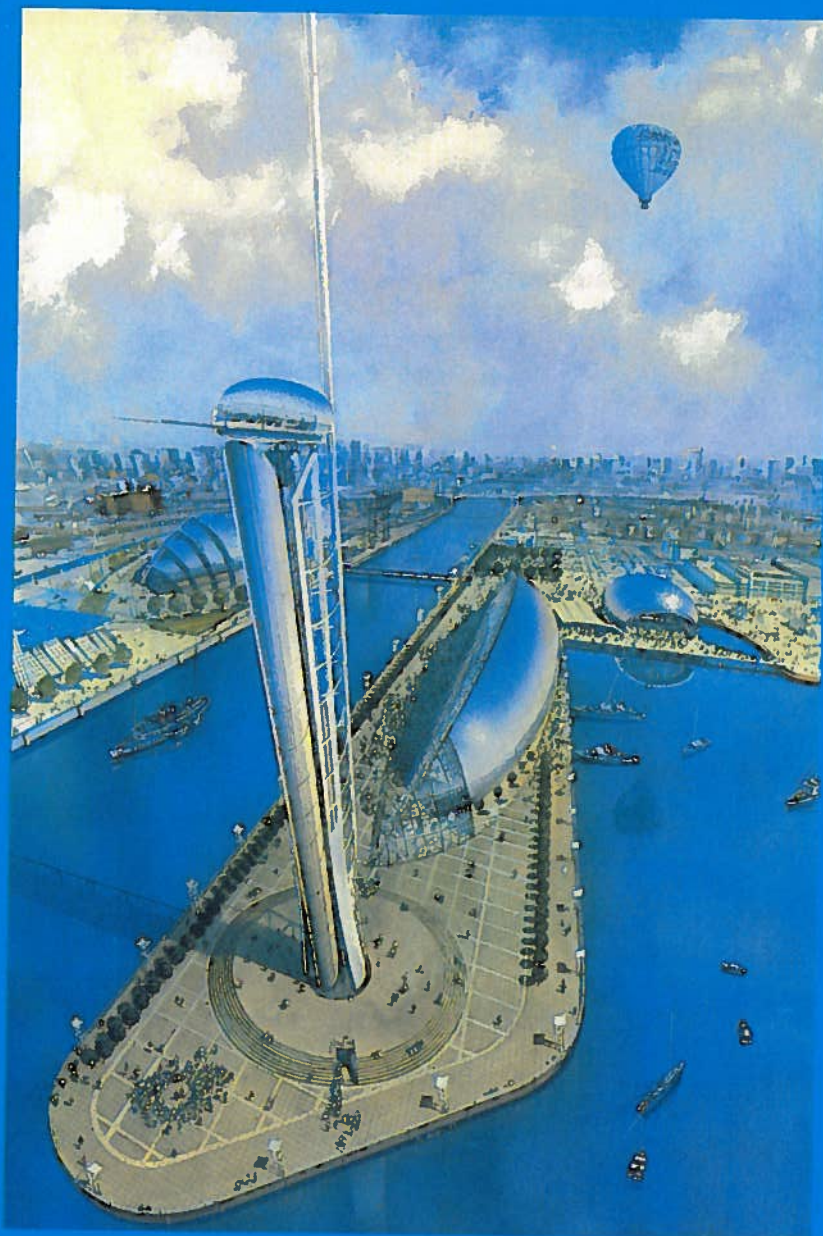


SCOTTISH SCHOOLS EQUIPMENT RESEARCH CENTRE



Science & Technology Bulletin

For: Teachers and Technicians in Technical Subjects and the Sciences

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Winter 2000

Science and Technology Bulletin

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NEWS AND COMMENT

See me! See DTP - nae PC

We owe readers and subscribers apologies. These are for both the delay in getting out Bulletin 200 and for the poor quality of reproduction of the graphics in Bulletin 199. It's not usual for us to shift blame but, for once, it really wasnae me. The Bulletin is set by us in a PC version of Adobe Pagemaker. Our printer also uses the same package but running on Apple computers. Somewhere between the two, our photographs for issue 199 got severely minced. The front page colour photo of a bioreactor which left these virtual shores appeared on the other side of a deep digital divide in full, inglorious if more environmentally friendly, monochrome. Many of the other illustrations inside the publication but intended as black and white, fared little better. Our own laser print copies were of better resolution and quality than those printed 'properly'. If you don't believe us then take a look at the web page versions on our internet site.

We think we've cracked the technical problems (more or less) but at the expense of many frayed nerve ends and a huge increase in the amount of memory and processing (mine as well as the machine's) taken up in producing half-decent illustrations. At one time (i.e. in our Archimedes and RISC PC days) we could get a whole thirty six page Bulletin on a single floppy. We now have to swap stuff with the printers and others on Zip discs and archive on CD ROMS with umpty megabytes of memory to achieve much the same effect.

Apparently there are those amongst the so-called 'leadership class' who preach that computers and ICT will eventually and wholly take over from teachers in schools and colleges. Anyone who truly believes that should perhaps either try DTPing for a living, apply to work for the Scottish Qualifications Authority, or - more simply - just get a life.

* * *

Dates for the diary

A new IMAX cinema has been built as part of the *Glasgow Science Centre*. Although the Science Centre proper isn't due to open until the Spring of 2001, the IMAX facility had its official launch (if one can 'launch' a cinema, even one on Pacific Quay) in the first week of October and opened to the public thereafter. For more detail see our website link to the Glasgow Science Centre.

The UK *Association for Science Education Centennial Annual Meeting* will be held at the University of Surrey, Guildford, 4th - 6th January, 2001. The *ASE Scotland 2001 Meeting* will be held 23rd to 25th March in the Science and Technology Block of the Education Faculty, Edinburgh University. (This is also the building in which SSERC rents a floor).

Since their inception, the *Royal Society of Chemistry's* meetings for teachers in St Andrew's have been superbly organised and well received by chemistry teachers. Not everyone can, nor it seems is inclined to, travel to said Royal and Ancient Burgh. The RSC has thus organised a West of Scotland Meeting for Teachers of Chemistry for Wednesday the 24th of January 2001.

This meeting is to be hosted by the Department of Pure and Applied Chemistry in the Thomas Graham Building, the University of Strathclyde. The fee for the day is only £10 (it could cost you more than that to park in the multi-storey so go by train). Further details from the address listed on the inside back cover of this issue.

The established Biotechnology, and the newer, some might say upstart, Chemistry, *Summer Schools* will again be held in Edinburgh University in the week beginning Monday 25th June 2001. Rumours persist about the possibility of a similar initiative for the physicists.

* * *

Spam, spam and spam

Are we knocking back your Email? We did have some problems a few weeks ago because of technical snags, not the least of which was the gas contractor slicing through a fibre optic cable. You may, understandably have experienced difficulty getting through to us. If we are now consistently refusing your Email, however, it could be because your ISP (Information Service Provider) is operating what's known as an open relay which allows the sending on of electronic junk mail.

Junk Emails are known, not at all affectionately, in the trade as *spam*. Insecure servers which can be taken loan of by spammers are known as *open relays*. This is nothing less than theft. Spammers steal the use of someone else's infrastructure to send advertising material across the web.

We are a secondary connection to the joint academic network (JANET) whose administrators are quite rightly vigilant about such matters. Our Email software filters out potential spammers by checking any incoming mail against databases of known open relays.

Regrettably, some Scottish local authority servers are at present blacklisted as open relays. For obvious reasons we're not about to name them. Similarly, some well known commercial ISPs are not quite as secure as we would all like to think. Even private households may be at risk if they use a cable modem or other services where a flat fee means that a home computer may be continuously connected to the web. Spammers can gain access to the hard disk of such a computer and use it as the first step to spawning spam. So if you can't get Emails through to us it may be worth checking your Email server's IP number (not the domain name) at the ORBS or SPAMCOP databases - see

<http://www.orbs.org/> and <http://spamcop.net>

* * *

Pearls before swine?

A while back, I had the privilege of attending a Royal Society of Edinburgh lecture by Sir Robert May, currently Chief Scientific Adviser to the UK Government. His talk was wide ranging covering many contemporary, and often contentious, scientific issues. Typically antipodean in both attitude and delivery, Sir Robert can, when necessary, cry the proverbial a bloody shovel. He didn't mince his words when discussing the need for sustainability.

He also provided insights into public understanding of science and of the public's sub-conscious application of cost/benefit analysis to scientific research and technological applications. Sir Robert reported that he understood public reluctance to embrace GM foods when the long term environmental risks remain ill quantified and major benefits may seem likely only to flow toward agribusiness and the large food retailers. Therapeutic applications of medical research involving genetic modification may be more acceptable but only where the citizenry see clear benefits. For example where they, their wider family or friends might benefit from new treatments flowing from such research. Thus work on cloning might be less objectionable where, as in the case of sheep, the animals secrete therapeutically useful products or in pigs where organs and tissues become available for xenotransplantation with the possibility of fewer complications from rejection.

This principle of lay cost/benefit analyses is well documented in professional health and safety circles. Given that there is much in what Sir Robert had to offer in his analysis, it is surprising that professionals in the biosciences have made so little of a third category of biotechnological applications. These are based also on molecular biology and genetic modification but they hold out significant promise for tackling a number of urgent, and potentially critical, environmental problems.

These techniques of bioremediation, including gene transfers and cloning, are already in use in Scotland as responses to problems such as land contamination and recycling techniques. Many other environmental difficulties are not yet amenable to solutions because as yet we don't even fully understand the problems. In many instances modern techniques of molecular biology, including usage of DNA analyses and genetic modification, can assist us to unravel some of these complexities. Certainly unless we do the science we shall not access these potentially benign technologies.

For example, DNA analysis has already revealed much we didn't know about key species in Scotland's rich wildlife tapestry - from the precise lineage of Scots Pines to causes of lice infestations of Sea Trout and Atlantic Salmon. The wild salmon, we now also know, is in turn closely associated with the threatened freshwater mussel that source of rare and distinctive Scots pearls. Perhaps it would be no bad thing if we heard a bit more of such biotechnologies and a wee bit less about GM tomatoes, Dolly, cloned hens and the PPL piggie wiggies?

* * *

SQA debacle

For once, the motivation for any attempt at humor(?) escapes us. We find it of no comfort whatsoever that, alongside anyone else in Scottish education with two neurones to make a synapse, we saw this coming from a very long way off [1,2]. Not only are we angry that the weans have been so badly let down by the very system meant to serve them, we also deeply resent being tarred with the brush of another Scottish agency's professional incompetence. One has now to set out for any educational meetings south of the border with a degree of trepidation and a good deal more reticence than hitherto. Courtesy largely of SCOTVEC, Scottish Education now has a new motto:

Aye, weel. Here's tae us, whaur's like us.

Damn few an they're a useless tae.

References

1. *W(h)ither Higher?* Bulletin 185 SSERC 1995
2. *Per ardua without the astra*, op.cit.

* * *

Bulletin back issues

Following a review of our fire safety arrangements, we've been having a tidy-up and clearout of publication stocks. This to cut down on the unnecessary storage of paper. This exercise has unearthed surplus stocks of back copies of some Bulletin and Newsletter issues. Before we consign these to the recyclers we offer them here to anyone who missed out on their copy of any of these issues. Prompt requests would be appreciated. We don't intend holding on to these back numbers for too long after publication of this current issue. Depending on the size of your order, post and packing may be charged at cost.

The **Bulletin** issues available are :

152 (June '86)	154 (November '86)	156 (March '87)
157 (May '87)	159 (March '88)	160 (June '88)
161 (October '88)	162 (April 89)	163 (Sept '89)
165 (March '90)	168 (December 90) (a few only)	
169 (April '91)	171 (October '91)	172 (January 92)
173 (March '92)	175 (October '92)	176 (March '93)
177 (June '93)	179 (December '93)	180 (Spring '94)
181 (Summer '94)	182 (Autumn 84)	183 (Winter '94)
184 (Spring '95)	185 (Summer '95)	186 (Autumn '95)
187 (Spring '96)	190 (Spring '97)	191 (Summer '97)
193 (Spring '98)	195 (Autumn '98)	196 (Spring '99)

The 5-14 **Science & Technology News** issues are:

6 (Summer '95)	8 (Winter '95/96)	9 (Summer '96)
12 (Summer '97)	13 (Autumn '97)	15 (Summer '98)
	16 (Autumn '98)	

* * *

HSE update on MDF

The Health and Safety Executive has published a *Hazard Assessment Document for MDF* (medium density fibreboard) [1]. This is a wide ranging review which deals with the health effects of exposures which may arise from the machining of MDF and which have to be controlled under the COSHH (Control of Substances Hazardous to Health) Regulations. It is somewhat specialised and thus likely to be of more interest to health and safety officers, safety representatives and technical resource support managers than teachers or technicians. Amongst other data, the document provides general information on MDF types, on sources and means of exposure and on the toxicology of the various individual components of such fibreboards. A fairly comprehensive bibliography provides references to other important sources.

The publication summarizes the results of assessments of exposures resulting from machining MDF and of particleboard. Somewhat tentative conclusions are drawn on the effects of combined exposures to wood dust and free methanal (formaldehyde) vapour resulting from the machining of MDF compared to the effects of either alone.

Reference

1. *Medium density fibreboard (MDF) : Hazard Assessment Document*, (EH75/1) HSE 1999 ISBN 0 7176 1735 1

* * *

'Replacement' for BS 5304

In Bulletin 195 [3] we railed against a BSI (British Standards Institution) decision, to declare obsolescent, BS 5304 : 1988 the *British Standard Code of practice for Safety of Machinery*. We were particularly concerned that there was to be no obvious, single, replacement for BS 5304 and that access to similar information would mean consulting an extremely expensive collection of thirty-plus separate EN documents. We argued strongly that BSI had to come up with a single document the scope of which would match that of BS 5304.

The good news is that BSI has, more or less, done exactly that and in July it published PD 5304 : 2000 [4]. This is entitled *Safe use of machinery* and covers more or less the same ground as the earlier Standard Code of practice albeit - as a 'Published Document' - its status is not as great.

The overall format is also different in that PD 5304 is arranged in sections in a ring binder rather than in the bound, single volume. There are a number of other, fairly minor, differences between PD 5304 and the old BS but on the whole these are useful additions or amendments. Most of the excellent figures and diagrams, notable for their clarity, are there and it remains the nearest thing we've seen to a 'Bible' of machine safety. The bad news is that, although it's much less pricey than an equivalent collection of separate EN documents, PD 5304 is still relatively expensive in educational terms, especially at the full, non BSI member price of £170 per copy!

