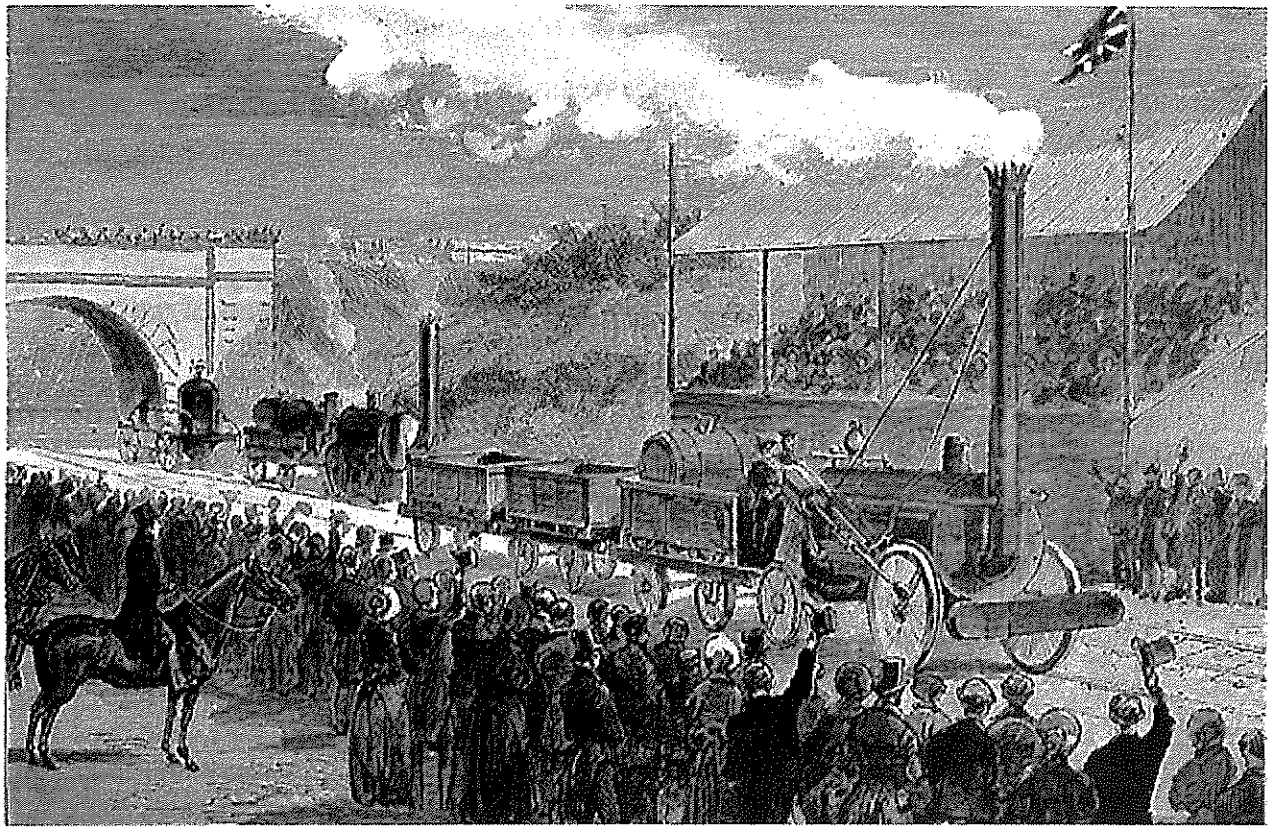
TOPIC 1a: The Industrial Revolution



Stephenson's *Rocket*, the first steam locomotive used on the Manchester–Liverpool railway

Historians use the term 'Industrial Revolution' to describe the period of rapid change that took place, initially in Britain, between about 1750 and 1850. During the nineteenth century it spread to Europe, the United States and Japan.

In Britain in 1750, apart from a few major cities such as London, most people made their living from agriculture, using methods that had changed very little from the Middle Ages. Most people lived in small villages. The spinning and weaving of textiles took place in cottages; iron was worked by the village blacksmith and most other industries were small family businesses. Apart from the physical work of men and women, the only additional sources of power were wind, water and animals like horses and oxen.

By 1850 Britain's population was three times that of 1750, but a far smaller proportion of the population worked on farms. Most people lived in large towns and worked in big factories servicing machines that were powered by steam engines. Iron was now produced in large blast furnaces. Goods and people were now transported by locomotives and ships. These were driven by powerful steam engines, at far greater speeds than would have been thought possible 100 years earlier.

In this topic we will explore:

- the causes of this revolution

- the stages through which it passed
- the different ways in which it spread to other countries
- the effects it had on the lives of men, women and children.

1a:1 Background

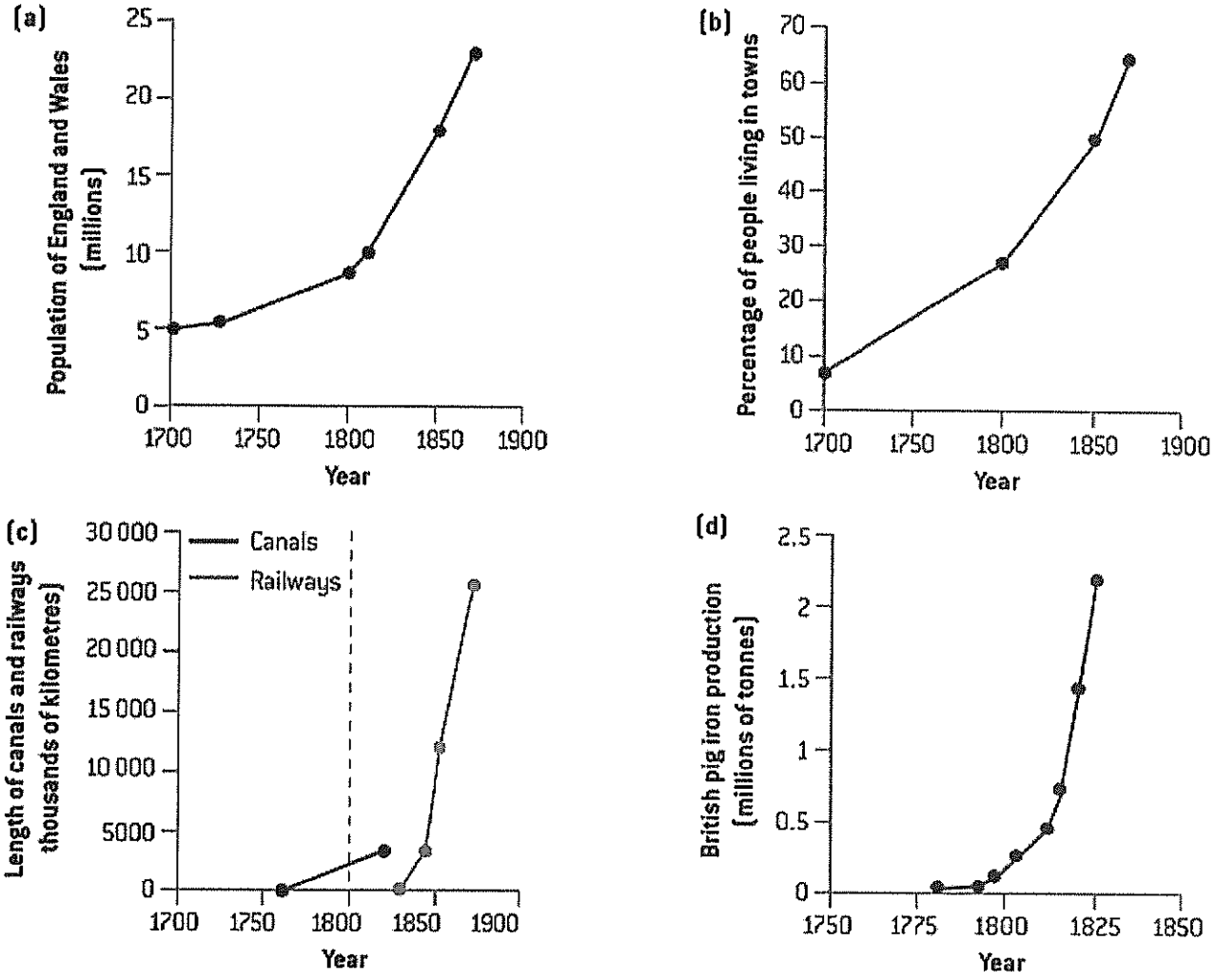
In Year 7 you learned about the **agricultural revolution**. This began some 12 000 years ago when people began to grow their own crops instead of gathering seeds, fruits, nuts and berries in the wild, and people domesticated animals and kept them close to where they lived instead of hunting animals only when they needed food. Over the next 6000 or so years this agricultural revolution spread to most areas of the world, although until about 300 years ago there were still isolated communities with a hunter–gather economy. This agricultural revolution made possible villages, towns and early cities.

A second widespread change in the ways in which people produced food and goods took place about two and a half centuries ago. Instead of people producing goods at home or in small family businesses, goods were now produced in large factories powered by machines. Instead of travelling by foot, on horseback or in a horse-drawn coach, people travelled in trains powered by steam engines. It began in England, and by 1900 had spread to Western Europe, the United States and Japan. Its impact was also felt in Australia from the 1850s. This has been called the **Industrial Revolution**. Rapid industrialisation is today taking place in the two most highly populated countries in the world — China and India.

Significant factors that characterised the Industrial Revolution were: the use of coal as a source of energy; wide availability of iron; the use of steam-driven machinery; and applying steam power to transport.

There were many other changes that were also an essential part of the Industrial Revolution, including: improvements in agricultural production; a rapid rise in population; a rapid increase in the number of cities; the development of banking and insurance facilities to finance this.

Source 1 provides data on a number of these factors.



SOURCE 1 Graphs showing some of the key indicators of the changes that were part of the Industrial Revolution in England between 1700 and 1880

Source questions

Use source 1 to answer the following questions.

1. What do graphs 1a and 1d both indicate about the rate of change from the period 1750–1800 when compared with the rate of change in the period 1800–1850?
2. After studying graph 1c, write a sentence describing what happened to the building of canals and to the building of railways between 1800 and 1850.
3. What could be some connections between the growth of railways in graph 1c and the production of pig iron in graph 1d?

Increased production of consumer goods at a low price and improvements in methods of transport benefited the growing middle class, but for most of the workers there were negative effects: poor working conditions with long hours and dangerous machinery, crowded cities with poor sanitation, and pollution from the extensive burning of coal.

Some effects of the Industrial Revolution continue today. As China and India industrialise, the amount of carbon dioxide in the atmosphere from burning coal will continue to increase and lead to increased global warming.

Population growth and movements

Until 1700, Britain's population had either grown slowly or occasionally suffered a sudden decline due to epidemics such as the bubonic plague. However, from 1700 it began to rise dramatically. A population of five million in 1700 approached nine million in 1800 and 20 million by 1861. Some of the factors causing this increase were advances in medical science, such as a vaccine for smallpox and an understanding of the causes of typhoid fever; women marrying younger and having more babies; and more babies and infants surviving to adulthood.

Improvements in agricultural techniques and changes in farming methods meant fewer people were required as farm labourers, so people moved into towns and cities. In industrial towns these people could be employed in the new factories, but in eighteenth-century London there was less work and people turned to crime. Because the jails could not cope with the number of convicts, many were transported to the American colonies. When the United States won their independence from Britain, these convicts were sent instead to New South Wales.

During the nineteenth century millions more chose to emigrate to Canada, the United States, Australia and New Zealand. Different factors operated in different places. In the Scottish Highlands, in the early nineteenth century landowners turned from growing crops to raising sheep and evicted many thousands of small farmers. In Ireland in 1845–1852 and Scotland in 1846–1857 a potato fungus destroyed the major source of food, resulting in the death of over a million people and the emigration of up to two million. People were also attracted to places such as Australia by the discovery of gold and the chance to own their own land.

The importance of consumerism

The scientific and technological advances of the Industrial Revolution, examined in the following sections, initially came in response to a greatly increased demand for consumer goods, both those imported from China like fine porcelain and for locally produced goods such as clocks and watches, pottery, silverware, and fine cloth.

Most of the demand came from the newly emerged middle class — people in the professions such as doctors or clergymen, or people who made their income from banking, selling of property or trade.

Most of these lived in or near London. By 1700, London was a major world city. It had an estimated population of 674 000, more than a tenth of the total population of England and Wales. It was a centre of trade with the colonies, the centre of Parliament and the centre of banking and trade. During the eighteenth century it also became the place where there was a flourishing trade in consumer goods.

The birth of the modern shop

Much of London had been rebuilt following the Great Plague of 1665 and the Great Fire of 1666. While there were areas of slums on the East Side of London, the first modern shops were appearing on streets like Pall Mall, Regent Street and the Strand. The French had discovered how to make plate glass in 1688. This glass could be made in large panes, was clear, and did not distort light as earlier glass did. It was used to make large windows to display the goods and attract customers.

> *It is almost impossible to express how well everything is organised in London, every article is made more attractive to the eye than in Paris or in another town... We especially noted a cunning device for showing women's materials. Whether they are silks, chintzes or muslins, they hang down in folds behind the fine high windows, so that the effect of this or that material, as it would be seen in the ordinary folds of a woman's dress can be studied... Behind great glass windows absolutely everything one can think of is neatly and attractively displayed and in such abundance of choice as almost to make one greedy.*
>
> **Quoted in R. Porter, *London A Social History*, Harvard, Massachusetts, 1995, p. 144.**

SOURCE 2 Sophie von La Roche (1731–1807), a German novelist, describes the London shops.

SOURCE 3 An engraving showing Harding Howell & Co., a fashionable draper's shop in London, 1809

> *On both sides tall houses with plate-glass windows. The lower floors consist of shops and seem to be made entirely of glass; many thousand candles light up silverware, engravings, books, clocks, glass, pewter paintings, women's finery, modish and otherwise, gold, precious stones, steel-work, and endless coffee rooms and lottery offices. The street looks as though it were illuminated for some festivity: the apothecaries and druggists display glasses filled with gay-coloured spirits; the confectioners dazzle your eyes with their candelabra and tickle your nose.*
>
> **Quoted in R. Porter, *London A Social History*, Harvard, Massachusetts, 1995, p. 145.**

SOURCE 4 Another visitor describes a walk on London streets at this time.

Source questions

Use sources 2, 3 and 4 to answer the following questions.

1. Make a list of the consumer goods available in London at this time.
2. Identify at least three ways in which shopkeepers aimed to make their goods seen and seem attractive to the consumers.

To satisfy this growing market for consumer products, many goods that had been made in small family businesses were increasingly being produced in large factories. Some of the names associated with the manufacturers of these products are still known today: Wedgwood for pottery, Chippendale for furniture and Wiltshire for knives. Some names of places are also still associated with consumer goods: Staffordshire for pottery, Sheffield for cutlery and Manchester for household linen.

As well as changing the way goods were produced, the development of factories also led to improvements in transport, banking and finance, and organisation. In the eighteenth century, improvements in the cotton industry were the most dramatic, but widespread changes took place in other industries as well. The pottery industry, as developed by Josiah Wedgwood, is one such example.

ACTIVITIES

CHECK KNOWLEDGE AND UNDERSTANDING

1. What were the major changes brought about during:

a. the agricultural revolution

b. the Industrial Revolution?

