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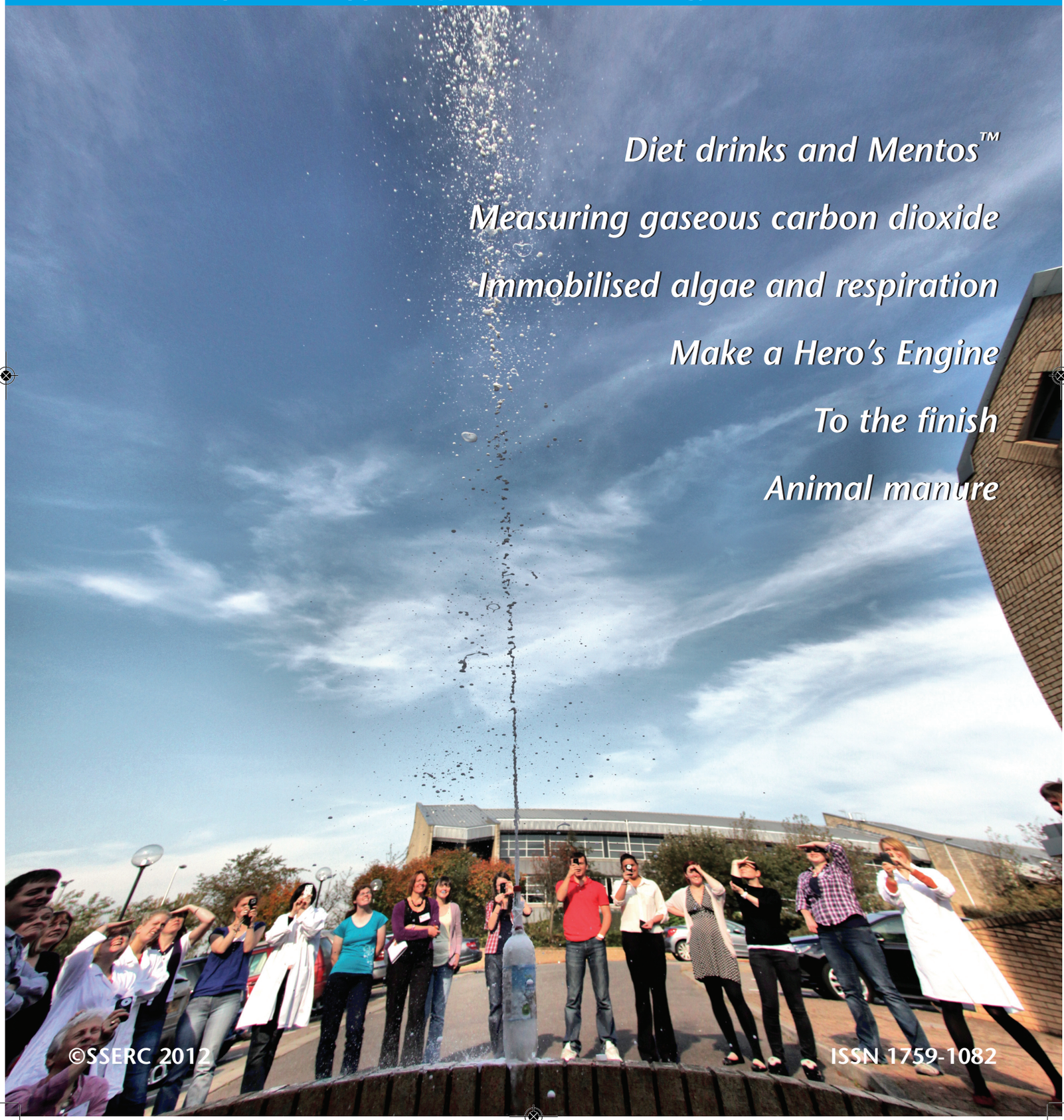
Ideas and Inspiration supporting Science & Technology for all Local Authorities



Diet drinks and Mentos™

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Make a Hero's Engine

To the finish

Animal manure

ISSN 1759-1082

Diet drinks and Mentos™:

Figure 1 *- Geyser Tube arrangement with 3 Mentos™ in place. Removal of the pin (located just underneath the Mentos™) releases the Mentos™ into the bottle.*

Background

In a recent article in this Bulletin [1] we explored a number of possible ways in which fluorescence might be demonstrated in the classroom. We hinted in that article that we would continue to search for carbonated drinks so that we might produce a variant of the so-called Diet Coke™/Mentos™ eruption [2-4] in which different colours of fluorescence were produced; our intention at that time was to produce a rainbow of colours. Thus far, our search for commercially available fluorescent carbonated drinks has been disappointing in terms of results other than tonic water in which blue fluorescence arises from the quinine contained therein. The only other possible candidate for inclusion which we found, despite intensive researches in local supermarkets, was Red Bull™ although the level of fluorescence obtained under UV illumination was low compared to that obtained from tonic water. We did get quite excited after buying a bottle of Mountain Dew Energy® only to find that the yellow-green fluorescence we observed was from the container rather than the contents! Undeterred by our inability to locate suitable materials we decided to add fluorescent materials to diet lemonade to provide us with a range of colours of the rainbow. Lemonade was chosen because it is readily available, non-fluorescent and 'cheap'. We wish to present the results of our researches here.

