Unit 21 From Aristotle to the atom: scientific discoveries that changed the world?

About the unit

In this unit pupils learn about the discoveries of some important scientific thinkers, to evaluate the impact these ideas had on the society within which they were developed and the long-term importance of these discoveries. The emphasis is on the discoveries and their effects on men, women and children at the time and later. Knowledge of the science involved is not expected.

This unit is expected to take 8–11 hours.

Where the unit fits in

This unit aims to span the whole of the key stage, pulling events, people and ideas together and making appropriate links from a different perspective. The unit also links to unit 7L 'The solar system and beyond', unit 8C 'Microbes and disease', 9I 'Energy and electricity' and unit 9J 'Gravity and space' in the science scheme of work.

Expectations

At the end of this unit

most pupils will: understand the impact of certain scientific discoveries on the people living at the time they were made and on the long-term importance of these discoveries; identify and evaluate sources of information, which they use critically to reach and support conclusions

some pupils will not have made so much progress and will: know that some scientific discoveries affected people living at the time and some had a long-term effect; begin to evaluate sources of information and identify those that are useful for particular tasks

some pupils will have progressed further and will: make links between scientific discoveries and the dynamics of the period within which they were made, understanding that their importance and impact varied between people and across time; use sources of information critically, carry out historical investigations, and reach substantiated conclusions independently

Prior learning

It is helpful if pupils have completed the key stage 3 programme of study as this unit revisits elements within several aspects of it.

Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly words relating to:

- the universe, *eg solar system, planets*
- fundamental laws, *eg gravity, planetary motion, atomic theory*
- evolution, *eg inheritance, survival of the fittest, natural selection, species*
- medicine, *eg miasma, germ*

Reading – through the activities pupils could:

- appraise texts quickly and effectively for their usefulness
- identify what information is needed, and draw together information from different sources
- evaluate how effectively information is presented in whole texts

Writing – through the activities pupils could:

- understand the effect of different aspects of formality – passive verbs, third person, abstract nouns

Resources

Resources include:

- source material relating to the interest of ancient civilizations in the visible universe
- sequences of pictures to illustrate Darwin's theory of evolution
- a range of source material representative of reactions to Darwin's Theory of Evolution
- useful websites, *eg www.bbc.co.uk/education/medicine/; www.rnv.u-net.com/*

Out-of-school learning

Pupils could visit museums, *eg Science Museum, London*, and sites of scientific exploration, *eg Greenwich Observatory, Jodrell Bank, Cheshire*.

Future learning

Links can be made with unit 22 'The role of the individual' and with an individual's impact on society. Pupils going on to study history at GCSE will be able to build on the knowledge of different periods drawn together in this unit and on skills such as evaluating evidence from different sources to present a reasoned argument.

