SSERC *Bulletin*

Ideas and inspiration supporting science and technology for all Local Authorities

No. 241 - Winter 2012

 - ISSN 1759-1082

Let's Talk - Diet, Diabetes

Like many areas of the UK, Scotland is experiencing a dramatic increase in obesity and the related health issues which arise from some members of our population being overweight. The increase in the number of people who have Type 2 diabetes correlates to this increase in obesity and the overall trend has been likened to an epidemic (see Figure 1).

The onset of Type 2 diabetes has been occurring at a younger age and many school children are now exhibiting signs which show that they are likely to have the condition in the near future. This is obviously a great concern to teachers and many are looking for ways in which they might raise some of these on-going issues in their classrooms. Clearly these are not easy matters to discuss and teachers will want to approach the discussion in a supportive environment.

The Principle and Practices: sciences [2] document for *CfE* calls for a variety of approaches to be used in teaching and learning including:

- use of relevant contexts, familiar to young people's experiences;
- collaborative learning and independent thinking;
- emphasis on children explaining their understanding of concepts, informed discussion and communication.

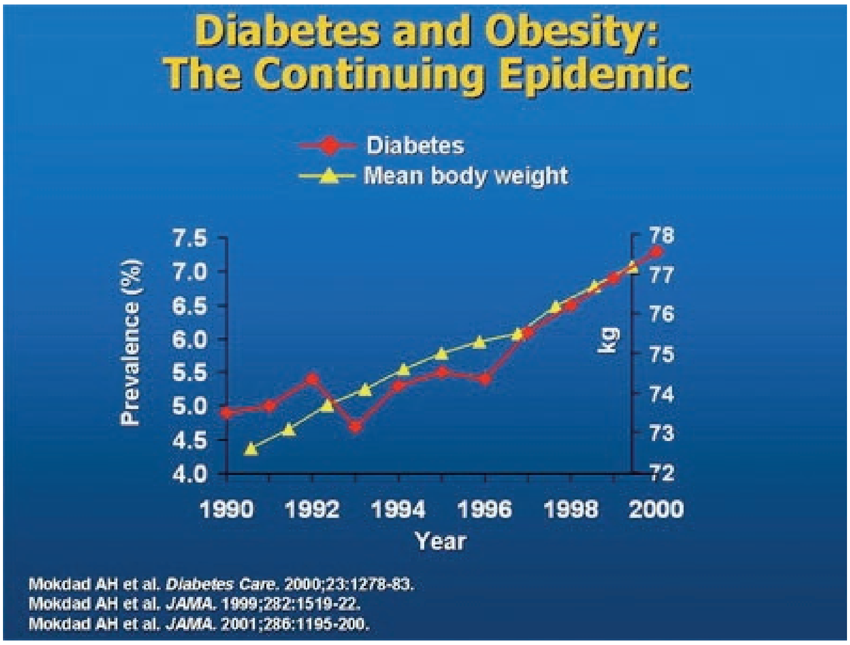


***Figure 1** - Correlation between prevalence of diabetes and mean body weight [1].*

Over the past 10 years at SSERC we have been producing activities which help teachers to encourage meaningful discussion about scientific issues. One of the areas which we have been developing supports science and health issues such as Diet, Diabetes and Obesity (DDO). These activities are based around a series of resources which were made possible with funding from the AstraZeneca Science Teaching Trust (AZSTT) and are aimed at upper primary and early secondary school pupils and their teachers.

There are a number of opportunities to use the DDO resource to support teaching of *CfE* as shown in the following experiences and outcomes statements:

- By investigating some body systems and potential problems which they may develop, I can make informed decisions to help me to maintain my health and wellbeing - *SCN 2-12a*.
- Having selected scientific themes of topical interest, I can critically analyse the issues, and use relevant information to develop an informed argument - *SCN 4-20b*.

and Obesity

- Having explored a range of issues which may affect food choice, I can discuss how this could impact on the individual's health - *HWB 3-34a / HWB 4-34a*.

Additionally in National 4 Science (Health Issues) diet and diabetes is suggested as a context to enable student to '...analyse and discuss aspects of healthy living and supportive environments'.

In the last few months the DDO resources have been, updated and re-designed.