2. What were the major factors that resulted in a rise in population in England during the eighteenth and nineteenth centuries?

3. What contributions did this increasing population make to the Industrial Revolution?
4. List the negative effects the Industrial Revolution had on ordinary people in England.
5. What is the connection between global warming today and the origins of the Industrial Revolution?
6. In 1700, London was the only major city of England. What were the activities around which this importance was based?
7. With what product is each of the following places in England still associated today?

a. Sheffield

b. Manchester

c. Staffordshire

PERSPECTIVES AND INTERPRETATIONS

8. Many of the ways in which London shopkeepers used to entice customers to enter their shops and buy goods are still in use today.

a. Make a list of similar methods used today.

b. What additional methods are used today?

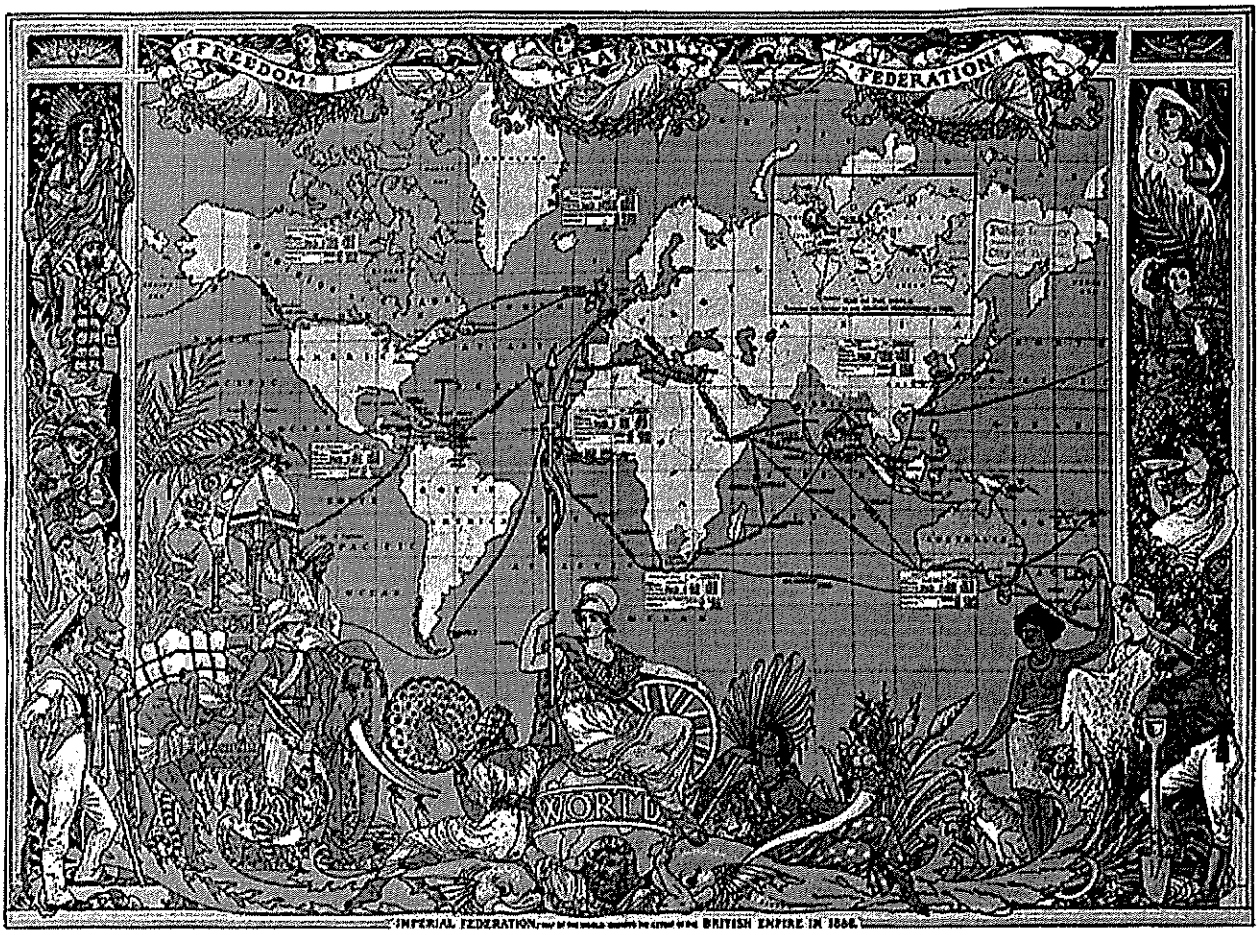
EXPLANATION AND COMMUNICATION

9. Many of the innovations in the early stages of the Industrial Revolution were a result of trying to meet a consumer demand for quality goods at as low a price as possible. Write a paragraph, based on this section and your own research, that will support this argument.

1a:2 The importance of Empire

Another important factor in Britain's early industrialisation was its possession of a vast empire stretching around the world. Having an empire helped in three ways:

- it provided a large market for goods that were produced
- it was a source of necessary raw materials — Australia, for example, provided copper, zinc, wool and, when refrigeration was possible, meat.
- colonies such as Australia and Canada were places to send excess population.



SOURCE 1 An elaborately decorated map of the world glorifying the British empire in the late nineteenth century

In the sixteenth century the Portuguese and the Spanish were the dominant overseas powers and divided the known world between them. It was in the seventeenth century that the Dutch, British and French began to acquire territory, especially in India, South East Asia and North America. The Dutch concentrated on what is now Indonesia, but which they called the Dutch East Indies. The English and French set up trading posts in India and settlements in North America.

Rivalries between England and France led to the Seven Years War (1756–63), which resulted in England acquiring territory from France and becoming the dominant imperial power. Although the American colonies won their political independence from Britain in 1786, they remained important trading partners of England. By 1830 Britain had added South Africa, more territory in India and Australia, and New Zealand to its empire.

In the nineteenth century it was common practice to say that 'the sun never sets on the British Empire' (see source 2).

> *On her dominions the sun never sets; before his evening rays leave the spires of Quebec, his morning beams have shone three hours on Port*

Jackson, and while sinking from the waters of Lake Superior, his eye opens upon the Mouth of the Ganges.

SOURCE 2 One example of the use of the phrase 'the sun never sets on the British Empire' from 'The British empire', *The Caledonian Mercury* 15 October 1821, p. 4

ACTIVITIES

DEVELOP SOURCE SKILLS

1. Study source 1. As the sun appears to move from east to west across the world map, name five British territories it would pass over.
2. Does this support the statement 'The sun never sets on the British Empire' (see source 2)? Why or why not?
3. Name five items in source 1 that are used to represent Australia.
4. Name other territories that are shown as British and identify one symbol for each.

RESEARCH

5.

a. Who were the main colonising countries in the sixteenth century and what colonies did they establish? (Find at least two colonies for each country.)

b. Who were the main colonising countries in the seventeenth century and where did each of these establish colonies?

c. Who were the two main rival colonising countries in the eighteenth century and what were two areas they fought over?

1a:3 Improvements in agriculture

In 1700, over half of the farms still followed farming practices of the Middle Ages, but this was a time when changes in the use of the land, in farming machinery and in selective breeding began to revolutionise agriculture. Increases in farm production provided food for the increasing population, particularly the growing number living in towns and working in the factories.

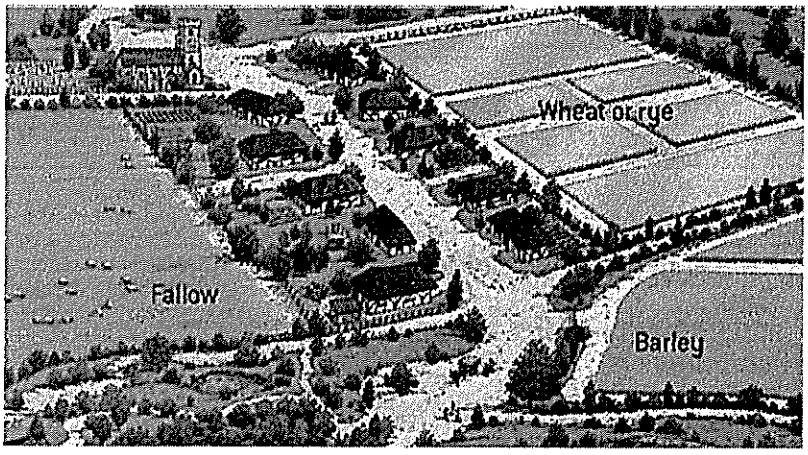
Traditional open-field farming

The traditional open-field village was based on subsistence farming, supplying only enough food for its inhabitants, who were peasants or tenants of the actual landowner. It usually involved the rotation of different crops across three large fields. One field would carry a crop of wheat or rye, one a crop of barley, and one would lie fallow. Each year the crops would be rotated so that each field would

lie fallow for one year in every three. The villagers each had a number of strips on each field, usually spread out so that everyone had equal access to the best land. There was also an open area of common land where everyone had the right to graze livestock and collect firewood. Grazing also took place on the field lying fallow, helping to fertilise it ready for crops the following year.

Although the open-field system had worked well for centuries, it had a number of disadvantages.

- The system was very inefficient because one-third of the land was left idle each year.
- Weeds and animal diseases could spread easily when everyone was sharing so much of the available land.
- There was very little opportunity to try new crops or new methods because everyone had to grow the same crops and work together.



SOURCE 1 Three-field rotation meant that one third of the land would be lying idle each year.

Source questions

1. From source 1 and the text, what were the major crops grown in the open-field system?
2. Why was one field left to lie fallow each year?
3. Why did the open-field system make it hard to experiment with new ideas?

Enclosures

The process of enclosure involved the consolidation of open fields into single farms, owned by one farmer, and fenced off from neighbouring farms by hedges or low stone walls. The peasants either became paid employees on the enclosed farm or had to seek work in nearby towns. Enclosure gave the farmer greater control over the total area of the farm, with less wasted land, and animals kept separate from neighbours' livestock.

Adoption of new farming techniques

Increased control over their farms and animals that followed from enclosure allowed farmers to adopt new and more efficient methods of farming.

Changes in crop rotation methods

As the open fields were enclosed, new systems of crop rotation were introduced. The most successful of these was the four crop rotation system, introduced by an aristocrat, Lord Charles Townshend (1674–1738) on his estates. He became known as 'Turnip' Townshend because of his use of this crop. His farm was divided into four fields, with wheat in the first, turnips in the second, barley in the third, and clover in the fourth. Each year the crops would be rotated by one field. This rotation continued over a four-year cycle. Clover added nitrogen to the soil and could be used as a summer food for livestock while turnips could be fed to animals in winter; this meant that most livestock no longer needed to be slaughtered before each winter, as had been the case previously.

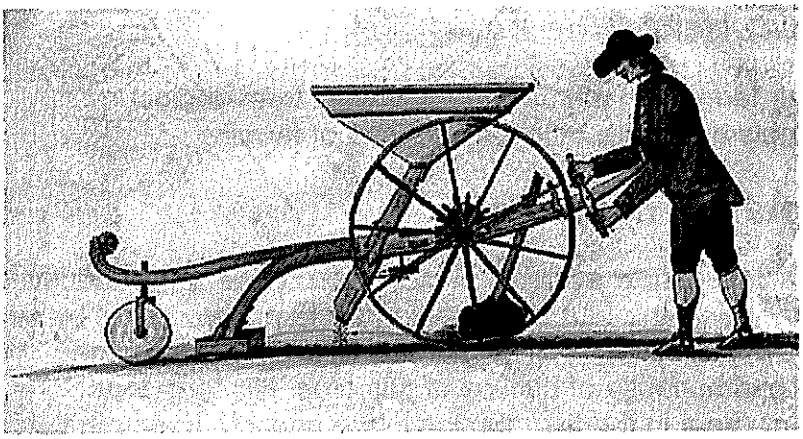
Improved stock breeding methods

Farmers such as Robert Bakewell (1725–1795) and Thomas Coke (1754–1842) began selective breeding of sheep and cattle. Only the largest and strongest animals were mated, and this produced offspring with the best characteristics. Robert Bakewell cross-bred different varieties of sheep to produce the best breeds for both wool and meat production. His New Leicester breed was introduced in 1755, and proved to be a great success. Thomas Coke continued Bakewell's work and crossed Leicester and Norfolk sheep. He discovered the use of lucerne as feed and used turnips as food to fatten the sheep.

Invention of labour-saving devices

Jethro Tull's seed drill

Traditionally seed had been scattered by hand into ploughed furrows. This often meant a lot of wastage as the wind could blow much of the seed away, or birds could eat it. In 1700, Jethro Tull (1674–1741) developed a horse-drawn seed drill that could plant three rows of seeds at a time. A hole would be drilled for seeds to be dropped in, the hole would be covered with soil, and the drill moved forward to the next planting position. It is estimated that this invention produced a five times bigger crop for the same area of land than had been achieved under the old methods.



SOURCE 2 Jethro Tull's seed drill revolutionised the planting of crops and increased production by five times.

Source question

From source 2 and the text, list at least three ways in which the seed drill made the growing of crops far more efficient.

The Rotherham plough

In 1730, Joseph Foljambe patented the Rotherham triangular plough. This plough had an iron blade and was lighter and easier to handle than the rectangular wooden ploughs that had been used previously. Instead of being drawn by a team of four oxen, and requiring both a ploughman and an ox-driver, the Rotherham plough could be handled by one person, and drawn by two horses. The Rotherham plough proved to be quicker and more efficient, and significantly reduced costs for farmers.

RETROFILE

The agricultural revolution produced great improvements in the quantity and quality of both crops and livestock. In 1705, England exported 150 million kilograms of wheat, but by 1765 this had risen to 1235 million kilograms. In 1710, sheep sold at market weighed an average 13 kilograms, while cattle weighed an average 167 kilograms. By 1795, this had risen to 36 kilograms for sheep and 360 kilograms for cattle.

SOURCE 3 Traditional ploughing required a team of four or more oxen, an ox driver and a ploughman to operate the heavy rectangular wooden plough.

SOURCE 4 The lightweight Rotherham triangular plough was developed in 1730.

Source questions

Use sources 3 and 4 to answer the following questions.

1. What features of the Rotherham plough made it more effective in digging up the soil?
2. How many people and animals were required to operate:

a. the old wooden plough

b. the Rotherham plough?

A business approach to farming

Prior to the eighteenth century, farming activity was primarily directed towards satisfying local food and clothing needs. Any produce left over could be sold or traded at markets, but this was only a small proportion of farming output. The great improvements of the agricultural revolution not only increased the amount of food available to the farmers and their workers, but provided increasing surpluses that could be sold to feed the growing urban population. Rural populations grew very slowly, but output per person employed in agriculture rose dramatically. Exporting grain to other countries also brought profits to farmers who were prepared to innovate and embrace new methods of production.

ACTIVITIES

CHECK KNOWLEDGE AND UNDERSTANDING

1. What impact did the enclosure of farms have on the peasants and tenant farmers who had previously worked the land?
2. Outline the contribution of each of the following to the improvements in agriculture in England in the eighteenth century.

a. Jethro Tull

b. Joseph Foljambe

c. 'Turnip' Townshend

d. Robert Bakewell.

3. Why would each of the following innovations not have been possible before the enclosure of farms?

a. The four-field crop rotation system

b. Selective breeding of animals

4. Show the life spans of each of the following agricultural innovators:

a. Jethro Tull

b. Lord Townshend

c. Robert Bakewell

d. Thomas Coke.

