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ABSTRACT

This issue of the newsletter presents a discussion relative to a revised equipment list for physics, alerts the readers of the newsletter to the fact that the list for integrated science is being revised, presents the second of a two-part article on choosing a microscope for teacher demonstrations and microprojection uses, and concludes with a list of equipment suppliers. (PEB)

SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 66. October, 1973.

Contents

Introduction

We include in this bulletin a summary of microscopes which we consider suitable for 'H' grade and beyond. This has been requested by a number of teachers who wish to have collated in one place, information on various models of a given instrument so that they can make comparison between them. Summaries on 'O' grade microscopes and on other instruments in our testing range will follow.

To our customers abroad, in which we parochially include England, Wales, and Northern Ireland, we have to explain that our bulletin is thinner than usual because of the exclusion of the above summary on pages 7 - 10. The reasons for this are bound up in legal red tape. We carry insurance against the possibility of legal action by a manufacturer, despite the fact that manufacturers are sent a copy of our report on their equipment and that they are invited to comment on the substance of the report. A condition of the insurance is that our reports and any information such as the summary which is drawn from these reports, be treated as confidential. While we do not believe that the ability to respect confidentiality is any less in foreign parts than it is at home, the legal advice has been that the circulation of the material should be restricted to schools and other educational bodies within Scotland.

Perhaps this is as good a place as any, in the light of what has been said above, to point out to teachers and others in Scotland who read our bulletins that our reports and any information or advice drawn from them are confidential. It is therefore inappropriate for a teacher to ask the representative of firm A why SSSERC prefers firm B's balance, say, to their own; the rep. will be unable to answer the question, and it is giving him information which he ought not to have, since another condition of our indemnity policy is that no manufacturer or agent should receive information on a competitor's equipment. Such queries should be addressed to us; as a matter of private communication we will certainly give comparative advice on balances or any other item of equipment we have tested, to any individual either within or outwith Scotland.

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All readers on our address list should have received a copy of our equipment list in physics. This is the first of our lists to be revised from the original of several years ago and it may not be out of place to include here a word or two on its limitations, and on the ways in which we think it can be used. Firstly, price stability seems to be a thing of the past and we know that some prices have risen between our revision and getting the list out to teachers. Prices therefore should be regarded as only a rough guide, and one which will grow daily more out of date.

Secondly, suitability. We have not seen and tested every item on the list, so that we cannot be completely certain that there are no snags in the use of a particular item. What we have done is, in the light of our experience to examine the syllabus and to try to match against it equipment which we think ought to be adequate to do the job, guided(?) by the claims of the manufacturer's catalogues. The equipment list is in no sense a list of "best buys" although obviously we would exclude anything which we had found gave rise to difficulty or was otherwise unsuitable. We would be very grateful to learn from anyone who has experienced difficulty with any item we have listed, so that these faults can be identified and if possible corrected.

On the topic of how the list can be used, we think there are at least two view points. For the teacher we think the list specifies the minimum quantity and quality of apparatus which the teacher needs to teach 'O' and 'H' grade syllabuses to an acceptable standard. In this respect the list should be a powerful tool for the principal teacher to obtain money to make good any deficiencies in his department. For the local authority the list should be equally powerful as a check on the more flamboyant demands of a principal teacher. In many education offices there is no administrator with a scientific training, and even under the forthcoming regionalisation it is unlikely that all the science advisers will be knowledgeble in physics. Thus there may arise cases where the official responsible for requisitioning has doubts about the essential character of some of the items requested, where he can make reference to the SSSERC list. We are not suggesting that only items on our list should be purchased; what we do say is that where the cost, after making due allowance for price trends since the list was published, is substantially higher than we have quoted, the teacher be asked to explain why he finds the SSSERC recommendations inadequate. Equally we are prepared at any time to give our opinion by letter or telephone to any LEA official on the appropriateness of any item of equipment about which he may have doubts. It may well be that we would with the passage of time agree with the teacher; improvements in equipment are being made daily, and in the words of one well-known H.M.I. - if it works, it's obsolete.

