11 What was alchemy and why was it important to Robert Boyle?

FOR TEACHERS

Lesson Title: What was alchemy and why was it important to Robert Boyle?

Area of Learning: explanation

Aims. Pupils should be able to: describe past societies; describe different historical interpretations of people and changes; analyse and explain why there are different historical interpretations of events, people and changes; select, organise and deploy relevant information to produce structured work, making appropriate use of dates and terms.

Vocab: alchemy, alchemical, Enlightenment, transmutation, transformation, transmutation, occultism, supernatural, superstitious, Aristotelian, four elements, forms and qualities, esoteric, symbol, cipher, rational, irrational, empirical, crucible, sublimation, elixir

Time frame: at least one hour plus homework task.

Resources: worksheet given below

Pupil tasks. The lesson is in three sections, addressing three questions: what was alchemy?; how relevant was alchemy to Boyle?; how have historians interpreted Boyle's alchemical interests?

In section A, pupils read through the material and discuss it with the teacher, and then perform the tasks, one of which is an interesting exercise where a picture of a model of a 16th century alchemy lab is annotated.

In section B, pupils investigate, through analysing sources, alchemical elements in Boyle's work. In section C, pupils learn why Boyle's alchemical interests have been downplayed or discredited by post-Enlightenment historians and investigate different modern interpretations of Boyle's work.

There is great scope for cross-curricular links with chemistry when dealing with alchemy topics. Some Latin translation can also be done with the names of alchemical substances.

A. What was alchemy?

Harry Potter is a fictional character from a popular children's book by J. K. Rowling that you may have read. He attends a special boarding school for trainee wizards, called Hogwarts. The first book about Harry's adventures is entitled *Harry Potter and the Philosopher's Stone*. In this, on his first train journey to begin school, Harry eats a chocolate frog and looks at the collectable card, concerning famous wizards, in the packet. His card described Professor Dumbledore:

'Albus Dumbledore, currently Headmaster of Hogwarts. Considered by many the greatest wizard of modern times, Professor Dumbledore is particularly famous for his defeat of the dark wizard Grindelwald in 1945, for the discovery of the twelve uses of dragon's blood and his work on **alchemy** with his partner, Nicolas Flamel'. J. K. Rowling, *Harry Potter and the Philosopher's Stone* (London, 1997), p. 77.

Later on in the book, Harry and his friends Hermione and Ron discover, in an ancient book in the school library, a description of **alchemy** - a particular area of expertise of Professor Dumbledore.

'The ancient study of alchemy is concerned with making the Philosopher's Stone, a legendary substance with astonishing powers. The Stone will transform any metal into pure gold. It also produces the Elixir of Life, which will make the drinker immortal. There have been many reports of the Philosopher's Stone over the centuries, but the only Stone currently in existence belongs to Mr **Nicholas Flamel**, the noted alchemist and opera-lover. Mr Flamel, who celebrated his 665th birthday last year, enjoys a quiet life in Devon with his wife, Perenelle.' J. K. Rowling, *Harry Potter and the Philosopher's Stone* (London, 1997), p. 161.

Scholars in the west first learnt about alchemy as they copied and translated into Latin certain Arabic texts with alchemical content in about the 12th /13th centuries. As the quote from the Harry Potter book states, alchemy was a branch of natural philosophy whose goal was to find wealth, longevity and immortality. Alchemists thus tried to find a substance called the Philosopher's Stone which, when heated and combined with 'base' or non-precious metals, would turn them into gold. It was also thought gold could be made into an elixir of immortality. Alchemy was based on older Aristotelian principles where it was thought that elements could be changed or transmuted by impressing new substances onto them. To some extent the alchemists laid the foundations of modern chemistry, although the science has been increasingly discredited since the 18th century because of its associations with mystical occult and irrational practices.

