SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

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Introduction

It was almost two years ago that we undertook to accept and dispose of any unwanted and dangerous chemicals which schools might possess. During the time that these materials were accumulating in the Centre, the Disposal of Poisonous Waste Act, to which we referred in Bulletin 60, came into force. We collected over 150 different chemicals, mostly in small quantities, although there were 11 litres of carbon disulphide and more than twice that amount of diethyl ether. Local disposal firms would not touch the stuff, and we were obliged to place it with a West of Scotland firm who on their letterhead describe themselves as industrial waste disposal specialists. They decided that the material could only be disposed of in the South of England, and would advise us when they had transport going there, so that the costs could be shared.

One Monday afternoon we were 'phoned by a lorry driver to say he would uplift the material the next morning. We said this was no use because the chemicals were not packed; were the firm to send their own packers or could he pack them? The driver didn't know; he'd simply been told to uplift chemicals. We 'phoned the firm to get postponement for a few days; knowing that the same firm had refused to accept a similar load of chemicals from Glasgow LEA we felt that they had us over a barrel and we had to accept their conditions or be left holding the baby. They advised us to pack in wooden boxes, which we did, some of them tea chests, and the driver duly arrived and collected them. He was not employed by the firm, but was a general haulier to whom the removal had been sub-contracted. He did not know the nature of the chemicals, or that they were dangerous. The exercise cost us £176, more than half of which was for transport. Needless to say, we will not accept chemicals for disposal in the future.

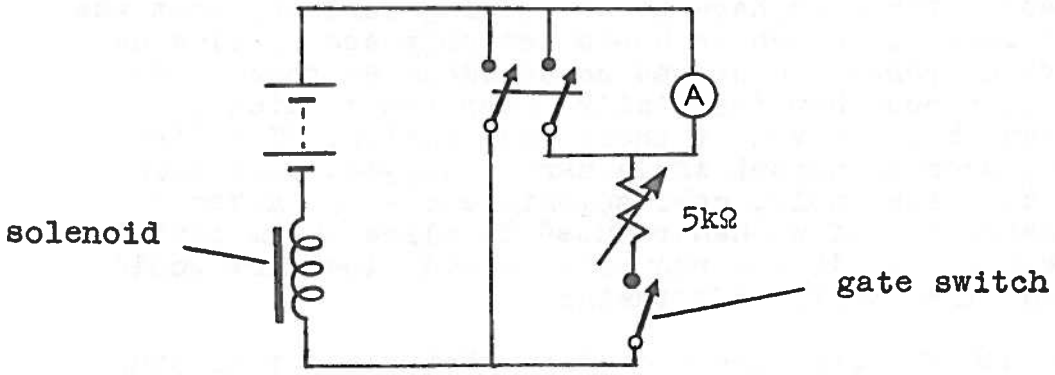
We assume, since we have heard nothing further, that the driver arrived safely, though we could not help speculating on what might have happened had he had an accident en route. We speculate also, on just how 'specially' were the chemicals disposed of when they arrived at their destination. The firm's lack of concern over transport would hardly suggest that each type of chemical - flammable, carcinogenic etc - was given individual treatment. If we had refused to allow the material to be taken away unless it was properly packed, the firm would likely have cancelled their undertaking.

What could we have done then, and what can any teacher in a similar situation do now? We have good reason to believe that, had the Disposal of Poisonous Waste Act not been in force, we ourselves could have disposed of much of the material more safely, and with more concern for possible pollution effects, than actually happened. But we are not allowed to do so, nor, apparently, is anyone in the local authority administration although they are charged with the responsibility for applying the Act. From those instances where a teacher has told us of his difficulties, it would seem that the LEA does not want to know that the school has hazardous chemicals requiring disposal. In one case the authority actively encouraged the teacher to break the law they are supposed

to administer. This teacher had ascertained how much it would cost to have his material disposed of locally and his education authority refused him the money, telling him to bury it in the ground. One is led to the conclusion that the Disposal Act is a piece of bad legislation, it tells us what not to do and places no responsibility on any organisation to provide adequate alternatives.

