Scottish Schools Equipment Research Centre

SSERC Bulletin

for **S**cience, **T**echnology and **S**afety education

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Contents

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SafetyNet surfaces!

It has taken a wee while but, as they say, good things are worth waiting for. Just like our, what seemed interminable, search for new premises, we have reached the stage with our SafetyNet CD when we can now let you have it, so to speak. We have been wary in the past of touting vapourware and this CD was coming dangerously close. A combination of the SSERC move and difficulties in obtaining important data are offered as believable excuses since we were conscious of promising the Technicians' Conference in Crieff last November that it would be ready in January of this year. Apologies all round to those who were disappointed.

Contrary to what we did with previous CDs this one is free to all secondary schools and such establishments currently in membership of SSERC. This forms part of what we call a service level agreement with each of the Education Authorities who subscribe to SSERC.

We shall endeavour to update SafetyNet annually in order that you have the latest safety information on hand in your schools. The ideal location would be to mount it on your school network as it contains more information than is strictly relevant to science and technology. We are working on ways of delivering up-to-date content to all schools which doesn't involve sending out hundreds of discs or active web access. Watch this space.

Retirals

We are sorry to announce the retiral of two of our longest-serving staff members.

John Richardson, Lead Officer with the Supporting Science Education through CPD Project and former Director of SSERC has decided the lure of piscatorial pursuits is preferable to the co-ordination of a panapoly of courses in personal professional progress. John joined SSSERC in 1973 as Assistant Director and was appointed Director in 1982 after the untimely death of Joe Stewart, the very first Director of SSERC. He successfully steered us through many difficult political and financial waters as well as two moves of premises and close to 150 SSERC Bulletins. John will be missed for his encyclopaedic knowledge of all-things-SSERC, anarchic humour and shrewd ability to know the right people at the right time. His legacy of work in the aforementioned Bulletins is plain for all to see and will form the guidelines on 'how to communicate scientific knowledge to teachers, technicians et. al' for years to come.

All at SSERC wish him all the best in his well deserved retirement. Tight lines!

(continued on page 2)

(continued from page 1)

Anne White, our erstwhile Office Manager, has taken the long walk to freedom and a welcome rest from the onerous task of keeping everyone in SSERC organised, despite our best (worst?) efforts to do the contrary!

Anne had a two year spell as our secretary in the early 70's, spent time recovering, and returned for another valiant 22 years at the keyboard face.

Like the rest of us she experienced the doubtful delights of a vast number of technological changes in word processing, databases and spreadsheets. From Wordwise on the BBC Micro, through "Perfect Writer" (now there's a misnomer if I've ever seen one - Ed) on the Torch and First Word Plus on the Archimedes to Microsoft Word on various generations of PC. Anne has 'been there and done that'. And the best bit is that she was always willing to adapt to the new ways of doing things with dedication and good humour, in spite of our often cack-handed methods of on-the-job training.

Anne will be greatly missed for her organisational skills and attention to detail as well as her patience and personable manner in the face of the impossible odds of keeping the "professionals" in line at SSERC!

Anne is a keen walker and may come across a wee fisherman snoozing by a loch down in the Borders. I'm sure she'd wake him up and say "We've definitely made the right move".

New legislation regarding disposal of electrical & electronic goods

Waste Electrical and Electronic Equipment Regulations (WEEE Regs) and Restriction of the Use of Certain Hazardous Substances (RoHS) (SI 2005 no 2748)

Introduction

The mountain of used computers, mobile phones, TVs, fridges and other goods containing electronic components has been growing at an alarming rate. See Appendix 1 for the different types of electrical waste. Apart from the huge bulk filling up landfill, electrical and electronic equipment (EEE) contains environmentally damaging amounts of heavy metals and polyhalogen compounds. WEEE will be classed as a special case of "Special Waste" (called "Hazardous Waste" in England and Wales) and it is illegal to place it in ordinary refuse. In order to address these problems, the EU issued two directives which were implemented into UK law in the form of the WEEE Regs and RoHS. Whereas the disposal of hazardous chemicals and substances is quite expensive for the school or business disposing of them the good news here is that in the majority of cases all or most of the cost will be borne by the manufacturer or supplier.

WEEE Regulations - the aim of these is to ensure that these waste items of electrical and electronic equipment are either disposed of safely for the environment or re-cycled. These Regulations are based on the principle of "extended producer responsibility". This is done by placing large obligations mainly on "producers" (defined as those businesses who manufacture, supply, sell Electrical and Electronic Equipment (EEE) or import it into the European Union.)

Duties placed on producers, retailers and distributors of EEE are as follows:

(i) Ensure that products placed on the market are marked with certain info. including a crossed out wheelie bin sign indicating that it has to be collected separately. Otherwise, the product could be banned from sale.

(ii) Take the legal responsibility for arranging and funding the collection, treatment plus recovery and environmental disposal, the re-use or re-cycling of WEEE. This they may do as individual firms or they may join a clearing house. Note that not all waste electrical equipment is subject to these Regulations; more details are given in Appendix 1.

The 13th August 2005 is an important date. If you are replacing older equipment purchased before that date with like-for-like, eg a whole set of computer stations from an ICT suite with new ones, then the producer (manufacturer, supplier or retailer) is required to take the old WEEE off your hands and dispose of them at their expense, even if you hadn't purchased the original computers from them. This seems tough on the supplier, but that is the law. It is very possible that producers' retail prices will be higher in order to cover or defray the costs of disposal. Domestic consumers will be provided with a "free take-back in-store" to enable consumers to return their WEEE when making a like-for-like purchase of new equipment."

If, in some years' time, you purchase a new set of computers to replace a set purchased after the 13th August 2005, the Regulations go a little woolly. They state that the main responsibility will again be on your supplier to finance its collection, treatment, recovery and re-cycling as before. However, they also state that you and he may negotiate alternative arrangements and that this is a commercial matter for you. Time will tell as to how this aspect develops.

For some situations it may be favourable to use commercial firms for recycling and disposal of ICT equipment rather than hand it in on a like for like basis. For equipment that is not too old and can be recycled, one firm presently defines this as "post Pentium IV", you may be paid money for each computer. There could be a small charge for disposing of older machines, but that might be less than the hidden increase added on by producers to cover disposal costs. So the advice is to bargain. See Appendix 2 for names of some ICT equipment recycling firms.

Domestic householders can presently bring their own WEEE to many council amenity waste sites which are geared up for separate collection of WEEE. Many councils are considering enlarging these facilities so that businesses can take advantage of them in the future.

What is meant by *like-for-like*? Buying a replacement for a broken internal hard-drive with a new one is a like-for-like purchase, but replacing with a new external drive instead would not be.

These Regulations apply to the whole school and not just the science department. Indeed the Science departments will probably be only a minor contributor to the total of a school's WEEE.

Old ICT equipment may be re-used and indeed voluntary sector groups will probably continue to play a valuable role in recycling.

Data Protection Act - it should also be remembered that the school and the education authority have a responsibility to staff and anyone whose personal details are stored on the hard drive of a computer. This information must be destroyed and can be done in-house, which means you have full control over the task. Some disposal firms will give the option of providing a certificate that the data has been destroyed at a small cost. One firm waives the cost of the certificate against their receiving the computer.