Alchemists used a wide range of exotic-sounding chemicals including cinnabar (mercuric sulphide), spiritus fumans (stannic chloride), saccharum saturni (sugar of Saturn or lead acetate), sal ammoniac (ammonium chloride), oil of vitriol (sulphuric acid), aqua regia (nitric acid and hydrochloric acid) and aqua fortis (nitric acid). They tried to keep their work secret and therefore they used many esoteric practices. For example, they frequently used a system of symbols to denote the substances and processes used in their experiments. These are shown in the illustration below.

A list of the symbols used to denote alchemical substances and processes, from a printed edition of *The Last Will and Testament* of Basil Valentine (1671), a typical alchemical work.

A well known medieval alchemist was the Frenchman Nicholas Flamel (1330-1418); a tradition beginning in the seventeenth century claims that he wrote alchemical texts and was able to prepare the much-coveted Philosopher's Stone. Thus, the character mentioned in the Harry Potter extract above was a real live historical figure who was indeed married to a women called Perenelle. An excellent website on alchemy can be found at www.alchemywebsite.com/symelem.html

Model of an alchemical laboratory, c.1540, by Tom McRae

This reconstruction is built to a scale of 1/12th. The solid looking walls and flagstones are actually just painted card. The model is illuminated by candles and the light from the flickering athenor (furnace). Dried snakes hang from the left hand side of the front beam while at the left hand wall the remains of a spillage can be seen beside the bench. A rat lies poisoned in the spillage, reminding us of the toxic conditions in which those pioneers worked.

A great press can be seen at the left of the back wall and the athenor is built at the centre with the bellows to its right. Vessels stand on shelves around the athenor for heating at different temperature gradients. To the left of the front shelf can be seen The Pelican with its tubes for spirit production.

On the floor in front of the bellows stands a cauldron of decomposing organic material. A large pentacle (five-pointed shape used as a magic symbol) has been drawn in the centre of the floor with candles at each point. Within the circle a mortar-like altar is used to hold mixtures which "Other Powers" are invoked to charge with occult powers. A ritual sword leans on the altar and was used to close the circle when the alchemist started working.

Reproduced, with kind permission, from the Alchemy website
http://www.alchemywebsite.com.alchlab.html

Tasks

1. Using the commentary about the sixteenth century alchemist's laboratory, see if you can label the picture of it.

2. Look at the list of alchemical symbols. See if you can find and copy the ones for : water ('aqua'); nitric acid ('aqua fortis')'; ammonium chloride ('sal ammoniac') and sulphur.

3. After reading the above lesson notes, write about two paragraphs on alchemy. Mention: the aims of alchemists; famous alchemists; the processes, substances and symbols used by alchemists. You may illustrate your answer.