As members, ours cost only half that but even at £85 we could hardly recommend it as a student text. If there were sufficient interest it would be our intention to explore the possibility of BSI bringing out a discounted version of PD 5304 for educational users. It is a useful resource and should be more accessible to school and college technology departments.

References

1. *Machinery safety : BS 5304 obsolescent* Bulletin 195 SSERC 1998
2. *Safe use of Machinery : PD 5304 : 2000* British Standards Institution 2000 ISBN 0 580 33207 1

* * *

Health and Safety in D&T

The other good news is that BSI has revised and republished BS 4163 [1], its specific guidance on health and safety in design and technology in schools and similar establishments. This BSI 'Code of practice' provides detailed and authoritative information on which educational employers can base local guidance and operational policy frameworks (see also page 13 in this Bulletin issue).

HSE has also recently published a new edition of its 1995 publication "*Health and Safety in Engineering Workshops*" [2]. It's not intended specifically for education but this is still a useful reference also for workshop safety in schools and colleges. It draws on, and effectively summarizes, guidance from "over two hundred separate HSE publications in one easy to read and follow guide - as well as providing a comprehensive list of references and other sources of help". In particular, it provides much useful guidance on the implementation of *The Provision and Use of Work Equipment Regulations* (PUWER), 1998 in small engineering workshops.

Reference

1. *Health and safety for design and technology in schools and similar establishments - Code of practice BS 4163* British Standards Institution 2000, ISBN 0 580 33167 9.
2. *Health and Safety in Engineering Workshops* (HSG 129) HSE 1999 (second edition) ISBN 0 7176 1717 3

* * *

Health and Safety Law

Since October 1999 new versions of the statutory *Health and Safety Law poster* [1] and the leaflet *Health and safety law - What you should know* [2] have been issued. Employers have a legal duty to display the poster in a prominent position in each workplace or provide a copy of the leaflet outlining British health and safety laws for each of their employees. The old poster is out of date and must be replaced. The law states that the poster must be 'kept displayed in a readable condition at a place where it is reasonably accessible'.

References

1. Poster (420 x 594 mm) HSE Books 1999 ISBN 0 7176 2493 8 £7.50.
2. Leaflet *Health and safety law - What you should know* HSE Books 1999 ISBN 0 7176 1702 5 £5.00 for pack of 25 (single copy free).

Balance review

Recently SSERC tested nine commercially available balances, all of which are aimed at the school and college market. This article reports the findings of that test programme. Best buys are provisionally indicated.

Modern electronic balances are generally sophisticated instruments often with computer interfacing capability and software for recording and processing results. There are many brands of balances out there. However, on careful inspection a number of the models aimed at the educational market suffer from what has become known as *badge engineering*. Some, all too obviously, share a common manufacturing origin! Our own short list for testing was based on specifications and price.

Balances are routinely used pieces of science laboratory equipment. Students and staff alike recognise a balance as an instrument that 'weighs things'. But, they are also one of the more expensive purchases a department has to make and they can be relatively easily damaged. Recently they have also become a security headache as targets for theft by those involved in the production of illegal drugs.

Careful consideration of educational applications should indicate how precise a balance is required. This will go a long way to identifying a suitable instrument. Often, a compromise has to be struck between range, sensitivity and affordability. In general, a more expensive balance will give more precise, dependable readings than a cheaper balance of equivalent capacity. The accuracy of a balance is often the key concern of purchasers when considering which instrument to buy. However, it is just as important also to consider the points listed in Text Box A (below left). In terms of accuracy, remember even an expensive 'precision' balance is only as good as its operator and the mode of usage. For example, to get accurate results it may be necessary to provide a reasonably constant environment and to calibrate the balance at the actual position of use. The main factors contributing to the accuracy of the results from an electronic, indeed any, balance are listed in Text Box B (below, this column).

1. *Ease of use* – remember many naive operators may use the balance.
2. *Robustness* – some operators may be heavy handed?
3. *Connectivity* – can it communicate electronically with other devices especially dataloggers, computers etc? Is such connectivity actually important?
5. *Portability* - easily moved but with the ability also to secure against theft.

[A]

1. *Resolution* – often referred to as sensitivity or readability ie 0.1g or 0.01g.
2. *Repeatability* – in simple terms, the same weight placed on a balance should give the same reading each time.
3. *Linearity* – a measure of how consistent the balance is throughout its capacity range.

[B]

Make/Model	Range (g)	Sensitivity (g)	Supplier	Cost
A & D Instruments EK-600G	600	0.1	Scientific & Chem Supplies	£245
Fisher Education	500	0.1	Griffin & George	£166
Student Range1200	1200	0.1	Philip Harris Education	£325
Ohaus Scout SC4010	400	0.1	Griffin & George	£169
A & D Inst EK-200G	200	0.01	Scientific & Chem Supplies	£270
Bonso 337	200	0.01	P.S.S Science Supplies	£195
Fisher Education	150	0.01	Griffin & George	£188
Student Range 200	200	0.01	Philip Harris Education	£230
Ohaus Scout SC2020	200	0.01	Griffin & George	£232

Table 1 Balances reviewed in this article. The models fall roughly into two categories. Four of the models have medium capacity (range) with a 0.1 g sensitivity. Four of the remaining five have 200 g capacities whilst one is 150 g. All five with the lower range have 0.01 g sensitivity. Please note that just prior to publication, we were told that the Ohaus *Scout* balances, SC4010 and SC2020, are to be phased out and replaced by the 'advanced' *Scout II* series balances. We have requested new versions for evaluation. We will publish the results on the Members' section of the SSERC web site in due course.

Assessment criteria

In assessing the suitability of these balances for use in schools and colleges in Scotland, ratings were assigned on a three point scale in each of three broad aspects of overall performance: design, ease of operation and performance in selected activities relevant to Scottish courses.

Details of the scheme used to assign ratings are given in the Text Box below. These ratings were then used to produce an overall assessment of the general suitability of the balances for use in schools and colleges in Scotland.

Electrical Safety

Note that, although SSERC's criteria for electrical safety are quoted below, all of the models tested were low voltage appliances with mains adaptors. Some had rechargeable battery packs available as optional extras. All of the mains to low voltage adaptors examined were Class II (double insulated) devices. Each was given a thorough visual inspection and a thermal soak test but none was actually flash tested.

1. Design:		4. Electrical Safety (where relevant):	
<i>Rating</i>	<i>Criteria</i>	<i>Rating</i>	<i>Criteria</i>
A	Robust enclosure and parts. Secure fitment of parts. No significant weakness.	A	Complies fully with IEC 1010-1 as far as our tests are able to indicate, except for minor infringements; has no appreciable risk for use in schools or colleges.
B	Minor significant weaknesses identified.	B	Complies in general with IEC 1010-1, but one or more features where there is a very small risk of harm.
C	Major weaknesses identified.	C	One or more features present an unacceptable risk of harm.
2. Operation:		The ABC rating in general stands for:	
<i>Rating</i>	<i>Criteria</i>	A = Good B = Fair C = Poor	
A	Controls clearly marked. Operation simple, clear and obvious.	Overall Assessment Ratings :	
B	Minor weaknesses identified.	A = Most suitable for use in schools and non-advanced FE.	
C	Awkward to work with, or misleading to operate.	B = Satisfactory for use in schools and non-advanced FE.	
3. Performance:		C = Unsatisfactory.	
<i>Rating</i>	<i>Criteria</i>		
A	Performs to or near specification.		
B	Significant minor underachievement.		
C	Significant underachievement.		

Results and Assessment Summary

Our assessments of the balances are summarised in Table 2 overleaf. Short form test reports are also provided. Full technical reports, with supporting data, are available on request from the Executive Director of SSERC.

All the balances reviewed in this article performed to, or near, specification in our evaluation. All would be suitable for use in school science departments.

The *Ohaus*, *Fisher Education* and *Bonso* balances are all well designed and easy to use. The *Bonso* does not have interfacing capability, whereas the *Ohaus* and *Fisher Education* balances are capable of interfacing with a computer via a *LogIT* balance interface that can be fitted at an additional cost.

It is worth noting that this only allows interfacing via *LogIT*, which makes these balances, in terms of computer interfacing, less flexible than models which can be fitted with an RS232 serial connection. Of these, we particularly liked the *Ohaus* balances. The models tested were sturdy and soundly constructed. Our information is that the new *Ohaus Scout II* balances, referred to earlier, will be available with a factory fitted RS232. We see this as a positive and welcome development. However, it must be stressed that, to date, we have not evaluated these new balances and the results and comments given in this article for the SC2020 and SC4010 should not be assumed to apply to them (see notes to Table 1).

Model	Design	Operation	Performance	Assessment
<i>A & D Instruments EK-600G</i>	A	B	A	A
<i>Fisher Education 500 g</i>	B#	A	A	A
<i>Student Range 1200</i>	A	B	B*	B
<i>Ohaus Scout SC4010</i>	B#	A	A	A
<i>A & D Instruments EK-200G</i>	A	B	A	A
<i>Bonso 337</i>	A	A	A	A
<i>Fisher Education 150 g</i>	B#	A	A	A
<i>Harris Student Range 200</i>	A	B	A	A
<i>Ohaus Scout SC2020</i>	B#	A	A	A

Table 2 Summary of assessments against stated criteria

Given on the basis that these will interface via *LogIT* only. Otherwise would be rated A for design.
 * We would rate the performance of the balance as an "A" if the software problems were resolved.

Results and Assessment Summary cont.

The *A & D Instruments* and *Philip Harris Student Range* balances are again well designed but we feel are slightly less easy to use than the other models. For an additional cost, both balances can have an RS232 serial connection fitted to allow interfacing with a computer.

We had problems when using *Datamass Pro* software with the Student Range 1200 balance. As things presently stand we cannot recommend this balance for datalogging. Philip Harris are aware of the problems we experienced and are currently investigating them.

(cont./opposite)

Short form reports

A & D Instruments

EK-600G

Cat. No. BLH02020 Price - £245.00

Optional extras

Cat. no.	Description	Price
BLH020500	RS232 interface for connection to a PC	£65
BLH020510	Comparator output with buzzer	£95
BLH020520	Internal rechargeable battery pack	£120
BLH020530	Carrying case	£45

* * *

Description

This balance is a lightweight instrument with a large rectangular stainless steel weighing pan. It provides multi-weighing units, counting, percentage weighing and a comparator mode (High-OK-Low).

The design allows for easy cleaning with a sealed keyboard and moulded spill ring to protect against spillage. It features push button operation, a clear LCD display, security bracket, overload protection, spirit level, and adjustable feet. Catalogue entries indicate that it also has an underhook weighing facility. The example tested did not have this capability. An RS232 serial interface can be fitted at an additional cost of £65.00 to allow datalogging.

Performance

This balance performed to or near specification. The test results were satisfactory, or better, in all the tests that were carried out.



Figure 1 A & D Instruments EK-600G

Documentation

A comprehensive instruction manual is provided with the balance.

Summary

This balance is one of the more expensive tested. However, it performed well in our evaluation. The design is sound and the balance can fitted with an RS232 serial connector to allow interfacing with a computer. This balance would be more than adequate for school and college applications requiring such a range and 0.1 g sensitivity.

Overall assessment

A : Most suitable for use in schools and non-advanced further education.

* * *

Fisher Education

500 g

Cat. No. BFM-120-040v Price £166.00



Figure 2 Fisher Education 500 g by 0.1 g balance

Description

A compact balance with a stainless steel weighing pan. The instrument features simple push button operation and a clear LCD display. The simple design allows for easy cleaning and a sealed keyboard and moulded spill ring protects against spillage. A weigh below facility is provided, the hook being stored in the battery compartment. It also features a security bracket along with both stability and error indicators. A *LogIT* Fisher balance interface is available as an extra at a cost of £75.00. This incorporates a small microprocessor, which converts the proprietary signal into a *LogIT* compatible signal. The mass value is directly transferred digitally, so that *LogIT* reads and stores exactly the same data as the balance.

(cont./page 8)

Performance

This balance performance matched the specification and produced results that were satisfactory or better in all the tests that were carried out.

Documentation

The instructions supplied with the balance were both concise and informative.

Summary

This balance is reasonably priced and easy to operate. It is well designed, quite sturdy and should be able to perform the routine tasks required of a school laboratory balance. The ability to interface only with *LogIT* data loggers may be a disadvantage.

Overall assessment

A : *Most suitable for use in schools and non advanced further education.*

* * *

Philip Harris

Student 1200

Cat. No. A51421

Price - £325

Optional extras

Cat. no.	Description	Price
A51299	RS232 interface for connection	£65.00
B30289	9 pin PC lead	£25.00
B30291	25 pin PC lead	£25.00
A51287	carrying case	£45.00
A51305	spare a.c. adaptor	£20.00
A51342	Repair service for <i>Student</i> Balances [Maximum charge shown but does not include delivery charges]	£150.00



Figure 3 Harris Student 1200 g by 0.1 g balance.

Description

This balance is a lightweight instrument with a large rectangular stainless steel weighing pan. It provides multi-weighing units, counting, percentage weighing and a comparator mode – (High-OK-Low). The design allows for easy cleaning and a sealed keyboard and moulded spill ring protects against spillage. It features push button operation, a clear LCD display, security bracket, overload protection, spirit level, and adjustable feet. An RS232 serial communication facility can be fitted at an additional cost of £65.00 to allow computer interfacing.

Performance

This balance performed to or near specification and produced results that were at least satisfactory in all the tests that were carried out. When interfaced to a PC we had problems above 500 g. The LCD continuously flashed and there appeared to be an offset problem.

Documentation

The instruction manual supplied with the instrument is informative and relatively easy to follow. It contains comprehensive instructions on the setting up and use of the balance.

Summary

This balance is well designed and can be interfaced with a computer. We had difficulty interfacing using *Datamass Pro* software. Philip Harris have acknowledged that there is a problem with the sample balance we used. They are currently looking into it. This model is more expensive than the other 0.1 g balances reviewed, but it does have a much higher capacity. Its performance in our evaluation suggests that, presently, it would be satisfactory for all activities apart from datalogging.

