Classroom Group Sizes

Size	Benefits	Limitations	When to Use
Individual			
Pair			
Small Group 3-4			
Whole Class			

Group Composition

Handout 2.4

Size	Benefits	Limitations
Friendship Groups		
Ability Groups		
Structured Groups		
Random Groups		
Single Sex Groups		

MIXTURES, ELEMENTS AND COMPOUNDS

Argument in this activity is based on a list of statements presented in a table format. Working in small groups pupils are asked to indicate which statement they agree or disagree with and explain why by making reference to evidence to support their point of view.

Aims

The aim of this exercise is to explore the concepts of elements, mixtures and compounds and the criteria for distinguishing between the two. Pupils are asked to evaluate arguments for similarities and differences between mixtures and compounds.

Learning goals

The learning goals for this activity are for pupils to:

- learn how to distinguish between mixtures and compounds. Pupils will generate criteria which they can be used to distinguish between mixtures and compounds and also used to define mixtures and compounds;
- construct arguments to justify their choice of statements as being right or wrong by providing evidence to support their choice.

Teaching points

The pupils will need to have some understanding of concepts such as an atom, molecule, mixture, compound and chemical reaction. Textbooks should be available as reference material for the activity. They can also use drawings to help them understand the differences between the terms.

Teaching sequence

Distribute the handout to the pupils.

- Ask the pupils to work on their own and decide what they believe and to put their reasons in the evidence box. Encourage them to make reference to their textbooks or any other resources to provide justifications in the last column of the table. Allow 10 minutes maximum for this phase of the activity.
- Now ask the pupils to work in pairs and compare their answers. Tell them that where they disagree, they should compare their reasons and see if they can agree. Allow 10 minutes maximum.

- Now ask the pairs of pupils to come together as a four ('pairs' to 'fours'). Again they should compare their views and discuss any disagreements.
- For the final plenary session, go through each statement in the table. Ask which groups agree with the statement. Ask what is their reason for agreeing. Then ask if there is a group who disagrees with the statement. Ask them to explain why. Encourage counter argument. When you have heard arguments for both sides, ensure that you give the scientific argument. Continue like this through all the statements.

Mixtures, Elements and Compounds

The following are a selection of common ideas about mixtures and compounds. Some are true, some are not. For each statement, discuss whether you believe it to be true, false or whether you do not know. For those that you know the answer, make a note of what evidence you base your beliefs on. You can use your notes or textbook to help you with this activity.

Statement	Agree/Disagree/ Unsure	Evidence
Salty water is a compound		
Air is a mixture of different elements and/or compounds		
Elements have only one type of atom in them		
Elements can join together to form compounds		
Pure substances are substances that don't have harmful things in them		

A Burning Candle

This activity uses a framework called "Predict-Observe-Explain" where pupils are asked to predict the outcome of an experiment which is then demonstrated by the teacher. This prediction should be based on some knowledge of what happens when objects burn in air. The pupils then record their observations and compare their observations with their predictions. If their prediction is found to be at fault, they then need to examine their original arguments to see which of their original premises might be at fault.

Aims

The purpose of this exercise is to:

- provide a context for pupils to generate arguments about combustion using evidence collected from the demonstration;
- to consider the evidence for the scientific conception of combustion.

Learning goals

The learning goals of this activity are to:

- provide an opportunity to consider and evaluate evidence;
- generate an explanation for what happens when the candle is burnt;
- consider and evaluate the arguments of others.

Teaching points

Pupils will need to have some understanding of concepts such as oxygen, carbon dioxide and burning. The alternative predictions and explanations produced by the pupils will provide a context for argumentation. For example, one explanation could be that the candle burns out because the oxygen dissolves in the water. Another could be that the candle will stop burning because of the carbon dioxide produced. The scientific explanation is that oxygen gets used up in burning the candle. In which case, we would expect the water to rise to take its place. However, carbon dioxide will be produced which is a gas. The evidence that would support each position can be explored and pupils can be encouraged to justify their points of view.

