Checkpoint Science Scheme of Work

Physics – Year 2

Topic: Magnets and electromagnets

Aims
That pupils should be able to:

- describe the properties of magnets
- recognise and reproduce the magnetic field patterns of a bar magnet
- construct and use an electromagnet

Links
Checkpoint curriculum – Pm 1, Pm 2, Pm 3
IGCSE Physics 4.1, IGCSE Co-ordinated Sciences P 14, IGCSE Combined Sciences Physics Topic Three, IGCSE Physical Science 4.1

Words
magnet, magnetic poles, repulsion, magnetic field pattern, compass, electromagnet

Activities

Objectives Students should be able to:	Possible Activities	Health and safety/notes
investigate the properties of magnets	Students can investigate the properties of magnets given a pair of magnets, a simple compass, various metallic and non-metallic materials, a small dish of water and piece of lightweight object to float the magnet on. If available some objects like door seals, magnetic catches, magnetic putty can be demonstrated as well.	Magnets: Always come to rest pointing N-S Attract iron and steel (and nickel and cobalt) Repel the same pole of another magnet Attract / repel other magnets without contact
make magnets	Students can magnetise strips of steel / screw driver blades by stroking with a magnet several times in one direction. To return to the start of the stroke the magnet should be taken to some distance from the iron. Demagnetising can be achieved by heating or pulling from a coil carrying an alternating electric current. The coil should be orientated in an E-W direction.	

know about attraction and repulsion	Attraction and repulsion can be seen very easily if magnets are suspended. This is also an opportunity to check which pole points to the north of the earth.	Poles should be defined and the rule of attraction and repulsion emphasised.
plot magnetic fields	Field patterns for single magnets or for facing poles can be observed using iron filings on paper held over the magnet but these do not give very clear patterns. The method using plotting compasses avoids the problem of getting iron filings on magnets but does need explaining carefully.	
consider some examples of the use of magnets	There are a number of tricks and games which use different properties of magnets, usually hidden. Students can make up their own or bring any they have to show the class.	
make electromagnets	Students will be intrigued by the idea of a magnet which can be turned on and off. They can make their own using a low voltage power pack and design a way to test its strength, and improve its strength.	
research the use of magnets and electromagnets	Students can research uses and should find some in medical contexts, route finding, security, sorting steel from other materials for recycling etc.	

Resources

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

Topic: Light

Aims
That pupils should be able to:

- use rectilinear propagation to explain the formation of shadows and other phenomena
- describe how non-luminous objects are seen
- describe reflection and refraction and use the law of reflection
- explain the dispersion of light to give a range of colours
- explain colour addition and subtraction, and the absorption and reflection of coloured light

Links
Checkpoint curriculum – Pl 1, Pl 2, Pl 3, Pl 4, Pl 5, Pl 6, Pl 7
IGCSE Physics 3.2, IGCSE Co-ordinated Sciences P 10, IGCSE Combined Sciences Physics Topic Five, IGCSE Physical Science 3.2

Words
scatter, shadow, reflection, refraction, dispersion, absorption

Activities

Objectives Students should be able to:	Possible Activities	Health and safety/notes
understand the rectilinear propagation of light	Students observe sources of light, candles, bulbs etc and suggest how it is possible to see them. Cut off the light with a screen with a hole in and look for an illuminated spot. Pass light through a glass sided box containing smoke to show a ray of light. Ask students to suggest how they see objects which are not luminous.	Introduce a ray of light as a straight line with an arrow.
explain the formation of shadows	Students should be able to explain why shadows form and investigate them e.g. size and sharpness, using a clearly defined object and bright light.	
understand how a pin-hole camera works	A good way to reinforce the idea of rectilinear propagation is to make and use a pinhole camera. A simple box can be made light-tight and have a pin-hole in the centre of a sheet of	Diagrams with light rays should be used to show why the image is inverted. Students love to take pictures with such a simple device. In this case the screen is

