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Teaching ideas

These teaching notes are intended to provide outline ideas for ways in which you might cover the IGCSE Physics syllabus with your students. They do not provide a complete scheme of work, nor lesson plans. They are simply suggestions, some of which you might like to incorporate into your lessons.

It is most important to remember that physics is not just a body of knowledge. Physics is a science, and students should be made constantly aware that research is ongoing and continues to surprise us with new findings, some of which contradict what we thought we already knew. They need to become familiar with scientific method. They should be asked to make careful observations and record them, to display, analyse and interpret results, to evaluate the reliability of results and to plan and evaluate their own experiments. The activities in the Coursebook, exercises in the Workbook and the worksheets supplied as part of this Teacher's Resource provide many opportunities for developing these skills, and you will probably also like to add some of your own.

The notes for each chapter begin with a table suggesting a possible way of breaking up the material to be covered into a number of topics. The number of lessons you might spend on each topic is given as a general guide, because it will depend very much on what students have done before, and also on how much time you decide to spend on providing students with opportunities to develop skills such as data-handling or planning experiments. For each topic, relevant resources in the Coursebook, Workbook and worksheets are listed.

Outline descriptions of what might be included in lessons covering each topic are then given. These are no more than suggestions, and they are not comprehensive. You may like to use all of them, some of them or none of them. Most indicate ways in which students can become actively involved in their learning, rather than passively absorbing information.

There is also a list of some of the most common misunderstandings and misconceptions that are regularly seen in students' answers, and some suggestions for tasks that could be set for homework.

Teaching ideas

Chapter 1 Making measurements

Syllabus sections covered: 1.1, 1.3 (part), 1.4

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
1.1 (part)	Measuring length and volume	1	Activity 1.1 Measuring lengths and volumes Questions 1.1 to 1.3	Exercise 1.1 The SI system of units Exercise 1.3 Paper measurements	
1.1 (part)	Improving precision in measurements	1	Question 1.4	Exercise 1.2 Accurate measurements	Worksheet 1.1 Precise measurements
1.3 (part), 1.4	Density	2 to 3	Activity 1.2 Measuring density Questions 1.5 to 1.7	Exercise 1.4 Density data	
1.1 (part)	Measuring time	1	Activity 1.3 The period of a pendulum Questions 1.8 and 1.9	Exercise 1.5 Testing your body clock	
	Summing up		EOCQs 1 to 11		

Topic 1 Measuring length and volume

Coursebook section 1.1

Teaching ideas

- Students will have made many measurements of length and volume in earlier stages of their education, in science and in other subjects. They will also have made similar measurements at home and elsewhere, for example in cooking. A discussion of this would make a useful starting point.
- The emphasis in science is always on improving measuring techniques to give more accurate and more precise answers. Activity 1.1 Measuring lengths and volumes encourages this. Finish off the activity with a discussion of how the techniques used give improved results.

- Discuss the SI units used in measurements. Units of mass and length are base units but units of volume are derived units. Point out that these units are shared by all scientists, even in countries such as the USA where non-metric systems still persist in many areas of life. Ask students to name non-SI units they have heard of.
- Check that students are familiar with the various multiples of the basic units s and m. They need to be familiar with the prefixes used in the SI system.

Common misunderstandings and misconceptions

- Students may think that it is acceptable to scribble down numbers when making measurements and to add units later, or to make a neat version later. Encourage them to record all data clearly and neatly, including units. This is best practice. All scientists and engineers are expected to do this.

Homework ideas

- Coursebook questions 1.1 to 1.3
- Workbook exercise 1.1 The SI system of units
- Workbook exercise 1.3 Paper measurements

Topic 2 Improving precision in measurements

Coursebook section 1.2

Teaching ideas

- Start by discussing the importance of being able to measure small thicknesses, or measuring to high degrees of precision. This is important in science, but also in engineering and manufacturing. You could point out some products that are made to high precision, such as the metal wires inside electricity cables, or the pistons and cylinders of a car engine. Lego bricks would not stay together if they were not made to the correct size and precision.
- This section involves the use of callipers and micrometers to make measurements in millimetres to 1 or 2 decimal places. Although the Coursebook refers to vernier scales and the rotary scale on the micrometer, you may have access to digital instruments that show the reading on a digital readout, which you can demonstrate to students.
- Worksheet 1.1 Precise measurements gives practice in reading scales and is provided as an alternative if you do not have equipment for students to use themselves.

Common misunderstandings and misconceptions

- Students may assume that, because an instrument gives values to 1 or 2 decimal places, its readings must be very accurate. This is not the case – the instrument may be incorrectly calibrated. Measuring instruments can become less accurate if they are used frequently over a long period of time. You could look to see if any of your instruments have a zero error, for example. Do all of your instruments agree when they are used to make the same measurement?

Homework ideas

- Workbook exercise 1.2 Accurate measurements
- Worksheet 1.1 Precise measurements

Topic 3 Density

Coursebook section 1.3

Teaching ideas

- Discuss the meaning of 'lighter' and 'heavier' as applied to materials. Then introduce the idea of density as a way of comparing materials. Although we could take 1 cm^3 of each of several materials, we don't have to if we can calculate mass/volume.
- Point out the units involved: the answer comes out in g/cm^3 or kg/m^3, which should remind students to divide mass by volume.
- Activity 1.2 Measuring density starts with asking students to compare blocks of two different materials by hand. It is relatively easy to judge differences in density if the blocks are similar in size. Students should then go on to make accurate measurements from which they can calculate values of density. It is helpful if you can provide blocks of materials of similar densities, to emphasise the need for measurement rather than relying on judgement.
- You could go on to use a displacement method to find volume. Use measuring cylinders, or you may have displacement cans. Do different methods give the same answers? This is an opportunity to evaluate different techniques. These practical activities provide practice in measurement and also practice in calculating values of density.
- Use the idea that objects whose densities are less than that of water will float. You could challenge students to hold an object and then say whether they think it will float. Test their answers.
- Ask students to estimate the density of a human being. They should know that people float, so density must be less than 1 g/cm^3. If a person floats in a vertical posture at the deep end of a swimming pool, the water level will be close to their nose, i.e. about 95% of their height is submerged, suggesting a density 95% of that of water.
- Answer Coursebook questions 1.5 to 1.7 in class.

Common misunderstandings and misconceptions

- Students are familiar with the idea of one material being lighter than another. This has to be formalised into the notion of density.
- Some students will need help with dividing one quantity by another.

Homework ideas

- End-of-chapter questions 2, 4 and 6 to 10
- Workbook exercise 1.4 Density data
- Students could find objects at home and determine their densities either by making measurements or using information on labels (for example, bags of flour and sugar, bars of soap, bottles of liquids).

Topic 4 Measuring time

Coursebook section 1.4

Teaching ideas

- Start by looking at some timing devices. You may have clocks, stopwatches and other electronic timers. Students may have timers on their phones or watches. How do they start and stop? How many decimal places do they measure to?
- Discuss time measurements in sport. How precise are world record sprint times, for example? How can high precision timings of races be achieved?
- In physics, we often make repeat measurements or multiple measurements. A good example is timing many swings of a pendulum in order to find the time for one. Activity 1.3 The period of a pendulum gives instructions for this. Ask students to make repeat measurements to assess whether the answer varies significantly. The activity asks the students to test two ideas: that changing the length of the pendulum changes its period, and also Galileo's idea that the period of a pendulum is independent of the amplitude. Discuss suggested approaches to this before students carry them out. Check that students have appreciated that it is important to vary one factor (one variable) only at a time.
- If time allows, students could carry out Workbook exercise 1.5 Testing your body clock in class.

Common misunderstandings and misconceptions

- As with measurements using instruments such as micrometers, students may believe that a digital reading to two decimal places must be accurate to this degree. You will need to discuss the uncertainty introduced by starting and stopping a timing device.

Homework ideas

- Coursebook questions 1.8 and 1.9
- End-of-chapter questions 1, 3, 5
- Workbook exercise 1.5 Testing your body clock

Teaching ideas

Chapter 2 Describing motion

Syllabus sections covered: 1.2 (part)

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
1.2 (part)	Understanding speed	2	Activity 2.1 Measuring speed Activity 2.2 Measuring speed in the lab Questions 2.1 to 2.7	Exercise 2.1 Measuring speed Exercise 2.2 Speed calculations Exercise 2.3 More speed calculations	
1.2 (part)	Distance–time graphs	1	Activity 2.3 Story graphs Question 2.8	Exercise 2.4 Distance–time graphs	
1.2 (part)	Understanding acceleration	1	Questions 2.9 to 2.11		Worksheet 2.1 Speed–time graphs
1.2 (part)	Calculating speed and acceleration	2	Questions 2.12 to 2.16	Exercise 2.5 Acceleration Exercise 2.6 Speed–time graphs	Worksheet 2.2 Acceleration problems
	Summing up		EOCQs 1 to 20		

Topic 1 Understanding speed

Coursebook section 2.1

Teaching ideas

- The idea of speed is a common one in everyday life. Ask students to name some things that move quickly and others that move slowly. These could include sportspeople, fictional characters, cars, animals, etc. Ask them to estimate their speeds. This should start you on a discussion of the units of speed.
- Ask what quantities we need to know to determine speed. If units have already been discussed, this can provide a clue. (Note that cars have speedometers that don't rely on measuring distance and time.)

- Carry out Activity 1 Measuring speed in a safe outdoor place. This will give practice in calculating speed, as well as measuring distance and time.
- Show how to measure speed using light gates or a similar electronic measuring system. Activity 2.2 Measuring speed in the lab gives practice in this. Students could measure the speed at the bottom of the ramp as a trolley runs down a slope at different angles. If they always release the trolley at the same height above the bench, they should find that the speed is roughly the same.
- Students will need to practise using the equation for speed, including rearranging it. The coursebook questions and workbook exercises can be used for this.
- Students should also be given practice in changing units such as kilometres, minutes and hours to metres and seconds.

Common misunderstandings and misconceptions

- Some students will struggle with rearranging the equation for speed. It may help them to think in terms of units rather than quantities.

Homework ideas

- Coursebook questions 2.1 to 2.7
- End-of-chapter questions 4, 6, 9, 10
- Workbook exercise 2.1 Measuring speed
- Workbook exercise 2.2 Speed calculations
- Workbook exercise 2.3 More speed calculations

Topic 2 Distance–time graphs

Coursebook section 2.2

Teaching ideas

- You could start by asking a student to walk across or around the room at a steady speed, then at a varying speed. On the board, sketch graphs of distance against time.
- Ask students what they can tell from the changing shape of the graph. They should recognise that a steeper line indicates faster movement (greater speed).
- Draw a graph and ask students to make up a story to match the shape. This should emphasise the importance of the slope of the graph.
- Activity 2.3 asks students to write a description for a graph. When you have a selection of graphs and descriptions, mix them up and ask students to match them up.

Common misunderstandings and misconceptions

- Some students will try to draw graphs which slope downwards (negative gradient). This is impossible for a distance –time graph, since distance travelled always increases (even if an object reverses its direction).

Homework ideas

- Coursebook question 2.8
- End-of-chapter questions 5, 7, 8

Topic 3 Understanding acceleration

Coursebook section 2.3

Teaching ideas

- This section starts off with a qualitative consideration of speed–time graphs in the same way that distance–time graphs were considered in the previous section. You could ask a student to describe their journey to school in terms of changing speed rather than distance, and sketch a graph as they do so. Point out the sections where speed is changing.
- Introduce the terms 'accelerating' and 'decelerating', meaning speeding up and slowing down. Remind students that we like to be quantitative in science so we use the term 'acceleration'.
- If your students have experienced fairground or theme park rides, they will be able to describe their experiences of accelerating suddenly.
- Now you can go on to look at some numerical examples, including the idea that the area under a speed–time graph gives the distance travelled. You could introduce this by showing a simple graph and dividing the area under the graph into vertical strips of width 1 s. Each represents the distance travelled in 1 s. Repeat this but with strips of, say, 5 or 10 s.
- If you have a ticker timer you can cut up a tape into sections with equal numbers of dots and place them side-by-side to show the same idea.
- Use the worked examples in the Coursebook to show how to find the area under graphs of different shapes.
- Students could solve question 2.11 in class.

Common misunderstandings and misconceptions

- You may be tempted to introduce acceleration as a quantity at this stage, but it is probably better to simply talk about accelerating and decelerating. Acceleration as a quantity appears in the next topic.
- Some students may think that a negative slope means going backwards; it doesn't, it means slowing down. Speed cannot be negative.