Physics Notes

The use of a high speed pen recorder as a timing device may seem uncalled-for sophistication, but this is only one of several uses of a modestly priced instrument. The Russian H320/1 recorder, from Morris Laboratory Instruments costs £55, and has a sensitivity of 8mA FSD and a maximum chart speed of 50 mm/s. The trace produced is fine enough to allow one to estimate to 0.05 mm, which means that the duration of an event can be estimated to 1 mm, or 0.02 s. This is nearly as good as the centisecond timer, and probably as good as most multi-flash strobe photographs. If centisecond timers are used for linear air track experiments on conservation of momentum, two are required, and this can make the cost greater than the single pen recorder which can be used for the same experiments. The other advantage of the recorder is the permanency of the record - there can be no doubt whether the time was correctly recorded. The advantages over multi-flash photography lie in the lack of any need to make special lighting provision, and in lower running costs. Individual results can be provided for about $\frac{1}{2}$p, which is many times less than that of the Polaroid photograph. While the pen recorder can replace the centisecond timer for all purposes, the same is not true of photographic techniques. We still require the camera to record velocities in two dimensional collisions.



One experiment for which the recorder is suitable is the measurement of g for free fall. One has to arrange that the switches which start and stop the fall of a ball also start and stop the flow of 1-2 mA direct current through the recorder. For example, in the Griffin and George version of the free fall apparatus, a double pole break switch can be used to initiate the drop. The ball when released strikes a hinged gate switch, causing it to open and thus stop the count. The circuit for carrying out these operations is given above. The supply voltage recommended for the solenoid is 7.5V, which means that the resistance in series with the recorder A

must be about 3k8Ω. The operation is as follows; when current flows in the solenoid due to the closure of the double pole switch, the recorder is shorted out and no current flows in it. Opening the DP switch initiates the fall of the ball and starts current in the recorder. When the ball strikes the gate it opens the gate switch, cutting off the recorder current.

In Bulletin 8 we discussed a variant of this in which the steel ball itself acted as the initiating switch and this is equally suitable in the above circuit.

* * * * * * *

Timing on the linear air track is another application of the pen recorder. If one recorder is to be used with two photo-electric cells, some method must be arranged for identifying the trace produced by each cell, and the simplest is to ensure that the current into the recorder differs depending on which cell is operative. This is achieved by the circuit of Fig. 1. The 'rest' current of each photo-resistor(PR) unit is about 1 mA. When illuminated with a 12W lamp at 10 cm distance PR_1 gives 2.4 mA and PR_2 3.2 mA. These currents are sufficiently distinct to be identifiable on the pen recorder trace.

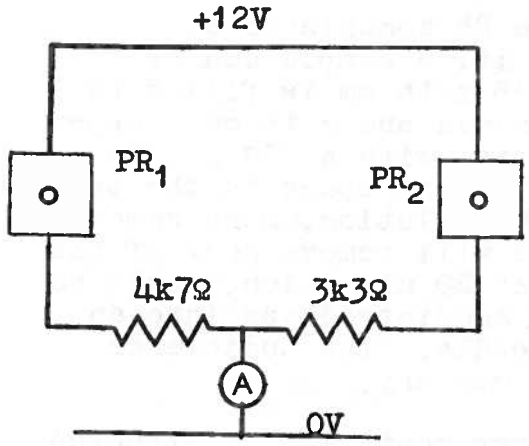


Fig. 1.