Methods

The UV lamp (catalogue XX-40BLB) we used was from Ultra-Violet Products Ltd. (Trinity Hall Farm Estate, Nuffield Road, Cambridge CB4 1TG (see http://uvp.com) with a peak emission wavelength of 365 nm.

In all experiments reported here we used 'diet' carbonated drinks since the residues which we occasionally produced on benches, and in extreme cases ceilings, of the laboratory could be more easily removed. Proprietary brands of drinks were used without special preparations being made; so for example Schweppes Diet Tonic Water™ was used. In most of the experiments reported we used Premium Diet Lemonade from Tesco; this choice being based on 2 key factors *viz* (i) both container and lemonade were non-fluorescent when viewed under UV light, and (ii) the drink was on 'special offer' on the day of purchase.

Rhodamine B and Rhodamine 6G and were drawn from laboratory stock (both were from Aldrich - www.sigmaaldrich.com/) and used without further purification. Aqueous stock solutions of the dyes were prepared at a concentration of 5×10^{-4} mol dm^{-3} and appropriate aliquots (typically 30 – 40 cm^3) of these solutions were added to bottles (1 dm^3) of diet lemonade at room temperature. To produce green fluorescence we used Tesco Lemon All Purpose Cleaner™ and in this case approximately 40 cm^3 of undiluted cleaner was added to a bottle (1 dm^3) of diet lemonade. Mentos™ were released into the carbonated drinks using a 'Geyser Tube' (available from a number of sources including Amazon [www.amazon.co.uk]). A typical set-up is shown in Figure 1.

A novel twist on an old favourite

Those familiar with the Diet Coke™/Mentos™ experiment and its variants will know that significant volumes of liquid can be released and typically this activity is not normally performed indoors. The experiments described here require the environment to be blacked out or, at the very least, lighting levels should be kept to a minimum and for this reason it is convenient to perform the experiment indoors. Consequently, you will need to consider how best to reduce the effects of spillages. We place our carbonated drinks bottles (1 dm^3) in the centre of a large paddling pool (Figure 2) and we find that of the 500 cm^3 of liquid typically released (the actual volume released depends on a number of factors including the number of Mentos™ used and temperature of the carbonated drink) some 90%+ of this volume falls back into the paddling pool. In line with good laboratory practice, we recommend that the demonstrator wears eye protection. Clearly it is important to avoid directing the liquid at any electrical (e.g. ceiling lights) or sensitive equipment and we recommend that the UV lamp should be kept at a minimum of 2 m from the drinks bottle.

Results

Our choice of fluorescent dye was based on a number of criteria:

- water solubility
- availability at (relatively) low cost
- high yield of fluorescence
- suitable absorption properties – our excitation source is a UV lamp emitting predominantly at 365 nm
- low toxicological concerns at the concentrations used.

In looking to produce the colours of the rainbow we immediately encountered a problem in that it has proved a challenge too far to identify a substance which meets the above selection criteria and emits violet fluorescence. We made reasonable progress with other parts of the spectrum and our results are shown in Figure 3.

The amount of fluorescence emitted by a sample is related to (i) the fluorescence efficiency, Φ_F, (i.e. the ratio of emitted photons to absorbed photons), and (ii) the extent to which excitation light (in this case 365 nm) is absorbed by the sample. The fact that the fluorescence fountains observed are not all of the same light intensity can be explained by consideration of these 2 factors. We would be keen to hear from anyone who can suggest dyes which display fluorescence in the violet or red portions of the spectrum and which additionally meet the criteria in the Methods section.

It had been our original intention to use fluorescein as one of our chosen dyes but the observed yield of fluorescence was quite low under the conditions used. In part the explanation for this is that Φ_F for fluorescein is pH dependent. At pH 3 (the approximate pH of the lemonade used) Φ_F is reduced by some 90% compared to that at pH 7 [5]. Tesco Lemon All Purpose Cleaner™ contains the trisodium salt of 8-hydroxypyrene-1,3,6-trisulfonic acid (also known as pyranine and Solvent Green 7) as the fluorophore (information taken from http://www.detergentinfo.com/) and the yield of fluorescence is appreciable and apparently not affected by changes in pH.

