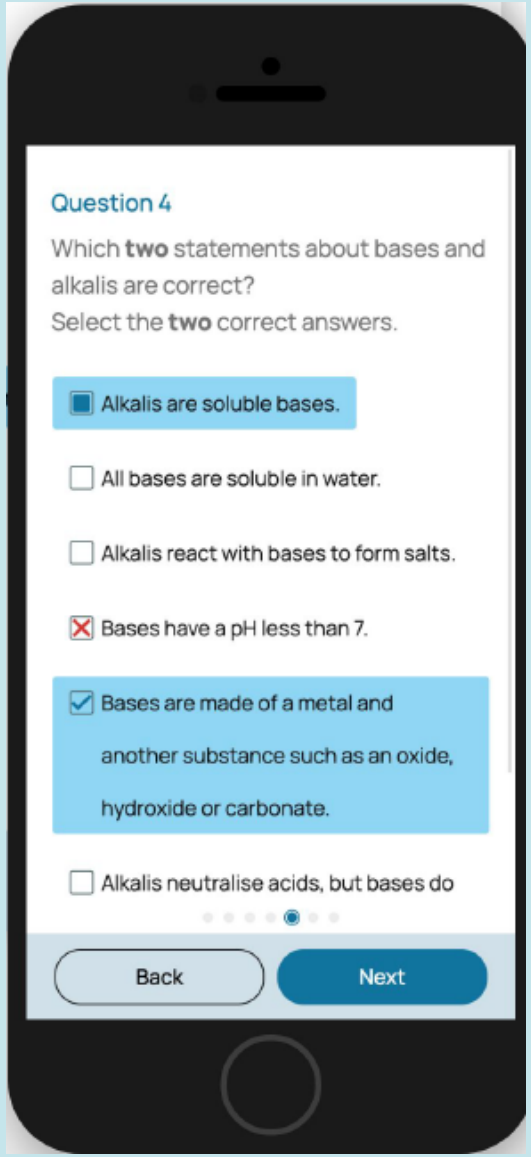
10. Device optimisation & accessibility



1. **Offline access to the digital Course Books**
2. **Single sign-on**
3. **Accessibility requirements**

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Sales Support

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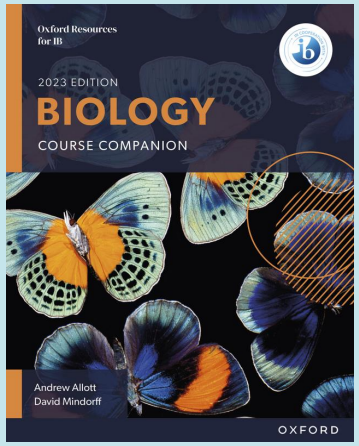
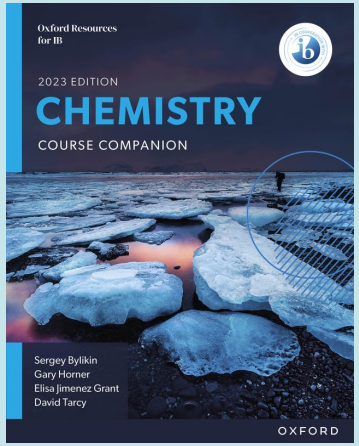
Sample chapters & DICs



[Sample of DP Biology Course Book 2023]

[FULL digital evaluation copy DP Biology Course Book 2023]



[Sample of DP Chemistry Course Book 2023]

[FULL digital evaluation copy DP Chemistry Course Book 2023]

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Testimonials & Reviews

“The book nicely uses images to help to break up the text, and the images are relevant to the real world, which helps when teaching through a lens or a context. There are also plenty of other real-world applications with regard to the syllabus context and this will help students and teachers to see things through a particular lens, enhancing their learning experience. The content follows the road map given in the guide but the structure and reactivity sections are nicely broken up using the skills section. This ties together both strands of the course seamlessly. I think the book will be very useful in helping students understand the conceptual nature of the course, as well as providing teachers with an extremely useful resource to enhance their teaching. The Scientific Investigation section is well written and easy to understand and follow with plenty of useful examples.”