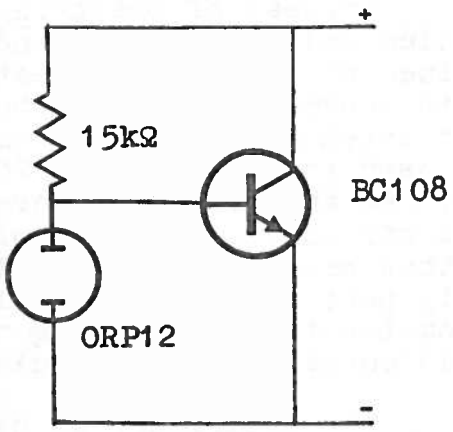
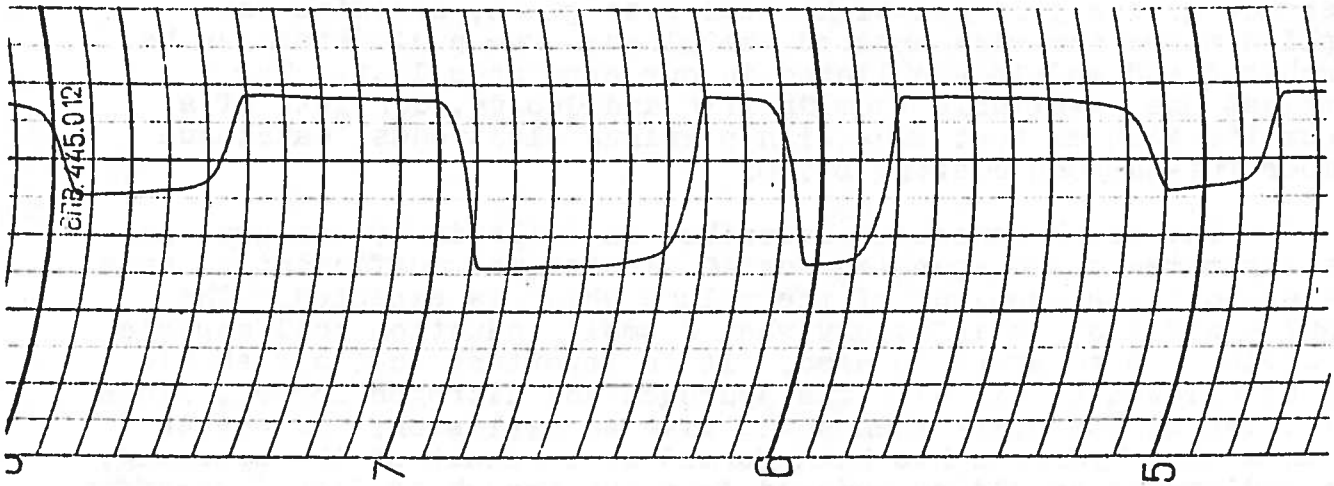


Fig. 2.



The photo-resistor unit is shown in Fig. 2, and is a modification of a circuit published in Bulletin 12. The components were mounted as described in that bulletin, so that the window through which light is admitted to the ORP12 is 6 mm diameter. Both ORP12 and BC108 are obtainable from Bi-Pak at 48p and 10p respectively. The trace above shows the results of a collision between two vehicles of nearly equal masses on the linear air track, using the circuits above.

Chemistry Notes

Sparking ammonia gas over liquid paraffin is suggested as a demonstration experiment in Section M2 of the chemistry syllabus. In the report on "Evaluation of Practical Work in School Chemistry Courses at 'O' Grade", Gunning and Johnstone, University of Glasgow, this experiment was listed as one which had been abandoned or never done by teachers. Since the experiment is in the syllabus we feel that we should encourage teachers to do it and it is for this reason that we suggest a simple and rapid method for carrying it out.

Instead of preparing the gas from 88 ammonia or an ammonium salt and alkali and then drying it, a sample can be obtained as follows. A test-tube e.g. 125 x 16 mm is filled to within about 20 mm of the top with 88 ammonia and a 15 mm stopper is inserted tightly. A 20 ml syringe fitted with a 23G needle is then used to remove about 20 ml of gas from the space in the test-tube. As the pressure decreases above the solution, more ammonia comes off and the removal of 20 ml of gas will remove most of the air that was present initially. A further 20 ml, which should be fairly pure ammonia is similarly removed and introduced into an eudiometer tube by bending the syringe needle. The eudiometer should contain either liquid paraffin or mercury.

The eudiometer we used in our experiments was constructed from a 150 x 16 mm soda glass test-tube. 24 SWG nichrome wire electrodes were pushed into the heated end of the test-tube and positioned to give a spark gap of about 5 mm. Since nichrome wire does not give a good gas tight seal with glass, araldite was applied where the wire entered the glass. The eudiometer can be purchased and models are listed in our apparatus list. The simplest one, available from Griffin and George, consists of a pyrex 150 x 25 mm test-tube with platinum electrodes, catalogue number T01-640/060 costing £1.60.