Overall assessment

B : *Satisfactory for use in schools and non advanced further education.*

* * *

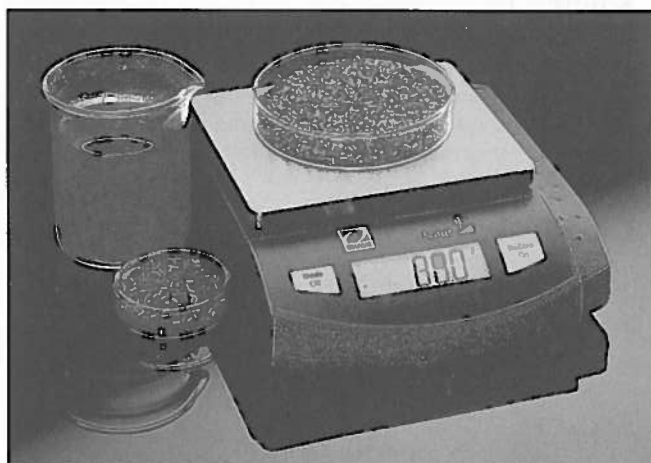


Figure 4 Ohaus Scout SC4010 400 g by 0.1 g balance

Optional extras

A *LogIT* balance interface is available as an extra at a cost of £75.00. This incorporates a small microprocessor, which converts the proprietary signal into a *LogIT* compatible signal. The mass value is directly and digitally transferred, so that *LogIT* reads and stores exactly the same data as does the balance.

Description

A lightweight balance featuring a large rectangular stainless steel weighing pan, clear LCD display and simple push button operation. The instrument has a moulded spill ring and sealed keyboard to protect against spillage. A weigh below facility is provided, the hook being stored in the battery compartment.

This model also features a security bracket, front panel controls and a simplified menu. It has an auto shut-off facility as well as stability and error indicators. The design incorporates a novel side grip to assist safe carrying of the instrument.

Performance

Our sample of this model performed at or close to specification. Results were satisfactory or better in all the tests that were carried out.

Documentation

This is succinct, i.e. concise whilst still informative.

Summary

This balance is reasonably priced and easy to operate. It is a sturdy and well designed unit, which has a performance that is more than adequate for school and college use. The ability to interface only with *LogIT* data loggers may prove a disadvantage.

Overall assessment

A: Most suitable for use in schools and non-advanced further education.

* * *

Optional extras

Cat. no.	Description	Price
BLH020500	RS232 interface for connection to a PC	£65
BLH020510	Comparator output with buzzer	£95
BLH020520	Internal rechargeable battery pack	£120
BLH020530	Carrying case	£45

Description

This balance is a lightweight instrument with a round stainless steel weighing pan. It provides multi-weighing units, counting, percentage weighing and a comparator mode – (High-OK-Low). The design allows for easy cleaning with a sealed keyboard and moulded spill ring to protect against spillage. It features push button operation, a clear LCD display, security bracket, overload protection, spirit level, and adjustable feet. (cont. /p. 10)



Figure 5 A&D Instruments 200 g by 0.01g balance

Catalogue entries indicate that it also has an underhook weighing facility. The example we tested did not have this capability. An RS232 serial connection can be fitted at an additional cost of £65.00 to allow computer interfacing.

Performance

This balance performed to or near specification and produced results that were at least satisfactory in all the tests that were carried out.

Documentation

A comprehensive instruction manual is provided with the balance.

Summary

At £270.00 this balance is relatively expensive. However, the design is sound and it performed well in our evaluation. It can be interfaced with a PC and would be more than adequate for most school and college science purposes.

Overall assessment

A : *Most suitable for use in schools and non-advanced further education.*

* * *

Bonso Electronics

FB 337

Price £195.00

Optional extras

Cat. no.	Description	Price
N/A	Adaptor, class 2 construction	£9.00

Description

A compact balance with a stainless steel cover to the weighing platform. The instrument features simple push button operation and a clear LCD display. The simple design allows for easy cleaning and a sealed keyboard and moulded spill ring protects against spillage.

Performance

This balance performed to or near specification and produced results that were at least satisfactory in all the tests that were carried out.

Documentation

A double sided A4 sheet of instructions is provided with the balance. Although brief the instructions are reasonably comprehensive.

Summary

This is an easy to use compact balance. It is well designed and quite sturdy. The performance of the unit tested was more than adequate for school use. The fact that this balance cannot be interfaced with a computer may be seen as a disadvantage.



Figure 6 Bonso Electronics FB337 200 g by 0.01 g balance

At £204.00, including an adaptor, this balance is more expensive than some other equivalent resolution balances that have interfacing capability.

Overall assessment

A : *Most suitable for use in schools and non-advanced further education.*

* * *

Cont./p 11

Fisher Education

150 g

BFM-120-020E

Price £188.00

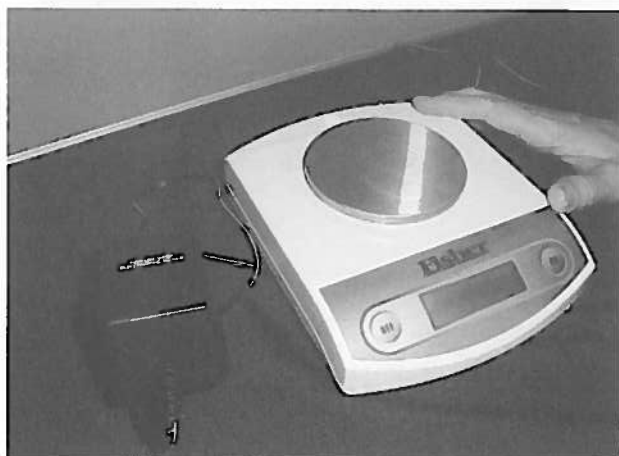


Figure 7 Fisher Education 150 g by 0.01 g balance

Description

A compact balance with a stainless steel weighing pan. The instrument features simple push button operation and a clear LCD display. The simple design allows for easy cleaning and a sealed keyboard and moulded spill ring protects against spillage. A weigh below facility is provided, the hook being stored in the battery compartment. It also features a security bracket along with both stability and error indicators.

A *LogIT* Fisher balance interface is available as an extra at a cost of £75.00. This incorporates a small microprocessor, which converts the proprietary signal into a *LogIT* compatible signal. The mass value is directly transferred digitally, so that *LogIT* reads and stores exactly the same data as the balance.

Performance

This balance performed to or near specification and produced results that were at least satisfactory in all the tests that were carried out.

Documentation

This is both concise and informative

Summary

This two decimal place balance is reasonably priced and easy to operate. It is well designed, quite sturdy and its performance is more than adequate for school use. The ability to interface only with *LogIT* data loggers may be a disadvantage.

Overall assessment

A : *Most suitable for use in schools and non-advanced further education.*

* * *

Philip Harris

Student 200

Cat. No.A51408

Price £230.00

Optional extras:

Cat. no.	Description	Price
A51299	- RS232 interface for connection to a PC -	£65.00
B30289	- 9 pin PC lead -	£25.00
B30291	- 25 pin PC lead -	£25.00
A51287	- carrying case -	£45.00
A51305	- spare a.c. adaptor -	£20.00
A51342	- repair for <i>Student</i> Balances (max. price) -	£150.00
	[repairs do not include delivery charges]	

Description

This balance is a lightweight instrument with a round stainless steel weighing pan. It provides multi-weighing units, counting, percentage weighing and a comparator mode - (High-OK-Low). The design allows for easy cleaning and a sealed keyboard and moulded spill ring protects against spillage. It features push button operation, a clear LCD display, security bracket, overload protection, spirit level, and adjustable feet. An RS232 serial connection can be fitted at an additional cost of £65.00 to allow computer interfacing.

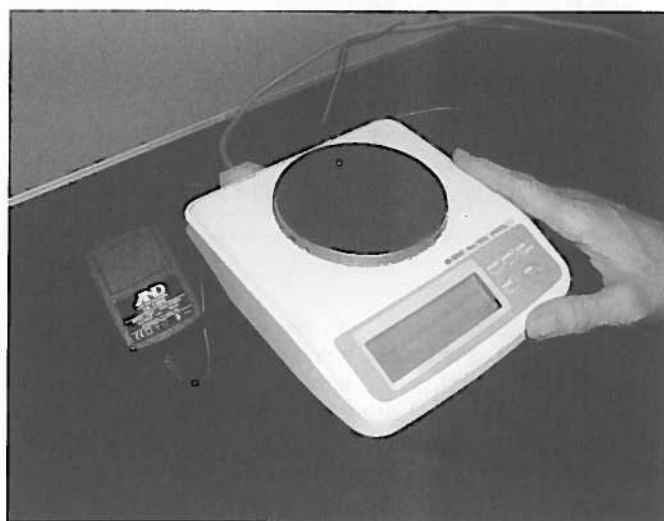


Figure 8 Harris *Student* 200 g by 0.01 g balance

cont./p.12

Performance

This balance performed to or near specification and produced results that were satisfactory or better in all of the tests carried out.

Documentation

The instruction manual supplied with the instrument is informative and relatively easy to follow. It contains comprehensive instructions on the set up and use of the balance.

Summary

The design of this balance is sound and it performed well in our evaluation. The balance can be interfaced with a PC and its performance would be more than adequate for most school science purposes.

Overall assessment

A : *Most suitable for use in schools and non-advanced further education.*

* * *

Ohaus Scout

SC2020

Cat. No BCM515L

Price £232.00

Description

A lightweight balance featuring a stainless steel weighing pan, clear LCD display and simple push button operation. The instrument has a moulded spill ring and sealed keyboard to protect against spillage. A weigh below facility is provided, the hook being stored in the battery compartment. It also features a security bracket, front panel controls, simplified menu, auto shut off and stability and error indicators. The design incorporates a novel side grip to aid safe carrying of the instrument.

A *LogIT* balance interface is available as an extra at a cost of £75.00. This incorporates a small microprocessor, which converts the proprietary signal into a *LogIT* compatible signal. The analogue mass value is digitally encoded and directly transferred, so that *LogIT* reads and stores exactly the same data as the balance.

Performance

This balance performed to or near specification and produced results that were at least satisfactory in all the tests that were carried out.

Documentation

This is concise yet still informative.

Summary

This balance is reasonably priced and easy to operate. It is a sturdy and well designed unit, which should be able to perform the tasks required of a two decimal place balance in a typical educational laboratory. The ability to interface only with *LogIT* data loggers may well be a disadvantage.



Figure 9 Ohaus Scout 200 g by 0.01 g balance

Overall assessment

A : *Most suitable for use in schools and non-advanced further education.*

* * *

BEST BUYS

For a number of reasons, our choices currently are both provisional and conditional. Much depends on interfacing capabilities. There is, on one hand, the matter of whether or not suppliers succeed either in enhancing the interfacing capabilities of their models or, in one case, merely sort out existing problems. Conversely such expectations presuppose that interfacing balances to computers or dataloggers is in practice critical. So:

If *Ohaus* succeed in adding satisfactory serial communication facilities to their *Scout SC4010* and *SC2020* models these would be our undoubted choices in both capacity categories. If interfacing is not a concern or

LogIT would in any case be your preferred route to data-logging, computer analysis and display then this condition does not apply. In our view, these models are currently the best of the bunch on both performance and price.

If for now *Ohaus* is put to one side, until the *Scout II* models actually appear, then in the upper range category should *Harris* sort out their interfacing problems, or if these aren't of interest anyway, we would choose their *Student 1200* model, or, as next choice, *A&D's EK-600G*. In the lower range category our non-*Ohaus* choice would be the *Harris Student Range 200*.

* * *

Safety sources for technology

For workshop activities, the CLEAPSS publication *Risk Assessments for Technology* [1] performs a similar function to the SSERC and CLEAPSS publications for science. Copies are available from SSERC at £4-50 each (members only). Note though that a new, two part, edition is currently in preparation at CLEAPSS. A number of Scottish Education Authorities also have produced their own detailed guidance in this area (for example, see Aberdeen City details below). In addition the National Association of Advisers & Inspectors in Design and Technology (NAAIDT) has published some excellent guidance on specific health and safety issues in technology education [2].

Note that BSI 4163 has been reissued as a design and technology code of practice (see page 3 of this Bulletin) and SSERC has also published frameworks for relevant, action-based or operational health and safety policies. These latter adopt a common format, one based on recommendations of the HSE's Education Services Advisory Committee and endorsed also by CLEAPSS as well as professional organisations like ASE. These frameworks may be downloaded from the Members' section of our website and customised for use in individual schools and departments.

Recently, a number of Scottish EAs have formally adopted this strategy of basing health and safety management arrangements on such operational documents. For example, Fife Council has issued departmental policy frameworks for science and is considering this approach for Design & Technology. Aberdeen City Council Education Department has also recently issued policy based guidance on health and safety management issues. Four of the documents are of direct relevance to technology department staff [3,4,5 & 6]. Contact details are provided in the address list, inside back cover. See pages 3 and 14 in this issue for some other useful sources.

References

1. *Risk Assessments for Technology in Secondary Schools* CLEAPSS 1994 (A new two part, loose leaf, edition to be entitled *Model Risk Assessments for Design & Technology*, is currently in preparation).
2. NAAIDT Publications (available through DATA see address list):
 - a) *Make it safe!* Safety guidance for Design and Technology (Primary and Lower Secondary);
 - b) *D&T for the Under-Fives: some Health & Safety Issues*;
 - c) *Safety Training Courses for Teachers/Technicians*.
3. *Health and Safety Policy : Design & Technology Department*, Aberdeen City Council, Education Department 2000.
4. *Design and Technology Department Handbook* Aberdeen City Council, Education Department 2000.
5. *Risk Assessment for Design & Technology Departments*, Aberdeen City Council, Education Department 2000.
6. *Managing Health & Safety in Design & Technology Departments* : Two volumes - *Principal Teacher Guide* and *Teacher Guide*, Aberdeen City Council, Education Department 2000.

* * *

Prosecution after technology incident

A school in England (which was grant-maintained at the time) was recently prosecuted by the Health and Safety Executive (HSE) following an accident to a pupil in a Design and Technology lesson. The pupil was injured by a piece of wood that flew off a pedestal drill, hitting the pupil on the forehead, causing a blood clot for which he received emergency treatment. Clamps and other safety equipment were available but were not in use.