RoHS - this complements the WEEE Regulations by adding further to the protection of the environment by attacking the problem at source rather than at the disposal stage. RoHS requires the amounts of hazardous materials, i.e. lead, mercury, cadmium, chromium(VI) and polybrominated biphenyl (PBB) or polybrominated biphenylether, used in the construction of electronic components or cables to be limited to zero or to extremely low concentrations at the stage of construction. RoHS comes into force on 1st July 2006. This clearly applies to manufacturers and not to the users.

Older apparatus purchased before this date may continue to be used even if it would not be considered to be environmentally fit for sale after that date. Furthermore you can repair such apparatus using old components and materials which would not be permitted by RoHS. It might be a good idea to hold onto your old lead tin solder for making repairs on older equipment as many of the new solders are incompatible with older materials. You are also permitted make your own non-compliant EEE in-house for your own use.

Appendix 1

WEEE is considered in 10 specific categories:

- **large household appliances** including refrigerators, freezers, stoves, microwaves;
- **small household appliances** including clocks and watches, irons, grinders;
- **IT and telecommunications equipment** including computer stations, printers, pocket and desk calculators;
- **consumer items** including radio and TV sets, hi-fi equipment, electronic keyboards;
- **lighting equipment** including sodium lamps, fluorescent (tubes and compact containing more than specified amounts of mercury), but not tungsten filament bulbs nor special fluorescent tubes used for special purposes, e.g., growth cabinets;
- **electrical & electronic tools** including drills, saws, equipment for milling, sanding, grinding, riveting, welding, soldering;
- **toys, leisure and sports equipment** e.g. electric trains, small portable body monitors used for body monitoring during exercise;
- **medical devices**; some similar ones may be used in school health studies, eg pulse and blood pressure monitors. Medical devices are exempted from the requirements of WEEE;
- **monitoring and control instruments** including smoke detectors, thermostats, "weighing appliances" as laboratory equipment;
- **automatic dispensers** e.g. biscuit and drinks machines i.e. if you haven't already taken on board Jamie Oliver's advice.

Where possible, batteries should be removed from WEEE and disposed of separately, but where they are embedded, integral and rechargeable they are treated as part of the instrument. The rules for battery disposal have been changing frequently and are likely to change again in the next two years. When the latest EU Directive is implemented in the next few years batery producers will be responsible for the uplift and recovery of the metals from at least the collection point onwards.

Appendix 2

If the task of disposal is given to a recycling firm it is the responsibility of the producer of waste (school and education authority) to ensure that the chosen firm is licensed to deal with that type of waste. It is prudent for the education authority not only to ask for a sight of the accreditation paperwork, but also to see the process happening. We know of two firms in Scotland where this has happened and of others who, although they had the paperwork, did not permit the user/producer to carry out a traceability audit. These latter firms may be satisfactory, but schools and education authorities have a responsibility to ensure that the disposal is carried out properly and legally. There have been some instances of "cowboy" firms sending the WEEE overseas to African countries or to the Far East where the dismantling and treatment has been anything but safe for both the workforce and the environment.

The four firms listed below will collect from anywhere on the mainland. Restructa, CCL(North) and MIREC also collect from the Islands. Prices given or costs asked for generally have to be negotiated and will depend on numbers, the age and quality of the machines, etc. Some firms have a charge for the uplift of £100. Usually there is no charge for the treatment and disposal of PCs and peripherals, but there is a charge for dealing with the CRTs of monitors as they are classed as Special Waste (in England now renamed *Hazardous Waste*).

Restructa Limited (Offices)
1 Dunlop Drive,
Meadowhead Industrial Est.
Irvine KA11 5AU
Tel 01294 311444
Fax 01294 273399
www.restructa.co.uk

(Factory)
15 –16 Arkwright Way,
North Newmoor Industrial Est.
Irvine

CCL (NORTH) Ltd
1 Dunlop Drive,
Meadowhead Industrial Estate
Irvine
KA11 5AU
Tel 01294 278844
Fax Fax 01294 275399
www.cellnorth.com

MHG Group Scotland,
131 Deerdykes View,
Westfield South,
Cumbernauld G68 9HN
Tel 01257 279999
Fax 01257 279797
www.mgh-group.co.uk

MIREC Asset Management Ltd,
Irongray Industrial Park,
Lochside Industrial Estate,
Dumfries DG2 0NR
Tel 01387 723000
Fax 01387 723020
www.mirec.com

There are others based in England or Wales who will no doubt also cover Scotland. Several of these can be found from their web sites on the site for Industry Council for Electronic Equipment Recycling (ICER) – www.icer.org.uk/direct.htm

Errata in SSERC Bulletin 216 - Our apologies to *Scientific & Chemical* for a typo on page 11 of the recently published SSERC Bulletin 216 where we inadvertently headed their range of environmental meters as Scientific & (******). Page 7, column 2 under the preparation of *Solution 2* for the *Oscillating Reaction* should read "0.4 g of manganese(II) sulphate".

Electric circuit model using water

Voltage is a difficult idea. This analogue was developed to help formulate the concept. The model uses the vertical dimension to represent voltage. The flow of water in that part of the model that represents the circuit is entirely in the horizontal plane. Current and voltage are modelled by fluid flow and water levels respectively.

Introduction

You can see from the illustration (Figure 1) that the circuit lies on a large cream-coloured plastic tray sitting on a dark grey plastic box. The box is filled with water and represents the electrical earth - or a near-infinite supply of charged particles. The tall translucent plastic food container represents the battery. To charge the battery, there is a 12 V submersible pump submerged in water in the grey box. The pump is operated by a hand-cranked generator (PASCO, EM-8090). The effort required to operate this to completely recharge the battery, is enough to tire you out. The model therefore gives you the feeling that work has to be done for current to flow; i.e. it provides a kinaesthetic learning experience. A hand-operated lift pump was also tried, but rejected because it delivered water in large dollops.

Electrical wiring is represented by pvc bubble-tubing (1/4" ID, 3/8" OD); the bubble feature lets the tube fit securely on any component that does not have this exact size. The 1/4" ID size was determined by the flow indicator. Were it not for this, a smaller ID sized tubing might be preferable.

There are two horizontal rods set up across the tray at a height of 40 cm above the plane of the circuit. Bossheads on these rods support the three manometer tubes and the water inlet to the battery tank. The battery tank is on a lab jack. Its outlet is set at about tray-height and it holds water to a depth of 28 cm. The water outlet is a valved-coupling with hosebarb. In fitting it, the plastic wall was drilled with a chassis cutter to ensure that the joint does not leak. Downstream (Fig. 2) there are the following components in series - the analogous electrical component is shown in brackets:

- T-piece, with 40 cm manometer tube (voltmeter) ;
- Keck clamp (blue) (variable resistor or switch)
- T-piece, with 40 cm manometer tube (voltmeter);
- Roto-flo indicator (ammeter) ;
- Screw clamp (variable resistor or switch)
- T-piece, with 40 cm manometer tube (voltmeter)
- Outlet to large box (earth or ground)

