

Art meets science



UNIT A4

This unit looks at three famous paintings depicting science experiments and the effects of science.

Using this unit

Black-and-white copies of the three pictures are provided in the printed text. Colour copies are provided on the accompanying CD. The three paintings can also be found in full colour on the following web pages:

Coalbrookdale by Night:

http://www.aakb.bib.dk/forfatternet/VagnLyhne/ynd_laes.htm

The Alchemist:

http://www.derby.gov.uk/museums/docs/alchmt_i.htm;

<http://www.chemistry.nmsu.edu/faculty/divisions/jnsnlab.html>

An Experiment on a Bird in the Air Pump:

<http://metalab.unc.edu/wm/paint/auth/wright/wright.airpump.jpg>;

http://www.nationalgallery.org.uk/collection/e_wing/W0725.html

There is scope here for collaboration with colleagues in the Art and History departments.

Links with KS3 programme of study

- ◆ The benefits and drawbacks of scientific and technological developments, including those related to the environment, health and quality of life (breadth of study)
- ◆ How scientists worked in the past including the role of experimentation, evidence and creative thought (Sc1 ideas and evidence).
- ◆ The possible effects of burning fossil fuels on the environment (Sc3 materials and their properties: chemical reactions)

Moral and spiritual aims

- ◆ To consider the moral aspects of animal experimentation and the restrictions applied to scientists (*An Experiment on a Bird in the Air Pump*).
- ◆ To show that scientists can display awe and wonder at their discoveries and may even come to idolise their work (*The Alchemist*).
- ◆ To encourage care for the environment in the manufacturing of materials (*Coalbrookdale by Night*).

Notes and answers

The Alchemist discovers Phosphorus

This picture is exhibited in Derby Museum and Art Gallery.

1. Phosphorus ignites in the presence of oxygen.
2. The motive for making gold might be to make money or to become famous or simply to do the experiment successfully.
3. Gold is an element. Elements are simple substances and cannot be made from joining two different elements.
4. You need to boil a liquid and then condense the vapour.
5. Vapour takes up more room than the liquid so the vapour needs to expand. The distillation apparatus must not be air-tight.
6. The effect on the scientist is of awe and wonder.
7. Kneeling could indicate an attitude of worship.
8. - 10. are for discussion.

An Experiment on a Bird in the Air Pump

This picture was painted by Joseph Wright of Derby in 1768. It is now housed in the National Gallery, London.

The scientist depicted here would have travelled to a wealthy private residence to talk about the properties of air. (The actual term 'scientist' was not in general use before 1831 when it was coined by William Whewell.) The demonstration is one that was performed at the Royal Society using Robert Hooke's and Robert Boyle's air pump to evacuate the glass bowl. The bird inside is a white cockatoo. It first becomes unconscious and then dies unless air is re-admitted by opening the tap at the top. One of the observers has a watch and is timing the experiment. Is this so that air can be re-admitted at the right moment, or is it to find out the time taken for the bird to die? It is also not clear whether the bird cage is being raised by the boy because it is no longer needed, or perhaps it is being let down so that the bird can be put back inside when it recovers. However, these birds were very rare and expensive in Britain at the time. The dramatic scene shows the power that a scientist can have over life and death.

1. The picture is ambiguous so you should not expect all the pupils to agree! Often the tap was opened just before the bird died, but there are many

uncertainties and the various reactions of members of the audience heightens this uncertainty.

2. (a) The scientists - response 4 (or 2).
(b) The father - response 2 (or 4).
(c) The two girls - response 1.
(d) The philosopher - response 3.
(e) The two observers - response 4.
(f) The two lovers - response 5.
3. The scientist's right hand is gesturing towards the audience and he is also making direct eye contact. He seems to be asking us, 'what do you think I should do?'
5. This involves the pupils putting different values on the life of different animals.
6. Some suggest this is a lung which could have been blown up using a straw. Others think it is a skull, indicating the frailty of life.
7. Pupils may see this as an early picture of the stereotypical 'mad scientist'. They could be encouraged to discuss whether it is really true of scientists today. The artist was actually expressing admiration for the work of scientists as was commonly done for other famous people and their accomplishments.

