Topic: Solids, Liquids and Gases

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Issues tackled:

1. **Misconceptions – Pupil misunderstandings about solids, liquids, gases and changes of state**.
2. **Models and analogies – Using role play and other analogies to develop understanding of the particle model.**
3. **Practical work – Useful demonstrations and experiments to develop understanding of the particle model.**
4. **ICT - Using data logging and computer simulations to teach about solids, liquids and gases.**
5. **Differentiation and SEN – Encouraging an understanding of solids, liquids and gases in less able pupils.**

Issue 1: Misconceptions – Pupil misunderstandings about solids, liquids, gases and changes of state

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:

1. Plan how you might spot and address three of the following misconceptions in a starter or plenary activity.
    - When a solid dissolves in water it is no longer there; its substance has disappeared.
    - Dissolving and melting are the same thing.
    - A snowman is warmed by having a coat put on it.
    - The condensed water on the outside of a glass beaker containing iced water comes from the iced water and not from the atmosphere.
    - There needs to be a high temperature for evaporation to occur.
    - Gases have no weight.
    - Bubbles in boiling water mainly contain air.
2. Many pupils do not understand how a solid changes to a liquid which, in turn, changes to a gas. Develop a teaching sequence, including practical work and use of models, which will help to develop pupils' understanding.
   If available (see resources), watch Key Stage 3 National Strategy video – Drawing out pupils' thinking and misconceptions in science to identify pupil misconceptions on cooling curves and changes of state.

Possible activities during tutorial:

1. Share findings and ideas based on preparation done.

Select other misconceptions and suggest strategies to address them.

AST Input:

Lead the discussion on the misconceptions prepared by trainees.

Reading:

Subject knowledge and understanding

DfES. (2003) Key Stage 3 Strategy; Strengthening teaching and learning of particles in Key

Stage 3 Science; Resource Pack for Tutors. Not available on the website. LEA consultants have this pack.

Subject pedagogy

DfES. (2003) Key Stage 3 Strategy; Strengthening teaching and learning of particles in Key Stage 3 Science; Resource Pack for Tutors. Not available on the website. LEA consultants have this pack.

DfES. (2002) Misconceptions in Key Stage 3 science; Resource pack for tutors. LEA consultants have this pack which contains a video on Drawing out pupils' thinking and misconceptions in science

Ryan, C. (1990) "Student Teachers' Concepts of Purity and of States of Matter", **Research in Science and Technological Education**, 8, 2 pages 171-83. Described in this study are student teachers' frameworks of purity and the related concepts of the states of matter. The concept of natural versus pure substances, classifying states of matter, and implications for teaching drawn from the results are discussed.

Gabel, D. L. et al.**,** (1987), "Understanding the Particulate Nature of Matter"**, Journal of Chemical Education**, 64, 8 pages 695-97.
Cites studies related to students' misconceptions about the particulate nature of matter. Stresses that a good understanding of these concepts is fundamental to the study of chemistry itself. Reports on a study of pre-service elementary teachers views of the particulate nature of matter before instruction on the topic.

Useful websites and applications:

This website has references to journals that might be useful for misconceptions. http://www.oise.utoronto.ca/~science/chemmisc.htm

This website has resources that could be used to get ideas on how to use models to address misconceptions. http://www.chemsoc.org/networks/learnnet/miscon3.htm

Resources:

Task 1

DfES. (2002) Misconceptions in Key Stage 3 science; Resource pack for tutors. LEA consultants have this pack which contains a video on Drawing out pupils'-thinking and misconceptions in science.

Task 2

DfES. (2003) Key Stage 3 Strategy; Strengthening teaching and learning of particles in Key Stage 3 Science; Resource Pack for Tutors. Not available on the website but possibly from your LEA consultant. Handout 2.10 pages 44-45

Issue 2: Models and analogies – Using role play and other analogies to develop understanding of the particle model

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:
1. Research use of models and analogies to aid knowledge of pupil misconceptions. Plan an activity to do this.
2. Plan a role play activity to demonstrate particle theory.

Possible activities during tutorial:
1. Trial the activity planned, discuss the uses and limitations of the model or analogy selected.
2. Describe then evaluate the role play activity and talk about possible improvements.

AST Input:

- Discuss the advantages and disadvantages of various commonly used models and role plays.
- Explain the use of role-play to aid understanding the theory behind a practical activity.

Reading:

Subject knowledge and understanding

DfES. (2003) Key Stage 3 Strategy; Strengthening teaching and learning of particles in Key Stage 3 Science; Resource Pack for Tutors. Not available on the website. LEA consultants have this pack.

Subject pedagogy

DfES. (2003) Key Stage 3 Strategy; Strengthening teaching and learning of particles in Key Stage 3 Science; Resource Pack for Tutors. Not available on the website. LEA consultants have this pack.

DfES (2002) Framework for teaching science; years 7, 8 and 9. KS3 strategy yearly teaching objectives, pages 25-30.

Useful websites and applications:

Website has ICT models of melting and explaining dissolving. It has links for looking at using appropriate language and examining the language used for the concepts.
http://www.sep.org.uk/stuff.htm

Resources:

Tasks 1 and 2
This website has resources that could be used to get ideas on how to use models to address misconceptions.
http://www.chemsoc.org/networks/learnnet/miscon3.htm

Issue 3: Practical work – Useful demonstrations and experiments to develop understanding of the particle model

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:
Plan a class practical/demonstration for **one** of the following:

1. Changes of state (heating and cooling curves) such as stearic acid, heating ice.
2. Expansion and contraction (ball and hoop, bar and gauge, bimetallic strip, expansion of liquid in a sealed container).
3. Diffusion experiments (through a liquid, gas or solid).