The first of these is done as an example:

1650 1700 1750 1850

X----------X

Jethro Tull

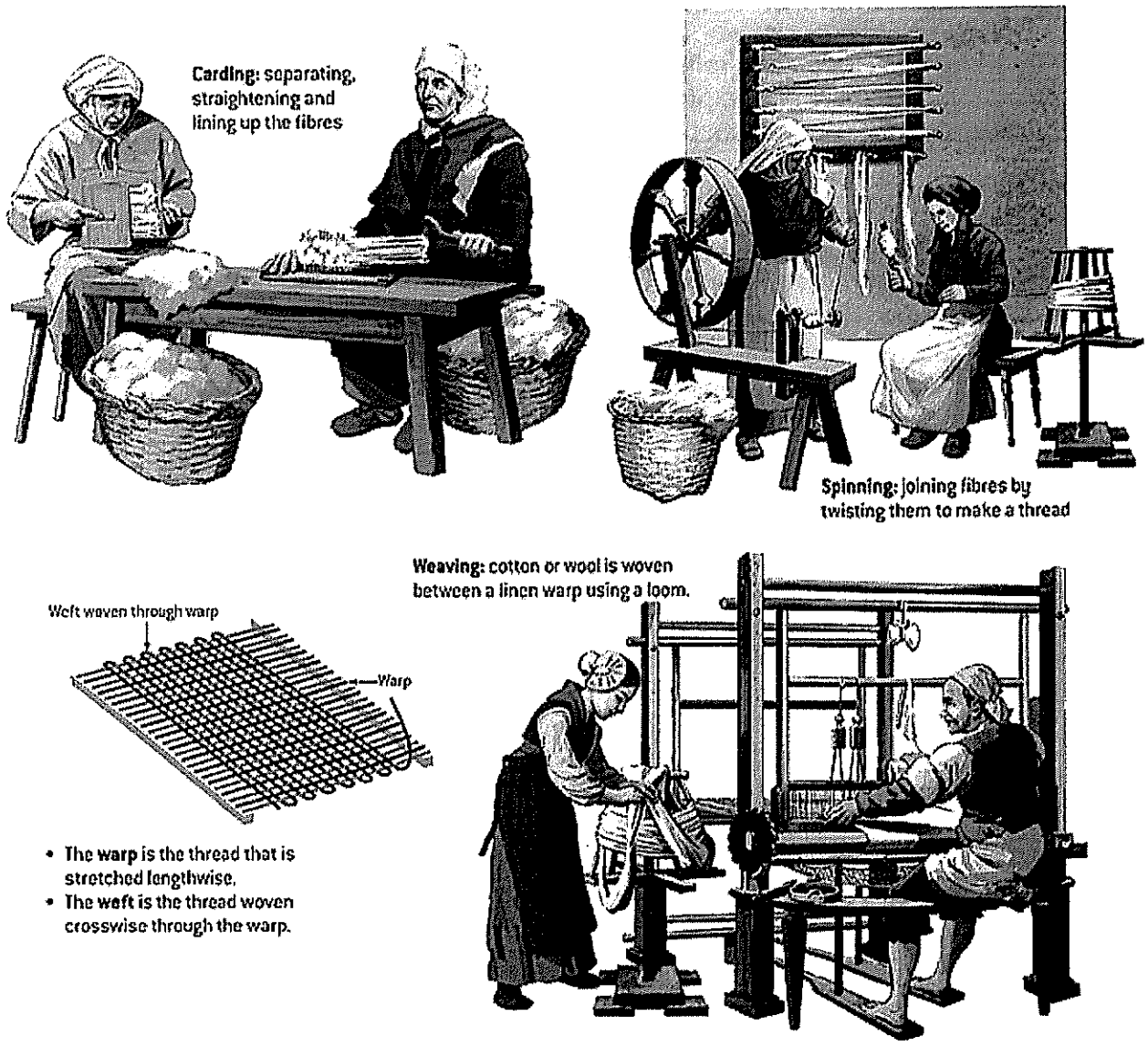
5. The Industrial Revolution relied on the availability of an urban workforce to work in factories. Identify and explain two ways in which the agricultural revolution supported the growth of such a workforce.

PERSPECTIVES AND INTERPRETATIONS

6. Imagine that you are one of a young married couple in a village at the end of the eighteenth century. For generations your families have been peasant farmers but now you must decide whether it is best to move to a nearby town and work in a factory. Make a list of the arguments you might put both for and against such a move.

1a:4 The importance of cotton

During the Middle Ages most clothing in England was made from wool. Wool had the advantage of warmth but at the same time it was difficult to wash and slow to dry. England's climate was too cool to grow cotton so, until the development of plantations in the American colonies in the late 1700s, cotton had to be imported from places such as India and Egypt.



SOURCE 1 A diagram showing the key processes and terms in making woven material

Source questions

Use source 1 to answer the following questions.

1. What was the purpose of spinning?
2. What was the difference between the warp and the weft? On which of warp or weft did the strength of the material depend? Explain why this was so.

50Both wool and cotton were made on a spinning wheel. This was done as a cottage industry. During the day, the man worked on a farm, while the children carded the cotton fibres and the wife produced the thread on a spinning wheel. This thread would then go to a weaver who would make the cloth on his loom.

Cotton produced in this way was not strong enough to form the warp. The warp was made from linen (derived from flax), and the cotton was then woven through it.

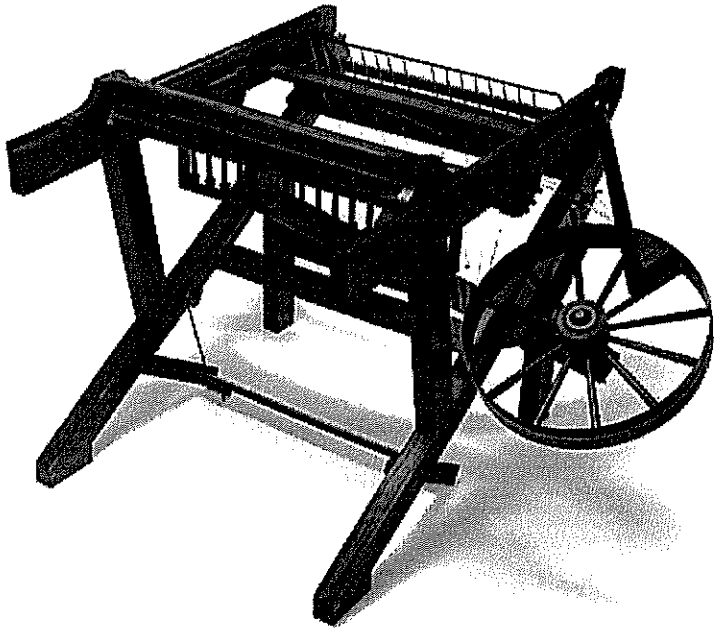
Innovation in the textile industry

Early innovations in the textile industry applied to both cotton and wool production, but the period after the 1750s saw a greater demand for cotton products. This was due to an increased foreign market for cotton goods, particularly in Europe, and increases in population and domestic incomes. The domestic-based industry could no longer meet this demand. Inventors began to develop spinning and weaving machines to improve the quantity and quality of cloth produced.

Spinners and weavers

Traditionally, the weaving process involved a weaver sitting at a loom and passing a device called a shuttle (which contained the weft thread) through the warp and back again. The process was repeated until the fabric piece woven was of the size required. With this method, the width of cloth that one weaver could make was limited to the distance between his two outstretched hands; a wide piece of fabric would require two people to manage the throwing and catching of the shuttle. Even with this somewhat inefficient method, a weaver would still require three or four spinners to provide enough yarn for his loom.

With John Kay's invention of the Flying Shuttle in the 1730s, however, the demand for spun thread increased dramatically. Kay's invention involved the use of a lever and pedals to control the movement of the shuttle and the warp on the loom. Thread could be passed through the loom at greater speed and across greater widths than had previously been possible, allowing weavers to process fabric much faster than before. This meant that as many as a dozen spinners might be needed to supply the necessary yarn for one weaver. With the increasing use of the Flying Shuttle, it was clear that a more efficient method of spinning was also required.



SOURCE 2 A reconstruction of the original of James Hargreaves' Spinning Jenny, c.1765

The development of the Spinning Jenny by James Hargreaves (c.1720–1778) in the 1760s was a response to this. In early models, one person turning a wheel could spin eight spindles of yarn simultaneously. Later models could hold over 100 spindles at one time. However, the cotton produced was still not strong enough to be used for a warp and in 1769 Richard Arkwright (1733–1792) patented a machine that produced a stronger thread that could replace the more expensive linen warp in the weaving process. The heavy machine was driven by a water wheel — a wheel turned by running water. For this reason, it was called the Water Frame. To house the Water Frame, 51special buildings were built near swiftly flowing streams — these became known as 'factories'.

In 1775, Samuel Crompton (1753–1827) invented a device called the Mule, which combined features of the Spinning Jenny and the Water Frame. The Mule allowed the production of strong, fine, soft yarn, which could be used to make many different types of fabric.

In the 1750s a worker would take 1000 hours to spin a kilogram of cotton; by the 1790s the same amount could be spun in six hours.

The move to factory production

As larger machines were introduced to carry out the spinning and weaving processes, these could no longer operate in the cottages of spinners and weavers. Larger buildings were needed to house them, and textile production began to be moved into specialised factories, known as cotton mills. By the 1780s, all stages of textile manufacture were becoming centralised in mills, particularly in the growing towns of Lancashire in northern England.

Cotton and the slave trade

Once quality cotton could be produced cheaply, the demand grew rapidly and new sources for raw cotton had to be found. This came from the American colonies. Slavery of Africans became legal in the English colonies of America in 1750. At first slaves were used as labour in tobacco, rice and indigo plantations on the south-east coast; but as the demand for raw cotton grew, more and more land was claimed for cotton plantations.

The use of Africans as slaves on the plantations enabled the English to develop a profitable business in what was called the 'Triangular Trade'. Raw cotton was brought across the Atlantic to English ports from the American colonies. This was made into cotton cloth in the English mills and some of this cloth was carried to Africa. In Africa, ships picked up slaves to carry back to the West Indies to work on sugar and cotton plantations. This was called the 'Middle Passage'. More cotton was picked up in the West Indies and the process was repeated.

ACTIVITIES

CHECK KNOWLEDGE AND UNDERSTANDING

1. Place the following in their correct chronological order.

a. Water Frame

b. Flying Shuttle

c. Spinning Jenny

d. The Mule

e. Cotton mills

2. Why did the use of the Flying Shuttle lead to an increased demand for cotton thread?

3. Despite the Spinning Jenny being able to produce more thread, there was still a problem with the thread produced. What was this?

4. How did developments in methods of spinning and weaving lead to the establishment of the first factories?

PERSPECTIVES AND INTERPRETATIONS

5. During the eighteenth century, the quality of cotton material improved and its price dropped. However, many people's lives got worse through this. Who were the main people who suffered, how were they affected and why were they affected?

1a:5 The age of coal and iron

Coal had been mined in England for hundreds of years before the Industrial Revolution and, as early as 1700, about 2.5 million tons of coal was being extracted per year. Demand for coal began to grow well before its industrial uses because of the need to replace timber as a source of heat. There were no plantations of timber, so all the timber came from old growth forests and was being used up faster than it could be replenished.

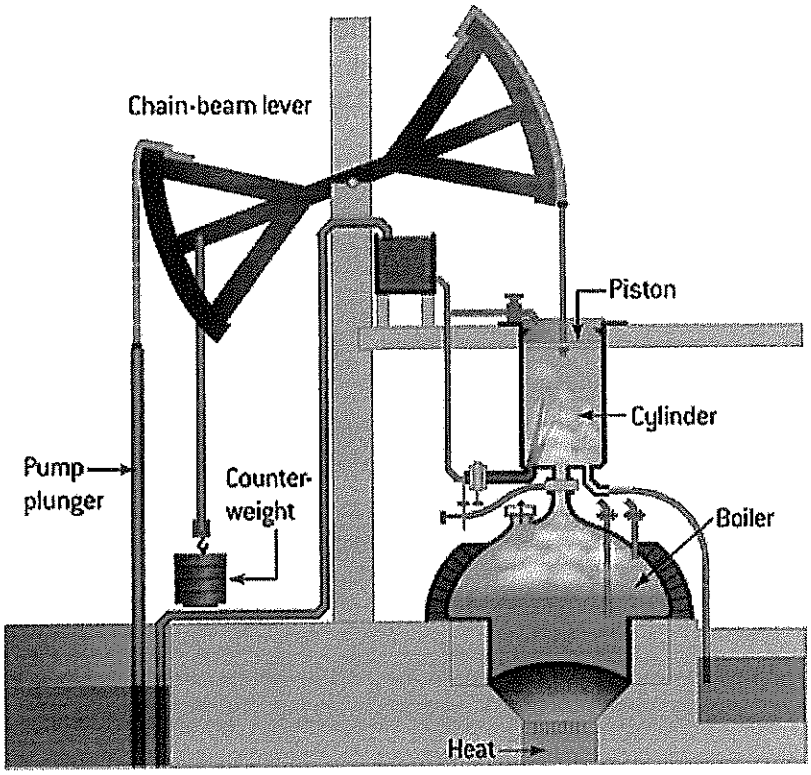
Up to the eighteenth century, timber had been the main source of heating, but by this time it was becoming quite scarce. It was being used for building houses for the increasing population, building ships for the navy and for trade, as well as heating. In London in the 1750s, timber as fuel was four times more expensive than coal. Following the Great Fire of London, new houses were being built with fireplaces and chimneys. This made it possible to use coal for domestic heating because the chimneys carried away the noxious gases and soot produced as coal burned.

Coal in the Industrial Revolution

Heating houses was a pre-industrial use of coal. It was in the late eighteenth and early nineteenth centuries that demand for coal skyrocketed. There were two main causes for this:

1. Coal was a basic ingredient in the production of iron. Iron ore was iron oxide, and the carbon in the coal combined with the oxygen in the iron ore to produce carbon dioxide and leave the iron behind.
2. From the 1830s onwards, with improvements to the steam engine, coal was being used to drive the factory machinery, locomotives and steam ships.

   There was one problem to be solved in extracting this extra coal. By the eighteenth century most of the surface coal had been taken. There was still plenty of coal but it lay below the watertable, and flooding of the mines was a problem. Initially this was solved by using buckets attached by rope to a large wheel. Horses walking in circles turned the wheel and pulled the buckets up. However, there was a limit to how much water could be pulled up this way. Trying to solve this problem led, in 1712, to the invention of the first steam-powered machine of the Industrial Revolution — Thomas Newcomen's heat engine.



