Lesson 12 The Historiography on Robert Boyle: was Boyle the progenitor of modern science?

FOR TEACHERS

Lesson Title: The Historiography on Robert Boyle: was Boyle the progenitor of modern science?

Area of Learning: explanation

Aims. Pupils should be able to: describe different historical interpretations of people and their achievements and analyse and explain the reason for these differing interpretations; select, organise and deploy relevant information to produce structured work, making appropriate use of dates and terms.

Vocab: historiography, progenitor, era, conceptual, methodological, institutional, three laws of motion, mathematical, formula, formulae, natural phenomena, inertia, equation, physicist, *Philosophiae Naturalis Principia Mathematica* (the Mathematical Principles of Natural Philosophy), expound, teleological, mathematized, mathematization, contemporary, precursor, inductive, experimental, cornerstone, progressive, manuscript

Time frame: at least one hour, plus homework

Resources: worksheet

Pupil tasks. Pupils will not be able to tackle this lesson unless they have been well-prepared through doing a selection of other preliminary lessons on Boyle.

The task in section A allows pupils to see that perceptions, analysis of, understandings and explanations of events and people can take many forms, depending on the agenda of the observer/reporter. It should take only 5 minutes to complete and discuss. The understanding gained through this exercise can then be related to the historiography of Boyle and the Scientific Revolution.

For sections B-D, pupils need to read through the texts, with frequent stops so that the teacher can thoroughly explain the complex ideas contained within them. Additional questioning will help in this section. Help with analysing the three sources in the task will also probably be needed; teachers might wish to divide the class into groups and allow different groups to work on one of the three questions on sources.

There are many cross-disciplinary opportunities in this lesson, not least with physics. Science teachers could be consulted about *Boyle's Law* and Newton's three laws of motion and they could perhaps be encouraged to teach a lesson on these subjects before they are encountered in History.

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Section A

Task: you attend a football match of your favourite team, who wins. Your friend is also present, and she/he supports the losing side. After the match you both write an account of how the wining side won the game. Discuss with a partner how you think *your* account of what might happen could differ from *your friend*'s. When you have finished, discuss your ideas with your teacher and the rest of the class.

Section B: Interpretations of Robert Boyle's importance in the History of Science

Read: In the above task concerning the football match, it is likely that you would have described your team's victory as the result of skill and hard work. Perhaps your friend interpreted the action differently – for him or her, the victory of your team may have been simply the result of luck and nothing else! Sometimes, historians hold different opinions about what events were important in history and, at different times, they have interpreted the same evidence in radically different ways. The study of the writings that historians produce about any historical figure or event, and their differing interpretations over time, is called **historiography**.

In the previous lessons you have learnt about some of the many scientific discoveries Robert Boyle was responsible for. Historians have long been aware of Boyle's work, and they have argued about exactly how important Boyle was and to what extent his work is to be seen as a radical break from the past and the beginning of modern science. A value judgement has often been attached to these interpretations. Over time, Boyle's work has often been viewed and evaluated on the basis of its resemblance and importance to the prevailing concerns of **contemporary** science (ie, the values held by scientists at whatever time the historian is writing). Thus, recently, Boyle's work with the air pump and the inductive, experimental methods he used have often been characterised by historians of the later twentieth century as a *positive* advance in the development of modern science because scientists still use his discoveries and methods today. (Characterising the past in terms of the present is known as a **teleological** approach). In contrast, Boyle's work with *alchemy* – a practice which has long been discredited by modern scientists – has been characterised negatively and has been seen as a sort of 'dead end' or *mistake* that he must be forgiven for. Similarly, Boyle's interest in *religion* has been downplayed by those who, because of ideas formulated during the nineteenth century after Charles Darwin's work, think that religion and science should be *separate* fields of enquiry.

Section B tasks

Below are printed three extracts from twentieth century historians who wrote about the work of Robert Boyle.

Source One 'Robert Boyle was one of the ablest scientific investigators. A large part of the foundations of the modern sciences of chemistry and physics was laid down by this man. … Boyle's most famous work, the *Sceptical Chymist* (1661), opens the

modern period of chemistry, and marks the end of the doctrine of the four elements of the Aristotelians'.
(Adapted from a chapter entitled 'The Insurgent Century (1600-1700): Downfall of Aristotle and New Attempts at Synthesis' in Charles Singer, *A History of Scientific Ideas* (New York, 1959), pp. 271-73.)

1. Read source one. Does Charles Singer, the author of the book from which this extract was adapted, characterize Boyle as being the first modern chemist?