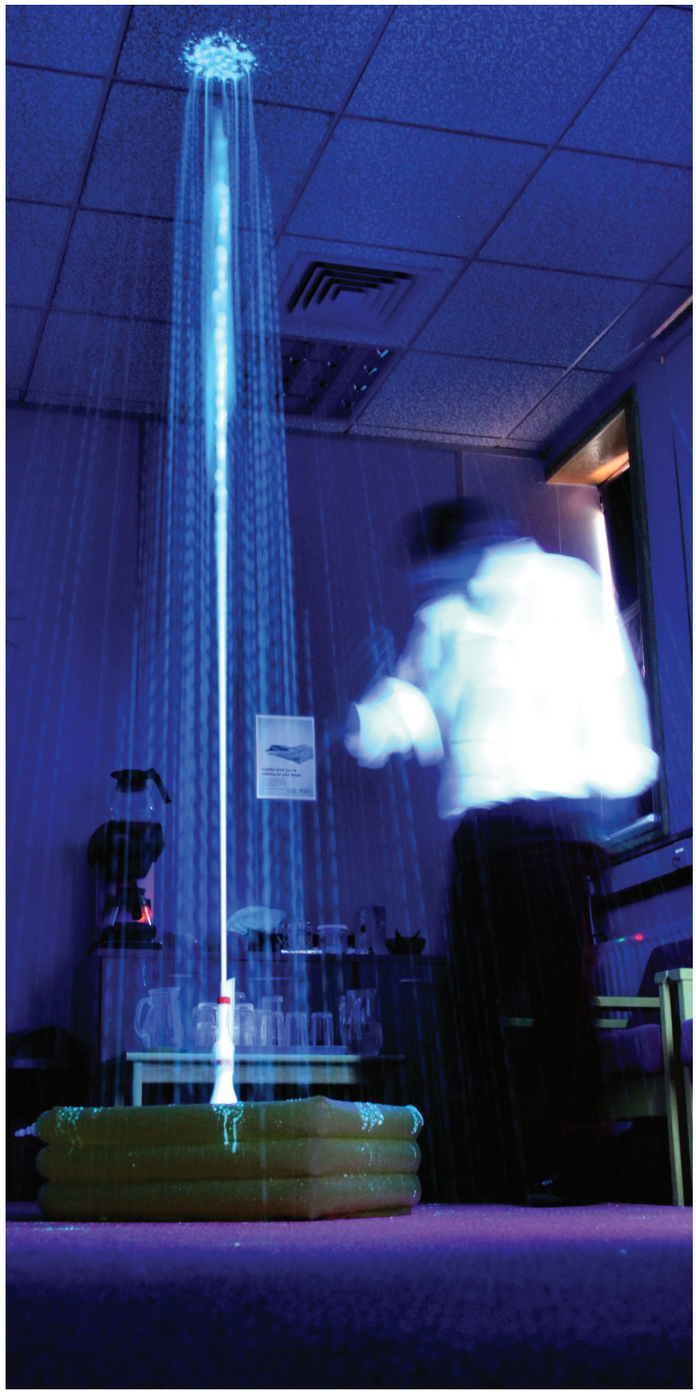

Figure 2 *- Diet tonic water + Mentos™ eruption. Illumination was from a 365 nm UV lamp located just out of camera shot.*

Diet drinks and Mentos™ cont.

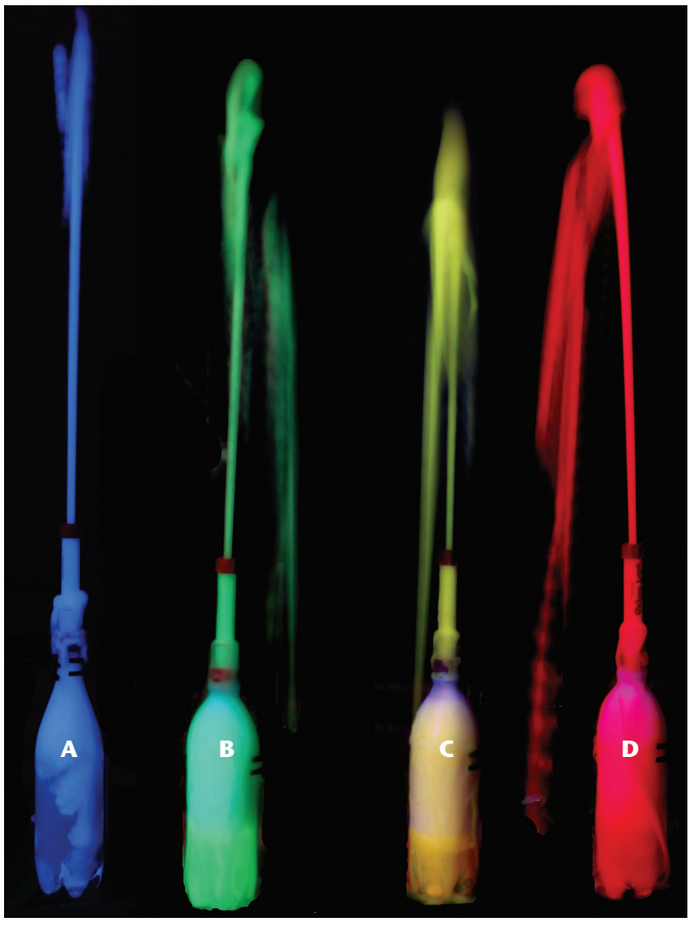

Figure 3 *- The Mentos™ eruption in the presence of fluorescent dyes and illuminated with UV (365 nm) light. In each case 2 Mentos™ were added via a Geyser Tube.*

A *Tonic water*
B *Lemonade + Tesco Lemon All Purpose Cleaner™ (40 cm^3 cleaner added to 1 dm^3 of lemonade)*
C *Lemonade + Rhodamine 6G (1.5 x 10^{-5} mol dm^{-3})*
D *Lemonade + Rhodamine B (1.5 x 10^{-5} mol dm^{-3})*

We recognise that the costs of the rhodamine dyes used in these experiments may be beyond the scope of many school budgets in the current economic climate but we anticipate that access to diet tonic water, diet lemonade and Tesco Lemon All Purpose Cleaner™ should not be too problematic. If you have a UV lamp and a room which can be blacked out we thoroughly recommend that you try one or more of the fluorescent combinations described here.

This article is based on a manuscript accepted for publication elsewhere [7].

