GIREP newsletter

Groupe international de recherche sur l'enseignement de la physique
International Research Group on Physics Teaching
Internationaler Arbeitskreis zur Förderung des Physikunterrichtes

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NEW WAYS OF TEACHING PHYSICS

Thoughts in view of the forthcoming Ljubljana Conference

The theme of this year's formal GIREP-Conference is inviting, useful, demanding; it is a challenge to participants and to contributors, to organizers and to sponsors. "New Ways of Teaching Physics" obviously means a selection, perhaps even a survey of new possibilities and new subjects for teaching physics by employing new facilities; but it also means to take into consideration new insights concerning the processes of learning and understanding physics and to realize practical consequences from them.

Although most of the participants, members and nonmembers, will have a general interest into this fairly wide scope, it is natural that everyone has his own preferences and intentions. But still, in spite of various personal interests, one unique attitude typical for all of us will be present, the desire to learn and to communicate for the benefit of our lifelong task and challenge: a proper and suitable teaching of physics.

Of course, there are diverse personal opinions on the primary purpose of a teacher's task: He may see himself mainly as a demonstrating physicist, or more as a neutral instructor, or just as an engaged educator – in any case he will draw profit from the mutual interactions at the Conference. As all of us know, a sensible mental connection between various components may reach a value far above the mere sum of the single components.

In this sense, each GIREP-member should feel encouraged to realize and to make use of our potential and to try to enhance it. Inform your professional surrounding – your collegues, your principal, your educational authorities – on the needs for information connected to the communication of personal experiences and ideas for the benefit of today´s physics teaching; try to find a possibility to participate in our communications and to increase the efficiency of our community!

Karl Luchner, President of GIREP

GIREP 96 ICPE 96

NEW WAYS

OF TEACHING PHYSICS

LJUBLJANA / SLOVENIA /

21.8. - 27.8.1996

Thanks to recent communication possibilities, information about the conference on the www home page http://www.pef.uni-lj.si/~girep is now available throughout the world. Many physics teachers on different levels get interested in conference agenda and decide to take part in it. At the deadline, the organisers had about 160 proposals for contributions. The abstracts of the contributions are published on the conference home page. This communication through computer creates strange virtual contacts, and we hope that in the short week when the conference will be taking place, real contacts will arouse out of it.

Since all GIREP members get the second circular in the same envelope, they will find in it all information they need.

Seta Oblak, secretary of GIREP

Physics In the UK: History and Projections

From a Bountiful History we have much to loose

Past

Nuffield

This evolved from a model for collaboration between higher education and schools which yielded a high quality product and stability over time. Many new syllabi have come forward since then but very few courses. This is the strength of the Nuffield Schema and why it continues to evolve and command the support of many passionate teachers - it had a strong view of what physics was about. It was effective precisely because it involved effective training and a supportive exam.

Smaller Projects

With the introduction of co-cordinated and combined sciences pre -16 there were many courses, some of which provided small innovations, some of which were predicated on a particular view of science, but few of which achieved such a profound and lasting impact.

Present

We have what we would regard as significant governmental interference - the National Curriculum and a large core at A level. These are seen as quite insensitive and badly managed changes which are an imposition and threaten to deskill teachers. Many physics teachers feel quite isolated and under pressure.

Equipment and environment are both in need of repair and renewal.

Future

Prediction is hard but the time has come for a fundamental rethink in the same way as pressure built up before the Nuffield reforms. Here are some thoughts as to what might be useful which recently appeared in the education group newsletter of the IoP.

Remodelling Physics

Physics is essentially a modelling activity and hence what we need to engender is the ability to model. This requires confidence and competence in a small number of areas. [Heisenberg was not held up (much) by not knowing about diffraction at a single slit.]

We need to continuously challenge what teachers and students see as physics so that we can be certain that what we are offering is something which is recognisably physics and not some sterile dessicated offshoot which owes more to generations of refinement by schools and a much more dangerous recent development, unaccountable government quangos.

Physics is an essentially human activity of sense making and not a list of things to be got. We cannot educate people by packing in more dammed facts. This cannot be the essence of any course which aims to educate effective citizens for the 21st century. Equally we cannot process information and participate in debate without conceptual schema with which to do so. It therefore behoves us to do a little selection and to choose a few areas of physics to do well. These should be rich in historical links, exemplify physics at work as a descriptive schema, provide instances of the interaction between theory and experiment in refining our conceptions, and be useful tools for thinking. I would suggest that all we need are a functional understanding of Newtonian mechanics, DC circuit electricity including RC circuits, and an understanding of the fundamentals of quantum mechanics. Functional here implies no more than that we should not demand a greater conceptual purity of 14 - 19 year olds than we do of those at the forefront of research.