1	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
	Where is the world?			
	• about the ideas of people in ancient civilisations concerning the structure and functioning of the universe • that Aristotle's idea of a geocentric solar system dominated thinking for over 1,500 years • about the work of Copernicus, identifying how it differed from the Aristotelian universe • to explain the attitude of the Roman Catholic Church to Galileo and why he was tried for heresy • to select information from sources and reach conclusions • about differing points of view and how these can be represented	• Give pupils a range of written and pictorial sources showing the ways in which people of ancient civilisations regarded the sun, moon, stars and planets. • Pupils, either individually or in groups, work with the sources in order to determine what they tell us about people's ideas about the universe. They frame questions and draw conclusions. • Discuss the findings as a class and record them on large posters. Use the posters to emphasise that ancient civilisations throughout the world were very aware of the heavens and the movement of the objects within them. • Tell pupils about Aristotle's idea about how the solar system worked and show them a large drawing or model. • Ask pupils to demonstrate how the Aristotelian model worked by pacing out the movement of the earth, sun, moon and the planets. • Explain that this model of the universe survived, unchanged, for over 1,000 years and that this view of an earth-centred solar system was accepted by the Catholic Church (and by the Protestants in the sixteenth century) as being true. • Brief a small group of pupils on the way Copernicus' model worked. Ask these pupils to show the rest of the class, by pacing out, how the system worked. Discuss as a group the differences between the two models. • Tell the story of Galileo, explaining the attitude of the Roman Catholic Church and Galileo's subsequent trial and conviction for heresy. Pupils take notes to use in the next activity in this section. • Pupils take on the role of legal correspondent for either a pro- or anti- journal and write a report of the trial that would be acceptable to the paper for which they work. • In a class discussion ask pupils to consider what made Copernicus' ideas so revolutionary. Focus on the extent of the differences, the reaction to his ideas at the time, how his ideas would have affected people at the time, *eg a peasant, a sailor, a crusader, a monk*. Pupils can also consider the later importance of the ideas.	• extract information from sources to create a composite picture that represents the understanding that people in ancient civilisations had of the universe and earth's place in it • demonstrate an understanding of the differences between the Copernican and Aristotelian universe • write a report from a specific point of view, either for or against the Catholic view of Galileo's alleged heresy	• Links can be made with unit 7L 'The solar system and beyond' in the science scheme of work, but it must be emphasised that in this history unit the focus is on the effects of specific discoveries. Lessons on Newtonian physics will not be required. • This unit spans a considerable stretch of time. It might be appropriate to work with a timeline so that events and discoveries can be placed on it as they unfold. • Sources used in the first activity should be as stimulating and wide ranging as possible, *eg Stonehenge, Egyptian astronomy, Indian observatories, Greek and Roman gods, the story of Persephone*. • This section should draw on pupils' knowledge and understanding of the medieval church from unit 4 'Medieval church'.

2	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note

The scientific revolution: what is a revolution?

- that the seventeenth century in Britain was one of unprecedented scientific discovery
- to use prior knowledge of revolutions in order to identify key features
- to assess the contribution made by specific individuals to the scientific revolution using period knowledge
- to carry out investigations in groups
- to make links between the discoveries of those contributing to the scientific revolution

- Link back to the previous section by discussing why Copernicus' ideas were revolutionary.
- Remind pupils of the work they have done on two seventeenth-century revolutions: the English civil wars (sometimes called the English Revolution) and the Glorious Revolution. Ask pupils to look out any common factors between these events that made them revolutions.
- Widen the discussion to include any and all revolutions they know about, *eg American, French, industrial, agrarian.* Ask pupils to decide whether there are any common criteria that can be applied in defining a revolution.
- Using their agreed criteria, introduce the idea of a scientific revolution.
- Remind pupils that Aristotle and Copernicus had described the relationship of the earth to the sun and other planets. It was Isaac Newton who explained why they move as they do.
- Tell the story of Isaac Newton. Emphasise that Newton's importance was that he discovered that the universe was governed by fundamental laws. This discovery encouraged later scientists to look for other unchangeable laws.
- Consolidate pupils' understanding by using a card-sorting activity where they match 'ideas' 'discoveries' and 'people'.
- Ask pupils, working in groups, to use a range of sources to investigate the life and work of other contributors to the scientific revolution, *eg Francis Bacon, William Harvey, Richard Lower, Robert Hooke, Robert Boyle, Charles II*. Emphasise that it is not the science they need to find out about but the impact, both at the time and later, of what these people did.
- Each group then presents its findings to the class. A whole-class activity could be to build up a visual display of the links between all the contributors to the scientific revolution.
- Pupils refer back to their early work on the other revolutions and the activity above to answer the question *Is it accurate to describe the scientific revolution as a revolution?*

- identify and describe common criteria underpinning revolutions
- show that there are specific links between the ideas of Aristotle, Galileo, Copernicus and Newton
- describe the main features of the scientific revolution and its impact within and across periods
- select and use a range of sources of information to produce a summary of the significance of an individual's work

- It may be helpful to have some visual sources to help pupils make links back to work on other revolutions.
- The work of more able pupils could be extended by including other individuals in the scientific revolution, *eg philosophers and artists*.
- ICT: in planning their work on the individuals involved in the scientific revolution, pupils could discuss which ICT tools to use to research effectively, to present work and to allow merging to produce a whole-class presentation.

