Checkpoint Science Scheme of Work

Physics – Year 3

Topic: Electric Charge

Aims
That pupils should be able to:

- describe electrostatics and the concept of charge
- recognise that current is the same everywhere in a series circuit
- measure current in circuits

Links
Checkpoint curriculum – Pc 2, Pc 5, Pc 6
IGCSE Physics 4.2, IGCSE Co-ordinated Sciences P 7, IGCSE Combined Sciences Physics Topic Three, IGCSE Physical Science 4.2

Words
electrostatic, charge, ammeter

Activities

Objectives Students should be able to:	Possible Activities	Health and safety/notes
observe the production of electrostatic charge	There are a number of demonstrations possible to show electrostatic charging. After charging by rubbing, plastic rulers pick up small pieces of paper, strips of cling film spring apart, balloons stick to walls, plastic rods deflect a steady stream of water etc.	Explain that only negative charges move in these circumstances and that by moving away from a neutral site they leave a net positive charge. They can also induce opposite charges on neutral material. The effect is only noticeable on insulators because conductors allow negative charge to pass to the hand and then to earth.
investigate the laws of attraction and repulsion	Establish that there seem to be only two types of charge (only two effects are seen). Suspending one charged item and approaching with another shows that similar charges repel and unlike charges attract.	
consider the electrostatic generator	This machine for generating electrostatic charge usually provides a memorable lesson for students.	

	Even a simple one can build up several thousand volts and cause lightning flashes, hair to rise, neon lights to light up, windmills to turn etc. Electric current can be linked to charge through the electrostatic generator. Charge clearly flows from the metal dome and also lights a lamp, as does electric current.	

Resources

http://www.lessonplanspage.com/ScienceCurrentStaticElectricity68.htm

Topic: Heat Energy Transfer

Aims
That pupils should be able to:

- identify and explain the heat transfer processes of conduction, convection and radiation
- explain cooling by evaporation

Links
Checkpoint curriculum – Pe 3
IGCSE Physics 2.3, IGCSE Co-ordinated Sciences P 6, IGCSE Combined Sciences Physics Topic Four, IGCSE Physical Science 2.2

Words
heat energy transfer, conduction, convection, radiation, evaporation

Activities

Objectives Students should be able to:	Possible Activities	Health and safety/notes
investigate thermal conduction	Rods of different metals can be heated to find out which is the best conductor. It is important to heat the ends of the rods equally, perhaps by supporting on a non-combustible mat on a tripod and heating them all at the same time. The heat energy can be detected by a pin attached by wax to the far end of the rod, it is released when the wax melts.	Distinguish between heat and temperature. Give a particle explanation of the process. Safety goggles should be worn for heating.
investigate thermal insulation	Students can design and carry out an investigation into the best insulator, ensuring as far as possible a fair test. They can use the insulation to keep a liquid hot or to stop ice from melting for as long as possible. Data-logging could be used.	Offer practical insulators such as roof insulation (though not fibreglass), bubblewrap, polystyrene and if possible provide some feathers for comparison – small ones from an old pillow work best. Emphasise that materials containing air pockets are the best insulators. Warn students about the danger of carrying hot water around.
describe convection	Convection currents can be demonstrated in liquid (warming coloured crystals placed in a beaker of	Give a particle explanation of the process.

	still water) and air (using a candle in a box with two chimneys and placing a smoking taper above).	
describe radiation	Thermal radiation (infra-red) comes from all hot objects but students can investigate which surfaces emit / absorb heat the best. One way is to fill a metal container with hot water. Different surfaces, black, dull, white, shiny, give off more or less radiation. This can be detected by placing the hand 2-3 cm away from the surface.	Explain that the heat is not carried by particles in this case but by a type of ray similar to light which can travel through space. Warn students not to touch the metal cube.
describe evaporation	Students can investigate which conditions aid the rate of evaporation using tissues or small pieces of cloth, dampened. Factors which can be tested are temperature and moving air. Humidity is more difficult to test. The rate of cooling is a measure of the rate of evaporation.	Give a particle explanation of the process. Remind students about 'sweating' from the biology programme.
consider the vacuum flask	A vacuum flask (a broken one to reveal the inner layers) can be demonstrated as it has ways of preventing conduction, convection, radiation and evaporation which students can identify. Ensure that students understand that the flask can be used for keeping things hot or cold.	Students have great difficulty in distinguishing the different processes so as much practice as possible is necessary. They can consider ovens, air currents, why metals feel cold/ hot, the arrival of energy from the Sun etc.
apply knowledge about heat transfer processes to everyday situations.	Students can be set a challenge using their knowledge about heat transfer processes. Examples include designing / making an insulated house, designing clothing for a injured person or premature baby.	

