2 THE SCIENTIFIC REVOLUTION IN ENGLAND AND EUROPE, 1500-1700

FOR TEACHERS

Lesson Title: The Scientific Revolution in England and Europe, 1500-1700

Area of Learning: states of affairs; change

Aims: Pupils should be able to: use their factual knowledge and understanding of the history of Britain and the wider world to describe past societies and periods, and to make links between features within and across different periods; to examine and explain the reasons for, and results of, events and changes.

Vocab: inductive, deductive, Aristotle, Aristotelian, Ptolemy, Ptolemaic, Francis Bacon, Baconian, ideal, Democritus, Copernicus, Copernican, atomists, Descartes, Cartesian, mechanistic, hypothesis, atomistic, atomic structure, corpuscles, corpuscularian, phenomena, cosmology, solar system, proposition

Time Frame: up to one hour, depending on tasks chosen

Resources: information and question sheet; scope for research using the internet or school library

Pupil tasks:
This lesson could be divided up into a least two sections. In the first, pupils should read (probably using class volunteers) the information sheet, which contains a great deal of complex information about the conceptual and methodological changes in scientific enquiry in the period 1500-1700. Teachers can explain terms and ideas as they are encountered. Teachers will need to explain the spider diagram concerning the causes of the Scientific Revolution. In order to help pupils fully understand this diagram, teachers may need to devise other tasks to enhance pupil comprehension.

In the second section, pupils should tackle the questions set, which have been devised to help them digest some of the information presented; they should be encouraged to continuously refer back to the information sheet when writing their answers.

Other tasks have also been set to ensure that pupils know the differences between the ancient Aristotelian explanatory schemes and methods and the new Baconian and Cartesian approaches in the 17th century. One of these may be set for homework although teachers may need to go through the Copernican and Ptolemaic diagrams (obtainable from the web).

Teachers may wish to liase with chemistry or physics teachers to ensure that pupils understand some basic information on atomic theory upon which much of modern science is based. Latin words occur in the Copernican and Ptolemaic cosmologies; these can be translated by classes familiar with the language.

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For Pupils THE SCIENTIFIC REVOLUTION IN ENGLAND AND EUROPE, 1500-1700

Read the text and answer the questions which follow.

As you have learnt in the last lesson, until the 16th century views about the natural world were dominated by ideas formulated by ancient Greek thinkers, particularly **Aristotle** (384-22 BC). Aristotle believed that the earth was at the centre of the universe. He believed that the world was made up of matter which was shaped by fixed 'forms' and 'qualities'. Both of these were essentially ideal types: the form of man, for instance, was a rational two-legged creature. Aristotle's **cosmology** – his view of how the planets were positioned in the solar system - was made more precise by **Ptolemy** (c.100-170 AD).

Others among the ancient Greeks had taken a different view of the working of the universe from Aristotle. Some, such as **Democritus** (460-370 BC), were **atomists**, believing that everything in the world could be explained by the action of self-directing matter. This was the basis of the atomic theory that scientists in the 20th and 21st centuries have made use of. Unfortunately, the atomic ideas of Democritus were generally dismissed in favour of those of Aristotle.

In the 16th and 17th centuries, many came to feel that the ideas of Aristotle did not give a satisfactory account of how the world worked. In 1543, **Copernicus** (1473-1543) questioned the claims of Aristotle and Ptolemy that the earth was at the centre of the universe. As a result of rethinking and fresh observation, a new Copernican cosmology gradually came to be accepted where the earth and other planets revolved around the sun.

An engraved portrait of Bacon, 1626

There was also a new *method*, championed particularly by the English thinker, **Francis Bacon** (1561-1626). Bacon advocated discovery by **'induction'**, by collecting as much information as possible, often from experiments, and drawing conclusions from it. This contrasts with the methods of **deduction** used by Aristotle and his followers, who worked from given **propositions** (statements) to reach a set conclusion.

