



# SSERC Bulletin

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Ideas and Inspiration supporting Science & Technology for all Local Authorities

*Tackling big issues (Let's Talk)*

*SSERC + NSLC + RCUK = Credit Crunch CPD*

*Pasco SPARK*

*The Art of Induction*

*Health & Safety*

*Laser guidance*

*The Signs they are a changin'*

## Summary

*Let's Talk* is an initiative, funded by the AstraZeneca Science Teaching Trust and the Wellcome Trust, which aims to encourage Scottish primary and early secondary school pupils to discuss important health related science issues. In sympathy with the vision of the new 'Curriculum for Excellence', *Let's Talk* sets out to embed innovative ways of approaching science and health in the classroom and independent evaluation has shown how exposure to the approach has had a marked impact on teacher confidence to try new techniques and a better learning experience for their pupils. Science features increasingly in our lives, especially in areas of health where technological advances pose important social, ethical and economic questions. We face increasing choice in how we live our lives, and are subject to powerful economic and social forces that attempt to influence which paths we take. *Let's Talk* sets out to provide young people with the knowledge and skills that will serve them in the future to evaluate both the choices on offer and the messages that accompany them.

## Introduction

Deaths from coronary heart disease and cancer in Scotland are amongst the highest in the UK. Figures have fallen in recent years overall, though the downward trend is less pronounced amongst the most deprived communities. Between 2000 and 2007 deaths from cancer reduced by nine per cent



**Figure 1** - Technological advances pose ethical questions.

amongst the population as a whole, but actually increased by one per cent in the most deprived areas. Reducing these figures further will rely on persuading more people to change their attitudes and behaviours.

Therefore educating young people about the science associated with health choices has taken on a new significance. Where once biology teachers were expected to go beyond anatomy and physiology to discuss the reasons why, say, smoking is bad for you or the science behind a healthy diet, a combination of factors has squeezed the time available for such discussion in science lessons. With lifestyle diseases at the forefront of political and health economic concerns, perhaps now is the time to restore the link between what we do and what we know, when it comes to our health.

In Scotland, the need to meet challenges about physical and mental health has placed this work at the core of the Government's major education reform 'Curriculum for Excellence'. The new curriculum, currently being taught from primary year 7 (P7) includes a commitment to ensure that each pupil:

- understands and develops their physical, mental and spiritual well-being and social skills
- understands how what they eat, how active they are and how decisions they make about their behaviour and relationships affect their physical and mental well-being
- participates in a wide range of activities which promote a healthy lifestyle
- learns about where to find help and resources to inform choices
- assesses and manages risk and understands the impact of risk-taking behaviour

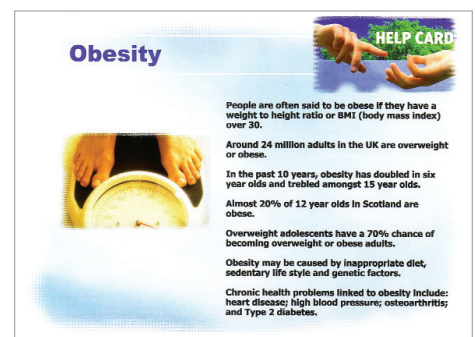
Our technological, knowledge-rich and choice-oriented society poses further challenges to today's young people. The choices are great - stem cells, genetics, food security and global warming all pose difficult political and lifestyle



**Figure 2** - Example of Agree/Disagree card.



**Figure 3** - A popular kit from the *Let's Talk* range.



**Figure 4** - Help cards give background information.

challenges. Yet when it comes to the effects of scientific advance, how well informed are we to make difficult personal, social or ethical choices that they bring?

*Let's Talk* is an education programme aimed at teachers and their pupils that sets out to develop a scientifically literate society, one in which individuals feel

<sup>1</sup> Health of Scotland's population - Health Inequalities, High Level Summary [www.scotland.gov.uk/Topics/Statistics/Browse/Health/TrendsHealthOutcome](http://www.scotland.gov.uk/Topics/Statistics/Browse/Health/TrendsHealthOutcome)

empowered to weigh up options and reach their own conclusions. Scotland has always excelled in producing scientists and engineers, but this scheme has as its core the desire to produce an informed citizenry with the confidence to challenge and interrogate health and environmental messages and their sources.

*Let's Talk* is the brainchild of Marjorie Smith, a teacher at Dollar Academy and curriculum development expert, currently working with SSERC. *Let's Talk* is based around a series of teaching and learning packs developed with funding from the independent AstraZeneca Science Teaching Trust (AZSTT) and the Wellcome Trust, and aimed at upper primary and early secondary school pupils and their teachers.

Currently the work being carried out in more than 20 Fife primary and secondary schools is being extended to include Midlothian, East Lothian and Edinburgh.

## Look Who's Talking

The teachers' packs comprise professionally produced DVDs, guidance notes, background information, a glossary and activity materials that provide all that a teacher needs to get young people talking about science, society and ethics. The initial idea and early materials were developed with the support of the Wellcome Trust, through its Engaging Science awards scheme.

A particularly popular kit is themed *Diet, Diabetes and Obesity* (Figure 3) and has been used in 200 schools in Scotland. Typically, teachers using the packs introduce the theme to their class and then are encouraged to divide them into small groups. Each group is given a set of cards and one member reads its contents to the others. Each card comprises a series of facts e.g. Figure 4.

The group has to discuss and arrive at an answer to the generic question: *Do you think this is a problem for society and if so, why?* Next, pupils decide on the acceptability of a series of policy options

(also presented on cards), such as: After sifting and small group discussion, the teacher brings the entire group together to consider the complexity of the subject under consideration. The pack also provides a set of postcards on which each pupil is encouraged to write a summary of his or her position on the matter. A few weeks later the teacher will post the cards - the passage of time providing an opportunity for pupils to reflect on their ideas and to see their original suggestions afresh.

