Collapsing cans

I repeated Subramaniam and Aun’s collapsing cans experiment (Phys. Educ. May p209) with the following modifications:

● I used an empty 300 ml plastic Coca-Cola bottle in place of the can.
● The bottle top was closed with a rubber bung with a glass tube through it, and the tube was connected to the aspirator through rubber tubing.

The photographs here show different stages in the experiment. The arrangement is much cheaper than the one described in the article and requires no workshop facilities.

I extend my thanks to R Subramaniam and Toh Kok Aun for their excellent ideas. My students really enjoyed the experiment.

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20th century science

Frank Thompson’s article One hundred years of electronics (Phys. Educ. May p252) set me thinking. Biology is by definition complex. Yet biology education has been relatively successful in keeping up to date with biotechnology and new scientific discoveries. By comparison, the physics curriculum seems to shed the technological past rather slowly.

Has electronics become part of the school physics curriculum (apart from using electronic devices in experiments)? The answer is yes, to a very limited extent. Students commonly learn about potential dividers and are likely to encounter thermistors, LEDs and light-dependent resistors.

Some courses try harder than others. For example, instrumenta-
tion and communications get good coverage in Advancing Physics and Salters Horners Advanced Physics. These courses show how the physics behind modern applications can be explained at school level. However, standard courses need to do more.

Take Moore’s law, formulated in the 1960s. It predicts a doubling in the complexity of integrated circuits every 18 months or so. That’s pretty remarkable. Most students are aware of the shrinkage of everyday electronic products, such as mobile phones, and their increasing power. It is a simple step to refer to the integrated circuits that they contain.

Then things get interesting. For Moore’s law is not a law of nature, it is a bald challenge to scientists and engineers to go on being clever. Microprocessors today contain more than 10 million transistors per square centimetre, made from components with dimensions of less than a micrometre. How is it possible to make circuits so small? There are science stories here about lithography and its limits, based on the wave nature of light, and an explanation of why new methods of engineering at the sub-micrometre scale are being developed at considerable expense.

What new problems arise when you make circuits so small? First, the many metres of interconnects within every chip get thinner. Resistivity becomes so crucial that it forced a shift from using aluminium to using copper. Second, as the wires get closer together there are also capacitance effects between the wires and the silicon...
dioxide insulator. The crosstalk this produces can result in logic errors, making chips useless. The search is now on for an insulating material with a lower dielectric constant, so that it will store less charge. Semiconductor technologies could breathe new life into the teaching of resistivity and capacitance in post-16 physics courses.

And I have not yet started on band theory, tuning the wavelength of the light emitted by optoelectronic devices, or other quantum effects, or memory devices. Potentially there are many ways of keeping up to date and motivating young people.

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Energy efficiency

In the 16 April issue of New Scientist a reader asked why a runner uses more energy to travel the same distance as a walker. Surely, the reader asks, conservation of energy dictates that the same amount of energy is used?

The answers given are shocking – especially the one from a US physics professor who simply relates the energy ‘use’ to the kinetic energy. At a higher speed you have greater kinetic energy so you must have used more energy. The misunderstanding of energy implicit in this is quite remarkable. Indeed none of the answers really comes close to being sensible and I suspect it is because none of the answers is given in terms of work. They all cast energy as a thing, a fluid perhaps. It seems such basic errors are not limited to our GCSE syllabus but appear to be common around the world.

My classes find it quite a revelation when they realize that a car driving at constant speed is converting chemical energy from the combustion of fuel in air into thermal energy. And a car going downhill at constant speed even converts gravitational potential energy into thermal energy as well!

Concerned of Slough

Einstein the rector

Did you know that Einstein was the rector of a school society in a small town in the Midlands? This is an interesting story that reflects Einstein’s gift for the ordinary touch, and the affection in which he was held by the younger generation.

During a meeting of the Wollaston County Grammar School sixth-form society in February 1952, six students each presented an argument for a personality to be ‘elected to the imaginary position of rector of the sixth-form society’. The records do not show who else was considered, but Einstein was chosen and on 25 February a letter was sent to him in Princeton informing him of his success.

The office involved no duties, but the group felt that Einstein would appreciate the gesture as an indication of their recognition of the greatness of his work.

On 17 March 1952 Einstein replied in a letter: ‘As an old schoolmaster I received with great joy and pride the nomination to the office of rectorship of your society. Despite my being an old gypsy, there is a tendency to respectability inherent to old age – so with me. ‘I have to tell you, though, that I am a little (but not too much) bewildered by the fact that this nomination was made independent of my consent.’

The reply is mentioned in the school magazine of spring 1952 as being ‘typically Einsteinean’. The letter was framed and placed in the school library, but as the original began to fade it was replaced by a copy and the original placed in a safe dark place (initially a chemistry storeroom).

This little-known letter has been of interest to many people; it has even featured in a Japanese television documentary about the great man.

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