SOURCE 1 A diagram showing how the Newcomen heat engine worked

The heat engine

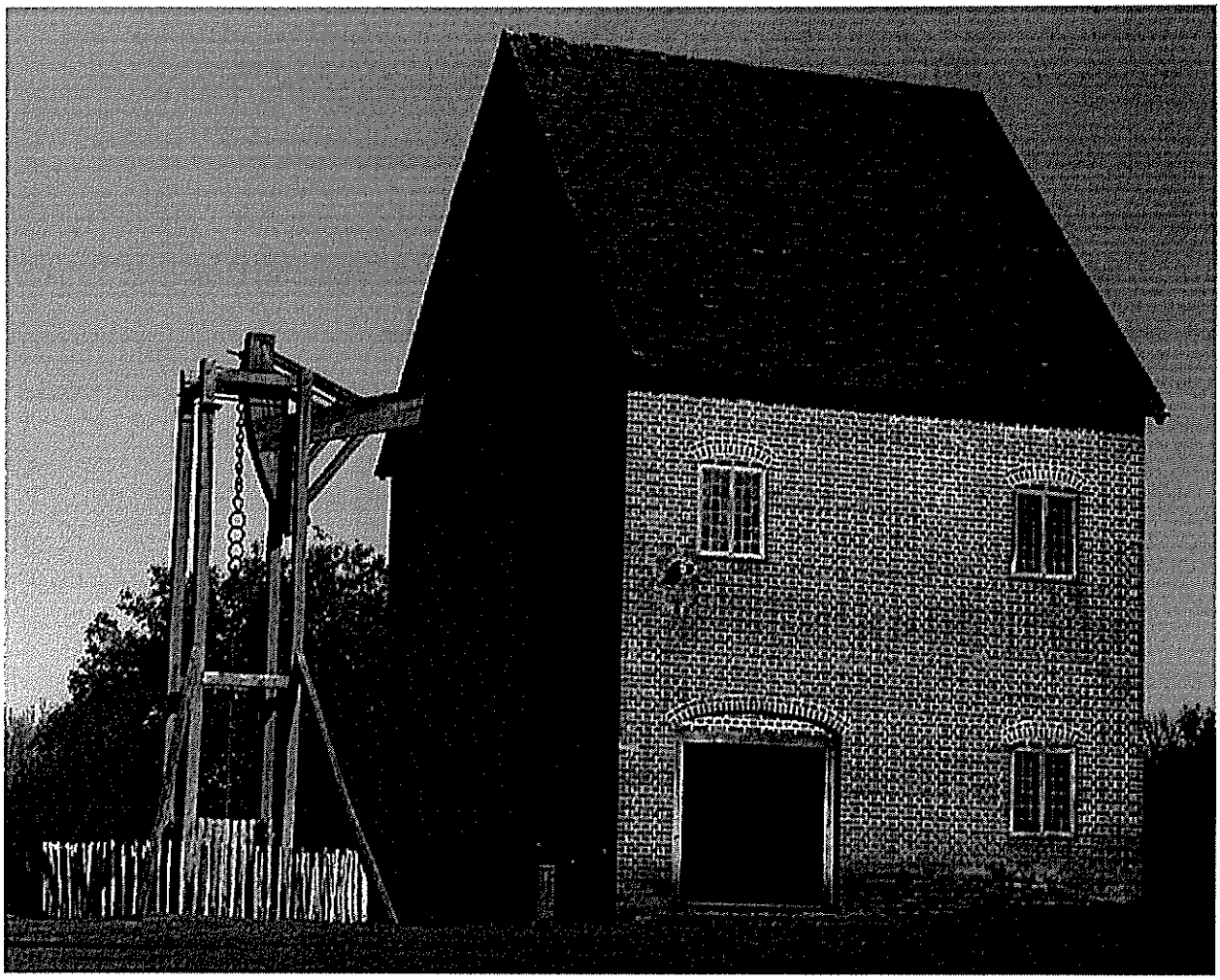
This machine involved the use of air pressure. An example of how this operates can be shown by taking a metal can with a top that can be screwed tight. First, water is boiled in an open can and, when it is full of steam, the top is screwed down. When the can is cooled, a partial vacuum is created inside the can, and air pressure will crush the can.

In the Newcomen engine, the cylinder at the bottom was filled with steam. Water was used to cool the steam, and air pressure forced the piston down, raising the pump in the pit and drawing up water. When the cylinder was opened again at the bottom, weights on the end of the arm pulled the piston back to the top of the cylinder. Although this involved a piston in a cylinder, the steam was not used to move the piston itself.

This machine had two significant weaknesses. Firstly it was very inefficient, as large amounts of water had to be boiled for each up-and-down movement. The earliest machines took 22 kilograms of coal per hour to do the work of one horse, but where coal 53was free this was no problem. Improvements over the next 50 years brought this down to eight kilograms of coal per hour.

Another weakness of the heat engine was that it had an up-and-down motion and could not be used to turn wheels. However, where there were water wheels operating, a heat pump could be used to 'recycle' the water — raise it to a higher reservoir where it could be used again to flow over the water wheel. This was

particularly useful in summer when rivers might dry up. Richard Arkwright used this combination to drive machinery in his large cotton mill. A heat pump was also used in Paris to lift water from the Seine to fill reservoirs for the use of the population.



SOURCE 2 An early pumping station used to pump water out of a mine shaft in Dudley, West Midlands, England

Source questions

Use sources 1 and 2 and the text to answer the following questions.

1. What was the heat engine used for?
2. Why did it involve a very inefficient use of heat energy?
3. Why was this inefficiency not a problem when used to pump water out of coalmines?

Iron

During the Middle Ages and early modern period, iron was used for armour, farming implements, cooking utensils and cutlery. Iron had been produced by heating the iron ore with charcoal to remove the oxygen. Charcoal was produced by heating wood in the absence of oxygen; and as wood became scarce, coal was used instead.

However, because there were impurities in the coal, the iron was not of good quality. In 1709, Abraham Darby (1678–1717) demonstrated that using coke — coal heated to drive out impurities — in a blast furnace could produce a purer form of pig iron.

Henry Cort and 'puddling'

Although pig iron had many uses, it could be brittle because of the presence of small amounts of carbon. In 1783, Henry Cort developed a method of reducing the carbon content of pig iron through a process known as 'puddling': stirring molten metal with rods [54]to bring the carbon near the surface and burn it off. A further process was rolling the iron into a part-molten state to drive off more impurities. This resulted in a product that was stronger and could be bent, rolled or cast into many different shapes. High-quality iron could now be used for making machinery, a huge variety of tools and implements, boilers for steam-driven engines, as well as bridges and the framework for buildings.

As iron production methods improved, quantities increased, and large scale production made good quality iron cheaper. By 1850, Britain was producing over 70 times as much iron as it had in 1760 (see source 3).

Year	Horse cost (pennies per hour)	Coal price (shillings per ton)	Pounds of coal per horsepower hour	Steam cost (pennies per horsepower hour)	Steam cost advantage
1720	1.8	4.72	45	1.6	0.2
1740	(2.2)	4.48	45	1.6	0.6
1770	2.5	6.03	25	1.0	1.5
1790	4.0	6.41	20	1.0	3.0

1810	(3.8)	10.35	12	1.1	2.7
1830	3.5	9.13	12	0.9	2.6
1850	3.0	10.13	12	0.9	2.1

Sources

N. Von Tunzelmann, *Steam Power and British Industrialization to 1860*, Clarendon Press, Oxford, 1978.
G. Clark and D. Jacks, 'Coal and the industrial revolution, 1700–1869', *European Review of Economic History*, 11(01), 2007.

Notes

SOURCE 3 Comparative cost of steam and horse power, 1740–1850

Source questions

Use source 3 to answer the following questions.

1. In which year did the steam engine show the greatest advantage in cost?
2. What evidence is there that the steam engine became far more efficient after 1790?
3. Over the period covered by this table calculate the percentage increase or decrease in:

- the cost of using horses
- the price of coal
- the efficiency of the steam engine (in terms of how much coal was required to do the work of one horse)
- the cost of using steam.

ACTIVITIES

CHECK KNOWLEDGE AND UNDERSTANDING

1. There was a scarcity of timber in 1750. List three uses that were taking up an increasing amount of timber.

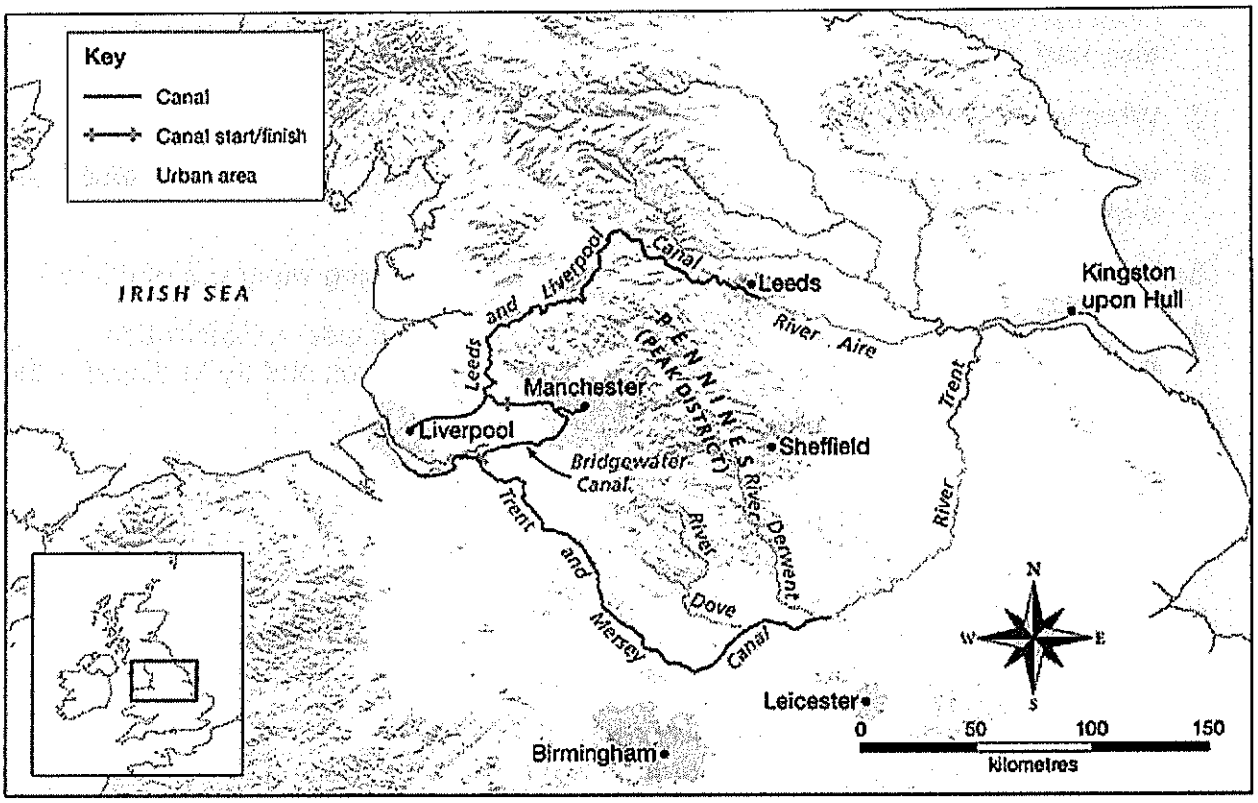
2. Coal had an advantage in price over timber when used for heating houses, but it also had problems. What was the major problem and how was it solved?
3. What were two new uses for coal in the late eighteenth and nineteenth centuries?
4. What was the main problem that had to be faced when coal replaced charcoal as a method of removing carbon from iron ore?
5. What were two uses for the heat pump apart from pumping water out of mines?
6. Prepare an advertisement promoting the heat pump. Include an illustration. Remember that advertisements highlight the good features and try to disguise the bad features of a product.

1a:6 Transport

For Britain to industrialise, good transport links were essential. Raw materials needed to be transported to manufacturing sites, and manufactured goods then had to be transported to the cities for sale, or to ports for export.

In the 1750s, goods were usually carried in horse-drawn carts along dirt roads that were often badly pot-holed, or they were transported along rivers. The difficulties with river transport, however, were that rivers followed winding courses and could vary greatly in width and depth.

The solution was to build canals, which were effectively artificial rivers. They could be made deep and wide enough to carry barges and could connect different river systems. Canals could be tunnelled through hills or carried over valleys by aqueducts.

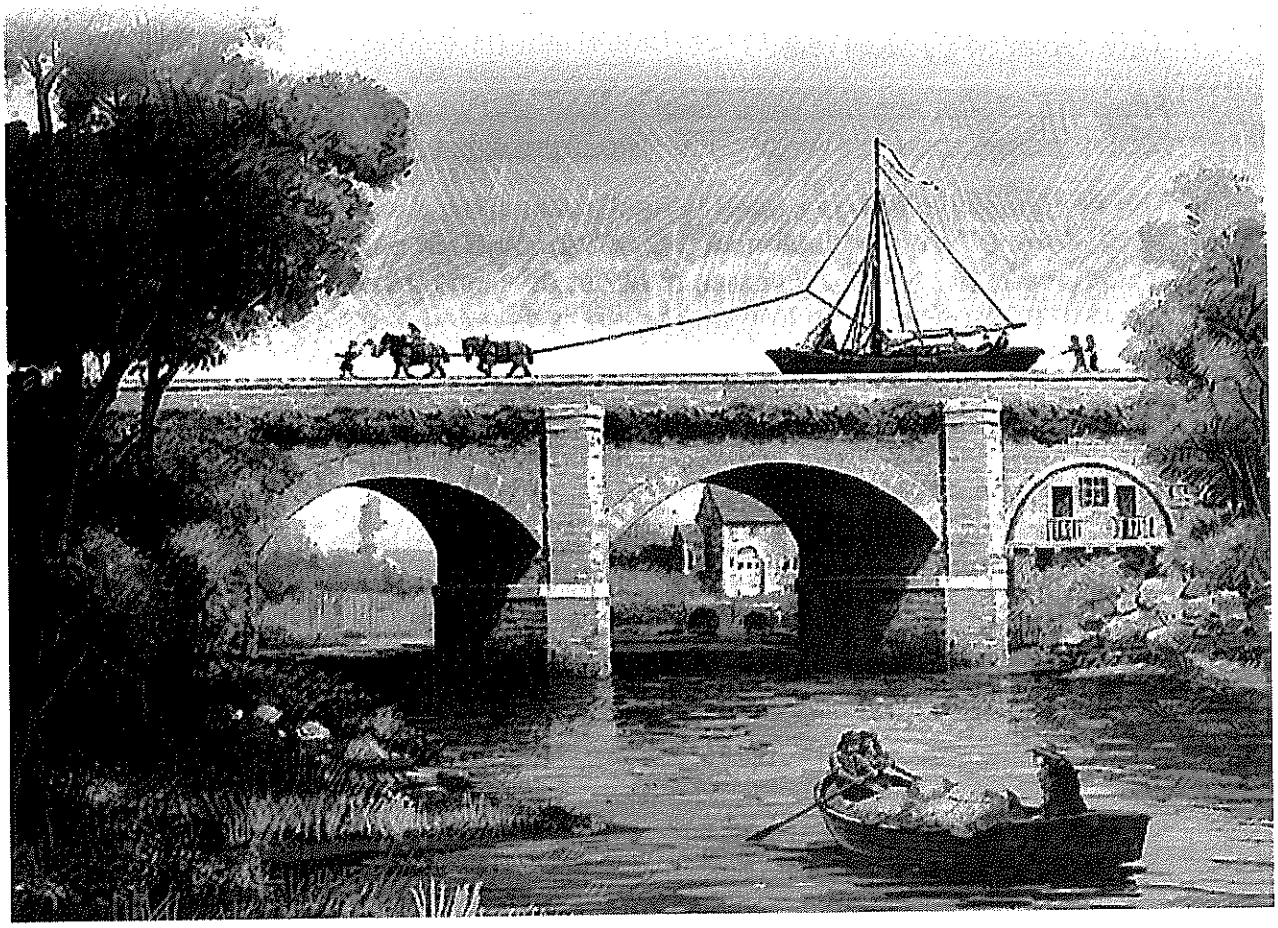


SOURCE 1 Three of the earliest canals, built in the Midlands region of England

Some of the earliest canals were built in the Midlands region of England (see source 1). The first true canal was opened in 1761. Francis Egerton, the Duke of Bridgewater (1736–1803), had a canal built from the coalfields in Worsley to the nearby city of Manchester. Barges were drawn by horses; tracks for horses were built along the banks of the canal. A barge carrying 30 tons could be drawn by just one horse — it would take ten horse-drawn carts to carry the same amount by road. This meant that the Duke of Bridgewater's coal could be sold for one third less than the original price in Manchester, and the canal soon paid for itself.