1a. Do you think that Charles Singer thought that Boyle was a 'success'? Why do you think Singer thought that?

Source Two 'Our greatest difficulty in estimating Boyle's importance lies … in our own confused picture of the developments in chemistry during his lifetime. We know, roughly, the things the chemists did, but not why they did them. We know how they failed to anticipate the discoveries of the eighteenth century, but we find it difficult to understand why they failed, or to forgive them for their failure.
(Adapted from Marie Boas, *Robert Boyle and Seventeenth-Century Chemistry* (Cambridge, 1958), pp. 1-2)

2. Read source two. Does Marie Boas, the author of the book from which this extract was adapted, think Boyle was a 'success'? By what standards does she judge Boyle?

Source Three 'I believe that much of the apparent conflict between Boyle as a seeker of the [Philosopher's] stone and Boyle as a founder of early modern chemistry in writings about Boyle vanishes ... There is no conflict; Boyle was simply a seventeenth-century 'chymist' – some of his 'chymical' activities have potential counterparts in modern chemistry, while others continue older traditions. Both activities fell unproblematically within the domain of the 17th century chymist'.
(Adapted from L. M. Principe, *The Aspiring Adept* (New Jersey, 1998), p. 219).

3. Read source three. What is the 'conflict' in ideas concerning Boyle's importance referred to in the adapted extract from the book by Lawrence M. Principe?

3a. Does Lawrence M. Principe see Boyle as a 'success' or 'failure'? By what standard does he judge Boyle's work?

Section C: Boyle's place in interpretations of the Scientific Revolution

The Scientific Revolution is the name given by historians of science to the period in European history, usually considered the period spanning approximately 1550-1750, when the conceptual, methodological and institutional foundations of *modern science* were first established. Boyle lived and worked in the key phase of the Scientific Revolution, 1660-1700, and historical views of him and his work are often closely connected with interpretations of the period and movement as a whole. There are a number of different strands to the Scientific Revolution which different historians emphasize: the 'mechanical philosophy', seen as a precursor to modern atomic theory; a developed theory of **inductive experimental** practice; the rise of collaborative research centres and the growth of scholarly publications and journals; and the '**mathematization** of nature', the expression of natural phenomena in terms of general and abstract mathematical formulae. Those historians who see the first three – the mechanical philosophy, experimentation and the growth of institutionalised science –as the key to the Scientific Revolution often regard Boyle, and his involvement in the Royal Society, as the **epitome** of the movement.

Despite his pioneering achievements in relation to the use of experimental method and the development of the theory of a 'mechanical philosophy', the importance of Robert Boyle's work has often been relatively downplayed by other writers on the Scientific Revolution. In particular those writers who see the Scientific Revolution primarily in terms of developments in mathematical astronomy tend to neglect Boyle, who never considered himself much of a mathematician and did not devote much time to astronomy.

Mezzotint portrait of Sir Isaac Newton by John Smith, after Sir Godfrey Kneller's portrait of 1702.

In contrast, the well-known figure of Isaac Newton (1642-1727) has dominated historians' writings about the period, because he developed generalized *mathematical formulae* to express and predict a whole range of events that happened both on earth and in the wider universe. Newton is the most famous figure in the Scientific Revolution, and most people have heard of him and his discovery of the theory of gravity. He developed mathematical equations to express the law of gravity as well as Newton's *three laws of motion*, and scientists have been able to use them to predict how all bodies would move through space; these laws were expounded (explained) in his book *Philosophiae Naturalis Principia Mathematica* (1687) (the Mathematical Principles of Natural Philosophy).

(Some of the writings of Newton are available on the University of London Imperial College website www.newtonproject.ic.ac.uk) Modern physicists such as Albert Einstein (1879-1955) were familiar with Newton's work and responded to some of his ideas).

Portrait of Boyle engraved by William Faithorne (1664).

Isaac Newton

Why is Newton more famous than Boyle?

Boyle and Newton lived at the same time, and during the late seventeenth century Boyle was the more famous natural philosopher. They respected each other, but each did a very different type of 'science', and the relative value historians have placed on their different approaches has changed over time. Nowadays, familiarity with Boyle's achievements, at least in comparison with Newton's, is probably *not* common because Boyle did not express his discoveries in general mathematical terms or equations that other scientists could make use of. For example, the gas law known as 'Boyle's Law', which he developed through his experiments with the air pump, can be expressed mathematically ($P_1V_1=P_2V_2$). Yet Boyle did not present it in these mathematical terms when he stated it in 1662. This was done *later* when it was felt that such a fundamental law needed to be stated in general terms. Boyle also did not produce a large-scale **synthesis** of his ideas like Newton's main book the *Principia Mathematica*. Instead, Boyle published many works on a very wide variety of topics, and wrote in a long-winded style. He also did not encourage an edition of his *collected works* to be published during his lifetime.