The school had model risk assessments from the Education Authority for this and other activities. There was no evidence, however, that the advice had been read and certainly none that it had been acted upon. The Board of Governors, as the employer for such a grant maintained (now a 'Foundation') school, were prosecuted under the:

- Health and Safety at Work Act (Section 3)*, for not ensuring the health and safety of those not in their employment,
- and the
- Management of Health and Safety at Work Regulations*, for not carrying out a suitable and sufficient risk assessment.

The school was fined £1250 for the first offence and £5000 for the second.

Although this incident happened in a technology department, there are lessons too for science departments. Many schools use the SSERC *Hazardous Chemicals Manual* and Bulletins as well as CLEAPSS *Hazcards*, the CLEAPSS Laboratory Handbook or similar publications. Each of these provides a basis for model risk assessments.

However, this case shows once again that merely having these sources on the shelf is not enough. There needs to be evidence that schools read them and act upon the advice, customising it as necessary for the situation in a particular school or class. In general, both CLEAPSS and ourselves suggest noting down the major points on schemes of work, teachers' guides or similar point-of-use texts [1].

Reference

1. *Managing risk assessment* Bulletin 193 SSERC 1998 (Available also on SSERC members' website).

Acknowledgement

This note is based on a report first published in CLEAPSS Bulletin 109. We are most grateful to colleagues in our sister organisation for permission to so adapt this material.

* * *

Active braking, workshop machinery

With a number of recent legal cases and incidents on the wider front nationally, health and safety issues have again become topical in educational establishments. Senior managers also more aware of their legal responsibilities. Workshop safety has always had a reasonably high priority, probably because many of the mechanical hazards therein are fairly obvious. One only has to note the number of missing digits or parts thereof on technical teachers and technicians, both practising and ex.

The most common cause of such injuries has been the removal of cuttings and swarf from a saw bench after it had been switched off. Even though the machine was without power the rotational energy in the blade remained great enough to cut through a finger during run-down. With the advent of recent legislation, such as PUWER¹, the 'active' braking of such workshop machinery is very much a live issue in schools and colleges. In the past a favourite trick was to tighten up a drive belt to increase frictional loads. This increased deceleration after power-down and thus shortened stopping times. With most circular saws this actually worked reasonably well.

But nowadays somewhat more sophisticated methods are needed and electrodynamic braking systems are increasingly being used on educational workshop machinery. These systems are however not without pitfalls and traps for the unwary. To describe their major disadvantage we can do no better than quote from the BSI publication *Safe Use of Machinery* [1]. The italicised emphasis is ours.

"Electrodynamic braking systems

General:

Electrodynamic braking systems are arrangements by which electromagnetic forces are used directly to bring the moving part(s) to rest e.g. within the drive motor itself. Such systems have widespread application *but it should be borne in mind that they generally fail to danger in event of supply failure. They should have been connected in such a way that their power supply is maintained when emergency stop controls are used.*"

BSI PD 5304 (see also page 3 of this issue)

One commonly used system is known as *d.c. injection*, where, at switch off, the motor stator windings are disconnected from the a.c. supply and reconnected to a d.c. supply. This has a powerful braking effect and is better than *reverse plugging*² because there is no tendency to restart in the reverse direction.

1. PUWER - Provision and Use of Work Equipment Regulations.
2. *Reverse plugging* - covers a range of techniques whereby a change over of connections at switch off couples an active or passive load to the motor under braking.

At a recent Scottish Technicians' Advisory Group meeting there was some discussion on this form of braking for educational workshop machinery. The relevant BSI documents point out that in event of a supply failure, those machines so fitted will fail to danger. With the more usual wiring arrangements in educational workshops, this is precisely what happens should a teacher hit the emergency stop button. Since all power has been cut off the machines will then run down without any active braking. What is needed is separate d.c. wiring to each machine, independent of the main a.c. supply.

Ideally such a wiring arrangement should be fully specified in any contract documents and fully discussed with the contractor before any work begins. If this has not been the case and such a technical, but critical, point has been missed then the only remedy is an expensive retrofitting of suitable supplies. Sam McFarlane of Glasgow City Council's Resource Support Services, and Chair of the Technicians' Group, has direct experience of both the specification and post-installation remediation work for such braking systems (see address list for contact details). He is also willing to discuss such matters with colleagues in other Scottish EAs. He can advise on reliable contractors with experience in carrying out this type of conversion.

We should also point out that d.c. injection is a very efficient braking system. At switch off it may produce stopping times as short as three seconds. In some circumstances this can be too short a stopping time. It may reduce the motor life on some machine tools. In the case of some older band saws with cast-iron flywheels it can even be dangerous. The inertia inherent with such a large mass in a wheel, stopped too suddenly, can cause the blade to heat, distort and even to shatter. This emphasises the need for active braking devices to be properly designed, specified, selected and installed.

Reference

1. *Safe use of Machinery* : PD5304 BSI 2000 ISBN 0 580 33207 1
(See Safety Notes page 3 for a brief review).

* * *

Pressure systems

The *Pressure Systems Safety Regulations 2000* came into force in February, updating and consolidating previous legislation. A recent HSE ACoP [1] publication explains how to comply with the legislation, the purpose of which is to prevent serious injury from a pressure system failure.

Reference

1. *Approved Code of Practice and Guidance*, L122, HSE Books, 2000, ISBN 0 7176 1767 X.

A recipe for CPD

Notes from a Scottish Biotechnology Summer School

Take 50 battle-weary Scottish Biology teachers, isolate them from the normal minutiae of day to day teaching and return them to their student days; to a time when a major concern was not being terrified when asked to carry out new pieces of practical work. Add a selection of high quality speakers, at the cutting edge of scientific research, as well as good accommodation and food. Next mix in a visit, an exhibition, add a splash of social activities and presentations, in less formal settings. Place in Edinburgh University's modern Swann Building and leave to incubate for 5 days. The end result – rejuvenated, maybe not, but inspired, excited, challenged, with a much deeper understanding of where biotechnological research is leading at this momentous time and of the ethical problems inherent in this work – definitely. How the organisers managed to arrange the human genome sequencing announcement to coincide with our summer school Marjorie Smith would not tell us, although her powers of persuasion are legendary.

Most of us have no idea what it must be like to organise an event of this nature and it is a tribute to all involved that it all ran so seamlessly. Events like this require commitment and sponsorship, in both money and facilities. There is no doubt, in my mind, that the sponsors' aims have been achieved, as this event has started the process of producing better informed and more ethically aware students, by doing the same for fifty fortunate teachers.

The lectures were demanding, in the detail they provided. The practicals covered a range of activities from the isolation of micro-organisms, through transformation of bacteria to ELISA (*Enzyme Linked ImmunoSorbent Assay* - see, I learned a few things). Faced with these new techniques, many of us soon realised why our pupils often seem to need so much reassurance that they are "doing it right", just like we did. The mix of activities allowed for that other feature of a successful symposium, time for discussion with other teachers from a wide range of schools and colleges as well as allowing those who started the week a bit "shy and introverted" to develop fully.

The visit to the Scottish Blood Transfusion Service was memorable for a number of reasons. The bus got stuck, Lucy couldn't find her Rain Mate, the range of products made from blood is far greater than we ever imagined, and as to what they get up to with granulated bone, one's old joints simply boggled!

The ethical evening, watching and discussing the issues raised by the video, "The Gift", was very challenging and forced us to look at the personal side of Biology and the effects that our new genetic knowledge could have on people's lives. Also very memorable was the presentation about the versatile uses of Bioreactors by two former Dollar Academy students, Guy Mozolowski and Mairi Wilson. How many of us would be comfortable giving a presentation to about seventy teachers, especially if we had to do it when we were eighteen or twenty year olds ?

The Biotechnology Summer School 2000 represented the sort of high quality, inspirational in-service that should be available to all Biology teachers, on a regular basis. Thank you to all those who made it happen and to the other participants for a memorable week, good company and some great memories - *Who climbed the gates at 2 am and why?* In answer to the most important question, "*Should this be run again?*" the answer, from us all, is an unequivocal "*Yes, Marjorie!!*"

Alastair Walker¹

The views expressed in this article are the author's, with additional material from those brave few who survived the open top bus tour (you had to be there!).

¹Guest contributor Alistair Walker teaches biology at Forres Academy and was a participant this year at the Third Biotechnology Summer School. The school is hosted by the University of Edinburgh and sponsored by Unilever and The Wellcome Trust.

EQUIPMENT NOTES

Gas pressure apparatus

Test reports and experimental details on new gas pressure apparatus.

This is a report on some gas pressure apparatus made by three foreign manufacturers of physics equipment, Frederiksen, PASCO and STA (Table 1).

Frederiksen's products are generally unknown in this country because they did not have a UK agent until now. Only a small amount of their equipment was ever sold here - a linear air track and air blower for instance. Knowing these to be of top quality, SSERC imported a selection of apparatus for testing. Finding them to be excellent also, we set about trying to interest UK suppliers in stocking more of their product range. It is good to report that two companies, DJB Microtech and

Nicholl Education, now have a modest selection of Frederiksen products for sale here.

We also comment on an item made by the South African manufacturer, STA, sold by their UK dealer, STE, to school suppliers such as, in this instance, Scientific & Chemical. Confusing acronyms? Their choice. Our confusion!

This report completes the series of articles on gas law experiments published in the preceding three issues [1,2,3] and adds to the group of equipment reports on fluid pressure in the last issue [4,5].

Apparatus	Purpose	Manufacturer (Supplier)	Product code	Price £
Boyle-Mariotte's Law Apparatus	Tacit dependence of pressure on force Tacit experience of springiness of air Absolute calibration of Bourdon gauge Boyle's Law	Frederiksen (DJB Microtech)	1805.00 B2-1805.00	116.00
Plastic cylinder with Piston	Tacit dependence of pressure on force Tacit experience of springiness of air Boyle's Law	Frederiksen	1810.00	40 (estimate)
Magdeburg Hemispheres (nickel-plated brass)	Effect of atmospheric pressure	Frederiksen (DJB Microtech)	1735.00 B2-1735.00	61.00
Magdeburg Hemispheres (rubber suction pads)	Effect of atmospheric pressure	(Frederiksen) (Carolina) (Instruments Direct)	1735.20 BA-75-3090 BA-75-3090	36 (est.) (x4) 13.19 (x1)
Magdeburg Plates Magdeburg Accessory Kit	Effect of atmospheric pressure Dependence of force on area Vacuum chamber experiments Density of air determination	PASCO (Instruments Direct)	SE-9717 SE-9718	79 32
Atmospheric Pressure Demonstrator	Effect of atmospheric pressure	PASCO (Instruments Direct)	ME-8966	19
Kinetic Gas Theory Model Vibration Generator	Simulation of : molecular behaviour in solid and gaseous state; gas under a piston; Brownian movements; boiling a liquid	Frederiksen (DJB Microtech) (DJB Microtech)	2185.50 B2-2185.50 2185.00 B2-2185.00	41.00 61.00
Kinetic Theory Model	Simulation of molecular behaviour in a gaseous state	STA (Scientific & Chemical)	XPG010.10	51.95

Table 1 Gas pressure apparatus reviewed in this issue.

Boyle-Mariotte's Law Apparatus

Frederiksen : 1805.00

The apparatus has a horizontal cylinder with piston of cross-sectional area roughly 10 cm^2 . The length of the chamber is 150 mm. It is marked in arbitrary units from 0 to 4 with subdivisions of 0.1. The reading uncertainty is about ± 0.02 units. The piston has a hook with which to attach a dynamometer. The air chamber connects through a short passageway to a Bourdon gauge. This passageway has a port connecting to the atmosphere permitting the piston to be set in any position such that the air chamber is at atmospheric pressure. Because of the combined volume of the passageway and Bourdon gauge mechanism, the system has a systematic error. The pressure gauge has a large scale (diameter 97 mm), which may be easily read. It has a range of 0 to 25 N cm^{-2} with divisions of 1 N cm^{-2} and subdivisions of 0.5 N cm^{-2} . The reading uncertainty is $\pm 0.1 \text{ N cm}^{-2}$. A hole in the apparatus structure allows the apparatus to be clamped to a spigot fitted to a benchtop. Its mode of use is greatly simplified when clamped because the force exerted by an experimenter thrusting or pulling the piston may reach 50 N.

The apparatus (Fig. 1) has an attractive appearance. Being made chiefly of clear perspex, the cylinder, air chamber and connecting passageways are visible. The way it works is therefore obvious.

Ancillary equipment was a 50 N dynamometer, used to exert a measured force on the piston.

Educational uses :

- 1 To show that pressure increases directly with the applied force.
- 2 To make an absolute calibration of the Bourdon gauge by applying a known force to the piston.
- 3 To show that the pressure of a trapped mass of air is inversely proportional to its volume (Boyle's law).
- 4 To experience the springiness of air under compression or rarefaction.

Experiment :

- 1 Dependence of pressure on applied force
- 2 Absolute calibration of a Bourdon gauge

The chamber vent was opened, the piston set at the midway mark (2.0) with the air at atmospheric pressure. The vent was closed and the piston extended by pulling with a 50 N dynamometer. For values below 20 N, the force of static friction was too great to obtain meaningful data. Between 20 N and 45 N, sets of ordered pairs of values of pressure versus force were obtained and graphed (Figure 2 overleaf).

Comments :

- The relationship between pressure and force is seen to be linear, agreeing with theory.
- The intercept on the Force axis is $1 \pm 2 \text{ N}$ (95% confidence limit). Either it goes through the origin, implying proportionality and no side effects, or it indicates a frictional force contribution of $1 \pm 2 \text{ N}$ (95% confidence limit).
- From the gradient of the slope, we are able to work out a value for the cross sectional area of the cylinder. This is $10.2 \pm 0.4 \text{ cm}^2$, agreeing with the manufacturer's specification. This shows that the Bourdon gauge can be calibrated by absolute means.

