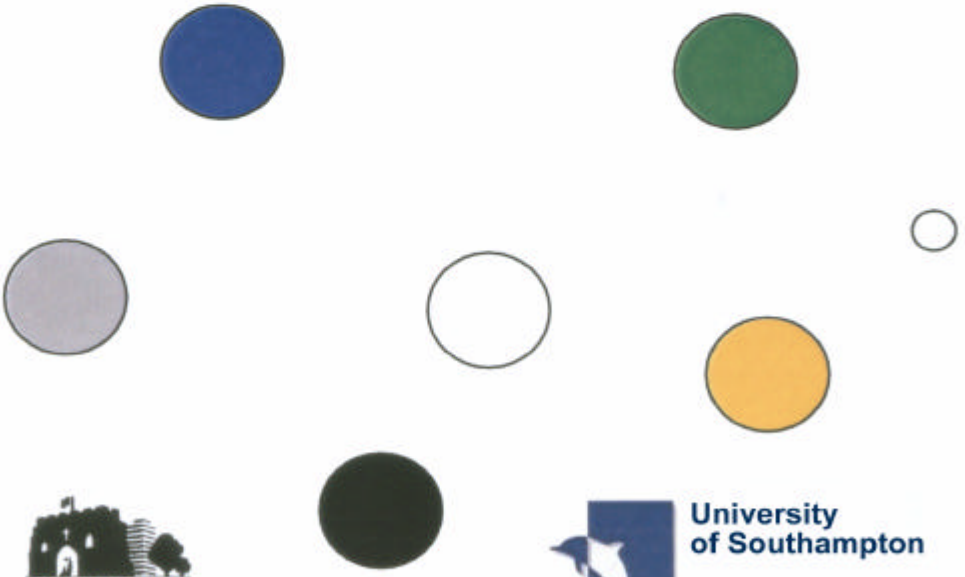
ON THE BALL



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PARTICLE MODELS FOR KEY STAGE 3 SCIENCE

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Particle models for KS3 Science

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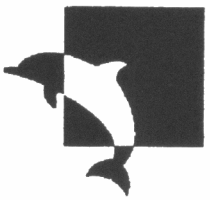

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Particle models *for* KS3 Science

CONTENTS

Models – a strategy for learning science

Science is about explanation. It attempts to make sense of the world by constructing models or theories through a creative approach, often referred to as the hypothetico- deductive method. These models or theories are VISUALISATIONS; they are pictures we carry in our heads, often brought about by concrete representations.

What are models ?

A model is a representation of an object, event or idea. This representation creates a vehicle through which the object, event or idea can be conceptualised and understood.

Models are important in science teaching, as major tools for teaching and learning. They are more than this, however. Models are one of the main products of science – the progress of science is normally marked by the production of a series of models, each associated with a distinctive theory. Modelling is a major element in scientific methodology (Gilbert, 1994).

Models can be of a number of different types (Gilbert, 1998):

***Mental* model** – that each of us visualise in our mind;

***Expressed* model** – when we try to explain or present in another form our mental model;

***Consensus or scientific* model –** an expressed model which has gained acceptance within the scientific community;

***Historical* model** – a *consensus* model which has been superseded at the 'cutting edge' of science e.g. the 'plum pudding' model of an atom is an historical model which was superseded by 'orbiting electrons' model.

A ***teaching* model** is one specifically produced to teach a *consensus* or *historical* model. This is something that can help pupils grasp the idea and help visualise the idea, for instance using the ball bearing 3D model for the kinetic theory. An analogy can also be a teaching model, such as the water flow model to represent current.

Models to teach Key ideas at Key stage 3.

What has to be taught at Key Stage 3 should not be regarded as simply content all of equal worth. Rather there are some ideas which are key. Understanding these key ideas well and being able to apply them to explain and understand new phenomena and events makes learning effective. We must not lose sight of the wood for the trees.

Principles:

- There are some key ideas in science an understanding of which helps development in other areas.

