AS and A-level Physics

Key skills and knowledge booster

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Introduction – from the authors

About the Key Skills and Knowledge Booster Series

We have developed this series based on our own teaching, to enable students undertaking science AS and A-levels to experience a smoother transition from GCSE to AS and A-level.

Students often find this transition very difficult and can easily become overwhelmed by the new subject knowledge they meet, which is often abstract, and the level of understanding required. It is not uncommon for students to find themselves in the unenviable position of failing early exams or gaining grades that lead to them to become despondent with the subject or reconsider their subject choices.

The tasks outlined in this series aim to cover areas of common misconceptions in the main science AS and A-levels of biology, chemistry and physics, and to aid teachers in their delivery of underpinning concepts, such as general maths skills or practical skills, needed for each subject. The newly updated AS and A-level science curricula place a far greater emphasis on these underpinning skills and, for this reason, each of the books in the Key Skills and Knowledge Booster series has had extra tasks added to ensure that teachers can provide as much support as possible to help students develop these skills.

Due to the wide number of GCSE specifications covered by students, it is impossible for all students to begin their AS and A-levels with identical background knowledge, and there will always be huge variability in the grades students have achieved in their GCSE exams. Both of these factors can have an impact on the delivery of the AS and A-level syllabus and, ultimately, on the success of students. At the time of writing, the new GCSE science curriculum was in the process of being finalised. This curriculum also places an emphasis on underpinning skills, including maths, and has introduced new topics within each of the three subjects. Extra tasks have been added so that teachers can check students' understanding of these areas. This will be of particular importance when teaching students who have moved from the old GCSE specifications, as it will highlight areas that were not covered but which are expected to be commonplace as students progress through their science studies.

The Key Skills and Knowledge Booster Series has been developed to complement your existing teaching. It has not been written to meet any particular AS and A-level specification, rather to cover general areas within each subject that we have found anecdotally to give rise to problems for students. These tasks are not intended to replace your existing text books or to act as a stand-alone teaching guide.

What the Key Skills and Knowledge Boosters series contains

A separate book has been produced for biology, chemistry and physics. Each title is broken down into the following sections. Ideas on how you may wish to use each type of task within your own teaching have been shown in italics.

- **GCSE Checker Tasks:** these tasks can be used to get an overview of GCSE knowledge that students have.

  These could be used as an induction exercise to ascertain students' background knowledge and highlight areas that students will need to revise or they could be combined to form an induction test.

- **Basic Skills for the AS and A-level Student:** these tasks give instructions and guidance to students on skills they will need throughout AS and A-levels, such as essential maths skills. We have found that maths skills, or confidence in particular, is often an area that causes many problems, especially if students are not following AS and A-level courses in maths. These tasks aim to cover some of the gaps in knowledge that students may have.

These could be used at the beginning of the AS year to bring students up to a basic level in skills such as graph plotting, using calculators or using scientific notation. They can also be given to students if work they are completing throughout the year shows they have weaknesses in certain areas: for example, rearranging equations.

- **Investigation Skills for the AS and A-level Student:** these tasks outline key skills or techniques that students will need in order to access their specific AS and A-level syllabus; they form an excellent bank of resources that students could refer to in order to remind themselves of practical techniques, or skills that they may need to use time and time again. These will complement the teaching around any investigations or assessed practical activities that students may need to complete.

  These could be used when introducing practical skills and results analysis, in the run-up to practical exams, or to aid in-depth investigations.

- **Topic Builders:** these tasks lead students through the topics that, in our experience, students find the most difficult to comprehend. They have been written in as simple a manner as possible to try and support students through topics and to steer them away from forming misconceptions. Where possible, simple analogies have been included to help students overcome the abstract nature of some of the topics. These tasks include a 'Taking it Further' section that allows students to consolidate what they have covered and to go on and extend their understanding, once they have grasped the essential points and are feeling more confident with the topic.

  These can be given to students who are struggling with specific concepts. They could be used as individual self-study exercises, homework, material to work through in tutorials or within small group settings.

- **Physics and its Applications:** these tasks are open ended and research based. They encourage students to consider how the subject they are studying impacts on everyday life, industry or perhaps the world of academic research. Students can become so focused on what they need to know for exams that they lose sight of what the subject they are studying is all about; these tasks allow students to become enthused on topics and may (hopefully) lead to interest in studying the subject further.

  These could be used throughout the year, perhaps as homework, research tasks or extension work.

- **Accompanying CD:** this contains a copy of the entire book plus answers to the tasks. The CD files can be used either to project the tasks onto a whiteboard, or to print off relevant pages for individual students.

The tasks in the first four sections all contain questions or tasks for students to attempt to check their understanding. Answers (contained on the CD) have been provided for self-marking. Where necessary, 'workings out' have been shown to help students check through, and learn from, their answers. Key words and terms have been shown in bold throughout the tasks contained in the books to help students identify words or phrases they should know and be able to define or interpret.

Who is the Key Skills and Knowledge Booster series aimed at?

The tasks have been written predominantly for first-year AS and A-level students, although some of the tasks will be relevant to both AS- and A2-level students. The tasks would be very suitable for students who are finding the transition from GCSE-level science into AS and A-level difficult.

They have been written with students in mind who are achieving grades lower than a C in homework or exams; they are designed to assist these students to fill gaps in their background knowledge or subject-specific knowledge.

Not all students will find all topics difficult, so the tasks can be used as and when required for any student; to help 'top-up' understanding when they meet an area of study they find more difficult.

The series would also be an excellent resource to use with students who miss lessons due to illness or university visits, for example. The tasks would also be an excellent resource to give to students as preparation to be completed prior to, or during, personal tutorials or group seminars.

When do I use the Physics tasks?