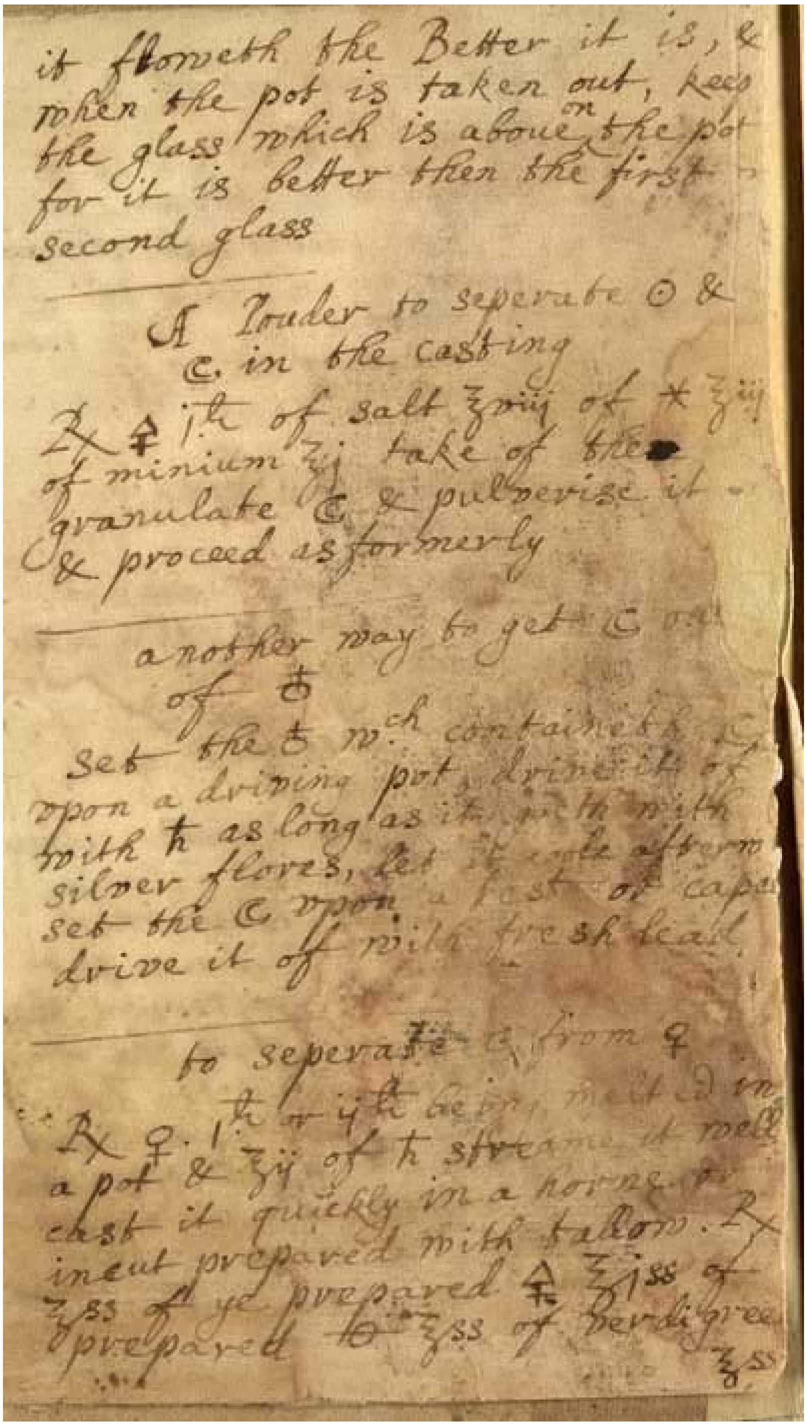
B. How relevant was alchemy to Robert Boyle's work?

Robert Boyle had a great interest in alchemy for he thought it would give him information on the structure of matter. This was a view he shared with his contemporary, Isaac Newton, who was similarly interested in alchemy. As he was deeply religious, he also thought that finding the philosopher's stone would allow him to communicate with angels and other spirituals beings. However, the overtones of mystical revelation involved in this aspect of the science caused him concern, since he worried that the shortcuts that it appeared to offer to an understanding of nature might represent temptations from the Devil.

Historians know about Boyle's interest in alchemy because he wrote a text entitled *Dialogue on the Transmutation and Melioration of Metals* which, as one historian (Lawrence M. Principe) has recently shown, showed Boyle to believe in the possibility of metallic transmutation just like the alchemists before him. He was also interested in meeting people who had seen base metals transformed into gold and some of his papers contain descriptions of meetings with people who claimed to have seen such events. Boyle had read the writings (published in the seventeenth century) attributed to Nicholas Flamel referred to above, and he was also eager to make contact with other alchemists who had carried out experiments. For example, in 1678, a French man wrote to Boyle inviting him to join a secret society of alchemists; he was promised that upon joining he would receive the alchemical secrets of the transmutation of metals. In order to join, Boyle was told to send expensive gifts to the leader of the group in Turkey. Boyle did do this, and sent his expensive gifts … but he never did receive his alchemical secrets. Had he been duped?

Like the alchemists, who often tried to keep their art secret by the use of esoteric symbols and ciphers, Boyle also deployed these techniques of secrecy and he too used ciphers and alchemical symbols in his writings. In fact, such was Boyle's interest in alchemy that he supported the repeal (reverse) of the medieval laws that punished people who tried to manufacture gold from base metals through alchemy.

