GCSE
ADDITIONAL SCIENCE, PHYSICS
UNIT P2 – Example 1
4463, 4451

Scheme of Work

Introduction

This Outline Scheme of Work is one of a number of schemes prepared by practising teachers for the new AQA GCSE Sciences suite. It is hoped that other teachers will find them helpful as the basis for the fully detailed schemes prepared for teaching from September 2006. Each outline scheme covers one unit (B1, B2, B3, C1, C2, C3, P1, P2, P3) and for some units more than one outline scheme is available. This is because there are different, equally valid ways of approaching the teaching of the specifications and a single scheme would not show the range of possible approaches.

The AQA specifications are designed to be used with a wide range of resources, so this scheme does not assume the availability of any particular printed or electronic publications, or any special equipment. Teachers are enabled to use existing resources, including their own, together with resources specially purchased for the new specifications.

The outline scheme is arranged under the section headings of the relevant specification, for example, *13.1/12.1 How can we describe the way things move?* The content in the section is further subdivided with a brief statement given of the coverage of each subdivision, together with activities that relate to that content and an indication of the number of hours it is suggested are needed to deliver that part of the content.

Opportunities to deliver 'How Science Works' and to use ICT are highlighted using the same icons as used in the specifications.

This identifies parts of the content which lend themselves to extended investigative work of the type needed to explore Sections 10.3–10.7 of the specifications. These sections are about obtaining valid and reliable scientific evidence.

This identifies parts of the content which lend themselves to activities which allow Sections 10.2 and 10.8–10.9 to be considered. These sections are about using scientific evidence, for example, how scientific evidence can contribute to decision making and how scientific evidence is limited.

This identifies where there are opportunities to use ICT sources and tools in teaching the specifications.

UNIT PHYSICS 2			
Total hours: 4		**13.1/12.1 How can we describe the way things move?**	
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Speed, velocity and distance-time graphs: • The slope of a distance-time graph represents speed • The velocity of a body is its speed in a given direction		• Construct distance-time graphs for a body moving in a straight line when the body is stationary or moving with a constant speed • HT: Calculate the speed of a body from a distance-time graph	Ideas about the relationship between speed, distance and time will have been met at KS3 but will need to be reviewed now, and graphical interpretations introduced. This leads on to new ideas about acceleration. The terms scalar and vector are not required.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Acceleration and velocity-time graphs: • The acceleration of a body is given by: acceleration = change in velocity/time taken for change • The slope of a velocity-time graph represents acceleration • The area under a velocity-time graph represents distance travelled		• Construct velocity-time graphs for a body moving with a constant velocity or a constant acceleration • HT: Calculate the acceleration of a body from the slope of a velocity-time graph • HT: Calculate the distance travelled by a body from a velocity-time graph	Work could be done using trolleys and runways. Data could be recorded using tickertape or light gates and data loggers. If data loggers are available this is an ideal opportunity to use ICT. Particularly useful for How Science Works: 17.5 - Presenting Data, and 17.6 - Identifying Patterns and Relationships in Data