Homework ideas

- Coursebook questions 2.9 to 2.11
- End-of-chapter questions 1, 11, 12
- Worksheet 2.1 Speed–time graphs

Topic 4 Calculating speed and acceleration

Coursebook section 2.4

Teaching ideas

- In this section, the idea of acceleration is made quantitative. Students may have heard of accelerations described in terms of '*g*' or '*g*-forces'. You could explain that this is what pilots and astronauts experience when they are accelerating; it is why they are forced back into their seats.

- You could also start by considering the acceleration of a car or a runner. A sprinter can win a race simply by accelerating at a high rate at the start. How can we make this quantitative? A sprinter requires a big increase in speed in a short time. So

$$\text{acceleration} = \frac{\text{change in speed}}{\text{time taken}}$$

- Explain the equation and, by considering the units of speed and time, deduce the units of acceleration.
- Show how to calculate acceleration and also how to deduce values of change in speed and time from a speed–time graph.
- Students will need lots of practice with these ideas. Opportunities are provided by questions in the Coursebook, workbook exercises and Worksheet 2.2 Acceleration problems.

Common misunderstandings and misconceptions

- Students may struggle with rearranging the equation for acceleration. They may also struggle to make sense of the units m/s^2.

Homework ideas

- Coursebook questions 2.12 to 2.16
- End-of-chapter questions 2, 3, 13 to 20
- Workbook exercise 2.5 Acceleration
- Workbook exercise 2.6 Speed–time graphs
- Worksheet 2.2 Acceleration problems

Teaching ideas

Chapter 3 Forces and motion

Syllabus sections covered: 1.2 (part), 1.3, 1.5 (part), 1.6

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
1.5.1 (part)	We have lift-off	1 to 2	Questions 3.1 and 3.2	Exercise 3.1 Identifying forces Exercise 3.2 The effects of forces Exercise 3.3 Combining forces	Worksheet 3.1 Balanced forces
1.2 (part), 1.3	Mass, weight and gravity	1	Activity 3.1 Comparing masses Questions 3.3 and 3.4	Exercise 3.5 Mass and weight	
1.5.1 (part)	Falling and turning	1	Question 3.5	Exercise 3.6 Falling	
1.5.1 (part)	Force, mass and acceleration	2	Activity 3.2 *F*, *m* and *a* Questions 3.6 to 3.9	Exercise 3.4 Force, mass and acceleration	
1.6	The idea of momentum	2	Questions 3.10 and 3.11	Exercise 3.8 Momentum calculations	Worksheet 3.2 Impulse and momentum Worksheet 3.3 More on impulse and momentum
1.5.5	More about scalars and vectors	1	Question 3.12 EOCQs 1 to 19	Exercise 3.7 Vector quantities	
	~~Summing up~~		~~EOCQs 1 to 19~~		

Topic 1 We have lift-off

Coursebook section

Teaching ideas

- Students may already have met ideas about forces. You can open this topic by discussing what a force is (an interaction between two bodies) and considering how we represent forces using arrows.
- Students need to be able to identify different forces by name: these are shown in Figure 3.3 of the Coursebook. Workbook exercise 3.1 Identifying forces can be used here.
- You can also introduce the idea of the newton as the unit of force, and the way that forces combine to produce a resultant force. If the resultant force is zero, the forces are balanced – see Worksheet 3.1 Balanced forces.
- Students can practice adding up forces which are in the same straight line. Workbook exercise 3.3 Combining forces can be used here.

Common misunderstandings and misconceptions

- Many students will get confused between the forces acting on a body and the forces that the body exerts on other objects. To avoid this problem, it is simplest always to draw isolated objects with force arrows acting on them, rather than objects touching each other or in contact with the ground.
- There is no need to deal with Newton's third law here.

Homework ideas

- Workbook exercise 3.1 Identifying forces
- Workbook exercise 3.2 The effects of forces
- Workbook exercise 3.3 Combining forces
- Worksheet 3.1 Balanced forces

Topic 2 Mass, weight and gravity

Coursebook section 3.2

Teaching ideas

- Start by showing an object falling and asking what force pulls it downwards. Students may say 'gravity', which is correct, but the name of the force acting on the object is its weight.
- Ask how we know that the object accelerates as it falls. (It has no speed at the instant that it is released; it is very difficult to see it speeding up.) So gravity causes an object to accelerate. Figure 3.6 in the Coursebook shows a ball accelerating as it falls.
- Now you can define the acceleration due to gravity, *g*. You could discuss what difference you would see if the ball fell on the Moon. Students may have some odd ideas – see misconceptions below.
- Now you have to tackle the distinction between mass and weight. You could ask how to measure weight – use a forcemeter. The meter will be calibrated in newtons. This emphasises the nature of weight as a force.
- To measure mass, we have to compare two objects, one with its mass already given in kilograms. See Figure 3.7 in the Coursebook.

- Discuss how these quantities will change on the Moon. Mass won't change because the scales will still balance. There is no less matter in the object when it is on the Moon, although it will weigh less.
- Activity 3.1 Comparing masses should help to emphasise the nature of mass. The activity also asks students to decide how small a difference in masses they can detect when they hold two objects, one in each hand.

Common misunderstandings and misconceptions

- This entire topic concerns a misconception that students have to get to grips with, the difference between mass and weight.
- Students may think that a ball falls more slowly on the Moon because there is no atmosphere, or because the Moon does not spin. They may think it will not fall at all, but hover in 'mid-air'.

Homework ideas

- Coursebook questions 3.3 and 3.4
- Workbook exercise 3.5 Mass and weight

Topic 3 Falling and turning

Coursebook section 3.3

Teaching ideas

- This is a short topic looking at some of the effects of forces on motion. Start by dropping some different objects from high up – a feather, a sheet of paper, a crumpled sheet of paper, a piece of sponge, a toy person. Why do some fall faster than others? (Air resistance.)
- Can students suggest how to make the toy figure fall more slowly? Add a parachute.
- Ask students to sketch a speed–time graph for an object falling through air with air resistance. Then look at the slope of the graph and deduce how the acceleration is changing – it is decreasing. This shows that the resultant force is decreasing.
- You could now give students three drawings of a falling person with force arrows: weight unchanged on all three, air resistance small, medium and large, balancing weight. Can they use these to explain why the parachutist reaches a steady speed? (Can they explain why the weight arrow is of constant length?)
- The graph for a freefall parachute drop (Figure 3.10 in the Coursebook) can now be explained in terms of changing air resistance and greatly increased air resistance when the parachute opens. Ask students to draw force diagrams for different points in the fall. (You could provide a series of diagrams and ask students to put them in sequence.)
- Now you can consider the motion of an object following a curved path. An unbalanced force is needed to make the object follow the curve. Whirl an object around on the end of a piece of string. You will feel the need to pull inwards on the string. Let go so that there is no force; the object will no longer follow the curved path.

Common misunderstandings and misconceptions

- Students often think that, when a parachute opens, the falling person is jerked upwards. This is not true; the illusion comes from seeing films in which the cameraman continues to fall rapidly while the parachutist suddenly falls more slowly.
- Students are likely to predict that, when the force on an object moving in a circle is removed, it will fly directly outwards; it does not. It follows the tangent to the circle.

Homework ideas

- Workbook exercise 3.6 Falling
- If students have access to a digital camera (such as in a mobile phone), they could film objects falling under gravity and then watch the film in slow motion to check whether the object is moving at steady speed or accelerating.

Topic 4 Force, mass and acceleration

Coursebook section 3.4

Teaching ideas

- You could start by demonstrating the experiment (Activity 3.2) which shows the connection between force, mass and acceleration. However, many students find the experiment difficult to understand, so it is better to present the relationship first and then demonstrate it.
- It is helpful to think of mass as a measure of how difficult it is to start an object moving (i.e. to accelerate it). You could show a number of balls and ask students to put them in order, from easiest to push to hardest. Include some heavy balls such as bowling balls and medicine balls. They should deduce that the force needed to give a particular acceleration is proportional to mass.
- Now consider an individual ball. Most students will appreciate that, the greater the force applied, the greater the resulting acceleration.
- Combining these gives F proportional to ma. Explain that, by choosing our units carefully, we have $F = ma$. Use this equation to show that $1\text{ N} = 1\text{ kg m/s}^2$. It is important that students understand that SI units form a coherent set whose relationships are based on underlying physical relationships.
- Continue with Activity 3.2 F, m and a to show that the relationship (which you can call Newton's second law) is true.
- Students can practise using the relationship in Coursebook questions 3.6 to 3.9. (You may wish to go through Worked examples 3.1 and 3.2 with them.)

Common misunderstandings and misconceptions

- Students may think that it is weight that makes an object hard to accelerate. However, even where objects are weightless, an object with a large mass is difficult to accelerate. You may be able to show a film taken in the International Space Station which illustrates this.

Homework ideas

- Workbook exercise 3.4 Force, mass and acceleration
- You could ask students to devise their own problems involving $F = ma$ to test their partners.

Topic 5 The idea of momentum

Coursebook section 3.5

Teaching ideas

- The idea of momentum is approached through the idea of impulse of a force. The longer a force acts for, the greater its effect will be on the motion of a body. In other words, the more its velocity will change. Show the impulse equation and describe how it represents these ideas.
- From here, you can define momentum = mass × velocity. Go through Worked example 3.3, which uses these idea.
- Students can now try questions 3.10 and 3.11 in the Coursebook.
- Once students have the idea of momentum, you can show some examples of collisions. As is usual in physics, we reduce things to a manageable situation. Work in one dimension, perhaps with trolleys on a bench, or with a linear air track, or with marbles in a narrow channel. Students should come to appreciate that the outcome of a collision is predictable; for example, if one trolley strikes a stationary ball of the same mass and they stick together, they will move off with half the speed of the first one.
- Go through Worked example 3.4 to show how momentum is conserved in any collision, and how we can use this idea to solve problems.
- Students could work through the problems on Worksheet 3.2 Impulse and momentum and Worksheet 3.3 More on impulse and momentum to practise using the equations.

Common misunderstandings and misconceptions

- Students may have difficulty appreciating the vector nature of momentum. If an object bounces back in a collision, it has negative momentum.
- Avoid dealing with situations where an object collides with, say, a wall, since this involves an object that is attached to the Earth. It may appear that momentum has disappeared, but in fact it has been transferred to the Earth.

Homework ideas

- Workbook exercise 3.8 Momentum calculations
- Worksheet 3.2 Impulse and momentum
- Worksheet 3.3 More on impulse and momentum

Topic 6 More about scalars and vectors

Coursebook section 3.6

Teaching ideas

- Here, students learn about adding vector quantities. Remind them about how forces are added when they are in-line (Topic 1 above).
- Give a situation where forces are not co-linear. Figure 3.13 in the Coursebook shows a rocket acted on by a horizontal force and by its weight vertically downwards. Ask how it will move. (We can picture it having both horizontal motion and downward motion, both accelerated.) It will follow a curved path downwards.

- How can we combine these forces to find the resultant? Show how to add them using a vector triangle. Draw arrows head-to-tail, and complete the triangle to show the resultant. This is detailed in Worked example 3.5 in the Coursebook.
- Students can try Coursebook question 3.12 in class. This is about combining velocities rather than forces.

Common misunderstandings and misconceptions

- Students may try to combine dissimilar vectors, for example, force and acceleration, or acceleration and velocity.

Homework ideas

- End-of-chapter questions 1 to 19
- Workbook exercise 3.7 Vector quantities

Teaching ideas

Chapter 4 Turning effects of forces

Syllabus sections covered: 1.5.2, 1.5.3

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
1.5.2 (part) 1.5.3 (part)	The moment of a force	1	Activity 4.1 Balancing Questions 4.1 and 4.2	Exercise 4.1 Turning effect of a force	
1.5.2 (part), 1.5.3	Calculating moments	2	Activity 4.2 A question of balance Questions 4.3 and 4.4	Exercise 4.2 Calculating moments	Worksheet 4.1 Balancing problems
1.5.2 (part)	Stability and centre of mass	2	Activity 4.3 Centre of mass of a plane lamina EOCQs 1 to 10	Exercise 4.3 Stability and centre of mass Exercise 4.4 Make a mobile	
	Summing up		EOCQs 1 to 10		

Topic 1 The moment of a force

Coursebook section 4.1

Teaching ideas

- You could start by discussing some of the ideas shown in Figures 4.2 to 4.4 of the Coursebook. These include door handles, crowbars, wheelbarrows and seesaws. Demonstrate them if you can. Ask where the forces are acting, and their directions.
- Ask students how to maximise the effect of the force. Students should be able to suggest applying the force at the end of the lever – that is, as far as possible from the pivot. Identify the pivot as the stationary point about which the force has its turning effect.
- Go on to introduce the idea of equilibrium, in the simple sense that there is no resultant force on an object and the moments of forces also cancel out.
- Although this section is not mathematical, students can carry out Activity 4.1 Balancing to deduce the idea that the quantity force ´ distance from pivot is important.