Teaching sequence

- Distribute the activity sheet and tell the pupils that you will shortly demonstrate the experiment.
- Show the apparatus to the pupils. Remind them that they are going to watch an object burning. Ask what might be likely to happen and why? Elicit one or two alternative hypotheses from the pupils. If they are not forthcoming, you will need to generate these yourself (see the background notes).
- Then ask the pupils to work in pairs to complete the part of a sheet requiring a prediction. They should spend up to 5 minutes to complete the prediction section of the sheet. Emphasise that they should *write an argument* to justify their prediction. When they have finished use the pairs to fours technique to compare their prediction with another pair. If necessary, you can sum the range of predictions on the board.
- Now conduct the demonstration. This should take about 5 minutes to do and about 5 minutes to explain the actions taken during the demonstration. Explain to the pupils what you are doing as you are placing the candle on the water. Tell them that you will cover the candle with a glass and then ask them to carefully observe what happens to the setup. Once they have finished their observation, ask them to write down their observations.
- Now ask them to work in groups of three or four, and ask them to discuss their explanations for why what they observed happens. First, they should discuss and compare their predictions, their observations and their explanations. They should also discuss if there was any disagreement with their predictions and final explanations. If there was a disagreement, they should discuss in their groups why they think their predictions and explanations differed and what this demonstrates about their reasoning. Tell the pupils that each group will need to select a member to present their results to the whole class. Allow 15 minutes maximum for this discussion.
- Conduct a plenary discussion with each group presenting their results. When there are differences between groups, encourage the pupils to provide justifications for how the other group's point of view is not valid. For instance, ask 'does anyone want to suggest why they think that might be wrong?' In other words, encourage the pupils to provide rebuttals to other's arguments. Their rebuttals should be based on evidence that can be referred back to the demonstration. There is no need to hear the presentation from each group.

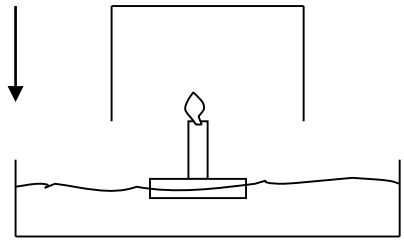
Background Notes

The scientific explanation for what happens here is very uncertain. Ostensibly the water rises by approximately one fifth and the experiment has traditionally been used to argue that one fifth of the air is oxygen which gets 'used up' in combustion. However, a moment's thought about the products of combustion leads to the acknowledgement that the major product is carbon dioxide which is a gas and should have approximately the same volume. If this is so, the effect should be bigger with two or more candles.

In addition, the gases will be heated and so should expand to occupy more volume. Carbon dioxide is, however, to some extent soluble in water. With some of this information, it is possible to construct a credible argument that the water should go down, not up.

A Burning Candle

What will happen when the candle is covered?



What do you think will happen?

Why do you think this will happen?

What happens when it is demonstrated?

Explain why you think what you observed happens.

Activity 5 *EUGLENA*: PLANT OR ANIMAL?

This activity requires pupils to use and evaluate evidence presented on cards to argue whether the organism – in this case *Euglena* – is either a plant or an animal, both or neither. The evidence is then summarised in a table format. The pupils are asked to work individually, in groups and also to conduct presentations following group work.

Aims

The aim of this exercise is to consider the evidence whether the single cell organism *Euglena* is a plant or an animal, both or neither. Pupils will use the evidence presented on cards to argue for the appropriate classification of *Euglena* as an animal or a plant.

Learning goals

The learning goals for this activity are that:

- Pupils will have the opportunity to construct arguments for *Euglena* being either a plant or an animal and use the evidence from the cards to substantiate their claims.
- Pupils will learn to evaluate the evidence presented on the cards and select them to support their point of view about *Euglena*. Since some of the evidence can be ambiguous and could indicate that *Euglena* is both an animal and a plant (e.g. it moves and it has chlorophyll), the activity provides an opportunity to generate cognitive conflict for pupils. The anomaly will create a context where pupils will argue against each other since some pupils may overlook evidence that makes *Euglena* a plant while others emphasise it more.
- Pupils will learn that there are organisms, protists, which are neither animals or plants.