	black paper at one end and a screen at the other. If the hole is pointed towards a fairly bright light source the image of the light source will be seen inverted on the screen. Students can investigate making several holes, enlarging one hole and placing a convex lens in front of the enlarged hole.	replaced with a piece of film which can be developed to give a negative. A trial run is necessary to estimate a reasonable time of exposure in the prevailing conditions.
understand reflection	Students can study images in plane mirrors. Rays of light directed at the mirror can be used to investigate the law of reflection. A periscope can be made from cardboard tubes and small plastic or aluminium mirrors. The distance of the image can be investigated using a Pepper's ghost model.	Always use the word image to refer to what is seen in the mirror. Diagrams should be used to show the directions of the rays of light.
understand refraction	Students can observe refraction by the 'disappearing coin trick' at the bottom of a pan which is slowly filled with water or seeing a ruler 'bending' in water. They can investigate the effects by looking through a glass block and observing apparent depth. The swimming pool is a good context to use if appropriate. Plotting the passing of rays through glass blocks, rectangular and semi-circular, enables students to link to ray diagrams.	Diagrams should be used to show the directions of the rays of light.
understand dispersion	A spectrum can be demonstrated using a good prism. They can also be observed using cheap diffraction gratings. They can be compared with a rainbow to try to emphasise that light is a mixture of all the colours.	Diagrams should be used to show the directions of the rays of light through the prism.
understand absorption and transmission	Students should investigate filters and explain that some colours are absorbed and some transmitted. Demonstrate seeing coloured objects using a shiny white board and primary coloured felt pens. In a well darkened room the shapes light up or disappear. You can try writing a message which has a different meaning depending on the colour of light falling on it.	

understand addition of colours	A demonstration of adding colours (lights not dyes) uses three lights with red, green and blue filters in a circuit with a rheostat. Being able to fade out / in the different colours enables cyan, magenta and yellow to be obtained (on a white board) and even white when all three are mixed.	

Resources

http://www.spartechsoftware.com/reeko/Experiments/refraction.htm
http://www.eduref.org

Topic: Sound

Aims
That pupils should be able to:

- explain the properties of sound in terms of movement of air particles
- recognise the link between loudness and amplitude, pitch and frequency

Links
Checkpoint curriculum – Ps 1, Ps 2,
IGCSE Physics 3.3, IGCSE Co-ordinated Sciences P 10, IGCSE Combined Sciences Physics Topic Five, IGCSE Physical Science 3.3

Words
vibration, amplitude, pitch, frequency, longitudinal

Activities

Objectives Students should be able to:	Possible Activities	Health and safety/notes
recognise how sounds are made	Students can make sounds with simple objects such as plucking stretched elastic bands on a box, twanging rulers, blowing across test tubes. They should be able to suggest how their 'instrument' might be given a range of different notes and the ability to be loud or soft. Students can invent an instrument (design only).	Emphasise the word 'vibration' of a source of sound.
relate sound to hearing	A model ear is interesting to see and gives an opportunity for discussing ways of preventing ear damage. Students can research the sound receptors of animals such as the bat and dolphin. Using a signal generator and a loud speaker the class can investigate their range of hearing. The additional use of a CRO enables students to 'see' that the sound is still being produced even when it is above the pitch they can hear.	It is important to produce such notes for a short time and at relatively low amplitude otherwise it can cause pain and headaches.
understand how sound travels	A drum, or loudspeaker on very low pitch, are good ways to show that vibrations are moving large quantities of air to and fro.	Give the name 'longitudinal' to these waves.