Common misunderstandings and misconceptions

- While it is possible to calculate the moment of a force about any point, it is simplest here to think about the turning effect of a force about a fixed pivot.

Homework ideas

- Coursebook questions 4.1 and 4.2
- Workbook exercise 4.1 Turning effect of a force

Topic 2 Calculating moments

Coursebook section 4.2

Teaching ideas

- Now you can make the idea of turning effect quantitative by defining moment in terms of force and distance from the pivot.
- Discuss the idea that a force must be at right angles to a lever to have maximum turning effect. This leads to the idea that it is the perpendicular distance of the force from the pivot that counts. You could refer back to question 4.1 in the Coursebook.
- Try lifting one end of a heavy beam using a forcemeter. Ask students to predict: which angle requires the least force? You could try the same thing using a forcemeter to pull a heavy door open.
- Worked example 4.1 shows how to deduce an unknown force by calculating moments. Emphasise the need to decide whether each force has a clockwise or anticlockwise turning effect.
- Figure 4.7 shows a beam with its weight and the contact force of the pivot on the beam shown explicitly. Because they both act through the pivot, they have no moment about the pivot. Workbook exercise 4.2 Calculating moments has a variety of problems for practice.
- Activity 4.2 A question of balance asks students to balance a beam, but first they must calculate moments to determine weights and distances. The experiments are thus tests of the principle of moments.
- The second experiment involves a beam that is not balanced at its midpoint, so that its weight has a turning effect about the pivot.

Common misunderstandings and misconceptions

- Many students struggle to decide whether the turning effect of a force about a pivot is clockwise or anticlockwise. Encourage them to twist their hand as if to follow the force as it causes the beam to turn.
- Don't be tempted to draw curved force arrows, but you could add an extra curved arrow to show which way a force is tending to turn the beam.

Homework ideas

- Coursebook questions 4.3 and 4.4
- Worksheet 4.1 Balancing problems

Topic 3 Stability and centre of mass

Coursebook section 4.3

Teaching ideas

- You could start by showing the 'magic can' balancing trick. Show that you can balance a drink can on a point on its rim. Challenge a student to do the same with a second can. The trick is to have your can partly filled with water so that its centre of mass is low. This makes it much easier to balance (but requires some practice before your students see the trick). An internet search will find many other balancing 'tricks'.
- Discuss the idea of centre of mass – the point at which we can consider the mass of an object to act. (At this level, there is no distinction to be drawn between centre of mass and centre of gravity.) Show how a tall, thin object will topple more easily than a short fat one – Figure 4.9 in the Coursebook shows an example. Make a two-dimensional cut-out of a wine glass like that shown in the figure, mark its centre of mass, and explain that it tips over when its weight lies outside its base area.
- Ask for other examples of objects that have a low centre of mass and a wide base for stability, and others that are unstable because of their high centre of mass and narrow base. (Humans are an interesting example of the latter; our bodies are constantly adjusting to ensure that we do not fall over when we are standing, walking or running.)
- Activity 4.3 asks students to find the centre of mass of a lamina. Ensure that they understand why the lamina hangs so that its centre of mass is below the point of suspension. Discuss why it is better to use three points of suspension rather than two. (The third acts as a check on the other two.)
- Coursebook questions 4.5 and 4.6 require students to use these ideas.

Common misunderstandings and misconceptions

- Some students will be familiar with the term 'centre of gravity'. You can say that this is the the same as centre of mass. (At this level, there is no distinction between the two.)

Homework ideas

- End-of-chapter questions 1 to 10
- Workbook exercise 4.3 Stability and centre of mass
- Workbook exercise 4.4 Make a mobile
- Ask students to find examples of balancing 'tricks' that they can demonstrate to the class.

Teaching ideas

Chapter 5 Forces and matter

Syllabus sections covered: 1.5.1 (part), 1.8

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
1.5.1 (part)	Forces acting on solids	1			
1.5.1 (part)	Stretching springs	2	Activity 5.1 Investigating springs Questions 5.1 and 5.2	Exercise 5.1 Stretching a spring	
1.5.1 (part)	Hooke's law	2	Activity 5.2 Stretching rubber Questions 5.3 to 5.5	Exercise 5.2 Stretching rubber	Worksheet 5.1 Stretching rubber
1.8	Pressure	1	Activity 5.3 Pressure experiments Questions 5.6 to 5.8		Activity 5.3 Pressure experiments
1.8	Calculating pressure	1	Questions 5.9 to 5.15 EOCQs 1 to 16	Exercise 5.3 Pressure	
	~~Summing up~~		~~EOCQs 1-16~~		

Topic 1 Forces acting on solids

Coursebook section 5.1

Teaching ideas

- This introductory section presents the idea that forces can alter the shape and size of solid objects. You could start by showing some modelling clay and asking how you could change its shape. Demonstrate stretching and compressing, bending and twisting. Ask students if they can draw diagrams to show how the forces act for each of these changes (see Figure 5.1 in the Coursebook).
- Discuss some everyday examples of deformation of solids, for example, the denting of a car body in a crash.
- You could introduce the idea that some deformations are permanent whilst others reverse themselves when the forces are removed – this is elasticity.

Common misunderstandings and misconceptions

Homework ideas

- Ask students to gather examples of people whose work involves deforming solid materials (metal-workers, cooks, etc.). they could also give examples of sporting activities that involve deformation of materials.

Topic 2 Stretching springs

Coursebook section 5.2

Teaching ideas

- This section looks at the deformation of a spring without formalising the ideas as Hooke's law. You could show a long spring and stretch it. Ask students how they would investigate the pattern of its stretching – what quantities should be measured, and how?
- Show how to hang a spring and increase the load on it. Figure 5.5 in the Coursebook shows the pattern. Explain that it is the extension that we are interested in, and how to calculate this.
- Students carry out Activity 5.1 Stretching springs. Before they start, point out that the care that they take will be reflected in the quality of their graph. You can compare good and bad graphs at the end.
- Students may also need help in tabulating their data (see Table 5.1 in the Coursebook). A table is useful for repetitive calculations like calculating the extension values. An alternative would be to use a spreadsheet. Coursebook question 5.2 gives practice with this.

Common misunderstandings and misconceptions

- Students may think that extension means increase in length from one reading to the next, rather than from the unloaded original length.

Homework ideas

- Coursebook questions 5.1 and 5.2
- Workbook exercise 5.1 Stretching a spring

Topic 3 Hooke's law

Coursebook section 5.3

Teaching ideas

- Start by looking at a load–extension graph from the previous topic. You may have to explain the idea of proportionality and how it relates to a straight-line graph.
- Introduce the equation $F = kx$. You could give students an example to calculate and graph (e.g. $F = 0.60x$) to convince them that such an equation corresponds to a straight line through the origin.
- Check that students have added sufficient load to exceed the elastic limit, where the spring becomes permanently deformed.
- Activity 5.2 involves students in stretching and releasing rubber. They will need to work carefully if they are to see the difference between loading and unloading.
- Worksheet 5.2 Stretching rubber is a data analysis exercise related to this.

Common misunderstandings and misconceptions

- For some students, Hooke's law may seem either obvious or dull. Point out that it is not obvious – it took many people's efforts before it was discovered. Also, it was important because it was discovered at a time when people were looking for ways to use springs in machinery so it was important to know how they behaved (see Figure 5.8 in the Coursebook).

Homework ideas

- Coursebook questions 5.3 to 5.5
- Worksheet 5.2 Stretching rubber

Topic 4 Pressure

Coursebook section 5.4

Teaching ideas

- This section takes a qualitative look at pressure. You could start by talking about the everyday meaning of the word 'pressure' and go on to explain the scientific meaning.
- Another approach would be to discuss atmospheric pressure and how it varies, giving us changes in weather. Show an aneroid barometer.
- Activity 5.3 Pressure experiments includes some suitable demonstrations to show the effects of pressure in fluids. Students should be asked to identify the surface that pressure is acting on, and its direction.
- You could also demonstrate a manometer; explain how it can be used to show pressure differences. (It is not necessary to use mercury for this; water and oil are fine.)
- If your students already have the idea that fluids are made up of moving particles, you could ask them to explain how fluids exert pressure in terms of these particles.
- Coursebook questions 5.7 and 5.8 require students to use these ideas.

Common misunderstandings and misconceptions

- Some students may think that pressure only acts downwards. They should appreciate that pressure acts in all directions in a fluid. Inflate a balloon – it bulges in all directions.

Homework ideas

- Coursebook questions 5.6 to 5.8
- Students could find out the value of pressure in car tyres, cycle tyres, etc. in preparation for the next topic.

Topic 5 Calculating pressure

Coursebook section 5.5

Teaching ideas

- Having established above that pressure acts on an area, go on to present the equation that defines pressure, as well as the SI units of pressure. (You might wish to mention some other units which students may come across.)
- Work through Worked example 5.2 to show how the equation is used. Make sure that students can rearrange the equation. Coursebook questions 5.9 to 5.13 use these ideas.

- Now go on to consider how we can calculate pressure at depth h in a fluid. It is easiest to start with water in a tank or swimming pool. At the bottom of the pool, there is a large weight of water pressing down from above. The weight of water causes the pressure on the bottom.
- If your students are mathematically competent, you can derive the equation $p = h\rho g$. (Coursebook question 5.15 follows the logic of this derivation.) This will emphasise the fact that pressure in a fluid arises from the weight of fluid above. However, it is important to stress that the pressure acts in all directions, not just downwards.
- It is also useful to talk about atmospheric pressure as arising from the weight of air above us. When solving problems, students should try to identify the fluid above any particular point or level, pressing downwards.
- As in Topic 4, it can help to relate pressure to the collision of particles in a fluid with the surfaces with which it is in contact.

Common misunderstandings and misconceptions

- See above for a discussion of the direction of pressure in a fluid.

Homework ideas

- Coursebook questions 5.9 to 5.15
- End-of-chapter questions 1 to 16
- Workbook exercise 5.3 Pressure

Teaching ideas

Chapter 6 Energy transformations and energy transfers

Syllabus sections covered: 1.7.1, 1.7.2 (part)

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
1.7.1 (part)	Forms of energy	1	Questions 6.1 to 6.7	Exercise 6.1 Recognising forms of energy	
1.7.1 (part)	Energy conversions	1	Activity 6.1 Energy conversions Question 6.8		Worksheet 6.1 Energy conversions
1.7.1 (part) 1.7.2 (part)	Conservation of energy	1	Questions 6.9 to 6.14	Exercise 6.2 Energy efficiency	
1.7.1 (part) 1.7.2 (part)	Energy calculations	2	Activity 6.2 Running downhill Questions 6.15 to 6.21	Exercise 6.3 Energy calculations	
	Summing up		EOCQs 1 to 13		

Topic 1 Forms of energy

Coursebook section 6.1

Teaching ideas

- In this section, students learn to identify energy in its many guises. You could show a lump of coal or a battery. How do we know it has energy? Burn the coal, use the battery in a circuit. These are energy stores. We only know there is energy there when it changes.
- You could talk through the examples of energy changes at the start of Chapter 6 in the Coursebook. Then you could show some other stores and build up a list. Some situations involve energy being transferred from place to place. Try to build up a list like the one shown in Table 6.1 of the Coursebook.
- Students could try Coursebook questions 6.1 to 6.7 in class. Discussing the answers will help to establish the ideas more clearly.
- Workbook exercise 6.1 could also be used here.

Common misunderstandings and misconceptions

- Students will have many different preconceptions relating to the idea of energy. For example, they will think that a lump of coal has no energy because it is not hot. They may know that uranium is warm, but this is a sign that it is losing energy.
- Students may talk about energy being 'used up'. This is acceptable if it relates to a store of energy which can be depleted, but, as discussed in Topic 3, we know that energy is conserved. You will probably wish to deal with this later.

Homework ideas

- Coursebook questions 6.1 to 6.7
- Workbook exercise 6.1

Topic 2 Energy conversions

Coursebook section 6.2

Teaching ideas

- We mostly notice energy when it is changing. This section deals with energy conversions. You could start with the example of a rocket launch, as described in the Coursebook.
- Discuss the Sankey diagram shown in Figure 6.7 in the Coursebook. Have your students identified all of the energy changes involved in the rocket launch?
- Note that a Sankey diagram implicitly assumes that energy is conserved. See the next topic.
- Activity 6.1 Energy conversions asks students to examine some devices and to describe the energy changes taking place. They could test their answers against those of others in the class.

