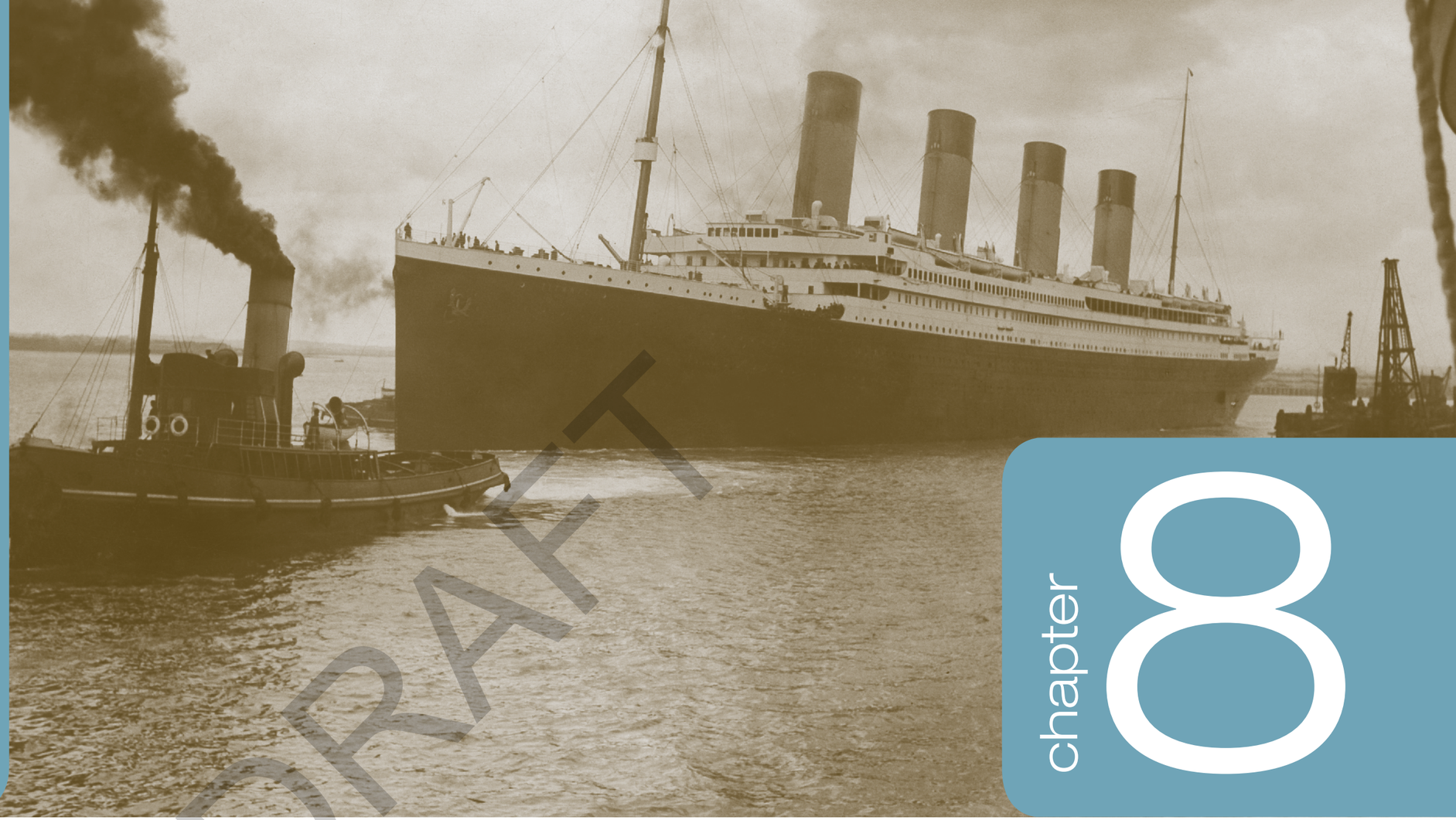
Unit 1 The Industrial Revolution

The Industrial Revolution

The **Industrial Revolution** was a period of rapid technological change that took place from around 1750 to 1914. It began in Great Britain before quickly spreading to Europe and other parts of the world. Huge developments in farming and manufacturing changed not only the way things were produced and sold, but also how people lived and where they worked. The changes were so significant that they revolutionised many societies.