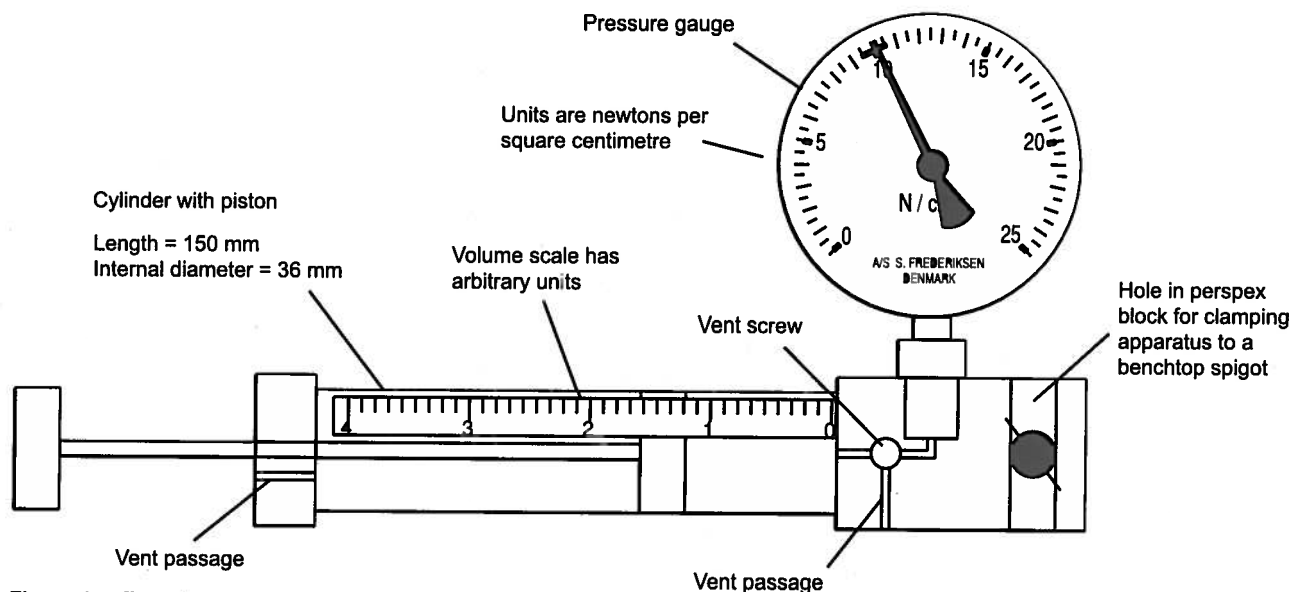


Figure 1 Frederiksen's apparatus for Boyle-Mariotte's law.

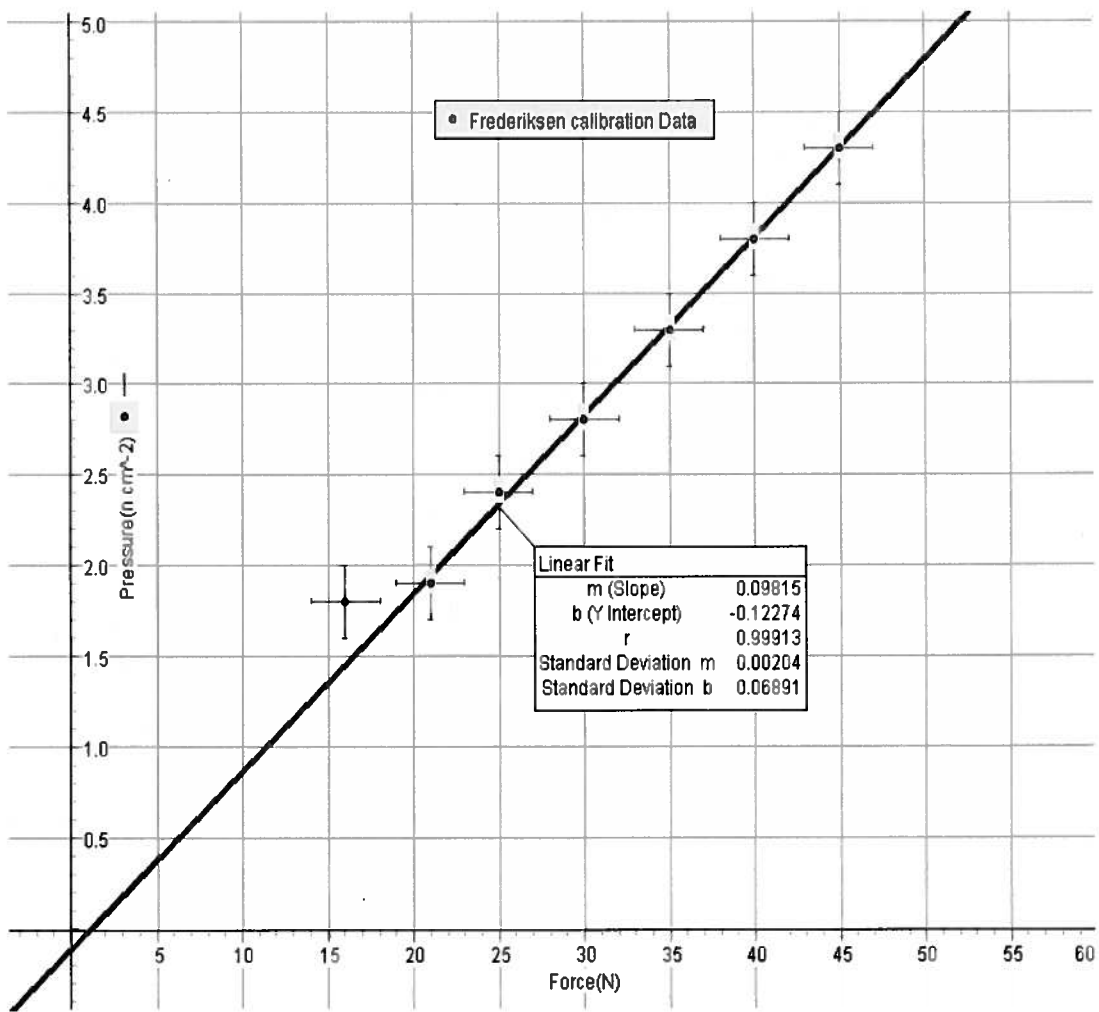


Figure 2
 Results with Frederiksen's Boyle-Mariotte's Apparatus showing that air pressure is directly proportional to the applied force on the piston. The point at 16 N is discounted because of static friction. The graph is drawn with *Data Studio* (PASCO).

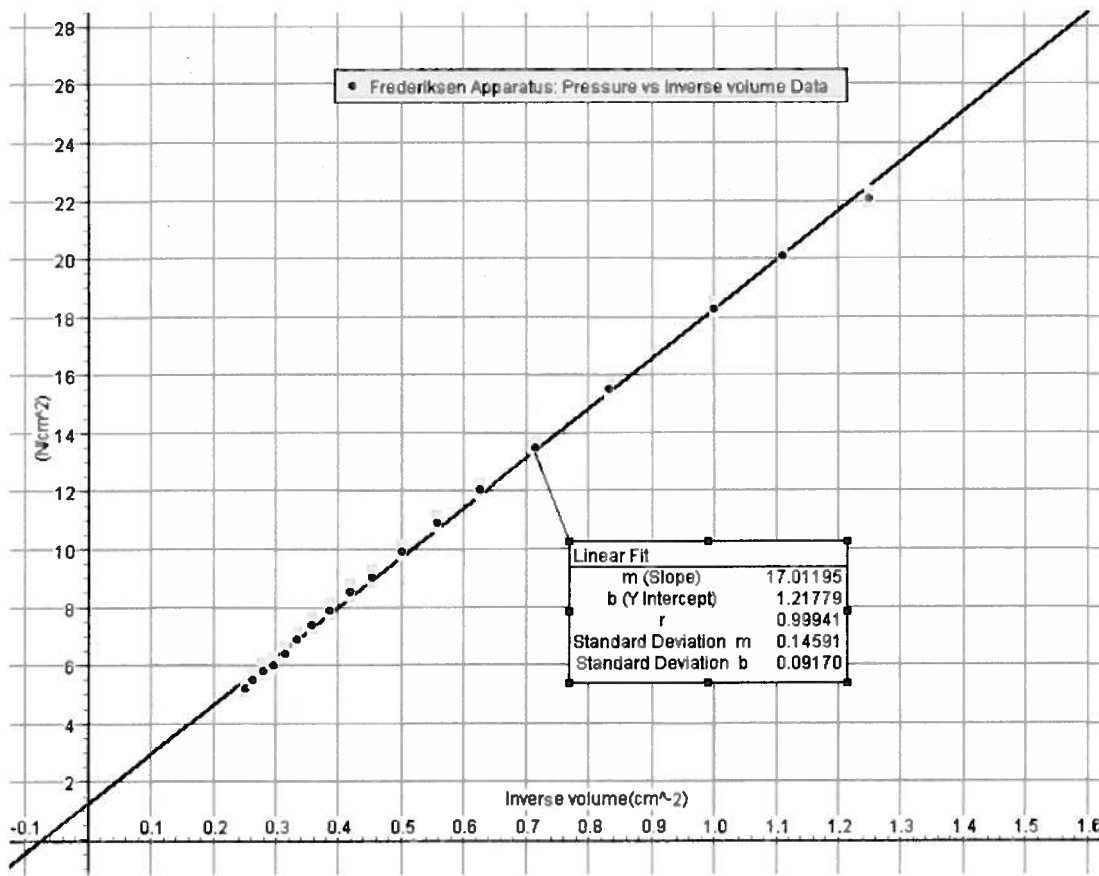


Figure 3
 Uncorrected results with Frederiksen's Boyle-Mariotte's Apparatus showing the dependence of air pressure on inverse volume. If the volume is corrected by 0.2 volume units because of air in the vent passage and Bourdon gauge, the relationship becomes linear. The graph is drawn with *Data Studio* (PASCO).

Experiment :

- 3 To show that the pressure of a fixed mass of air is inversely proportional to its volume (Boyle's law)
- 4 To experience the springiness of air

The chamber vent was opened, the piston set at the midway mark (2.0) with the air at atmospheric pressure. The vent was closed and the piston drawn out to its maximum extent. The piston was gradually and slowly pushed in, taking readings of pressure and volume (Figure 3 overleaf).

Comments :

- The apparatus permits students to get a tacit feel for air pressure and the springiness of air under both rarefaction and compression.
- The relationship between p and $1/V$ is nearly, but not quite, linear.
- The relationship does not show proportionality between p and $1/V$.
- Both of the above effects can be caused by the values of volume being systematically low. There is an obvious systematic error from the passageway between the air chamber and Bourdon gauge and a less obvious error within the Bourdon gauge mechanism. Firstly an empirical correction of 0.1 volume unit was applied. This improved the defect, but did not sort it completely. Therefore secondly a correction of 0.2 volume units was applied. This resulted in a graphical relationship (not illustrated) showing direct proportionality.

Conclusion

The Boyle-Mariotte law apparatus of Frederiksen is highly suitable for use in schools. Although it does have a significant defect in showing Boyle's law, the error is obvious and can be corrected for easily using computer graphical methods. The apparatus is of a good size and attractive appearance. We like the fact that its mode of operation is clear and it can give students a tacit feel for air pressure and the springiness of air. Other excellent features are its ability to make an absolute calibration of the Bourdon gauge and to show that pressure is directly proportional to the applied force. It is in our opinion the best apparatus we have tested for showing these physical laws.

Plastic Cylinder with Piston

Frederiksen : 1810.00

The apparatus (Fig. 4) has a vertical cylinder of 1 cm^2 cross sectional area, marked in 1 cm divisions. The total volume is 9 cm^3 , but because of the space taken up by the piston, the effective volume of the air chamber is 8 cm^3 at most. With a readability of 0.05 cm^3 the apparatus is certainly capable of showing Boyle's law quantitatively. It is attractive to look at and handle. Being machined out of clear perspex, its operation is patently clear.

If the cylinder is set up as illustrated (Fig. 4), air trapped in the cylinder is compressed by the force

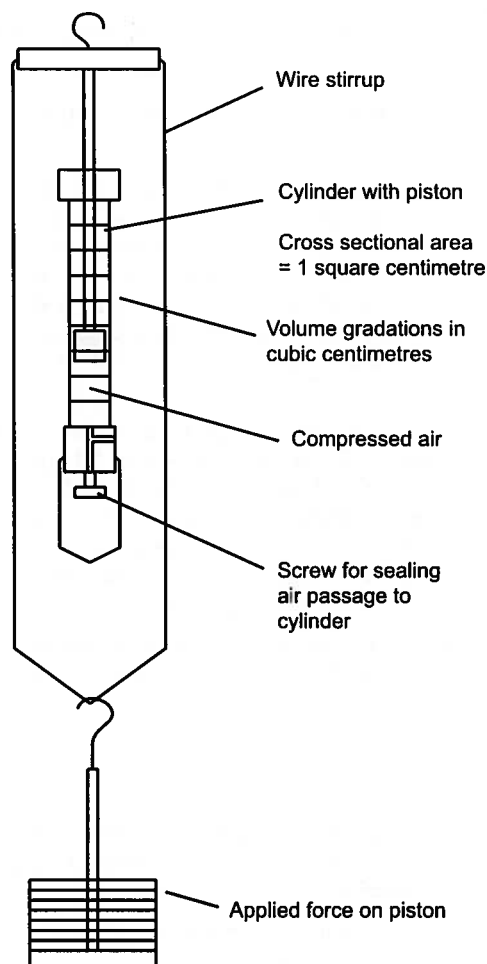


Figure 4 Plastic Cylinder with Piston by Frederiksen (1810.00). Air trapped in the lower part of the cylinder is compressed by the weights suspended on the wire stirrup.

applied on the piston. If the cylinder is inverted (not shown), the applied force attempts to withdraw the piston, thereby rarefying the trapped air.

Educational uses :

- 1 To carry out gas law experiments quantitatively from first principles.
- 2 To show that the pressure of a trapped mass of air is inversely proportional to its volume (Boyle's law).
- 3 To experience the springiness of air under compression or rarefaction.
- 4 To illustrate the Ideal Gas Equation $pV = nRT$.

Experiment :

- 2 To show that the pressure of a fixed mass of air is inversely proportional to its volume (Boyle's law)

The piston was set with 4 cm^3 of air at atmospheric pressure in the cylinder and the vent was then sealed. The air was compressed initially by loading the wire stirrup with 100 g weights to a total of 1.4 kg. The load was removed, the cylinder inverted and the air rarefied by applying 50 g masses to a total of 400 g.

Air pressures were derived from the relationship

$$p = 1.00 \times 10^5 \pm (mg/A)$$

with atmospheric pressure being read from a barometer.

It was noticed that there was a discontinuity of 0.5 cm^3 in the values of volume when the cylinder had been inverted. This was interpreted as the effect of the unloaded mass of the piston and wire stirrup, which was judged to be about 50 g. When the applied loads were corrected by this amount, the relationship between pressure and inverse volume was seen to be proportional.