These thoughts are designed to be provocative, are almost certainly not the view of the IoP education group as a whole, or the editor, but are probably connected with the thoughts of this correspondent at this time! He would like as many people in the wider physics community as possible to have a stake in what comes to pass in physics over the next few years. Disagreeing violently with the above in intelligent prose, attending the IoP Education Group conference next April, or getting involved in consultations with Bryan Chapman are all ways to get your institute moving along the right lines. If you do not then the Institute will be the poorer for it and there is no institute apart from us anyway...

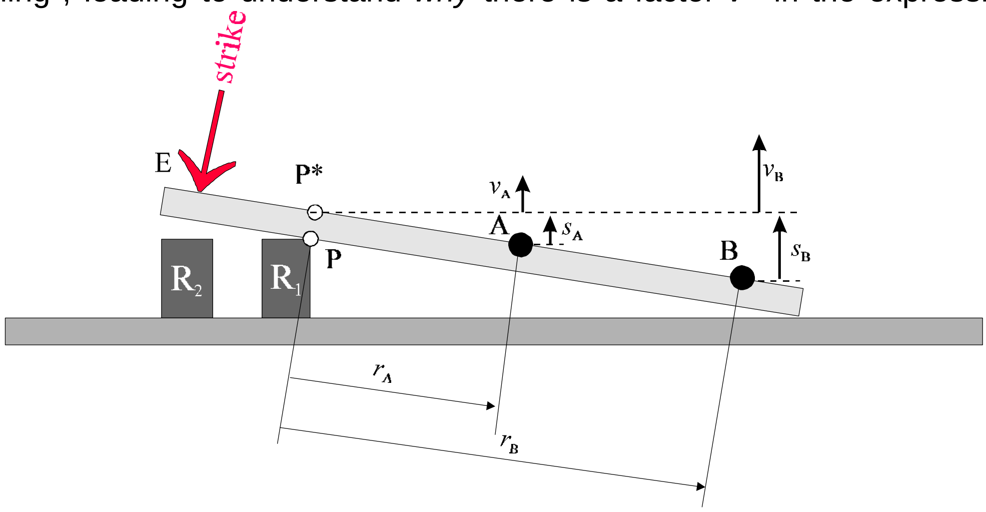
Ian Lawrence
King's School, Worcester

Early Reasoning - a Help to reach Understanding

In the attempt to build up a kind of first insight or a provisional understanding of a physics problem, in a first step it is important to work at a level of qualitative and semiquantitative reasoning and use verbal communication for it. This "early reasoning" or "first step reasoning" often is jumped by the teacher in favour of a shortcut rigorous treatment, which quickly leads to a mathematical result and thus finishes up the problem. As a long term consequence of such stressed treatment, the student probably may tend to consider physics as a smart collection of definitions and equations, but he hardly will develop the ability to give verbal explanations and produce and express ideas of his own. Of course, here is not the place for a general scientific analysis of this situation, but still the reader might want to see a short example of the advantages provided by this "early reasoning", which may lead to a well founded insight and may help to overcome the feeling of blindly relying upon a mathematical formula.

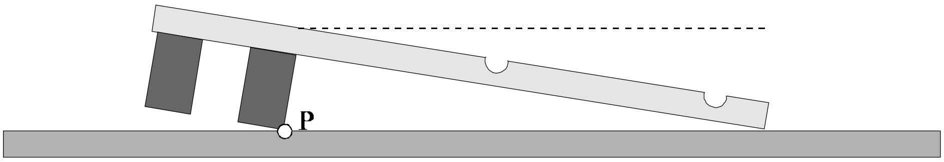
The following example deals with the kinetic energy, which is the work done in order to accelerate a body from rest to speed *v.* An introducing and for almost all students surprising experiment is to throw two bodies vertically upward, one with twice the speed of the other. The usual expectation of the students is, the hight of flight of the one will be twice the hight of the other; there is quite some surprise that the hights of flight come out to differ by the factor four, not by the factor two.

Usually, the teacher will point out this result to confirm that the factor v^2 shows up in the formula for the kinetic energy. Somehow, as mentioned above, this seems to be a shortcut jump into the formal description instead of taking the chance for an "early reasoning", leading to understand *why* there is a factor v^2 in the expression



for the kinetic energy.