3	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
Charles Darwin: are people just another species?				
	• about Charles Darwin and his ideas on natural selection • that Charles Darwin's theory of evolution challenged many people's established beliefs • to examine and explain a range of contemporary attitudes towards Darwin's ideas • to make inferences from several sources and reach a balanced conclusion	• Establish the context for this activity by reminding pupils of the focus on new ideas in the seventeenth century in the previous activity, then taking them forward in time to the nineteenth century. A timeline could be used, drawing on topics that pupils have studied over the key stage. • Show pupils a range of images of nineteenth-century Britain emphasising exploration, discovery, investigation and invention. Pupils brainstorm the words they would use to describe a society that generated this level of enterprise and curiosity. • Show pupils a different range of images of nineteenth-century Britain emphasising convention, propriety and conformity. Pupils brainstorm the words they would use to describe a society that generated this level of conservatism. • Tell pupils, or show a video, about Charles Darwin and the voyage of *HMS Beagle* to South America and the Pacific islands in 1831. • Illustrate his findings, explaining how he arrived at his ideas regarding natural selection and came to write *On the origin of species*. • Remind pupils of their conclusions about nineteenth-century Britain and ask them to suggest the impact that Darwin's ideas could have had on Victorian society. • Provide pupils with a range of contemporary source material indicative of attitudes to Darwin's theory of evolution. Working in groups, pupils sort the source material according to the attitude displayed and begin to suggest reasons why people reacted as they did. • Interview each group (who take on, collectively, a particular attitude or attitudes). Each group must explain to their puzzled interviewer why it is a shocking idea that people should believe that the human species is part of the evolutionary chain, along with other animal species.	• reach conclusions about Victorian society based on inferences and synthesis of sources • explain the reasons for the complex impact of Darwin's theory of evolution • demonstrate an understanding of contemporary attitudes to Darwin's theory of evolution	• Categories may need to be suggested to the pupils, *eg 'fear', 'understanding of importance', 'ridicule'*. The nature of the source material collected will dictate the specific categories. • Extension work could include the work of Gregor Mendel which complements that of Darwin and could provide a useful bridge into the next section of this unit. • Teachers might consider it appropriate to discuss the reasons why, in some parts of the world, the teaching of Darwin's theory of evolution is forbidden by law. Teachers should be sensitive to the beliefs of others. • Specific links could be made with unit 11 'Industrial changes' and unit 12 'Middle-class life 1900' to draw on pupils' knowledge of Victorian ideas and attitudes for the first and second brainstorming activities. The images given to the class could relate specifically to those covered by the local study.