Looking beyond the present Higher syllabus, the gradient of the graph of p against $1/V$ agrees experimentally with the theoretical value of nRT where n is the amount of air in mols, R is the universal molar ideal gas constant and T is the absolute temperature. This shows that the apparatus has applications for the Advanced Higher Physics Investigation.

There is a second version of the apparatus, similar to that reviewed here, but with a piston area of 2 cm^2 (product code 1810.10).

Comments :

- The apparatus permits students to get a tacit feel for air pressure and the springiness of air under both rarefaction and compression.
- The relationship between p and $1/V$ is proportional.
- The method is beautifully simple because it is based on first principles. It is bound to have real physicists salivating with pleasure.
- However many of the budding physicists we teach would fail to appreciate how pressure is derived. For them, another method with a direct reading pressure gauge would be simpler. We suggest therefore that this equipment should be used with able students only, perhaps as an extension to another, simpler introduction to Boyle's law.
- Because there are two versions of the apparatus, there is greater scope for investigating gas pressure, qualitatively and quantitatively.

Conclusion

Frederiksen's *Plastic Cylinder with Piston*, in both its versions, is strongly recommended for studying the gas laws. The equipment is suitable for pupils of all abilities in providing a tacit feel for air pressure. Also it gives abler pupils an interesting means of establishing Boyle's law, or investigating the Ideal Gas Equation.

Magdeburg Hemispheres (nickel-plated brass)

Frederiksen : 1735.00

The traditional version of this popular apparatus relies on both flanges being perfectly machined to make a seal. Therein lies its weakness. Any bash can destroy its integrity and render it worthless.

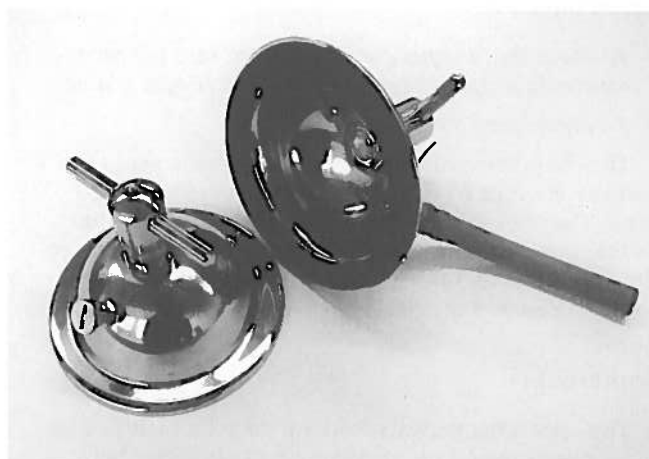


Figure 5 Set of Magdeburg hemispheres in nickel-plated brass from Frederiksen (1735.00). Note the rubber gasket.

With this version from Frederiksen (Fig. 5), the rubber ring which fits between the flanges should ensure that the apparatus remains in service for a very long period of time.

In other regards the apparatus is conventional. The fairly massive brass cups, diameter 108 mm, have sturdy T grips for yoking to teams of horses. One cup is provided with a connection socket and valve for the withdrawal of air. The other cup has an air valve which can be opened by the turn of a screw.

The following method of use is recommended. Air is withdrawn with a 50 ml polypropylene gas syringe connected to the apparatus by rubber tubing (o.d. 12 mm, i.d. 8 mm, length 100 mm). Two strokes are needed. In each, the piston should be pulled back sharply such that it is withdrawn from the syringe cylinder. To prepare for a second stroke the syringe nozzle should be removed from the rubber tubing and the piston replaced in the syringe. After pushing the piston to the bottom of the cylinder, the syringe can be reconnected to the rubber tubing and the second stroke done.

If a better vacuum is needed, apply more strokes of the pump.

This method is instructive in showing how air is pumped to create the vacuum.



Figure 6 Set of rubber suction pads which may be used as Magdeburg hemispheres.

Magdeburg Hemispheres (rubber suction pads)

Frederiksen : 1735.20 (set of 4 pairs)

Carolina Scientific : BA-75-3090 (1 pair)

The suction pads (80 mm diameter) are composed of a pliable, black rubber with a convex meniscus shape and have strong finger grips (Fig. 6). Singly, a pad will grip by suction to any smooth, flat surface, such as a table top or wall. Jointly, if a pair of pads are pressed together, they may not be pulled apart without the aid of horses.

This is an excellent, inexpensive gadget for showing the effect of atmospheric pressure. It would be suitable for a range of investigations in junior science (S1-S4).

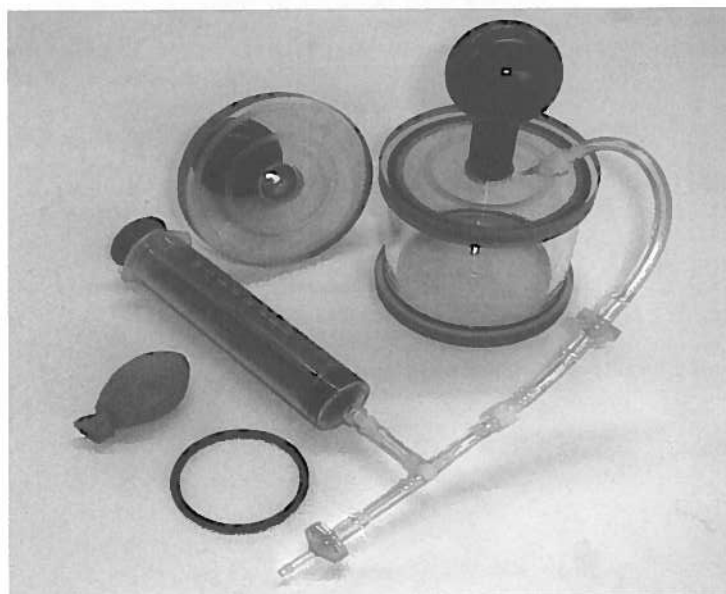
Rubber suction pads are available in the UK through Instruments Direct, who distribute products of the US science supplier, Carolina Scientific.

Magdeburg Plates

PASCO : SE-9717

Each plate (Fig. 7) is a disc of clear acrylic, or perspex, 12 mm thick and 96 mm in diameter, fitted with a black knob for a handle. Cut into each plate are a pair of circular grooves, 54 mm and 86 mm in diameter. The plates fit together with an O-ring partially recessed into a pair of opposing grooves. Depending on which ring is fitted, the effective plate area experiencing the vacuum can be altered by the ratio of 2.5 to 1.

One of the plates has a quick-connect plastic fitting, known as a luer connection. A 60 ml clear plastic syringe connects to this through $\frac{1}{8}$ inch clear polyurethane tubing, check valve and T-piece. The space between the plates is evacuated by extracting air into the syringe and expelling it from the system through a second check valve. An attractive feature is that the materials with which the apparatus is made are transparent. Thus the method of operation is clear.



One stroke of the pump is sufficient to ensure that the plates cling together. Under this condition the plates can be pulled apart if fitted with the smaller ring, but not with the larger ring. This is not a fair test of how pressure depends on area. Although the areas vary by a factor of 2.5, the internal pressure would have been lower with the smaller ring. The makers seem to recognize this because the kit includes extra tubing to connect to a pressure sensor, which is not provided, to set up a fair test.

Magdeburg Accessory Kit

PASCO : SE-9718

The kit is used with the Magdeburg plate which has the quick-connect fitting. It consists of a flat, circular base plate, O-ring and acrylic tube 65 mm high and 75 mm internal diameter. When used together, the parts assemble into a small vacuum chamber with hand pump (Fig. 7).

As with the *Microscale Vacuum Apparatus* reviewed in the last issue [4], this vacuum apparatus may be used by students under supervision and subject to the specified safety controls. Experimental work which might be done includes:

- 1 Observing that after one draw of the syringe, the bell jar is attached to the base plate.
- 2 Seeing a slightly inflated balloon expand as the chamber is evacuated.
- 3 Seeing a similar effect with a marshmallow.
- 4 Seeing that a suction cap detaches on evacuation.
- 5 Seeing that warm water boils when the surrounding air pressure is reduced.
- 6 Seeing that air has weight, because the mass of the bell jar and contents are reduced on evacuation.
- 7 Determining a value for the density of air.

Density of air determination

To find the density of air, the apparatus is assembled to form a vacuum flask. Its weight is about 440 g. Since the vacuum flask's volume is about 280 ml, the mass of air evacuated is about 0.3 g. From these values, we can specify what type of balance to use. The capacity should be at least 500 g; the sensitivity should be 0.01 g.

The *Microscale Vacuum Apparatus* may be the better buy for this experiment. Being lighter, it needs a balance capacity of 120 g only.

Figure 7 Photograph of the vacuum chamber and hand pump assembled with PASCO's Magdeburg Plates (SE-9717) and Magdeburg Accessory Kit (SE-9718). The pump comprises tubing with two check valves, a T-piece and 60 ml syringe. A second Magdeburg plate with its two circular grooves for O-rings is seen lying unused.

Atmospheric Pressure Demonstrator

PASCO : ME-8966

This it does with dramatic effect (Fig. 8). Comprising of a flat piece of rubber matting, 200 mm square, with a lifting knob, when placed on a flat, smooth surface, the partial vacuum created underneath prevents the mat from being lifted off the surface. If the surface is on a freestanding laboratory bench, you may succeed in lifting the bench off the floor. It is quite amazing.

How much can be lifted? Given that its area is 0.04 m^2 , then the most you could lift might be 400 kg, but at the risk of a hernia, ruptured muscles, or back injury. Or the handle might tear itself from the mat. Sensibly the smallness of the handle limits the grip to three fingers, preventing too much force being exerted. Anyone using the apparatus should be warned to be canny and not exert immoderate force.

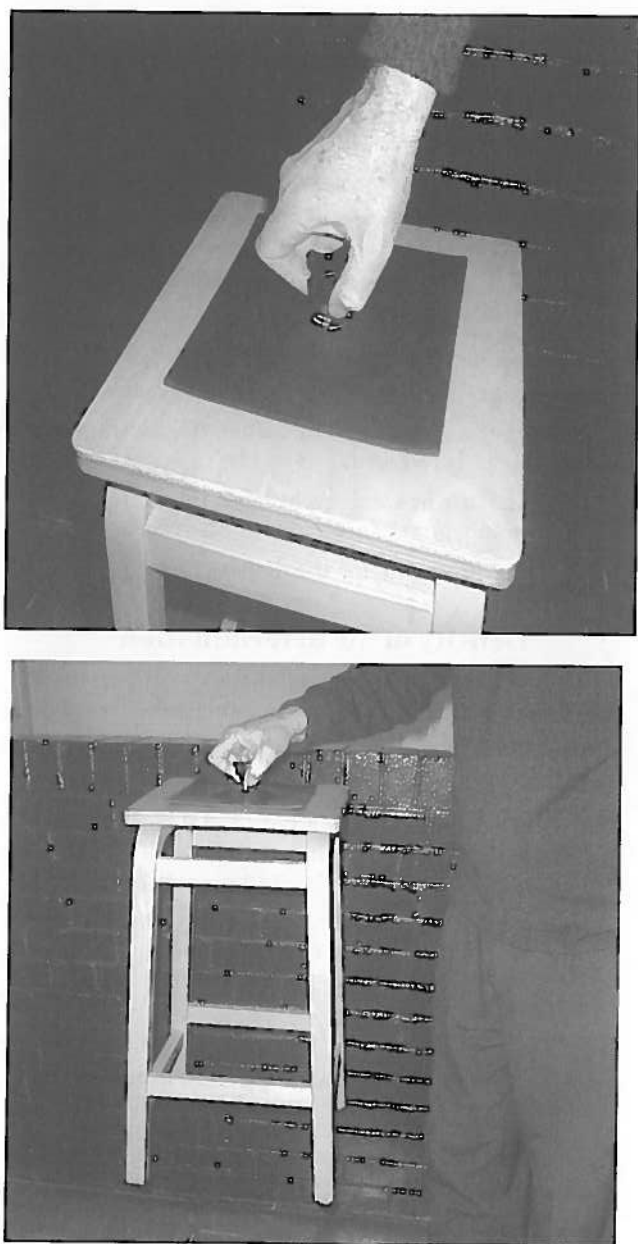


Figure 8 Photographs of PASCO's Atmospheric Pressure Demonstrator being placed on (Top) and lifting (Bottom) a laboratory stool.

Kinetic Gas Theory Model

Frederiksen : 2185.50

Vibration Generator

Frederiksen : 2185.00

On starting our adventures into gas law apparatus, we did not expect to come across anything quite so delightful as this. Unlike the usual kinetic gas theory models, which are three dimensional, being only two dimensional, the Frederiksen model is suitable for projection. In this respect it resembles the model developed by SSERC lang syne [6], which itself had been derived from one made by a Clydebank technician.

Molecules are represented by 3 mm diameter steel balls which are able to move freely in a rectangular glass case 55 mm by 50 mm (Fig. 9). The case can be mounted in two positions. When vertical, the balls can be viewed only directly. However if at an elevation of 10° on an underlit overhead projector, viewing by projection is also possible.

The steel balls are continuously agitated by a metal plate which fastens to the moving part of a vibration generator. Only the vibration generator made by Frederiksen (2185.00) is suitable. It has been engineered to accept the Kinetic Gas Theory Model. The vibration generator is driven off a signal generator with power amplifier. Any type would suffice.

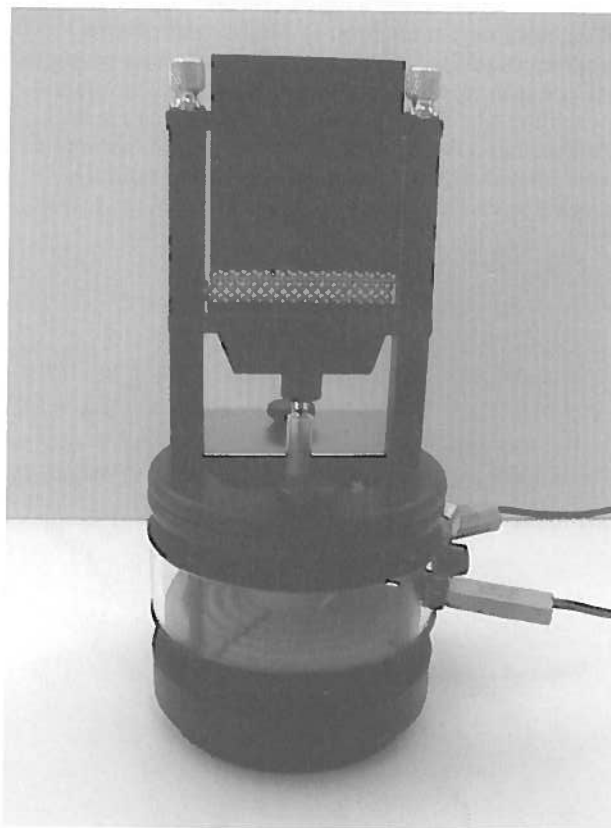


Figure 9 Kinetic Gas Theory Model and Vibration Generator.