## What do teachers think?

Many science teachers feel uneasy about addressing social and ethical issues in science classes. Changes in curricula and professional development opportunities have gone some way to ensuring that science is not simply the 'delivery of factual knowledge', yet many teachers of science find it hard to shift from this more traditional role. Michelle Russell, a biology and guidance teacher in West Lothian, identified the nature of the challenge for some. Ms Russell told the Times Educational Supplement Scotland that while science teachers like to "tell pupils the facts" they are "less comfortable with the kids forming their own opinions".

A study of this project as part of AZSTT's wider evaluation of the programme states: *"This project has been particularly successful at generating high-quality material and involving teachers in the development, so they are powerful advocates"*

## The impact and value of Let's Talk

A sample of 15 *Let's Talk* users completed survey questionnaires comprising structured and free response questions. In addition, responses were gathered from 58 evaluation forms included with packs and returned by teachers. The following sections are based on a synthesis of both sets of data.

Respondents were asked to rate three sets of activity<sup>1</sup> using a six-point scale ranging from poor (1) to excellent (6). Their views were overwhelmingly

### acceptable/not acceptable

Couples wanting to adopt a baby will be turned down if either of the couple are obese.



### acceptable/not acceptable

Nursery schools will introduce weight loss programmes for all over-weight children.



### acceptable/not acceptable

Children at school should be weighed each year. Schools with children with low average weights will get rewards from the local authorities.



**Figure 5** - Pupils decide on the acceptability of a series of policy options.

positive, with the majority ranking the usefulness of the resources as excellent for all three themes, though fewer teachers appear to have used the Vaccinations and Health scheme. The quality of each resource was also highly regarded, with responses registering as excellent in all but three cases.

## Who is using Let's Talk

Response from the evaluation suggests that the resource packs have been used in a range of subjects: Higher Biology, Science, Biology, Home Economics, Chemistry, Social Education, Human Biology, Access Science, English. The year groups using the activities comprise: P6, P7, Int2, S1, S2, S3, S4, S5 and S6. The materials have also been used by Access to Science groups, in teacher professional development and in health education for parents.

## Changes in classroom practice

Though *Let's Talk* stands alone as a resource, the intention is that its usage will broaden the themes, contexts and approaches for teaching and learning about science. The evaluation highlights how the scheme promotes better discussion activity by providing a real structure for managing meaningful

<sup>2</sup> (i) Diet, Diabetes and Obesity; (ii) Liver and Alcohol; (iii) Vaccinations and Health

► debate. The increase in teacher confidence seems to have an effect that goes beyond the individual topics and packs:

*"I have tried to introduce more active learning into lessons. I have incorporated more debates and discussions. I am also more confident to try out new ideas".*

## Pupil understanding and enjoyment

Pupils appeared to understand some of the issues associated especially with the 'lifestyle' diseases covered in *Diet, Diabetes & Obesity* and *The Liver*. They started with different levels of knowledge about the subject matter, with greater awareness of the science associated with obesity and alcohol abuse and less about the relevance of vaccinations and cervical cancer, other than the fact that girls would be receiving an injection but little appreciation as to why. Teacher feedback indicated that the activities really did help pupils to think about issues they would otherwise not have considered and increased their awareness of the issues, and sensitivities associated with them.

The skills that pupils felt *Let's Talk* most improved while engaged in this unit of work were communication, discussion and listening. The Vaccines materials also managed to convey some fairly complex concepts in an accessible and enjoyable way. The DVD was valued as the best activity by almost 70 percent of respondents, with around a quarter praising the 'agree-disagree' cards approach as the most enjoyable. All pupils said that they understood more about vaccines after they had completed the unit, with 80 percent suggesting they would recommend the lesson format to friends in other classes.

*Let's Talk* has been shown to establish an environment in which discussion about the social and ethical questions linked to health-related science can occur. But how much of the success of the scheme simply focuses on giving both teachers and pupils the confidence simply to talk and how much encourages reference to real evidence and data? The project unapologetically sets out to raise issues of science and its impact on society, yet attempts to underpin the ensuing discussion with sound science.

## Impact on education policy

The overall aims of the project were to encourage teachers to develop strategies and approaches that engage young people in understanding the science behind the headlines and to help them articulate considered views based around evidence. It would appear that *Let's Talk* has met these expectations and achieved more. Working closely with curricular leaders, education officers and education advisers at the heart of the Scottish Government means that the work is potentially much more than a curriculum initiative. *Let's Talk* has set in train the essential elements that hopefully will become embedded in how science is taught in Scotland. The philosophy is consistent with the principles of the Curriculum for Excellence and Marjorie Smith and her associates appreciate that long-term

**Let's Talk**

**The liver and alcohol**

Form a group of about 6 pupils and collect a LIVER help card. Read it and then, as a group, use the information to complete this table:

The production of:	The breakdown of:	The storage of:

Now collect 2 other help cards, Alcohol facts and Alcohol effects and give one or other of the cards to each member of your group. Read the cards and choose one person to lead the discussion about each card. Write 4 facts which worried your group into the box below.

Now each pupil should complete the 'Is this ok?' task and as a group discuss any differences which you find in your answers.

Figure 6 - The liver and alcohol activity sheet.

sustained success relies on training and support, establishing cross-curricular links and promoting buy-in.