Total hours: 8	13.2/12.2 How do we make things speed up or slow down?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
• Whenever two bodies interact the forces they exert on each other are equal and opposite		• Illustrate with simple examples, eg tug of war, stepping out from a rowing boat	No formal statement of Newton's Third Law is required.
• A number of forces acting on a body may be replaced by a single force which has the same effect on the body as the original forces all acting together. The force is called the resultant force.		• Students could try drawing some simple vector diagrams, although formal treatment of a triangle of forces is not required	Illustrate with examples of two tugboats pulling a ship.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
• If the resultant force acting on a stationary body is zero the body will remain stationary • If the resultant force acting on a stationary body is not zero the body will accelerate in the direction of the resultant force • If the resultant force acting on a moving body is zero the body will continue to move at the same speed and in the same direction • If the resultant force acting on a moving body is not zero the body will accelerate in the direction of the resultant force		• Illustrate with reference to an object resting on a table, where the weight is balanced by the reaction of the table • Illustrate with reference to a firework rocket; when the rocket is lit the upward force is greater than the downward force and the rocket accelerates upwards • Illustrate with reference to space ships, where rockets are not required to maintain uniform velocity once out of the gravitational field of planets • Illustrate with reference to a moving car being hit in the side by another car	Video clips or computer simulations may be useful here.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Force, mass and acceleration are related by the equation: resultant force = mass × acceleration		• Calculate the weight of a body using weight = mass × gravitational field strength	Continue using trolleys and runways or similar equipment, e.g. an air track. Data could be recorded using tickertape or light gates and data loggers. If data loggers are available this is an ideal opportunity to use ICT. Use different forces and different masses to find the effect on acceleration. There are also several computer simulations available.
• When a vehicle travels at a steady speed the frictional forces balance the driving force • The greater the speed of a vehicle the greater the braking force needed to stop it in a certain distance • The stopping distance of a vehicle depends on the distance the vehicle travels during the driver's reaction time and the distance it travels under the braking force.		• Instil the idea that the driving force pushes the vehicle forwards, whereas the frictional force acts in the opposite direction • Link to the idea that all of the kinetic energy must be transferred to heat • Link to stopping distances and braking distances shown in the table in the Highway Code	Discuss the advantages of fitting slicks to racing cars. Dragster cars need a parachute in order to provide sufficient braking force. Students could test their own reaction times – eg by using their foot to operate a switch, thus replicating the conditions when driving.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
A driver's reaction time can be affected by tiredness, drugs and alcohol		• Link to information in the Highway Code	How do the police collect data to determine whether a driver is drunk? Eg the breathalyser is always followed by a blood test or urine test - why is this?
A vehicle's braking distance can be affected by adverse road and weather conditions and poor condition of the vehicle		• Link to information in the Highway Code	The condition of a vehicle is checked during an MOT test. What do you think would be the most important data to collect, and why?
The faster a body moves through a fluid the greater the frictional force which acts on it		• Discussions concerning streamlining of cars and ships • Construction and testing of simple parachutes	Find and consider articles concerning the way that cars are designed in order to reduce drag. How do the scientists obtain this information and how do they interpret it?
A body falling through a fluid will initially accelerate due to the force of gravity. Eventually the resultant force on the body will be zero and it will fall at its terminal velocity		• Draw and interpret velocity time graphs for bodies that reach terminal velocity, including a consideration of the forces acting on the body	Experiments to determine terminal velocity, eg ball-bearings falling through glycerol or wallpaper paste.

Total hours: 5	13.3/12.3 What happens to the movement energy when things speed up or slow down?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
When a force causes a body to move through a distance, energy is transferred and work is done		• Discuss the transformation of kinetic energy to other forms of energy in particular situations	Examples may include lifting weights to gain gravitational potential energy.
Work done = energy transferred		• Idea that work is a measure of the amount of energy transferred, and therefore both are measured in joules	
The amount of work done, force and distance are related by the equation: work done = force applied × distance moved in direction of force		• Students could measure the amount of work they do in different situations, eg lifting weights on to a bench or using a bicycle ergometer	Work is measured in joules if the force is in newtons and the distance is in metres. Calculations will only involve forces parallel to the direction of movement.
Work done against frictional forces is mainly transformed into heat		• Show video clip of disc brakes on a racing car glowing white hot when in use	Calculations involving the amount of heat energy produced will not be required.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Elastic potential is the energy stored in an object when work is done on the object to change its shape		• Illustrate using springs or rubber bands	Note that if calculating work done on stretching a spring or rubber band, it is the *average* force that must be used: the force is not constant but increases with the amount of stretch.
The kinetic energy of a body depends on its mass and its speed		• Use trolley or air track to measure the kinetic energy of different masses at different speeds	Data loggers may be useful here to illustrate this.
Calculate the kinetic energy of a body using the equation: kinetic energy = $\frac{1}{2} \times$ mass $\times$ speed^2		• Practice calculations	HT only