	A Slinky spring pushed rhythmically along its length shows rarefactions and compressions. Students should know that sound also travels through water (swimming pools, whales, ultrasound) and through solids (ticking watch through table, railway lines etc)	
consider how fast sound travels	Students can think of examples where they can tell that sound is travelling more slowly than light (noise across a field, thunderstorms). The speed of sound can be measured using a sharp sound which can be heard at least 200 m away. Alternatively the echo received from a distant wall can be used but remind students that the sound travels twice the distance.	If students make this measurement it is good practice for the class to average their measurements, discarding any which seem to be very inaccurate.
interpret information provided by a cathode ray oscilloscope	The cathode ray oscilloscope can be used to give traces of the sounds produced by a signal generator, synthesizer or a microphone. It is worth explaining by using a battery or power pack that the CRO responds to an electrical pulse and that a microphone transfers sound energy to electrical energy.	Students can relate the waves they see with the sounds they hear. Using instruments will show that different ones have different patterns associated with their sound. Show the characteristics called wavelength, amplitude and frequency.
understand the relationship between loudness and amplitude	The trace described above can be used to show how louder sounds have higher amplitude waves. Use a simple trace like that from a recorder or entertain your students by singing notes louder and softer.	A signal generator or synthesizer can again be used.
understand the relationship between pitch and frequency	The trace described above can be used to show how higher sounds have a higher frequency, again a recorder or voice at different pitches will show this.	A signal generator or synthesizer can again be used.

Resources

http://school.discovery.com/lessonplans/programs/soundwaves/
http://www.teachervision.com/lesson-plans/lesson-342.html (**Note: needs membership)**
http://www.teachnet.com/lesson/science/physics/speedofsound.html

Topic: Energy Transformations

Aims
That pupils should be able to:

- describe energy as the ability to make things happen (do work)
- describe how energy is converted from one form to another
- say what is meant by the conservation of energy

Links
Checkpoint curriculum – Pe 2
IGCSE Physics 1.6 IGCSE Co-ordinated Sciences P 5, IGCSE Combined Sciences Physics Topic Two, IGCSE Physical Science 1.6

Words
transformation, conservation, kinetic (moving) energy, stored energy

Activities

Objectives Students should be able to:	Possible Activities	Health and safety/notes
understand the relationship between energy and work	Students can discuss what energy is used for in the modern world and what alternatives for each use (if any) were available say, 100 years ago. They could illustrate their ideas. Examples might be electric light compared with oil lamps, cars compared with carts etc. The alternatives available in 100 years time might also be considered.	Emphasise that this useful **work** is done when the energy obtained from a source is transferred to a different type of energy.
measure work	Students can measure quantities of work most easily by lifting things. Ideally they should lift weights of around 10 N or 20 N through a known height in metres, calculating the work done in joules. Sandbags are the safest with the weight in newtons marked on. They can also lift their own weight by doing step-ups or climbing stairs. Some Centres have machines called ergometers which	Note that calculations will not be tested at Checkpoint level. Avoid allowing this to become too competitive. A large number of sandbags is not needed if a partner puts one back down while a second is being lifted.

	enable a known force to be used over a known distance.	
interpret and draw energy transfer diagrams	Lots of examples can be provided here so that as many different types of energy and transfer are covered as possible. Examples include; catapult, Bunsen burner, clockwork toys, electric motors lifting small weights, blowing up and releasing balloons, dynamos, the use of batteries heating or lighting circuits, light sensitive paper, musical instruments. Students can list some home appliances and say what energy transfers take place. They can study some Sankey diagrams and suggest what energy is wasted i.e. passed to the surroundings by various processes.	These represent quantities of energy by the width of an arrow.
recognise energy transfer in green plants	Students may not have studied photosynthesis at this stage so they might need to compare some plants growing in the light and some in the dark. They need to appreciate that the plants can only be successful in the light and that they are then useful for food.	The outcome of this process is that plants gain energy from Sunlight and store it as chemical energy.
relate energy requirements to food intake	Students should study food packets and compare energy contents of various foods. They should appreciate that the units are the same as those of work and that the chemical energy released from these foods in respiration is mainly transferred as movement and thermal energy.	
consider the energy conversions taking place in a power station.	Students can be provided with the outline of the processes in a power station and complete the stages and transfers by cutting and pasting. A Sankey diagram showing the wasted energy and so rather low efficiency of the process, is worth seeing.	
understand the conservation of energy	Swinging a pendulum starting at the teachers nose gives the opportunity to see that the bob does not lose a noticeable amount of energy but simply	

	transfers it from ‘moving’ to ‘stored’ and back again. Sankey diagrams also help in the explanation that energy is not used up but simply transferred to something else.	