The RMS *Titanic* was one of the most important achievements of the Industrial Revolution. On 10 April 1912 after more than a century of industrial development, she set out from England on her maiden voyage to New York. The night *Titanic* sank, over 1500 people died. Like the Industrial Revolution itself, the *Titanic* was an immense achievement and a triumph of technology. For many though, it was also a disaster.



chapter 8

Source 1 The RMS *Titanic* leaving Southampton, England, on her maiden voyage to New York, 10 April 1912

8A

What developments and innovations led to the Industrial Revolution?

1 The Industrial Revolution was brought about by a range of technological, economic and social changes. As a class, brainstorm some examples of each.

2 Do you agree that we are in the middle of a digital revolution?

8B

How did the Industrial Revolution affect the lives of men, women and children?

1 During this period people gave up farming to find work. How do you think this affected their lives?

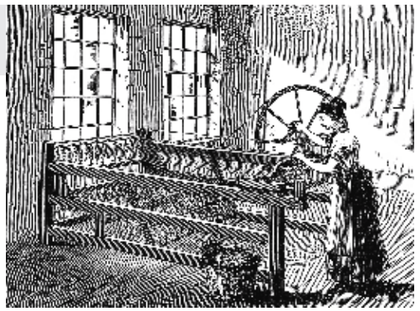
2 What do you think living conditions would have been like at the time?

8C

What were the short- and long-term impacts of the Industrial Revolution?

1 Industrialisation had many impacts on society and the environment. In pairs or small groups, brainstorm as many changes as you can that were brought about by the Industrial Revolution – both in the short-term and long-term.

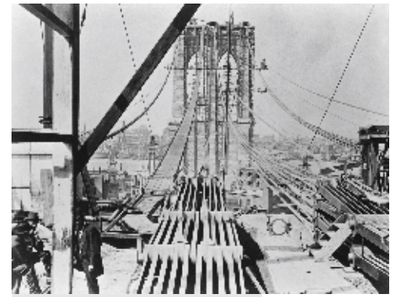
8.1 The Industrial Revolution: a timeline



A woman using a spinning jenny

Brunel's engineering feat: the Thames tunnel

The steamship *Great Eastern* laying the first successful Atlantic cable



The Brooklyn Bridge under construction, *c.* 1878

1709
Abraham Darby discovers how to make coke from coal – a more efficient fuel in the production of iron

1710
Thomas Newcomen builds a steam engine to pump water from coalmines

1765
James Hargreaves' spinning jenny allows one worker to make eight times the previous amount of yarn

1792
Inventor William Murdoch uses coal gas for house lighting

1825
Isambard Brunel starts building a tunnel under the Thames River; work is completed in 1842

1839
The world's first screw-propelled steamship, SS *Archimedes*, is built in Great Britain

1866
First transatlantic telegraph cable laid

1883
The first ten-storey skyscraper is built in Chicago and the longest suspension bridge at this time, the Brooklyn Bridge in New York, is completed

1903
The Wright brothers carry out the first powered heavier-than-air flight

1908
Henry Ford uses a production line (assembly line) to produce the Ford Model T

1580 | 1700 | 1750 | 1800 | 1850 | 1900 | 1915

1589
William Lee invents the stocking frame, a mechanical knitting machine for knitting stockings. It played an important role in the early part of the Industrial Revolution

1733
John Kay invents the flying shuttle, allowing weavers to make larger sections of fabric at greater speed, increasing demand for yarn

1775
James Watt creates an efficient steam engine

1779
Steam-powered mills with automatic weaving machines begin to be built

1793
Eli Whitney invents the cotton gin (engine), which can clean large quantities of raw cotton

1811
Riots begin, lasting until 1815, in which workers smash up factories and equipment in protest, fearing machines will replace them. These people become known as Luddites

1821
Michael Faraday demonstrates the principle of an electric motor

1863
Bulk steel creation is made possible through the open-hearth process created by Siemens-Martin; the use of steel combined with reinforced concrete enables the construction of skyscrapers

1876
Alexander Graham Bell patents his 'acoustic telegraph', or telephone

1885
Karl Benz uses an internal-combustion engine in the first 'automobile'

1912
The Titanic, then the world's largest passenger steamship, hits an iceberg in the north-west Atlantic Ocean and sinks; 1517 people die

The flying shuttle introduced a more efficient way of weaving

A stocking frame, *c.* 1770

Source 1 A timeline of the key events of the Industrial Revolution

Check your learning 8.1

Remember and understand

1 What was the 'flying shuttle' used for, and when was it invented?
2 When was the first transatlantic telegraph cable laid?