4	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
	Miasma or germs: how is disease spread?			
	• to use prior knowledge to explore common features • to use a range of sources to investigate the validity of ideas relating to the spread of disease before the germ theory • that Pasteur discovered and Koch developed a scientific theory about the spread of disease • to assess the initial impact of the germ theory on British society • to select, organise and deploy relevant information to produce structured work, making appropriate use of dates and terms • to draw on their knowledge of nineteenth-century Britain when assessing and using new information	• Revisit, briefly, work done in previous units on the spread of two major infectious diseases: the Black Death in the fourteenth century and cholera in the nineteenth century. *What did these diseases have in common?* • Provide pupils with a range of sources illustrating different ideas about the spread of disease from earliest times to mid-nineteenth century. Pupils, individually or in groups, decide firstly what the 'cure' would be if the 'cause' was correct and then whether the 'cure' would, in fact, work. • Pupils research the work of Louis Pasteur and Robert Koch and decide which scientist really did discover the germ theory of disease. As a class discuss the findings and consider the question *Why was the germ theory so important?* • Give pupils a range of sources on public health in Britain in the second half of the nineteenth century. Ask them to assess the impact of the germ theory on aspects of British society. • Ask pupils to design posters or write newspaper articles to encourage people in the 1880s to protect themselves from the spread of disease by germs.	• recognise that there were many pre-scientific theories about the spread of disease, some of which worked when acted on • demonstrate research skills of investigation, selection and deployment, appraising texts quickly and effectively for their usefulness • recognise that some people did not accept scientifically proven theories • use historical knowledge accurately to produce a persuasive piece of writing	• Teachers should use as wide a range of 'causes' as possible, from superstition to the miasma and spontaneous generation theories of the nineteenth century. • The purpose of asking pupils to sort out whether any of the 'cures' would work is to encourage them to consider both the accidental outcome of events and the fact that the achievement of a desired outcome does not mean that the way it was achieved is valid and could be replicated. • Teachers may wish to indicate that the spread of disease is an area of science into which research is continuing. Links could be made with unit 3 'Medieval people', unit 11 'Industrial changes', unit 12 'Middle-class life 1900' and unit 20 'Twentieth-century medicine'. • Links can also be made with unit 8C 'Microbes and disease' in the science scheme of work.

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
Splitting the atom: for good or ill?			
• that the scientists who split the atom discovered an enormous source of power • that politicians made use of this source of power by encouraging the development of atomic bombs – and later used them in war • to analyse the decisions made by key individuals in history • to use a range of sources of information to reach and support conclusions	• Remind pupils of the work done in unit 18 'Twentieth-century conflicts' in connection with the Second World War and the ending of the war with Japan by dropping atomic bombs on Hiroshima and Nagasaki. • Ask the question *Where did this tremendous power come from?* Briefly outline the work of Rutherford and his team in splitting the atom. Emphasise the potential long-term importance of this, rather than the scientific intricacies of what was done. • Explain that between the splitting of the atom and the building of the atom bomb some scientists warned politicians what the likely outcomes could be. Ensure that pupils are aware of the basic difference between scientists, who make discoveries, and politicians, who decide what to do with these discoveries. • Through the use of source material, consider the situation facing political leaders, *eg Truman, Churchill,* in 1945. Pupils prioritise the reasons each war leader had for agreeing to drop the atom bombs and reach a supported conclusion as to whether the decision was justified. • Provide a range of sources for and against the development and use of nuclear power. Working in groups, pupils prepare a case either for or against nuclear power. Each group devises a means of publicising its case, *eg magazine article, leaflets, structured debate.*	• demonstrate an understanding that politicians use the work of scientists • recognise that there were many different pressures operating on war leaders that led to the decision to drop the atomic bombs • evaluate a range of source materials on the war leaders and on the development and use of nuclear power • reach substantiated conclusions based on the critical use of sources	• Links can be made with unit 18 'Twentieth-century conflicts'. • Teachers will need to make it clear to pupils that Rutherford was working on atomic structure and would not have necessarily foreseen one of the eventual outcomes – the development of the atomic bomb. • The moral implications of the use and abuse of nuclear power could be explored. • Language for learning: pupils appraise texts quickly and effectively for their usefulness, and evaluate how effectively information is presented.
Which discoveries changed the world the most?			
• to present a reasoned case in support of the importance of a specific individual • to make links between their knowledge of key developments within and across periods	• Introduce pupils to the idea of a 'balloon debate'. • Pupils, in groups, select one of the individuals they have studied in this unit and prepare a case for that person (or group of people) staying in the 'balloon' until the end. Pupils should be encouraged to study the individual's contemporary and subsequent significance. • One pupil from each group, supported by the rest of the group, argues that their chosen individual's discoveries make it imperative that he or she remains in the balloon until the end.	• use detailed knowledge to construct a coherent argument that recognises the significance of individuals • communicate knowledge and understanding orally	• The written work in preparation for the balloon debates will provide summative evidence of pupils' understanding of the main themes of this unit.