



## Scheme of work – Cambridge IGCSE® Physics (0625)

### Unit 8: Mechanics 2

#### Recommended prior knowledge

By the time this stage in the course is reached, most students will have already studied much if not all of *Mechanics 1* and will have begun to distinguish the terms *force*, *energy*, *pressure*, *work* and *mass*. By the end of the unit, these distinctions should be complete and familiar.

Mechanics is a part of physics that students can easily understand. Most of the concepts are accessible and the ideas are generally straightforward. *Mechanics 2* might well be dealt with earlier rather than later in the course, although it will probably be taught after *Mechanics 1*, since the idea of *force* and its corresponding unit *the newton* will need to be familiar to the students. Students are not always aware of the way in which forces act. Many students are tempted to believe that a stretched spring which exerts a force of 5.0 N at one end and (inevitably) the same force at the other end is somehow subject to a tension of 10.0 N. Where students have previously carried out experiments on springs in parallel and series, such misunderstandings are less likely to arise. Many students will have encountered simple experiments on making things balance and will have developed ideas concerning the product *mass*  $\times$  *distance*. It might be necessary to emphasise that this approach relies on the double cancellation of *g* and that the important quantity is *force*  $\times$  *distance*. Where the distinction between mass and weight has been encountered previously, this should be easier to teach.

*Pressure* cannot be taught easily without having met with *force*, and pressure in a liquid will need students to understand *density*. Students might well be aware that some units are merely special names for combinations of other units and the *pascal* and the *joule* can be used as examples of this. Graph plotting can be used in the work that deals with springs and Hooke's law.

#### Context

There is little in this unit that is likely to prove especially difficult; mechanics is much more related to a student's everyday experience of the world than some other topics. It can be dealt with fairly early in the course if desired. Again practical lessons can bring the subject home to students in a particularly direct fashion.

#### Outline

This unit contains ideas that are quite familiar to many students and their understanding is likely to be decent enough. It is a unit where teaching other important skills such as accuracy, meticulousness, neatness and a systematic approach to problems can be encouraged without the danger of obscuring the topic being investigated.

(Please note: **(S)** in **bold** denotes material in the Supplement (Extended syllabus) only)

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
1.5 (a)	<p>State that a force may produce a change in size and shape of a body</p> <p>Plot extension/load graphs and describe the associated experimental procedure</p> <p>Describe the ways in which a force may change the motion of a body</p> <p>Find the resultant of two or more forces acting along the same line</p>	<p>Use a simple experiment to stretch a steel spring. Further experience could be gained with a similar experiment to stretch a rubber band.</p> <p>Compress trapped gases in syringes; change the shape of malleable objects.</p> <p>Use force sensors and newton meters to add and subtract the forces acting on bodies.</p>	<p>Sang IGCSE Physics Coursebook CD-ROM Activity Sheet 3.1</p> <p>Sang IGCSE Physics Coursebook CD-ROM Activity Sheet 5.1</p> <p>Unit 8: Past Paper Question Extension 2</p>
1.5 (a) (S)	<p><b>Interpret extension/load graphs</b></p> <p><b>State Hooke's Law and recall and use the expression <math>F = kx</math></b></p> <p><b>Recognise the significance of the term 'limit of proportionality' for an extension/load graph</b></p> <p><b>Recall and use the relation between force, mass and acceleration (including the direction)</b></p> <p><b>Describe, qualitatively, motion in a curved path due to a perpendicular force (<math>F = mv^2/r</math> is <i>not</i> required)</b></p>	<p><b>Use a home-made copper spring or stretch a length of copper wire between two pencils and feel or measure or show the limit of proportionality. An air track can be used to show momentum effects using collisions and 'explosions' (magnets attached to the vehicles to produce repulsion). This work can be extended to investigate model rockets and Newton's cradle.</b></p> <p><b>Circular motion can be shown using a smooth turntable (old record player) and a marble to illustrate behaviour without centripetal force and then an object attached to the axis with cotton to provide the centripetal force.</b></p> <p><b>Thread a piece of string through a short length of glass tubing and attach a weight to one end of the string. Set the weight rotating by holding the glass tube vertical and rotating it in a small circle. The weight pulls the string up out of the tube. Attach another weight to the bottom end of the string and this weight can be used to exert a force on the other weight in a centripetal direction. Equilibrium can be achieved.</b></p>	<p>Hooke's Law:  <a href="http://www.matter.org.uk/schools/content/hookeslaw/index.html">www.matter.org.uk/schools/content/hookeslaw/index.html</a></p> <p>Centripetal force:  <a href="http://www.youtube.com/watch?v=oFiXtcXRpVE">www.youtube.com/watch?v=oFiXtcXRpVE</a></p>

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1.5 (b)	Describe the moment of a force as a measure of its turning effect and give everyday examples Describe, qualitatively, the balancing of a beam about a pivot	Experiments involving balancing a rule on a pivot with a variety of different weights should be used here. Talk about everyday examples e.g. see-saws, steelyards, crane jibs.	IGCSE Physics Coursebook CD-ROM Activity Sheet 4.1, 4.2  Question sheet: IGCSE Physics Coursebook CD-ROM Activity Sheet 4.3  Unit 8: Past Paper Question Core 1 and 2 Unit 8: Past Paper Question Alternative to Practical 1
1.5 (b) (S)	<b>Perform and describe an experiment (involving vertical forces) to show that there is no net moment on a body in equilibrium</b> <b>Apply the idea of opposing moments to simple systems in equilibrium</b>	<b>This can be extended quantitatively for extension candidates and further extended to using a weight to balance the rule on a pivot away from the centre to introduce the concept of centre of mass.</b> <b>Determine the mass of a rule by balancing it away from its centre of mass with a known laboratory mass at one end. Replace the mass with an apple and determine its mass. Check by balancing the mass and the apple.</b>	
1.5 (c)	State that, when there is no resultant force and no resultant turning effect, a system is in equilibrium	When a bridge or trestle table is in equilibrium, the moment is zero about any point at all; it is merely convenient to take moments about one of the support or trestles.	A lesson plan for a model bridge building investigation: <a href="http://www.school.discovery.com/lessonplans/programs/bridges/index.html">www.school.discovery.com/lessonplans/programs/bridges/index.html</a>