Coalbrookdale by Night

This painting is housed in the Science Museum, London.

1. Pipes, container tanks.
2. Iron oxide + carbon \rightarrow carbon dioxide (or carbon oxide) + iron. (This is a simplified expression. In practice, the reducing agent in a blast furnace is carbon monoxide.)
3. Carbon dioxide (or carbon oxide).
4. The moon is painted a pure white colour as it is 'natural', 'non-polluting', 'a heavenly body'.
5. Trees show signs of stunted growth; the houses would be dirty and might show signs of corrosion; and the people might suffer from respiratory problems.
6. (a) Shift work and long hours had to be worked.
(b) Profit.
7. Mud, dangerous objects, horse traffic, hot slag pits, air pollution, etc.
8. If there is a lot of pollution, someone will be making money.
9. (and 10.) Environmental effects need to be taken into consideration when processing minerals and manufacturing on a large scale.

Art meets science



UNIT A4

Paintings and photographs try to say more than a simple diagram. They try to pass on something of the artist's opinions, values and beliefs about the scene they describe.

The Alchemist discovers Phosphorus by Joseph Wright, 1795

In this painting the 'scientist' is an alchemist (also spelled alchemist). Alchemists were the early chemists. Phosphorus is a chemical element discovered by them in 1669.

Alchemists tried to make gold out of other substances. They thought they would be able to find a perfect recipe and change chemicals into gold. Although they never succeeded, they did make other interesting discoveries. The alchemist in this picture is using phosphorus.

1. Phosphorus is being collected in the cold flask in the centre of the dark room. What is the special property of phosphorus that so amazes the scientist in this picture?
2. Why was he spending so much energy trying to make gold? What might be some of his reasons or motives for his experiment?
3. Is it possible to make gold by joining other elements together? Give a reason for your answer.

In this experiment the scientist had been trying to distil liquid urine!

4. What is distillation?
5. Why did there have to be a small hole in the flask where the liquid was being collected?

Eventually, if we did distil gallons of urine, we would produce a concentrated solution of urine rich in phosphorus. This glows in the air when it reacts with the oxygen. This is what causes the spectacular effect.

Look at the picture.

6. The whole room is lit up by the glowing phosphorus. What do you think is the effect on the scientist?
7. The painter has chosen to paint the scientist in a kneeling position. Why? Does the kneeling position signify anything special? When might a person kneel like this?
8. Do you think it is strange that a scientist could bow down before the products of urine?
9. Can you think of any examples in modern life of people worshipping things that have been made by humans?
10. What do you think the painter is trying to say to us?

What do you worship?

Do you think that people should worship things they have made themselves? Or things that someone else has made? Do you think people should worship created things or the Creator?

An Experiment on a Bird in the Air Pump by Joseph Wright, 1768

In this painting, the scientist at the centre is showing one of the properties of air. At the time of this picture, ideas about the air being made of gases and about how we breathe were not very well understood. Can you see a small bird near the middle of the picture? It has been put inside the glass bowl and then a pump at the bottom slowly sucks the air out. First the bird will become unconscious, then it will die. However, the bird might not die if the scientist turns the tap at the top of the bowl and lets the air back in. People in the mid-eighteenth century wanted to see proof of scientific theories.

There are no right or wrong answers to the questions below, but you need to write down or talk about your opinions.

If you have the picture on CD-Rom, you can zoom in to see details more clearly.

1. Do you think the bird is going to live or die? Explain why.

Clues:

- (i) Look at the expression of all the faces around the table.
- (ii) Do you think the scientist looks as if he will open the tap?
- (iii) The boy by the window has a rope which is attached to the bird cage. Is he pulling it up because it is no longer any use for a dead bird, or is he letting it down ready to put the bird in when it revives?

2. Look at each person around the table. Can you work out what each one might be thinking? Write down what might be in the thought bubbles of the people at a, b, c, d, e and f.