Total hours: 4		13.4/12.4 What is momentum?	
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
• Momentum, mass and velocity are related by the equation: momentum = mass × velocity • Momentum has both magnitude and direction • When a force acts on a body that is moving, or able to move, a change in momentum occurs		• A difficult concept, but by referring to it as a resistance to a change in motion may help get the idea across • Possible using of computer simulation programmes	At first glance, momentum may seem a strange concept to students. However it is useful because, using the conservation law, we can use it to predict what will happen in collisions ands explosions. NB Momentum is a function of velocity and not speed; this is why it has both magnitude and direction. No formal statement of Newton's second Law is required.
Momentum is conserved in any collision/explosion provided no external forces act on the colliding/exploding bodies		• Use the conservation of momentum (in one dimension) to calculate the mass, velocity or momentum of a body involved in a collision or explosion	Use the ideas of momentum to explain safety features.
Force, change in momentum and time taken for the change are related by the equation: force = change in momentum / time taken for the change		• Practice calculations • Idea that when a car stops, all momentum must be lost. This can be achieved in a very short time, but involves a very large force (eg hitting a brick wall) or in a longer time using a smaller force (seat belts aim to achieve this)	HT only

Total hours: 5	13.5/12.5 What is static electricity, how can it be used and what is the connection between static electricity and electric currents?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
When certain insulating materials are rubbed against each other they become electrically charged. Negatively charged electrons are rubbed off one material onto the other		• Use polythene and acetate strips to generate static electric charge • Try picking up pieces of paper using a plastic pen rubbed on a cloth • Demonstrate bending a stream of water from a tap using a plastic ruler rubbed on a cloth	Video: Electrostatics
The material that gains electrons becomes negatively charged. The material that loses electrons is left with an equal positive charge		• Explain that it is only the negatively charged electrons that can move	
When two electrically charged bodies are brought together they exert a force on each other		• Use metallised polystyrene spheres together with polythene and acetate strips to verify the relationship	
Two bodies that carry the same type of charge repel. Two bodies that carry different types of charge attract		• Use metallised polystyrene spheres together with polythene and acetate strips to verify the relationship	

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Electrical charges can move easily through some substances, eg metals		• The idea that metals have some electrons that are free to move	
Current – the rate of flow of electrical charge		• The idea that current = charge moved ÷ time taken	Introduce the coulomb as the unit of charge.
A charged body can be discharged by connecting it to earth with a conductor. Charge then flows through the conductor		• Discussion of, eg lightning conductors, why do petrol tankers need to connect an earth strap when transferring fuel?	Explain why static electricity is dangerous in some situations and how precautions can be taken to ensure that the electrostatic charge is discharged safely.
The greater the charge on an isolated body, the greater the potential difference between the body and earth. If the potential difference becomes high enough a spark may jump across the gap between the body and any earthed conductor which is brought near it		• If a Van-de-Graff machine is available, this may be demonstrated	If a coulomb meter is available, this may also be used.
Electrostatic charges can be useful, re photocopiers, smoke precipitator and the basic operation of these devices		• Describe how these two devices work and provide the students with simple diagrams	Discuss why smoke precipitators are an important means of reducing atmospheric pollution.

Total hours: 8	13.6/12.6 What does the current through an electrical circuit depend on?		
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
Current-potential difference graphs are used to show how the current through a component varies with the potential difference across it		• Students practise drawing and interpreting V/I graphs	Interpret and draw circuit diagrams using standard symbols. The following standard symbols should be known: switch (open), lamp, switch (closed), fuse, cell, battery, resistor, diode, variable resistor, thermistor, ammeter, voltmeter, LDR.
The current through a resistor (at a constant temperature) is directly proportional to the potential difference across the resistor		• Practise questions on Ohm's Law	Apply the principals of basic electrical circuits to practical situations.
Potential difference, current and resistance are related by the equation: potential difference = current $\times$ resistance		• Introduce the algebraic form of the equation, V=IR	
The resistance of a component can be found by measuring the current through and potential difference across the component		• Could carry out an Ohm's Law experiment, using a power supply, ammeter in series and voltmeter in parallel to determine the value of an unknown resistance (eg a wire-wound 15 ohm resistor with the value obscured)	