Josiah Wedgwood saw the advantages of a canal for his pottery works near Stoke-on-Trent — both to bring large amounts of clay to his factory works and also to carry delicate pottery to markets throughout the Midlands. A canal first linked his works with the port at Liverpool, and was soon extended to link the Mersey and Trent rivers, which meant that goods could be carried right across England.

A third canal — some 204 kilometres in length — linked the cities of Leeds and Liverpool, tracing a path through the lower sections of the Pennine Mountains. The greatest height reached was 148 metres and there were 91 locks along its route. Within the next 20 years a vast network of canals was created across England.



SOURCE 2 An artist's view of an aqueduct of the Bridgewater Canal where it crossed the Barton River. It was demolished in the 1890s and replaced by a swing bridge.

Source questions

Use source 1 and the text to answer the following questions.

1. What was already happening in this part of England to encourage the building of canals?
2. What was the first section of canal completed?
3. Which canal linked two rivers flowing in different directions? Which two cities on either side of England did this allow communication between?
4. Why did the Manchester–Leeds Canal take such a long route?

Railways and locomotives

Wooden rails, sometimes called tramways, had been used in coalmines since the early 1600s. Wagons carrying coal moved downhill along these by gravity, or

uphill by being drawn by horses. As iron became cheaper, these wooden rails were replaced by steel rails.

From the 1790s, engines were used to haul coal wagons by means of long cables wound around a large drum. The drum was turned by a stationary engine.

The first locomotives were used to haul trucks loaded with coal from mines. In 1812, John Blenkinsop built a locomotive to transport coal from Middleton (near Manchester) to Leeds, a distance of about 60 kilometres. It used a central third rail with a rack and pinion to give traction. It travelled at six kilometres an hour and could haul 90 tons of coal — the work of 50 horses.

These locomotives inspired an engineer, George Stephenson, to promote the idea of steam locomotives being used to haul a wide variety of goods, and possibly even passengers.

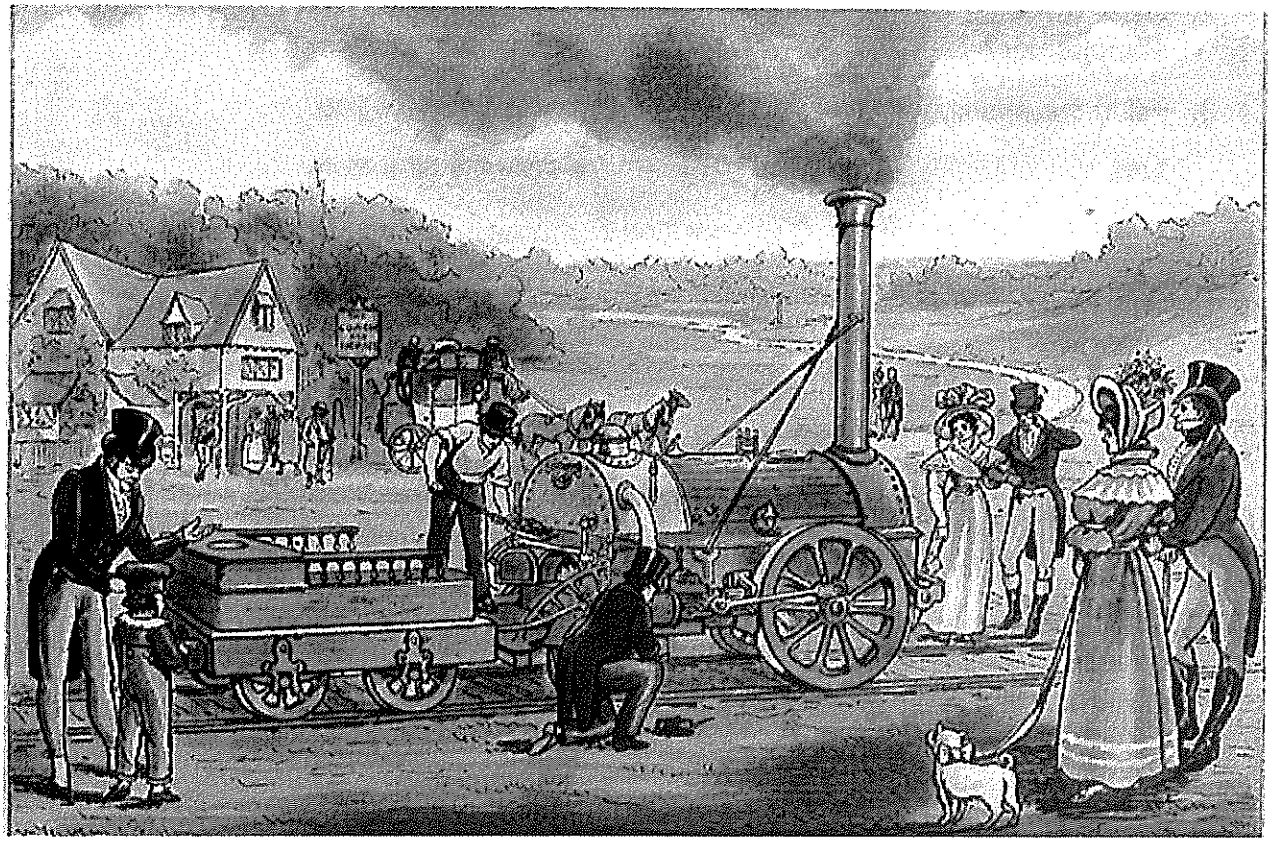
SOURCE 3 John Blenkinsop's early locomotive is shown here hauling coal trucks that he designed.

The first successful railways

In 1825 the first public railway was opened in north-east England. It was designed to carry coal from mines near Darlington to the port of Stockton, and it employed George Stephenson's *Locomotion No. 1* locomotive to haul its cargo. Before long the owners expanded its activities to provide a passenger service with a regular timetable.

In the meantime, Stephenson and his son Robert were contracted to build a railway line between Manchester, the largest textile-producing city, and Liverpool, a major port almost 60 kilometres away. (One of the earliest canals had been built to link these two sites — see source 1.) The line was constructed as a double track to allow trains to travel both ways simultaneously, and was designed to bring imported raw materials to Manchester, and return completed goods to Liverpool for export. The directors of the line staged a contest to determine the

best locomotive for the line. Stephenson's latest locomotive, 57the *Rocket*, won easily, reaching a speed of 38 kilometres per hour and averaging 22 kilometres per hour. The line opened in 1830, and Stephenson's *Rocket* was used to haul both goods and passengers between the two cities. The line was a huge financial success, and became the model for a succession of railways that were soon constructed throughout Britain.



SOURCE 4 Stephenson's *Rocket*, used on the Manchester–Liverpool railway.

Source questions

1. By comparing source 3 with source 4, and from reading the text, what are the major modifications that George Stephenson made to locomotives?
2. What was the difference in speed achieved by these methods?
3. What other form of transport is shown in source 4?

The growing demand for fast, efficient transport for both the raw materials and products of industrialisation led to a huge growth in railway construction. The 20years from 1830 saw frantic growth in the rail network. By 1852 there were over 10 000kilometres of track in Britain. Lines extended from London to the coast of Wales, and through to Glasgow and Edinburgh in Scotland. The industrialised north and Midlands of England were covered by extensive rail networks, transporting passengers, as well as a huge variety of goods.

ACTIVITIES

CHECK KNOWLEDGE AND UNDERSTANDING

1. Make a list of the advantages of canals compared with road transport at the time.
2. What were the advantages of running a double track between Liverpool and Manchester?
3. Fill in the missing dates and events. The first is done for you.

1761	Bridgewater canal opens
1790s	.....
.....	Middleton–Leeds line used for carting coal
.....	Stockton–Darlington Railway opens
.....	Manchester–Liverpool line opens

1a.7 The impact on Australia

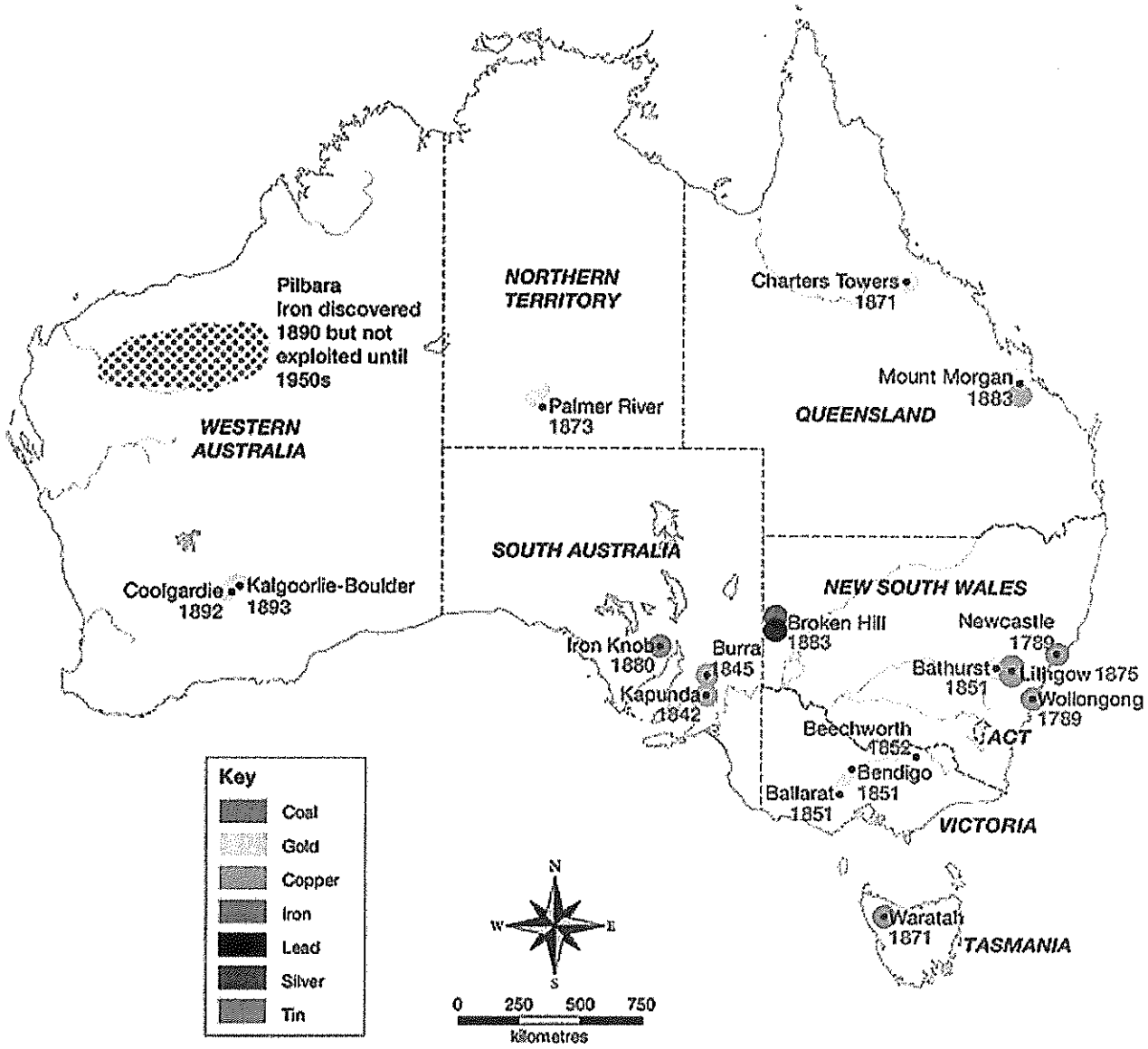
The European colonisation of Australia took place just as the pace of industrial change in Britain began to accelerate. The main roles the Australian colonies played during the nineteenth century were in providing:

- a source of quality wool to meet the demands of the new textile machinery
- a source of wheat to feed the growing population and supplement what was being produced on British farms
- a source of metals such as copper and gold, and later silver, lead, zinc and tin
- a place where those displaced by changes in Britain and Ireland could begin a new life
- a market for consumer items produced in England, especially as people became richer after the gold discoveries.

Riches from the earth

Sydney had its own supply of good coal as it was on top of a large basin of coal, which came near the surface around Newcastle, Wollongong and Lithgow. Mining of metals began in South Australia with the discovery of rich deposits of copper at Kapunda in 1842 and Burra in 1845.

Gold was discovered near Bathurst in New South Wales in 1851 and in richer goldfields around Ballarat in Victoria later that same year. Gold was later discovered in Tasmania, Queensland and Western Australia. Other metals mined between 1870 and 1900 included tin, silver, lead, zinc and iron.