The noise from the mechanism is much less than with traditional gas models. It is at its worst with the tank vertical when it can rise to 71 dB. In its other position on an OHP the intensity lies between 47dB and 58dB. A teacher could comfortably talk above this and be heard by all, should they choose to listen.

Molecular systems which the model can be set up to illustrate are shown in Figure 10 below. The model piston is a metal plate which slips between the glass case plates. By placing a finger lightly on the piston, the student can experience the springiness of gas pressure modelled by the steel balls' bombardment.

Brownian movement is simulated by a small disk being buffeted continually by the faster moving, smaller, steel balls. If the vibrator's amplitude is very low, the balls congregate in arrays with regularities and dislocations modelling the particulate constitution of a solid. If the tank top is removed and the amplitude raised, some balls are ejected illustrating evaporation.

The model works best when set up in its vertical position. A greater dynamic range of effects can be shown. If set up for projection, friction between the case walls and model piston or small disk restricts the scope of effects somewhat. *(cont./over)*

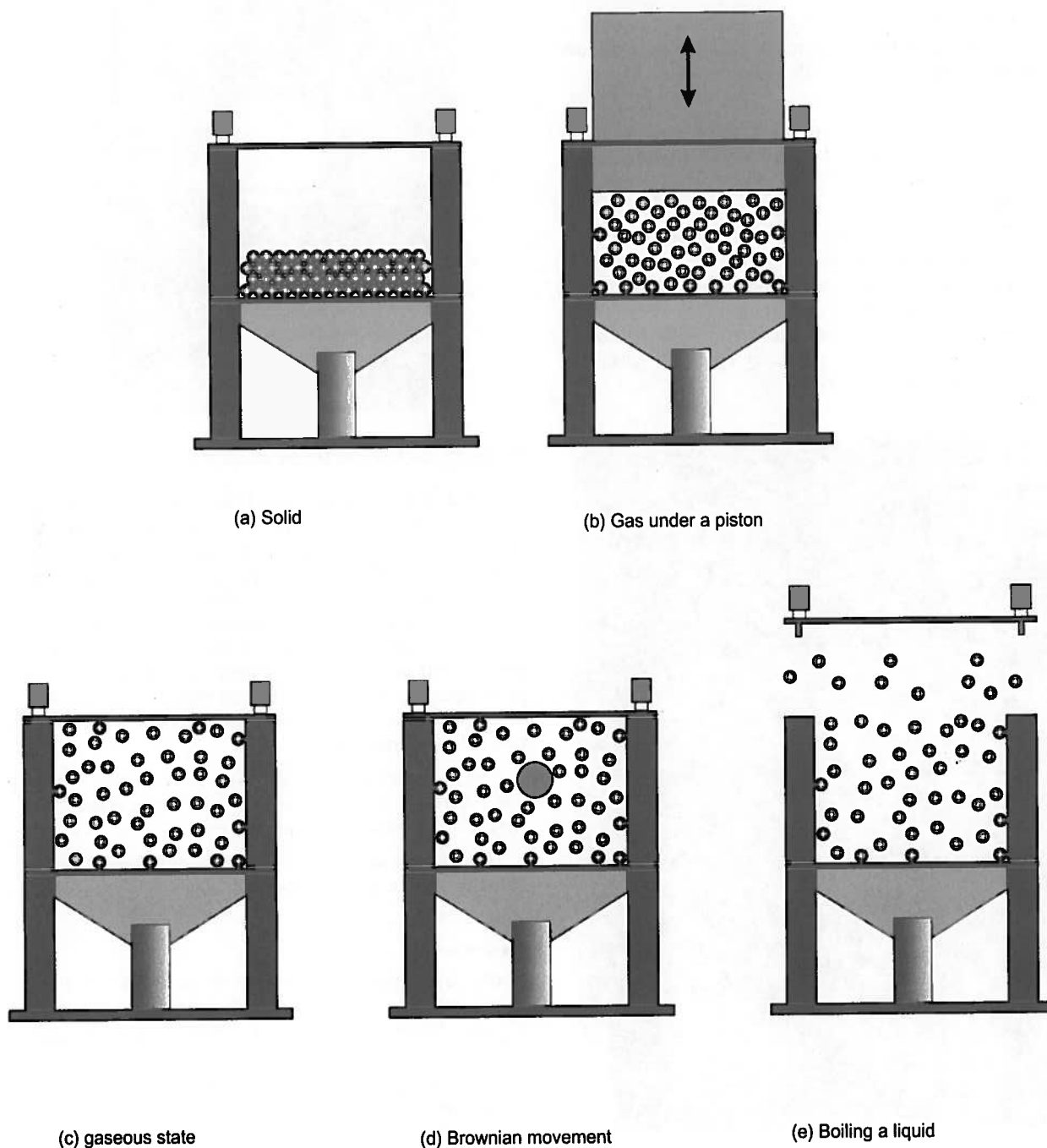


Figure 10 (a) to (e) Various molecular states which may be illustrated with the Kinetic Gas Theory Model.

A photograph of the projected screen image reveals information on the particulate movements (Fig. 11).

- A sharp image indicates that the particle velocity is low, or even stationary.
- A blurred image implies a higher particle velocity.
- From the differing image definitions, we can infer that there is a range of velocity magnitudes.
- From the differing orientations of the blurred images, we can infer that the velocity vectors can be in any direction.
- There is evidence of collisions.
- Apart from an empty area by the vibrator, the particles are fairly uniformly spaced. If the area is divided into quadrants, each has the same number of particles.
- Considering all of these points, a reasonably full picture of the concepts of random velocity and random movement can be constructed from the experimental evidence.

Startlingly all this can be seen with the naked eye because of persistence of vision. A high velocity ball creates a transitory image in the retina corresponding to a virtual track of up to 10 mm in length (the tank is about 50 mm overall). If the tank is viewed from about 50 cm, at any instant there are many virtual tracks of apparently random orientation.

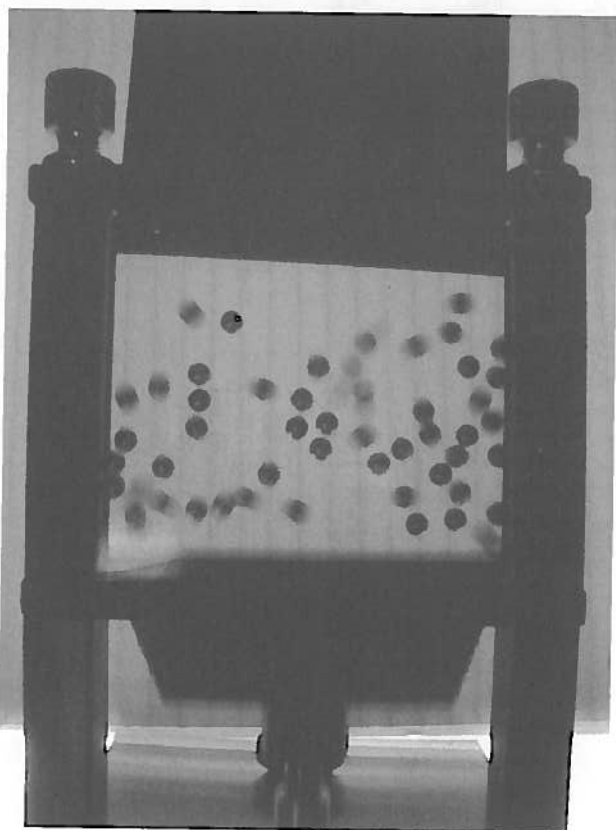


Figure 11 Photograph of the gaseous state model mounted on coloured corriflute on an OHP. The coloured filter reduces the light intensity sufficiently to allow a slow camera speed to show the blurring of fast moving balls.

Kinetic Theory Model

STA (Scientific & Chemical : XPG010.10)



Figure 12 STA Kinetic Theory Model.

The design is conventional (Fig. 12). A 50 mm diameter perspex tube sits on top of an electromagnetic vibrator, which is supplied from an external 6 V d.c. source. This drives an oscillating piston keeping about forty 3.5 mm steel balls in agitation. The control knob does nothing useful other than switch on. There is however a transitional phase between off and on when all the balls oscillate up and down in consort with the phut phutting piston. As we can think of no useful function served by this transitional phase, it could lead to muddled thinking.

The noise from the mechanism is around 77 dB at one metre. It may irritate everyone in the class and would be impossible to speak above.

In our opinion, this is the sort of equipment that gives Science a poor image.

References

- 1 *Gas law experiments: Part 1* SSERC 1999 Bulletin 197 20-27
- 2 *Gas law experiments: Part 2* SSERC 1999 Bulletin 198
- 3 *Gas law experiments: Part 3* SSERC 2000 Bulletin 199 18-21
- 4 *Microscale vacuum apparatus* SSERC 2000 Bulletin 199 22-25
- 5 *Pressure and depth in fluids* SSERC 2000 Bulletin 199 28-29
- 6 *Air table molecular motion model* SSERC 1977 Bulletin 99

* * *

SAFETY NOTES

Leaflet for governors and heads

The Association for Science Education (ASE) has updated its six page, fanfold, safety information leaflet [1] for governors and headteachers. In independent secondary, 'foundation' or voluntary-aided schools and incorporated colleges, governors effectively hold the primary legal duties of an employer under the Health and Safety at Work Act. In local authority establishments, it may be necessary to ensure that there are clearly defined lines of communication and responsibility between an EA (which retains the primary duties as the employer of staff) and the senior management team in the school.

The major partion of this handy little publication is a simple checklist for ensuring that appropriate health and safety management systems have been set up in science departments and are being adequately monitored.

In Scotland, this leaflet is likely to be of interest to senior staff and boards of governors in independent schools, to EAs and senior staff in local authority controlled secondaries. It may in some circumstances be of interest also to chairpersons and members of school boards.

Reference

1. *Safety in Science in Secondary Schools and Colleges - an information leaflet for governors and headteachers*. Enquiries to ASE HQ.

A fuller checklist for managers is available in *Safety Reprints* from ASE booksales. ASE members may freely copy these checklists for use in their own school or college.

* * *

Work experience - organiser's guide

HSE Books has published a new guide on managing health and safety on work experience [1]. This is a guide principally aimed at those organising work experience for secondary school students below the minimum school leaving age. It is intended as a UK document and carries not only the logo of HSE itself but also those of The Scottish Executive, The National Assembly for Wales, and the DfEE.

Reference

1. *Managing health and safety on Work Experience : A guide for organisers HSG 199* HSE Books 2000 ISBN 0-7176-1742-4 £6-50.

* * *

Mobile 'phones

There is at present considerable controversy over health and safety issues related to mobile 'phones and base station masts. In many parts of Scotland that last sentence might be considered a significant understatement. We were fortunate, at the recent SSERC Annual Conference, to receive a balanced and independent view from a speaker who works at the National Radiological Protection Board (NRPB).

One of the publications referred to by the speaker was the report of the Independent Expert Group on Mobile Phones (IEGMP) chaired by our very own Sir William Stewart, President of the Royal Society of Edinburgh. Copies of the Summary and Recommendations from that report [1] were made available on the day of the SSERC Conference. The summary document reproduces Chapter 1 of the full report which is available on the IEGMP website. Hard copies of the summary document cost £2 from the IEGMP Secretariat (the full report is bigger, more specialised and costs £20). There is also information on the POST (Parliamentary Office for Science and Technology) site which we have mentioned several times in these pages.

Reference

1. *Mobile Phones and Health : Summary and Recommendations*, Independent Expert Group on Mobile Phones, 2000, ISBN 0-85951-451.

* * *

Safe use of gas cylinders

In some of our recent inspections we have noticed some poor storage and usage of gas cylinders in science and technology areas. Although they are rare, when accidents involving gas cylinders do occur they can have serious, even grave, consequences. The issue of a succinct leaflet on this topic by the HSE is thus welcome.

The leaflet summarises useful advice on good practice in gas cylinder usage. It is aimed at anyone who uses, owns, fills or repairs gas cylinders at work. Additional guidance and other useful sources of advice are listed at the end.

Reference

1. *The safe use of gas cylinders* INDG308 5/00 C1200 HSE, 2000.

* * *

Glass gas syringes

Following the death of a family member, the firm Webber Scientific has been taken over by another company. They are no longer the source of best buys for the glass gas syringes used in a number of practicals and investigations. Karen McEvoy of Williamson High School has told us she has managed to source substitute 100 cm³ gas syringes from the firm *Scientific & Chemical Supplies Ltd*. The school has used these successfully for the HigherBiology enzyme investigations using catalase with good results.

These 100 cm³ glass syringes with a Luer fitting cost £16.50 each. Other syringe volumes are also available. For contact details see list on inside rear cover.

* * *

3-way stopcocks

Gas-tight and liquid-tight three way taps are extremely useful bits of kit for all sorts of experimental set ups. Recently the proven types of which we have become particularly fond have disappeared from the market. These had but a single handle and were easy to use once you'd sussed out that the arm of the tap along which the handle was pointing was the arm which was shut off with the fluid flow directed via the other two arms. *Philip Harris* have stopped selling these excellent wee devices so we've had to cast around for alternatives.

Three types were tested for their suitability for use in gaseous measurements (eg rates of reaction dependent on rate of evolution of a gas) and where the control needs to be reasonably liquid tight. We found that sample stopcocks from three manufacturers, *Becton & Dickinson*, *Vygon* and *Braun*, appeared to be suitable substitutes for the classic three way tap. Details are tabulated (Table 1 below).