First consider the experimental setup (Fig.1) to throw two bodies vertically upward, the initial speeds reliably differing by a factor of two. The setup consists in a solid stiff rod (length about one meter), with two balls A and B on it and rested as shown in the figure. When the end of the rod is violently hit near point E, it will turn around point P until it comes into contact with block R_2, which defines the horizontal (dashed line); in this position the rod comes to a sudden rest and the balls will jump off with initial speeds v_A and v_B . The speeds are related to each other in the same way as their distances r_A and r_B from point P (in Fig.1 for simplicity P is replaced by P*; a similar simplification applies in the alternative arrangement shown in Fig. 2, which seems a little more practical than the arrangement of Fig.1). The angle covered by the rod's motion is small enough to consider the motion as infinitesimal, i.e. any variations of forces along the motion are neglectible.



Now consider the "early reasoning" (simplified case assuming equal masses and $r_B = 2r_A$):

The task is to find out, how the energies of both balls relate to each other when crossing the horizontal line; in other words, we must compare how much work is done while accelerating each ball on its way from the initial resting position up to the horizontal (the small difference in the increased potential energy may be neglected). For geometric reasons, ball B will have twice the speed of ball A, as long as both keep contact with the rod: $v_B = 2v_A$.

The acceleration from 0 to v_A and from 0 to v_B occurs during a time-interval Dt, which is the same for both balls; this means, B is accelerated twice as much as A. Thus, from $F = ma$ it must be concluded, that B feels an accelerating force twice as large as A, $F_B = 2F_A$.

Now it can be seen how much work is done in accelerating each ball: The displacements (the distance, along which the forces are acting) are s_A and s_B , respectively, and again for geometric reasons $s_B = 2s_A$. Thus, the work done (force· distance) to B comes out to be four times as large as the work done to A: $F_B \cdot s_B = 4\, F_A \cdot s_A$; the energy of B is *four* times as large as the energy of A while crossing the horizontal. Conclusion: the hight of flight (maximum potential energy) for B is understood to be *four* times as large as for for A.

This example appears transparent especially because there is the chance to *compare* things; it seems adviseable for this kind of early reasoning to construct situations, where comparison is possible.

As a next step, now it seems more natural to look for a relation describing the ball's energy in terms of its speed while crossing the horizontal; this is readily obtained, just express the acceleration and the displacement by the speed: $a = (v_A - 0)/Dt$; $s_A = a \cdot Dt^2/2 = v_A \cdot Dt/2$; with these relations one obtains

$$F_A \cdot s_A = m_A \cdot a \cdot s_A = m_A \cdot (v_A/Dt) \cdot (v_A \cdot Dt/2) = m_A \cdot v_A^2/2 \quad .$$

However, the argument used here employs a special arrangement, and thus it does not have a convincing general meaning. But nevertheless, it seems useful to raise the interest for the usually given general derivation and to gain an understanding for the functioning and the meaning of the widely known formula.

Karl Luchner
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Environment, Energy, Society and School

This project is coordinated by the CIFFUL (Centre Interdisciplinaire de Formation des Formateurs de l'Universite de Liege) within a more general projet called FIREES (Formation Interdisciplinaire aux Relations entre Energie, Environnement et Societe). Four other European universities are involved:

- University of Athens, Greece, Pedagogical Department, Mathematics and Physics section;
- Universidade de Aveiro, Portugal, Departamento de Fisica
- Universitat Autonoma de Barcelona, Facultat de Ciencies de l'Education, Departamento de Didactica de la Matematica y de las Ciencies Experimentales;
- Universite Denis Diderot, Laboratoire Interuniversitaire de Recherche sur l'Education Scientifique et Technique (LIREST), Groupe de didactique des Sciences Experimentales de Paris 7 (GDSEP7).

This project is supported by the DG XI of the European Union.

The objectives of this project are:

- the design, testing and editing of didactic materials with the help of teachers directly involved in this research;
- the organisation of in-service training for other teachers.

In a first step, each European team is developing didactic material specific to its own country; during the training periods, organised not only for physics teachers but also for teachers in the life and social sciences, all teachers are invited to submit their criticisms and to contribute to the improvement of the material they receive.

The material is written in a way to motivate pupils through everyday problems; it tries to take into account their preconceptions and mental models; it is hoped to start a fruitful debate between the different partners such as pupils and teachers.