Curriculum Links to *CFE* [6]

By exploring radiations beyond the visible, I can describe a selected application, discussing the advantages and limitations [SCN 3-11b].

By carrying out a comparison of the properties of parts of the electromagnetic spectrum beyond the visible, I can explain the use of radiation and discuss how this has impacted upon society and our quality of life [SCN 4-11b].

Safety

None of the experiments here present significant health and safety risks provided standard laboratory practices are observed. Eye protection to reduce exposure to UV light should be worn by those carrying out the experiment. We recommend that the experiments, as described, should not be carried out by students.

At the final concentrations used the fluorescent dyes do not pose significant health risks although care should be taken when handling pure rhodamine dyes and undiluted Tesco Lemon All Purpose Cleaner™. In preparing stock solutions of rhodamine dyes appropriate care should be taken to avoid skin and eye contact.

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Measuring gaseous carbon dioxide

Background

The Biology Team in SSERC is responding to the publication of the Arrangements Documents [1, 2] for the Revised Highers in Biology and Human Biology through the publication of a series of protocols to support practical work. In due course, these protocols will appear on the Science 3-18 website [3] or in this Bulletin (for example [4]).

In Unit 2 (Metabolism and Survival), part 2 (Maintaining Metabolism) of the Revised Higher in Biology [1] one of the suggested learning activities and approaches is to '*Investigate metabolic rate using oxygen, carbon dioxide and temperature probes'*. The aims of this article are twofold *viz* (i) to show how gaseous CO_2 can be measured in experimental systems, and (ii) to highlight the availability from SSERC, via a loan system, of a set of carbon dioxide sensors.

Equipment

A number of sensors are available which can measure gaseous carbon dioxide concentrations. We have opted to use the CO_2 gas sensor (Figure 1) manufactured by Vernier and marketed in the UK by Instruments Direct Services Ltd (www.inds.co.uk).

At the time of writing (January 2012) the sensor and Go!™ Link interface have a combined price, to include VAT and postage, of just under £400. The CO_2 gas sensor is designed to measure gaseous levels of CO_2 only and will not function in liquid systems. Useful User and Technical Guides are available on-line from Vernier [5].

Figure 1 *- CO_2 gas sensor (Product code VR105512) from Instruments Direct Services Ltd.*

Interface / software

To connect the CO_2 gas sensors to our computers, we use the Vernier Go!Link interface and Logger Lite software package (PC and MAC versions are available) which comes with the interface (shown in Figure 2).

Figure 2 *- Go!™ Link interface and Logger Lite Software*

How does the sensor work?

The basic structure of the sensor is shown schematically in Figure 3. Infra-red radiation is produced from a light emitting diode at one end of the sensor and is detected at the opposite end. CO_2 absorbs infra-red radiation and so at increased CO_2 concentrations less radiation will be detected. CO_2 moves in and out of the sensor by diffusion through one of the vent holes. The sensor is calibrated assuming an atmospheric CO_2 concentration of 380 ppm. Care should be taken if a re-calibration is deemed necessary since it is advisable to use 'fresh' air from outside rather than using air from a laboratory which will probably have a higher CO_2 level.

Measuring gaseous carbon dioxide

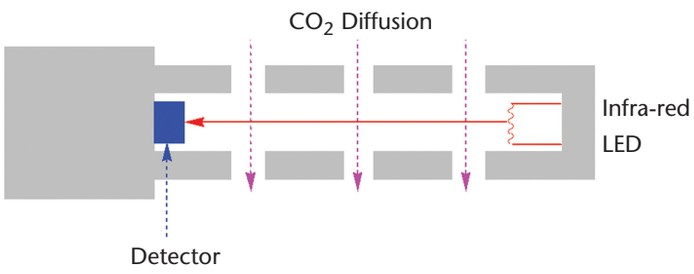

Figure 3 *- Schematic representation of the Vernier CO_2 gas sensor.*

Figure 4 *- Experimental set-up for measuring respiration and photosynthesis rates in plants.*

Experiments

For those looking for ideas for experiments involving measurement of gaseous CO_2, the article by Delpech [6] is highly recommended. In an unpublished experiment, Roger Delpech suggests measuring the carbon dioxide levels in the air space above UHT and pasteurised milk samples to show the presence or absence of viable microorganisms in samples – very impressive!

With the recent introduction of the Revised Higher Biology programme, some support materials which include an 'Experimental procedure for investigating respiration rates in germinating peas' based on the use of the Vernier CO_2 gas sensor have been published by LTScotland (now Education Scotland) [7]. In SSERC we have used the sensor with a variety of different protocols, all of which have been based on experiments published by Redding and Masterman [8].

In our view an experiment which shows carbon dioxide uptake and release by plants is a particularly interesting and valuable exercise. The basic experimental set-up is shown in Figure 4 and in this case we have taken 6 leaves from a basil plant. However, we have successfully used a variety of plants for this purpose. A tissue culture flask filled with water (to act as a heat sink) is placed in front of the experimental chamber into which the CO_2 sensor is placed. The light source is a small desk lamp although a range of lamps could be used. The detailed protocol is available elsewhere [3] but briefly:

- Leaves are placed into the respiration chamber which is wrapped in aluminium foil so as to exclude light.
- The CO_2 sensor is placed into the chamber and data collected for about 10 min.
- The aluminium foil is removed and the lamp switched on and data collected for a further 10 min.