The spark generator described in Bulletin 49 was used in our experiments and sparking for 10 minutes was sufficient to show the approximate doubling of the volume which is expected. The results are also satisfactory when a small induction coil capable of giving a 6 mm spark is used. It is important that air should not be allowed to mix with the hydrogen and nitrogen formed, since switching on the spark then would give an explosion. Of course to show that hydrogen has been formed as a result of the sparking, the eudiometer should be removed from the trough of liquid paraffin and tested for hydrogen by applying a light.

* * * * * * *

We have received from an Australian source, a 'horrible warning' about a chemistry experiment, in the form of two newspaper cuttings which speak for themselves:

"Wed. Nov. 7th. Wayne Robert Fien, 13, of Inala, Brisbane, was killed when an explosion ripped through a science laboratory at Inala High School. A teacher, Adrain Droog, 21, had 13 pupils round him at a bench when the blast occurred. One boy said the class had been making a solid rocket propellant, using potassium and sulphur chlorate (sic). Mr Droog received severe abdominal injuries and lost a hand. He is dangerously ill. Trevor Vincent Feeley, 14, lost one hand and half the other. Six other pupils are in hospital and five were treated for injuries.

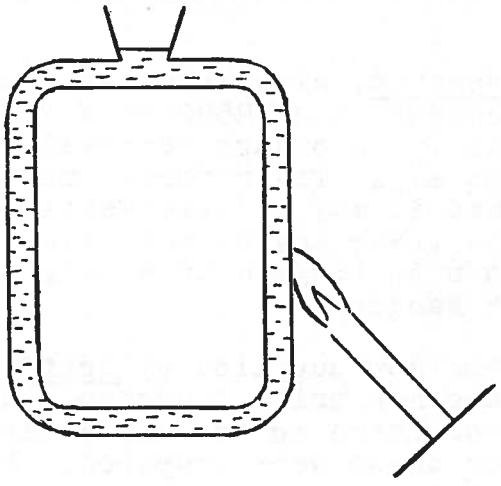
Mon. Nov. 12th. Adrian Droog, teacher, who was injured in a science classroom explosion, died in hospital".

* * * * * * *

Thermo-chromic liquid for illustrating convection current is simple to make in the laboratory. We used the following materials:

100 ml industrial spirit (not mineralised),
2-3 ml water,
2g cobalt(II) chloride.

The solid dissolves slowly and if a magnetic stirrer is available it should be used. The liquid, which can be used as shown below in the apparatus L44-780 from Griffin and George, is pink, almost purple, and changes to blue when heated. Adding more water gives less sensitivity, more heat being needed to produce the colour change.



Trade News

A suitable screen material for the flower pot viewing head described in Bulletin 67 is "Cobex Clearlite" a semi rigid rear projection screen material from the Clear-Vue Projection Co. The material can also be used to make daylight-viewing screens. Instructions and plans are supplied with order. Cost is £2.00 for 4 ft. x 2 ft.

Pyser-Britex (Swift) Ltd., have launched a new '0' grade microscope - the "Technar", this sells at £24.80 with 10x wide-field eyepiece and retractable 4x, 10x and 20x objectives.

Ideas for Education are marketing a range of horticultural instruments which should find a use in biology departments. These include soil thermometers, -5 to 110°C, £1.65, and -10 to 40°C at £1.80; a soil moisture meter at £3.66, and an ingenious max/min. thermometer at £2.25. The last has no separate resetting magnet to be lost, as often happens with the more traditional types.

The same firm is also offering the Checkerplug, a device which plugs into a square pin mains socket and indicates by means of two neon bulbs whether the socket wiring is faulty either in the form of a high resistance to earth of any of the current-bearing pins, or of wrong connections. The device costs £1.90 and we believe its regular use by the technician would be an important safety action throughout the school, not merely in the science laboratories.

Our latest purchase of bi-metallic strip has obliged us to increase the price from $2\frac{1}{2}$p to 10p - a sign of the times. These strips are off-cuts from the material used in the manufacture of thermostats etc, and are about 15cm long and of varying widths and thicknesses.

The Scottish representative of Morris Laboratory Instruments has asked us to inform teachers that in consequence of his extending his activities with the firm he is not now able to attend to orders sent directly to him. This does not mean that the personal service he has provided to MLI customers will be reduced, but that orders and requests should in the first instance be addressed to the main offices of the firm.