Source one: Workdiary 18 – How to separate gold from silver and from copper.
In this manuscript, Boyle uses the symbols used by alchemists


it floweth the Better it is, & when the pot is taken out, keep the glass which is above on the pot for it is better then the first second glass

A Pouder to seperate ☉ & ☾ in the casting

℞ ♀ 1 lb of salt ℥viij of * ℥iij of minium ℥j take of the [illegible] granulate ☾ & pulverise it & proceed as formerly

another way to get ☾ out of ♁

set the ♁ wch containeth ☾ upon a driving pot drive it of with ♄ as long as it [illegible] with silver flores, let it coole afterw[illegible] set the ☾ upon a test or cap[illegible] drive it of with fresh lead

to seperate [illegible] from ♀

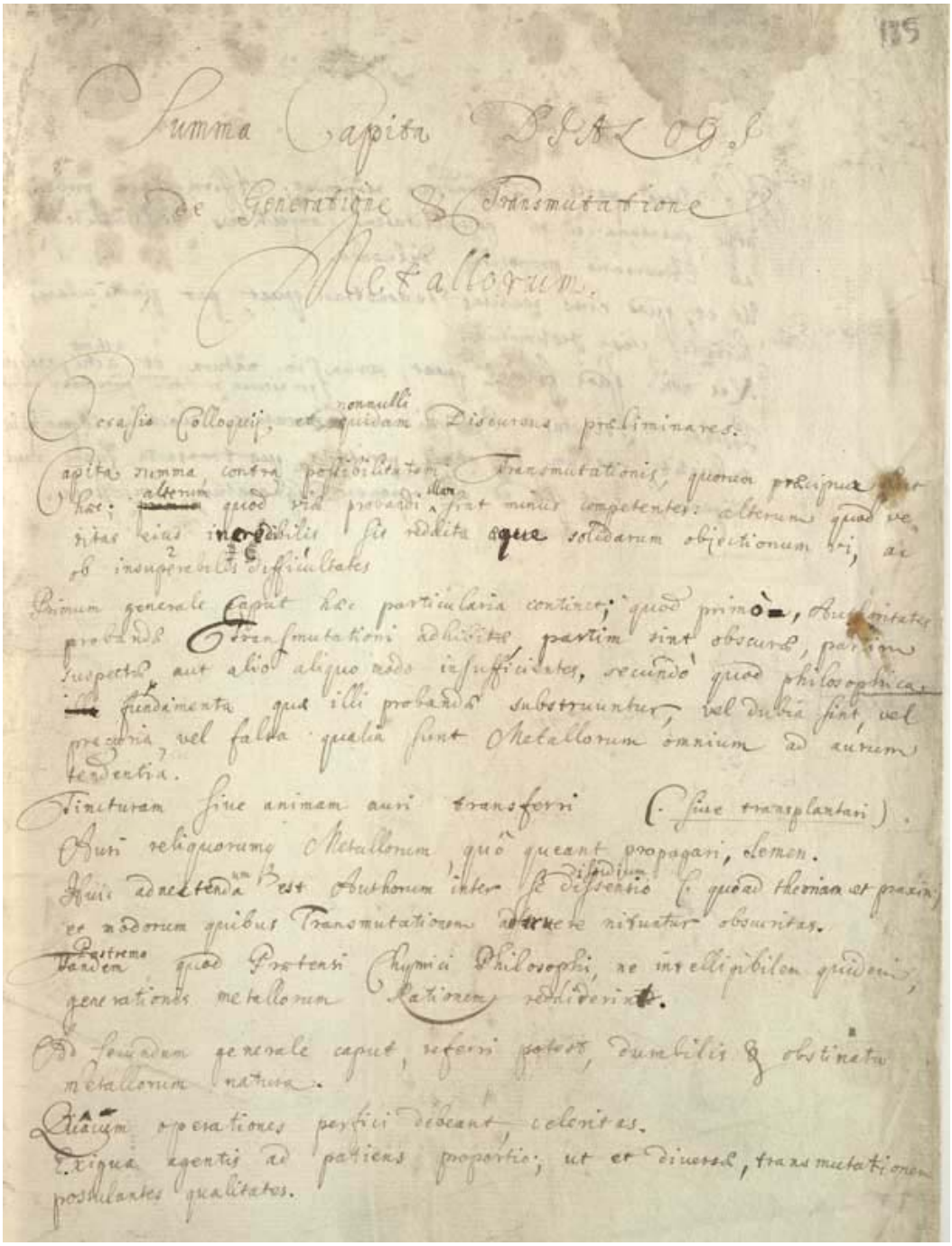
℞ ♀ 1 lb or 4 lb being melted in a pot & ℥ij of ♄ [illegible] it well cast it quickly in a horne [illegible] [illegible] with tallow. ℞ [illegible] prepared with [illegible] [illegible] ℥iss of ℥ss of ye prepared [illegible] ℥ss of verdigree prepared [illegible] ℥ss