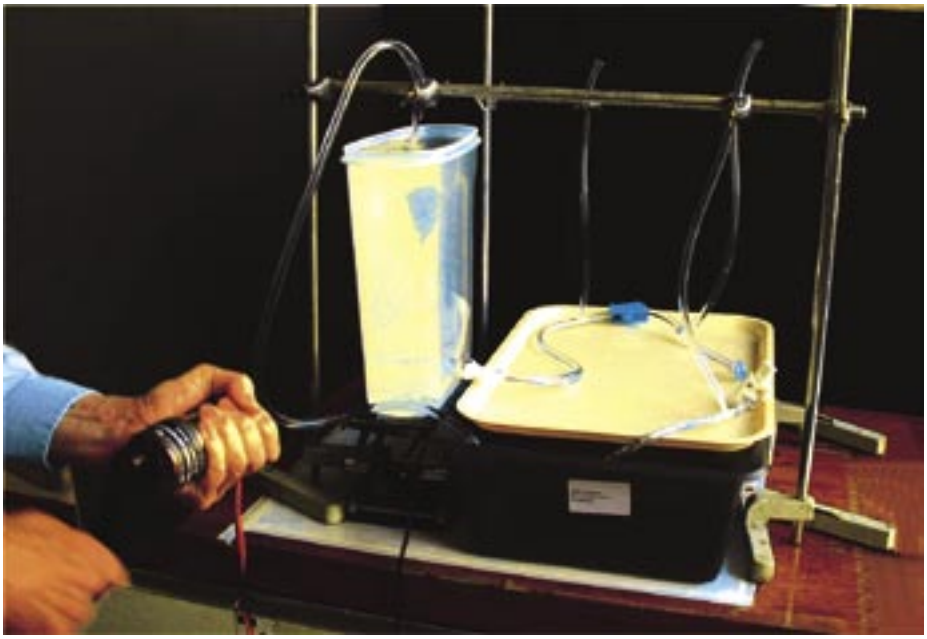


Figure 1 - Electric circuit model using water

Two different types of clamp (Keck and screw) were used in the trials and both were effective. Whether you standardize on one type, or get two types for the sake of variety, is a matter of choice. Different styles of clamp merely reflects different types of resistor – but this may only confuse some pupils.

Advantages - satisfactory features

- Water current can be raised or lowered by controlling the variable resistors.
- Manometer-tube levels satisfactorily show the expected potentials around the circuit. The first level is lower than the battery-tank level because of the pressure difference across the valved outlet (representing the 'lost volts'). The second level is lower still, and its height can be raised or lowered by adjusting one or other of the resistors in the potential divider. The third level is tray height, or ground.
- When one of the clamps shuts off the flow, the system represents an open circuit, or static electricity. The manometer levels upfield of the clamp are equivalent to the battery-box level. The manometer levels downfield of the clamp are at ground level.

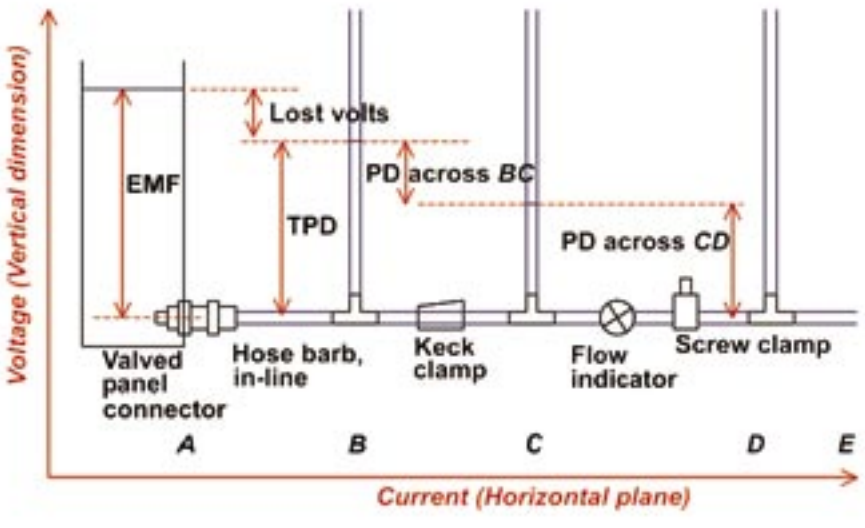


Figure 2 - Components and representation of electrical quantities

Disdvantages - unsatisfactory features

- The flow-rate wheel does not turn when the water flow is very low.
- The water flow has to be low for the desired water-tube levels. If the water flow-rate is high, the water wheel turns fast (which is satisfactory), but there is a significant pressure drop across lengths of tubing. Electrically, this is equivalent to placing a 0.5 ohm resistor in a circuit where the resistance of the wires is about 0.2 ohms. When the resistance of the clamp is increased such that it is more than ten times greater than the resistance of the tubing, the flow rate is insufficient to turn the paddle wheel.
- Because the final manometer tube pressure is at ground potential, or just very slightly higher, air enters the water stream, generating large bubbles downstream of the final T-piece. This retards the flow, causing pressure to back up at the final T-piece, and eventually the flow rate to speed up. As a consequence, the water level in the final manometer tube sometimes oscillates between heights of about 3 cm down to zero.

None of the less-than-satisfactory features are sufficiently detrimental as to ruin the general performance. Each is an interesting talking point:

- The ammeter cannot detect low currents.
- Wires have resistance, which cannot always be overlooked.
- The electrical analogue of the third detriment is an LC oscillation. The electrical analogue of inertia is inductance; and, because of the mass of flowing fluids, the system has this characteristic. The manometers store mechanical energy, which may relate to capacitance [1]. The oscillation at the tail-end of the circuit results from the combined effects of the resistance, inductance and capacitance built into the system.

Acknowledgement

Useful discussions were held with Jim Campbell (Lesmahagow HS) and Professor Miles Padgett (Department of Physics & Astronomy, University of Glasgow). Feymann's 'Lectures in Physics' has information on mechanical analogues of electrical properties.

Item	Supplier	Cat. No.	Cost (£)
Flow indicator, ¼"	Cole Palmer [2]	A-06297-05	10.79
Screw clamp x 3		A-06833-10	11.33
Keck clamp, 10 mm x 12		BH-06835-07	38.12
T-connectors, ¼" ID tubing, x 10		A-30610-30	8.06
PVC Bubble Tubing ¼" ID, 50 ft		A-95805-01	27.33
Coupling, Male, Hosebarb, ¼" ID(valved panel connector)		A-06361-71	10.25
Hose Barb, in-line, ¼"		A-06361-51	5.28
Tray, 46 x 34 cm	Local		
Box, plastic, 53 x 34 x 15 cm			
Battery tank, 23 x 11 x 29 cm			
Submersible pump, 12 V	Opitec [3]	224.091	6.48
Hand-cranked generator	PASCO [4]	EM-8090	106.00

Table 1 - Parts list for electric circuit model

[1] Then again, the inverse of capacitance (1/C) is the electrical analogue of stiffness. Water is an incompressible fluid and would seem to have this property.
[2] Cole-Parmer, Hanwell, London W7 2QA; Tel: 020 8574 7556; Web: www.coleparmer.co.uk
[3] Opitec: 7 West Road, Woolston, Southampton, SO19 9AH; Tel: 023 80 44 69 91; Web: www.opitec.co.uk
[4] Feedback, Crowborough, East Sussex TN6 2QR; Tel: 01892 653322; Web: www.fbk.com

Security of radioactive holdings

Introduction

How safe are your sources? Generally they are looked after with great care. Yet, disturbingly, two instances have come to light in the past year of the disappearance of a school's radioactivity cabinet with its entire stock of sources. One occurred during a school closure; the other in the middle of a rebuilding programme – the story was told in a recent issue. They highlight the vulnerability of radioactive materials during irregular working operations. Whereas the security record during normal working procedures has been very good, the chance that things will go wrong increases ever so greatly during school reconstructions or closures.

A new report *Security of radioactive holdings* has been placed on the Members/ Downloads of the SSERC website. Please study it. It will also be on the *Radiological Protection* section of the new *SSERC SafetyNet CD*. Evidence reviewed in the report includes eight instances of the loss of radioactive material and the findings from school audits.