In addition to the pupil activities, the new resource pack contains a comprehensive teacher guide along with background information and links to suitable websites. Earlier editions of this resource were very well received by teachers who have responded with comments such as:

- the pupils find the activities controversial and they encourage debate;
- the activities identified misconceptions pupils had. Stimulated discussion amongst the pupils. Raised their awareness of current issues;
- I found the Let's Talk Diet, Diabetes and Obesity resources extremely useful as pupils were extremely engaged by the discussion activities. In addition, pupils were encouraged to ask questions and share their opinions with the class.

The new resource pack, Diet, Diabetes and Obesity is available for purchase from SSERC. The pack contains class sets of all the pupil materials including worksheets, help-cards and a variety of activities to stimulate meaningful discussion. The cost of a pack is £10 to include postage and packing.

References

[1] Image taken from Obesity, Type 2 Diabetes, and Fructose at www.indiana.edu/~oso/Fructose/Fructose.html

[2] Curriculum for Excellence: sciences (principles and practice). Available for download at www.educationscotland.gov.uk/learningteachingandassessment/curriculumareas/sciences/principlesandpractice/index.asp

Dissecting eyes - hints and tips

Hands on activities such as carrying out an eye dissection are extremely engaging and exciting for learners. Even a demonstration carried out by their teacher can bring the most attractive illustrations of the eye to life for learners and aid their understanding of its anatomy and physiology. In our view, it is a pity that many teachers and science departments have shied away from carrying out eye dissections with their classes in the belief that 'eyes are banned'.

Following the recent SSERC Bulletin article [1], which provided guidance to schools on complying with current legislation on the acquisition and disposal of animal by-products such as eyes, the biology team at SSERC believe that an article on carrying out an eye dissection is timely.

The Code of Practice, *Materials of Living Origin* [2], which can be accessed from the SSERC website (www.sserc.org.uk), has recently been reviewed, updated and issued to all Member schools. This Code of Practice contains health and safety advice on the use of animal material, which teachers should be aware of prior to carrying out dissection work with learners.

The Code of Practice states [2], "Only materials fit for human consumption obtained from abattoirs, butchers or fishmongers may be used for the purpose of dissection or experimentation". There is further specific advice [1, 2] on the acquisition and disposal of nervous tissue (including eyes) from cattle, sheep and goats. The Code of Practice [2] also outlines methods for disposal of materials used for dissection.

Preserved eyes can be purchased from Blades Biological (www.blades-bio.co.uk).

The fresher the eyes, the easier they will be to cut. Often, however, there is no alternative to using eyes which have been purchased in advance and frozen, or purchasing eyes which have been preserved in chemicals. It should be noted that freezing or preserving eyes in chemicals can cause the lenses to become opaque.

It is best to get eyes with muscle and fat still attached as these provide useful teaching points.

Health and Safety considerations

Who should take part?
Sensitivity to pupils' feelings about observing or carrying out a dissection is essential. According to the Code of Practice [2], "No pupils should be required to take part in or observe any dissection procedure if they do not wish to do so".

Which instruments are best to use?
The Code of Practice suggests that the use of scissors rather than scalpels for any dissection will reduce the incidence of accidental cuts. We would suggest that, apart from the initial small incisions through the cornea and sclerotic coat, which are most easily done with a scalpel, scissors should be used for eye dissection.
(See paragraph below on the question of eye protection).

Should gloves be worn?
Prior to, and on the completion of any dissection work hands should be washed thoroughly with soap and warm water. Any cuts or grazes should be covered with waterproof dressings.

The question of gloves is always a tricky one to address. Because they may affect dexterity, the use of disposable gloves might pose a hazard, increasing the risk of accidental cuts from a scalpel or scissors, and therefore is not deemed necessary. However, the Code of Practice [2] does state that disposable gloves should be available to pupils who wish to use them. If there are several cuts or grazes on the hands, gloves should be worn and extra care advised.

Is eye protection necessary?
It should not be necessary to wear safety glasses. However, the sclerotic coat of an eye is very tough and making the initial incision through this requires some pressure. A case was recently reported to SSERC where the contents of an eye being dissected spurted in to the eye of a pupil. Teachers may decide to have learners wear safety glasses for this stage of the procedure, or teachers may make the initial incision with a scalpel and learners can then use scissors to complete cutting round the sclerotic coat. Depending on

the age of the learners and nature of the group, it may be sufficient to point out this hazard and to advise caution.