For this reason, later historians writing about the Scientific Revolution, who searched for the origins of ***mathematized*** science, have often underestimated Boyle's importance to his own time. Thus the **historiography**, that is, the historical writings, about Boyle can be influenced by what later generations (with their own concerns) think are the most important and lasting aspects of the time in which he lived. His **contemporaries** (people living at the same time as Boyle), though, may have had a different view.

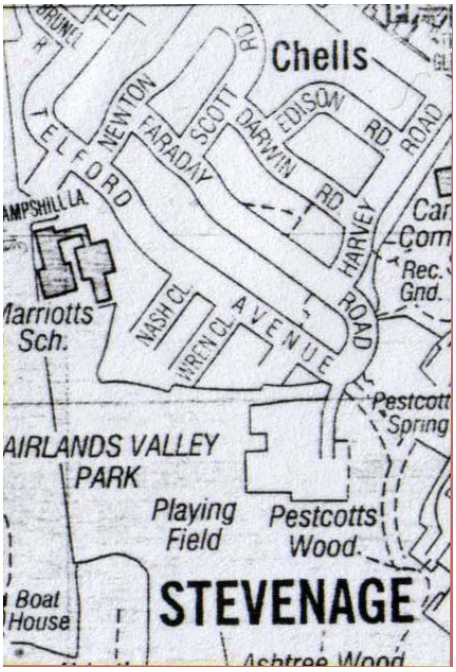
Section C Questions

1. What was the name of the book in which Newton set out his ideas on the laws of motion?

2. What does 'mathematized' mean?

3. In what basic way did the work of Newton and Boyle differ? How does this help to explain why Newton has overshadowed Boyle in some historians' descriptions of the scientific revolution? (Write at least 5 sentences to answer this question adequately; try to use the word 'mathematized').

4. Look at source one, a road map of Stevenage in Hertfordshire. In the late 1940s Stevenage was designated a *new town*. The town is a 25 minute train ride from London and it was thus chosen to be developed to house the London overspill – the excess population of the capital who needed to work there but who could not find a place to live. Lots of new residential areas were built in Stevenage and this meant lots of new roads had to be named. The section of the map presented in source one shows road names connected with the theme of 'famous scientists, architects and engineers'



Source One road map of Stevenage

- 4a. Make a list of the people mentioned in the road names under the headings 'scientists', 'architects' and 'engineers' (use an encyclopaedia or biographical dictionary to help you identify the people).
- 4b. Look at your list of the scientists and think about what you have learnt about Robert Boyle. If you had been the town-planner naming the roads, would you have chosen Boyle or Newton?

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Section D: Making Boyle 'modern'

Even those historians who do concentrate on Boyle's achievements often cover up or ignore his interest in alchemy and his enthusiastic pursuit of the Philosopher's Stone. In modern times, alchemy (because it is no longer practised by modern scientists) has been treated with suspicion, because of its associations with the irrational and occult. Thus, any individual such as Boyle who used it was thought to be 'old-fashioned' and backward-looking. Those writers who wish to make Boyle into 'the Father of Modern Chemistry' (such as Charles Singer in Section B, Source 1) tend to ignore or downplay his involvement in alchemy – sometimes treating it as just a passing fancy of the young Boyle, or apologizing that Boyle could even be involved in such a 'dead end'. Again, this tells us more about later generations' visions of what constitutes proper, modern and progressive science, than it does about Boyle and his own time (see Section B, Source 3 above). In this context it is interesting to note that even Isaac Newton, who is often seen as the great figure of the Scientific Revolution and whose work on gravity is often thought to provide the cornerstone of modern physics, was also interested in alchemy and pages upon pages of his **manuscripts** concern his own search for the Philosopher's Stone.

Homework Task: imagine a publisher has asked you to produce a school textbook on the History of Science. Think back to your lessons on Robert Boyle and what you have learnt about Isaac Newton in this lesson. Would you want to include some material about Robert Boyle and/or Newton in your textbook in the section on seventeenth century England? What kinds of things would you write about each man and why would you include them?