From incidents and audits, there is evidence of simple safety measures not being followed, and some staff failing to recognize that materials being held are radioactive. (Figures 1, 2 and 3 show examples of unmarked cloud-chamber sources. We have found these sources being kept wrongly with their instruments in insecure storage. They should be kept in the radioactivity cabinet.) There seems to be no supervision or monitoring by council officials in some councils. These councils need look at what happens in schools, helping where it is needed. Moreover the security of materials during school reconstruction work must be carefully managed.

Security: the critical points

- All radioactive materials must be kept in secure storage in a locked steel cabinet fastened to the fabric of the building or fixed furnishings.

Figure 1 - Griffin diffusion cloud-chamber source. There is radium-based radioluminescent paint on the bell-end of the source holder.

Figure 2 - Irwin diffusion cloud-chamber source. This is the worst example we have met with of an unmarked source. Irwin had drilled into the tip of a 4 mm plug and filled the hole with what we think is a radium-based paint.

Figure 3 - Nicolson Wilson cloud-chamber source. This is a radium source in metal foil wrapped round the recessed end-part of the source holder.

- The only exception is a cloud chamber with non-detachable source. This apparatus should be kept in a locked store.
- Because quite a lot of radioactive artefacts are unlabelled, there is a significant chance that they may be kept in insecure storage with other apparatus. Be on the lookout for such items and test anything suspicious with a GM counter to find out if it is radioactive. Your RPA can help with the identification and tests. An illustrated guide to sources is available.
- Maintain an accurate list of stock, listing every radioactive article or substance held. Don't omit items.
- Maintain a logbook of usage and stock checks.
- Check stock every month (except in the summer vacation) and make a record in the logbook that this has been done.
- Don't keep extraneous stuff in the radioactivity cabinet. The contents should be minimalist for easy checking.
- Radioactive materials are vulnerable to loss during irregular operations. From the historical evidence, losses have occurred during a school rebuild, a closure and a transferral to another site. Arrangements must be made to ensure the security of sources during irregular working conditions.
- If sources are to be transferred from one site to another, then a responsible person must be delegated to remove the material from the originating store and a responsible person must be there to accept the sources at the receiving store.

A sourcespotter's guide

A new catalogue has been written by SSERC to help identify radioactive materials held by schools. Because most of the materials were purchased in the 60s or 70s, there may now be in post no member of staff who knows what is being held. Some of these unknown materials are kept in the radioactivity cabinet because the items are known to be radioactive. Far worse, other unmarked materials are found held in general storage because no one is aware that they are radioactive – and the catalogue lists many items that are not apparently radioactive because of an absence of marking.

The sourcespotter's guide has several related purposes: (1) to help you identify the radioactive materials you are holding, whether in your locked store or not, securing items found to be insecure; (2) to let you draw up an accurate record of stock (another legal requirement); and (3) to facilitate a clearout of waste stock (the means of disposal depend on the type of material to be got rid of).

The guide will be sent to every school by post along with a questionnaire asking for a record of stock. From looking at the returns, we will advise you on what to keep and what to get rid of. Moreover, we should be able to advise the government on how many redundant or aged sources are being held by schools, from which they can assess how much money to budget to undertake a national disposal. The survey is being funded by the Environment Agency and has the support of the Scottish Executive and SEPA.

Ammonium molybdate test for phosphate

Introduction

We have had several calls about this test failing and we confirmed that a method for Intermediate I Chemistry using 0.5 cm^3 of 1M nitric acid did not give the expected yellow precipitate of ammonium phosphomolybdate. Traditional methods certainly worked, but used higher concentrations of nitric acid. which would have had to be dispensed by the teacher or technician.

After several trials we came back to a method, which does work, using a slightly larger volume of 1M nitric acid. This method also has the benefit of working at room temperature in 15-30 seconds!

We found it worked best using boiling tubes. Ensure these are new or cleaned and rinsed with distilled water. Also all solutions, including the dilute nitric acid, should be freshly prepared using distilled water.

These precautions are to avoid possible contamination from detergents etc.

Preparation of the phosphate sample solution

Dissolve 0.38g of Na_3PO_4 in a little distilled water and make the volume up to 20 cm^3 with more distilled water to give a 0.05M solution.

Preparation of ammonium molybdate reagent solution

1. Dissolve 4 g of ammonium molybdate in 4 cm^3 0.880 ammonia (Corrosive & Dangerous for the Environment) and 6 cm^3 of distilled water.

2. Add about 50 to 60 cm^3 of distilled water, dissolve 12 g ammonium nitrate (Corrosive, Irritant & Oxidising) in it and dilute to 100 cm^3 with distilled water.

Testing for phosphate ions

1. Place a 1 cm^3 of the sample solution in a boiling tube. A control can also be done simultaneously by replacing the phosphate solution with 1 cm^3 of distilled water.

2. Add 2 cm^3 of ammonium molybdate solution and then 4 cm^3 of 1M nitric acid (Corrosive) and shake gently to mix.

3. Continue shaking the tube gently.

4. Formation of a yellow precipitate indicates the presence of phosphate ions.

Safety

Substance	Hazard	Control measures
0.880 Ammonia	Corrosive, Dangerous for the Environment: Toxic if inhaled in high concentrations or if swallowed. Forms explosive mixtures in air (16-25%). Gas and solutions very irritating to the eyes. Solution burns skin and swallowing causes internal damage.	**Preparation of solution** Wear gloves and goggles and prepare in fume cupboard or in very well ventilated room. Do not grind ammonium nitrate or evaporate solution to dryness. Avoid raising dusts from ammonium nitrate and ammonium molybdate; this is easy because of the crystalline nature of these two salts. Wash up well any spillages of ammonium nitrate as it can ignite dust or paper. **Use of solution** Wear indirect vent goggles and rinse any splashes off the skin immediately.
Ammonium Nitrate	Corrosive, Irritant: A powerful Oxidising agent. Dust is irritating to eyes	
1M Nitric Acid	Corrosive: The dilute acid burns the eyes, digestive system & the skin.	
Ammonium molybdate	Harmful by ingestion and inhalation.	

Table 1 - Substance, hazards and control measures required for preparation of solution