## Conclusions

*Let's Talk* is more than simply a pack of school resources. In fact it is an exemplification of the challenges and opportunities that science offers. Health and lifestyle choices are hard to make, especially when we are continually exposed to the persuasive power of the media and prevailing cultural experience. Access to reliable knowledge and a context in which young people can explore choices, should be the very least formal education provides. The strength of *Let's Talk* goes beyond its potential to help teachers to talk to pupils and pupils talk both to their peers and to their parents, but also its position at the interface between education policy, curriculum change, professional development and health awareness. The health impact of programmes like this, takes time to become visible, since attitudes and behaviours are resistant to change, and health benefits slow to surface. Yet the evidence suggests that the educational outcomes alone are more than worth the effort.

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In Bulletin 229 [1], we urged readers to look out for more courses that we would be running in partnership with Research Councils UK, following an agreement between SSERC and the National Science Learning Centre. These courses bring teachers and researchers together to promote contemporary, exciting science in the classroom. The last group of these CPD days proved very popular as RCUK awarded a bursary of £200 per teacher to participants' schools. In all cases, this covered the cost of the course.

The next round of RCUK courses is now underway. In December, thanks to the British Geological Survey, we were able to run two days at which 39 physics and geography teachers were not only introduced to the science of earthquakes and their detection but also left the BGS HQ with a working seismometer to take back to school. This equipment proved capable of detecting January's Haiti earthquake. A further 7 physicists went to CERN in Geneva where the world's biggest experiment, the Large Hadron Collider (LHC) is based. They were accompanied by SSERC's Senior Physics Associate, Jim Jamieson.

In February, 15 chemists had a day themed around cheap solar electricity at Edinburgh University. Innovative practical work included the extraction of dyes from plants in order to construct and test dye-sensitised solar cells.

The Roslin Institute is famous for creating Dolly the Sheep and was also the venue for the biologists' course on transgenics. This was a day where the ethical side of science featured very strongly. What lies beyond Dolly, and what are the implications for society?

Looking to the future, the partnership between SSERC, NSLC and RCUK is continuing, with further courses planned later in 2010. Details of all SSERC courses can be found at [www.science3-18.org](http://www.science3-18.org)

## Reference

[1] <http://tinyurl.com/look-for-RCUK>

Cover pic: - Globe of Science and Innovation at CERN



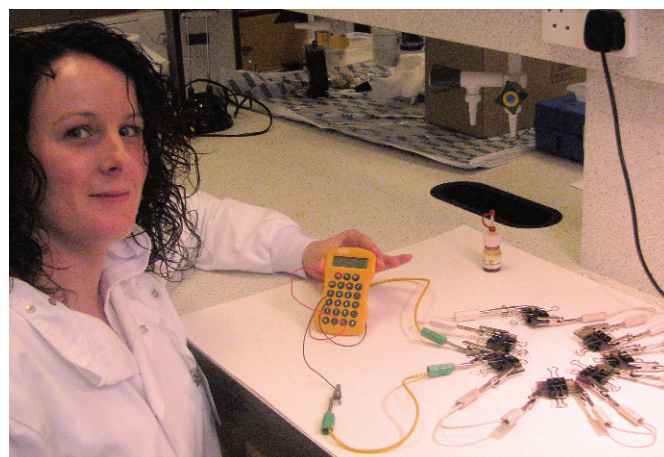
**Figure 1** - CERN delegate and her home-made particle detector



**Figure 2** - LEIR (Heavy ion programme for the LHC)  
Photo courtesy of SOLARNU on Flickr



**Figure 3** - Building and testing the seismometer



**Figure 4** - Measuring the output from the solar cells

One of the chief difficulties in reviewing a Pasco SPARK (Figure 1) is deciding how to categorise it. The SPARK certainly has features that take it beyond the realm of a conventional data logger. It uses a system of electronic workbooks called SPARKlabs. The Pasco website [1] claims that SPARKlabs “...completely integrate background content, data collection and analysis, even assessment—all within the same environment”. According to the manufacturers, it is a “science learning system”. The SPARK looks tough, attractive and quite simple. Make your own jokes about professional footballers. The 14.5 cm colour LCD display screen is touch-sensitive. It has 1 GB memory and comes with a mains charger, software CD and voltage and temperature probes. The two large buttons at the top of the screen can be used to start and stop logging. On one side of the unit (Figure 2) is an on / off switch, charger socket and a compartment for the built-in battery. A charging bay is available that allows a class set of SPARKs to be charged together. The two round contacts that mate with this can be seen to the right of the switch.

The SPARK has four sensor ports (Figure 3). 3.5 mm and 2.5 mm jack sockets are available for the supplied temperature and voltage probes respectively. There are also two ports for PASport sensors. Two USB sockets facilitate connection to a computer, printer, mouse or memory stick. A package can be downloaded to allow a SPARK to interface with a computer.

There are more than 60 SPARKlabs built into the SPARK and the users can design their own. A SPARKlab consists of a number of pages. These may contain text, images or displays such as graphs. Figure 4 shows a page from a SPARKlab on pH. The page gives instructions to the user and also displays pH when the data collection icon (the triangle at the bottom of the screen) is touched.

Screenshots can be saved to a pen drive for inclusion in student reports.

We tested the SPARK for ourselves by using the voltage probe to investigate the variation of current with time when a capacitor is charged (Figure 5).

To obtain the graph in Figure 5, we had to define current in terms of the measured voltage across a known resistance in the circuit divided by that resistance, then change the graph to display current rather than voltage against time. Carrying out these steps was easy and fairly intuitive, though we did have to RTFM [2] now and again. We would have liked to have been able to define our own units for current, but this did not appear to be possible.



Figure 1 - Nothing fishy about the Pasco SPARK.



Figure 2 - on/off switch and charging sockets (base of unit).



Figure 3 - SPARK ports (top of unit).

