IGCSE Co-ordinated Sciences 0654
Unit 18: Forces and motion

Recommended Prior Knowledge
Students should have a basic knowledge of the effects of balanced and unbalanced forces. They should have good graphing skills. Extension students should be able to manipulate formulae.

Context
This Unit covers Topics P3, P4, P13 and P12, all of which relate to forces and movement.

Outline
Students use graphs to show relationships between speed, time, acceleration and distance travelled. They relate force and acceleration, and consider the effects of friction. The effects of gravity are considered, including a simple treatment of the effects of air resistance on falling objects. Students learn the relationships between mass, velocity, kinetic energy and momentum. They can relate all of this work to road safety issues.

Topic	Learning outcomes	Suggested Teaching activities	Learning resources
P3	Understand the meaning of the terms *speed* and *acceleration.*		Some good work on velocity and acceleration with animations. http://www.fearofphysics.com *IGCSE Physics*, Hodder, Duncan T and Kennet H, pages 100–101
	Appreciate the existence of errors in measurements and understand how these may be reduced by taking the average of a number of readings.	A set of objects to be measured could be passed around between groups of students, and the measurements made by each group collected and compared.	*IGCSE Physics*, Hodder, Duncan T and Kennet H, pages 52–57 covers the main kinds of measurements that students will need to make
	Understand the relationships between distance, time, speed and	Students can work with trolleys using ticker tape or light gates, producing data that can be used to draw	*IGCSE Physics*, Hodder, Duncan T and Kennet H, pages 100–105

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	acceleration and appreciate how graphs may be used to display these relationships. Understand how distances travelled can be derived from the area under a speed-time graph.	speed/time graphs for constant speed and constant acceleration. Extension students can extend the trolley work to analyse the graphs further and calculate acceleration and distance travelled.	
	Be able to use the relationships $v = at$ and $s = 1/2at^2$ when applied to an object accelerating uniformly from rest.		*IGCSE Physics*, Hodder, Duncan T and Kennet H, pages 105–106
	Appreciate how the ideas of speed and acceleration can be applied to transport (e.g. road, rail etc.).	Work on thinking distance and braking distance of cars is relevant here.	*IGCSE Physics*, Hodder, Duncan T and Kennet H, page 123
	Understand the difference between *speed* and *velocity*. Appreciate that a body may accelerate by change in velocity, but without a change in speed.		*IGCSE Physics*, Hodder, Duncan T and Kennet H, page 100
P4	Know that force is measured in newtons.	Give students a 'feel' for the size of forces by providing a set of objects of different weights. Then set a challenge to estimate the weight in newtons of a further set of five objects. Extend this activity to other types of forces, for example the force required to open a drawer.	
	Understand that unbalanced forces change motion and that in the absence of an unbalanced force an	Students can investigate the effects of friction forces. They can find the friction force opposing the motion of a block on different surfaces by pulling on the block	*Teaching and assessing practical skills in Science*. CUP, Hayward D, pages 45–46.

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	object will either remain at rest or travel with a constant velocity. Appreciate that friction often provides an opposing force acting on moving bodies.	using a newton meter.	*IGCSE Physics*, Hodder, Duncan T and Kennet H, pages [illegible] and 112
	Appreciate qualitatively that the acceleration of a body depends both on its mass and on the size of the unbalanced force acting on it. Know the relationship between force, mass and acceleration given by the equation $F = ma$ Be able to use the relationship $F = ma$ in simple problems.	Students can find the effects of applying a constant force to a trolley on a runway, using ticker tape, to investigate whether a constant force produces a constant acceleration.	*IGCSE Physics*, Hodder, Duncan T and Kennet H, pages 113–114
P13	Appreciate that gravity is a force which acts between bodies even when they are not in contact.		There is much on this site about gravity, particularly to stretch the more able students: http://www.curtin.edu *IGCSE Physics*, Hodder, Duncan T and Kennet H, page 114
	Know that the Earth is the source of a gravitational field.		*IGCSE Physics*, Hodder, Duncan T and Kennet H, pages 125–127
	Appreciate why it is possible for objects to orbit the Earth without falling to its surface.	Students can feel, and see the effects of, centripetal force by spinning a bung attached to a string (see the suggested text resource for details). This can help them to understand how gravity provides a centripetal force that keeps satellites in orbit.	

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	Understand the part that air resistance plays in the way objects fall when close to the Earth's surface.		*IGCSE Physics*, Hodder, Duncan T and Kennet H, page 11
	Appreciate the distinction between *mass* and *weight*		*IGCSE Physics*, Hodder, Duncan T and Kennet H, pages 55 and 114
P12	Understand the meaning of the terms *kinetic energy* and *momentum* Be able to find both the kinetic energy and momentum of a moving body from a knowledge of its mass and velocity.	An air track can be used to show momentum effects using collisions and 'explosions' (using magnets attached to the vehicles to produce repulsion, or sprung buffer rods).	*IGCSE Physics*, Hodder, Duncan T and Kennet H, pages 118–121 At this site students can experiment with a 'Newton's Cannon' simulation: http://www.phys.virginia.edu Click on Newton's Cannon. http://www.ktca.org How the function of airbags can be explained using the concept of momentum, and ideas for investigations http://www.glenbrook.k12.il.us/gbssci/phys/mmedia/index.html#momentum Click on The Astronaut Catch for an example of a calculation using momentum, involving space walkers; this site also has many other examples of momentum calculations
	Be able to use kinetic energy to solve simple, qualitative problems involving force and motion. Be able to use momentum in simple, qualitative problems involving recoil.	Students could be given simple problems to solve relating to road safety.	*IGCSE Physics*, Hodder, Duncan T and Kennet H, pages 118–122

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	Be able to use kinetic energy and momentum to solve simple, quantitative problems involving force, motion and recoil. Understand the way the concepts of “kinetic energy” and “momentum” can be applied in simple everyday situations. Appreciate the relationship between the transfer of energy to a gas by heating and the rise in its temperature and the increase in the kinetic energy of its particles.	Students should already be familiar with this concept from their work in Unit 17.	