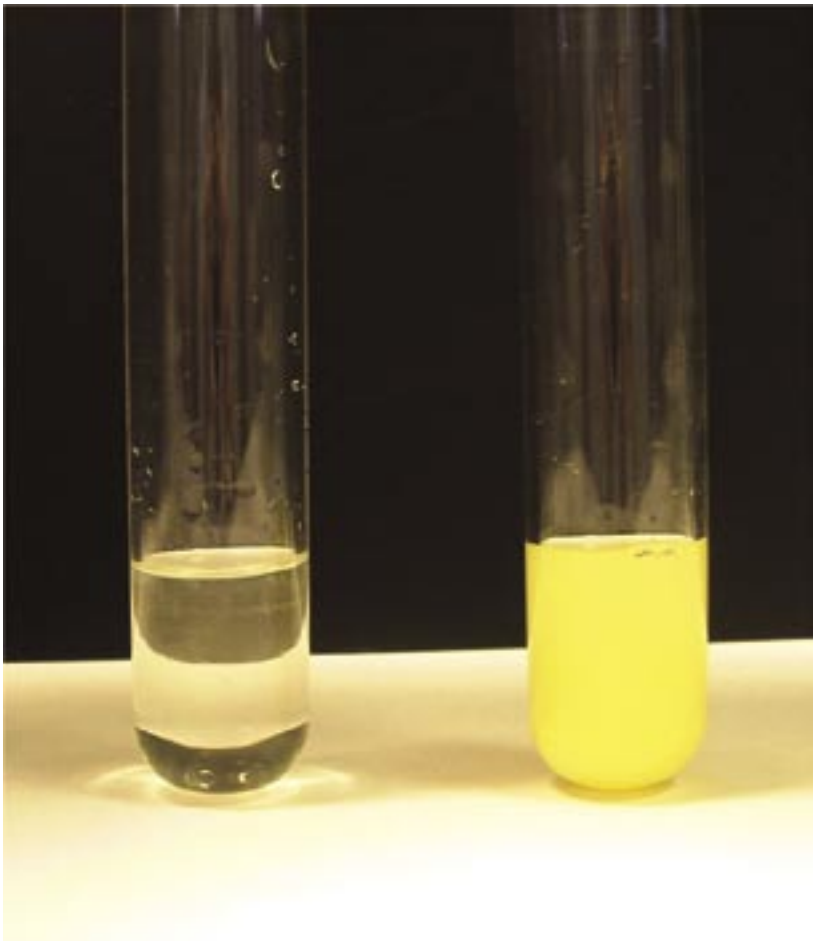


Figure 1 - Control solution and solution containing phosphate ions after testing

Forensics - investigative learning activities

Introduction

We outline here a number of practical activities which are suitable for pupil investigations covering learning outcomes in the Science component of Environmental Studies at Attainment Levels E-F.

These activities complement those outlined in the SSERC Science & Technology News No. 35 published earlier this year. These were suitable for Levels A-D in Primary and the ones discussed here cover S1/S2 with added recognition of the principles enshrined in a Curriculum for Excellence:-
www.scienceeducation3-18.com/documents/cerv.pdf

What has been developed?

A number of discrete *Detective* activities have already been developed. These include forensic analysis techniques covering chromatography, hair, blood, DNA, chocolate, pollen, burglar alarms and soil (microscopes, vinegar, footprints, filtration and pH).

The teacher sets the scene where a 'crime' has been committed (Fig. 1) and the children then have to work cooperatively in groups to deduce "Who dunnit?"

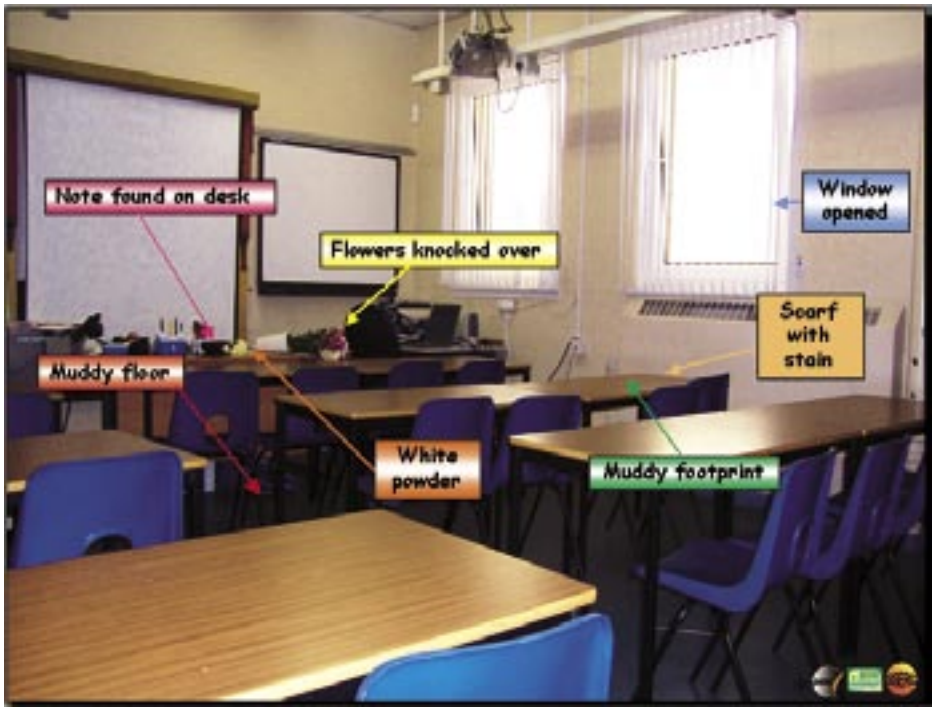
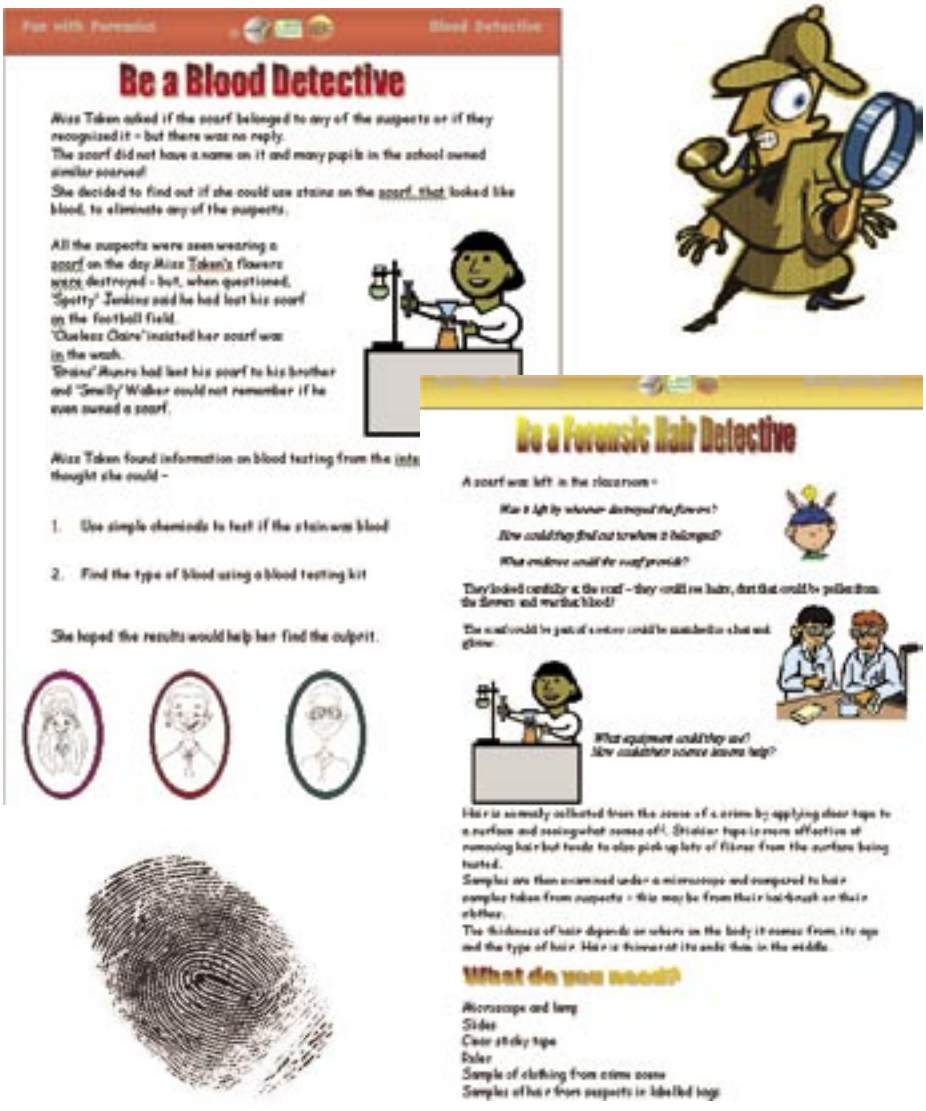


Figure 1 - Teacher sets the 'scene of crime' using Powerpoint slide or photograph.