(Royal Society MS 193, fol.1v. © The Royal Society)

Source Two In this extract, Boyle tells his friend Gilbert Burnet about a time when he saw a man supposedly change lead into gold before his very eyes.

'The man had a crucible in which was contained some lead. He put in a bright power and put the crucible on the fire to heat. He removed it and when it was cold I was surprised to find not lead but gold, which, after testing, turned out to be true gold'. (Adapted from M. Hunter, *Boyle by Himself and His Friends* (London, 1994), pp. 29-30)

Source Three: The opening page of Boyle's principal alchemical work, his 'Dialogue concerning the Transmutation of Metals' (translated into Latin)



(Royal Society, Boyle Papers 25, p. 185 © Royal Society)

Task

1. Read the passages above and then look at sources one to three. What aspects of Boyle's work shows him to have been interested in alchemy? Write several sentences in your answer, refer to the sources and give some examples.

C. How have historians interpreted Boyle's alchemical interests?

Historians of the 18th century and later have tended to ignore and discredit Boyle's alchemical interests. This was because their ideas were shaped by a new intellectual movement called *The Enlightenment*, in which rational observation was thought to be better than irrational, 'mystical' ideas. These 'enlightened' historians felt that alchemical knowledge was 'old fashioned', misguided and superstitious. It was thus thought to be no longer relevant to the development of modern science which was based on empirical study (ie rational observation and experiment). For example, in the 1950s and 1960s, Marie Boas wrote a number of books on Boyle. In them she claimed that in his work Boyle avoided alchemy and that in particular in his book *The Sceptical Chymist* (1661) he blasted alchemy and did not like using 'secret' practices like the alchemists did.

As you have seen from the texts above, Boyle was clearly working within the alchemical tradition. However, as you will have learnt from previous lessons on Boyle, Boyle also pioneered other more 'modern' empirical scientific methods based on observation and experiment – methods which scientists still use today. Thus, post-Enlightenment historians wanted only to emphasize the 'modern' rational elements of Boyle's work rather than those based on irrational, and therefore redundant, practices.

Much more recently, a few twentieth-century historians have rediscovered and re-interpreted Boyle's alchemical interests and have described them in a much more positive light. As a result of this, they have shown that Boyle was a figure working in a time of transition, who used both older alchemical and more 'modern' scientific practices throughout his life. This is apparent in the work of Lawrence M. Principe, writing in the 1990s. In the preface to his recent book he stated '[the fact] that Isaac Newton or Robert Boyle or any other seventeenth-century natural philosopher should have believed in ... alchemy should no longer horrify [historians] ... and the sheer extent of alchemical material in Boyle's manuscripts ... [is] astonishing'. (*The Aspiring Adept: Robert Boyle and his Alchemical Quest* (1998), pp. 4-5).

Tasks

1. What was The Enlightenment? Use the information in the text in section C above, and look in a dictionary and encyclopaedia, to help you write your answer.
2. Why would post-enlightenment historians (historians writing after the Enlightenment) tend to discredit alchemical knowledge?
3. What attitude did the historian Marie Boas have towards the alchemical elements in Boyle's work? Why do you think she had this attitude?
4. What attitude did the historian Lawrence Principe have towards the alchemical elements in Boyle's work?