- DP Chemistry Workshop Leader
- Reviewing DP Chemistry Course Companion

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Marketing support

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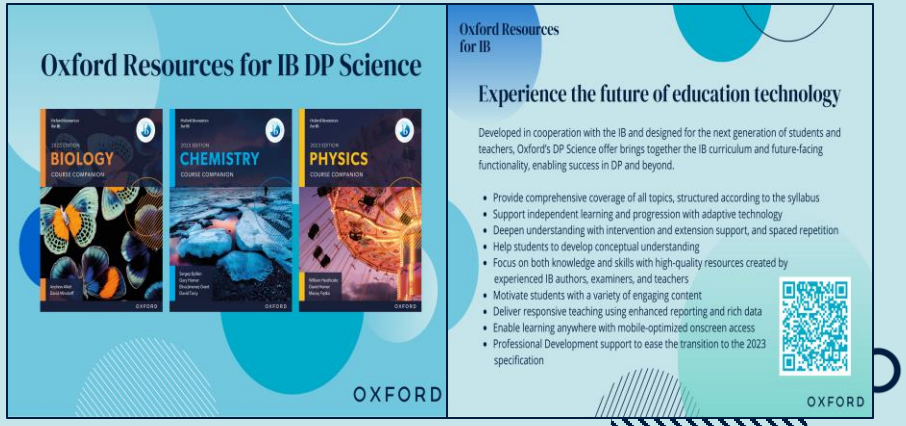
Marketing links

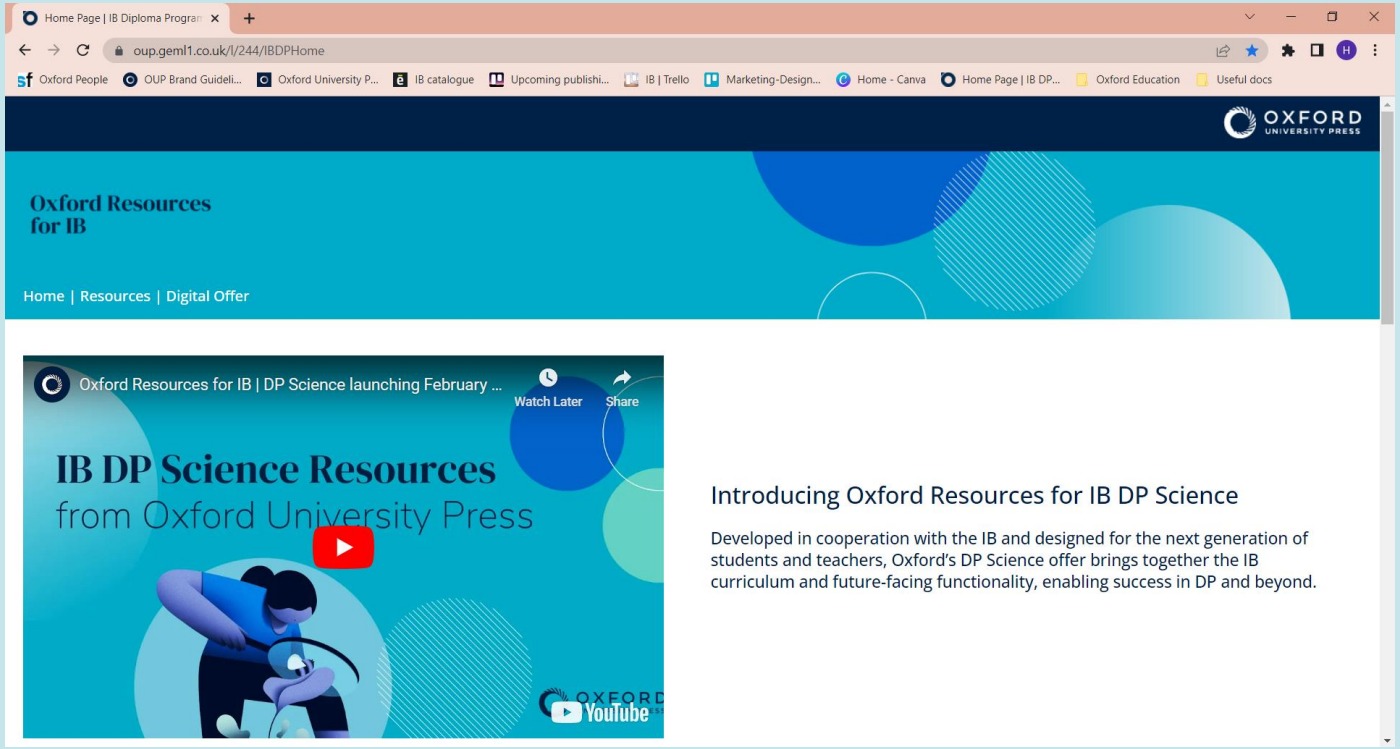
- DP Science Hub (see next slide)
- DP Science Series page: Click Here
- DP Biology & Chemistry Course Guides: Biology & Chemistry
- DP Biology & Chemistry Digital inspection copies: Click Here
- DP Biology & Chemistry digital free-trials: CLICK HERE
- YouTube DP Science video: https://www.youtube.com/watch?v=4dwtWT15bqU
- DP Science Marketing Pack