The tasks do not need to be used in a sequential order; they can be used as and when they are suitable within your own specification. Nor does each of the tasks need to be used – the book forms a resource bank that can be dipped in and out of.

About the author

Spencer Senior is an experienced KS3, KS4 and A-level classroom teacher who now specialises in post-16 physics.

Electricity

The questions below are intended to test your knowledge of key ideas covered in most GCSE specifications. Answers with brief explanations follow. You should revise any areas which you find difficult or do not score well on.

Conductors and insulators

1 Name three good electrical conductors, including one non-metal.

2 Name three electrical insulators.

3 What name is given to the property of a material that gives a measure of how easy it is for electrical current to flow through it?

4 Why does a circuit stop working when a switch is open?

Circuit symbols

5 Copy the table and complete the missing circuit symbols and their names.

symbol	name
	cell
	
	resistor
	
	bulb

Circuits

6 Draw a simple circuit containing a cell, bulb, ammeter and voltmeter.

7 Label the positive and negative sides of the cell symbol.

8 Copy and complete: An ammeter measures ..... flowing in a circuit and is always placed in ..... with components in the circuit.

9 Copy and complete: A voltmeter measures .... across a component and is always placed in ..... with components in the circuit.

10 What changes and what remains the same as you move round a series circuit?

Electricity

Safety

11 What are the colours of the mains wires in a plug?

12 Name what each wire is.

13 Explain how a fuse works.

14 If someone is electrocuted what is the first thing you should do?

Calculations

15 What is the total resistance when a 470 Ω resistor is placed in series with a 500 Ω resistor?

16 What is the voltage across a 24 Ω resistor if a current of 0.78 A flows through it? (Use $V = IR$)

17 What is the voltage across an 11 kΩ resistor if a current of 0.055 A flows through it? (Use $V = IR$)

18 Rearrange $V = IR$ so that current is the subject instead of voltage.

19 Calculate the resistance of a circuit if 1.2 A flows around it when the voltage of the supply is 12 V.

20 Calculate the resistance of a resistor if 0.22 A flows through it when the voltage across it is 230 V.

Forces

The questions below are intended to test your knowledge of key ideas covered in most GCSE specifications. Answers with brief explanations follow. You should revise any areas which you find difficult or do not score well on.

Examples of forces

1 What name is given to the force of gravity on an object?

2 What is the name of the force that makes raindrops and bubbles round?

3 What force between tyres and the surface of a road enables a car to corner?

4 What force causes some objects to float in water?

5 What name is given to the force acting along a rope that is pulled taut?

6 What name is given to the force on the wings of an aeroplane during flight?

7 Draw the forces acting on

a. a book on a table

b. a ball on the floor

c. a ball falling towards the ground

d. a boat on a still lake

Balanced and unbalanced forces

8 What is the name given to the force put on an object by the surface it rests on?

9 What is the same, and what is different, about a pair of forces if they are balanced with each other?

10 What does it mean to say a body is in equilibrium?

11 What does an unbalanced force do to an object's motion?

Newton's Laws of Motion

12 State Newton's First Law of Motion.

13 Write the formula for Newton's Second Law of Motion.

14 What 'saying' is a version of Newton's Third Law of Motion?

Pressure

15 a. State the equation for pressure in a liquid and name all the variables and their units.
b. Describe a situation where pressure is exerted on one object by another.

16 State the density of water.

17 a. Explain how pressure varies with varying depth and density in a liquid.
b. State the equation that shows the relationship between pressure, depth and density.

18 Calculate the pressure at a depth of 0.1 m in water.

19 Calculate the pressure in air of average density 0.6 kg m^{-3} at a depth of 18 km.

20 Calculate the pressure at a depth of 253 m in seawater with a density of 1030 kg m^{-3}.

Motion

The questions below are intended to test your knowledge of key ideas covered in most GCSE specifications. Answers with brief explanations follow. You should revise any areas which you find difficult or do not score well on.

Speed

1 Speed is a measure of how far an object travels in a given time. Write an equation that relates speed, distance and time.

2 What is the metric unit for speed?

3 What is the average speed of a sprinter, if they travel 200 metres in 19.2 seconds?

4 Calculate the average speed of a snail covering 1.6 metres in 26 minutes.

5 How far does sound travel in 10 seconds, if its speed in air is 330 ms^{-1}?

6 How long does it take a car travelling at 24 ms^{-1} to cover a distance of 1.2 km?

Acceleration

7 Acceleration is the change in speed in a given time. The change in speed is the final speed minus the initial speed, so when the initial speed is zero (that is, when an object starts at rest), the change in speed is the same thing as the final speed. Write an equation that relates acceleration, speed and time.

8 Write the metric unit for acceleration.

9 If a cyclist reaches a speed of 5 ms^{-1}, after starting from rest, in 3 seconds, what is their acceleration?

10 A sprinter achieved a speed of 12 ms^{-1}, 1.4 seconds after the starter's gun was fired. What was their acceleration?

11 If an object starting at rest falls with an acceleration of 10 ms^{-2}, what is its speed at 8 seconds?

12 How long does it take for a rocket travelling at 100 ms^{-1} to increase its speed to 150 ms^{-1}, if the rocket motor can produce an acceleration of 25 ms^{-2} ?

Force and motion

13 Explain the difference between stopping distance, thinking distance and braking distance for vehicles on the road.

14 Give three factors that affect thinking distance.

15 Give three factors that affect braking distance.

16 Name two safety features modern cars have that are designed to reduce the size of forces on occupants during an impact.

17 Engine thrust acts forwards when a car is travelling on a road. This is opposed by drag (friction and air resistance) acting in the opposite direction to motion. What happens to these forces:

a. when the car accelerates?

b. when the car brakes?