The practical work

Setting the scene

Starting with the familiar is important when introducing any new concept, or subject matter. Before handling the eyes to be dissected, learners should be able to identify the *pupil, iris* and *sclerotic coat* (or *sclera*) of another person's eyes, or their own eyes in a mirror. This is a good time to point out and discuss the roles of eye lashes, tears, tear glands and tear ducts. It is also interesting to note how well protected the eyes are by their bony sockets and how little of the eye is actually visible.

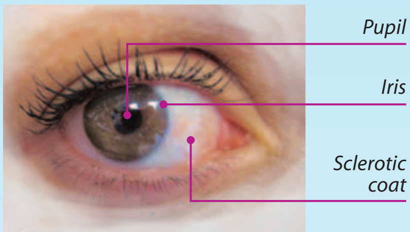


Figure 1 *- External view of a human eye .*

Observation and identification of the parts of an eye in section is a useful next step. A frozen eye can be sawn longitudinally so that each part can be related to a typical text book diagrammatic representation of an eye.

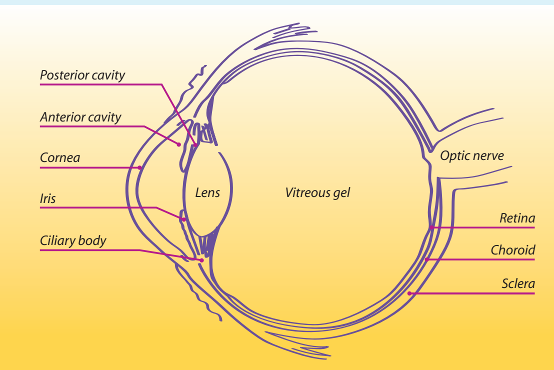


Figure 2 *- Eye diagram [3].*

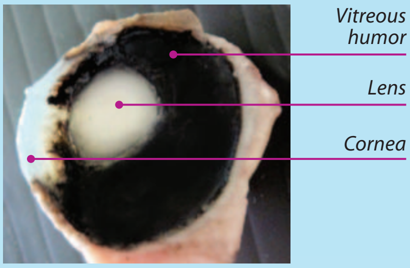


Figure 3 *- Longitudinal section of a frozen bull's eye.*

The dissection

Learners should examine the outside of the eye and identify the *sclerotic coat* (sclera), the transparent *cornea* at the front (although this may appear to be cloudy). It may be possible to look through the *cornea* to see the *iris* and *pupil* and to note the shape of the pupil.

Figure 4 *- Bull's eye viewed from the front.*

On further examination of the outside of the eye, the protective function of the fatty tissue can be noted. This is also a good opportunity to discuss the function of the *extraocular muscles*. The movement of these muscles is voluntary; often and normally done without thinking. Learners could consider the different ways in which eyes need to move. For example, in activities like reading the movement of the muscles needs to be precise and fast.

The fat and muscle can now be cut away revealing the optic nerve at the back of the eye.

Figure 5 *- Cut away the fat and muscle.*

Holding the eye firmly in place with tongs, a scalpel can be used to very carefully make a small incision in the cornea allowing the clear liquid (*aqueous humor*) to run out. This liquid is mostly water and maintains the shape of the cornea.

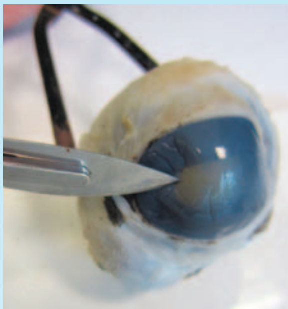


Figure 6 *- Make an incision in the cornea.*

The next step is to make an incision in the sclerotic coat in the middle of the eyeball. Great care is needed at this stage as it will take some pressure on the scalpel to cut through this tough protective layer (see Health and Safety considerations above).

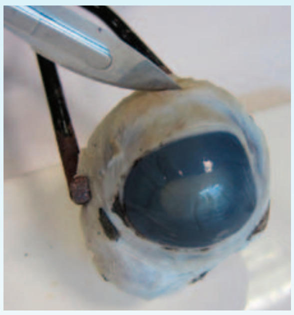


Figure 7 *- Carefully make an incision through the sclerotic coat.*

It should now be easy to cut through the sclerotic coat all the way round the eye using scissors.

Figure 8 *- Cut all the way round.*

Covering the front half of the eye is the transparent *cornea*. Learners will notice that this is a tough, protective layer. Together with the lens and the *aqueous humor* in the *anterior chamber*, the cornea has an important role in the refraction of light. At this stage it becomes very obvious that the pupil is a hole which lets light in to the eye and is covered by the cornea.

