

1 SCIENCE AND NATURAL PHILOSOPHY BEFORE THE 17TH CENTURY

FOR TEACHERS

Lesson Title: *Science and Natural Philosophy Before the Seventeenth Century*

Area of Learning: chronology, states of affairs

Aims. Pupils should be able to: gain factual knowledge of the history of the wider world outside Britain; describe the intellectual culture of a past society; make links and note contrasts between ‘scientific’ enquiry in the 21st century and in ancient times

Vocab: classical antiquity, Renaissance, Aristotelian, natural philosophy, Robert Boyle, Plato, observation, experiment, deductive, inductive, phenomenon, phenomena, theology, objective, subjective, scholastic, contemporaries, precursor, anatomy, theologians, Christians, formulate, theory, thesis, theses, BC, AD, anno domini

Time frame: at least one hour plus homework

Resources: worksheet given below

Pupil tasks: pupils should volunteer to read the worksheet text aloud in class, with pauses for explanation and questioning by the teacher. The chronology task (1) on the pupil worksheet could then be completed.

In the second part of the lesson pupils answer questions (2)-(6). Answers will be found in the text which has just been read and discussed. Also, another question and answer plus discussion session could occur, based around several key questions which will allow pupils to encounter key terms, definitions and understandings concerning the nature and methods of scientific enquiry in ancient and modern times. These should enhance the understanding of the text on the pupil worksheet and facilitate answering questions (2) – (6). These key questions could be copied onto the board and answers added by the teacher. Pupils could copy these, providing them with a text to refer to when answering questions (2) – (5) which will supplement the worksheet text. **Key question: *What is science in its modern-day sense and how many branches of science can you think of?*** (Science is a way of studying and explaining the world through experiment and objective observation. Experiments involve creating a test environment in which to observe results and make general propositions to record ‘the objective truth’. Modern science is based on atomic theory. In contrast with this, before the nineteenth century ‘science’ was usually called ‘natural philosophy’; a number of scientific disciplines that are today considered ‘separate’ were subsumed under this umbrella term whose meaning differed in a number of ways from that of the modern day term.) **Key question: *What would have been some of the most obvious things for early natural philosophers/scientists to have observed and wanted to explain?*** (Pupils should know about components and preoccupations of early science. Early natural philosophers were interested in the passage of time and the regularities in nature upon which primitive man depended for survival (sun, moon, stars, planets, seasons). Therefore early natural philosophers were often concerned with astronomy, the movements of the sun and planets.) **Key question: *How did man begin to explain the natural world?*** Pupils should understand that the natural world could be described and explained by mathematics, hence mathematics and *deductive* methods (using abstract reasoning) became an important branch of natural philosophy. *Inductive* methods involving experimentation were not used. Some of the earliest natural philosophers were mathematicians. **Key question: *Who did the early natural philosophers think made the natural world work?*** (Pupils should understand the early connection between science and religion. Natural philosophy was usually connected with religion and theology (in the broadest sense) in early times because it was thought that when creating the universe, the *gods* were bound by rational principles that governed the natural order of the world. Greek philosophers such as Plato were the early proponents of this view. Science or natural philosophy was viewed chiefly as a means of understanding God’s creation. Science, maths and theology were all integrated subjects.

After having completed the timeline (1), done the discussion outlined above and copied some of the key questions and answers, pupils could quickly answer questions (2)-(6). Task (7) could be completed for homework.

SCIENCE AND NATURAL PHILOSOPHY BEFORE THE SEVENTEENTH CENTURY

Read the text below:

Plato was a Greek philosopher who was born about 427 BC – just over four centuries before Christians and theologians think that Jesus Christ was born. Plato founded an Academy in Athens in Greece, for the pursuit of philosophical and scientific teaching. One of his pupils who became very famous was **Aristotle**, a man who produced a great deal of philosophical writing. A few other very well-known philosophers who formulated very important theories are listed below:

Plato (428 – c. 338 BC) **Aristotle** (384-322 BC) **Ptolemy** (c. 2nd century AD)

Pythagoras (b. 580 BC) **Democritus** (b. 460 BC) **Epicurus** (341-270 BC)

All these natural philosophers tried to explain and answer many fundamental questions relating to man's life on earth - like how the world had been created and how various natural phenomena could be explained.