Figure 5 shows the results obtained using the experimental set-up in Figure 4. The experimental chamber was initially covered for about 800 seconds. During this period CO_2 levels are seen to rise as the process of respiration takes place. The lamp is then switched on. This shows a leveling off of CO_2 concentration and shortly thereafter (at about 960 s) CO_2 concentration starts to fall as photosynthesis dominates. The software package allows for linear regression analysis of sections chosen by the user. For the data in Figure 5 it is sufficient to record that the rate of respiration and the apparent rate of photosynthesis can be readily determined

(note that the apparent rate of photosynthesis is lower than the true photosynthetic rate since we can assume that respiration continues while photosynthesis takes place).

It is entirely possible to investigate factors which affect the rate of photosynthesis. So for example the experimental chamber can be wrapped in filters of different colour (such filters can be readily obtained [9]) and protocols available on the SAPS website [10] can be adapted for this purpose). Judicious use of neutral density filters (also available from Lee Filters [9]) can lead to estimation of the compensation point in an extension to a previous experiment suggested by Rodger McAndrew [11].

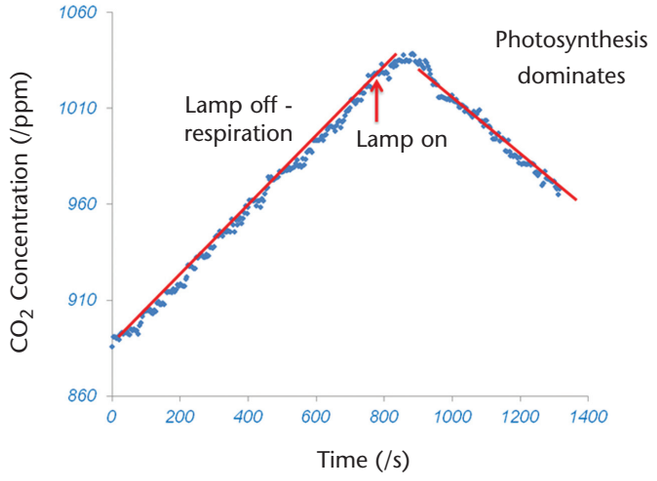

Figure 5 *- Carbon dioxide levels in the absence and presence of light (see text for detailed explanation)*

SSERC Support

We recognise that the costs of purchasing CO_2 sensors may be prohibitive, given the current financial constraints under which most science departments are operating. We are able to offer, through a loan system, six CO_2 sensors together with associated software and interfaces. We anticipate high demand for such a service and so we would recommend contacting us as soon as possible if you or your colleagues wish to take up this offer. Anyone wishing to borrow the CO_2 sensors from SSERC should, in the first instance, contact sts@sserc.org.uk.

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Immobilised algae and respiration

Background

There are a number of well-established practicals which can be used in the classroom to show plant photosynthesis. For studies at Biology National 4 and 5 it is likely that experimental systems involving the use of *Elodea* and/or *Cabomba* will be recommended. The Biology Team in SSERC has previously published, in this Bulletin and elsewhere, details of methods involving the aquatic plant *Cabomba* [1 - 3]. Immobilised algae have increasingly been used since details of their preparation and descriptions of appropriate experimental conditions for classroom practicals were first published [4-6]. A comprehensive kit for the production of immobilised algae, together with supporting documentation, is available from the National Centre for Biotechnology Education [7].

A common misconception amongst students is encapsulated in the statement 'Plants respire at night but breathe in carbon dioxide during the day' [8]. Whilst plants do indeed respire at night they also respire during the day; under 'appropriate' conditions of light intensity plants are net producers of oxygen and when light conditions fall below a certain level plants are net consumers of oxygen as respiration dominates. Early indications from the draft arrangements documents relating to Biology National 4 and 5 indicate that experimental systems which allow students to investigate the process of respiration will be recommended. Whilst there are a number of possible experiments which one might use to cover this aspect we feel that the use of plants, specifically immobilised algae, is a particularly powerful system since such studies allow the misconception outlined above to be explored and addressed.

Experimental System

For the experiments described here 100 immobilised beads of algae are required for each temperature run. The standard protocol which we use in SSERC for the production of immobilised algae is available on the Science3-18 website [5].

Briefly suspensions of algae are combined with a solution of sodium alginate and the resulting mixture allowed to flow into a solution of calcium chloride. The immobilised beads thus formed (Figure 1) are rinsed with cold tap water and distilled water to remove excess calcium chloride.

A stock of hydrogencarbonate indicator is prepared as follows:

1 Cresol red (0.10 g) [**Caution HARMFUL** if ingested in quantity or inhaled as dust] and thymol blue (0.20 g) [**Caution HARMFUL** if ingested in quantity or inhaled as dust] is dissolved in ethanol (20 cm^3) [**Caution** – ethanol is **HIGHLY FLAMMABLE** and an **IRRITANT**]