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
• The resistance of a filament lamp increases as the temperature of the filament increases		• Measure and plot V/I characteristics for a 12 volt 6 watt lamp	There are ideal opportunities for practising graph work in this section.
• The current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction		• Measure and plot V/I characteristics for a diode (eg, IN4001) in series with a resistance	
• The resistance of a light-dependant resistor (LDR) decreases as light intensity increases		• Measure and plot V/I characteristics for an LDR (eg ORP12) in series with a resistor	
• The resistance of a thermistor decreases as the temperature increases (ie knowledge of negative temperature coefficient thermistor only is required)		• Measure and plot V/I characteristics for a thermistor (eg TH4) in series with a resistor	

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
The current through a component depends on its resistance. The greater the resistance the smaller the current for a given potential difference across the component.		• The idea of resistance as being something which makes it difficult for a current to flow • Analogies may be made between electrical current flow and the flow of traffic along roads or water through pipes	There are ideal opportunities for practising graph work in this section.
The potential difference provided by cells connected in series is the sum of the potential difference of each cell (depending on the direction in which they are connected)		• Students can use a voltmeter to measure the p.d. across several cells connected in different ways	
For components connected in series: (i) the total resistance is the sum of the resistance of each component; (ii) there is the same current through each component; (iii) the total potential difference of the supply is shared between the components		• Students could use a digital multimeter to check the total resistance of different combinations of carbon resistors	

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
For components connected in parallel: (i) the potential difference across each component is the same ; (ii) the total current through the whole circuit is the sum of the currents through the separate components		• Students can set up circuits with resistors or lamps in parallel and measure the current at different points in the circuit using ammeters	

Total hours: 5 — 13.7/12.7 What is mains electricity and how can it be used safely?

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Cell and batteries supply current which always passes in the same direction. This is called direct current (d.c.).		• Connect cells and low voltage a.c. supply to an oscilloscope to look at the pattern	
• An alternating current (a.c.) is one which is constantly changing direction. Mains electricity is an a.c. supply. In the UK it has a frequency of 50 cycles per second (50 hertz). • UK mains supply is about 230 volts		• Compare potential differences of d.c. supplies and the peak potential differences of a.c. supplies from diagrams of oscilloscope traces	HT: determine the period and hence the frequency of a supply from diagrams of oscilloscope traces.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
• Most electrical appliances are connected to the mains using cable and a three-pin plug • The structure of electrical cable • The structure of a three-pin plug • Correct wiring of a three-pin plug		• Students practise wiring a 3-pin plug. NB Safety precautions – turn off mains supply in lab.	Recognise errors in the wiring of a three-pin plug.
• If an electrical fault causes too great a current the circuit should be switched off by a fuse or a circuit breaker • When the current in a fuse wire exceeds the rating of the fuse it will melt, breaking the circuit • Appliances with metal cases are usually earthed		• Discussion of the pros and cons of fuses versus circuit breakers. Find out what sort of appliances should always be used with a circuit breaker • Demonstration of thin fuse wire (or strands of wire wool) glowing red-hot and melting when a large current is passed through. A 12 volt power supply may be used, but note danger of burning • Find out and explain how these two work together to protect the user. What happens to appliances that do not have a metal case? (Double insulation)	Recognise dangerous practice in the use of mains electricity.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
• The live terminal of the mains supply alternates between positive and negative potential with respect to the neutral terminal • The neutral terminal stays at a potential close to zero with respect to earth		• HT only • HT only	

Total hours: 5 — 13.8/12.8 Why do we need to know the power of electrical appliances?