In the 17th century, there was a challenge to Aristotle's view of matter. Many thinkers, including René **Descartes** (1596-1650), argued that the world was a kind of machine, everything in which could be explained according to the principles of matter in motion. This was a **mechanistic view** of the world. Robert Boyle adopted the mechanistic view, calling it his 'mechanical hypothesis'. He believed that matter had an **atomic structure,** an idea which was not really new because it had indeed been put forward by thinkers in classical antiquity like **Democritus** but, as stated above, most people living at that time had not really felt it was a relevant theory**.** Boyle called the units of matter **'corpuscles'** and called himself a **'corpuscularian'.**

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Brass cast by C.R.Berch of an ivory medallion of Boyle produced by Jean Cavalier in 1690

Boyle believed that mechanical principles were sufficient to explain all **phenomena** (things and events) in the world. He argued that the Aristotelian 'forms' and 'qualities' were meaningless. For instance, Boyle asked why snow dazzles the eyes, to which an Aristotelian would answer simply 'because of the Quality of Whiteness in it'. 'What is this quality?' Boyle asked. The Aristotelian would answer: 'it is that which denominates the matter it is made of, White'. 'Why does white dazzle, when blue and green do not?' asked Boyle. An Aristotelian would reply 'It is their natures that make them act this way'. Boyle thought that all this Aristotelian reasoning was circular and empty. Instead, he considered that a mechanical explanation in terms of light and its reflection was much more plausible.

Boyle was a pioneer of controlled experiment. He laid down guidelines for making experiments, arguing that they should be recorded in detail, even when they failed. He exemplified his principles by making, recording and publishing experiments throughout his life.

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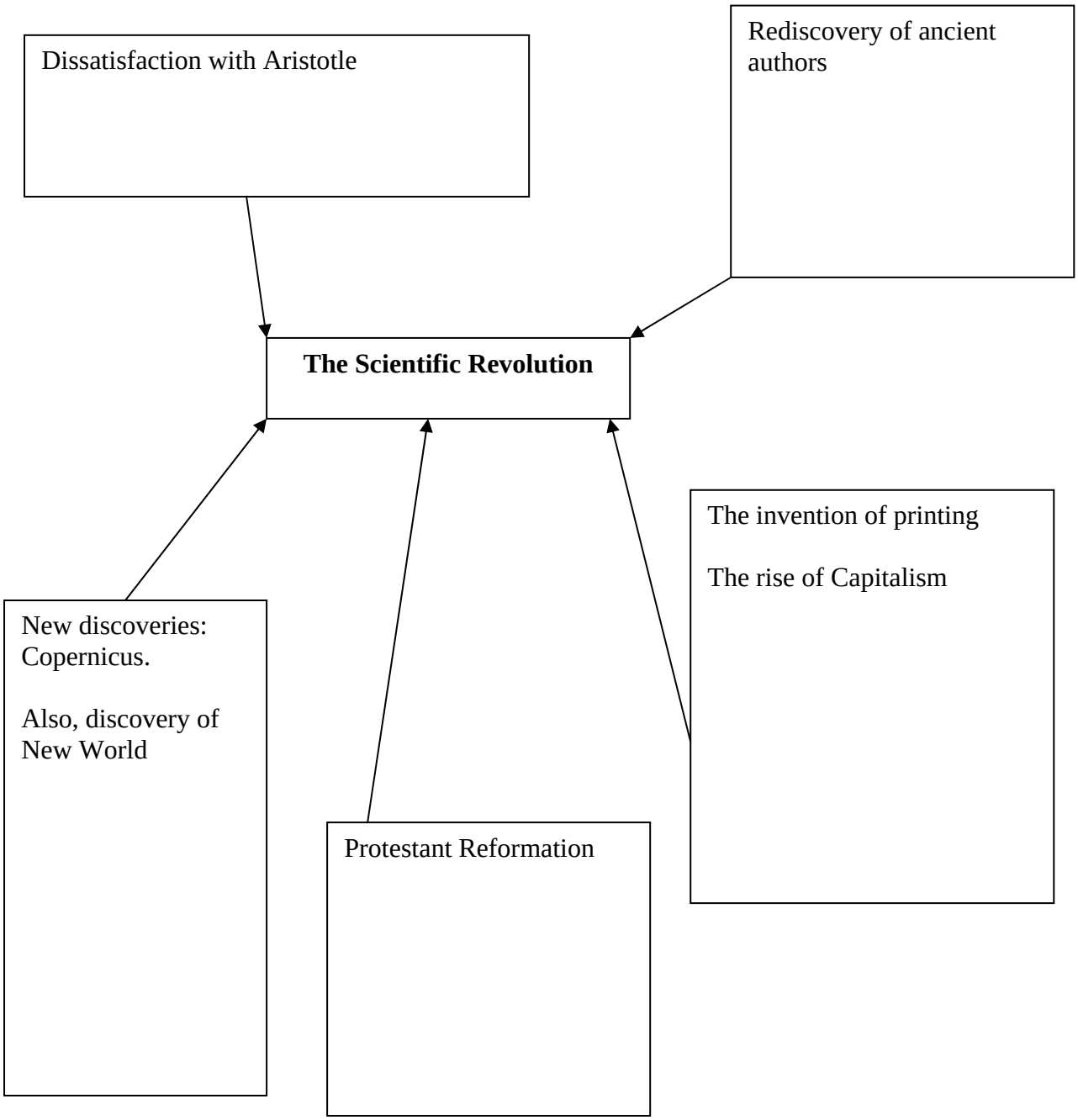
Why did the Scientific revolution happen?