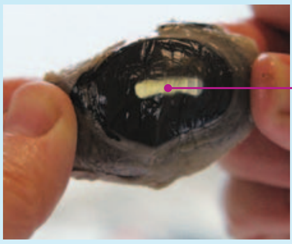


Figure 9 *- The pupil is a hole in the iris and is protected by the cornea.*

It should be possible to pull the iris away in one piece from the cornea. The pupil is the hole in the centre of the iris. The iris controls the size of the pupil.

Figure 10 *- The iris separated from the cornea.*

The back of the eye is filled with a clear jelly, the *vitreous humor*, which helps maintain the shape of the eyeball. The lens is a harder jelly lump which is easily separated from the vitreous humor.

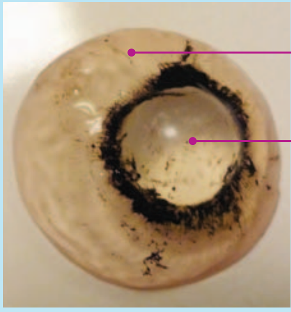


Figure 11 *- Vitreous humor and lens.*

This is also a good opportunity to discuss 'accommodation' with learners. Accommodation involves the shape of the lens being changed by the action of the *ciliary* body (*ciliary muscle*) in order to focus on objects at varying distances. The ciliary body is a ring of smooth muscle fibres that holds the lens in place and also produces aqueous humor.

Once the lens has been removed its magnifying effect can be seen by placing it on a piece of print.

Figure 12 *- The lens will magnify print.*

Now that the vitreous humor has been removed from the back of the eye it is possible to observe the blood vessels that form part of a thin fleshy layer - the *retina*.

Figure 13 *- The retina.*

Light entering the eye is focussed on the retina. The cells of the retina convert light energy to electrical impulses which travel to the brain via the optic nerve.

The retina can be moved around but is prevented from being removed by its attachment at *the blind spot*. This is the place where the nerve fibres of the retinal cells come together and enter the *optic nerve*.

Figure 14 *- The retina remains attached at the blind spot.*

The optic nerve is visible at the back of the eye in the area corresponding to the blind spot.

Clean-up and disposal

Guidance on disposal of the eye dissection material is given in *Materials of Living Origin* [2].

Any instruments used in the dissection should be cleaned using hot water and detergent.

'Avoid the use of detergents, such as those based on chlorine, or *Virkon*, which can corrode instruments. Autoclaving before re-use is the preferred method' [2].

Hands should be washed thoroughly with warm water and soap.

References

[1] Dissecting bulls' eyes (2012), *SSERC Bulletin*, **240**, 11.

[2] Third editions of Codes of Practice published (2012), *SSERC Bulletin*, **240**, 12. Copies of the Code of Practice are available via the Biology Health & Safety pages on the SSERC website www.sserc.org.uk

[3] Free Anatomy Clipart Images - available at www.cksinfo.com/ medicine/anatomy/index.html (accessed 20th September 2012).

Reaction timers

Three years ago, SSERC teamed up with Elaine Lorimer from Renfrewshire Road Safety to look at ways of teaching forces in the context of road safety.

Figure 1 *- Reaction Timer.*

The result was a reaction timer (figure 1), designed with the help of Fifex [1] and subsequently manufactured by that company. The reaction timer and associated lessons appealed to Road Safety Scotland who managed to secure funding to buy a class set of five for every local authority. SSERC has now trained local road safety officers in the use of the reaction timers.

The reaction timer displays the user's reaction time and calculates the thinking and braking distances for different speeds and road conditions. A number of the devices are already in use in schools, having been given away to participants on SSERC residential courses. Feedback has been very good. The reaction timers are being used at CfE Levels 3/4, Standard Grade Physics and parents' open evenings. The suggested lessons include links to numeracy, literacy and health and wellbeing.

If you would like to learn more about lessons on forces in the context of road safety, or like the idea of borrowing a set of the devices, please contact SSERC.

Reference

[1] www.fifex.co.uk

Standard solutions

When carrying out any quantitative work in chemistry, it is important to know the concentration of any solutions you use. Too great a concentration and some reactions will become dangerous, too low a concentration and some reactions will not work.