Common misunderstandings and misconceptions

- Some students may think that a battery stores electrical energy. However, it is a chemical store. Electrical energy is transferred by the wires when a circuit is complete.

Homework ideas

- Coursebook question 6.8
- Workbook exercise 6.1 Energy conversions
- Students could describe a scene (e.g. a room at home) in terms of the energy changes taking place.
- In preparation for the next topic, students could look at food labels to see stored energy values; they could also look at advice on energy intake for different sorts of people.

Topic 3 Conservation of energy

Coursebook section 6.3

Teaching ideas

- Now we have to quantify the idea of energy. Give the unit: the joule. You could look at some food wrappers to see values of stored energy.
- Return to Sankey diagrams (Figures 6.9 and 6.10 in the Coursebook). Students should be able to see that the total amounts of energy before and after a change are the same. Explain the principle of conservation of energy. This may puzzle students – surely energy gets used

up? Draw attention to the forms of energy after the change, compared with before. Some energy is made use of while some is wasted. So, although energy is conserved, it is less useful after the change.

- This can act as an introduction to the idea of energy efficiency. What fraction of the original energy do we make good use of?
- Ask students to think of places where energy is wasted, and why this is a bad thing. It is bad because it wastes money and resources and pollutes the environment.
- Students could tackle Coursebook questions 6.9 to 6.14 and discuss the answers.

Common misunderstandings and misconceptions

- Some students, despite the assertion of the principle conservation of energy, will cling to the idea that this is only an approximate rule and that in fact the total amount of energy always decreases a bit. They may think that, with good insulation, for example, we could reduce the amount of energy that disappears. This is all incorrect; every joule of energy can be accounted for after a change.

Homework ideas

- Coursebook questions 6.9 to 6.14
- Workbook exercise 6.2 Energy efficiency
- Students could find data concerning energy efficiency of different electrical appliances. They could also find out about how householders can make more efficient use of the energy supplied to their homes.

Topic 4 Energy calculations

Coursebook section 6.4

Teaching ideas

- Energy is a quantity. It cannot be measured directly; it has to be calculated from measurements such as temperature, mass, speed, height, etc. So in this section we look at calculations of k.e. and g.p.e. You could place different objects around the room at different heights and ask students to judge which has the greatest or least gravitational potential energy. Show a student lifting objects of different masses to different heights.
- Students should deduce that g.p.e. depends on mass and height. (Note that we are implicitly using the idea of doing work, covered in Chapter 8.)
- Give the formula for g.p.e. What does it suggest about g.p.e. on the Moon? Worked example 6.1 shows how to use the formula.
- Continue with the idea of kinetic energy. How can we increase an object's k.e.? (Make it go faster.)
- Give the formula for k.e. Worked example 6.2 shows how to use this.
- Activity 6.2 is an excuse for calculations of g.p.e. and k.e. Students will find that energy is lost, presumably as heat and sound.
- Questions 6.15 to 6.22 will give practice with these equations and ideas.

Common misunderstandings and misconceptions

- Some students may be tempted to think that energy is a vector quantity – k.e. in a particular direction, g.p.e. upwards. Energy is a scalar.
- Some students will have difficulty calculating k.e. because of the square of v. They should start by calculating v^2, then multiply by $\frac{1}{2}m$.

Homework ideas

- Coursebook questions 6.15 to 6.22
- End-of-chapter questions 1 to 13
- Workbook exercise 6.3 Energy calculations

Teaching ideas

Chapter 7 Energy resources

Syllabus sections covered: 1.7.2 (part)

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
1.7.2 (part)	The energy we use	3	Questions 7.1 to 7.7	Exercise 7.1 Renewables and non-renewables Exercise 7.2 Wind energy	Worksheet 7.1 Solar cells
1.7.2 (part)	Energy from the Sun	1	Question 7.8	Exercise 7.3 Energy from the Sun	Worksheet 7.2 Renewables versus non-renewables Worksheet 7.3 Future energy
	Summing up		EOCQs 1, 2 3 to 5, 6, 7, 8		

Topic 1 The energy we use

Coursebook section 7.1

Teaching ideas

- In this topic, you need to build up a picture of all the available energy resources that we can draw on. Start by considering energy resources with which students are familiar. These can include fuels, sunlight, wind, etc.
- Electricity may be suggested; this is a resource that is derived from other resources and is probably best left until later in the topic.
- Figure 7.2 in the Coursebook is a pie chart that shows world use of energy resources. Similar charts are available for most countries; it would be a good idea to compare energy resources for your country with this world chart.
- You may also be able to find data for your country on how these resources are used. What proportions are used for transport, industry, heating, etc.? This could be a research activity for students.
- Now you can go on to build up a picture of how different resources are made use of. The Coursebook starts by considering how sunlight is used. You could show how sunlight causes warming of water, as in a solar panel. You could also demonstrate how solar cells generate electricity to drive, for example, a small electric motor.

- Continue with wind and wave power. Demonstrate a turbine turning a generator to produce electricity.
- Move on to fuels. Biomass is familiar from the burning of wood; students can research the development of biomass crops and the controversy around this – are these crops displacing food crops?
- Continue with fossil fuels. Point out that, in developed countries, most of the human environment has been produced by the use of fossil fuels, which are extremely concentrated stores of energy (compared to, say, wind energy or sunlight). It is interesting to note that, when a car is being refuelled, the driver may be transferring 1 litre per second of fuel to the tank. This has about 50 MJ of energy, so the rate of energy transfer is about 50 MW, similar to a small power station.
- Students could research the use of fossil fuels in their own countries. Where do they come from and what are they used for?
- You can continue in this way, adding nuclear fuels, water power and geothermal energy to the mix.
- You can also introduce the idea of renewable resources. Look back to the chart (Figure 7.2) and you will see that less than 20% of the energy resources used worldwide are renewable.
- To develop and test students' understanding of these ideas, they should research and make presentations on one or more energy resources, commenting on cost, reliability, scale and environmental impact. Worksheet 7.1 Solar cells looks at these aspects of solar cells.

Common misunderstandings and misconceptions

- There is a danger that students will start to think that they are being introduced to some new 'forms of energy', as in the previous chapter. 'Wind energy', for example, is not a form of energy. You could discuss how each energy resource can be understood in terms of forms of energy (wind energy is the kinetic energy of moving air, etc.).

Homework ideas

- Coursebook questions 7.1 to 7.7
- End-of-chapter questions 1, 3 to 5, 7 and 8
- Workbook exercise 7.1 Renewables and non-renewables
- Workbook exercise 7.2 Wind energy
- Worksheet 7.1 Solar cells

Topic 2 Energy from the Sun

Coursebook section 7.2

Teaching ideas

- In the previous topic, you established a range of energy resources. Now you can discuss how most of them can be traced back to energy from the Sun. For example, students are likely to be familiar with the water cycle, which will help them to understand how the Sun's energy is the source of hydroelectricity.
- Ask your students to draw 'energy chains' showing how energy is transformed, starting with heat and light from the Sun and ending up as, say, the kinetic energy of a car, or the sound of music in their ears.

- You can now introduce the idea that energy is released in the Sun by the process of nuclear fusion. Think of the Sun when it formed, a cloud of gas collapsing under its own gravitational pull. The particles move faster and faster and collide more and more often, eventually sticking together to form heavier elements. Without nuclear fusion we wouldn't be here.
- Students could research the efforts being made to develop fusion reactors that would harness this energy resource here on Earth.

Common misunderstandings and misconceptions

- As in the previous topic, students should be discouraged from imagining that 'solar energy' is a form of energy in the same way that k.e., g.p.e., etc. are.

Homework ideas

- Coursebook question 7.8
- End-of-chapter questions 2 and 6
- Worksheet 7.2 Renewables versus non-renewables
- Worksheet 7.3 Future energy
- Workbook exercise 7.3 Energy from the Sun

Teaching ideas

Chapter 8 Work and power

Syllabus sections covered: 1.7.3, 1.7.4

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
1.7.3 (part)	Doing work	1	Questions 8.1 and 8.2	Exercise 8.1 Forces doing work, transferring energy	
1.7.3 (part)	Calculating work done	3	Activity 8.1 Doing work Questions 8.3 to 8.7	Exercise 8.2 Calculating work done Exercise 8.3 Measuring work done	
1.7.4 (part)	Power	1	Question 8.8		
1.7.4 (part)	Calculating power	2	Activity 8.2 Measuring your power Questions 8.9 to 8.12	Exercise 8.4 Power	Worksheet 8.1 Calculating work and power
	Summing up		EOCQs 1 to 12		

Topic 1 Doing work

Coursebook section 8.1

Teaching ideas

- In this topic, you are developing the qualitative idea of doing work, including the idea that the bigger the force and the further it moves, the greater the amount of work done and energy transferred.
- Start by asking a student to lift a modest load from the ground on to the bench. Ask another student to lift a heavier load on to a higher level.
- Ask them to describe what they are doing in terms of forces. Then ask them to describe what they are doing in terms of energy. Who uses the greater force? Who transfers most energy? How can you tell?
- Explain that, in science, we say that they are doing work. Or better, that the force they apply is doing work and transferring energy to the load. So doing work = transferring energy using a force.

- Discuss some more examples, such as those given in the Coursebook (Figure 8.2).
- It is important to emphasise that the term 'work' in science has a more specific sense than in everyday life. A student may feel that they are doing work and using energy simply by holding a heavy load. It is true that their body uses energy to do this, but no energy is being transferred to the load.
- You could end with a discussion of activities in a gym. How is work done during press-ups or weight-lifting? How can the amount of work done be increased?

Common misunderstandings and misconceptions

- See above for a comment on the everyday meaning of 'work'.

Homework ideas

- Coursebook questions 8.1 and 8.2
- Workbook exercise 8.1 Forces doing work, transferring energy
- Students could write a description of everyday activities making specific reference to forces, work done and energy transferred.

Topic 2 Calculating work done

Coursebook section 8.2

Teaching ideas

- Since work depends on force and distance moved, it should seem logical to students that the two quantities are multiplied together to give the amount of work done (and so energy transferred). You can argue this as follows:
- For each metre an object is raised, it gains the same amount of energy, so work done is proportional to distance moved.
- Imagine lifting an object of weight 10 N. This is equivalent to lifting 10 objects each weighing 1 N. So 10 times as much work is done.
- Use Worked example 8.1 to show how the equation is used.
- Go on to discuss examples (Figure 8.4 in the Coursebook) of situations where no work is done because there is no movement in the direction of the force. Worked example 8.2 emphasises how to choose the correct forces and directions. It can also be used to revisit the idea of energy efficiency introduced in Chapter 6 of the Coursebook.
- Activity 8.1 is a simple activity that requires students to make measurements and calculate work done. It includes some suggestions for extension work which can reinforce the idea of doing work.

Common misunderstandings and misconceptions

- As discussed in Topic 1, students need to be clear that their personal experiences are not a good guide to when work is being done. Holding a heavy object above your head takes energy, but no work is being done.
- Students also need to clearly identify the force that is doing work and the distance moved in the direction of the force. It can help if you ask them to draw before and after diagrams, showing force arrows and distances.

Homework ideas

- Coursebook questions 8.3 to 8.7
- Workbook exercise 8.2 Calculating work done
- Workbook exercise 8.3 Measuring work done

Topic 3 Power

Coursebook section 8.3

Teaching ideas

- This is a short topic on the qualitative idea of power. Introduce the idea that power is a measure of the rate at which energy is transferred. You could return to the idea of a gym; the faster you lift weights or the more press-ups you do per minute, the greater the power involved.
- Although students following the Core specification do not have to treat work and power quantitatively, they could try Activity 8.2 Measuring your power at this stage.

Common misunderstandings and misconceptions

- 'Power' is another word with multiple meanings. In everyday life, when we think of someone as powerful, it has the sense of potential; they might take action. In science, power is active and describes energy being transferred. There is no power involved when objects and forces are stationary.

Homework ideas

- Coursebook question 8.8
- End-of-chapter questions 1 to 3, 6, 7, 11

Topic 4 Calculating power

Coursebook section 8.4

Teaching ideas

- Now you can go on to introduce the idea of power as a quantity calculated as work/time or energy/time.
- Give the SI unit (W). (This will be revisited later in the chapters on electricity.)
- Some students will find it helpful if you show how the units of power and energy are related to the SI base units m, kg and s.
- Worked example 8.3 shows how to use the equation for power. You may need to help students with rearrangements of the equation, to find energy and time. Coursebook questions 8.9 to 12 use these relationships.
- Worksheet 8.1 Calculating work and power has some more examples for practice.

