Teaching ideas for Chapter 1, *Moles*

Questions

Three worksheets of questions are provided:

- Core Worksheet 1 involves mostly fairly straightforward questions
- Core Worksheet 2 has some more challenging questions
- The Support Worksheet aims to simplify the moles concept for less able students.

There are also a large number of questions available in the Coursebook and on the accompanying CD-ROM.

Teaching ideas

- To illustrate the mole concept, you could demonstrate how coins can be counted by weighing.
- Jars containing 1 mole of various substances could be made up.
- This is a topic that requires a great deal of practice on the different methods of calculating reacting quantities. Students will benefit from exposure to as many questions of different types as possible. Questions could be taken from IB past exams for this.

Practical activities

This topic lends itself to practical work and practicals can be carried out to illustrate the ideas of empirical formula, limiting reactants, titrations, etc.

Safety

Extreme care must be exercised when carrying out any practical activities in the classroom and a risk assessment should be conducted before carrying out the experiments.

Demonstrations

- 'Methane rockets' can be used to demonstrate Avogadro's law and the importance of stoichiometry.
  See **Practical 1 – Chapter 1:** ***Methane rockets***.
- The determination of the relative molecular mass of a gas can be demonstrated: see http://www.rsc.org/images/massgas_tcm18-188832.pdf

Student practicals

There are many practicals that could be carried out.

- **Practical 2 – Chapter 1:** ***Determination of the empirical formula of magnesium oxide***
- **Practical 3 – Chapter 1:** ***Determination of the value of x in*** $MgSO_4.xH_2O$
  The method for carrying out this practical can be determined by class discussion. Students can be told that hydrated magnesium sulfate loses water when heated and/or the loss of water by hydrated copper sulfate crystals can be demonstrated by heating the crystals in a test tube. Students can be asked to suggest which measurements need to be taken to determine the number of moles of water of crystallisation. They should also consider how they will know that the reaction is complete – there is no colour change involved so need to heat to constant mass.
- **Practical 4 – Chapter 1:** ***Determination of the*** A_r ***of lithium***

- An acid–base titration
  Examples of an acid–base titration could be a simple titration of 0.1 mol dm^{-3} sodium hydroxide with approximately 0.1 mol dm^{-3} hydrochloric acid or a titration of white wine with 0.1 mol dm^{-3} NaOH. The concept of a standard solution could also be introduced/discussed.

- **Practical 5 – Chapter 1:** ***Determination of vitamin C concentration in a solution***
  This is a more complicated practical but is a good exercise in following instructions. It will allow students to gain experience of a different type of titration.

- General details of how to carry out a titration may be found at
  http://www.dartmouth.edu/~chemlab/techniques/titration.html
  and in the volumetric analysis section of the interactive chemistry laboratory primer from the Royal Society of Chemistry
  http://chem-ilp.net/
  This RSC website also contains videos and details of many other important chemical lab techniques.

- Worksheets for titrations and other practicals may be found at
  http://www.creative-chemistry.org.uk/alevel/practical.htm

  However, if you use these practicals for assessments then take care not to give too much information, such as data tables, etc., to the students.

- Other ideas for practical work can be found at
  http://www.practicalchemistry.org/experiments/advanced/amount-of-substance/topic-index.html

- The Avogadro constant can be determined using the following procedures:
  http://www.lahc.edu/classes/chemistry/arias/Exp%203%20-%20Avogadro.pdf
  http://spot.pcc.edu/~chandy/100F03/DeterminationofAvogadro'sNumber.pdf
  http://www.chem13news.uwaterloo.ca/issues/339/may06_2006_page_14.pdf
  http://omnis.if.ufrj.br/~moriconi/termo_fisest/avogadro.htm

- A practical procedure involving limiting reactants can be found at:
  http://www.chymist.com/plop%20plop%20fizz%20fizz.pdf