SOURCE 1 Sites of some major mineral discoveries up to 1900

Source question

Use source 1 to make a list of the main minerals discovered before 1900 in each of the following states.

a. Queensland

b. New South Wales

c. Victoria

d. Tasmania

e. South Australia

f. Western Australia

Wool and wheat

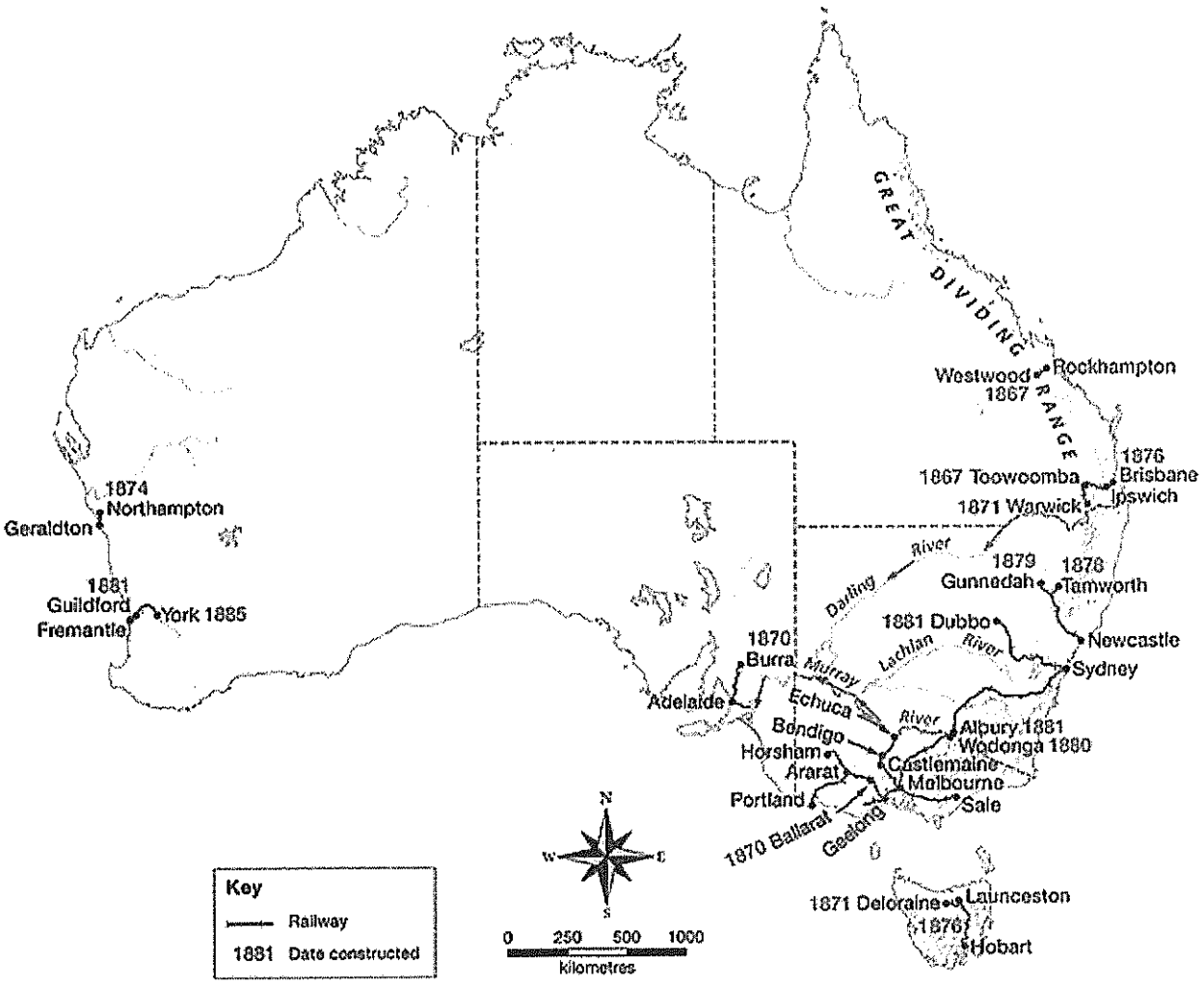
During most of the nineteenth century, wool was by far the most important export. The source of this wool was the Merino sheep, a breed that originated in Morocco, and was further developed in Spain. John Macarthur (1767–1834), in partnership with his wife, Elizabeth (1766–1850), played the major role in the early development of the wool industry. By 1840, sheep runs stretched in an arc from the Darling Downs of south-eastern Queensland to the dry country north of Adelaide and parts of Tasmania. By 1847, Britain imported more wool from Australia than all of Europe combined, and increased this amount by ten times over the next 40 years.

Although James Ruse grew small amounts of wheat in the early days of the European settlement, the first major development of the wheat industry was in South Australia where soil suitable for growing wheat was close to the sea and therefore close to transport. From here it spread west to Western Australia and east to the Mallee region of Victoria. Following the building of a road over the Blue Mountains in 1815, and the settlement of inland New South Wales, this also became a wheat-growing area.

Railways

The first railways were set up in Australia only 24 years after the Manchester–Liverpool railway began operating in England (see section 1a:6). They played a particularly important role in Australian transport history as Australia lacked the river systems of both Britain and the United States.

The first railways were set up as private companies. The first steam train line was in Victoria in 1854, running from the city to Port Melbourne and powered by a locally built steam engine. In the same year, South Australia had a ten-kilometre horse-drawn 60railway between Port Elliot and the Murray River port of Goolwa. The first Sydney line ran from Sydney to Parramatta in 1855, and the following year there was a line in Adelaide running from Adelaide to Port Adelaide. By the 1870s, all colonial railways were under the control of the respective colonial governments instead of being privately owned.



SOURCE 2 Some early railway lines in Australia up to around 1880, and the major river transport routes. (Note that not all lines are included, especially in Victoria where many lines were built in the period 1870–80.)

Source questions

Use source 2 and the text to answer the following questions.

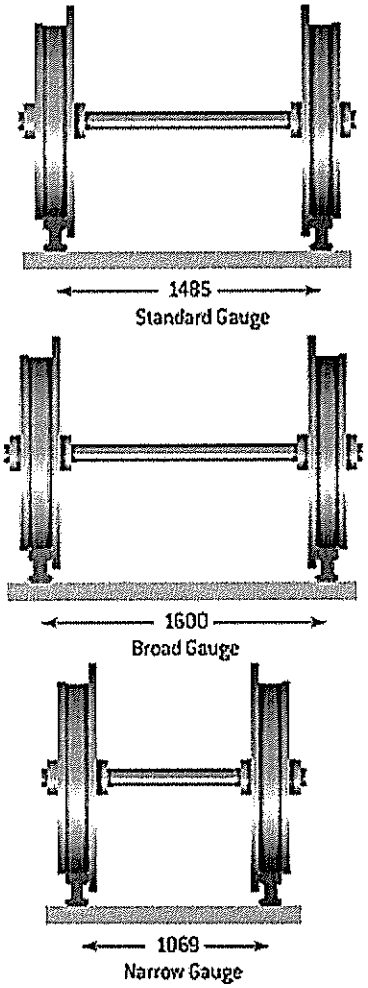
1. Which Australian state benefited most from being the export point for goods brought to the coast by rivers?
2. Provide one example of a railway line built for each of the following reasons:

a. to bring agricultural products such as sheep and wool to a coastal port

b. to bring mineral resources to a port

c. to capture river trade that would have gone to another state.

3. Why did all the early railways travel inland rather than go along the coast? What method of transport was used to carry goods and passengers between coastal ports?



SOURCE 3 Diagram showing the difference between the three railway gauges

The gauge muddle

The gauge is the distance between the two railway tracks. The gauge of the Liverpool–Manchester line was 4 feet 8.5 inches (1485 millimetres), which was the same gauge as had been used for the earlier horse-drawn railways. This became known as Standard Gauge. However, two other gauges were used in Britain and elsewhere in the world. Broad Gauge was 5 feet 3 inches (1600 millimetres). Its advantages were that it gave a smoother ride and made it possible for trains to travel safely at a faster speed. It was, however, more expensive to build, requiring longer sleepers to support the track and wider bridges, tunnels and cuttings. A third, and cheaper, version was Narrow Gauge, which was 3 feet 6 inches (1067 millimetres).

In 1848, the British Colonial Secretary specified that all Australian railways should have Broad Gauge. South Australia, Victoria and New South Wales began planning for Broad Gauge railways, but at the last moment NSW changed to Standard Gauge. Matters became further complicated when Queensland later decided that it would use Narrow Gauge. South Australia used three gauges:

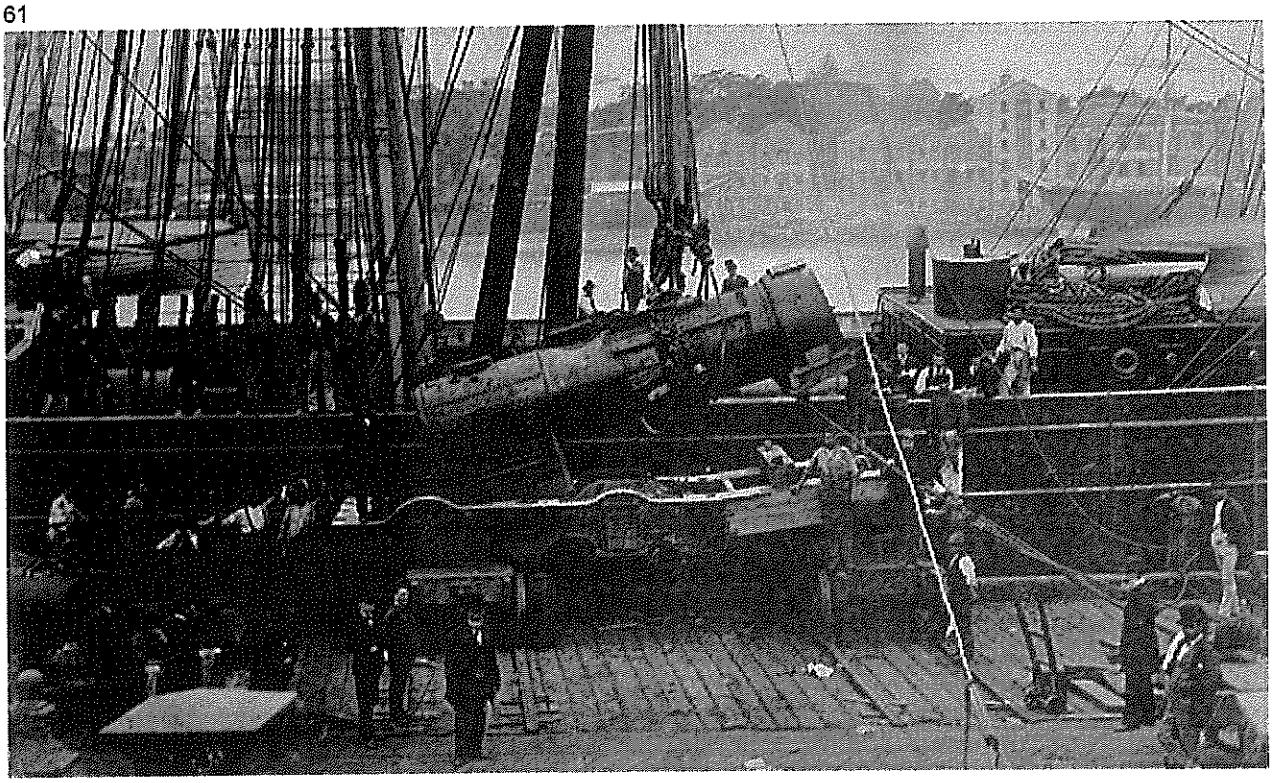
Broad for its main lines, Narrow for small branch lines and, later, Standard for its connection to Western Australia lines.

Steam ships

For travel within Australian waters, there was an ample supply of coal, and steam ships were the main means of transport along the coast between coastal towns and between the major cities; steamers continued in use until the 1940s. Side-wheel paddle steamers carried goods along the Murray River from 1852, with the final destination being ports in Adelaide. In Queensland, goods were carried by boat from Brisbane to Ipswich until the Ipswich–Brisbane railway was completed in 1876.

Manufacturing

Britain saw the Australian colonies primarily as a source of raw materials such as wool, wheat, timber and gold. Coal was mainly used for heating and in steam locomotives and, until World War I, iron production in Australia was also on a small scale. Most manufactured goods were imported from Britain. For example, by 1890 in New South Wales, of 449 locomotives used, 395 were imported from England and only 54 were made locally. In Victoria in the same period, the majority of its engines — 263 locomotives — were made at the Phoenix Foundry at Ballarat.



SOURCE 4 A contemporary photograph of steam engine parts produced in Britain being off-loaded at Circular Quay in Sydney

Source questions

1. In source 4, why are many men being used to unload the steam locomotive boiler instead of horses?
2. Why were locomotives shipped in parts rather than being completely assembled in England?

During the First World War most British ships were involved in the war effort, and Australians realised that they had to begin developing their own manufacturing industries. The Broken Hill Proprietary Company (BHP) was the major firm involved in Australia developing its own industrial capacity at that time.

Telecommunications

Australia's first telegraph line, sending messages by Morse code, was built from Melbourne to Williamstown in 1854, ten years after Samuel Morse developed the telegraph in the United States. In 1856, Victoria, New South Wales and South Australia agreed to work together to set up a common telecommunications system. By the end of 1858, Adelaide, Melbourne and Sydney were linked by telegraph. Sydney and Brisbane were linked in 1861, and Adelaide and Perth in 1875.

Australia was connected with the rest of the world when the Overland Telegraph Line from Adelaide to Port Darwin was completed in 1872, and this was linked by a cable to Singapore, and from there on to England.

ACTIVITIES

CHECK KNOWLEDGE AND UNDERSTANDING

1. What were the major ways in which Australia was involved in the Industrial Revolution in Britain?
2. In which Australian state did each of the following first develop?

a. The wheat industry

b. The wool industry

3. Why did the development of railways play a more important role in the early stages of Australia's development than they played in Britain or the United States?

RESEARCH AND COMMUNICATE

4. Choose one of the industries mentioned in this unit. Trace its early development and, through research, indicate the major later developments in that industry.
5. Explore the various reasons for Australian states having a wide range of different rail gauges and some of the problems this caused. Conduct further research to discover how some of the problems this caused have been overcome.

PERSPECTIVES AND INTERPRETATIONS

6. Australia did not become a major manufacturing nation until after World War I. Until then most manufactured goods came from Britain. Was this a deliberate policy of Britain to keep control of its manufacturing, or was it due to factors within the colonies themselves? Make a list of possible arguments that could be used in a debate for or against this being a deliberate policy of Britain.

1a:8 Changing ways of life

The rapid growth of factories between 1800 and 1850 affected everybody's lives. Life improved for mechanics — those who built and serviced the machines. They were paid well, and set up 'mechanics institutes' with their own libraries and held regular lectures there. They became part of a growing middle class.

However, for ordinary workers who had moved from the countryside or emigrated from Ireland and Scotland, working and living conditions were poor. Houses were crowded together with little natural light and no sanitation. To keep the machines running in the factories, people had to work up to twelve-hour shifts. There was little protection from contact with moving machine parts and no compensation for injured workers.

SOURCE 1 An illustration of a slum garret (attic) in London in 1843

Friedrich Engels (1820–1895) was the son of a wealthy German industrialist. Sent to work in his father's cotton mill in Manchester, Engels began to discover the reality of how working people lived, and in 1845 he published a book on the subject entitled *Condition of the Working Class in England.*

> *When a policeman went to his widowed mother's house to investigate, he found her with six of her children literally huddled together in a little back room, with no furniture but two old rush-bottomed chairs with the seats gone, a small table with two legs broken, a broken cup, and a small dish. On the hearth was scarcely a spark of fire, and in one corner lay as many old rags as would fill a woman's apron, which served the whole family as a bed. For bed clothing they had only their scanty day clothing.*

SOURCE 2 In his book *Condition of the Working Class in England*, Engels quotes from a police report after two boys were arrested for stealing and eating a half-cooked calf's foot.

Source question

From sources 1 and 2 and the text, make a list of difficulties faced by the poor in England during the Industrial Revolution.

Children

Most children had worked before the revolution — either helping on the farm or in spinning and weaving in the home. They had no schooling and no childhood as we have today. However, working in factories was far worse than working in the home. They were working near dangerous machinery and, being under the control of employers rather than their parents, they could easily be exploited. Yet wages were so low for adults that a family could not survive without children working.

Exploitation was particularly bad where their small size could be seen as an advantage, such as drawing wagons in narrow mine shafts, cleaning underneath machinery or being used as chimney sweeps. Masters of chimney sweeps found it cheaper to force little children through the chimney rather than use a brush.

SOURCE 3 A drawing of children working in a mine shaft

Pressure to change these conditions came from a variety of groups in society:

- evangelical churchmen who felt it their Christian duty to look after the weaker people in society
- rich landowners who resented the new wealthy industrialists
- industrialists themselves who wanted to stop unscrupulous use of cheap labour by their competitors.