- Activity 8.2 shows one way to measure a student's power. It should reinforce the ideas of this chapter and give practice in calculating work and power. Its results are not very reliable, but you should find that the most energetic students can develop powers of several hundred watts for a short time.
- You could finish by relating these ideas to the idea of food as our energy source. A typical student might consume 10 MJ per day, which is about 10^5 s, so their average power is about 100 W. Most of this is required for maintaining bodily processes including the brain (20 W).

Common misunderstandings and misconceptions

- See Topic 3 above for a comment on the word 'power'.

Homework ideas

- Coursebook questions 8.9 to 8.12
- End-of-chapter questions 4, 5, 8 to 10, 12
- Workbook exercise 8.4 Power
- Worksheet 8.1 Calculating work and power

Teaching ideas

Chapter 9 The kinetic model of matter

Syllabus sections covered: 2.1

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
2.1.1	States of matter	1	Activity 9.1 Measuring melting point Questions 9.1 to 9.6	Exercise 9.1 Changes of state	
2.1.2	The kinetic model of matter	2	Activity 9.2 Observing Brownian motion Questions 9.7 to 9.10	Exercise 9.2 The kinetic model of matter Exercise 9.3 Brownian motion	
2.1.3	Forces and the kinetic theory	1	Activity 9.3 Using the kinetic model Questions 9.11 to 9.13		
2.1.4	Gases and the kinetic theory	2	Questions 9.14 to 9.20 EOCQs 1 to 16	Exercise 9.4 Understanding gases Exercise 9.5 Boyle's law	Worksheet 9.1 Pressure and volume of a gas

Topic 1 States of matter

Coursebook section 9.1

Teaching ideas

- Students have probably met the idea of the three states of matter previously. You could give them a list of descriptions as in Table 9.1 of the Coursebook and ask them to decide which applies to which state.
- You could also get them to construct a diagram like Figure 9.2, given the terms 'melting', etc.
- Figure 9.3 in the Coursebook is schematic but also very important. Ask students about the steps in the graph – what does it tell them about the temperature while a substance is changing state?
- The experiment of Activity 9.1 is interesting because students often try to force their temperature readings to decrease at a steady rate, even when the temperature is no longer falling. This can form a valuable lesson on the need to record data accurately.
- Coursebook questions 9.1 to 9.6 test all of these ideas.

Common misunderstandings and misconceptions

- Given melting and boiling points, many students still find it difficult to determine whether a substance will be solid, liquid or gas at a particular temperature.

Homework ideas

- Coursebook questions 9.1 to 9.6
- Workbook exercise 9.1 Changes of state

Topic 2 The kinetic model of matter

Coursebook section 9.2

Teaching ideas

- The kinetic (particle) model of matter is extremely powerful and allows us to understand a wide range of phenomena. Students will have the idea that matter is made of 'atoms'. You could start by challenging them to use the idea of particles to explain what happens when ice melts, or when a puddle of water evaporates. Their answers will reveal a lot about what they understand already.
- Go on to set out the basic ideas of the kinetic model. Describe the arrangements of particles and how they move.
- Explain that we need evidence to support any such model, and this is provided by Brownian motion. Demonstrate this using polymer beads in water or smoke particles in air. This is such a fundamental observation that every student should see it.
- Check that your students understand what they are seeing and how the particle model explains it.
- Ask your students to use the kinetic model to explain different phenomena. Why can we move through air and water but not through wood? What happens when solid sugar dissolves in water? There are several other phenomena referred to in the coursebook.
- Workbook exercises 9.2 and 9.3 will reinforce these ideas.

Common misunderstandings and misconceptions

- Many students will imagine that there is something more than particles which make up matter – perhaps there is air in between, or some other fluid. They may imagine that particles can change size and shape as the temperature varies, or perhaps even disappear entirely. You should stress that there are particles and the forces between them, and nothing else.

Homework ideas

- Coursebook questions 9.7 to 9.10
- Workbook exercise 9.2 The kinetic model of matter
- Workbook exercise 9.3 Brownian motion

Topic 3 Forces and the kinetic theory

Coursebook section 9.3

Teaching ideas

- In this section, we think about the forces between particle. Show how you can break a thin piece of wood or a stick of chalk. You are separating adjacent particles by overcoming the forces between them. Ask if students can name a material with much stronger forces than chalk (steel, for example).
- If students have learned about bonding in chemistry, you can bring in these ideas here.
- Figure 9.8 in the Coursebook shows what happens when a gas condenses, in terms of the particles. At first, they are moving around rapidly so they do not readily stick together. At a lower temperature, they stick and clump together to form a liquid.
- Go on to consider evaporation in more detail. Now you can bring in ideas about the energy of a particle. Some particles have more energy than others and so can escape more readily; this explains the cooling effect of evaporation.
- Activity 9.3 will test your students' ability to devise explanations using the kinetic model. Unfortunately, it is difficult to find marbles that will stick together so we cannot model the intermolecular forces. However, students can answer the questions using the marbles to illustrate their ideas.
- Coursebook questions 9.11 to 9.13 can be used to sum this up.

Common misunderstandings and misconceptions

- As before, ensure that students do not have the idea that there is something in between the particles of a gas.

Homework ideas

- Students could write up some of the explanations from Activity 9.3.
- Coursebook questions 9.11 to 9.13

Topic 4 Gases and the kinetic theory

Coursebook section 9.4

Teaching ideas

- As an introduction to thinking about gases, students need to understand the concepts of pressure and temperature and how these relate to the kinetic model. You can ask your students to act as particles and show various effects: higher temperature means faster; pressure arises from collisions with walls; compressing a gas means more frequent collisions, and so on.
- Students could answer Coursebook questions 9.14 to 9.16 in pairs and present their answers to the class. Then they could write improved answers having heard a number of attempts.
- Now you can go on to consider Boyle's law. Demonstrate this with whatever apparatus you have. Alternatively, Worksheet 9.1 gives some suitable data (and there is more in Table 9.5 of the Coursebook).
- To analyse the data, students can calculate pressure × volume, and they can plot pressure against volume. Explain how to read the sketch graphs relating pressure and volume (Figure 9.13 in the Coursebook).
- Worked example 9.1 shows how to use the equation $p_1V_1 = p_2V_2$.
- Coursebook questions 9.17 to 9.20 can be used to check that your students have grasped these ideas, as can Workbook exercises 9.3 and 9.4.

Common misunderstandings and misconceptions

- The relationship between pressure and volume is one of inverse proportionality. Students may struggle with the mathematical representations of this, and with graphs with $1/V$ on one axis. They usually find the equation $p_1V_1 = p_2V_2$ more memorable.

Homework ideas

- Coursebook questions 9.14 to 9.20
- End-of-chapter questions 1 to 16
- Workbook exercise 9.4 Understanding gases
- Workbook exercise 9.5 Boyle's law
- Worksheet 9.1 Pressure and volume of a gas

Teaching ideas

Chapter 10 Thermal properties of matter

Syllabus sections covered: 2.2

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
2.2.2 (part)	Temperature and temperature scales	1	Activity 10.1 Calibrating a thermometer Questions 10.1 to 10.3	Exercise 10.1 Energy and temperature	
2.2.2 (part)	Designing a thermometer	1	Questions 10.4 and 10.5	Exercise 10.2 Calibrating a thermometer	Worksheet 10.1 Understanding thermometers
2.2.1	Thermal expansion	2	Activity 10.2 Observing expansion Questions 10.6 and 10.7	Exercise 10.3 Thermal expansion Exercise 10.4 Demonstrating thermal expansion	
2.2.3 (part)	Thermal capacity	1	Questions 10.8 and 10.9		
2.2.3 (part)	Specific heat capacity	2	Activity 10.3 Measuring s.h.c. Questions 10.10 to 10.12		
2.2.4	Latent heat	2	Activity 10.4 Measuring the specific latent heat of fusion of ice Questions 10.13 to 10.15 EOCQs 1 to 12		

Topic 1 Temperature and temperature scales

Coursebook section 10.1

Teaching ideas

- Ask students about when they have experienced thermometers in use. They should name some different types and uses.
- Ask: Why might you have to wait before taking the reading? The thermometer sensor must reach the same temperature as the object, i.e. thermal equilibrium is reached.

- Students may take thermometer scales for granted so it is useful for them to perform Activity 10.1 Calibrating a thermometer. This should emphasise the idea of fixed points with an interpolated scale.
- Coursebook questions 10.1 to 10.3 sum up these ideas.

Common misunderstandings and misconceptions

- It is easy to confuse temperature and internal energy (sometimes confusingly known as 'heat'). Temperature doesn't depend on the amount of matter being considered. You only have to sample a system to find its temperature. Workbook exercise 10.1 Energy and temperature should help to separate these ideas.

Homework ideas

- Coursebook questions 10.1 to 10.3
- Workbook exercise 10.1 Energy and temperature

Topic 2 Designing a thermometer

Coursebook section 10.2

Teaching ideas

- This topic looks at thermometer design (including range and sensitivity), and two less familiar types of thermometer.
- Show the class a number of thermometers. Ask how they differ. Why might one be better than another for a particular job? You are trying to establish the ideas of range and sensitivity.
- Go on to show any electrical thermometers you have available. (Students may be familiar with electrical thermometers in cars and in domestic appliances such as fridges.)
- If possible, show a simple thermocouple (as in Figure 10.6 of the Coursebook). A thermocouple generates a voltage directly while a resistance thermometer requires a source of voltage.
- Worksheet 10.1 Understanding thermometers can be used to test these ideas.

Common misunderstandings and misconceptions

- Students often assume that, because a thermometer or other instrument gives a reading, its must be correct. You could compare a number of thermometers all used to take the temperature of a beaker of water; do they all show the same reading? How could you test their accuracy? Perhaps start by looking at their readings in melting ice and boiling water.

Homework ideas

- Coursebook questions 10.4 to 10.5
- Worksheet 10.1 Understanding thermometers

Topic 3 Thermal expansion

Coursebook section 10.3

Teaching ideas

- It is useful to start this topic by demonstrating thermal expansion (and contraction as the temperature decreases). Activity 10.2 Observing expansion has some ideas, but what you choose to demonstrate will depend on the equipment you have available.
- The Coursebook has some examples of uses of expansion as well as some examples of the consequences of expansion. Students could research further examples and report them to the class.
- Workbook exercises 10.3 and 10.4 can be used to check that students have understood these ideas.

Common misunderstandings and misconceptions

- Some students struggle to work out which way a bimetallic strip will bend. They need to appreciate that the greater length is along the outer side of the curve. (This is especially hard when considering contraction of a cooled strip.) You could compare this with the extra distance on the outer lane of a running track.

Homework ideas

- Workbook exercise 10.3 Thermal expansion
- Workbook exercise 10.4 Demonstrating thermal expansion
- Students could write descriptions of experiments which demonstrate thermal expansion, using the headings 'description', 'observations' and 'explanation'.

Topic 10.4 Thermal capacity

Coursebook section 10.4

Teaching ideas

- This is a short section which looks at thermal capacity in a qualitative sense. Ask students about their experience of walking on hot roads or sand, or of touching cold metal or stone. Can they identify materials which stay relatively cold/hot on warm/cold days?
- Go on to discuss objects that are designed to stay hot or cold using appropriate materials. An example is a night storage heater (Figure 10.13 in the Coursebook).
- Water is an interesting example because it has a high specific heat capacity and so it heats up and cools down relatively slowly.
- Students could answer Coursebook questions 10.8 and 10.9 in class.

Common misunderstandings and misconceptions

- Some students may imagine that water is an intrinsically cold material. Similarly, they may think that metals are 'cold'. This is to do with a combination of factors: for water, it is because of the high specific heat capacity of water, so we are used to feeling water as something colder than our bodies. For metals, thermal conductivity is important.

Homework ideas

- Coursebook questions 10.8 and 10.9

Topic 5 Specific heat capacity (s.h.c.)