For most practical work, it is possible to get by making reasonably accurate solutions in the normal way. For instance weighing out the appropriate number of moles of solid and diluting to the required volume - or diluting a solution of concentrated acid. For analytical work, however (and this does crop up at Advanced Higher level), you sometimes need to know concentrations more accurately. This is achieved through a process called standardisation.

A number of chemicals can be used as primary standards meaning they can be used as references or yardsticks thereby allowing you to benchmark other reagents that will react with them.

Features of a primary standard include:

- **High purity** - if your compound is not pure, it is no use as a standard because you can never know its exact concentration.
- **Stability (low reactivity)** - if your compound is not stable, then you will only be able to use it as a reference if it is freshly obtained and even then you may not be entirely sure.
- **Low hygroscopicity and efflorescence** - similar to above. If your compound is absorbing or losing water, you cannot know its molecular mass accurately.
- **High solubility** - you need to be able to make a reasonably concentrated solution.
- **High molecular mass** - the higher the molecular mass, the more you weigh out to make a solution and so any error is proportionally less.
- Ideally, but not essentially, it should be of **low toxicity**, be readily available (and not too expensive) and not be too hazardous for the environment.

Some Common Primary Standards

Here are a few common chemicals that are suitable for use as primary standards:

- Sodium carbonate
- Potassium bromate
- Sodium chloride
- Potassium iodate
- Benzoic acid
- Potassium dichromate
- Sulphanilic acid
- Sulphamic acid

***Table 1** - Specific examples.*

Solution to be standardised	Standards used
Aqueous strong acids	Standard sodium carbonate solution (using methyl orange as an indicator).
Ethanoic and other weak acids	Pre-standardised sodium hydroxide (using phenolphthalein as an indicator).
Alkalis	Pre-standardised solution of hydrochloric acid (standardised as above) or benzoic acid (using phenolphthalein as an indicator) or sulphamic acid (using phenolphthalein as an indicator).
Sodium thiosulphate	Potassium iodate (or bromate) to release iodine and titrate against it (using starch as an indicator near the end-point). Each iodine molecule reacts with 3 moles $Na_2S_2O_3$.
Silver nitrate	Standard sodium chloride (using 5% potassium chromate solution as an indicator). Titrate until the first colour change.
Potassium permanganate	Standard ethanedioic (oxalic acid). No indicator needed. 2 moles of potassium permanganate react with 5 moles of ethanedioic acid.

Work out the mass of the primary standard you need for the chosen molarity of your solution. Weigh out slightly more than this mass - this measured mass need not be accurate. Dry your solid in an oven - usually at about 110-120°C and allow your chosen standard to cool in a dessicator.

Using the dried material, weigh out the exact amount of solid needed to make your solution and place it into a volumetric flask. Dissolve the material in less than the final amount of distilled/deionised water (ideally boiled out and cooled to remove dissolved gases). Use more of the distilled water to wash out the weigh boat and add the washings to the flask. Top up to the mark on the volumetric flask to obtain your standard solution.

It is a good idea to make up quite a concentrated solution that you can then dilute down - that way you will minimise any weighing errors.

Specific Examples

(See Table 1). This is just an overview. You will find details on how to standardise the above solutions on the SSERC website under the name of the solution to be standardised. Details of others can be found in books such as Vogel's 'Handbook of Quantitative Inorganic Analysis' [1]. If you do not have access to a suitable book and can't find the information on our website then get in touch and we'll find out for you.

References

[1] Svehla, G. (1996) Vogel's Qualitative Inorganic Analysis (7^{th} Edition), Prentice Hall, ISBN-10: 0582218667.

Demonstration corner

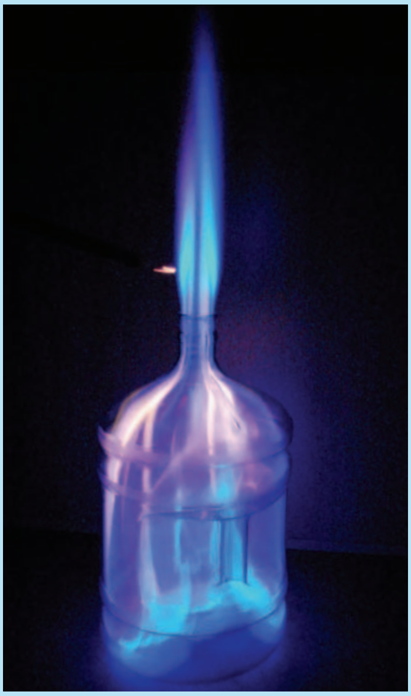


Figure 1 - Whoosh bottle with methanol.

