Module 4: Energy

Some teaching points

1. The third allotrope of carbon, buckminsterfullerene

This chemical oddity is currently attracting a lot of textbook attention, probably as chemists try to show that new and exciting 'breakthroughs' are occurring in what is really a very mature science. Use a soccer ball to demonstrate the structure of this allotrope. A useful web site for help on making a model is www.seed.slb.com. Click 'Welcome' then type 'buckyball' into the search box (beside Seedlink near the top right of the page) click on the magnifying glass then on the next screen click on 'Build a buckyball' .

2. Simple hydrocarbons

Note that the syllabus requires students to name only straight-chain alkanes and alkenes and only up to C_8 (not the C_{10} of the old syllabus). This means that isomerism is involved only for alkenes and only for position of the double bond.

3. Is enthalpy 'in'?

The syllabus does not actually mention enthalpy or enthalpy change for a reaction: however it does use ΔH in Section 8.4.5 without stating what it stands for (see *Item 6 under Some teaching points* in the web page for Module 3; click on it to go there and use the BACK button on your browser to get back here). Nevertheless *CC* introduces enthalpy change, ΔH, because it is a very basic chemical concept and because it would be awkward to discuss energy profiles (required by the syllabus) without it. Note that ΔH and heat of reaction are *not* synonymous. Heat of reaction equals ΔH *only* if the experiment is performed at constant pressure. In school laboratories most experiments are performed at constant pressure (open to the atmosphere) and so the measured heat of reaction is equal to ΔH. For experiments in bomb calorimeters for example (closed vessels, constant volume, but not constant pressure) the measured heat of reaction is not ΔH.

Since 2002 experimental measurement of heat of reaction and hence of enthalpy change has not been required in the Preliminary Course. However it is required in Module 1 of the HSC Course, and because it is always a good idea to show how a physical quantity is measured when the physical quantity is being introduced, the simplest method of measuring a heat of reaction has been included in CCPC. This will serve students in good stead when they come to measure heat of combustion of alkanols in HSC Module 1.

4. Why enthalpy?

It might be helpful (for teachers) to recall why we have enthalpy H as well as energy E. When we heat an object or sample of a substance, not only do we increase its energy content, but also we may inadvertently make it do some mechanical work – by expanding against its surroundings ($P\Delta V$ work). Hence we introduce a term enthalpy defined as

$H = E + PV$.

It follows then (see any standard Physical Chemistry text) that when an object or substance is heated at constant pressure the heat absorbed is equal to the change in enthalpy, $\Delta H,$ which is different from the change in energy ΔE. If the object or sample is heated at constant volume (no $P\Delta V$ work possible), the

heat absorbed is then equal to the change in energy ΔE. Now this thermodynamic argument is a bit complicated for school students so we avoid it by working backwards. We *define* the enthalpy change for a reaction as the heat absorbed at constant pressure. (We could then show that this leads to $H = E + PV$ and that at constant volume heat absorbed equals ΔE, but the argument is not necessary at school level.)

CCPC (p 224–5) uses ΔH_{soln} for heat of solution without explaining why the symbol H is used and without mentioning enthalpy there. (Strictly it should be heat of solution at constant pressure, because ΔH is the accepted symbol for enthalpy change and it will be equal to the heat absorbed or released only at constant pressure.) *CCPC* introduces enthalpy change on pages 276–7.

5. Heat or molar heat ..?

Sometimes chemists are a bit lax and omit *molar* when it should be put in; for example we often say heat of combustion or heat capacity when we really mean molar heat of combustion or molar heat capacity (quantities per mole). Ambiguity is easily avoided by looking at the units of the quantity; if the units include mol^{-1} then it is a molar quantity. A heat of combustion of 2220 kJ mol^{-1} is clearly a molar heat of combustion; similarly a heat capacity of 72 J K^{-1} mol^{-1} is a molar heat capacity whereas a heat capacity of 143 J K^{-1} is the heat capacity of the whole object or total amount of substance under consideration. Specific heat capacity (i.e. per gram, units J K^{-1} g^{-1}, Table 8.2 page 223) should never be abbreviated to 'heat capacity' (though it is sometimes abbreviated to 'specific heat').