Bring any relevant resources; equipment, worksheets, web links, models or animations.

Possible activities during tutorial:
1, 2 or 3. Demonstrate the practical activity prepared and discuss its usefulness.
1, 2 or 3. Demonstrate together and/or discuss the other practical activities referred to above.

AST Input:

- Do a health and safety assessment for these activities, especially for the bromine gas activity or the expansion and contraction.
- Considerations in terms of available practical resources. Looking at what resources are available and what they can be used for.
- Possible ideas for practical- discuss the ideas for practicals and what context they might be used in.
- Organisation of practical/demonstration- discussion of how practicals and demonstrations need to be organised for efficiency and for maximum gain for the pupils.
- Explanation /use of role play to aid theory behind practical activity discuss the advantages and disadvantages of the role plays and models they have come up with.

Reading:

Subject knowledge and understanding

Read the theory of explanations of changes of state/cooling & heating curves. There is some useful information in:
Wilson.E. (1999) **Teaching Chemistry to KS4**, Hodder and Stoughton, London.

Mines.G (2000) "Particles" in McDuell.B (Ed), **Teaching Secondary Chemistry,** John Murray, London. Chapter 2 pages 56-59.

Subject pedagogy

Useful websites and applications:

http://www.sep.org.uk/stuff.htm (use of inappropriate language when explaining. Has IT models of melting etc. and has links for looking at using appropriate language and examining the language used for the concepts).

Resources:

Task 1
Practical equipment – Bunsens, goggles, mats, tripods, gauzes and beakers.

Task 2

Ball and hoop, bar and gauge, bimetallic strip, expansion of liquid in a sealed container.

Task 3
Diffusion demonstrations – e.g. potassium permanganate crystals, jelly, round bottomed flask, concentrated bromine and large tube, concentrated ammonium hydroxide and acid with large tube, stoppers and cotton wool.

Issue 4: ICT – Using datalogging and computer simulations to teach about solids, liquids and gases

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:

1. Use the school temperature datalogging equipment to plan and test a practical about change of state.
2. Look at the available computer models and animations of solids, liquids and gases and consider how to use them in a lesson.
3. Plan an activity based in a computer room maybe using the Multimedia Science School (MSS) software or an interactive web site (see resources).

Possible activities during tutorial:

1. Demonstrate the datalogging equipment and describe how it would be used in a lesson.
2. Demonstrate the software model selected and discuss the advantages and disadvantages of using it in the lesson.
3. Demonstrate the planned activity and discuss its merits and possible pitfalls.

AST Input:

- Show the resources available in school which the trainees have not yet discovered.
- Give examples of chemicals that they can use with the equipment.
- Supply a model and discuss the ideas they have come up with.
- Discuss the implications and management of a lesson in a computer room as compared to a science room.

Reading:

Subject knowledge and understanding

Subject pedagogy

Pereira, M.P., Pestana, M.E.M., (1991) "Students' Representations of Models of Water", **International Journal of Science Education**, 13, 3 pages 313-19.
The pencil-and-paper assignment "Represent water in its three states using a model" was given to students (n=227) from eighth to twelfth grades. The findings show that the dominant model used was the space filling type; movement of particles was indicated by a minority of students; size of the model changed when drawn in different states.

Useful websites and applications:

Use of models to address misconceptions:
http://www.chemsoc.org/networks/learnnet/miscon3.htm.

Resources:

Tasks 1 and 2
This tutorial requires access to at least 1 computer, probably connected to the internet.

Task 1
Temperature sensors, either connected directly to a computer or for data collection followed by data analysis on a computer.

Task 3
CD-ROM.
New Media, Multimedia Science School (MSS): States of Matter.
Simulations of the behaviour of particles in solids, liquids and gases. Change the temperature to see the changes of state.
See www.platolearning.co.uk/ for information about the product.

Issue 5: Differentiation and SEN – Encouraging an understanding of solids liquids and gases in less able pupils

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:

1. Develop a model that describes the movement and arrangement of particles in a solid, liquid and a gas which is suitable for less able pupils.
2. Find an ICT or practical model to describe the movement and arrangement of particles in a solid, liquid and a gas and consider its use for less able pupils.
3. Look at an existing activity or a practical and adapt it for lower ability or gifted and talented pupils. Develop a new worksheet to support or extend the idea.

Bring any relevant existing resources in the department, for example ideas of models or possible animations aimed at SEN.

Possible activities during tutorial:

1. Present the model as if to less able pupils.
2. Discuss how the model could be extended to describe changes of state.
3. Explain the principles followed in developing the worksheet.

AST Input:

- Talk about existing models and their limitations and discuss their models and the advantages and disadvantages.
- Discuss the use of terminology/language in resources to be developed or that have been developed and discuss where misconceptions could arise or be addressed.
- Look at resources in the department and discuss their usefulness in terms of lower ability pupils or gifted and talented pupils.

Reading:

Subject knowledge and understanding

Subject pedagogy

Read the school SEN policy and any information about the needs of pupils in your class.

Useful websites and applications:

http://www.sep.org.uk/stuff.htm Try the particle theory and gas state models at the bottom of this page.

Consider the use of the PDF worksheets at:
http://www.sciencepages.co.uk Follow links to Key Stage 3, then teaching resources, then Chemistry.

Resources:

Task 1

Models used in the department to support the teaching of kinetic theory and particle model.

Task 2
Access to ICT models e.g. New Media, Multimedia Science School (MSS): States of Matter. Simulations of the behaviour of particles in solids, liquids and gases. Change the temperature to see the changes of state.
See www.platolearning.co.uk/ for info about the product.

Task 3
Departmental SoW and worksheets/resources.