The Whoosh Bottle

This is a tremendous demonstration from the RSC showing the exothermic nature of the combustion of alcohol. It looks particularly spectacular in a darkened room.

Preparation

You will need:

- An 18 litre, polycarbonate, "water-fountain" bottle. (There will be a PC mark if it is polycarbonate). Check the container for signs of cracks or frosting. If there are any, do not use. Make sure the container is clean and dry inside.
- A metre rule and some tape.
- Wooden splint.
- 40 cm^3 Industrial denatured alcohol (IDA is highly flammable) [1].

Carrying Out

1) Wear eye protection (demonstrator and onlookers).
2) Place the container so that there is at least 2.5 m of clearance between the top of the bottle and the ceiling - and that there is nothing above it that could catch light.
3) Ensure anything flammable (such as your ethanol) is at least 1 m from the bottle.
4) Ensure audience is more than 4 m away from the bottle.
5) Pour the alcohol into the container and insert a rubber bung. Roll the bottle on its side for 10 seconds.
6) Drain any excess alcohol back into the original bottle and remove to at least 1 m away from the demonstration area. Use care when removing the bung to ensure that any excess alcohol does not spray out.
7) Wipe off any excess alcohol from the outside of the bottle.
8) Attach a splint in a downward angle to the end of a metre rule.
9) Light the splint and hold over the neck of the bottle.

You will hear quite a loud 'whoosh' and see a blue flame (if the room is darkened) as the ethanol vapour burns rapidly.

On picking up the bottle afterwards, it is noticeably hot to the touch, though not too hot to hold.

References

[1] It is possible to use some other alcohols: Methanol will give a similar effect to ethanol but as it is much more toxic, there would seem to be no point. Propan-1-ol and propan-2-ol can also be used, they burn a little more slowly and you see bits of yellow in the flame rather than just blue.

The story of a standard

There are standards on performance; there are standards on safety. This is the story of the making of a safety standard for electrical apparatus for school laboratories. (The story is told from a personal perspective.) It covers most things electrical - ovens, fridges, heating mantles, centrifuges, power supplies, oscilloscopes and multimeters - and all manner of hazards - heat, fire, explosion, noise, radiation, cuts and bruises, scalding and electrocution. Exceptions are IT equipment and plugtop devices. Furthermore, the standard relates to the special needs of infants aged 3 and above, children in primary and secondary schools, and young persons aged up to 18 in educational laboratories.

The standard differs from a toy standard in that it presumes that usage is confined to school premises where children are shown what to do and supervised thereafter. That is not the case with toys, which are supposed to be safe even when children are left to their own devices.

The UK standards' body is the British Standards Institute, or BSI as it is mainly called. Most of the standards supported by the BSI are international, the two biggest providers being the International Standards Organization (ISO) and the International Electrotechnical Commission (IEC).

Thirty years ago there was no appropriate standard for lab electrical equipment. Many of the manufacturers had their own in-house ones. No two were alike. When equipment was sent to SSERC, one often had to make a judgement of Solomon in deciding whether to pass or fail.

We resorted to trying to apply one or other of the nearest standards to lab equipment. Sometimes the one on household articles, other times the one on audio equipment, and yet other times the one on IT machines. But with differences of detail between them, and little heed for usage by children, there were many fallings out, and times when a dispute was resolved without having access to the best available advice on which to base a proper rational judgement!

Then along came IEC61010. That was in 1993. I remember with excitement reading the title, 'Safety requirement for electrical equipment for measurement, control, and laboratory use'. Spot on! "That's exactly what we need!" I thought. And indeed it turned out to be immensely helpful. We immediately applied it when testing apparatus. If we found fault, we would write to the manufacturer telling him that his equipment did not comply with clause so-and-so of IEC61010.

They got the message. In 1995 the British Educational Equipment Association convened a meeting of makers and suppliers of lab equipment to agree to design and make to this standard.