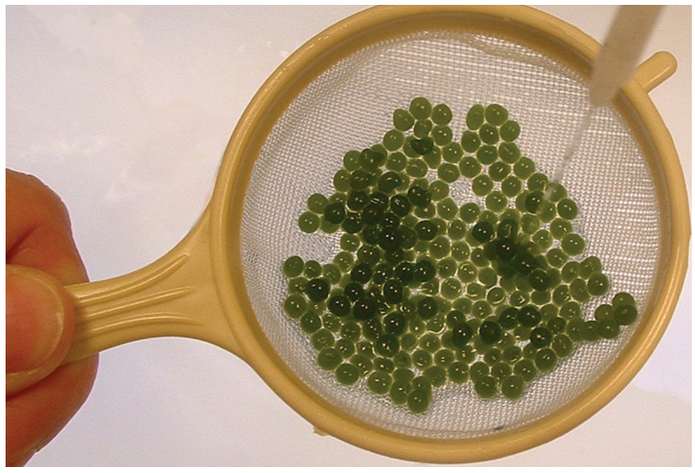

Figure 1 *- Immobilised Scenedesmus quadricauda.*

2 Sodium hydrogencarbonate (0.85 g) is dissolved in freshly boiled, cooled distilled water (approximately 200 cm^3) and combined with the ethanolic solution of cresol red/thymol blue and made up to 1.0 dm^3 with distilled water.

For routine use 100 cm^3 of the stock solution is diluted to 1.0 dm^3 with freshly boiled, cooled distilled water and the pH of this solution adjusted by the addition of small volumes of dilute sodium hydroxide or sulfuric acid solutions.

Into each of 5 Bijou bottles are placed 20 immobilised algal beads together with exactly 4.0 cm^3 of hydrogencarbonate indicator at pH 9.2. At this starting pH the solutions are purple in colour and have a relatively high absorbance when measured at 580 nm. The 5 Bijou bottles are then placed in a water bath at the desired temperature (or in the refrigerator for measurements at 4°C) and the absorbance measured at regular intervals. It is important that all solutions are kept in the dark in order to ensure that no photosynthesis takes place - so put a lid on your water bath. Immediately prior to measuring their absorbance, solutions are gently shaken to ensure a uniform distribution of colour.

Results

In the absence of light photosynthesis does not take place whereas respiration does occur and produces carbon dioxide and a consequent lowering of pH which is reflected in a change of colour from purple to red and eventually through orange to yellow.

This effect can be seen in the sample shown in Figure 2; it should be noted that we have placed the immobilised algae in a Universal bottle - we did this merely to allow for greater ease of photography. Immobilised algal beads were added to hydrogencarbonate indicator and left in the dark for 3 hours at room temperature (20°C).

Immobilised algae and respiration

An interesting observation about the image in Figure 2 is that whilst a purple colour remains at the top of the solution the algae are clearly respiring since the layer of solution immediately surrounding them is a yellow/orange in colour indicating an increased localised carbon dioxide concentration.

The data in Figure 3 show the change in absorbance of the hydrogencarbonate indicator as a function of temperature. As can be seen the rate of respiration increases with temperature. We have continued measurements beyond the 2 hours shown in Figure 3; so, for example, the absorbance at 4°C is only reduced to 1.07 (from a starting value of 1.45) after a period of 22 hours in the dark.

The experimental system described lends itself to investigative work for students in the senior phase. One could, for example, envisage using the basic technique of monitoring rate of carbon dioxide production and varying other factors which might affect respiration rate. In an accompanying article we describe how gaseous carbon dioxide levels can be measured [9] and the method described here complements that publication.

Figure 2 *- Respiring immobilised algae in hydrogencarbonate indicator.*

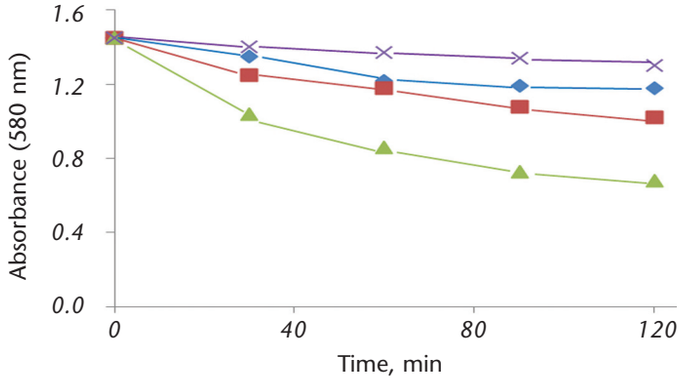

Figure 3 *- Effect of temperature on the rate of respiration in immobilised Scenedesmus quadricauda. Absorbance was measured at 580 nm in 1 cm cuvette using distilled water as the reference. The starting pH was 9.2 and the fall in absorbance reflects a drop in pH as a function of time.*

Key: X = 4°C; ◆ = 20°C; ■ = 30°C; ▲ = 40°C.

Acknowledgements

The Biology Team in SSERC would like to acknowledge the contributions of two former colleagues in the development and design of the experiments described here; Gordon Moore is now a Science Technician at Mearns Castle High School and Alison Rutherford is Principal Teacher (Biology) at Viewforth High School.

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Make a Hero's Engine

"I'm looking for a simple experiment to show motion from steam production." On receiving this query, vague memories of coming across an on-line guide to making a Hero's Engine made from a soft drinks can were stirred (not shaken). We set about checking to see if it actually worked. Having determined that it did, we then assessed whether or not it was safe.

You need: A full soft drinks can (unopened), Bunsen burner, clamp stand, sharp, pointed object (e.g. drawing compass), strong thread, safety screen, CD player playing Bonnie Tyler's Greatest Hits (optional).