Resources

http://www.bpa.gov/Corporate/KR/ed/sold/energy/45/can_it.pdf

Topic: Speeding up

Aims
That pupils should be able to:
- interpret simple distance / time graphs
- describe the effect of forces on motion
- describe the effect of gravity on objects

Links
Checkpoint curriculum – Pf 1, Pf 2
IGCSE Physics 1.6 IGCSE Co-ordinated Sciences P 5, IGCSE Combined Sciences Physics Topic Two, IGCSE Physical Science 1.6

Words
acceleration, gradient, gravity

Activities

Objectives Students should be able to:	Possible Activities	Health and safety/notes
measure speed	Students can measure their walking, hopping, running pace etc. They can estimate the speed of various objects such as a snail, a plane, or research the speed of athletes, to practice the use of different units. Data logging can be used for very fast or very slow speeds. Students can make model cars from cans and rubber bands.	A suitable safe site must be chosen if students are permitted to run at speed.
calculate average speed	Students can measure the speed of local traffic and relate it to the average speed of a whole car journey.	This can only be done if a safe place is available, such as behind a railing or fence. The distance between two markers e.g. posts, is best measured by the teacher at an earlier time.
produce distance-time graphs	A motion sensor is a very useful device for showing motion instantly on screen. The device emits ultrasound waves which reflect from an	

	object ahead and return. The computer measures the time interval and plots the distance-time graph so that a student moving towards the computer can see the shape immediately.	
interpret gradients on distance-time graphs	Given a graph e.g. of an animal tracking prey, students can explain how they know whether the animal is moving fast, slowly or still. They should be able to calculate the speed and can be shown that this is the same as the gradient of the line at that point.	
interpret changes of gradient on distance-time graphs	Students should discuss what happens where gradients change abruptly and whether it matches reality.	The program also contains some preset graphs which challenge students to reproduce the correct speeds, a popular activity. For practice a number of problems of graph interpretation should be set.
consider acceleration and braking	The motion sensor can also demonstrate acceleration and deceleration. Cars are a good example to use here and some questions on braking distances from a Highway code can be used. Students should not be expected to do any quantitative work on acceleration.	
understand balanced forces	It can be seen that, by applying equal forces in opposite directions to an object at rest, it can stay at rest, such as a wooden trolley with equal weights attached on opposite sides. Students can apply the idea to a floating object such as wood on water. The force acting downwards can be measured with a Newton meter and then the wood lowered into water showing the upthrust.	
understand the effects of friction	Friction can be introduced by looking at sliding forces along different surfaces e.g. the soles of shoes on gravel, tarmac, vinyl. Balanced forces can also result in constant speed. To show reduction of friction leading to balanced forces home-made hovercraft can be used. Use handmade helicopters and parachutes to find terminal velocities or marbles falling through oil etc	Handmade hovercraft are flat wooden shapes with a hole in the centre. The mouth of a blown up balloon can be pushed through the hole and the air will support the wood for a short time. Friction during movement can be compared with and without the balloon. The air resistance on falling objects leading to terminal velocity should be referred to here.

understand the relationship between gravity and weight	Kilogram masses can be hung on Newton meters to find their weight. This can be described as the pulling force of the earth. Other weights can be found to familiarise students with newtons.	Describe weight as the force of gravity.
consider gravity and the planets	The existence of a centripetal force can be shown by swinging a small object (a bung) around the head on a string. Releasing it shows the direction of travel of the object. Show a model of the solar system and discuss how the planets are held in place by the gravitational pull of the Sun.	A collection of spheres roughly to scale and held by students moving round will be sufficient.

Resources

http://www.school.discovery.com/lessonplans/programs/frictioninourlives/index.html