Roll on another seven years, by which time the disagreements between SSERC and the equipment manufacturers had subsided because we had a good standard to work with. And then along came a difficulty which took much wrangling to resolve. We were testing a power supply whose low-voltage output was separated from the mains supply in the usual fashion with an isolating transformer. We had no problem with that. The difficulty was with the control circuit that disconnected the mains supply. It was a strangely complex circuit with opto-isolation between hazardous live and the controller. On the controller's printed circuit board running midway between the pins on either side of this opto-isolator was a copper track bearing the phase-neutral conductor from the mains supply to the circuit. Wow! Common sense told me that this was dodgy. But it took a very, very thorough search of 61010 to find the clause that supported my judgement. The manufacturers disagreed. They engaged a firm of specialist engineers to advise them and the engineers reckoned that the system complied with the standard. I found fault with the engineers' report. They stood by it. I took the matter to the HSE, who backed me. Our dispute now stood on differences of interpretation of a single sentence in the standard. I took the dispute to the secretary of the BSI committee that looks after 61010 and had much correspondence both on what the clause actually meant, and what it was supposed to mean. At this point the manufacturers gracefully agreed to redesign their power supply, without admitting that the original design was at fault. I was grateful that's how it ended.

But that dispute was an impetus for BSI to decide to widen the scope of 61010 from laboratory electrical equipment used by adults to use by children in schools. In 2007, SSERC, together with the ASE and CLEAPSS, helped BSI draft some additional clauses to achieve this aim.

The next step was to persuade the IEC to do likewise. They agreed and the UK committee was given the task of drafting the expanded standard. SSERC played a large part in that work. The UK draft has now been through all of the international stages of consultation, being improved upon step by step. It has been voted upon positively by every full member country of the IEC and is proceeding to become an international standard. This is a satisfactory achievement for SSERC to record. ◀

Health & Safety

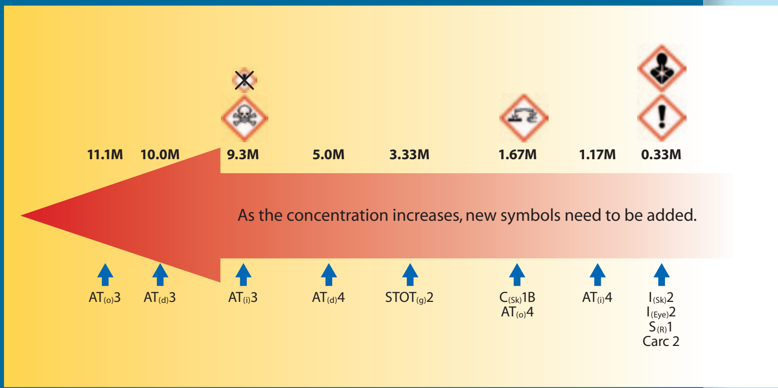
Hazardous chemicals updates

Now the new website (www.sserc.org.uk) is up and running, the long process has begun of updating the hazardous chemicals section to bring it in line with GHS. So far:

1) We have changed the tables that used to contain the Risk and Safety Phrases so that they now contain the GHS Hazard statements and the new symbols for each substance.

2) We have replaced the concentration effects tables. Given the number of different categories in the GHS system, the tables would have become unwieldy so we have decided on a different, more visual approach. E.g. methanal (see diagram):
   - Any solution below 0.33 mol dm^{-3} needs no label.
   - Above that, up until 1.67 mol dm^{-3}, it has the warning and the health hazard symbol.
   - At 1.17 mol dm^{-3}, it becomes an Acute Toxin by inhalation (Category 4) but this has no effect on the labelling. Cat 4 required the warning symbol but that is already there.
   - Above 1.67 mol dm^{-3}, various new categories appear but there is no change in the labelling until 9.3 mol dm^{-3} when the solution becomes an Acute Toxin by inhalation (Category 3). This requires the skull and crossbones.
   - At the same time the warning symbol is removed as it cannot appear along with a higher level symbol in the same hazard class.

3) The Safety phrases that were listed in the tables have been removed but have not been replaced with the GHS Precautionary Statements. In some cases there are 30 or more and it would simply become unwieldy. All the safety information itself is given in the body of the article so a simple list of the P Statements would seem superfluous.
   We have started going through all the articles making sure that there is no conflict between our advice and that given in the P statements. There seems to be nothing significant that needs to be changed at the moment just a few changes in terminology. If there are entries that merit a significant change we will flag them up so that you are made aware the entry has been changed. ◀



The circular saw

It's always worthwhile frequently going back to www.hse.gov.uk. A search for 'wood' currently reveals downloadable files including a very useful poster on the circular saw.