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The physics list is the first of our lists to be revised but we intend to carry out the same revision on all our lists. Without doubt the one most urgently requiring revision is that for Integrated Science. It has become a source of embarrassment to us to receive requests for this list, mainly from England, at the rate of one or two per week and to have to send in return a list with prices in £.s.d. and which includes non-existent firms like W. B. Nicolson. One reason for the delay in preparing the integrated science list is that the worksheets published by Heinemann are currently being revised by a group of teachers under the co-ordination of the Scottish Centre for Mathematics, Science and Technical Education. Until their work has been completed we cannot issue our list, since the two must be compatible. This should then avoid situations where we specify a 250ml measuring cylinder in demonstration quantity and the worksheet calls for each pupil to use one at some point.

Biology Notes

This second part of the article on choosing a microscope, the first part of which appeared in Bulletin 65, deals with microscopes for teacher demonstration, and micro-projection.

It is desirable that demonstration instruments have facilities for phase contrast as well as for general bright field work, and a further valuable facility is for micro-projection. General bright field demonstrations will from time to time require an oil immersion objective - for example when investigating micro-organisms and chromosomes - while CSYS work will also probably bring a regular demand for such an objective. Therefore a teacher demonstration instrument should be able to take an oil immersion lens, though this need not be permanently on the stand, and this in turn requires that the stand have a focussing Abbe-type condenser. Probably the most suitable optical combination for such an instrument is therefore 4x, 10x, 40x, and 90 - 100x (oil immersion) objectives; 10x eyepiece and focussing Abbe-type condenser.

The phase contrast system is now widely accepted as being valuable for much school work with living material such as protozoa, gametes and cheek cells, and in the last few years several firms have introduced phase models which are suitably designed and priced for school demonstration use. While it is not necessary to have a complete phase system in schools, it is generally agreed that the 40x objective should be phase type. Many instruments also carry a 10x phase objective which is useful, though a 10x bright field objective with a 40x phase annulus will usually give good dark ground conditions which can be almost as useful as phase when searching unstained material. A suitable optical arrangement for a phase instrument is then 10x objective, bright field or preferably phase; 40x phase objective, and phase condenser with suitable annuli. An alignment telescope will also be required to align annuli and phase plates. With most phase instruments such alignments have to be carried out every time that the phase system is used, but there are a few available where realignment is rarely if ever required and this is clearly an advantage for school use.

We have thus far treated bright field and phase requirements as though they should be catered for by separate instruments, but this would clearly be uneconomic. Two more reasonable alternatives exist. The first is to buy a bright field instrument together with a phase contrast kit, containing condenser, annuli and objective(s). The second is to buy a single instrument with similar specifications to those already outlined for a bright field demonstration instrument, but with condenser, 40x objective, and possibly 10x objective replaced by phase types and in addition an alignment telescope. In this respect it should be pointed out that phase condensers all have a position for bright field work, while phase objectives usually give quite reasonable bright field images. Therefore the second alternative is both cheaper than the first and covers the demands of both types of work quite adequately.

A final point to look for when choosing a phase instrument is the type of illumination required. For many phase systems a mains voltage, 100W pearl bulb as an external lamp provides adequate illumination. For some systems however, such illumination is inadequate and consequently a high intensity lamp must also be bought which effectively increases the cost of the instrument.

The widespread availability of photomicrograph transparencies in recent years has altered the position with respect to microprojection. We do not believe that photomicrographs have eliminated the usefulness of microprojection; rather we feel that the one complements the other. Photomicrograph transparencies are easy to project, are often of outstanding quality, and they greatly simplify the problem of identification. On the other hand this very ease of identification is possible only because a very limited view of the material is provided. With transparencies it is not possible to search through materials such as lung, kidney, or leaf sections with a class, as one can do with a microprojector. Further, a microprojector can be used to examine fresh preparations, including living material such as protozoa and gametes. We have investigated the use of ordinary microscopes with external light sources for microprojection extensively over the last two years, and as a result we feel that such arrangements are not only cheaper but also more versatile than conventional microprojectors.