Clues: Here are a couple of different reactions to this experiment. A person might be:

- (i) upset because the bird is dying;
- (ii) interested in explaining what is going on;
- (iii) wondering about the future power of science in the world - science can be used for good or evil;
- (iv) fascinated by the amazing things science can do;
- (v) have not really thought about whether it is right or wrong to experiment with the life of a bird.

3. Imagine you were in this room.

- (a) How would you feel?
- (b) What would you think?
- (c) What might you actually have done?

4. Do you think it is wrong for a scientist to have this amount of power? Is he playing God? Does that matter?

5. Do you think it would be better if the scientist used a rat or perhaps a large insect? Why might some people argue that killing a bird is worse than killing a rat?

6. Look at the bowl lit up in the middle of the table - there is something inside! Some people think it might be a skull, others think it might be a lung which has been blown up using the straw. What do you think? Why do you think the painter included this?

7. What do you think the painter is trying to say to us?

What would it be like to meet this scientist? Do you think he is a typical scientist?

Coalbrookdale by Night by Philippe Jacques de Loutherbourg, 1801

Coalbrookdale is near Ironbridge where the Industrial Revolution in Britain first began. An important process was first discovered here. They found out how to change iron ore into iron on a large scale.

Soon the iron-making industry spread throughout the world. This was because iron had so many uses and became the main material in many inventions, such as trains, steam engines, etc.

1. Can you work out some of the uses for the iron from the bottom right hand corner of the painting?

Iron ore contains iron oxide. To remove the oxygen (oxide), you can heat iron oxide with carbon (from coal).

2. Complete the simplified word expression for making iron:

iron oxide + carbon → +

3. What is the name of the main waste gas coming out of the chimneys in the picture?

This reaction requires a great amount of heat. This is why there is such a bright glow from the iron works even in the middle of the night.

4. There is a white glow on the right edge of the painting that looks a purer white. Where do you think it is coming from? Why do you think it is a such a pure white colour?
5. What do you think is the effect of the air pollution in this picture? Consider the effect on people, plants, birds and other animals.
6. The furnaces had to be kept hot and running all night so that molten iron could be made continuously.
 - (a) How do you think this affected the workers?
 - (b) What do you think was the main concern of some factory owners?
7. What would be the dangers to your safety if you were the child in this painting?
8. 'Where there's muck, there's brass' was a well-known saying in times gone by. What do you think it means?
9. Many people were proud of the scene at Coalbrookdale. They saw how powerful industry had become and how it dominated the countryside. How do you think you would feel about the growth of such an industry at that time?

Is it possible to use the resources of the Earth carefully to make the things we need but also prevent scenes of pollution like the one in the picture? People sometimes say that we should be 'good stewards of the Earth'. A steward is the manager of another person's property. What do you think it means to be a good steward of the Earth?

10. Do you think the artist has portrayed the iron industry in a good or bad light? Explain your answer. Do you agree with him?
11. What do you think the painter is trying to say to us?

The Alchemist



Joseph Wright of Derby 1734-1797, The Alchemist, 1795 © Derby Museums and Art Gallery

Urine vapour cools down here

Small hole in flask

Laboratory assistants holding a lighted taper

The scientist (alchemist)

Flask collecting solution containing phosphorus

Furnace boiling urine

An Experiment on a Bird in the Air Pump



(a) The scientist carrying out the experiment
 Here is the tap to let air in
 Here is the bird inside the glass bowl
 (b) The father and wealthy owner of house

The boy pulling the bird cage

(c) The girls watching

(d) The philosopher

Bowl containing a skull

Joseph Wright of Derby 1734-1797, An Experiment on a Bird in the Air Pump © The National Gallery, London

(f) The two lovers

(e) The two observers

Here is the vacuum pump

Coalbrookdale by Night



Local hills mined for coal, iron and limestone

Some products made of iron

Horses and wagon carrying away heavy iron articles

Tree affected by the air pollution

Mother and child watching

Philippe Jacques de Loutherbourg 1740-1812, Coalbrookdale by Night, 1801 © National Museum of Photography Film & Television/ Science & Society Picture Library, London