A series of bills that passed between 1830 and 1867 gradually led to some regulation of the industry, although the hours worked and the conditions of work were still harsh by today's standards. Some of the most important of these were:

- The Factory Act of 1833, which set legal limits to the working hours of children and was enforced by the appointment of factory inspectors
- The Mines Act of 1842, which banned the employment of women and under-age children in the mines
- The Ten Hours Bill of 1847, which limited the time worked by women and children in factories to ten hours a day. Because women and children were essential for the running of the machines, it effectively meant that a man's work day was also limited to ten hours.

A series of bills were passed to improve the conditions of children working as chimney sweeps; but because the business was so profitable, these were not enforced and it was not until 1867 that effective legislation was passed.

SOURCE 4 Children working in a textile factory, Missouri, 1911

The very poorest London parents found they could apprentice a child to a chimney sweep much younger than any other occupation. More than this, no apprentice fee was expected, and the master sweep was even ready to pay a sum to the parents for the service of the child, who was thus literally bought and sold. 'It was a common practice', said David Porter, a remarkable master chimney sweeper, 'for parents to carry about their children to the master chimney sweepers and dispose of them to the best bidder, as they cannot put them to any other master at so early an age'.

Dorothy George, from *England in Transition*, Penguin, 1964, pp. 123–4.

SOURCE 5 A historian describes how chimney sweeps were employed.

Source questions

Use sources 3, 4 and 5 to answer the following questions.

1. List the types of jobs children did.
2. For each job, list some of the dangers they faced.
3. Sources 3 and 4 are both illustrations of child labour. One is a drawing and one a photograph. If a historian was using these to investigate child labour in the Industrial Revolution, what would be (a) the advantages and (b) the disadvantages of each source?

Trade unions

At the end of the eighteenth century, only wealthy landowners had the right to vote. This meant they controlled Parliament and the making of laws. In 1799–1800, afraid of what had happened to the aristocrats during the French Revolution, the government passed the Combination Acts. These acts made it a serious offence for workers to organise together to improve their working conditions.

However, with the Reform Bill of 1832, the numbers eligible to vote was increased; but voting was still open only to the most wealthy in the country — and many of these were owners of factories.

In 1832, a group of farmers in the small village of Tolpuddle in south-eastern England vowed that they would not work for less than ten shillings ($1) a week. A landowner used an obscure law that made it illegal for a group of people to come together to swear an oath. The men were convicted and sentenced to seven years' transportation to Australia; and so they became known as the 'Tolpuddle Martyrs'. Public protest was so great that two years later they were allowed to return to England.

65For the next ten years the focus of workers was on a movement called Chartism (see section 1c:3) — a movement to make Parliament more representative. At the same time, some of the better-off workers were able to establish their own unions and one of the first of these was the Amalgamated Society of Engineers. It included workers from all over England and was able to employ fulltime staff to help in its organisation. Members also contributed to a fund to provide benefits for those who were injured or sick.

God is our guide! from field, from wave,

From plough, from anvil, and from loom;

We come, our country's rights to save,

And speak a tyrant faction's doom:

We raise the watch-word liberty;

We will, we will, we will be free!

SOURCE 6 George Loveless, the leader of the Tolpuddle Martyrs, was a Methodist local preacher. When he was sentenced he wrote this text on a scrap of paper.

Source questions

Use source 6 to answer the following questions.

1. In the first two lines, list the different occupations the words refer to.
2. In which line does he imply that the parliament does not represent the people?

3. From the text and source 6, what evidence is there that some Christians supported the working-class movements?

ACTIVITIES

CHECK KNOWLEDGE AND UNDERSTANDING

1. Match the following dates with an Act of Parliament, and for each one briefly indicate how it made reform for workers better or worse.

a. 1799–1800

b. 1832

c. 1833

d. 1842

e. 1847

f. 1867

2. Which group of workers set up places to educate themselves further?
3. Why were the early laws to protect chimney sweeps not enforced?
4. Why was reform of Parliament an important part of the effort to improve worker's conditions?
5. Even though children were employed before the Industrial Revolution, why were their conditions worse in industry?

RESEARCH AND COMMUNICATE

6. The most violent event in the movement for economic and political reform was what was called the Peterloo Massacre, which took place in St Peter's Fields in Manchester on 16 August 1815.

   Write a report on this that includes the following:

a. Why was the government afraid of reform movements at the time?

b. What was the meeting in St Peter's Fields about?

c. What actions did the military take?

d. What were the casualties?

e. What results did brutal suppression have?

1a.9 The global impact

Impact on the landscape

During the nineteenth century, industrialisation spread to Europe, the United States and, towards the end of the century, Japan. Each stage of the Industrial Revolution had an effect on the landscape. In the early days, charcoal was used to produce iron from ore and this led to large-scale deforestation in England and the eastern US states. In the United States, large areas of land were also cleared to grow cotton. The increasing use of coal meant large areas of countryside were dug up and there was widespread pollution from the burning of the coal. What had been rural lands were divided first by canals and then by railways. Finally, large towns and cities grew around the factories.

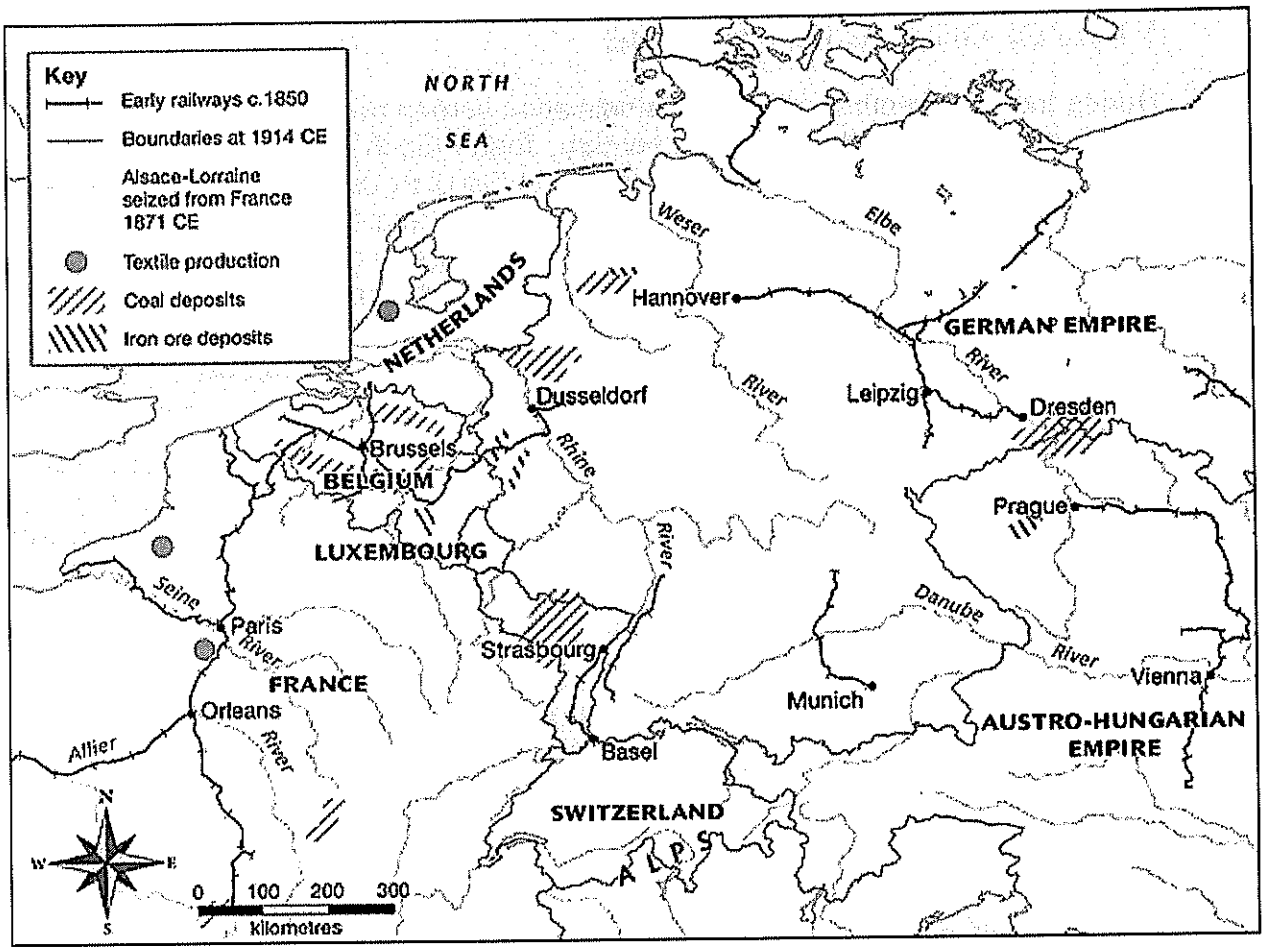
At the time, people were unaware of another effect of the burning of coal — the release of large amounts of carbon dioxide into the atmosphere that would increase the threat of climate change by making it more difficult for heat from the sun to escape.

Continental Europe

The effects of the Industrial Revolution were seen first in Belgium. This was because the resources in Belgium were similar to those in Britain:

- extensive coal resources
- iron ore deposits close to coal
- a strong textile industry.

By 1840, Belgium was the most industrialised nation in continental Europe and was supplying coal, wrought iron and steam engines to Germany and France.



SOURCE 1 Map showing some of the key industrial areas of continental Europe and the early development of railways

Source questions

Use source 1 to answer the following questions.

1. In which two countries were the coal and iron deposits closest together?
2. In which two countries did production of textiles become a major industry?
3. What evidence does the map provide that, in the early days of rail, rivers still remained an important means of transport?

Germany had rich deposits of coal and iron ore but exploitation of these was hampered because Germany at that time consisted of hundreds of separate states. It was not until the unification of Germany in 1871 that industrialisation began to take off. This was especially so in the Ruhr region in western Germany where there were large deposits of quality coal and iron ore to be exploited.

67France lacked good supplies of coal, and its population increased only slowly during the nineteenth century. Because coal was scarce, water-driven mills continued to be used, and therefore industries remained small and more spread out. Charcoal continued to be used to smelt the iron and it was sometimes

cheaper to import iron from places where coal was plentiful and cheap. In textiles, France specialised in quality cloth, such as the production of high-quality silk in Lyon.

France adopted electrical technology far more quickly than most other countries. Hydroelectricity from generators in the Alps allowed eastern regions of France to develop industries that required large amounts of energy but were also clean.

The United States

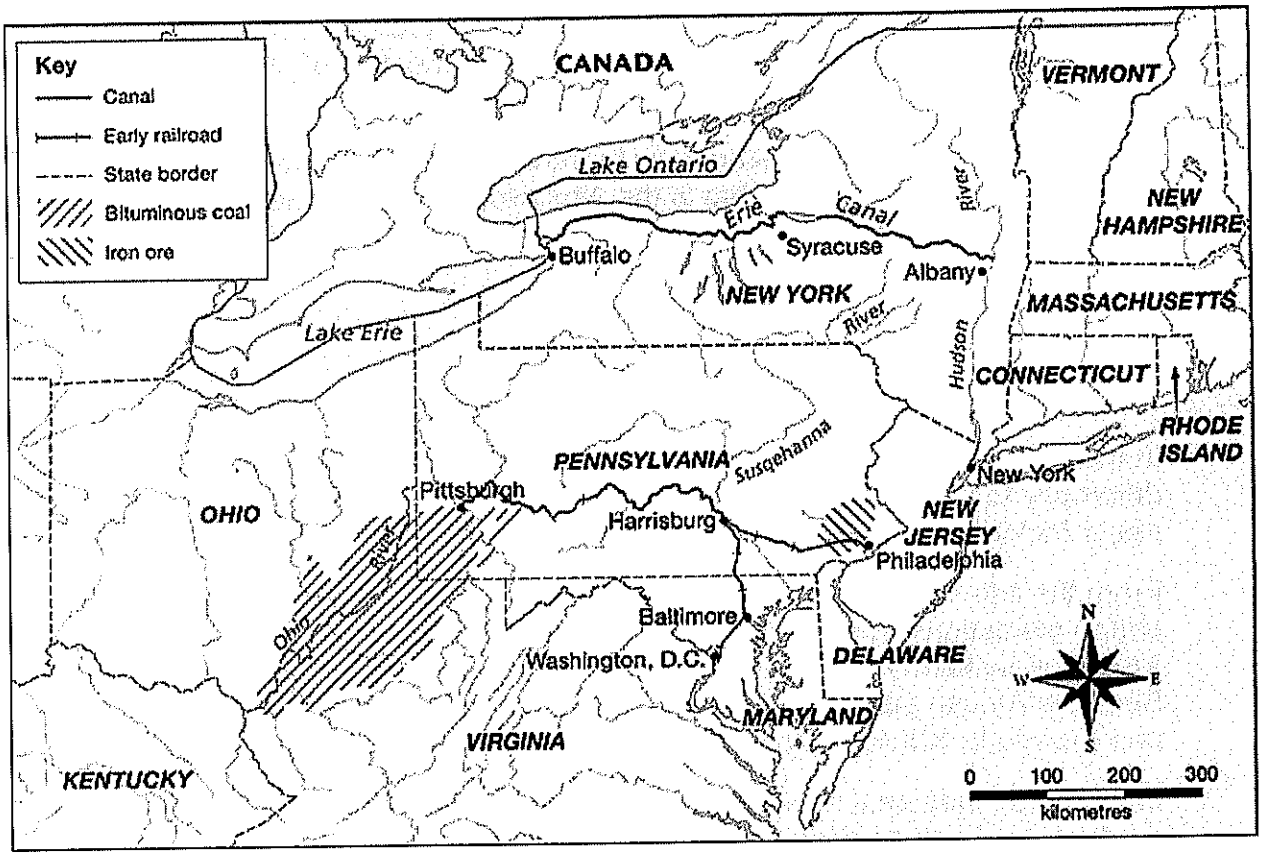
Two different economies

In the United States the economy of the northern states developed quite differently to that in the south. Apart from the issue of slavery itself, this was a major factor in the Civil War between the north and south in 1861–65.

From the late 1700s onwards, southern states moved from tobacco production to cotton plantations to supply the rapidly growing market in England and, as American settlement moved further west, more cotton fields were established. Because African slave labour was so cheap, there was little need to mechanise and the whole industry became dependent on the continued use of slaves.

In the north, industrial development began in the state of Pennsylvania with the production of iron as early as the 1720s, while America was still a British colony (see source 2). Pennsylvania had rich deposits of iron ore around Philadelphia and good-quality bituminous coal around Pittsburgh in the west. The growth of the railways created a demand for coal but also made it possible to bring together coal from one source and iron ore from another.

The widespread presence of coal and iron, and a growing migrant workforce from Ireland and Europe led to rapid industrial development. By 1914, the United States produced half as much coal and more steel than Great Britain, France, Germany and Austria-Hungary combined.



SOURCE 2 The north-eastern states — birthplace of the Industrial Revolution in the United States. This map shows the early canals and railroads in these states.

Source questions

Use source 2 to answer the following questions.

1. Why was the Erie Canal, in conjunction with the Hudson River, so important for the development of New York as a major city?
2. What advantages did the state of Pennsylvania have for industrial development?
3. Name the major cities that were linked by rail.