The 10 readings per second data capture rate was fine for this experiment. We were able to increase this to 1000 Hz for others. Capture rate appears to depend on the sensor used. By zooming in on a voltage / time graph, we determined the voltage resolution to be 5 mV, the same as the Xplorer GLX we reviewed in Bulletin 226 [3]. This suggests that a 12 bit analogue to digital converter is used. When we reviewed the Xplorer, Pasco pointed out to us that analogue to digital conversion usually takes place in the sensor itself and hence may be of a higher resolution for some sensors.

Figure 6 illustrates a number of the SPARK's data handling and analysis tools. Data has been selected by calling up the graph tools (on the right of the picture). Selecting a region of the graph involves touching two places on the screen. We found this quite fiddly at first, especially if the points were near the top, bottom or edges of the screen. When dragging the selection tool, it was quite easy to accidentally rescale the graph or shift its position. Also, dragging was very slow when we set the data capture rate to a high value, though it was not an issue with our capacitor experiment's 10 Hz capture rate. Some of these issues were less apparent when we used a mouse.

Once data is selected, you can zoom in on it, or perform various functions such as statistical analysis or curve fitting. This is perhaps the first handheld logger where we feel it is unnecessary to transfer data to a computer with a larger screen for detailed analysis.

## Conclusion

At the time of writing, the SPARK costs £305, £10 more than the same company's Xplorer GLX. The Xplorer has four ports for Pasport sensors as opposed to the SPARK's two, two fast response temperature probes whereas the SPARK has one, a built-in signal generator and sound sensor. In these respects it has a higher specification than the SPARK. Where the SPARK scores is in ease of use. Teachers can design their own SPARKlabs, deciding on the types of displays and instructions to show on screen. Combine this with a chunky, attractive design and push-button operation and you have a device that is appealing to a wide range of users.

The SPARK is available from Feedback Instruments [4].

- Stars:**
- \*versatile SPARKlabs,
  - \*looks sturdy yet attractive
  - \*(relatively) large, colourful touch screen

**Wishes:** less fiddly data selection

## References

- [1] <http://www.pasco.com/spark/>
- [2] RTFM = read the flaming manual
- [3] <http://tinyurl.com/interfaces-226>
- [4] [www.fbk.com](http://www.fbk.com) (but [www.pascophysics.co.uk](http://www.pascophysics.co.uk) takes you to data logging products and <http://www.pasco.com/featured-products/spark/index.cfm> is more useful for further SPARK information)

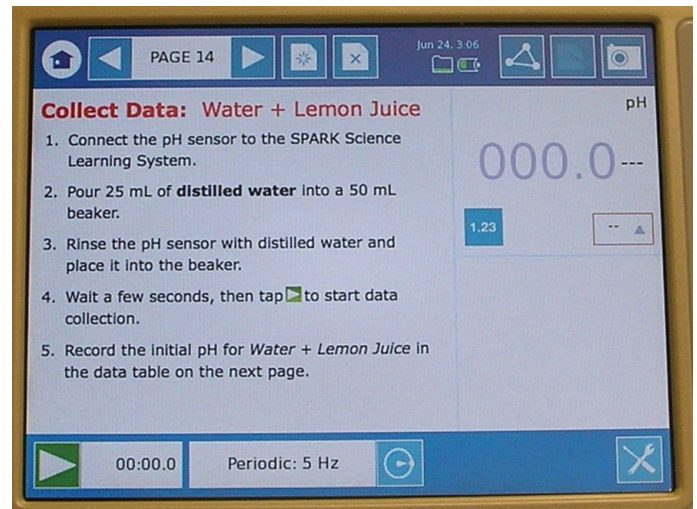


Figure 4 - One page of SPARKlab.

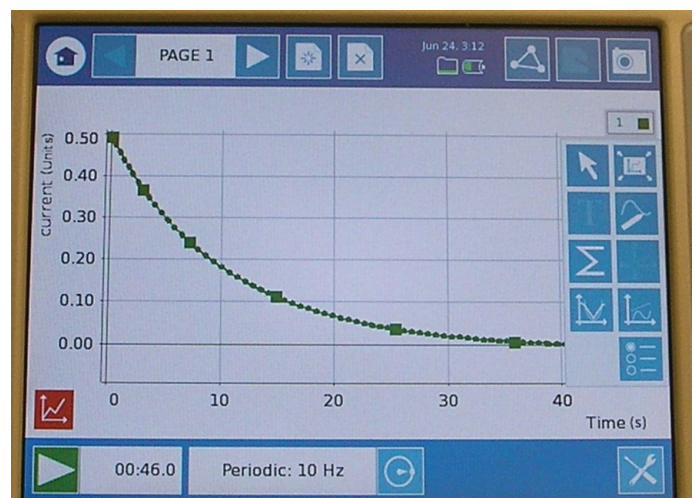


Figure 5 - Graph of charging current versus time in a d.c. circuit containing capacitor and resistor.



Figure 6 - Statistical analysis performed on selected data.

Here we look at a method for examining the factors that affect the voltage induced across a coil by a moving magnet. Schools are likely to have most of the necessary equipment for these activities. We see the potential for an Advanced Higher investigation here; indeed a student from an Edinburgh secondary school visited SSERC to carry out the experiments detailed below.

