



Inspector Clueless and the Missing Materials *Key Stage 2*

INTRODUCTION

INSPECTOR CLUELESS is based on Attainment Target 3 of the National Curriculum for Science and these notes are intended as a guide to the scientific content of the play should teachers wish to undertake some preparatory work with their pupils. However we do aim to present the play in such a way that the scientific content becomes self-explanatory so preparatory work is not essential.

The topics covered in the play are the properties of different materials, solids, liquids and gases, reversible and non-reversible changes and how they relate to mixtures and compounds and changes of state and the separation of mixtures using various processes.

MATERIALS AND THEIR PROPERTIES

Everything on Earth can be said to be made of some sort of material. Most substances on Earth are solids at normal temperatures and it is the group of solids that is used extensively by Man. All materials have individual characteristics, or properties, which govern how they are employed.

Our story begins with Inspector Clueless who has been sent to England to investigate some stolen materials. He and the chamber maid at his hotel discuss how to classify materials according to their properties - eg. glass can be described as see-through, hard, cold and smooth, wood as warm, natural, brown in colour and rigid etc. Three different materials are described using only their properties (metal, wood and plastic) and the audience has to work out what material they are. Inspector Clueless discusses with the maid and the audience what the best uses of each material might be considering the properties it has and the uses of the 3

different materials are summarised in a song - eg. metal is strong, hard and conducts heat and electricity so is used for a kettle, whereas plastic is pliable, man-made and can be coloured and moulded so is ideal for a multitude of everyday items.

In the classroom the children can try to find as many uses as they can for various materials - wood, glass, metal, paper, cloth, plastic, sand - and then explain which are the properties which govern its uses. They can then try to identify the properties which are common to each family of materials and classify each material using the appropriate properties - what makes something a metal or wood or plastic etc.?

SOLIDS, LIQUIDS AND GASES

There are three states of matter. All substances on Earth exist as either solids, liquids or gases. In general solids are hard and rigid and have a definite shape which is often difficult to change. Liquids have different properties. They are fluid and flow and have no definite shape but take on the shape of the container they are in. Gases have no definite shape or size and usually we cannot see them but they will fill whatever vessel or space they are in.

Again in Inspector Clueless' hotel room another classification is taking place. The Inspector puts a spoon into a coffee cup and takes it out again. We see the spoon has not changed shape to fit the cup – it has a fixed shape. He then pours the coffee from one cup to another and we see that the liquid drips and flows and changes its shape to fit the cup. Finally, Inspector Clueless looks in the empty cup and asks us what is in it. It's a gas, and it fills the space it's in!



Thus we see the three states of matter and define them with help from the audience. The different properties are discussed and we learn an action to remember each of them by.

In class the children can explore the variety and uses of solids, liquids and gases. What are the most common uses for each state? Where might you find a solid, a liquid and a gas in a bicycle and a car? Can they think of any other objects where all three substances are used? By considering a viscous substance, like thick custard, the children can discuss whether the substance is a liquid or a solid and why they would define it as such using the properties of solids and liquids to substantiate their case.

MIXTURES AND COMPOUNDS

A mixture of substances can be separated physically into its constituent parts. Most foods are mixtures, eg: salad dressing is a mixture of oil and vinegar. Air is one of the most important mixtures, being mainly nitrogen and oxygen plus many other gases.

A compound however is a combination of substances, or materials, that have been chemically joined, where their individual chemical structure has been altered in the bonding of the materials. They cannot be physically separated from each other. Two commonly found compounds are concrete, made from cement, sand, stone chips and water where the chemical reaction takes place at a low temperature to form a strong solid, and soap, a compound formed from oil, sodium hydroxide and water where the mixture is heated to enable the reaction to take place to form soap.

Our story moves on and we find ourselves at the kitchens of the famous chef Heston Bloominheck where Heston is making his signature dish – pickled onion flavoured fairy cakes. A discussion takes place on the subject of mixtures and compounds. Heston demonstrates a mixture by making his cakes and explains that before the mixture is cooked all the ingredients can be separated out again – a ‘reversible change’. Once cooked, however, the cake mixture chemically changes to form a compound and becomes a cake. He tells us this is a ‘non reversible change’.



The ingredients - a mixture



THE CAKES - a chemical reaction has taken place - A COMPOUND

In class the children can try to think of other instances, such as baking, where a mixture becomes a very different substance when a chemical reaction takes place to form a compound - such as cement mix to concrete when water is added and wood to ash when the wood is burnt.

SEPARATING MIXTURES

As mixtures are not chemically joined they can be separated back out into their constituent parts. There are several techniques: dissolving, filtering, evaporation, condensing, distillation and chromatography.