Teaching points

- For this activity pupils will need to know some of the basic cell biology vocabulary such as cytoplasm and vacuole. A textbook can be used as a reference. It may be useful to provide a demonstration of a *Euglena* culture if the resources are available.

Teaching sequence

- Begin the lesson with a demonstration on *Euglena*. This could either involve an opportunity to view them under a microscope or to demonstrate it to the whole class by using a projection microscope. Alternatively, there is a free Quicktime movie available from:

  http://biog-101-104.bio.cornell.edu/BioG101_104/tutorials/protista/movies/*Euglena*.MOV

- The purpose of this introduction is to provide a visual stimulus, to ask the question what type of organism is it, and to motivate the pupils to engage in the argument that follows. Allow about 10 minutes for the introduction of the task.
- Distribute the activity sheet with columns and the evidence cards. Explain that the pupils will need to place each card in the column where they think the statement goes. Arrange the pupils into groups of three or four.
- Allow about 10-15 minutes for pupils to work as a group to sort out the cards. While they are working in their groups, go around and probe their reasoning for selecting cards to put in one column over another column. Play devil's advocate! For pupils who claim *Euglena* is a plant, tell ask them how this is possible when it moves in water like an animal would do. Encourage pupils to use the textbook to look up any of the evidence that they may not be sure about.
- Hold a class plenary at the end. Begin by asking which group would like to argue for *Euglena* being an animal. Ask the pupils to report on their discussions and indicate the outcome of the group's exploration. Then ask who would like to argue against this – that *Euglena* is a plant. Encourage the groups to rebut each other's argument by providing evidence that would counter their position. Ask questions such as "what information would you use from the cards to prove that this argument is not true?"
- At the end of the lesson, tell the pupils that *Euglena* is in fact neither a plant nor an animal. Rather it is in a kingdom of its own called protists and that the point to this lesson was for them to evaluate evidence and justify their claims which is what scientists do all the time.

Background Notes

Euglena are unicellular organisms that are classified in the kingdom Protoctista. This kingdom comprises a wide range of organisms including other unicellular organisms (or protists) e.g *Amoeba* and the algae. It is an unusual group defined

by exclusion i.e. its members are not animals, not plants, not fungi and not prokaryotes (bacteria). They are linked by their relatively simple structure although their cell organization and life cycles may vary. Although *Euglena* contain chloroplasts and are able to photosynthesise they do not have a cellulose cell wall and therefore would not be classified as plants. If kept in the dark *Euglena* can feed heterotrophically – that is obtain their food from other sources rather than make it themselves.

Before the advent of modern biochemistry and the electron microscope, these organisms were fitted into the plant or animal kingdoms. It is now thought that, although green plants probably evolved from the green algae and animals from some other early forms, most modern protists have followed independent evolutionary lines. There are approximately 60,000 living species of protists which form their own kingdom.

Euglena Evidence Cards

Euglena **does not have a cell wall**	***Euglena*** **contains chloroplasts**
Euglena **has a nucleus**	***Euglena*** **is a single cell organism**
Euglena **can absorb food from its surrounding**	***Euglena*** **confused early scientists**
Euglena **is normally green**	**The nucleus contains DNA and controls the cell activities**
Chroloplasts enable a cell to photosynthesize	**A vacuole controls the amount of liquid in a cell**
Euglena **swims through Water**	***Euglena*** **can make its own food**

Euglena **has a vacuole**	***Euglena*** **is light sensitive**
Euglena **contains cytoplasm**	***Euglena*** **can change its shape**
Euglena **live in ponds and puddles**	***Euglena*** **is temperature sensitive**
Euglena **can reproduce**	**There are more than two classification groups**

Euglena – Plant or Animal?

Evidence that suggests *Euglena* is a plant	Evidence that suggests *Euglena* is an animal	Evidence that suggests *Euglena* is either a plant or animal	Evidence that suggests *Euglena* is neither a plant nor an animal