## Induced Voltage and Speed

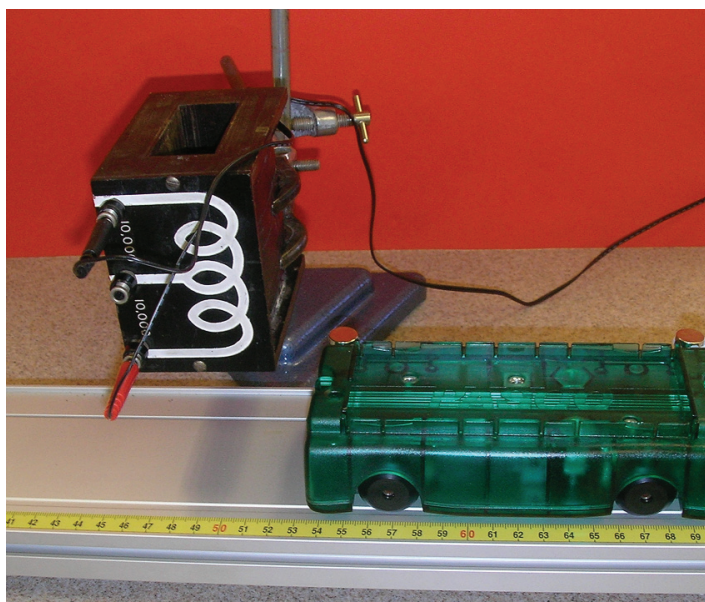


Figure 1 - Setup for investigating induced voltage versus speed.

This experiment uses neodymium magnets. These are very strong for their size, so much so that they can pinch skin when attracted to a magnetic object. They are particularly dangerous if swallowed and should be kept away from pacemakers, credit cards and magnetic storage media. Two magnets are fitted to

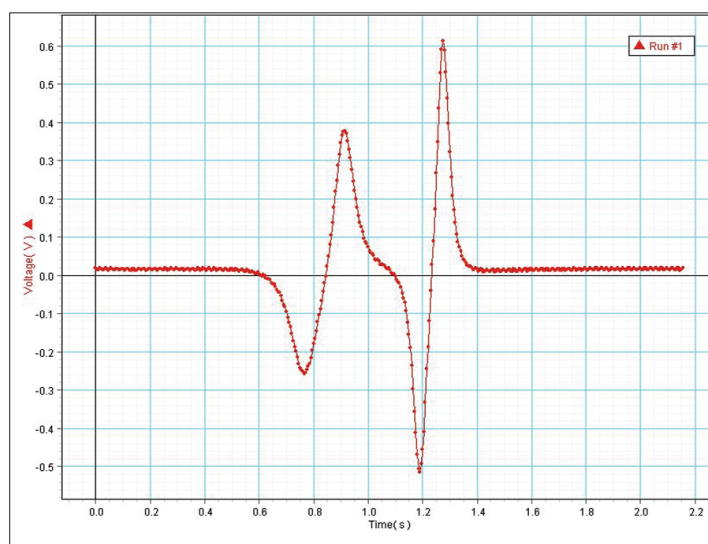


Figure 2 - Induced voltage versus time.

a trolley, same pole upwards in each case, at a known distance apart. As shown in Figure 1, the cart is placed on a ramp, above which is suspended a coil that is connected to a datalogger via a voltage probe. There should be as little clearance between the magnets and coil as possible. With the datalogger running, the trolley is released and passes beneath the coil. Figure 2 shows a graph of induced voltage with time for one run of the trolley.

As each magnet passes beneath it, a voltage is induced across the coil. This voltage changes polarity as each individual magnet passes. This is explained by Lenz's Law. An induced voltage opposes the change that brought it into being. Thus, as the magnet moves towards the coil, a voltage is induced across the coil, setting up a magnetic field that opposes the approaching magnet. After the magnet passes under and moves away, a field is created in the opposite direction to try to keep the magnet from moving away.

The first peak is smaller than the second because the trolley is accelerating as it passes under the coil. To find speed, we found the time to get from positive peak 1 to positive peak 2 and divided the separation of the magnets by this time. This gives an average speed. We then found the average induced voltage by adding the two positive peak voltages together and dividing by two. The trolley was released from different positions on the ramp, sometimes with the aid of a push, to give a range of speeds. Results are shown in Figure 3.

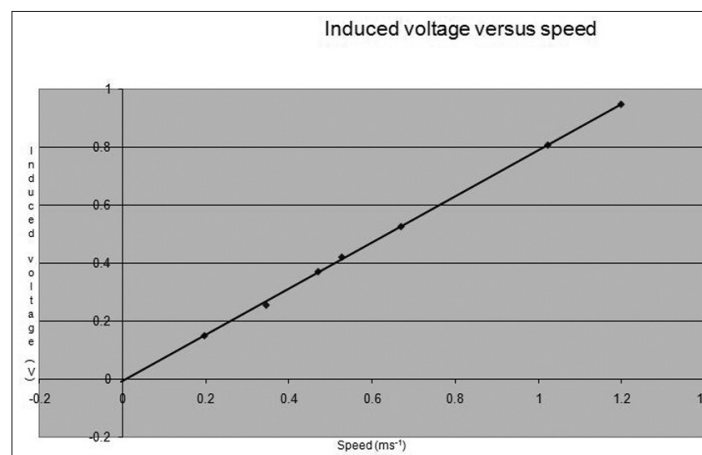


Figure 3 - Graph of induced voltage versus speed.

We recall seeing a spoof article in a journal that translated common phrases found in scientific papers. The phrase "typical results are shown" translated as "the best results are shown". Each time we or our visiting student tried this experiment we obtained a straight line with an acceptably small scatter. On occasions it did not go through the origin. This could not always be accounted for by the small systematic uncertainty present in voltage and visible in Figure 2, an offset we were unable to eliminate. The experiment relies on the magnetic



field of the two magnets being the same. This may not be the case for two reasons. The magnets themselves may not be identical or they may not be mounted at exactly the same height. There is a way of checking this. Look at Figure 4 below. It shows the relationship between the induced EMF and the rate of change of magnetic flux.  $N$  is the number of turns on the coil.

$$\varepsilon = -N \frac{d\Phi}{dt}$$

SO

$$\varepsilon dt = -Nd\Phi$$

**Figure 4** - Equation linking induced EMF with rate of change of magnetic flux.

If we integrate each side, we see that if the magnetic flux from each magnet is the same, the area under the induced voltage / time graph should also be the same each time a magnet passes under the coil. We were able to check this as we were handling data using Datastudio which has the facility to calculate the area under the graph for a selected region of data.