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
Electric current is the rate of flow of charge		• Demonstrate model of water flow	Introduce idea of coulomb as the unit of charge.
When an electrical charge flows through a resistor, electrical energy is transformed into heat energy		• Identify devices which are designed to produce a heating effect and those in which the production of heat is undesirable (eg computer chips)	
The rate at which energy is transformed in a device is called the power. power = energy transferred/time		• Calculations using the equation and familiarity with the units joules and watts • Compare the brightness of, say, three 12 volt lamps labelled 6 watt, 12 watt and 24 watt	Idea that more powerful devices (e.g. heaters) use the most current and cost the most to run. Link to ideas of energy saving.
Power, potential difference and current are related by the equation: power = current × potential difference		• Calculate the current through an appliance from its power and the potential difference of the supply. From this, determine the size of fuse needed	Students could measure the heating effect of a lamp (eg by putting it inside a box containing a temperature probe connected to a data logger) and see how this changes when the current is changed.
Energy transformed, potential difference and charge are related by the equation: energy transformed = potential difference × charge		• The idea of a volt as a joule per coulomb	

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
The amount of electrical charge that flows is related to current and time by the equation: charge = current × time		• Calculations on the ampere as a coulomb per second	

Total hours: 4 13.9/12.9 What happens to radioactive substances when they decay?

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
• The relative masses and relative electric charges of protons, neutrons and electrons • In an atom the number of electrons is equal to the number of protons in the nucleus. The atom has no net electrical charge • Atoms may lose or gain electrons to form charged particles called ions		• Draw up a table of properties • Explain how the Rutherford and Marsden scattering experiment led to the plum pudding model of the atom being replaced by the nuclear model	Some examples of the causes of ionisation may be given, eg radioactivity or flames.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
• All atoms of a particular element have the same number of protons • Atoms of different elements have different numbers of protons • Atoms of the same element which have different numbers of neutrons are called isotopes • The total number of protons and neutrons in an atom is called its mass number		• Not much opportunity for practical work here, but could use a mechanical model to illustrate the alpha scattering experiment, eg a ball-bearing (representing the alpha particle) rolled down a slope towards a 1/r shaped “hill” representing the nucleus. Several scientific equipment manufacturers can supply such an item.	Show video clip to illustrate structure of the atom.
The effect of alpha and beta decay on radioactive nuclei		• Examples to illustrate idea that alpha particles are 2 protons and 2 neutrons (same as helium nucleus), so atomic number reduces by 2 and mass number by 4	In beta decay a neutron in the nucleus effectively splits into a proton which remains there and an electron ejected as the beta particle, ie mass number is unchanged but atomic number increases by 1.
The origins of background radiation		• Draw/study data (eg pie chart), listing the relative contributions made to background from different sources (eg medical, cosmic, rocks in the Earth’s crust)	Several companies advertise and sell radon detectors and radon removal pumps. How could you find out if your home needs one - or is this just a 'hard sell' by the companies? Links to HSW 10.8 Societal implications.

Total hours: 3		13.10/12.10 What are nuclear fission and nuclear fusion?	
Topic outline		**Teaching approach including possible experiments/investigation opportunities**	**Additional notes**
• There are two fissionable substances in common use in nuclear reactors, uranium 235 and plutonium 239 • Nuclear fission is the splitting of an atomic nucleus		• Revise the meaning of mass numbers	
• For fission to occur the uranium 235 or plutonium 239 nucleus must first absorb a neutron • The nucleus undergoing fission splits into two smaller nuclei and 2 or 3 neutrons and energy is released • The neutrons may go on to start a chain reaction		• Video clip of nuclear power station and atomic bomb	Discuss the pros and cons of atomic power –the peaceful use in generating electrical power, and the potential for ill-use, eg in atomic bombs. Discuss whether developing countries should be allowed to develop nuclear capabilities.

Topic outline		Teaching approach including possible experiments/investigation opportunities	Additional notes
• Nuclear fusion is the joining of two atomic nuclei to form a larger one • Nuclear fusion is the process by which energy is released in stars		• Idea that very large amounts of energy are released when this happens	Fusion could potentially supply us with far more energy than fission. What are the pressures that society puts on scientists trying to develop it?