- Some of these are abstract explanatory theories, e.g. particle theory helps explain the changes and interactions between matter.

- When these ideas are introduced it is more effective if pupils are provided with clear visual models which make the ideas concrete (teaching models)

- These ideas network together and impinge on each other. The order in which we teach them will have an effect on how well pupils develop their understanding.

- Early introduction to these key ideas will provide more opportunity to develop understanding

- Understanding of these ideas deepens and further develops from constantly attempting to explain new phenomena using these key scientific ideas.

- As attempts to explain new phenomena increase, there will come a time for some phenomena when the accepted scientific idea will not be good enough. At this point the scientific idea will need to increase in sophistication to explain the new phenomena.

What ideas in Chemistry are important at Key Stage 3?

What has to be taught at Key stage 3 is arranged in the programme of study under a series of themes:
Materials and their properties
Classifying materials
Changing materials
Patterns of behaviour

A fundamental idea embedded in these areas is that of PARTICLES.

Teaching Strategy

In order for pupils to grasp ideas, such as particles, well they need to:

a. be introduced to them in Year 7

b. be introduced to them through the use of clear teaching models

c. have the chance to practise using the idea to explain new situations (apply) and if need be increase the sophistication of the teaching model to explain new situations

Recommendations for practice

Research evidence suggests the following as being effective in helping pupils understand chemical concepts and models as an important aspect of developing and explaining ideas:

- Use models at the beginning of a topic (Sizmur & Ashby, 1997) or integrated fully into the teaching of key ideas.
- Where analogies are used, check pupils' understanding of the analogy itself before using it to explain the key idea.
- Show the similarities and differences of the model to the target idea – i.e. highlight the strengths and limitations of the model.
- Give pupils practice in developing their own models and use them to explain ideas. Highlight the strengths and limitations of their models
- Encourage pupils to explore the use of (their) models in explaining related ideas – does the model still hold?
- When using concrete models (e.g. drawings/ 3D models of atoms, bonding etc), 3D models seem to lead to greater understanding and retention of key ideas compared to 2D.
- Enjoy using models – they provide an interesting, visual and stimulating way of understanding chemical ideas! Models can really help and motivate low achieving pupils.

Suggested Teaching strategy:

Step 1 Teach the model, making sure pupils understand it and that they can 'picture' it.

Step 2 Show pupils how the model can be used to explain certain phenomena and the limitations of the model

Step 3 Practice using the model e.g. introduce a new phenomenon and ask pupils to use the model to explain it

Step 4 Challenge the model - perhaps through an investigation. Encourage pupils to see the limitations of the model by asking them to explain new phenomena which cannot be explained with the model

Step 5 Teach a more sophisticated model as appropriate and return to step 1

How to use this resource

This resource contains examples of models which can be used in conjunction with teaching KS3 Materials and their properties. The underlying consensus model is that of particle theory.

Each page has common features as shown:

A clear **National Curriculum Reference** to the exemplar QCA scheme of work. The following units are covered in this pack:
7F Simple chemical reactions
7G Particle model of solids, liquids and gases
7H Solutions
8I Heating and Cooling
8E Atoms and Elements
8F Compounds and mixtures
9E Reactions of metals and metal compounds
9F Patterns of reactivity
9H Using Chemistry

Consensus model – This shows one representation of the accepted scientific model. It is this model we are trying to help pupils understand as an aid towards developing understanding of key concepts.

This is done through:

- Showing the strengths and weaknesses of appropriate **Concrete models**;
- Allowing **Student ideas** about the models to be explored fully, so that students have a clear opportunity to articulate their understanding in relation to the consensus model;
- Showing or carrying out **Observations** which relate the models to examples of the concept in practice;
- Evaluating the strengths and weaknesses of the particular **Consensus model** itself.

Suggestions for **Student activities** and **key questions** are included. KS3 'student speak' answers to questions are shown, recognising that these are not always full scientific answers. They are intended to encourage explanations in terms of particles.