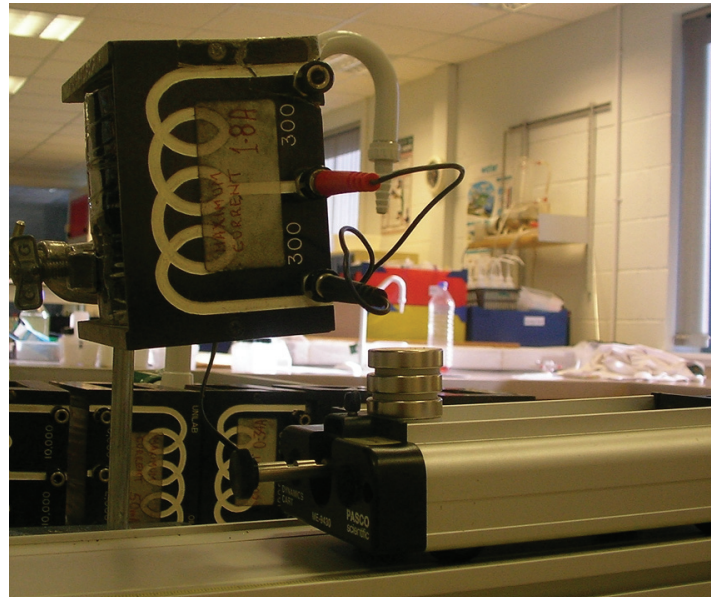
We had to place the magnets sufficiently far apart such that the first magnet was clear of the coil before the second passed below it. A smaller coil allowed us to place them closer together, meaning that the speed did not change as much from peak to peak. Our method assumes that the mean voltage occurs at the same time as the mean speed. If this is not the case, then the shorter the time interval over which average speed is found, the better. The trade-off is that, since the time interval is found by subtraction, a small time interval will be subject to a large percentage uncertainty. The coil supplied with the SEP Seismometer Modelling Kit [1], which has 7195 turns, allowed us to place the magnets 8 cm apart. This proved to be a good compromise.

Note that it is not necessary to measure the separation between the magnets. This will be constant throughout the experiment, so the inverse of the time between peaks can be used in place of speed when its relationship with induced voltage is studied.

Another potential confounder in this experiment is electromagnetic braking. As the magnet approaches the coil, the induced EMF sets up a magnetic field that will act against its motion. Our coil was connected to a datalogger which has a high impedance. Hence, any induced current in the coil will be small, as will be the resultant braking effect. Note also that some dynamics carts contain built-in magnets. These may result in blips on the graphs.

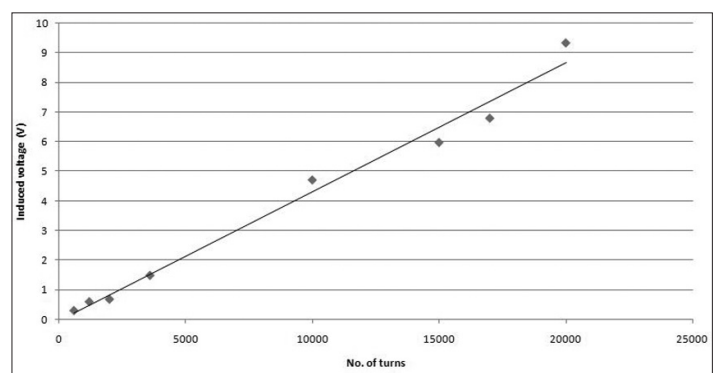
### Induced Voltage and Number of Turns

In this experiment, the speed of the moving magnet will be the same each time so there is no need for a pair of magnets. To get the maximum induced voltage, we used a stack of four 24 mm diameter neodymium magnets, as shown in Figure 5.



**Figure 5** - Number of turns experiment.

The setup presented us with two problems. Firstly, great care had to be taken to clamp the coil in the same position each time. Secondly, taking the coil in Figure 5 as an example, there are two sets of coils, each of 300 turns. They can be used individually, or together to give a coil of 600 turns. Using the top set of coils gives a different induced voltage to the bottom set and neither is half the value of that obtained when all 600 turns are used. Each set of coils behaved if it was a different distance from the magnets. We solved this by taking the average of the voltages obtained from the top and bottom sets. Some of the coils were not symmetrical, for example one set had 2000 and 15000 turns. In this case we took readings when the 2000 turn coil was at the bottom, then inverted the coil and took readings when it was at the top. We then averaged both sets of readings. When the experiment was repeated, the trolley was released from the same point on the slope so that the speed was the same each time it passed below the coil. This gave a straight line graph (Figure 6), though the scatter was greater than that in the first experiment. This may be due to the difficulties encountered in keeping the coils in the same place each time a new set is used.



**Figure 6** - Induced voltage versus number of turns.

### Induced Voltage and Distance

In this set up, the variation of the induced voltage with the distance from the moving magnet was explored. We had never heard of this experiment being attempted using school equipment before and were thus unsure of what to expect. Figure 7 shows a magnet with one of its poles uppermost. In theory, magnetic field strength varies as the inverse cube of  $x$ , the distance from the pole measured axially as shown.