Educational Measurements, also known as Jay Jay, have introduced a new chart recorder, the CR500 at a very competitive price of £65, which will apply to orders received before 1st April. Thereafter the cost will be £79. The recorder uses 25cm width paper, and a feature is that it may be used vertically, or even hung on a wall, so that the trace may be more visible to a class. Chart speeds are from 10mm/s to 1mm/min in 9 ranges, and sensitivity from 40μV/mm to 4V/cm in 5 ranges.

Olympus microscopes, now supplied by Griffin and George have been subject to yet another price increase. We apologise for not including this information in our summaries but the increase has occurred since these were prepared. Prices at the time of writing (1/2/74) are:

Olympus MIC, (LO7-280), £26.50;
Olympus STN, (LO7-290), 4x, 10x with 10x eyepiece £38.00;
The 20x (LO7-352/015) objective is now only supplied as an addition at £10.00;
Olympus HSC, (LO7-320), £62.00;
Olympus HSC with phase (OLY/2/18) £120.63;
The phase kit on its own, (LO7-390), £145.00, is more than the instrument fitted with phase!

Electronic Calculators

Explanation of columns in the chart.

✓ means that a facility is included; - that it is not; * see special remarks on this model.

1. We found it difficult to give assessment ratings, and they are all to some extent subjective.

2. The division between desk and portable is subjective, and a matter of size. Any machine with a fixed mains cable is described as desk.

3. Price is exclusive of VAT, which the school will be charged.

4. M = Mains only; R = Rechargeable batteries, the calculator will not function while the batteries are charging; MR = mains and rechargeable batteries; MD = mains or disposable batteries.

5. Here we give the number, colour and size in mm of the display digits. G = green, R = red, O = orange, W = white.

6. S means separate + and = key, C means combined; where combined keys are used, the = is always combined with both + and - keys.

8. If operation by a constant factor is provided for, we show the operations (+, -, x, or ÷) for which this is possible. "All" means that the facility is possible on all four functions.

9. S means separate 'clear machine' and 'clear last entry' keys; C means combined, in which case the rule is usually that the key is pressed once to clear last entry and twice to clear the machine.

10. F = floating point; the numbers give the possible number of fixed decimal places to which the machine can be set.

11. F = flow or add list mode operation; FF = full flow or algebraic mode. See Bulletin 69 for explanation of these terms.

12. Here we state whether the machine indicates in some way that its capacity has been exceeded, whether it retains the most (M) or least (L) significant digits of the calculation (a - here means that the answer is lost and the display shows only zeros). In this last section we explain how the machine deals with calculation overflow. D means that the decimal position is lost, but the machine can be unlocked and further calculations carried out on the digits retained by pressing the clear last entry key, U means that the machine has underflow - see Bulletin 69 for explanation - and locks up, no further calculation being possible.

13. A machine possessing this facility will operate on the same number if the function key is pressed more than once, and is usually available on all four functions.

14. This means that if the wrong function key has been pressed the mistake may be corrected by pressing the correct function key when the machine ignores the first instruction and follows the

second. If this facility is claimed on add list mode models, it is available only for correction to x and ÷ functions.

Notes on the various models tested.

General. We have not specified the country of origin, because all the models tested have a 1 year guarantee or more, and all are repairable in the U.K.

Remington 661D The price here excludes the battery charger, which is an additional £3 + VAT. This has a 6 digit display but 12 digit handling capacity. If a calculation overflow occurs, the less significant digits are not shown but can be brought up by pressing a special key. Further calculations can be done only on the most significant digits. On this and the Remington 803B, the zero digit is half size. It was only the absence of a floating point facility on the 661D which prevented us giving this an A rating.

Bowmar MX50 A model identical to the MX50, but without the % key, the MX40, is available at £39.95.

Sanyo 810 This has a metal case which may make it more durable. It also has provision for conserving battery power. If the machine has inadvertently been left on, the display switches off after a short time and a red lamp comes on. The digits which were in the display can be recalled by pressing a special 'hold' key.

Rapidman 1208LC This has a liquid crystal display which appears and disappears slowly, and may reduce the operating speed.

Kovac K80D This uses U2 type cells, so that a nickel cadmium rechargeable type could be used.