Lie the can on its side, preferably in a sink. Poke a hole in the side, about a third of the way from the bottom of the can (Figure 1).

The drink will probably come squirting out. Make a hole at the same distance from the end, at the opposite side of the can.

Let all the drink drain out of the can. This can take a while. Put your sharp object into each hole. Lever the pointer back (Figure 2).

Do the same at the other side. You are trying to make the holes face in the direction shown Figure 3.

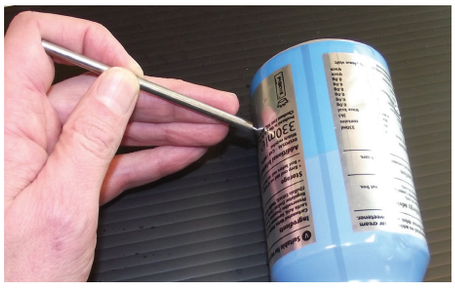

Figure 1 *- Making a hole in the can.*

Figure 2 *- Going off at a tangent.*

Carefully bend the ring pull as shown. Avoid breaking it off and avoid breaking the seal on the can (Figure 4).

Turn on a cold tap. Place one of the holes under the stream of water so that the can begins to fill with water. Try to judge the point where the space between the bottom of the can and the holes is about half full.

Now suspend the can above a Bunsen using a clamp stand (Figure 5). Check that it is stable. You might make it more stable by placing weights on the clamp stand base. Place a safety screen between all observers and the can.

Light the Bunsen. Put it on a blue flame and allow the water to boil.

When the water boils, steam is pushed out of the holes. This causes an equal and opposite force on the can. If the steam comes out at the correct angle (at a tangent), the can should rotate.

The can might wind the string up and come to a stop. If this happens, turn the gas low. The can should spin in the other direction as the string unwinds. Turn the gas back up and it should spin in the desired direction again.

Safety:

- Be careful when making the hole. Grip the can with one hand.
- Be careful when using the pointed object.
- Beware of sharp metal around the hole.
- A safety screen must be used.
- Beware of steam and hot water if adjusting the Bunsen.
- Do not let the can boil dry.
- The can will be hot after this activity. Allow it to cool before handling.

Make sure you can reach the gas tap without putting your hands or face anywhere where they could be splashed by hot water or scalded by steam.

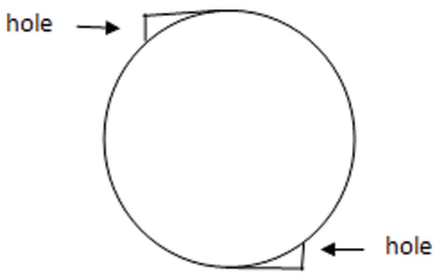

Figure 3 *- Hole positions.*

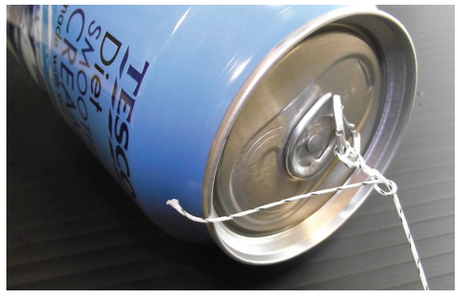

Figure 4 *- Bending the ring pull.*

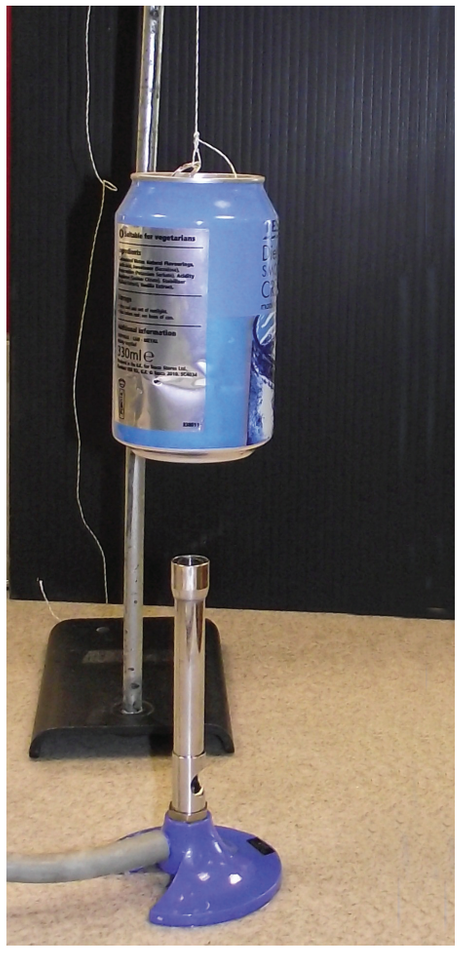

Figure 5 *- Set up and ready to go.*

How do you finish mild steel components in your department? Do you remember the days when hot components were immersed in old engine oil to blacken steel surfaces? Oil blackening has associated with it high risk, health and safety hazards. But what are the alternatives - brush or spray painting?

DTEP – Design and Technology Education Partnership are able to supply a starter pack, called 'FAB1 kit' of workshop safe chemicals which, when simply mixed with water, produces a 'blackening solution' A uniform black finish between 0.2 to 3 microns can be produced at room temperature. The finishing process can be achievable within one school period. The running cost varies between 2 - 12p per kg of steel, this depends upon the surface area to be finished. The quality of finish of course depends on the quality of finish of the steel component. Finish is easily produced on threaded areas and blind holes without affecting subsequent component assembly at a later stage.