Topic: Pressure and density

Aims
That pupils should be able to:

- explain that pressure is caused by the action of force on an area
- explain pressure in gases and fluids
- determine the density of solids, liquids and gases

Links
Checkpoint curriculum – Pf 3, Pf 4, Pp 4
IGCSE Physics 1.4, 1.7, IGCSE Co-ordinated Sciences P 2, P 5, IGCSE Combined Sciences Physics Topic One and Four, IGCSE Physical Science 1.4,

Words
density, pressure

Activities

Objectives Students should be able to:	Possible Activities	Health and safety/notes
calculate the density of a regular solid	If students are not completely happy with the concept of volume it is helpful if solids can be 'matched' by blocks of 1 centimetre cubes. The mass of the solids can then be found.	Explain that materials can only be compared if they have equal volumes so the mass of 1 cm^3 or 1 m^3 must be found in each case.
calculate the density of an irregular solid	Students should be able to suggest a way of finding the volume of an irregular solid and may even think of a way of dealing with a solid which floats.	
understand floating and sinking	Provide some objects for students to determine density and thus predict whether they will float. This could include liquids. They can suggest the effect on the floating object of using salt water.	

consider the pressure due to a solid	Discuss appropriate examples of experience of pressure such as walking on snow, mud, dry sand. Students explain why knives and drawing pins are effective but only if used the right way round. Pressing objects into plasticine, provided they are pressed with equal forces, shows that the smaller the area of contact the greater the pressure. Students calculate the pressure for items such as a suitcase on its different faces. They can calculate their own pressure by drawing round their feet on graph paper to find the area of contact and measuring their weight in newtons.	Units can be N / cm^2 or N / m^2 or kN / m^2 . Note that although this may be regarded as an appropriate activity, pressure calculations will not be tested at Checkpoint level.
consider pressure in liquids	The fact that pressure acts sideways can be shown with a plastic bottle which has holes in the sides at different heights. When filled, water is forced out sideways, the lower the hole the greater the pressure.	Reference can be made to dams and deep sea divers.
consider pressure in gases	Air pressure is relatively large so good demonstrations are possible. A container of at least three litres which can be connected to a vacuum or suction pump is compressed by the pressure of the atmosphere when the pump is switched on. Alternatively a heat-proof one containing a little water, can be heated and then have the top screwed on tightly causing the same effect as it cools. Blowing up balloons or tyres or heating tins with a lid on causes an increase of pressure which students can explain using the particle theory.	Plastic containers are safer in this context. A metal container will probably be needed here but if it is an old petrol container ensure that it is completely empty. For either method safety screens should be used.

Resources

http://www.explorescience.com/activities/Activity_page.cfm?ActivityID=29 (**requires membership)**
http://www.tnrcc.state.tx.us/air/monops/lessons/airpressurelesson.html

Topic: Electric Current

Aims
That pupils should be able to:

- use ammeters and voltmeters
- explain how the common types of component, including cells, affect current
- explain how current divides in parallel circuits
- interpret and draw simple parallel circuits

Links
Checkpoint curriculum – Pc 3, Pc 4, Pc 5, Pc 6
IGCSE Physics 4, IGCSE Co-ordinated Sciences P 7, IGCSE Combined Sciences Physics Topic Three, IGCSE Physical Science 4