Figure 2 - Front cover of the Detective pack containing all the techniques to find out "Who dunnit".

Here are a few screenshots showing some of the materials. Other activities under development include designing an ID card, fingerprints, DNA fingerprints and databases. For more information on all of this please e-mail Don Sutherland :

Don.Sutherland@sserc.org.uk



Cigarette Smoking machines

Since the ban on smoking in public places in Scotland came in during March 2006 we have had several enquiries regarding this. For many years we have all carried out this valuable demonstration safely. Risk assessments ensured that none of the harmful products would have been absorbed, via either inhalation or skin, by pupils or staff. The biggest danger would in fact be to the staff cleaning out the tarry messes afterwards.

The formation of the tars and other products of combustion in a burning cigarette is a most important demonstration which all pupils should see. There is no reason for not continuing with it provided suitable precautions are taken.

There have been two main versions :

1. Continuous flow model

A cigarette is placed in a holder (fashioned from a short length of rubber tubing fitted on the end of glass tubing) and lit. The fumes were then drawn away slowly through side-arm filter tubes, the first containing a pad of cotton wool and the second, water with a few drops of Universal indicator added. A slow running water pump can be used to draw the air though. Normally no fumes escape from the burning cigarette. However, if it is found that some fumes do escape from the exhaust water of the water pump, this is due to the cotton wool pad being too small and the air being drawn through too fast. This apparatus can usually be used in a very well ventilated lab, but move it to a fume cupboard if fumes can be smelled. Alternatively the filter pump could be running in a fume cupboard with a long piece of tubing connecting it to the apparatus outside. Some water pumps have a bad habit of sending water back and a large bottle or Winchester with reversed connections makes a good trap.

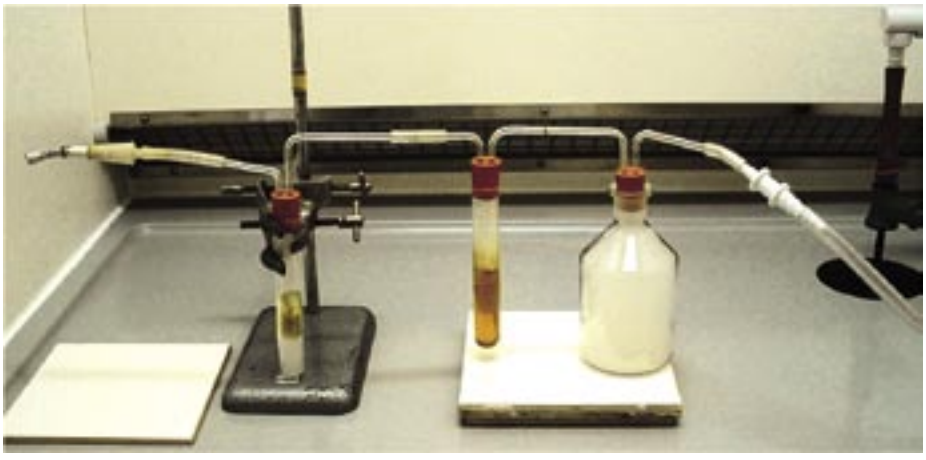


Figure 1 - Continuous flow model with slow-running water pump

2. The "puffing" model

This will definitely produce sidestream smoke and must be done in a fume cupboard. Here the air is drawn in short pulls of about a second but smoke will clearly go into the air around it in the "rest" periods. The safest puffing version is the apparatus (below) which is driven by a hand-operated vacuum pump in place of the water pump (see Figure 2).

An alternative to this is the "puffing dolly". In this version the track or path consists essentially of a filter in a small chamber and a Y piece on which are attached two balloons to represent lungs. With the "respiratory system" fitted in a clear plastic lemonade bottle (representing the chest cavity) a sheet of polythene or rubber can be fitted as a 'diaphragm'. Pulling and pushing the diaphragm causes inhalation and exhalation. We've tested this model and found that although it is suitable for showing lung function it cannot be recommended as a smoking model since the user is potentially exposed to smoke and the tarry residues left afterwards. A similar design was first seen way back in SSERC Bulletins 38 and 73. The latter showed a design for a 'smoking doll' - my, how times have changed! (see Figure 3).

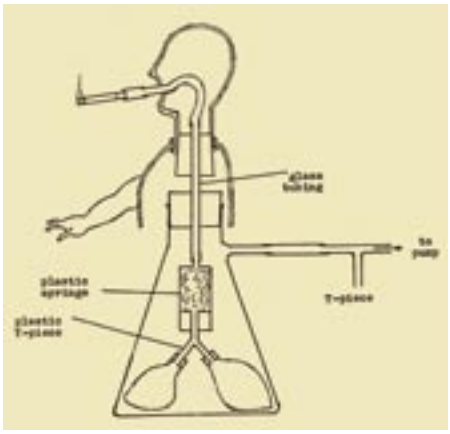


Figure 3 - Puffing dolly from Bulletin 73

Figure 2 - Puffing model driven by a hand-operated vacuum pump

Two further points should also be considered :

a) The air draught in a fume cupboard with a highish face velocity may cause the cigarette to burn too fast. Raising the sash may help. If the cupboard has a bypass and the draught can't be sufficiently reduced, switch off the fume cupboard for half a minute or so whilst the cigarette is burning and then switch it on to capture the fumes and prevent them from drifting out into the laboratory air.

b) Disposal must be carefully done. At the end a squirt of water from a wash bottle will extinguish the cigarette. The tar in the trap will contain potent carcinogens and should not be handled. Wearing nitrile gloves and with the aid of tongs in a fume cupboard remove the tarry filter, place it in a plastic bag, seal it and place with ordinary waste.

Likewise any paper towels used in wiping the inside of the tubes should be disposed of in the same way. Also, as it is a demonstration and not done on a class scale, consider discarding the tarry test tubes, etc. The rest of the kit will still be somewhat contaminated and should be stored in a closed box or bag.

SSERC Shop - Equipment Offers & Publications List

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VAT : The prices quoted do not include VAT. However it is added to every customer's order. Local authority establishments will be able to reclaim this input VAT.