For many applications it is vital that these devices are sufficiently gas and liquid-tight not to leak significantly under pressure nor partial vacuum. The stopcocks were each tested by connecting them to a 100 cm³ syringe with a 500 g load on the piston in both compression and then under tension. This was done with air and then water in the syringe.

All three types performed satisfactorily with little or no leakage. These tests of course do not allow for wear and tear in use and only experience will show if all or any of them are good substitutes for the three way taps which used to be sold by Harris. All have three arms to the mechanism rather than a single handle. Each thus takes a little getting used to in sussing out the exact significance of the position of the 'active' arm and its effect on the flow path through the device. If pushed to plump for a 'best buy' we would go for the Vygon type, which is also the least expensive. Supply details are given in the address list on the inside rear cover. We would be pleased to have feed-back on the practical uses of any of these devices.

* * *

DJB Microtech

As we report in the gas laws equipment article in this issue SSERC recently imported a range of equipment from the Danish company Frederiksen for testing. Being pleased with what we saw we then had to interest a UK equipment supplier in stocking Frederiksen's products. Our plan was simple. Exhibit the Danish goods at this year's IOP Stirling Meeting, at which we knew there would be several suppliers represented, and stand back to wait for market forces to react.

The response has been positive and we are pleased to find that Scotland's schools now have a local dealer, DJB Microtech, who are already stocking a limited range from Frederiksen. As well as some items from the gas equipment sector we had exhibited at Stirling, listed on page 16 of this issue, they stock the excellent linear air track with accessories at £265, a quiet air blower at £190, dynamometers at £6 or £7.50, and apparatus for Heat, Light, Sound and Radioactivity.

Otherwise DJB have released an update of the core *ALBA* software, VI.20, downloadable from their web site, and *Disk 3* with a further batch of physics experiments. The Philip Harris *SensorMeter* range of sensors can now be used with *ALBA*.

* * *

Manufacturer	Product code	Description	Price
Becton Dickinson	BV394601	Three way stopcock	£51.60 per 100 (52p each)
Vygon	VY0876.00	Lockable 3-way stopcock	£21.75 per 50 (44p each)
Braun	BND300	Three-way stopcock	£66.70 per 100 (67p each)

TABLE 1 Three way tap substitutes

Equipment Offers

Items are arranged by similarity of application, or for other reasons, and not by stock number sequence. Often the item number serves only for stock identification by us in making up orders. Newer stock items are underlined, so as to be more easily seen.

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.

Postage : Postage and, where necessary, packing, will be charged for. It is therefore best not to send cash with an order, but wait for us to bill you. Official orders may be used.

Please try and ask for at least £10 worth of goods because the administrative costs of handling orders are significant.

Don't send cash with orders. We repeat, please do not send payment with your order. Wait until you receive our advice note upon which payment may be made. This saves unnecessary complications, e.g. when items are out of stock, failure to make provision for VAT, or if a delivery charge needs to be made. Items of equivalent value may be deducted from your order to balance any shortfall.

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°, with 7 mm x 2 mm dia. output shaft. 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, two 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. 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, dims. 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, dims. 25 mm x 21 mm dia., shaft 8 mm x 2 mm dia. 30p
- 739 Miniature motor, 1.5 V d.c., dimensions 23 mm x 15 mm dia., shaft 8 mm x 1.7 mm dia. 25p
- 621 Miniature motor, 1.5 V to 3 V d.c., open construction, ideal for demonstration, dimensions 19 x 9 x 18 mm, eight tooth pinion on output shaft. 25p
- 839 Motor, solar, 12 mm long by 25 mm dia., shaft 6 x 2 mm 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. For related circuitry 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 with 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 to 12 V d.c. With a supply of 3 V, the no load current is 25 mA and the output shaft turns at ca. 20 r.p.m. Gearbox ratio 1 : 365. Overall body length including gearbox 43.5 mm and 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 - any system where a very slow angular velocity is required. £15

Miscellaneous items

- 801 Propeller, 3 blade, to fit 2 mm shaft, 62 long. 35p
(Replaces Item 791 at lower cost).
- 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 4mm to 2mm, pack of 5 25p
868 Ditto, 4 to 3mm 25p
- 846 Sound module, includes 'melody' chip and Piezo transducer. £1.00
- 710 Sonic switch and motor assembly. First sound starts the motor, a second reverses the direction of rotation, a third sound stops the motor. Driven by 4 AA cells (not supplied). 85p

715 Pressure gauge, ca. 40 mm o.d. case, 25 mm deep and 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	724 Dual in line (DIL) sockets, 8 way.	5p
		760 DIL sockets, 14 way.	7p
		826 DIL sockets, 16 way.	8p
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	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
166 Ditto, but 30 cm length.	40p	716 3-core cable with heat resisting silicone rubber insulation, 0.75 mm" conductors, can be used to re-wire soldering irons as per Safety Notes, Bulletin 166. Per metre.	£1.35
861 Bimetallic strip (new type - won't rust after exposure to Bunsen flame, hence higher price) 10 cm length.	30p	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
862 Ditto, but 30 cm length.	80p	714 Sign "Radioactive substance" to BS spec., 145 x 105 mm, semi-rigid plastic material. Suitable for labelling a radioactive materials store. With pictogram and legend.	£2.70
758 Loudspeaker, 8 ohm, 0.5 W, 66 mm dia.	5 0 p	763 Sign "DANGER, Electric shock risk" to BS spec., rigid plastic, 200 x 150 mm.	£2.70
771 Neodymium magnet, 13.5 mm dia. x 3.5 mm thick.	£1.30	764 Sign "DANGER, Laser hazard" to BS spec., rigid plastic, 200 x 150 mm.	£2.70
837 Ring magnet, 40 mm o.d., 22 mm i.d.	35p	731 Re-usable cable ties, length 90 mm, width 2 mm, 50 per pack.	12p
815 Ceramic block magnets, random polarisation, 19 x 19 x 5 mm.	15p	752 Shandon chromatography solvent trough.	£1.00
823 Ceramic block magnets, poles at ends, 10 x 6 x 22 mm.	12p	805 Condenser lens, bi-convex, 200 mm focal length, 75 mm dia. Crown glass.	£12.50
824 Ceramic block magnets, poles on faces, 25 x 19 x 6 mm.	35p	806 Condenser lens, plano-convex, 150 mm focal length, 75 mm dia. Crown glass.	£12.50
825 Forehead temperature measuring strips	SOLD OUT	833 5 1/4" double density floppy disks, box of 10	60p
745 Sub-miniature microphone insert (ex James Bond?), dia. 9 mm, overall depth 5 mm, solder pad connections.	40p	834 5 1/4" high density floppy disks, box of 10	60p
723 Microswitch, miniature, SPDT, lever operated.	40p	Components - resistors	
354 Reed switch, SPST, 46 mm long overall, fits RS reed operating coil Type 3.	10p	420 resistors, 5% tolerance, 1/4 W : Per 10.	6p
738 Relay, 6 V coil, DPDT, contacts rated 3 A, 24 V d.c. or 110 V a.c.	75p	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.	
875 Solenoid, 6 V, stroke length 3.5 mm, spring provided	£3.75	421 DIL resistor networks, following values available: 62R, 1K0, 6K8, 10K, 20K, 150K. Per 10.	30p
774 Solenoid, 12 V, stroke length 30 mm, spring not provided.	£2.25	BP100 Precision Helipots, Beckman, mainly 10 turn.	10p-50p
742 Key switch, 8 pole changeover.	40p	Components - capacitors	
382 Wafer switch, rotary, 6 pole, 8 way.	70p	813 Capacitors, polystyrene:	4p
688 Croc clip, miniature, insulated, red.	5p	180 pF, 330 pF, 560 pF, 1000 pF, 2400 pF, 3000 pF, 3300 pF, 3900 pF & 4700 pF	
759 Ditto, black.	5p	695 Capacitors, tantalum,	1p
788 Crocodile clip leads, assorted colours, insulated croc. clip at each end, 360 mm long.	£1.35	15 µF 10 V, 47 µF 6.3 V.	
809 Wire ended lamp, 3 V	10p	696 Capacitors, polycarbonate,	2p
741 LES lamp, 6 V.	15p	10 nF, 220 nF, 1 µF, 2.2 µF.	
770 LES lamp, but 12 V.	15p	697 Capacitor, polyester, 15 nF 63 V.	1p
789 MES lamp, 3.5 V, 0.3 A	9p	698 Capacitors, electrolytic,	1p
690 MES lamp, 6 V, 150 mA.	9p	1 µF 25 V, 2.2 µF 63 V, 10 µF 35 V.	
866 Lens-end lamps, MES, 1.2 V. Ideal where a concentrated beam of light is needed. Box of 100	£3.50	358 Capacitor, electrolytic, 28 µF, 400 V.	£1.00
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		

Components - semiconductors

807 Teaching Chip Set, designed by Edinburgh University. Now with a new, comprehensive, 12 page datasheet. The new datasheet was 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

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, b = 4200 K. Means of accurate usage described in Bulletin 162.	30p
641 Precision R-T curve matched thermistor, resistance of 3000 ohm at 25°C, tolerance ±0.2°C, R-T characteristics supplied. Means of accurate usage described in Bulletin 162. Now stocked by RS.	
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
504 Copper foil with conductive adhesive backing, makes pads for unscreened Kynar film to which connecting leads may be soldered. Priced per inch.	15p
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
858 Flash bulb older type (getting difficult to source) for UV triggered reactions in chemistry. Pack of 5.	85p

Economy variable volume micropipettors

Of slimline profile, these micropipettors are fully autoclavable (121° C max.). They have a nominal accuracy of ± 1.75%. Supplied with spare O-ring and lubricant. Tip ejector swivels, thus pipettors are suitable for either left- or right handed users. Colour coded bodies for ease of identification. Supplied with two tips and stocks of spare tips available. Three sizes :

849 micropipettor, 1 cm ³ , range 100 to 1000 µl	£16.00
850 micropipettor, 5 cm ³ , range 500 to 5000 µl	£16.00
851 micropipettor, 10 cm ³ , range 1000 to 10,000 µl	£16.00
Replacement tips in packs of 25 tips :	
852 replacement tips for 1 cm ³ micropipettor, pack.	£1.50
853 replacement tips for 5 cm ³ micropipettor, pack.	£1.70
854 replacement tips for 10 cm ³ micropipettor, pack.	£2.15

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 0-2 cm ³ pipette filler (Pi pump type), each	£5.75
864 0-10 cm ³ as above	£5.75
865 0-25 cm ³ as above	£5.75

Gloves

869 Gloves blue latex*, extra strength, lightly powdered*, ambidextrous. Small size only therefore suitable also for pupils. *NOTE : Some individuals may be sensitised to the glove material and, or, the powder or become so. Pack of 50 (25 pairs, normally £9-£10 per box).	£5.00
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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
810 Watch glasses, assorted sizes	20p
877 Volumetric flask, 50 cm ³ , Class B	£1.30
878 Volumetric flask, 100 cm ³ , Class B	£1.45
879 Petri dishes, glass, 52 x 20 mm, box of 18	£4.00
880 Petri dishes, glass, 63 x 18 mm, box of 18	£4.00
881 Petri dishes, glass, 100 x 15 mm, box of 18	£5.00
712 Smoke pellets. For testing local exhaust ventilation (LEV), fume cupboards and extractor fans : large, 50p, small, 40p	

ENDPIECE(S)

Last of the line

And, so it is - literally. As indicated in Bulletin number 199, we intend making Bulletin 200 the last in this format. The staff complement has remained relatively small for a centre with national, educational responsibilities for science, technology and safety. It has become increasingly difficult to publish a serial publication of this size and at the same time try to develop and maintain an increasingly popular website, design and deliver training courses and also support other national agencies and projects.

SSERC Bulletin issue number 1 was put together some thirty five years or so ago in September 1965. This seems like a good time to stop and try something a little different such as newsletters pointing to our website entries and to more discursive stuff available as printed papers or downloads.

Observant readers will have noted that we carry an accumulative index every ten issues. Since this the last issue of this format we have included articles from this issue also to complete the series to Number 200. This index is carried on the pages immediately following this.

Emerging E-groups

The Scottish Virtual Teachers' Centre has been criticised in some quarters on two grounds. One is that it is too po-faced and thus blandly boring. The other is that it is top down and over influenced by the views of hand-picked focus (yuck!) groups. Whether or not there is substance in either of these claims is not something we wish to get into. If there were, however, then redressing of any imbalance may already have begun. Two grass-roots Science Email groups have been launched recently, one for technicians and the other for science teachers. The technicians Egroup is UK based and is, we understand, the brainchild of Valery Cobb - Email address:

valerycobb@lineone.net

Struan Gardner, Dornoch Academy, is the promoter/founder of the teachers' grass roots Egroup. For more detail, take a look at the group's website at: <http://members.aol.com/dornocha/steg> To subscribe to the list (no charge) send a blank Email to:

science-teachers-scotland-subscribe@egroups.com

A word of warning on Egroups in general; spammers can abuse these if the systems of either a commercial ISP or the Email server at your end are not fully secured to filter out or prevent the relaying of junk (see page 1 of this issue). If you use Email from home and get bothered by a lot of junk mail then ask your ISP how to filter it out. If your server's insecure at your end then secure it or you could get blacklisted.

Change on the way?

It is encouraging to be able to put Bulletin 200 to bed at a time when the readings of the entrails and other portents look favourable for science. (What, moi - mix my metaphors and messages? What do you think my name is - McCrone?).

If things are not to get better, it's hard to see just who will be teaching science a few years from now. Nonetheless I'm optimistic. I was pleased to be invited recently to address a group of newly qualified science teachers at a Saturday meeting organised by ASE Scotland. Given what most of them have had to thole in the way of induction (or not as the case may be) they were a cheery lot. In preparation for my NQT slot, I'd asked some other young teachers what they thought was essential in order to survive the first five years or so in school (as teachers that is). The response from the majority included a sense of proportion as well as a keen one of humour. Gets my vote. My own advice was always to cling on to the fact that, just as Doctors do not actually cause illness and the Police are not responsible for crime - the teaching profession is not the cause of ignorance.

Hing on in there!

* * *

For the SQA

Where is the wisdom we have lost in our knowledge?

Where is the knowledge we have lost in our information?

Where is the information we have lost in our data?

Where is the data we have lost in our computers?

With acknowledgement to Dr Peter Williams, one-time Director of the Micro-electronics Education Development Centre at Paisley who adapted T.S.Eliot's "The Rock".

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