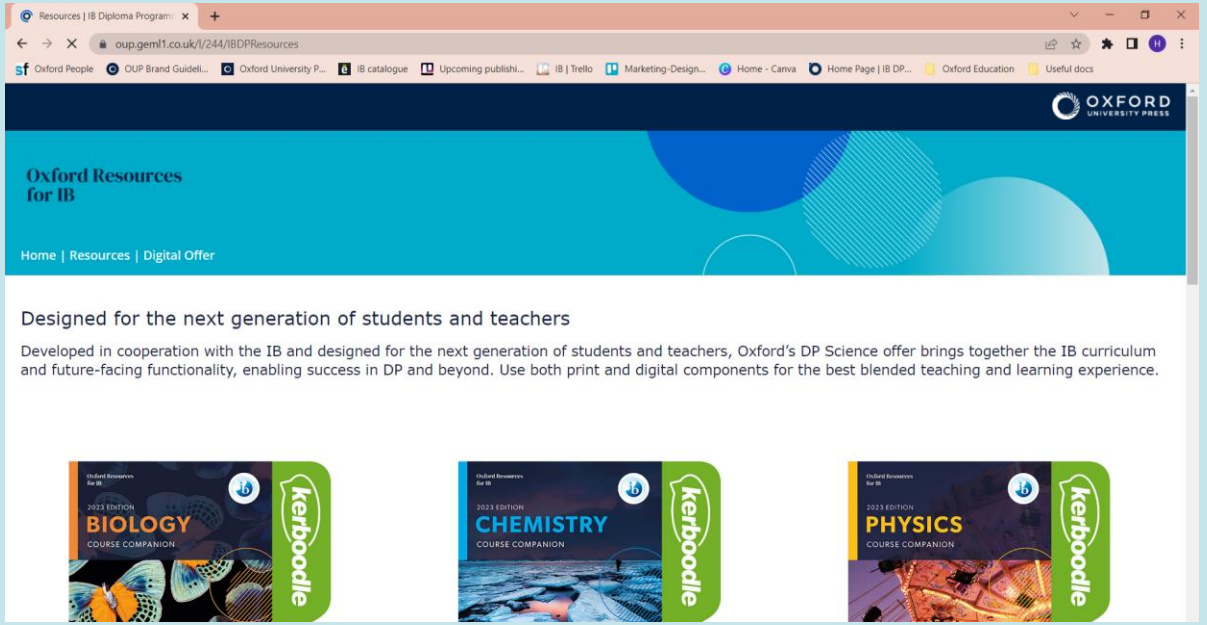


DP Science Hub

The hub is the one-stop-shop for all DP Science marketing, with full information on the print & digital offer, and is the main place to access evaluation materials

https://oup.geml1.co.uk/l/244/IBDPHome





ISBN list

IB Diploma Science 2023

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ISBNs

Print Resources	Biology	Chemistry
Course Book	9781382016339	9781382016469
Study Guide	9781382016438	9781382016568
IB Prepared	9781382058315	9781382058353

NB: ISBNs for Kerboodle are subject to number of users.