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Motors

778 **Stepper motor**: Philips MB11, been stored in damp conditions but unused and retested. 4 phase, 12 V d.c., 100 mA per coil, 120 ohm coil per phase. Step angle 7.5°. Output shaft: 7 mm x 2 mm dia. Dimensions: 21 mm x 6 mm dia. on oval mounting plate with 2 fixing holes, diam. 3 mm, pitch 42 mm, at 56 mm centres. Circuit diagram supplied..... £2.50

755 **Pulley wheel kit:** Comprising plastic pulley wheel, 30 mm dia., with deep V-notch to fit 4 mm dia. shaft, 2 M4 grub screws to secure pulley wheel, Allen key for grub screws, and 3 mm to 4 mm axle adaptor. The whole making up a kit devised for SSERC tachogenerators with 3 mm shafts. Specially supplied to SSERC by Unilab. £1.25

848 **Motor:** 12 V d.c. No-load current: 2 A at 12 V and 1.5 A at 5 V. Min. no-load starting voltage: 2 V. Min. no-load running voltage: 0.8 V. Body: 64 X 37 mm dia. Shaft: 11 X 3 mm dia.£2.50

614 **Miniature motor**: 3 V to 6 V d.c. No-load current: 220 mA at 9600 r.p.m. and 3 V. Stall torque 110 mN m. Body: 30 mm x 24 mm dia. Shaft: 10 mm x 2 mm dia. 45p

593 **Miniature motor**: 1.5 V to 3 V d.c. No-load current: 350 mA at 14800 r.p.m. and 3 V. Stall torque 50 mN m. Body: 25 mm x 21 mm dia. Shaft: 8 mm x 2 mm dia. 30p

621 **Miniature motor:** 1.5 V to 3 V d.c. Open construction, ideal for demonstration. Dimensions: 19 x 9 x 18 mm. 8-tooth pinion on output shaft..... 25p

839 **Solar motor:** 12 mm long by 25 mm dia. Shaft: 6 x 2mm dia. (see also Item 838 - solar cell)..... £1.70

773 **Tachometer** (ex equipment) £2.25

811 **Worm and gear** for use with miniature motors, 34 : 1 reduction ratio plastic worm and gear wheel. 35p

378 **Encoder disk:** 15 slots, stainless steel, 30 mm dia. with 4 mm dia. fixing hole..... 80p

642 **Encoder disk:** 30 slots, stainless steel, 30 mm dia. with 4 mm dia. fixing hole..... 80p

836 **Motor mounts:** Plastic push-fit with self adhesive base pad. Suitable for SSERC motors 593 & 614. (pk of 10)..... £1.95

772 **Encoder disk:** 4-bit Gray code, stainless steel, 81.28 mm dia., 3 mm fixing hole. Slots sized to register with components mounted on 0.1" stripboard. Applications: shaft position sensing, wind direction indicator. See Bulletin 146. ..... £3.00

Precision motor stock

785 **Precision motor with optical shaft encoder**: 0.25 to 24 V d.c. No-load current and speed: 9 mA and 6,600 r.p.m. at 24 V. Stall torque: 23 mNm. 9 segments. Overall body length including shaft encoder: 59 mm. Dia.: 23 mm. Output shaft: 20 x 3 mm dia. Back EMF constant: 3.6 V/1000 r.p.m. Suggested application - tachogenerator. Data on shaft encoder section available on application..... £15

787 **Precision motor with attached gearbox**: 0.15-12 V d.c. With a supply of 3 V, the no-load current is 25 mA and the output shaft turns at 20 r.p.m. Gearbox ratio is 1 : 365. Overall body length including gearbox: 43.5 mm. Diameter: 16 mm. Output shaft: 6 x 3 mm dia. with flat side to maximum depth of 0.3 mm along outer 5 mm length of shaft. Application: system where a very slow angular velocity is required..... £15

Miscellaneous items

893 **Zinc rods:** Length 125mm, supplied packs of 10 (per pack).. £2.70

801 **Propeller:** 3 blades, each 62 mm. Fits 2 mm shaft 35p

792 **Propeller kit:** with 10 hubs and 20 blades for making 2 or 3 bladed propellers. 130 mm diameter. Accepts either 2 mm or 3 mm shafts. £3.40

790 **Buzzer:** 3 V..... 55p

827 **Buzzer:** 6 V..... 55p

821 **Reducer:** 3 mm to 2 mm, enables gears, pulleys and wheels to be fitted to motor shaft, per 5..... 25p
867 **Reducers:** as above but 4 mm to 2 mm, pack of 5..... 25p
868 **Reducers:** as above, but 4 to 3 mm, pack of 5 ..... 25p

715 **Pressure gauge:** 40 mm o.d. case, 25 mm deep with 33 mm dia. dial reading 0 to 4 bar (i.e. above atmospheric). With rear fitting for 1/8" BSP. Suitable for use as indicator for pneumatic circuits in Technological Studies..... 75p

165 **Bimetallic strip:** Original type, length 10 cm. High expansivity metal: Ni/Cr/Fe - 22/3/75. Low expansivity metal: Ni/Fe - 36/64 (invar). 15p
166 **Ditto**, but 30 cm length. 40p

861 **Bimetallic strip:** (new type - won't rust after exposure to Bunsen flame, hence higher price) 10 cm length. 30p
862 **Ditto**, but 30 cm length. 80p

758 **Loudspeaker;** 8 ohm, 0.5 Ω, 66 mm dia. ..... 5 0 p

837 **Ring magnet:** 40 mm o.d., 22 mm i.d..... 35p

823 **Ceramic block magnets:** Poles at ends, 10 x 6 x 22 mm. ... 12p

824 **Ceramic block magnets:** Poles on faces, 25 x 19 x 6 mm... 35p

745 **Sub-miniature microphone insert:** (ex James Bond?) Dia.: 9 mm. Overall depth: 5 mm. Solder pad connections. ... 40p

723 **Microswitch:** Miniature, SPDT, lever operated. 40p

354 **Reed switch:** SPST, 46 mm long overall, fits RS reed operating coil Type 3. ..... 10p

738 **Relay:** 6 V coil, DPDT, contacts rated 3 A, 24 V d.c. or 110 V a.c. 75p

875 **Solenoid:** 6 V, stroke length 3.5 mm, spring provided..... £3.75

774 **Solenoid:** 12 V, stroke length 30 mm, spring not provided. £2.25

742 **Key switch:** 8 pole changeover..... 40p

382 **Wafer switch:** Rotary, 6 pole, 8 way. 70p

688 **Croc clip:** Miniature, insulated, red. 5p
759 **Ditto**, black. 5p

788 **Crocodile clip leads:** Assorted colours, insulated croc. clip at each end, 360 mm long. £1.35

741 **LES lamp**, 6 V. 15p
770 **LES lamp**, but 12 V. 15p
789 **MES lamp**, 3.5 V, 0.3 A 10p
690 **MES lamp**, 6 V, 150 mA. 10p
866 **Lens-end lamps, MES**, 1.2 V. Ideal where a concentrated beam of light is needed. Box of 100 ..... £3.50

691 **MES battenholder**. 20p

692 **Battery holder:** C-type cell, holds 4 cells, PP3 outlet. 20p
730 **Battery holder:** AA-type cell, holds 4 cells, PP3 outlet. 20p
845 **Battery holder:** Holds two C-type cells, PP3 outlet. 20p
835 **Battery holder:** AA-type cell, holds 2 cells, PP3 outlet. 15p

729 **Battery connector:** PP3 type, snap-on press-stud, also suitable for items 692 and 730. ..... 5p

724 **Dual in line (DIL) sockets:** 8 way. 5p
760 **DIL sockets:** 14 way. 7p
826 **DIL sockets:** 16 way. 8p

882 **Quartz clock movement:** Dimensions: 56x53x17 mm. With wall hanging bracket. Suitable for dial thickness up to 10 mm. Includes plastic hands suitable for dial diameter to 200 mm. Requires an AA cell. (See CD Clocks, Newsletter 18.) £1.75

808 **Electrodes** for making lemon or other fruit cells etc. 1 pair, comprising 1 of copper, 1 of zinc, each approx. 60 mm square, per pair 50p

716 **3-core cable with heat resisting silicone rubber insulation**: 0.75 mm² conductors, can be used to re-wire soldering irons as per Safety Notes, Bulletin 166. Per metre. £1.35

756 **Silicone coated, braided glass sleeving**, yellow, 2.5 mm dia. Gives both heat and electrical insulation to conductors (e.g. for autoclave rewiring). Price per metre. 55p

714 **Sign "Radioactive substance"** to BS spec., 145 x 105 mm, semi-rigid plastic material. Suitable for labelling a radio-active materials store. With pictogram and legend. £2.70

763 **Sign "DANGER, Electric shock risk"** to BS spec., rigid plastic, 200 x 150 mm. £2.70

Components - resistors

420 **Resistors:** 5% tolerance, $^1/_4$ W : Per 10. ..... 6p
1R5, 4R7, 5R6, 6R8, 8R2, 10R, 15R, 22R, 33R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K0, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 150K, 220K, 330K, 390K, 470K, 680K, 1M0, 1M5, 2M2, 4M7, 10M.