It is important that **Student evaluation** encourages you and the students to examine the good and bad features of the model in aiding their understanding of the key concept.

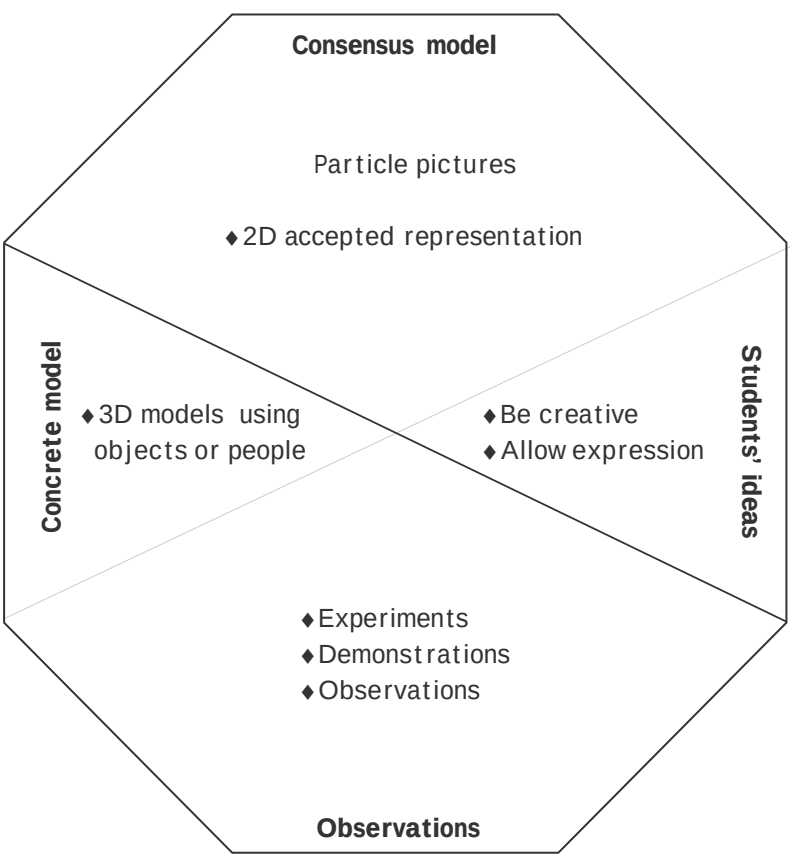
Drawings of models follow relevant pages. These are intended to be used as OHTs to illustrate the model and highlight its strengths and weaknesses.

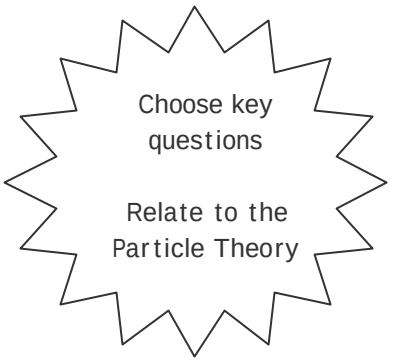
Guidance for teachers

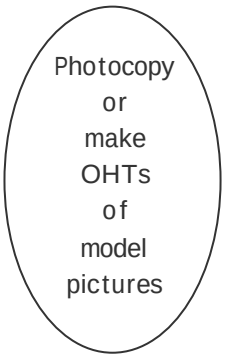
National Curriculum Reference : Title

National Curriculum learning objectives

- See Scheme of Work in left hand column







Student Activities

- Observe the experiments
- Explain the process – in terms of particles, using models
- Be the model – act out the arrangement/movement of the particles
- Devise your own model – it's like..... – allow students to be imaginative

Student Evaluation – any model has good and bad features

In what ways is the model good at helping you understand about particles?

Think of good features with your students–what can it explain? It can clarify misconceptions

In what ways is the model not good at helping you understand about particles?

Think of poor features–what can it not explain? It generates discussion.