Words
Ammeters, voltmeters, parallel circuits

Activities

Objectives Students should be able to:	Possible Activities	Health and safety/notes
investigate the flow of charge in a circuit	Emphasise that batteries produce charge which flows from one end to the other round a circuit. Students can suggest ways of increasing the rate of flow of charge (more batteries, easier path). Let students try this out using a variable resistor to dim / brighten a bulb.	Students should be able to draw circuit diagrams showing each arrangement they set up.
use an ammeter to measure current	Set up a variety of circuits	
understand the effect of simple components	Students should investigate the effect of adding various lengths of resistance wire, a variable resistor, different lamps, an ammeter. A demonstration of a fuse with an ammeter in the circuit shows their function clearly.	Students must be warned that short lengths of wire will get hot. Symbols for these components must be given.
understand the effects of further components	Students enjoy finding out about 'mystery' components such as diodes, buzzers, motors and reed switches. They can establish which are 'one-way' devices but of course must be warned about	

	any that may be broken by passing a current in the wrong direction. They might be challenged to protect a box from being opened by designing a buzzer alarm.	
investigate lamps in parallel circuits	Lamps can now be arranged in parallel and series circuits so that students can compare their brightness. They can be challenged to place switches to operate chosen bulbs for e.g. stage lighting.	Help will be needed with connecting circuits and drawing circuit diagrams. Apparently identical bulbs will have different brightness so it is worth exchanging them or selecting matching ones. Alternatively meters can be used.
measure currents in parallel circuits	Parallel arrangements can be set up placing an ammeter (or several) at different points in the circuit.	Students should see that currents divide at a junction and unite again before returning to the battery.
use a voltmeter	Students should be shown that a voltmeter measures the voltage output of a cell, two cells, etc. It can then be used to measure the voltage across any two points in a circuit. They should also try the putting the meter in series to show that the circuit then does not 'work'. The voltage across a home made cell can be detected using two different metals and a solution or simply a fruit. Investigate into the effect of different metals and different fruit / vegetables.	

Resources

http://www.learn.co.uk/default.asp?WCI=Unit&WCU=3059
http://library.thinkquest.org/28032/cgi-bin/psparse.cgi?src=activity0405

Topic: Energy crisis

Aims
That pupils should be able to:

- describe the major sources of energy
- describe alternative sources of energy
- state why alternative sources of energy are needed

Links
Checkpoint curriculum – Pe 1
IGCSE Physics 1.6, IGCSE Co-ordinated Sciences P 18, IGCSE Combined Sciences Physics Topic Two, IGCSE Physical Science 1.6

Words
solar, hydroelectric, renewable and non-renewable sources

Activities

Objectives	Possible Activities	Health and safety/notes
Fossil fuels	Students can research the origins / extraction of the main fossil fuels, coal, oil and gas. It should be emphasised that the original source is the Sun.	
Problems with fossil fuels	The reason for considering that there is an energy crisis is that these fuels are running out because they cannot be replaced. Another important problem is that of pollution. Students can observe the effects of acid (rain) on limestone or chalk (buildings) and also discuss environmental concerns. Other problems are cost of extraction and transportation and damage to the environment.	
Non-renewable fuels	As well as the fossil fuels, students should know that energy can be obtained from radioactive materials. This, too, is not a renewable source. Although it emits no polluting gases there is a major problem in dealing with the radioactive waste which results.	A careful definition of renewable is necessary i.e. a source that can be replaced in a short time and therefore does not get used up.

Solar energy	Students are probably familiar with solar powered calculators or a small solar powered motor can be demonstrated. Ensure that they distinguish between heating and transferring the solar energy as electrical energy i.e. between solar (photovoltaic) cell and solar panel.	
Waves and rivers as energy sources	Students can label / colour appropriately a diagram of the different parts of a hydroelectric power station. A dynamo will show the principle of transferring the kinetic energy of the turbine as electrical energy.	
Wind as an energy source	Small windmills can be made to show how the shape of the sail is responsible for converting the movement of the wind into rotation.	
Problems with alternative energy sources	Students should discuss and list the problems of using all kinds of energy sources, see Year 1). These might include suitability of site, climate, cost of converting to electrical energy, pollution of any kind and destruction of habitats. They could consider the energy sources most used in their region and whether there would be benefit in changing to other sources.	

Resources

http://www.infinitepower.org/pdf/FactSheet-04.pdf
http://www.ase.org/educators/lessons/hs/renewable.htm