

## IGCSE Co-ordinated Sciences 0654

### Unit 17: Materials and particles

#### Recommended Prior Knowledge

Students need very little previous knowledge to begin this Unit.

#### Context

This Unit covers Topics P1 and P2. Topic 1 introduces some of the effects of forces, which will form the basis of many concepts developed later in the syllabus. In Topic 2, the kinetic theory of matter is introduced, and once again this is a fundamental concept that will be revisited in several contexts in later Units. There are links with Topic B3, Support and movement.

#### Outline

An investigation into the extension of a spring leads into consideration of the behaviour of materials and the effects of forces on them. Students also look at the turning effects of forces. They use the kinetic theory of matter to explain changes of state and also the relationships between pressure, temperature and volume.

Topic	Learning outcomes	Suggested Teaching activities	Learning resources
P1	<p>know that there is a relationship between the extension of a spring and the force applied to it</p> <p>understand that the strength of solids derives from the forces between their constituent atoms and molecules</p> <p>appreciate the spring-like nature of these forces by comparing the behaviour of materials under tension and</p>	Students should hang masses on a spring and plot load/extension graphs.	IGCSE Physics, Hodder, Duncan T and Kennet H, pages 62–64

Topic	Learning outcomes	Suggested Teaching activities	Learning resources
	compression with the behaviour of springs		
	understand that equal and opposite forces acting on the same body may have a turning effect	Experiments involving balancing a rule on a pivot with a variety of different weights should be used here.	IGCSE Physics, Hodder, Duncan T and Kennet H, pages 72–75
	be able to calculate the turning effect (moment) of a force	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.	
	know that for a body in equilibrium both forces and their turning effects must balance		
	appreciate that the choice of materials for a particular use depends upon the materials' properties	Students may already have a simple vocabulary to describe properties of materials (brittle, elastic, hard, transparent and so on). Provide groups with a list of materials and properties, and ask them to match them to another list of uses. If possible, provide samples of the materials for them to see and handle.	A lesson plan for a model bridge building investigation <a href="http://school.discovery.com/lessonplans/programs/bridges/index.html">http://school.discovery.com/lessonplans/programs/bridges/index.html</a>
		If time allows, students could build model bridges, bringing together their knowledge of balanced forces and suitable materials.	
	understand the difference between vector and scalar quantities	This 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.	This site, about Leonardo da Vinci, provides a different approach to stimulate students. <a href="http://www.mos.org/leonardo">http://www.mos.org/leonardo</a>
	be able to add two vector quantities by graphical		click on exploring Leonardo click on Inventor's workshop

Topic	Learning outcomes	Suggested Teaching activities	Learning resources
	representation to produce a resultant		click on The elements of machines  IGCSE Physics, Hodder, Duncan T and Kennet H, page 80–82
P2	understand the meaning of the phrase <i>kinetic theory of matter</i> as describing a model for matter in terms of particles (atoms and molecules) in motion	Use examples of phenomena that are explained by the particle theory to build up understanding e.g. diffusion in liquids, diffusion of gases (bromine in air – fume cupboard required), crystal structure and so on. Students can observe Brownian motion, e.g. using the ‘smoke cell’ experiment.	This site has a good JAVA applet that shows diffusion. <a href="http://www.geocities.com/pirator/brown/Difus.html">http://www.geocities.com/pirator/brown/Difus.html</a>  Brownian motion is well illustrated on this site. <a href="http://www.phys.virginia.edu/classes/109N/more_stuff/Applets">http://www.phys.virginia.edu/classes/109N/more_stuff/Applets</a>  Click on Einstein’s explanation of Brownian motion.  IGCSE Physics, Hodder, Duncan T and Kennet H, pages 65–68
	appreciate that there is a connection between the temperature of an object and the movement of its particles		IGCSE Physics, Hodder, Duncan T and Kennet H, page 135
	appreciate that the three states of matter can be understood in terms of inter-molecular and inter-atomic forces and the motion of the atoms and molecules	Demonstrate the temperature changes that take place as ice is heated until it changes to water and then steam; provide a running commentary describing what is happening to the movement of the water particles. (This is probably not the time to introduce the concept of latent heat – concentrate simply on the increase in kinetic energy of the particles.)	IGCSE Physics, Hodder, Duncan T and Kennet H, pages 65–67
	be able to describe an experiment to determine the density of a liquid and or a regularly shaped solid and know that <i>density = mass /</i>	Simple experiments should be carried out in which students measure mass and volume of a liquid and calculate density. Using a solid, calculate volume from height, width and depth.	IGCSE Physics, Hodder, Duncan T and Kennet H, pages 59–61

Topic	Learning outcomes	Suggested Teaching activities	Learning resources
	<i>volume</i>		
	be able to use and describe the displacement method to find the density of an irregularly shaped solid	Extend to the displacement method (e.g. plasticine of different shapes in a measuring cylinder with water).	
	know the relationship between pressure and volume of a gas and understand how the relationship may be predicted by the kinetic theory	Extension students could carry out experiments using Boyle's Law apparatus, where pressure can be varied and the resulting changes in gas volume measured.	IGCSE Physics, Hodder, Duncan T and Kennet H, pages 141–146
	be able to describe qualitatively the effect of a change in temperature on the volume of a gas	Simple demonstrations can be used to show students the effect of temperature on gas volume, for example holding a round-bottom flask full of cold air (keep in the fridge before the lesson) with its open top under water, and holding the base with warm hands; and of temperature on pressure, as described in the text book reference.	
	know the relationship between pressure and temperature for a gas and understand how this leads to the Kelvin scale of temperature		<p>Extend this work by using the practical experiment suggested on this site about the temperature and pressure of a gas.  <a href="http://school.discovery.com/lessonplans/">http://school.discovery.com/lessonplans/</a></p> <p>Click on Physical science, then Temperature and Pressure</p>