This relationship breaks down if  $x$  is not large in comparison with  $a$ , the radius of the pole-face. Under these circumstances, the magnetic field strength varies with the inverse cube of  $r$  where  $r = \sqrt{(x^2 + a^2)}$ . Our hypothesis was that induced voltage would follow the same relationship if we kept the speed of the magnet and the number of turns of the coil constant. When we plotted induced voltage versus  $r^3$ , we got a straight line through the origin. This was with the small SEP coil (Figure 8). We felt that its dimensions were more suitable for an investigation involving distance.

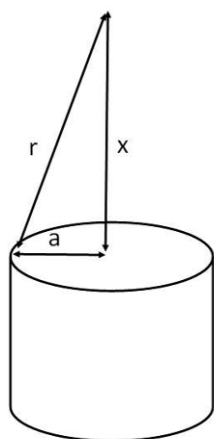


Figure 7

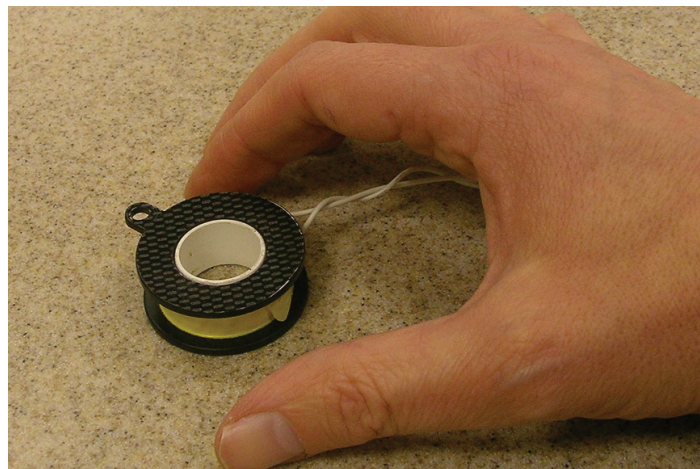


Figure 8 - SEP coil.

Taken as a group, we feel that these experiments could form the core of an Advanced Higher investigation. They go beyond the current curriculum but do not require exotic resources. The experiments work well and provide opportunities for data analysis and discussion.

### Reference

[1] [www.mutr.co.uk](http://www.mutr.co.uk), part number SEP 172

## Health & Safety – Laser guidance

We have recently revised our guidance on the use of lasers by pupils. Previously, we had said that certain lasers could be used by pupils in S3 and above. Much more is now known about lasers and their associated hazards. We therefore feel that we can extend their use to S1 and S2. Thus, all secondary pupils may work with lasers.

### Rules for safe laser use

- The laser classification is either Class 1 or Class 2, but not Class 1M or Class 2M or anything greater than Class 2.
- Pupils are made aware of the safety precautions they must take. They must never stare into the beam, which should be terminated by some sort of beam stop.
- The laser is stable or clamped.
- Work is supervised at all times.

Why Class 2? Class 2 lasers emit only visible light and are rated at 1 mW or less. Our natural aversion reflex – blinking or turning away – prevents us from becoming exposed accidentally to a harmful amount of laser radiation. Note that certain laser pointers are unclassified. Their power output can vary significantly depending on the batteries fitted. Indeed, we have heard of some that are nine times more powerful than they ought to be.

### Reference

[1] <http://tinyurl.com/green-lasers-sserc> Green lasers, Bulletin 229, SSERC 2009

Also, laser pointers may be picked up by pupils and waved around. Laser diode modules, such as the green one described in Bulletin 229 [1], are a safer option. Some may still ask why we would want pupils to use a laser device. Whilst it is true that using a laser introduces an additional hazard compared to a conventional light source, the risk is small if it is operated properly. Using a laser ray box (Figure 1) removes the need for a blackout, reducing the risks associated with moving around a darkened room.

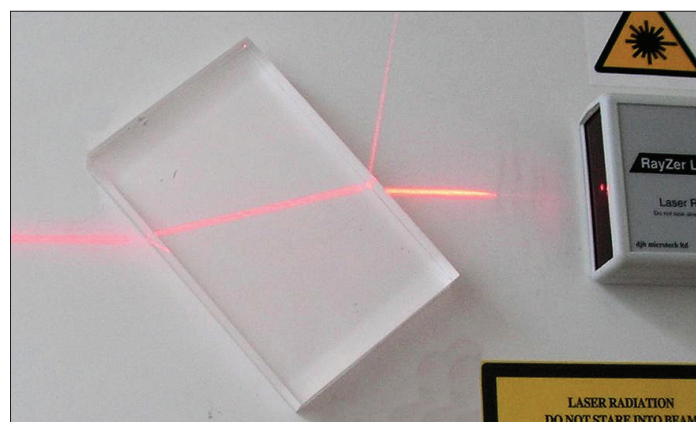


Figure 1 - A laser ray box used in a refraction experiment.

Under the Classification, Labelling and Packaging (CLP) Regulation EC 1272/ 2008 [1], the signs (and phrases) that are changing are the existing ones we use to alert us to the hazardous properties of chemicals as shown in Table 1.

Why change a system which has been used quite successfully for over 40 years? Worldwide, there are many different systems for classification and labelling of chemicals. Consequently, one and the same substance may be classified at the same time as toxic, non-hazardous or harmful to health – depending on in which country the classification has been made.

Different symbols are also used to indicate the same hazard.

Countries in the UN, including European Union Member States, have been working together with industry representatives and other stakeholders to agree on a classification and labelling system that can be used worldwide.

The outcome is the Globally Harmonised System of Classification and Labelling of Chemicals (GHS). The GHS provides a single system to identify hazards and to communicate them in transporting and supplying chemicals across the world.