Coursebook section 10.5

Teaching notes

- Start by showing objects of different masses but all made of the same metal – lengths of steel rod, for example. Ask: If they are placed in a tank of hot water, which will warm up most quickly, and why? Most students will guess that the smallest will warm up most quickly. Why? Because it has the least mass so less energy is required.
- Students will also appreciate that a bigger temperature rise requires more energy. Hence you can deduce that the energy required is proportional to mass and temperature rise.
- The other factor is material. Show identical objects of different materials. Which will heat up most quickly? This is hard to answer; that is why we have to measure s.h.c.
- For many students, these ideas are readily reinforced by taking a numerical example (as in the Coursebook). Given the energy required to raise the temperature of 1 kg by 1 °C, they can easily calculate the energy required for, say 5 kg and 20 °C.
- Go through Worked example 10.1 and use it to reinforce the idea of s.h.c. Emphasise the units used and how they relate to the equation for s.h.c.
- Look at the values shown in Table 10.1. Point out how they vary quite significantly.
- In Activity 10.3 students measure the s.h.c. of a metal. There is a lot of scope for discussing experimental errors here, particularly concerning heat escaping from the block.
- An alternative approach is to immerse a block in hot water and measure the final temperature. Given the s.h.c. of water, the s.h.c. of the metal can be deduced. (This is a useful approach if you do not have electrical heaters.)
- Students could answer Coursebook questions 10.10 to 10.12 in class. Workbook exercise 10.5 Heat calculations has more examples.

Common misunderstandings and misconceptions

- Students may struggle with equations involving multiplication or division of three quantities. By thinking in terms of proportionality, they should be able to decide whether quantities are multiplied or divided.
- Check that your students know how to use their calculators for these calculations.

Homework ideas

- Coursebook questions 10.8 to 10.9
- Workbook exercise 10.5 Heat calculations

Topic 6 Latent heat

Coursebook section 10.6

Teaching notes

- Show some ice floating in water and gradually melting. Ask why this is not instantaneous. Energy is required to melt the ice. Refer back to Chapter 9; what can they say about the temperature of the water/ice mixture? Use a thermometer to test their ideas. (The temperature should be constant at 0 °C.)
- Following the pattern of the argument in the previous topic, it should be clear to students that the energy required to melt ice depends on the mass (it is proportional). But there is no temperature rise so there is no temperature factor to be brought in.

- Show Worked example 10.2 to explain how calculations involving latent heat are done.
- Activity 10.4 Measuring the specific latent heat of fusion of ice involves mixing ice and water and finding the final temperature. As in the previous activity, there is scope for discussing experimental design and how it can reduce errors.
- Use Coursebook questions 10.13 to 10.15 to reinforce these ideas.

Common misunderstandings and misconceptions

- Some students will try to involve temperature values in their calculations, for example, including 100 °C when calculating the energy required to boil water. Remind them that there is no temperature change. Show an example of water being heated and then boiled; only the energy to raise temperature depends on the change in temperature.

Homework ideas

- Coursebook questions 10.8 to 10.9
- End-of-chapter questions 1 to 12

Teaching ideas

Chapter 11 Thermal (heat) energy transfers

Syllabus sections covered: 2.3

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
2.3.1	Conduction	2	Activity 11.1 Investigating conduction Activity 11.2 Investigating conduction using thermocolour film Questions 11.1 to 11.3	Exercise 11.1 Conductors of heat	
2.3.2	Convection	2	Activity 11.3 Convection experiments Questions 11.4 to 11.8	Exercise 11.2 Convection currents	
2.3.3	Radiation	2	Activity 11.4 Radiation experiments Questions 11.9 to 11.13	Exercise 11.3 Radiation	Worksheet 11.1 Absorbing radiation
2.3.4	Consequences of thermal energy transfer	1	Questions 11.14 to 11.15 EOCQs 1 to 11	Exercise 11.4 Losing heat Exercise 11.5 Warming up, cooling down	

Topic 1 Conduction

Coursebook section 11.1

Teaching ideas

- You might start this topic as in the coursebook, by comparing the 'feel' of metal and plastic (and wooden) spoons. How and why do they feel different?
- Can students divide materials into conductors and insulators of heat? Table 11.1 in the Coursebook compares materials according to their thermal conductivity. Explain that we refer to *thermal conductivity* to avoid confusion with *electrical conductivity*, although they are related.
- Activity 11.1 shows one way to investigate conductivity, using a temperature sensor. The instructions are minimal, so you should ask your students to help decide what measurements to take, how to make it a fair test, and so on.

- Students could answer Coursebook questions 11.1 to 11.3.
- Activity 11.2 Investigating conduction using thermocolour film gives an interesting way of investigating thermal conduction. The method is not difficult but interpreting the results may be tricky for some students. There is plenty of scope for students to decide on their own investigations using thermocolour film.
- Finish the topic by discussing how energy is transferred through solids, by thermal vibrations and (in metals) by electrons.

Common misunderstandings and misconceptions

- Many students find it hard to grasp that metals feel cold because they conduct heat away from your fingers; you may wish to avoid this idea.

Homework ideas

- Coursebook questions 11.1 to 11.3
- Workbook exercise 11.1 Conductors of heat
- Students could write descriptions of experiments which demonstrate thermal conduction, using the headings 'description', 'observations' and 'explanation'.

Topic 2 Convection

Coursebook section 11.2

Teaching ideas

- Students may have observed a 'mirage' effect caused by hot air rising above a road on a hot day. Ask about this. Can they explain it?
- Explain how heating air causes it to expand. How will its density change? Will hot air float or sink? This is an opportunity to revisit ideas about density, floating and sinking.
- Explain how a convection current is established.
- The phrase 'hot air rises' is a useful, everyday idea which you can build on. Demonstrate Activity 11.3 Convection experiments (you may have alternative equipment). Ask students to explain what they see, using the idea of changing density.
- Figures 11.9 and 11.10 in the Coursebook show everyday situations where convection currents can arise. Discuss these and ask where students have experienced similar effects. Students may also have discussed winds and ocean currents in geography lessons.
- Students could answer Coursebook questions 11.4 to 11.8 in class.

Common misunderstandings and misconceptions

- Students may struggle with the idea of decreased density leading to upward movement. It may help if you discuss how a helium-filled balloon becomes buoyant.

Homework ideas

- Coursebook questions 11.4 to 11.8
- Workbook exercise 11.2 Convection currents
- Students could write descriptions of experiments which demonstrate thermal conduction, using the headings 'description', 'observations' and 'explanation'.

Topic 3 Radiation

Coursebook section 11.3

Teaching ideas

- As in the two preceding topics, everyday observations provide a useful way in to this topic. We receive radiation from the Sun – how do your students imagine that it gets here? Explain that this is light and infrared, two forms of electromagnetic radiation.
- You might be able to adapt a digital camera so that it detects infrared radiation. (Methods are shown on the Internet.) Then you can use it to look around the room and find which objects are hotter, which are cooler.
- Coursebook questions 11.9 to 11.11 deal with some basic ideas about radiation.
- Now you can go on to ideas of good and bad emitters of radiation using Activity 11.4 Radiation experiments. This can be a demonstration or a student experiment. Students can suggest a range of variations using the same equipment.
- Worksheet 11.1 Absorbing radiation includes some questions about this experiment.
- (Note that, although we often say that black surfaces are good emitters of infrared radiation, this is not strictly correct. They are black in the visible region of the spectrum, but this is no guarantee that they will be 'black' in the infrared. This is why Leslie's cube experiments often give unexpected results.)

Common misunderstandings and misconceptions

- Students can generally accept that a bad absorber is a good reflector, but they may struggle to accept that a good emitter is also a good absorber.

Homework ideas

- Coursebook questions 11.9 to 11.13
- Workbook exercise 11.3 Radiation
- Worksheet 11.1 Absorbing radiation

Topic 4 Consequences of thermal energy transfer

Coursebook section 11.4

Teaching ideas

- Start by summarising the similarities and differences between the three mechanisms of thermal energy transfer. (You could also revisit ideas about evaporation and its cooling effect.)
- Discuss the design of buildings in terms of whether or not it is important to allow heat in, keep heat in, or get heat out. This brings in the idea of insulation, and students can research the different ways in which houses are designed to retain heat or to cool down.
- Other examples of situations to discuss are winds and ocean currents, and the design of a thermos flask.

Common misunderstandings and misconceptions

- Check that, if students have studied winds and currents in geography lessons, that the same ideas and terminology have been used there.

Homework ideas

- End-of-chapter questions 1 to 11
- Workbook exercise 11.4 Losing heat
- Workbook exercise 11.5 Warming up, cooling down

Teaching ideas

Chapter 12 Sound

Syllabus sections covered: 3.4

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
3.4 (part)	Making sounds	1	Questions 12.1 and 12.2		
3.4 (part)	The speed of sound	1	Activity 12.1 Measuring the speed of sound in air Questions 12.3 to 12.5	Exercise 12.1 Sound on the move	Worksheet 12.1 The speed of sound
3.4 (part)	Seeing sounds	2	Activity 12.2 Seeing sounds Questions 12.6 to 12.11		
3.4 (part)	How sounds travel	1	Questions 12.12 to 12.14 EOCQs 1 to 11	Exercise 12.2 Sound as a wave	

Topic 1 Making sounds

Coursebook section 12.1

Teaching ideas

- In this topic, you establish the idea that sounds are produced by vibrating objects. Most audible sounds are produced by objects whose vibrations are too fast to see, but close observation of a guitar string shows that it is blurred after it has been plucked or strummed.
- Discuss with your students how musical instruments produce sounds. Ask them to demonstrate using their own instruments.
- Discuss also how the sound reaches our ears – the vibrations travel through air.
- Questions 12.1 and 12.2 sum this up.

Common misunderstandings and misconceptions

- It is impossible to see the air in a wind instrument vibrating, so you may have to assert this to your class.

Homework ideas

- Coursebook questions 12.1 and 12.2
- Students could list, say, six musical instruments and describe how they vibrate to make a sound.

Topic 2 The speed of sound

Coursebook section 12.2

Teaching ideas

- Students will be familiar with the idea that some aircraft, superheroes, etc. can travel faster than the speed of sound (Mach 1). Ask what they think this means.
- Emphasise that this often results in very short time intervals between a sound being produced and it being heard. Someone's lips move and we hear the sound with no evident gap. It is different for thunder and lightning. We may hear thunder several seconds after the lightning flash.
- Worked example 12.1 shows a typical calculation involving the speed of sound. Point out that this involves an echo, so the distance travelled by the sound is twice the distance to the reflecting surface.
- In Activity 12.1, you can measure the speed of sound in air by an echo method. You should also demonstrate a time-of-flight method, as shown in Figure 12.7 of the Coursebook.
- Sound can travel through most materials but not through a vacuum. (You may be able to demonstrate the well-known 'bell-jar' experiment to show the latter point.) Table 12.1 shows some values of the speed of sound in different materials. Ask students to use the table to decide whether sound travels fastest in solids, liquids or gases. (In general, sound travels fastest in solids. The reason for this can be left to the final topic in this chapter.)
- Worksheet 12.1 The speed of sound provides practice in calculating the speed of sound and its measurement.

Common misunderstandings and misconceptions

- Students frequently forget to double the distance travelled when sound is reflected.

Homework ideas

- Coursebook questions 12.3-5
- Workbook exercise 12.1 Sound on the move
- Worksheet 12.1 The speed of sound

Topic 3 Seeing sounds

Coursebook section 12.3

Teaching ideas

- Students should already understand that sounds vary in loudness and in pitch. They need to relate these ideas to the amplitude and frequency of the sound. Note that we are not yet introducing the idea of sound as a wave motion of the particles of a medium.
- You could start by showing how different musical notes appear on an oscilloscope screen when played into a microphone. You can say that the trace represents the sound 'waves' that the instrument is producing.
- Activity 12.2 Seeing sounds suggests that you use a signal generator rather than a musical instrument to get a steady and easily varied sound. Students can hear the sound from a loudspeaker and see the corresponding trace on the screen.
- You could use the same setup to demonstrate the range of human hearing.
- Students could answer Coursebook questions 12.6 to 12.11 in class to test their understanding.

Common misunderstandings and misconceptions

- Some students identify the full wave height as the amplitude. It is difficult for them to deduce the frequency from an oscilloscope trace, and this is best left to a higher level.

Homework ideas

- Coursebook questions 12.6 to 12.11
- Students could start on Workbook exercise 12.2 Sound as a wave

Topic 4 How sounds travel

Coursebook section 12.4

Teaching ideas

- To understand how sounds travel, students need to have a picture of the particle nature of matter. You could show a stretched spring and discuss how vibrations travel along it – one segment pushes the next, which pushes the next, and so on. It will not be obvious to students why we call this a wave, but you can revisit these ideas later in Chapter 14.
- Describe how particles push against each other, and how the vibration thus travels through the material.
- Introduce the terms compression and rarefaction if this is appropriate.
- Coursebook questions 12.12 to 12.14 sum this up.