Transport

For American industry to develop, the problems of transport over distances far greater than in European nations had to be overcome. The answer lay in the vast river systems of the United States, primarily those flowing east into the Atlantic Ocean, and the inland system of the Mississippi flowing south, with rivers like the Ohio and Missouri flowing into it. These rivers were too wide for horse-drawn barges, so the Americans were quick to introduce steam transport to the rivers.

The first regular service was on the Hudson River in 1807 with Robert Fulton's *Clermont*. It was a flat-bottomed, 1000-ton ship powered by two paddlewheels, driven by a low-pressure steam engine, based on the models of James Watt. It

was fuelled by wood and travelled at about eight kilometres per hour, which was twice walking speed.

Friends of the art, — I send you here with drawings sketched from a machine that I have constructed, and with which I purpose soon to make experiments in causing boats to move on rivers by the aid of fire-pumps (pompes-a-feu). My first aim, in occupying myself with this idea, was to put it in practice on the long rivers of America, where there are no tow-paths, and where these would scarcely be practicable, and where, consequently, the expenses of navigation by steam would be placed in comparison with that of manual labour, and not with that of horse-power, as in France.

SOURCE 3 An extract from Robert Fulton's letter to friends in Paris (written in 1805, during the Napoleonic wars)

Source questions

Use source 3 to answer the following questions.

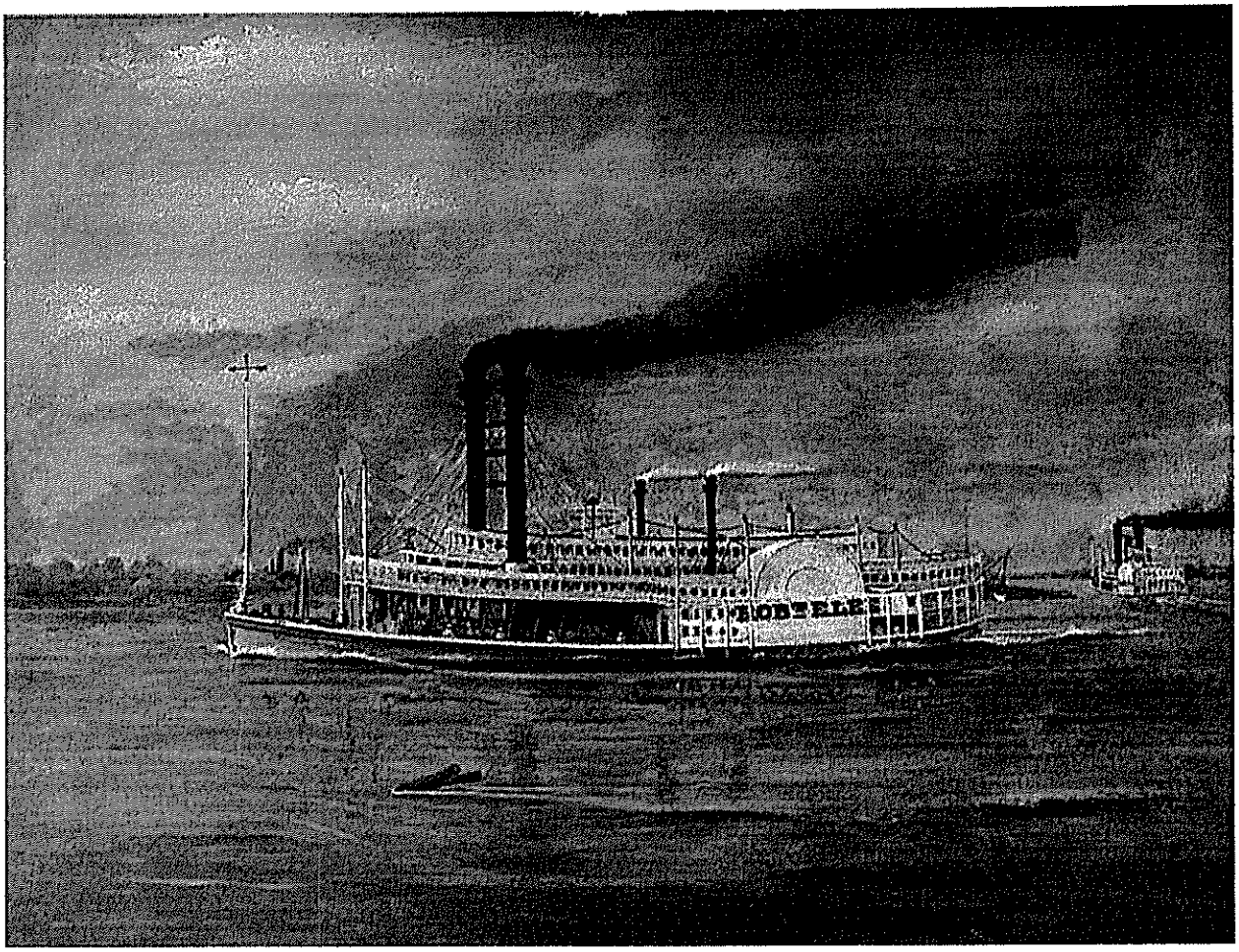
1. What source of power would steam power have to compete with in Britain and France?
2. Why wasn't this a factor in the United States?
3. Where do you think the idea of a water wheel for powering boats came from? What more efficient method was developed later for large ships?

Steam boats for use on the Mississippi River had to be specially designed to handle the often shallow water. There was no room in the hull for the engine, so two high-pressure steam engines, one for each paddle wheel, were built on the deck, while another deck was built above this for the pilot.

There was no link between the inland river systems and the east coast until the building of the Erie Canal, which linked New York with the city of Buffalo on Lake Erie (see source 2). Building of the canal commenced in 1817 and it opened in 1825. It was about 590 kilometres long and there were 32 aqueducts, crossing rivers and valleys. The canal played an important role in the development of New York as a major US city. Further canals were built in the north-eastern states over the next 25 years, but these were soon superseded by the rapid development of railways.

Most of the railways in the United States were built by private enterprise, but with charters from the state governments that gave them some rights to purchase land, even if the owner objected. The earliest railways were built in Maryland and, between 1827 and 1835, tracks were built west to join up with the Ohio River, and south to Washington, DC. Over the next 30 years the railway network grew rapidly, and in Utah in May 1869 a line from the west linked up with a line being built from the east to create a trans-continental line linking California in the west with New York in the east.

The United States began manufacturing their own steam engines, and the most important company was the Baldwin Locomotives Works established in Philadelphia, Pennsylvania, in the 1830s. As well as providing locomotives for the major American railroads, they exported locomotives to England, France, India and Egypt.



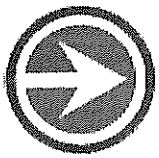
SOURCE 4 A Mississippi steam boat

ACTIVITIES

CHECK KNOWLEDGE AND UNDERSTANDING

1. What features did Belgium have in common with Britain that made rapid industrialisation possible?
2. Although Germany had iron and coal resources, what held it back from industrialising in the first half of the nineteenth century?
3. Why did France follow a different path to industrialisation to that of the other countries?

4. Why did the United States move quickly to steam-powered boats rather than barges?
5. What advantages did the state of Pennsylvania have in the early stages of the Industrial Revolution in the United States? Consider both its location and its resources.



Practise your historical skills

COMPREHENSION: CHRONOLOGY, TERMS AND CONCEPTS

1. Below is listed a series of events that took place during the Industrial Revolution.

a. Write each event on a small card.

- Passenger and goods trains driven by steam locomotives
- Fashionable shops with plate-glass windows
- Improvements in farming methods
- Machines used to spin cotton
- Improvements in breeding stock
- Canals built
- Flying Shuttle used in weaving
- Heat pumps used in coalmines
- Mills built to house machinery
- Enclosure of open fields

b. Place your events on a sheet of paper in landscape format in chronological order with the earliest events on the left and the latest events on the right. Draw arrows between events that are related. Arrange the events so that it is easy to do this and then paste down the cards and draw in the arrows to create a flow chart.

c. Use this flow chart to write 100 words on how the Industrial Revolution developed in England.

ANALYSIS AND USE OF SOURCES

Stratford: [In the last 'twenty or thirty years' the Village has] more than doubled in that time; every vacancy filled up with new houses ... generally speaking, of

handsome, large houses, from 20 pounds a year to 60 pounds, very few under 20 pounds a year; being chiefly for the habitations of the richest citizens...

St Edmunds: The only trade carried on was spinning and its industry depended on the gentry ...

[The river was small but engineers] made this river navigable to the said Milden Hall, from whence there is a navigable dyke, called Milden Hall Drain, which goes into the River Ouse, and so to Lynn; so that all their coal and wine, iron, lead, and other heavy goods, are brought by water from Lynn, or from London, by the way of Lynn, to the great ease of the tradesmen.

Norwich: [Based on the number of looms a weaver calculated that] There were 120 000 people employed in the woolen and silk and wool manufactures of that city only; not that the people all lived in the city.

[Increasing imports of calico (cotton cloth) were seen as a threat to the wool and silk industries so after Parliament passed laws in 1720 and 1721] prohibiting the use and wearing of calicoes, the stuff trade revived incredibly; ... the manufacturers assured me that there was not ... any hand unemployed, if they would work; and that the very children, after four or five years of age, could every one earn their own bread.

Yarmouth: [The merchants traded pickled herring with] Genoa, Leghorn, Naples, Messina, and Venice; as also to Spain and Portugal, also porting with their herring very great quantities of worsted stuffs, and stuffs made of silk and worsted, camblet....

They have also a considerable trade to Norway and to the Baltic, from whence they bring back deals and fir timber, oaken plank, balks, spars, oars, pitch, tar, hemp, flax, spruce canvas, and sail-cloth ... where they build a very great number of ships every year.

[A storm around 1692 destroyed many boats in] a fleet of 200 sail of light colliers (so they call the ships bound northward empty to fetch coals from Newcastle to London)

Cambridge: Defoe describes the products of a Fair near Cambridge:

[There are] all sorts of wrought-iron and brass-ware from Birmingham; edged tools, knives, etc., from Sheffield; glass wares and stockings from Nottingham and Leicester; and an infinite throng of other things of smaller value every morning.

To attend this fair ... there are sometimes no less than fifty hackney coaches which come from London, and ply night and morning.

SOURCE 1 Extracts from Daniel Defoe's 1722 publication *Tour through the Eastern Counties of England*

Daniel Defoe (c.1660–1731), the author of *Robinson Crusoe*, was also a journalist. In his *Tour through the Eastern Counties of England* (1722), he describes England on the brink of the Industrial Revolution.

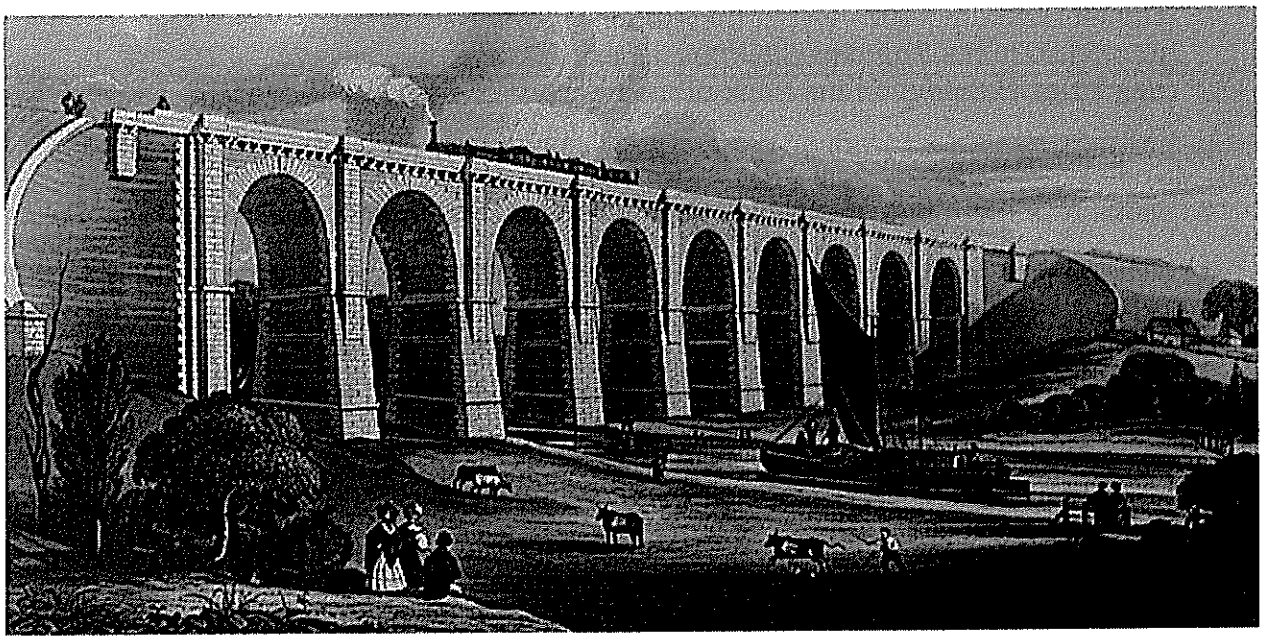
2. What does source 1 tell us about (a) population and (b) wealth in this period?
3. What was the major 'trade' in St Edmunds and who bought its products?
4. What important later development of transport is described here in an early form?
5. At what age were children being employed?
6. List the places Yarmouth traded with and the goods they exported. Why was Yarmouth in a good position to do this?
7. Why did so much wood have to be imported?
8. What changes in London made so much coal necessary?
9. 71List the industries that were already operating before the Industrial Revolution.
10. Where did the buyers of these goods come from?

PERSPECTIVES AND INTERPRETATIONS

11. Different people in England experienced the Industrial Revolution in different ways, and some of these contrasts can be seen by comparing the depiction of London slums shown in source 1 of section 1a:8 with source 2 below.

a. For each image, make a list of words that could be used to describe it. You may refer to: colours; shades of light and darkness; moods and feelings; attitudes to the changes that were being brought about.

b. Using your words from part (a), write a paragraph about each illustration that describes (i) the impression it makes and (ii) how the artist has conveyed this impression.



SOURCE 2 An 1831 artwork by T.T. Bury showing a train passing over the original Sankey Viaduct, built by George Stephenson and opened in 1830. The viaduct crossed the Sankey Canal, one of the first major canals of the Industrial Revolution.

EMPATHETIC UNDERSTANDING

12. *The Water Babies* was a serial published in 1862–63 that described the life of a young chimney sweep. It played a large part in changing the laws on child labour. You can find *The Water Babies* online at Project Gutenberg. Read the first few paragraphs of chapter one and then rewrite this as if you are Tom, the chimney sweep, telling your own story.

RESEARCH

13. You are going to explore the following question: In what ways was Australia's development in the nineteenth century affected by the Industrial Revolution?

    Find evidence from primary and secondary sources to answer the following sub-questions:

    – What materials did Australia provide to meet Britain's needs?

    – What items did Britain export to Australia?

    – Did Australia develop its own industries in the nineteenth century? Why or why not?

EXPLANATION AND COMMUNICATION

14. Locate the places mentioned in source 1 on a map of England.

15. Use material in the sources throughout this topic as well as your own knowledge to describe the important factors in England in the 1720s that were to have an influence on the Industrial Revolution. These include:

a. rise in population and wealth

b. demand for consumer goods

c. relevance of the textile industry

d. increasing role of coal/shortage of wood

e. Britain's overseas trade.