Heston helps the Chamber maid to separate out a mixture of sugar and a mysterious added ingredient to discover the identity of the mystery material. The most appropriate methods to use are dissolving and filtering and with the help of a member of the audience he demonstrates the techniques. Firstly he dissolves the sugar in water, and he is left with little black particles floating in the liquid. This is the mystery ingredient and to separate it from the liquid he filters the solution through a filter paper which collects the mystery ingredient whilst allowing the liquid to pass through.

Dissolve sugar mixture in water



Filter sugar solution



Filtered sugar solution



Mystery ingredient collected on filter paper

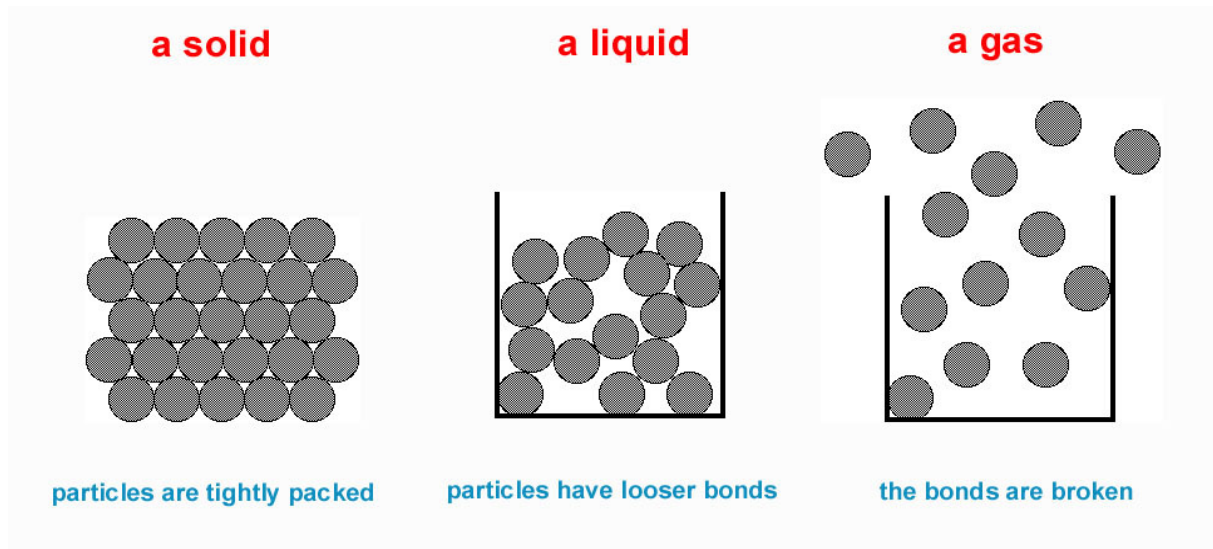
In class the follow up work could include separating muddy water, retrieving the salt crystals from salt solution whilst collecting the pure water or separating the dyes in black ink by putting a drop of black ink on blotting paper and watching the various colours spread out from the centre – some spreading further than others.

CHANGES OF STATE

Substances on Earth can, with changes of temperature, change their state. The most obvious example is red hot lava, being liquid rock, where the temperatures have increased to such an extent that the rock has melted. Nitrogen gas requires very low temperatures, well below the freezing point of water, to liquefy.

Using water as an example we see that a substance can exist in more than one state of matter. Six volunteers from the audience are required to represent water particles. Firstly they pack tightly together to become a solid, ice, where the bonds between the particles are strong and hold them in a fixed shape. The audience are asked what happens to ice when it is heated and we discover it will melt and become a liquid. The children then move apart but remain bonded by holding hands to form a liquid - water. They see that although they are still bonded together they have much more freedom of movement and it is this freedom that allows a liquid to change its shape. We raise the temperature again, this time to boiling point and we see that the liquid water becomes a gas. So the children are asked to drop their hands, showing that in a gas the bonds between the particles are broken, and they are free to move about wherever they like.

As this is a reversible change we cool our gas down, turning it back into liquid water and then into a solid, ice and we repeat the actions we learned previously to help us remember that a solid has a fixed shape, a liquid changes shape and a gas fills the space its in.



In the classroom the children could discuss the changes of state described by the words melting, evaporating or vaporising or boiling, condensing, solidifying or freezing. They should try to think of as many different substances as they can that exist in two or more states on Earth and write down where they might be found.

AT THE END OF THE PLAY

At the end of the play the actors will run a short question and answer session where firstly they will summarise the science by quizzing the audience on the scientific concepts covered and then they will throw open the session to the audience and answer any questions the audience might have on the science or the any other aspects of the performance.

Show Requirements

The actors will be arriving approximately forty minutes prior to the start time in order to set up and will need to have access to the school hall from then. They bring the set, lighting and sound equipment with them so only need access to a plug socket. They'll need a space approximately 15' wide by 10' deep with the children sitting in front, either seated or on the floor. The show works well 'on the flat' but if it's more convenient for the actors to use your stage, please let them know on arrival. The show lasts one hour but please allow for 10 minutes of questions on top of this.