It is meant to help teachers gain a better, global and interdisciplinary view of present problems such as waste disposal, the greenhouse effect, the development of renewable energies, etc.

Each problem is first approached from a societal point of view but the technical and scientific aspects are dealt with in depth when and where needed.

For further information or comments, contact:

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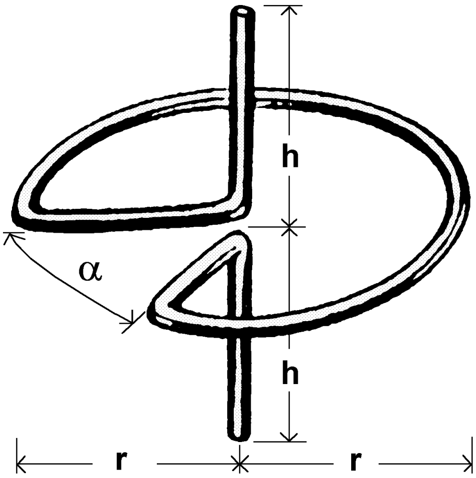
The paper-clip top (Sakai-top)



You can bend a top out of one piece of wire, e.g. a paper-clip. Takao Sakai, professor of mechanical engineering at the Tohoku university in Sendai/Japan has proposed an ingeniously simple solution. His top consists of a sector of a circle, from which the spokes lead to the shaft (= rotating axis) and hold in this way the arc of the circle. The spokes form an angle α. Both ends of the wire form the shaft which are bent rectangular to the spokes in the center of the circle.

The top will only work properly if the center of gravity of the whole system stays in the axis. This is exactly the case, if $\tan(\alpha/2) = 1/2$, with a being the angle between the spokes. It is a nice exercise for physics students to prove that, giving $\alpha = 53.13$ degrees.

To actually build the top you need a small pincers and a metallic paper-clip. Because it is not possible to bend the wire sharply, whereas the angle a was calculated under this condition, you may bend the angle α a little smaller than 53 degrees. Using regular paper-clips, the height h and the radius r of the circle are only about 1cm.

The Sakai-top runs well even if the curvature of the circle is not perfect. You can see the circle and the shaft of a very well made and fast rotating top sharply, while the spokes will be almost invisible. If you spin it up with your fingers, the small diameter of the wire will make the top rotate very fast, up to several thousands r.p.m. Try to calculate roughly the revolutions under your personal conditions (finger velocity and diameter of the wire) and to measure then the revolutions per minute with a stroboscope.

Be careful not to use all paper-clips in your surroundings.

Recently a recommendable book (in german) appeared about physics toys and related reflections from **Wolfgang Bürger**: *Der paradoxe Eierbecher* (Birkhäuser-Verlag, Basel 1995). There you can find some more information about the Sakai-top.

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Technische Universität München

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The new telephone and fax number from the treasurer (from 9.6.1991 on):
tel 4989 28912399 fax 4989 289523338

FEES

The accounting year runs from January 1 to January 1. Fees paid after September in any year will be credited on the following year, unless the applicant specify otherwise.

The current fee (1996) is 12 £st, preferably paid into the following account:
Christian Ucke, Postbank (GIRO) München
Account No. 355 28-808, BLZ 700 100 80.
BLZ (= Bankleitzahl) means a special sort of code for the postbank in Germany.
Please do not pay into other accounts.

The members should pay their own bank charges and mailing costs. At the same time, please send a note (by letter, fax or e-mail) to the Treasurer confirming how much money you sent and when and for what years.

In some countries it is possible to transfer money from the national postbank with EUROGIRO free of charge (Belgium, Germany, Japan, Luxembourg, Switzerland, Spain) or with a small payment (Denmark, Finland, France, Great Britain, Netherlands, Austria, Sweden).

If you prefer in order to reduce bank expenses you may pay several years fees in advance.

In cases of real difficulty of payment, please contact the Secretary or the Treasurer who are ready to advise whether special arrangements can be made.

The last General Assembly of GIREP members in Udine (August 1995) accepted the following supplementary new article for the GIREP statutes:
In the October each year, those members who have not paid for the previous two years will be removed from the membership list.

Italian members: Equivalent of 12 £st can be paid, in Italian Lire only, to Silvia Pugliese Jona, via San Nazario 22, 10015 Ivrea (Torino), Italy, (tel 0125 49869, fax 0125 631872, e-mail: MC5940@mclink.it)