Philip Harris sell a universal illuminating base, B4539, price £85.00 which supplies a suitable light source for projection with an ordinary microscope. Included is a mirror attachment which clips on to the top of the body tube above the eyepiece. The base contains a 12V, 100W quartz iodine lamp and a lens system which produces Kohler illumination. An open-based microscope with mirror or illuminator removed is placed on top of the base in such a position that the light beam travels directly up its optical axis. A control on the side of the box allows one to switch to a 'Direct Vision' position, i.e. one may then look into the microscope. This is useful when lining up the microscope and in this position the base also provides an excellent light source for general bright field or phase microscopy. Once the instrument has been aligned the mirror is fixed over the eyepiece and the light control moved to one of three projection positions - 'Low', 'High', or 'Over-run' - the last being used for short periods only, on high power.

With black-out facilities we have projected sufficiently bright images over distances of about 6 metres, even using 40x/0.65 objectives. It is most important to realise, however, that satisfactory images over such distances can only be achieved by using very low power eyepieces; the one which we have most commonly used is a 2.5x, also sold by Philip Harris, B4541/25, at a price of about £5. At 6 metres this gives a screen image diameter of just under 1 metre.

A further valuable accessory for use with the base is a Viewing Head, B4539/20, price £22.50. This fits over the eyepiece of any microscope with a vertical body tube and has the advantage of allowing bright images to be projected without any blackout. On the other hand the images are much more directional so that fewer pupils can see them at any one time. As with screen projection, it is advisable to use a low power eyepiece, in this case about 5x, to improve the brightness of the image.

Several models of microscope are suitable for use with these projection accessories. The ideal type of instrument should have the following features:

1. An open base is essential.

2. Mirror or illuminator should be easily removeable.

3. A focussing compound condenser is essential for projection with objectives of greater than 10x magnification. However, such a condenser will fill very little of the field of view of a 4x objective, and by no means all that of a 10x objective. Therefore the ideal condenser is one whose top lens is easily removeable for low power work and replaceable for high power. Such types are usually called 'flip-top' or 'swing-out' condensers, and although they cost a few pounds more than Abbe types we believe the extra expense to be more than justified by their extra versatility if one has projection in mind. Using such a condenser it is possible to 'scan' specimens such as leaf, kidney, and lung sections to show the layout of the tissues, and where necessary to relate the slide to book diagrams, before investigating the various tissues in more detail under high power. It is also easier to find specimens in fresh preparations.

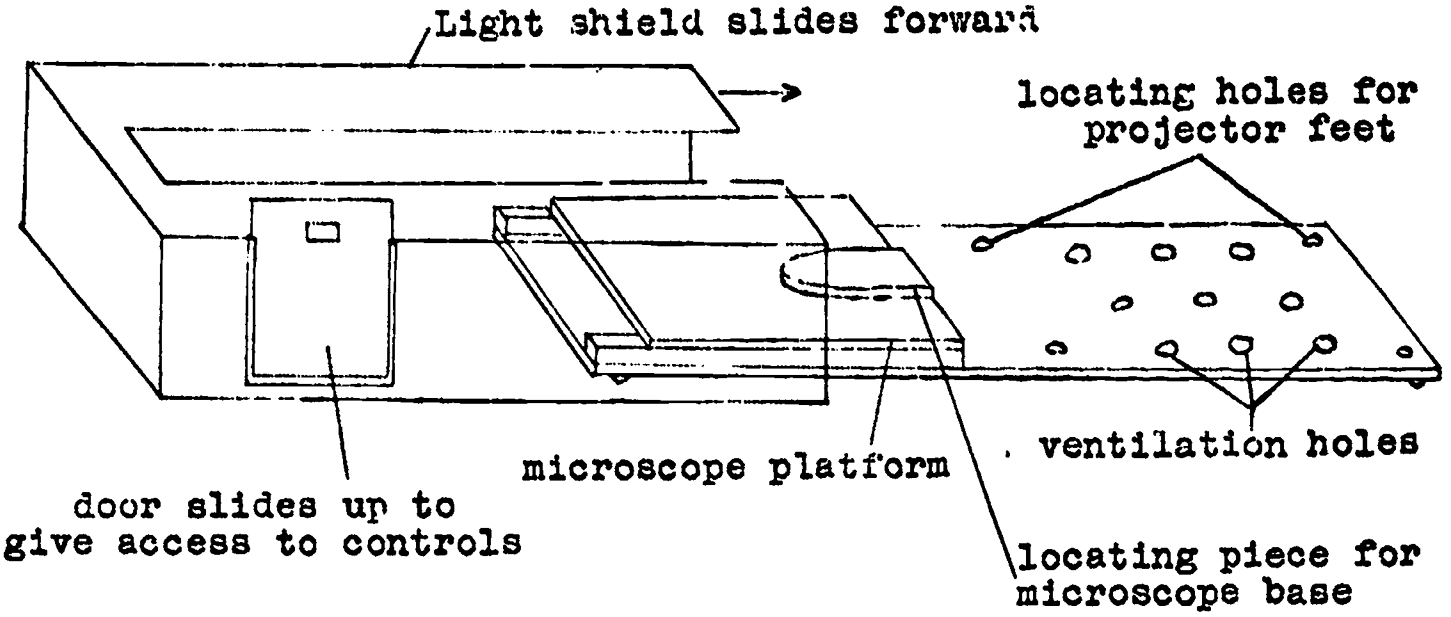
4. If the viewing head is to be used the microscope must have a vertical body tube. In practice this usually means that the traditional upright type of stand is needed though it is also possible to buy vertical body tubes as accessories for some angled-head instruments.