Royal Digital ST The operation of the clear last entry function is complex. One has to press the clear key once, and follow this by entering the correct function and the correct number.

Adler 804 The calculation overflow symbol is 10^8, which appears on the right of the display, and the decimal point is displaced by this amount to the left. Further calculation is possible by clearing the last entry.

Sanyo ICC805 This has a special 'recall' key so that the penultimate number may be recalled e.g. 12 x 3 when this is punched the display will read 3. Pressing the recall key will bring up the 12; when this key is released and the = key pressed, the result 36 will be given.

Hitachi KK 181A Two models are available, one having decimal point F,0,2; the other 0.2,4. Choice must be specified when ordering. Another model, KK181B, is identical to this one, but has rechargeable batteries, and costs £59.

Model	1 Assessment	2 Desk/Portable	3 Price	4 Power Unit	5 Display No. digits/ colour/size in mm.	6 + = Key(s)	7 % Key	8 Constant Key operation	9 Clear Key(s)	10 Decimal Point	11 Flow/Full flow arith.	12 Calculation overflow indic-ation/digits held/underflow	13 Function key multi-operation	14 Function key correction
Remington 661 D*	B	P	£23.41	MD	6/G/6*	S	-	-	C	0,2	FF	✓/M/-*	-	✓
Remington 803 B	B	P	£55.00	MD	8/G/8*	C	-	x÷	S	F,0,2,4	F	✓/-/-	-	-
Bowmar MX50*	B	P	£49.00	MR	8/R/3	S	✓	-	C	F	F	✓/M/D	✓	-
Prinztronic C44	A	D	£36.32	M	8/G/8	C	-	x÷	S	F	F	✓/-/-	-	✓
Bowmar MX80	B	P	£65.00	MR	10/R/3	S	✓	x÷	S	F	F	✓/M/U	-	✓
Sanyo 810	B	P	£69.00	MR	8/0/6	C	-	x÷	S	F	FF	✓/M/U	-	✓
Hitachi KK 181A	A	D	£[illegible].00	M	8/G/6	C	-	x÷	S	F,0,2*	F	✓/-/-	-	✓
Rapidman 800	B	P	£24.50	MD	8/R/3	C	-	-	C	2	F	✓/L/D	-	-
Rapidman 1208LC*	A	D	£45.00	M	9/W/12	S	✓	all	C	F	FF	✓/M/D	✓	-
Texas TI3500	B	P	£38.63	MR	10/0/12	C	-	x÷	S	F,2,4	F	✓/M/U	-	-
Kovac K80D	B	D	£39.90	MD*	8/0/10	S	-	x÷	S	F,2,3	FF	✓/M/U	-	-
Royal Dig. 5T	B	P	£29.55	MD	8/G/5	S	-	all	C*	F	FF	-/M/D	-	✓
Texas TI2500	B	P	£32.27	MR	8/R/3	S	-	x÷	S	F	FF	✓/M/U	-	-
Adler 804	B	D	£54.00	M	8/G/8	C	-	x÷	S	F	F	✓/M/U*	-	✓
Sanyo ICC805	B	D	£62.73	M	8/G/8	C	-	x÷	S*	F	FF	✓/-/-	-	✓
Olympia CD100	B	D	£79.00	MD	8/G/8	C	-	x÷	S	F,0,2,4	F	✓/M/U	-	-

S.S.S.E.R.C., 103 Broughton Street, Edinburgh, EH1 3RZ.
Telephone 031 556 2184.

Bi-Pak Ltd., P.O. Box 6, Ware, Herts.

Cleapse Development Group, Brunel University, Kingston Lane,
Uxbridge, Middlesex.

Clear-Vue Projection Co. Ltd., 92 Stroud Green Road,
London N4 3EN.

Educational Measurements Ltd., 1 Brook Avenue, Warsash,
Southampton SO3 6HP.

Griffin and George Ltd., Braeview Place. Nerston,
East Kilbride.

Ideas for Education Ltd., 5 Castle Hill Terrace, Maidenhead,
Berks.

Morris Laboratory Instruments, 480 Bath Road, Slough Bucks.

Pyser-Britex (Swift) Ltd., Fircroft Way, Edenbridge, Kent.

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