Common misunderstandings and misconceptions

- Students may imagine that sound is something other than the motion of particles – that there is some other 'stuff' travelling through (energy, perhaps). Of course, energy is being transferred by the sound, but there are only the particles of the medium and the forces between them.
- We should acknowledge that the standard diagram of a sound wave (Figure 12.11 in the Coursebook) is perhaps deceptive. The particles of air do not simply oscillate from side to side. They are rushing around at high speeds and this pattern is superimposed on their random motion. They can only change direction when they collide with another molecule.

Homework ideas

- Coursebook questions 12.12 to 12.14
- End-of-chapter questions 1 to 11
- Workbook exercise 12.2 Sound as a wave

Teaching ideas

Chapter 13 Light

Syllabus sections covered: 3.2.1, 3.2.2, 3.2.3

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
3.2.1	Reflecting light		Activity 13.1 The law of reflection Questions 13.1 to 13.4	Exercise 13.1 On reflection	
3.2.2 (part)	Refraction of light		Activity 13.2 Investigating refraction Questions 13.5 to 13.16	Exercise 13.2 Refraction of light Exercise 13.3 The changing speed of light	
3.2.2 (part)	Total internal reflection		Activity 13.3 Total internal reflection Questions 13.17 to 13.22	Exercise 13.4 A perfect mirror	Worksheet 13.1 Ray diagrams
3.2.3	Lenses		Activity 13.4 Investigating converging lenses Questions 13.23 to 13.30 EOCQs 1 to 14	Exercise 13.5 Image in a lens	

Topic 1 Reflecting light

Coursebook section 13.1

Teaching ideas

- In this topic we are concerned with the way light behaves when it strikes a surface and is reflected. In particular, we are thinking about flat, smooth surfaces like mirrors.
- You could begin by discussing the uses of mirrors. This should produce the idea that we see an image in a mirror.
- Explain that, to make sense of reflection, we draw rays. A ray is a line which shows where light goes when it passes through a point in a particular direction. A ray box shows how light rays behave (although the beam of light it produces is too broad to be a true ray). Show how to mark a ray on a piece of paper.
- In Activity 13.1 The law of reflection students can test the law of reflection using ray boxes.

- Emphasise the importance of measuring angles from the normal to the ray. Show this by moving your hand round from the normal to the ray. (For a plane mirror, we could consider the angle between the ray and the mirror, but for a curved mirror we would have to talk about the tangent to the surface, which is difficult.)
- Explain the meanings of the terms we use to describe a mirror image: it is virtual, upright, the same size as the object, and left–right reversed. The last of these means that, if we could put the image side-by-side with the object, they would be identical except that one would be reversed in space relative to the other, just as our left and right hands are reversed.
- The point is to emphasise that we can predict where a ray will go when it reflects. Worked example 13.1 shows how to use a ray diagram to show where the image is formed in a plane mirror. This is relatively simple for a plane mirror; more complicated in the case of refraction.
- Students could answer Coursebook questions 13.1 to 13.4 in class to test their understanding.
- Workbook exercise 13.1 On reflection gives practice in drawing reflected rays.

Common misunderstandings and misconceptions

- Students may have trouble in drawing the normal at the point where the ray strikes a surface. They may struggle with the idea of measuring the angle between a ray between the normal and the ray.

Homework ideas

- Coursebook questions 13.1 to 13.4
- Workbook exercise 13.1 On reflection

Topic 2 Refraction of light

Coursebook section 13.2

Teaching ideas

- Students will have observed many effects of refraction without necessarily be aware of this. Ask if they have seen the 'shadows' on the bottom of a swimming pool when the surface has waves on it. What can cause this?
- Figure 13.7 in the Coursebook shows another effect, the 'broken pencil'. You could demonstrate this and other refraction effects such as the 'disappearing coin'. Look for others on the Internet.
- It is conceptually demanding to relate this to the bending of rays when they enter and leave a glass block, so you must allow time for this. Figure 13.8 shows a ray of light being refracted (and partially reflected) by a glass block. Students can see this for themselves in Activity 13.2 Investigating refraction. (It is probably simplest if you describe how a ray is refracted and then students check these ideas, rather than expecting them to discover refraction for themselves.)
- Students could now attempt Coursebook questions 13.5 to 13.10.
- As with reflection, we are looking for a pattern so that we can predict how a ray will bend. Now you can move on to the idea of refractive index and Snell's law. While students will understand that greater change in speed will cause a bigger change in angle, the idea that it is the sines of the angles that matter will be obscure to most. (You can justify this by drawing triangles in the manner of a conventional proof of Snell's law.)

- Students could now attempt Coursebook questions 13.11 to 13.16.
- Workbook exercise 13.3 The changing speed of light involves drawing ray diagrams showing refraction and calculations of refractive index and angle of refraction.

Common misunderstandings and misconceptions

- Refraction is difficult to understand. It is 'explained' in Figure 13.10 in terms of a truck running into sand. This is hard for students to grasp, but it is in some ways more concrete than explanations using wave fronts, which are given in Chapter 14.

Homework ideas

- Workbook exercise 13.2 Refraction of light
- Workbook exercise 13.3 The changing speed of light

Topic 3 Total internal reflection

Coursebook section 13.3

Teaching ideas

- Total internal reflection (TIR) explains why diamonds and other transparent gemstones reflect light. It occurs when the angle of incidence is large (greater than the critical angle). This is a phenomenon that students are unlikely to discover for themselves and the experimental arrangement is not obvious, so you will need to explain what is going on when a light ray enters a semicircular block.
- You will need to explain that the ray enters the curved side of the block along a radius so that the angle of incidence is zero and there is no refraction.
- Show how the reflected and refracted rays change as the angle is changed.
- Activity 13.3 Total internal reflection gives instructions for students to try this for themselves. Explain the meaning of critical angle.
- Since critical angle depends on refractive index, students can use this method to deduce refractive index.
- Students could research the uses of TIR: prismatic reflectors, optical fibres, etc., and make brief presentations to the class.
- Coursebook questions 13.17 to 13.22 test ideas of TIR.
- Workbook exercise 13.4 A perfect mirror includes ways of using prisms as reflectors.
- Worksheet 13.1 Ray diagrams has a range of ray diagrams to be completed, summarising the first parts of this chapter.

Common misunderstandings and misconceptions

- Students find it difficult to express the meaning of critical angle, the angle of incidence greater than which TIR occurs.

Homework ideas

- Coursebook questions 13.17 to 13.22
- Workbook exercise 13.4 A perfect mirror
- Worksheet 13.1 Ray diagrams

Topic 4 Lenses

Coursebook section 13.4

Teaching ideas

- Lenses have been used for hundreds of years, if not thousands. Ask students where they have come across lenses; what are their uses and what part do they play?
- Allow students to examine a number of lenses. Can they divide them into two classes and explain their choices? They may do this by shape (fatter/thinner in the middle than at edges) or by their image production – diverging lenses cannot produce magnified images or focus rays onto a piece of paper.
- Show how to draw a ray diagram for a converging lens (as in Figure 13.18 in the Coursebook).
- Activity 13.4 Investigating converging lenses allows students to check these ideas for themselves.
- You can go on to show how a magnifying glass works, including the ray diagram. As with mirrors, you will have to explain the meanings of terms: real and virtual, upright and inverted, enlarged and diminished.
- Students can now try Coursebook questions 13.23 to 13.30.
- Workbook exercise 13.5 Image in a lens gives practice in completing ray diagrams for a converging lens, including a magnifying glass.

Common misunderstandings and misconceptions

- Students will not always grasp how rays are affected as they pass through a converging lens. It is not obvious that a ray through the centre will be undeflected. You could compare this to a ray passing through a parallel-sided block; it emerges travelling in the same direction as the incident ray, only slightly displaced to one side.
- Students may also imagine that rays bend *inside* the lens; in fact, they only change direction at the points where they enter and leave the lens; they are straight in between.
- The ray diagram for a magnifying glass is difficult to draw, and to understand. Position the object slightly closer to the lens than the focal point.

Homework ideas

- Coursebook questions 13.23 to 13.30
- End-of-chapter questions 1 to 14
- Workbook exercise 13.5 Image in a lens

Teaching ideas

Chapter 14 Properties of waves

Syllabus sections covered: 3.1

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
3.1 (part)	Describing waves		Activity 14.1 Observing waves Questions 14.1 to 14.7	Exercise 14.1 Describing waves	
3.1 (part)	Speed, frequency and wavelength		Questions 14.8 to 14.12	Exercise 14.2 The speed of waves	Worksheet 14.1 Waves: speed, frequency and wavelength
3.1 (part)	Explaining wave phenomena		Activity 14.2 Ripple tank Questions 14.13 to 14.17 EOCQs 1 to 12	Exercise 14.3 Wave phenomena	
	~~Summing up~~		~~EOCQs 1-12~~		

Topic 1 Describing waves

Coursebook section 14.1

Teaching ideas

- In everyday speech, we refer to sound waves and light waves. Students have already seen oscilloscope traces of sounds in Chapter 12. Now you need to relate these ideas to water waves.
- If you have a ripple tank, use this. Otherwise, show water in a rectangular bowl, or show a film of ripples from the Internet.
- Explain that the lines we see are wavefronts, spreading out like sound from a source. Now imagine slicing vertically downwards to get a conventional sine wave representation of a wave.
- To define quantities, start with the spatial ones: wavelength and amplitude. Refer back to the idea of loudness related to amplitude for a sound wave.
- Go on to define frequency and then period. Refer back to frequency and pitch of sound waves.
- Show what happens when you change the frequency of the vibrations. Note that you cannot change the wavelength directly, but you can increase it by decreasing the frequency.

- Talk about waves transferring energy as they move. It is transferred at the speed of movement of the wavefronts.
- Go on to Activity 14.1. You can demonstrate transverse and longitudinal waves using a stretch spring on a bench, or students can try this for themselves. Point out how the wave travels: each section of the spring causes the next to move, with a slight delay. This is why a wave is not instantaneous.
- Coursebook questions 14.1 to 14.7 can be used to check these ideas.

Common misunderstandings and misconceptions

- Students must simply learn that light (and other electromagnetic weaves) are transverse. To prove this would require an understanding of polarisation.

Homework ideas

- Coursebook questions 14.1 to 14.7
- Workbook exercise 14.1 Describing waves

Topic 2 Speed, frequency and wavelength

Coursebook section 14.2

Teaching ideas

- With your class, work through the argument at the start of this section in the coursebook, a numerical example that shows how speed, frequency and wavelength are related. Then go on to write the relationship as a general equation, speed = frequency × wavelength.
- If your students understand proportionality, you could refer back to the ripple tank: when the frequency is increased, the wavelength of ripples decreases. We might guess that their product is constant.
- Discuss Worked examples 14.1 and 14.2 in the Coursebook. Figure 14.9 emphasises how wavelength changes when a wave enters a material where its speed is reduced. This is useful later for explaining refraction.
- Coursebook questions 14.8 to 14.12, Workbook exercise 14.2 The speed of waves and Worksheet 14.1 Waves: speed, frequency and wavelength all provide practice in using the equation.

Common misunderstandings and misconceptions

- Some students may have difficulties in handling powers of 10, especially when dealing with the wavelength and frequency of light. Check that they know how to deal with this using their calculators.

Homework ideas

- Coursebook questions 14.8 to 14.12
- Workbook exercise 14.2 The speed of waves
- Worksheet 14.1 Waves: speed, frequency and wavelength

Topic 3 Explaining wave phenomena

Coursebook section 14.3

Teaching ideas

- You can demonstrate reflection, refraction and diffraction using a ripple tank. Take them one at a time.
- Reflection is perhaps best shown using a single plane wavefront reflecting off a barrier. Point out how it appears to be obeying the law of reflection. Change the angle of the barrier to check.
- Go on to show how this relates to the typical ray diagram of reflection (Figure 14.10 in the Coursebook). Students need to understand that rays are at right angles to wavefronts.
- Refraction is harder to show. You need a region of shallower water with a boundary at an angle to the incident wavefronts. You can use Figure 14.11 in the Coursebook to relate your observations to the ray diagram of refraction.
- Diffraction is clearly a wave phenomenon. Show how ripples spread out after passing through a gap, and around an edge. (You can also show the effect of changing the gap width and the wavelength.)
- Discuss how we can observe diffraction in everyday life – hearing around corners, and diffraction of light by water droplets in fog (Figure 14.14). Scatter fine dust (e.g. lycopodium powder) on a microscope slide and look through it at a point light source – you should see diffraction rings. You could also shine a laser pointer through a narrow slit to show how the light spreads out, though you may have trouble explaining the interference fringes observed.
- Use Coursebook questions 14.13 to 14.17 and Workbook exercise 14.3 Wave phenomena to check these ideas.