It has already been stated that we consider this form of microprojection to be more versatile than a conventional microprojector. Here we have in mind the fact that any instrument with open base and compound condenser can be placed on the Harris base and used for projection. Further, if the viewing head is used no blackout is necessary. The writer has known several occasions when one or two only of a class of senior pupils have obtained good results from chromosome squashes, for example. Under such circumstances it would clearly be an advantage to be able to project interesting specimens so that the whole class could see and discuss them. If all the members of the class had suitable instruments this would be possible, and without blackout being needed if a viewing head were available. It should be noted that while it would obviously be of some advantage to have all instruments equipped with flip-top condensers, at extra expense, this is not essential since almost always the image to be projected will be on high power and a conventional Abbe condenser will therefore suffice. The particular advantage of the arrangement is that one does not have to move the slide at all. If on the other hand one has to transfer the slide to a conventional microprojector, one can become involved in protracted and time-wasting search to find again the part in question.

We have found the Olympus HSC microscope from Griffin and George to be very suitable for use with the Harris base and head. This instrument carries 4x, 10x, and 40x objectives, 10x eyepiece and focussing Abbe condenser. It has a traditional upright stand with open base, and the mirror is easily removed. Further, it can be bought with a swing-out condenser in place of the Abbe type, while a 5x eyepiece is also available, for use with the viewing head. It is also worth mentioning that we have projected with a phase contrast version of this instrument, carrying 4x bright field, and 10x and 40x phase objectives together with rotary phase condenser with four annuli.

We have found that a particularly useful combination is the 10x objective with the 40x phase annulus. This has allowed us to project good images of fresh materials such as Paramoecium for several minutes without apparent ill effects, both using the viewing head and onto a screen. Probably this would be a valuable way of showing gametes, and hopefully fertilization, to a class.

Cheap though the Harris base may be compared to a good quality microprojector, £107 is still too large a slice of most biology department allowances to be contemplated with complete equanimity. We have therefore investigated the possibility of providing similar facilities in a home-made way, by using a slide projector as light source. Such a technique was first suggested to us by Galashiels Academy and described in Bulletin 35. Since then quartz iodine lamps have become much more widespread and these give greatly increased light intensity. The arrangement which we have used is shown below.



No dimensions are given because these clearly depend upon the type of projector and microscope used. We have used a Gnome projector with 24V, 150W lamp and an Olympus HSC microscope. Since the latter has an open base we have located it by glueing to the platform a piece of plywood shaped to fit inside the horse-shoe of the microscope base. Some instruments will require different methods of location. It is worth noting that this arrangement has an advantage over the Harris base in that it allows solid-base instruments to be used, provided that they have mirror illumination.