- The following sites provide information about back titrations:
  http://www.philadelphia.edu.jo/academics/adokka/uploads/Spr05455Wk2Lab.PDF
  http://www.toledotechnologyacademy.org/Documents/Chem%20Docs/ChemLab%2015-3%20Eggshell%20Titration.pdf

- Redox titrations (also considered in the Teaching Ideas for Chapter 9):
  http://homepage.smc.edu/kline_peggy/Chem_12/Labs/iron_titration.pdf
  http://www.a-levelchemistry.co.uk/AQA%20A2%20Chemistry/Unit%206/PSA%20(PSV)/AQA-2420-W-TRB-PSA10.pdf
  http://usm.maine.edu/~tracy/chy116sumfolder/chy116s2011labsfolder/RdxTi.html
  http://infohost.nmt.edu/~jaltig/Bleach.pdf
  http://www.ipfw.edu/chem/321/iodometric%20Cu%20determination.PDF
  http://mhchem.org/222/pdfLabs222/CopperTitrations.pdf
  http://www.csudh.edu/oliver/che230/labmanual/copbrass.htm

- **Practical 6 – Chapter 1:** ***Synthesis of alum,*** $KAl(SO_4)_2.12H_2O$
  This practical can be used to investigate percentage yield. Alum is prepared from aluminium. The following websites also deal with this reaction:
  http://wwwchem.csustan.edu/archive/alum.htm
  http://www.ic.sunysb.edu/Class/che133/susb/susb030.pdf

Common problems

- Students find this topic quite difficult and different approaches may have to be used with different students. Some students like the security of equations that can be used in all circumstances whereas others benefit from working things out from first principles.
- Many students have difficulty with number of particles and converting to and from moles. Problems such as 'how many hydrogen atoms are present in 0.10 mol CH_3COOH' often cause difficulties.
- Students can also get mixed up as to whether they are considering moles of atoms, molecules or ions.
- The ideas of limiting reactants can cause problems. Students can be advised that, to solve a moles problem, they only need enough information to work out the number of moles of one substance. If enough information is given to work out the number of moles of more than one substance then there is a high probability that one of these is a limiting reactant and that the others will be in excess.
- **Support Worksheet – Chapter 1: *Voles*** is a support question sheet that could be useful for weaker students.

ICT

- Students can use spreadsheets to process data from practical work.

Simulations

- Application 1 on the Coursebook CD-ROM can be used to calculate relative molecular masses and masses of single molecules.
- Number of particles/mass of a molecule:
  http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/stoichiometry/solid_atoms.html
- Empirical and molecular formula:
  http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/stoichiometry/empirical.html
- Limiting reactants:
  http://www.chm.davidson.edu/ronutt/che115/Simult/Simult.htm
  http://phet.colorado.edu/en/simulation/reactants-products-and-leftovers
  http://www.chemcollective.org/assignments.php#stoichiometry
- Gas laws:
  http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/gaslaw/boyles_law_graph.html
  http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/gaslaw/charles_law.html
- Titrations:
  http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/stoichiometry/acid_base.html
  http://www.mhhe.com/physsci/chemistry/animations/chang_7e_esp/crm3s5_5.swf
  http://lrs.ed.uiuc.edu/students/mihyewon/chemlab_experiment.html
  http://www.blackgold.ab.ca/ict/Division4/Science/Div.%204/Titration%20of%20Vinegar/vinegartitration.htm

Theory of knowledge (TOK)

Chemistry deals with enormous differences in scale. The magnitude of Avogadro's constant is beyond the scale of our everyday experience. Students could discuss how we attempt to 'understand' a number like this by reference to things with which we are more familiar.

The distinction between the Celsius and Kelvin scales as examples of an artificial and natural scale could be discussed. If **Practical 4 – Chapter 1: *Determination of the A_r of lithium*** is carried out, it could be discussed why the percentage uncertainty on a temperature in °C is meaningless.

Ideal and real gases could be discussed. Why do chemists use the concept of an ideal gas when it is 'not correct'?