BP100 **Precision Helipots:** Beckman, mainly 10 turn. 10p-50p

Components - semiconductors

807 **Teaching Chip Set:** Designed by Edinburgh University. Now with a new, comprehensive, 12 page datasheet, published in December 1999. It is freely available on request. One is supplied per order. The 4 chip set comprises : Resistors, MOSFETS, Diodes and Optoelectronics, and Ring Oscillator... £6.00

Single replacement chips: ..... £2.00 per chip:
871 **Chip 1 - Resistors**
872 **Chip 2 - MOSFETS**
873 **Chip 3 - Diodes & Optoelectronics**
874 **Chip 4 - Ring oscillator**

322 **Germanium diodes** 8p

701 **Transistor:** BC184, NPN Si, low power. 4p
702 **Transistor:** BC214, PNP Si, low power. 4p

717 **Triac:** Z0105DT, 0.8 A, low power. 5p

725 **MC74HC139N** dual 2 to 4 line decoders/multiplexers 5p
699 **MC14015BCP** dual 4-stage shift register. 5p

711 **Voltage regulator:** 6.2 V, 100 mA, pre-cut leads. 10p

Components - capacitors

813 **Capacitors, polystyrene:** 4p
180 pF, 330 pF, 560 pF, 1000 pF, 2400 pF, 3000 pF, 3300 pF, 3900 pF & 4700 pF

695 **Capacitors, tantalum:** 15 µF 10 V, 47 µF 6.3 V. 1p

696 **Capacitors, polycarbonate**: 10 nF, 220 nF, 1 µF, 2.2 µF. 2p

697 **Capacitor, polyester:** 15 nF 63 V. 1p

698 **Capacitors, electrolytic:** 1 µF 25 V, 2.2 µF 63 V, 10 µF 35 V. 1p

358 **Capacitor, electrolytic:** 28 µF, 400 V. £1.00

Sensors

615 **Thermocouple wire:** Type K, 0.5 mm dia., 1 m of each type supplied: Chromel (Ni Cr) and Alumel (Ni Al); for making thermocouples, (Bulletins 158 and 165). £3.10

640 **Disk thermistor**: (substitute type) resistance of 15 kohm at 25°C, β = 4200 K. Means of accurate usage described in Bulletin 162. ..... 30p

718 **Pyroelectric infrared sensor:** Single element, Philips RPY101, spectral response 6.5 µm to >14 µm, recommended blanking frequency range of 0.1 Hz to 20 Hz. The sensor is sealed in a low profile TO39 can with a window optically coated to filter out wavelengths below 6.5 µm. Data sheet supplied. For application see SG Physics Technical Guide, Vol.2, pp 34-5. ..... 50p

506 **Resistor:** 1 gigohm, $^1/_4$ W. £1.40

Optical and optoelectronic devices

838 **Solar cell:** 100 x 60 mm, 3.75 V per cell max. £2.10

507 **Optical fibre:** Plastic, single strand, 1 mm dia. Applications described in Bulletin 140 and SG Physics Technical Guide Vol.1. Priced per metre. 50p

508 **LEDs:** 3 mm, red. Price per 10. ..... 50p
761 **Ditto**, yellow. Per 10. ..... 60p
762 **Ditto**, green. Per 10. ..... 60p

891 **Ultra Violet LEDs:** 5mm LED in plastic clear untinted package. Peak wavelength: 400nm; Spectral halfwidth: 20nm; Viewing angle: 20° Luminous intensity: 160mcd; Emission: Violet & UV; Forward voltg: 3.8V Typical operating current: 20mA; Series resistor for 5 V supply: 68 ohm Cathode identified by short leg or flat on rim.
Also included with your order of UV LEDs supplied from SSERC, are the following items at no extra cost:
* Hazard sign with adhesive backing (1 per LED)
* UV filter film, cutoff wavelength about 390nm, 3 sq in (1 per LED)
* Instruction sheet, including risk assessment (1 per order)
* Manufacturer's data sheet (1 per order)
* Experimenting with UV LEDs, reprint from Bulletin 206 (1 per order) ..... £1.50 each

Light Shaping Diffuser - As described in SSERC Bulletin 216, page 6. Supplied in 35mm slide holder, two types:
894 **Elliptical cross-section beam**. 40° x 0.5°. £4
895 **Round cross-section beam**. 10°. £4

883 **Convex meniscus lens:** Focal length = 500 mm, dia. = 50 mm. APPLICATON: Demonstration of large scale, circular, interference fringes with laser radiation. Manufactured specially for SSERC with generous grant from EPSRC. £7.00

Other biotechnology items for Higher Practicals:

859 **Eppendorf tubes:** 1.5 cm^3, for use in TEP/SAPS/NCBE microcentrifuge, pack of 50 ..... 85p

860 **Nylon mesh** for protoplast isolation/fusion protocol, 70µm pore size, per 305 mm square £7-00

Pipette fillers

863 **Pipette filler** (Pi pump type): 0-2 cm^3 ..... £5.75

864 **Pipette filler** (Pi pump type): 0-10 cm^3 ..... £5.75

865 **Pipette filler** (Pi pump type): 0-25 cm^3 ..... £5.75

Items not for posting

The following items are only available to callers because of our difficulties in packing and posting glass items and chemicals. We will of course hold items for a reasonable period of time to enable you to arrange an uplift.

768 **Sodium lamp:** Low pressure, 35 W. Notes on method of control available on application 85p

712 **Smoke pellets:** For testing local exhaust ventilation (LEV), fume cupboards and extractor fans. Large: 50p. Small: 40p

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SSERC Science and Technology Bulletin: (Back issues from 160) £2.50

SSERC Science & Technology Equipment News (Back issues of Primary Newsletter) 50p

Health and Safety Bibliography (1996) £6.00

Preparing COSHH Risk Assessments for Project Work £5.00

ASE Publications

Be Safe! (3rd Edition, published 2001) (post and packing extra) .. £6.00

Safeguards in the School Laboratory (2006) £12.00

Topics in Safety (new 2001 edition) £17.50

CLEAPSS Publications

Hazcards (1995 Edition) £9.00

Recipe Cards £2.80

Laboratory Handbook £30.00

Physics Safety Notes £2.00

Risk Assessments for Technology £4.50

Teaching Chip Publications

Datasheet (12 page, 1999) ..... Free

Standard Grade Physics Practical Investigations (set of 8 investigations) £5.00

Optoelectronics and Semiconductors in Higher Physics (set of 7 experiments) £3.50

Practical Work with Chip 01 ..... £2.50

Modelling resistor behaviour with finite element analysis £1.50

MOSFETS: Guidance for teachers of Higher Physics (operational description, set of 10 experiments) £3.50

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