Much of the work of natural philosophers in late medieval times (about 1200-1500 AD) was based on the earlier writings of Aristotle and other ancient Greek philosophers. This means that the ideas in the Greek philosophers' writings were used for at least 1,000 years or more. **Aristotelian** theories were considered to be particularly important. These theories were based on the idea of 'essential forms and qualities' and they used **deductive** methods. Deductive methods were based on **abstract reasoning**; they were not based on experiments like modern science. For example, the answer of an Aristotelian to the question 'why is snow white?' would be 'because of the quality of whiteness in it'. A modern scientist would explain this very differently, with reference to the physical properties of ice, the behaviour, perception and transmission of light and the anatomy of the eye, optic nerve and brain.

Like many scientists of the seventeenth century, **Robert Boyle** (1627-91 AD) was very familiar with the writings of Aristotle. However, he and other seventeenth century scientists such as **Francis Bacon** (1561-1626) felt that Aristotle's ideas concerning forms and qualities and deductive methods did not help to explain the natural world very clearly. In fact, Boyle and others began to challenge the older scholastic modes of thought and formulated many new theories to help them understand the natural world. One of these was called the *mechanical philosophy*, which can be considered a precursor of the **atomic theory** used by modern scientists. This new philosophy was different from the Aristotelian theories which were based on *forms and qualities*. Moreover, Boyle and Bacon preferred to use **inductive methods** based on lots of experiments and the recording of results.



Francis Bacon (1561-1626). An engraved portrait by Simon van de Passe published in the year of Bacon's death. Bacon was a major influence on Boyle in his advocacy of an inductive method in science.



William Faithorne's engraved portrait of Boyle, with his air-pump in the background, 1664 (Sutherland Collection, Ashmolean Museum, Oxford).

PUPIL TASKS

1. Get some graph paper, turn it around into 'landscape' format and draw a horizontal line across it. Label the timeline (chronology) with the dates of birth and names of the natural philosophers listed above, being careful to distinguish between BC and AD dates. Add the year that Christians believe was the birth of Jesus Christ – 0 A.D. Add the birth and death dates of Robert Boyle (1627-91 AD) and Francis Bacon (1561-1626 AD). You do not have to draw the timeline to scale – just make it approximate. **Boyle's and Bacon's** names will occur towards the right hand edge; **Plato's** name will be placed at the extreme left hand edge. The birth of Jesus will be approximately one third of the way across the page from the left hand side. The title will be *Important Natural Philosophers from Plato to Boyle*.

2. If you were a natural philosopher in Plato's Academy, what questions concerning life and the universe would you wish to answer and explain? Try to list at least four. Do modern scientists have the answers to these questions? (hints: some questions might be 'how was the universe created?'; 'why are liquids different from solids?'; 'what things make up the parts of the human body?')

3. In which century did Plato and Aristotle live? What type of methods of enquiry did Plato and Aristotle use, *deductive* or *inductive*? What is special about inductive methods?

4. What types of methods of enquiry did Robert Boyle and Francis Bacon use? In which century did Bacon and Boyle live?

5. What types of methods do modern scientists use?

6. Do you think inductive methods are better than deductive methods? Explain your answer using the word 'because'.

7. Using the information on this worksheet and the notes copied from the teacher, complete the table below by ticking the boxes when the characteristic described in the left-hand box applies to modern science or natural philosophy in ancient times.

DIFFERENCES BETWEEN NATURAL PHILOSOPHY IN ANCIENT TIMES AND MODERN SCIENCE		
	Modern science	Natural Philosophy in Ancient Times
Uses inductive methods (experiments)	✓	✗
Uses deductive methods (abstract reasoning without experimental testing)		
Based on Aristotelian ideas		
Split into different subdisciplines		
Closely related to religion and theology		
Based on Aristotelian theories of forms and qualities		
Based on atomic theory		