CLP implements the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals into the European Union. GHS introduces a set of globally harmonised criteria for the classification of physical hazards, health hazards as well as environmental hazards.

More specifically, this implies the introduction of a uniform system of:

- hazard classes and categories
- hazard pictograms
- signal words
- hazard statements, and
- precautionary statements

Although many of the GHS pictograms are similar to the existing EU system, they have been re-designed and given a new shape and colour. Users will start to see these new pictograms, hazard and precautionary statements, and signal words on chemical labels as suppliers switch to the GHS system.

Sign	Hazard	Example of Statement
	Oxidising	Contact with combustible material may cause fire
	Flammable	Highly flammable
	Dangerous for the environment	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment
	Irritant	May cause sensitization by skin contact
	Corrosive	Causes burns
	Toxic	Harmful in contact with skin
	Explosive	Risk of explosion by shock, friction, fire or other sources of ignition

**Table 1 - Existing signs based on Dangerous Substances and Preparation Directives.**

We shall also endeavour to update the pictograms and associated statements on the Hazardous Chemicals part of SafetyNet on the SSERC website.



















The new symbols will look like this:

Physical Hazards				
Explosives	Flammable Liquids	Oxidising Liquids	Compressed Gases	Corrosive Metals
Health Hazards				Env. Hazards
Acute Toxicity	Skin Corrosion	Skin Irritation	Aspiration Hazard	Hazardous to the Aquatic Environment

**Table 2 - GHS-Hazard Pictograms and correlated Hazard Classes.**

A number of labelling elements will change under CLP:

- new pictograms replace the old signs (see Table 3 overleaf).
- descriptive Indications of Danger, such as “Flammable” and “Harmful” are replaced by the simpler Signal Words “Danger” and “Warning”.
- “Danger” indicates more severe hazard categories and “Warning” indicates less severe hazard categories.
- Wording is changed e.g. “very toxic” is replaced by “fatal”.
- Risk and Safety Phrases are replaced by Hazard Statements and Precautionary Statements. In many cases these new phrases are very similar to the old phrases, but there are also many new phrases, particularly for the Precautionary Statements. (see Table 3 overleaf).

DSD/DPD*	CLP Regulation No 1272/2008	Hazard Statement**	Precautionary Statement***
		Heating may cause an explosion flames/hot surfaces. No smoking	Keep away from heat/sparks/open
		Heating may cause a fire	Keep only in original container
		May intensify fire: oxidizer	Take any precautions to avoid mixing with combustibles
		Causes serious eye damage	Wear eye protection
		Toxic if swallowed	Do not eat, drink or smoke when using this product
		Toxic to aquatic life	Avoid release to the environment with long-lasting effects
		May cause allergy or asthma symptoms or breathing difficulties if inhaled	In case of inadequate ventilation wear respiratory protection
		May cause an allergic skin reaction	Contaminated work clothing should not be allowed out of the workplace
		Contains gas under pressure; may explode when heated	Protect from sunlight. Store in a well ventilated place.
		Corrosive to metals	

**Table 3 - GHS – Hazard and precautionary statements (H- and P- statements).**

\* signs relevant to old system of Dangerous Substances & Preparations Directives

\*\* replaces current Risk Phrases, many of which may be already seen as Hazard Statements

\*\*\* replaces current Safety Phrases

### The implementation schedule

The European Union adopted CLP on 20th January 2009 for all EU Member States. The EU states have until 1st December 2010 and 1st June 2015 respectively to classify and label all substances and mixtures in accordance with the new GHS criteria. In this context, a substance is taken as being a single chemical e.g. propanone (acetone).

Until then, the EU Dangerous Substances Directive (DSD) 67/548/EEC as well as the Dangerous Preparations Directive (DPD) 1999/45/EC [2] can be used in parallel with GHS as chemical products with the old and the new label will be in circulation together.

These EU Directives will be repealed at the end of the transitional period.

Chemical products already placed on the market (on the shelf) with the old labelling

### References

[1] <http://ec.europa.eu/enterprise/sectors/chemicals/classification/how-does-clp-work/>

[2] <http://tinyurl.com/DSD-DPD>

#### See also for further information:

<http://www.hse.gov.uk/ghs/index.htm> - Health & Safety Executive

[http://echa.europa.eu/help/nationalhelp\\_en.asp](http://echa.europa.eu/help/nationalhelp_en.asp) - National Helpdesk

[http://ec.europa.eu/environment/chemicals/ghs/index\\_en.htm](http://ec.europa.eu/environment/chemicals/ghs/index_en.htm) - EC classification, labelling and packaging of chemical substances and mixtures

[http://echa.europa.eu/classification/clp\\_guidance\\_en.asp](http://echa.europa.eu/classification/clp_guidance_en.asp) - European Chemicals Agency (ECHA)

are permitted to be sold for an additional 2 years after the expiration of the respective deadline. The main burden of implementing these changes will fall on the supplier. Early feedback from suppliers of chemicals commonly used by schools indicate they will be working on these changes in the summer of 2010 for inclusion in their 2011 catalogues.

If you use chemicals, you should:

- Look out for the changes and check that you are doing what is needed to use the chemical safely. With the change in the way that chemicals are tested under CLP compared to DSD/DPD to classify them, it is inevitable that some chemicals will be re-classified e.g. some substances may be re-classified as hazardous where they were not so before, while for others their classification criteria may have changed. If you are an employer, alert your employees to these changes too.
- Speak to your chemical suppliers if you have any questions or if you don't understand that changes that have been made.

If you are an employer:

- provide your employees with adequate information, instruction and training.
- Ask employees to follow the advice provided on the new labels and, where appropriate, in Safety Data Sheets.

The important thing is not to panic!