The system has the following advantages:

- No drying time
- Gives an example of an industrial process
- Produces a professional finish with immediate results
- Cheap setup and running costs
- Non-hazardous chemicals used
- Room temperature process
- Permanent finish
- No dimensional changes

Complete process achieved within a single class period (total process time approx 33 minutes)
Environmental issues are minimal as the solutions are simply 'topped up' when they have become weak.

Containers holding the solutions should be made of plastic/polythene.

The Process

The process involves four stages with a water rinse in between, stage 1 – degreasing, stage 2 – conditioning, stage 3 – blacking and stage 4 de-watering. A light alkaline degrease is used in the preparation of clean metal surfaces prior to blacking. Although the steel surface may be clean after de-greasing, in order to produce a consistent blacking, the next stage involves the use of a 'conditioner' the component being immersed for 1 – 2 minutes. Immersion for longer periods is not recommended as this will also lead to inconsistent blacking and patchy results. Stage 3 involves immersion in the blacking solution for about 1 minute, ideally at 20°C - room temperature. Temperatures less than 16°C will produce a poor surface finish. The final stage involving 'de-watering' using a white spirit based oil, this removes any water from the surface and produces a protective, anti-corrosive layer within the black coating.
The 'FAB1' schools kit provides all chemical concentrates for mixing.

Figure 1 *- Example of Blackfast finish*

Rather than have all the component finished in this way, why not complete the process, then lightly machine/skim or turn parts producing blacked and un-blacked surfaces on the finished component!

Further Information:

www.dtep.org.uk for further product information
Email enquiries quoting 'FAB1' made to: Annette@dtep.org.uk
www.blackfast.com A Surrey based company producing the required 'BLACKFAST' chemicals for the blacking process. Very useful 'Application Data Sheets' and 'Safety Data Sheets' are downloadable from this website.
Article: 'Finishing School' pages 18-19, Genius magazine, Winter 2010, downloaded from www.dtep.org.uk

	Process	Time	Solution	Solution Strength
1	Degreasing	15 – 20 minutes	BLACKFAST 716,	1:1 with water
2	Water Rinse	30 seconds		
3	Conditioning	1 minute	BLACKFAST 551	10% solution in water
4	Water Rinse	30 seconds		
5	Blacking	1 minute	BLACKFAST 181	3:1 with water
6	Water Rinse	30 seconds		
7	De-watering	5 – 10 minutes	BLACKFAST 833	Oil based, no dilution.

Health & Safety – Animal manure

Over the past few months we have received a number of enquiries relating visits to farms and the use of well-rotted manure in school grounds and gardens.

Farm animal faeces can be a potential source of pathogens such as *Salmonella* and *E. coli* (including *E. coli* 0157). General advice on school visits to farms where such hazards may be encountered and the control measures that can be taken to reduce risk of infection is provided by the Royal Highland Educational Trust (http://www.rhet.org.uk/Home), the Health and Safety Executive (http://www.hse.gov.uk/) and the Scottish Government (http://home.scotland.gov.uk/home).

1. Animal manure should be treated as a possible source of infection.

2. Manure which has been composted is likely to have a reduced or negligible level of contamination. In a risk assessment composting the manure would be a control measure to reduce risk. 'Well rotted' is a subjective although commonly used term but should mean that the manure has been composted for a period of weeks and been aerated (i.e. not composted in anaerobic conditions). It is recommended that fields used for grazing should be left for three weeks before recreational use as a control measure.

3. Infection is by the faecal/oral route so control measures should reduce the risk of that occurring by sensible hygiene procedures. If students are using well rotted manure to improve soil quality they must cover any exposed cuts and wash hands with hot soap and water afterwards (para 3.10 of Materials of Living Origin applies [1]). Footwear should be changed or cleaned after use. Food and/or drink should not be consumed unless hands are washed first. If clothes are contaminated they should be changed and washed.

4. Children under five should not be involved as they are particularly vulnerable to *E. coli* 0157 infection.

5. Samples from manure should not be used for microbiological culture.

In summary suitable control measures to reduce the risk of the potential hazards include:

- Using well composted animal manure as described in 2 opposite
- Applying the hygiene measures described in 3 above.

Further published information in the form Guidance Notes is available from both Health Protection Scotland [2] and the Health and Safety Executive [3].

References

[1] SSERC (2005) Materials of Living Origin – A Code of Practice for Scottish Schools. This document can be downloaded from the SSERC website (http://tinyurl.com/7wd8376) [Accessed February 2012]. Please note that to access resources on the SSERC website you will need to register and be provided with a log-on ID and password.

[2] *E. coli* O157 and Open Farms (Guidance Note 17) Update of SCIEH Guidance Note originally published February 2000 (2007). Available at: http://www.documents.hps.scot.nhs.uk/environmental/guidance-notes/ecoli-open-farms.pdf (accessed October 3rd 2011), Health Protection Scotland.

[3] Preventing or controlling ill health from animal contact at visitor attractions (2011). Agriculture Information Sheet 23 (rev 2). Available at: http://www.hse.gov.uk/pubns/ais23.pdf (accessed February 2012), Health & Safety Executive.

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