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Pupil Tasks **Questions on pupil text**

1. Why do you think ancient man, including Aristotle, might have thought that the planets revolved around the earth? (hint: how important might they have felt human beings were in the wider universe? Do you feel the earth moving when you look at the sun?)

2. Carefully describe Aristotle's *deductive* and Bacon's *inductive* and experimental methods of reasoning.

3.What advantages do you think Bacon's methods had? If you were a scientist in the 1650s in England, what method would you prefer to use, the *deductive* or *inductive*?

4. Robert Boyle thought it was important to record the results of experiments even when they went wrong or did not work. Scientists do that today. Why do you think it might be important to do this?

5. Using the spider diagram on The Causes of the Scientific Revolution, write a paragraph explaining why a 'revolution' in science occurred in the sixteenth and seventeenth century. (Use the back of this sheet if necessary.)

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ADDITIONAL TASKS

Task A Construct a chronology (timeline) including Aristotle, Democritus, Copernicus, Bacon, Boyle and Descartes. Work out a scale (you may need two sheets of paper for this). Use the dates of birth and death for each man given in brackets on the pupil text sheet. See if you can find images of any of these men on the internet and stick them onto your chronology. Write a brief sentence about the ideas of each man.

Task B Download and print out an enlarged picture of the **Ptolemaic cosmological system** from http://es.rice.edu/ES/humsoc/Galileo/Images/Astro/Conceptions/ptolematic_universe.gif. Label and highlight the moon, the sun, the earth, Venus and Saturn. Download and print out an enlarged picture of the **Copernican cosmological system** from http://es.rice.edu/ES/humsoc/Galileo/Things/copernican_system.html#fn0 Label and highlight the sun, the earth, Venus and Saturn. Find a modern-day diagram of the solar system in an on-line or printed encyclopaedia in your library. In what ways does it differ from the Ptolemaic and Copernican systems? (Look carefully at the position and number of planets listed, moons, asteroid belt etc)

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Robert Boyle made his own cosmological diagram, and copied it into the student notebook that he made when he was a student at Geneva in the 1640s. He entitled it *A Figure of the Construction of the World*. It is pictured below