Common misunderstandings and misconceptions

- Students may find it difficult to relate the three representations of waves: wavefronts, sine waves and rays. You may need to recap this; it can help if students draw ray diagrams and then add short, equally spaced wavefronts at right angles to the rays, along their length.

Homework ideas

- Coursebook questions 14.1 to 14.17
- End-of-chapter questions 1 to 12
- Workbook exercise 14.3 Wave phenomena

Teaching ideas

Chapter 15 Spectra

Syllabus sections covered: 3.2.4, 3.3

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
3.2.4	Dispersion of light	1	Activity 15.1 Making spectra Questions 15.1 to 15.3		
3.3	The electromagnetic spectrum	3	Questions 15.4 to 15.9 EOCQs 1 to 10	Exercise 15.1 Electromagnetic waves Exercise 15.2 Using electromagnetic radiation	Worksheet 15.1 Electromagnetic spectrum
	~~Summing up~~		~~EOCQs 1-10~~		

Topic 1 Dispersion of light

Coursebook section 15.1

Teaching ideas

- Students will be familiar with rainbows and will probably have seen spectra cast when light passes through glass objects. Explain that this is an effect called dispersion and that it shows that white light is a mixture of many different colours. (This is not self-evident; it took a long time to establish that colours were not being added to white light as it passed through glass.)
- Activity 15.1 Making spectra gives instructions for seeing a spectrum using a prism. It also refers to using a diffraction grating, a much more reliable method, although students may wonder why there are multiple spectra.
- Students should learn the colours, perhaps by inventing a mnemonic. (Again, the division into seven colours is not self-evident.) It is important to know that red and violet are at opposite ends of the spectrum.
- Coursebook questions 15.1 to 15.3 can be used to check these ideas.

Common misunderstandings and misconceptions

- Students need to know that refraction (and hence dispersion) occurs at the points where the rays enter and leave the prism. They do not bend or curve in between (see Figure 15.3 in the Coursebook).

Homework ideas

- Coursebook questions 15.1 to 15.3

Topic 2 The electromagnetic spectrum

Coursebook section 15.2

Teaching ideas

- Students have already met infrared radiation when studying energy transfer by radiation. You may be able to demonstrate the heating effect of infrared radiation in a similar way to Herschel's chance discovery (Figures 15.4 and 15.5 in the Coursebook). Alternatively, you may be able to show the presence of radiation beyond the red end of the spectrum using an infrared camera (adapted from a digital camera).
- You may also be able to show the presence of ultraviolet radiation using fluorescent paper (most white paper fluoresces in the UV region of the spectrum).
- Now you can go on to explain that we now know that visible light is just one part of a much broader spectrum, and explain how it is the frequency (and hence wavelength) that varies across the spectrum. Go back to the visible spectrum and show Figure 15.7 in the Coursebook, to show how the wavelengths of red and violet light compare. (You might like to point out that these wavelengths differ by a factor of two, roughly; for sound, we can detect a spectrum from 20 Hz to 20 kHz, a factor of 1000.)
- Students will be interested in the idea that different species of creature can see different ranges of wavelengths; you can probably find images of flowers taken in the ultraviolet to illustrate this.
- Continue to present the entire electromagnetic spectrum (Figure 15.8 in the Coursebook) and indicate the great range of wavelengths and frequencies it covers.
- Students can now go on to research various aspects of these radiations: their discovery, how they are produced, their hazards and their uses. This is supported by Worksheet 15.1 Electromagnetic spectrum, Workbook exercises 15.1 Electromagnetic waves and 15.2 Using electromagnetic radiation, as well as Coursebook questions 15.4 to 15.9.

Common misunderstandings and misconceptions

- Students may wonder why we talk about 'electromagnetic' radiation. The idea of varying electric and magnetic fields self-propagating through space is difficult; you might refer to a TV or mobile phone mast: there is an electric current in the mast, varying up and down, and producing a magnetic field in the same way that an electromagnet does.

Homework ideas

- Coursebook questions 15.4 to 15.9
- End-of-chapter questions 1 to 10
- Workbook exercise 15.1 Electromagnetic waves
- Workbook exercise 15.2 Using electromagnetic radiation
- Worksheet 15.1 Electromagnetic spectrum

Teaching ideas

Chapter 16 Magnetism

Syllabus sections covered: 4.1

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
4.1 (part)	Permanent magnets	2	Activity 16.1 Making magnets Questions 16.1 and 16.2	Exercise 16.1 Attraction and repulsion Exercise 16.2 Make a magnet	
4.1 (part)	Magnetic fields		Activity 16.2 Plotting field lines Questions 16.3 to 16.5 EOCQs 1 to 12	Exercise 16.3 Magnetic fields	Worksheet 16.1 Magnets and magnetic fields

Topic 1 Permanent magnets

Coursebook section 16.1

Teaching ideas

- It is likely that students will already have met the idea of magnetic poles and the rules of attraction and repulsion. In this case, you could ask them to work in pairs to decide how they would explain why the poles of a magnet are called North and South, and why we say that 'like poles repel'. Allow them to handle some bar magnets and provide string, etc.
- Once a pair are confident of their explanation, ask them to demonstrate to the class and ask the class how they would improve the demonstration.
- Students could then write up an ideal script with details of what to do and say.
- Next, ask students how they would test the idea that all metals are magnetic and all non-metals are non-magnetic. Have some non-magnetic metals such as stainless steel and copper available.
- Students can now magnetise an iron or steel rod. Figure 16.4a in the Coursebook shows how this is done, and Activity 16.1 gives instructions. They can test their magnets using a plotting compass.
- Discuss the various methods of demagnetisation. (You might want to introduce the idea of magnetic domains into this discussion.)
- Coursebook questions 16.1 and 16.2 test the ideas learned in this section.

Common misunderstandings and misconceptions

- Some students may think that all metals are magnetic (see above). Similarly, they may think that iron and steel are always magnetised – they are confusing the ideas of magnetic materials and magnetised materials. You can help them to sort out these ideas by emphasising what is happening when they magnetise and demagnetise an iron wire.

Homework ideas

- Coursebook questions 16.1 and 16.2
- Workbook exercise 16.1 Attraction and repulsion
- Workbook exercise 16.2 Make a magnet
- Students can write instructions for magnetising and testing an iron wire.

Topic 2 Magnetic fields

Coursebook section 16.2

Teaching ideas

- The idea of a field is a very general one in physics. Here we have a relatively concrete way to approach this idea, through magnetic fields.
- Explain that magnets show attraction and repulsion at a distance – that is what makes them fun to play with. We say that they create a field around them, a region where any piece of magnetic material will feel a force. Show a large magnet and ask how students would investigate its field. They might suggest using a piece of iron, another magnet or a compass. Test their ideas – how far away from the magnet can you detect its influence? (A 'magnaprobe' is good for this. It is a small bar magnet mounted with a handle so that it is free to turn in three dimensions.)
- Continue with a demonstration of the field around a bar magnet, shown using iron filings (Figure 16.6 in the Coursebook). The method of plotting field lines using a plotting compass needs to be demonstrated – it is hard for students to understand from a written description (Activity 16.2).
- You can also show a simple electromagnet and its magnetic field.
- Points to emphasise about magnetic fields: the lines show the direction of the force on a north pole placed at a point; lines close together show strong field.
- Coursebook questions 16.3 to 16.5 can be used to test these ideas.

Common misunderstandings and misconceptions

- Some students may imagine that field lines really exist and that they can be seen under a microscope. Some students may imagine that an electromagnet coil must be made of a magnetic material, or that the coil will itself become magnetised. Point out that it is the electric current that produces the field, not the wire. When the current is switched off, the field disappears.

Homework ideas

- End-of-chapter questions 1 to 12
- Workbook exercise 16.3 Magnetic fields

Teaching ideas

Chapter 17 Static electricity

Syllabus sections covered: 4.2.1 (part)

Teaching resources

Syllabus section	Topic	40-minute periods	Resources in Coursebook	Resources in Workbook	Resources on this CD-ROM
4.2.1 (part)	Charging and discharging	2	Activity 17.1 Investigating static electricity Questions 17.1 to 17.3	Exercise 17.1 Attraction and repulsion	
4.2.1 (part)	Explaining static electricity	1	Activity 17.2 Charging by induction Questions 17.4 and 17.5	Exercise 17.2 Moving charges	Worksheet 17.1 Electric charges
4.2.1 (part)	Electric fields and electric charge	1	Questions 17.6 and 17.7 EOCQs 1 to 9	Exercise 17.3 Static at home	

Topic 1 Charging and discharging

Coursebook section 17.1

Teaching ideas

- Experiments with static electricity are notoriously dependent on humidity, so you may have to pick a suitably dry day to carry these out. It can help to use a hairdryer on the materials you are using.
- Start by asking students about their experiences of getting electric shocks – perhaps when combing their hair, or getting out of a car. These effects arise because one material is rubbing against another.
- Go on to demonstrate the basic phenomena of static electricity. Figure 17.2 in the Coursebook shows how to do this. Discuss the laws of attraction and repulsion for electric charges. Point out that the names 'positive' and 'negative' are arbitrary.
- Activity 17.1 Investigating static electricity gives instructions for students to repeat these demonstrations – they are much more likely to make the correct observations if they have seen them done previously. The last question asks them to determine the sign of the charge on a rubbed balloon.
- If you have a Van de Graaff generator, this is a good point at which to use it to show some of the basic phenomena of static electricity.

Common misunderstandings and misconceptions

- Students may easily confuse magnetic and electric fields. They may imagine, for example, that when a plastic rod is rubbed, its ends gain opposite charges. They can test this idea by showing that both ends are attracted by a rod with opposite charge.

Homework ideas

- Coursebook questions 17.1 to 17.3
- Workbook exercise 17.1 Attraction and repulsion

Topic 2 Explaining static electricity

Coursebook section 17.2

Teaching ideas

- We use the idea of electron transfer to explain charging. This explanation leaves open the question of the fundamental nature of electric charge (which is not an easy question to answer!).
- Start by explaining that, when two objects rub together, tiny particles (electrons) may be transferred from one to the other. They must be different materials; the one which holds electrons more weakly is more likely to lose them to the other material.
- Explain that electrons are negatively charged; the material gaining electrons becomes negatively charged. Explain that, before the rubbing, both materials were neutral (uncharged). Explain how a charged object attracts an uncharged one (Figure 17.4 in the Coursebook). (Students may have studied the structure of the atom in chemistry, in which case they will know that electrons are on the outside of an atom and so are more easily removed. Atomic structure is in Chapter 22 of this course.)
- It is difficult to transfer charge from a charged object to an uncharged one. It is better to use the process of charging by induction, as we can be more certain of the resulting charge. The method is shown in Figure 17.5 of the Coursebook, and students can try it for themselves in Activity 17.2.
- Worksheet 17.1 Electric charges has some questions drawing on these ideas.
- Students could also answer Coursebook questions 17.4 and 17.5 in class.

Common misunderstandings and misconceptions

- Students do not always appreciate that a neutral object already has many positive and negative charges in it. This will become more evident once they have an understanding of the structure of the atom (Chapter 22).

Homework ideas

- Workbook exercise 17.2 Moving charges
- Students could write an explanation of charging by induction under the headings 'What you do' and 'How it works'.

Topic 3 Electric fields and electric charge

Coursebook section 17.3

Teaching ideas

- Point out that there is an analogy between an electric field and a magnetic field. Ask your students to discuss what we might mean by an 'electric field'. (A region where an electric field feels a force.)
- Discuss the shapes of electric fields, as represented by field lines (Figure 17.6 in the Coursebook). Ask students to list similarities and difference between electric and magnetic fields. You could collate their answers on the board.
- Go on to discuss the nature of electrons – smaller than atoms, tiny mass, tiny charge. And yet the movement of these electrons is enough to give the effects we see on a macroscopic scale. You could hint at their importance in understanding current electricity.
- Students could answer Coursebook questions 17.6 and 17.7 and compare their answers with each other.

Common misunderstandings and misconceptions

- As before, it is easy to confuse electric and magnetic fields. The exercise above (comparing the two) should help to draw attention to the differences and similarities.

Homework ideas

- End-of-chapter questions 1 to 9
- Workbook exercise 17.3 Static at home includes ideas for simple experiments involving static electricity to be carried out at home.

Good Luck!