In the website, search 'wood'. Next, select 'Health & Safety in the Woodworking Industry' then look under 'Resources'.

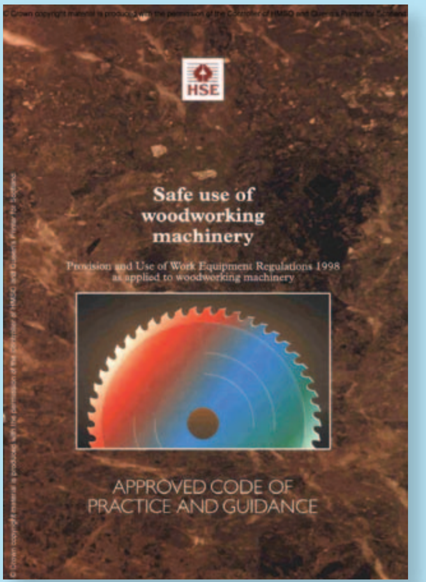


Figure 1 *- Approved Code of Practice (ACOP).*

Teachers and technicians who have completed our 'Safe Use of Fixed Workshop Equipment' course will know about the Approved code of Practice and Guidance or ACOP (Figure 1). This normally retails at £8 but is available as a free download from this website.

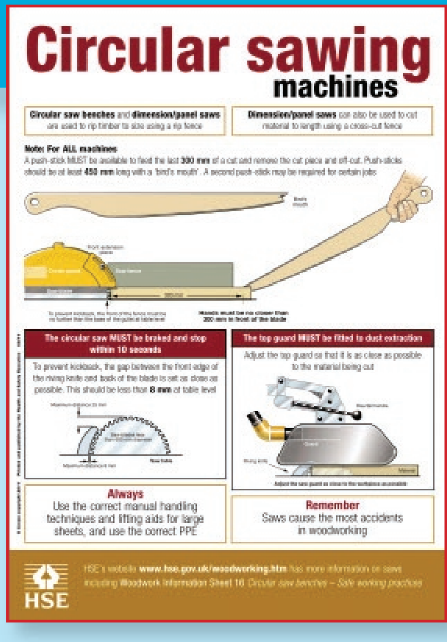


Figure 2 *- The circular saw poster.*

The document gives useful information that applies to most woodworking machinery, except hand held tools. It's a must for users in school wood machining areas. In the website, look for the 'Information sheets and circular saw poster,' download the pdf poster file (Figure 2) and display in your wood machining area.

The poster contains important information about the circular saw set-up and use of push-sticks, in particular it highlights the correct position setting of the saw fence on modern circular saws in order to prevent kickback (Figure 3).

The front of the saw fence MUST be no further than the base of the gullet at table level in order to prevent kickback.

The website also provides a series of 'Woodworking Information Sheets' (WIS) relevant to school machining areas.

There are plenty of free, downloadable resources, not for the department work-base shelf but designed to be put into practice in order to maintain high levels of safety when machining.

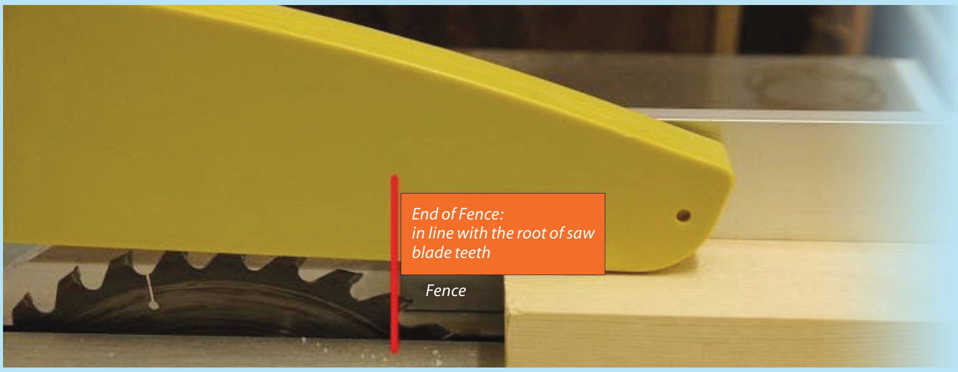


Figure 3 *- Correct Fence Setting to Prevent Kickback- taken from the Poster.*

The SSERC Bulletin is published by SSERC · 2 Pitreavie Court · South Pitreavie Business Park · Dunfermline KY11 8UB
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