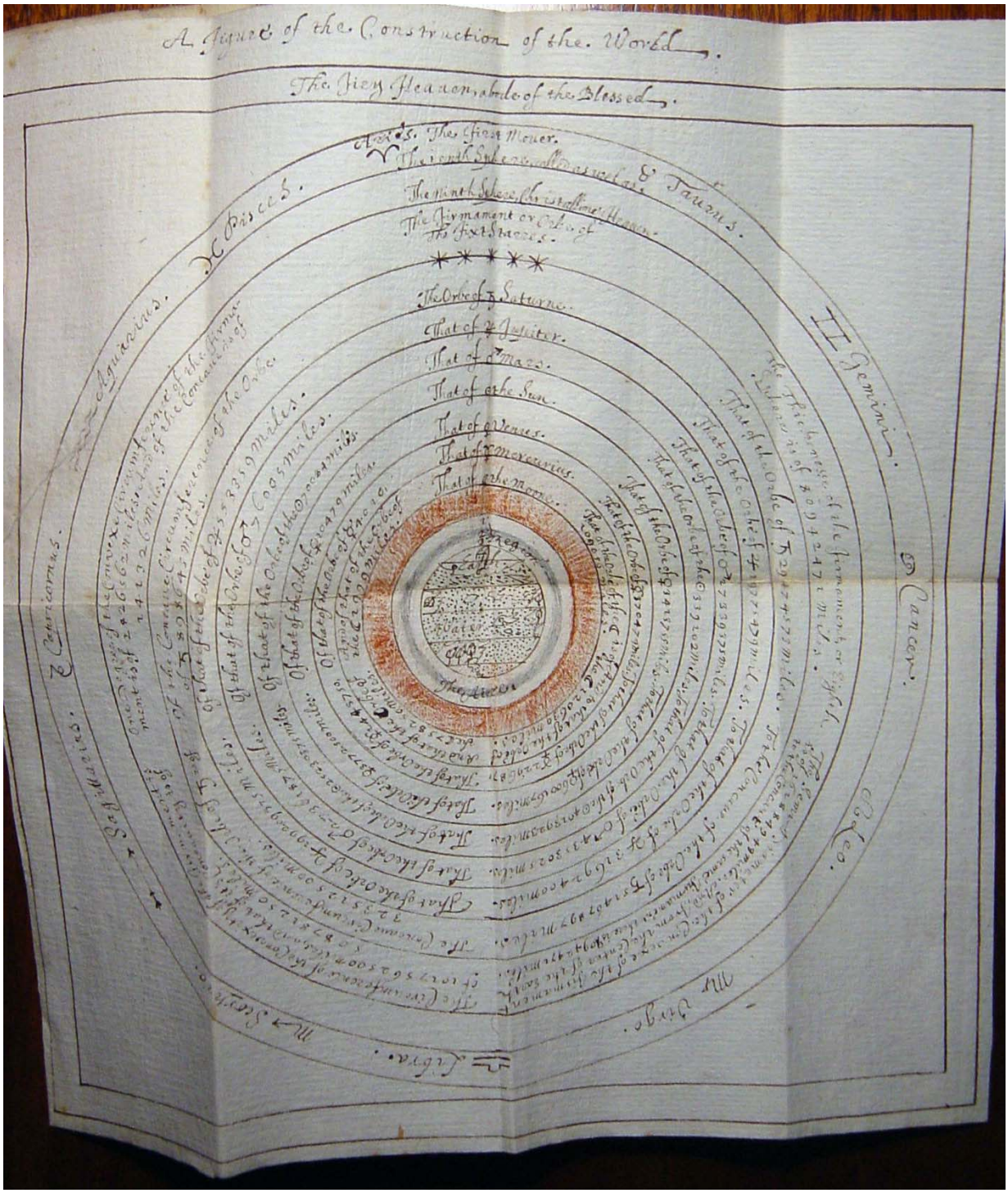

Diagram of universe from Boyle's student notebook (Royal Society MS 44. © The Royal Society).

Look carefully at the Boyle diagram and compare it to the Ptolemaic and Copernican ones. Which one do you think Boyle may have copied?

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Task C Create two posters, one advertising or promoting the Aristotelian deductive method of enquiry, the other promoting the Baconian inductive and experimental method used by Robert Boyle and some of his contemporaries. Draw the posters by hand or design them using a word processor. You could illustrate your posters using pictures of Boyle (http://www.bbk.ac.uk/Boyle) and Bacon (http://www.thoemmes.com/404.asp?404;http://www.thoemmes.com/encyclopedia/bacon.htm) found on the internet:

When searching for Bacon, define your search terms carefully so you do not get him confused with the twentieth century artist with the same name.

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