The correct height of the microscope platform has to be found by trial and error. It is the height at which the centre of the projector bulb filament can be brought to the centre of the field of view simply by tilting the microscope mirror. Therefore the image of the filament must first be projected; this is most conveniently done by using the Harris viewing head but an alternative is to project onto a screen or wall, using the mirror attachment which we will describe in the Workshop section of the next bulletin, but which very simply is a clamp which allows a mirror to be held at 45° above the body tube so that the image is projected forward horizontally. The low power objective is first focussed onto a specimen; then, with the viewing head or mirror attachment in position and the microscope standing on e.g. a pile of books so that it is at approximately the

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correct height, the condenser, with top lens in, is focussed up and down until a sharp image of the filament appears on the screen. This image is then centred as far as possible by using the microscope mirror after which the instrument is carefully raised or lowered until the centre of the filament image coincides with the centre of the field of view. This is then the correct height for the platform. The locating piece(s) of wood should position the microscope on the platform so that it is as close as possible to the projector and in line with it.

With a 2.5x eyepiece we have been able to project satisfactorily bright images under a 40x/0.65 objective onto a screen 6 metres distant as well as use the Harris viewing head without blackout. Stray light from the projector may detract from the image brightness when projecting onto a screen; to counteract this we made a cover, also shown in the diagram, which slides over the microscope stage and projector leaving an opening through which both slide and condenser can be manipulated. A mechanical stage is a useful accessory on a teacher demonstration instrument and the opening also gives access to the controls which operate this. From the school viewpoint this projection arrangement provides images which are almost as satisfactory as the Harris base. Its main disadvantage is that it cannot be used for direct viewing.

To summarise the foregoing discussion, the ideal teacher demonstration instrument would have the following features: 4x brightfield objective, 10x and 40x phase objectives, 90 - 100x brightfield (oil immersion) objective, phase condenser with 10x and 40x annuli and bright field position. The condenser should be readily replaceable by a swing-out or flip-top type, for projection. Alternatively, one of the senior pupil microscopes, which would most suitably have 4x, 10x, and 40x bright field objectives, could be bought with a swing-out condenser in place of an Abbe and used when required by the teacher, particularly for projection. The stand would best be an upright type for use with a viewing head, while a mechanical stage would also be a useful addition for projection.

In these articles we have discussed what we feel are the more important factors to consider when selecting microscopes for school use. On certain points, where we know that two more or less clearly defined viewpoints exist, we have attempted to give both sides of the argument. Nevertheless we have also indicated our own views on such issues where we have felt it important to do so. In taking up definite positions on such topics as mirror versus built-in illumination and Abbe versus simple condenser we have had in mind a common reason: that versatility is one of the key requirements of school microscopes. In many fields of biology highly specialised, repetitive tasks are often undertaken, for which equally specialised and often highly sophisticated types of microscope are required. This is not the case for school work, where one instrument may be used to look at soil particles, fish tails, protozoa, tropic movements, prepared slides etc.; and may hopefully be capable of use for microprojection of bright field and even phase images. In our view upright stands are more versatile than angled head types if one has daylight projection with a viewing head in mind; mirror models are more versatile than those with built-in illumination; and Abbe condensers are more versatile than simple types, not least because one can often replace Abbe types with others when required.

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

Ealing Beck Ltd., Greycaine Road, Watford, WD2 4PW.

Charles Frank Ltd., 145 Queen Street, Glasgow C.1.

Gillett and Sibert Ltd., Lynx House, 50 Vicarage Crescent, Battersea, London, S.W.11.

Gnome Photographic Products Ltd., Gnome Corner, Caerphilly Road, Cardiff, CF4 4XJ.

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

Philip Harris Ltd., 30 Carron Place Kelvin Industrial Estate, East Kilbride.

Heinemann Educational Books Ltd., 48 Charles Street, London, W1X 8AH.

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W. R. Prior and Co. Ltd., London Road, Bishop's Stortford, Herts.

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

Scottish Centre for Mathematics, Science and Technical Education, College of Education, Park Place, Dundee, DD1 4HP.

Technical and Optical Equipment Ltd., Zenith House, Thane Villas, London, N7 7PB.

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