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1.5 (d)	Perform and describe an experiment to determine the position of the centre of mass of a plane lamina. Describe qualitatively the effect of the position of the centre of mass on the stability of simple objects	A variety of shapes of lamina should be used in experiments to find the centre of mass. Standard shapes (circle, square, etc.) can be used first and then 'non-standard' shapes (e.g. the outline of a country) where the position of the centre of mass is not so obvious. Is the point found really the centre of the country – what about mountains, islands, lakes etc.) Extension students can be challenged with a lamina that has its centre of mass in space (e.g. hole in the lamina or an L-shape). Find the stability of glasses with stems, thick bases and wide bases on an inclined plane of variable slope. At what angle does the glass topple? What happens when the glass is full.	<a href="http://www.youtube.com/watch?v=hqDhW8HkOQ8&amp;feature=related">www.youtube.com/watch?v=hqDhW8HkOQ8&amp;feature=related</a>
1.5 (e)	<b>Demonstrate an understanding of the difference between scalars and vectors and give common examples</b> <b>Add vectors by graphical representation to determine a resultant</b> <b>Determine graphically a resultant of two vectors</b>	<b>This important concept can be illustrated by a few students attempting to pull a block of wood along the bench with strings, but pulling in a variety of directions at the same time. (It could be a large-scale outdoor activity).</b> <b>Use a forces table with weights or Newton-meters and draw a scale diagram of equilibrium arrangements.</b> <b>Can a cable car hang from a perfectly horizontal cable?</b>	This website, about Leonardo da Vinci, provides a different approach to stimulate students: <a href="http://www.mos.org/leonardo">www.mos.org/leonardo</a> click on exploring Leonardo click on Inventor's workshop click on The elements of machines
1.6 (c)	Relate, without calculation, work done to the magnitude of a force and distance moved	In this and the following sections it may be useful to calculate (although only required for the extension paper) personal work done and power. For example, by walking up steps, recording the student's weight, the vertical height climbed and the time taken. When rolling barrels up inclined planes the same work is done as when lifting the barrel vertically but the distance is greater and so the force is less. Humans get tired holding heavy weights at a constant height but no work is done. Humans make poor shelves.	IGCSE Physics Coursebook CD-ROM Activity Sheet 3.2  IGCSE Physics Coursebook CD-ROM Activity Sheet 8.1

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1.6 (c) (S)	<b>Describe energy changes in terms of work done</b> <b>Recall and use <math>\Delta W = F \times d = \Delta E</math></b>		Some worked examples: <a href="http://www.tutor4physics.com/examplesworkdone.htm">www.tutor4physics.com/examplesworkdone.htm</a>
1.6 (d)	Relate, without calculation, power to work done and time taken, using appropriate examples	Pupils find rates quite hard at this stage; it is worth considering a few other examples e.g. the rate of filling a bath and the time taken to fill it to a certain volume.	<a href="http://www.hyperphysics.phy-astr.gsu.edu/hbase/work.html">www.hyperphysics.phy-astr.gsu.edu/hbase/work.html</a>  For the teacher: <a href="http://www.tap.iop.org/mechanics/work_energy_power/index.html">www.tap.iop.org/mechanics/work_energy_power/index.html</a>
1.6 (d) (S)	<b>Recall and use the equation <math>P = E/t</math> in simple systems</b>		IGCSE Physics Coursebook CD-ROM Activity Sheet 8.2
1.7	Relate (without calculation) pressure to force and area, using appropriate examples Describe the simple mercury barometer and its use in measuring atmospheric pressure Relate (without calculation) the pressure beneath a liquid surface to depth and to density, using appropriate examples Use and describe the use of a manometer	Show and discuss examples such as: drawing pins, stiletto heeled shoes, sharpened knives, cheese wire, snow shoes/skis and furniture leg cups. Demonstrate a mercury barometer (Torricelli used water). Show that the pressure under water increases with depth and if possible use a less dense liquid to show that the pressure increases at a slower rate. Use a water manometer to measure the excess pressure of the gas supply (if safe). Use a U-tube with water in one limb and ethanol in the other; the two surfaces are not level.	Several activities here: IGCSE Physics Coursebook CD-ROM Activity Sheet 5.3  Unit 8: Past Paper Question Core 3
1.7 (S)	<b>Recall and use the equation <math>p = F/A</math></b> <b>Recall and use the equation <math>p = h\rho g</math></b>	<b>Use the formula in specific cases and determine the pressure exerted on the ground by an elephant and someone wearing stiletto heeled shoes.</b> <b>Calculate the pressure due to 1.0 m of mercury and show that it exceeds the atmospheric pressure; the mercury has to flow out of a barometer and leaves a vacuum above the surface in the tube.</b>	Unit 8: Past Paper Question Extension 1