Apply and analyse

3 Using the timeline, calculate how many years there were between when the first steam engine was invented and the first aeroplane flight.

Evaluate and create

4 Conduct some Internet research to find out the dates of some other significant inventions and discoveries that occurred during the Industrial Revolution. Add these events to a new timeline in your notebook.

8.2 The Industrial Revolution in Britain

Britain before 1750

Before 1750, Britain was an agricultural society. Around 80 per cent of people at the time lived and worked on small farms in rural areas. Most farms harvested small crops each year and raised small herds of livestock (such as sheep and cattle). Despite the small scale of most English farms, agriculture was still the main economic activity in Britain.

Source 1 A 19th-century artist's impression of rural life in Britain before the Industrial Revolution

By comparison, manufacturing, mining and trade employed relatively few people in Britain. For the most part, manufacturing was small and localised. Tools used in the manufacture of most goods (such as carts, mills and looms) were basic and powered by people, animals or waterwheels that harnessed the power of fast-flowing rivers and streams.

Towns and villages at the time were small and self-contained. Roads linking villages were poor and most people travelled on foot or by horse. In fact, Britain's road system had not improved much since the fall of the Roman Empire, around 1300 years earlier. As a result, most people rarely travelled far from the places where they lived and worked.

In most cases, the working day began at sunrise and ended at sunset. People's diets were inadequate and average life expectancy was short. Illness was common because of poor hygiene, bad or non-existent sewage systems, and polluted water supplies.

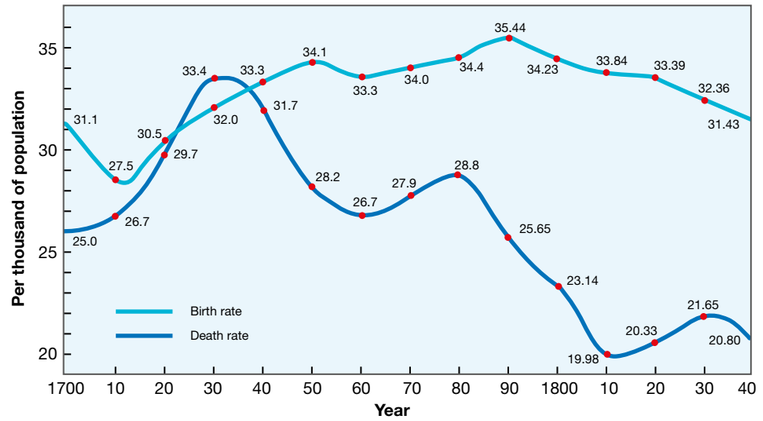
British society was divided into strict social classes according to wealth and position based on birth. The aristocratic (noble) families made up only one per cent of the population but controlled about 15 per cent of Britain's wealth. Noble gentlemen did not involve themselves in farming, trades or professions. Instead, they invested much of their wealth in land.

There is no single event that marks the beginning of the Industrial Revolution in Britain, but the industries that first experienced it were connected with the production of iron, coal, cotton and wool.

The Industrial Revolution begins

During the Industrial Revolution, Britain's population quadrupled from an estimated 6.5 million people in 1750 to around 32.5 million in 1900. This increase was mainly a result of improved living standards and declining death rates. The population of Britain moved from rural to urban communities, and Britain was transformed through the development of:

- *factories and textile mills* – the Industrial Revolution led to thousands of new factories and mills being built across Britain. These factories relied on large numbers of workers and machinery to manufacture massive quantities of goods in one place. The growth of factories and textile mills transformed Britain's economy and society.
- *modern towns and cities* – great industrial and commercial cities like London and Manchester grew as people moved to towns and cities to work at the new factories, mills and metal foundries. Before the Industrial Revolution, 80 per cent of the population lived in the countryside and only 20 per cent in cities. **Industrialisation** reversed this pattern. By 1850, 80 per cent of people in Britain were living in a major city or town and only 20 per cent remained on the land.
- *new sources of power* – the development of steam power and electricity transformed the manufacturing, agricultural transport and communications industries, having a major impact on people's everyday lives. Supplies of coal became vital to fuel steam engines and, later, electrical power stations.
- *improved transport and communications* – as the population grew, towns became linked by new canals, roads and railway lines. New modes of transport were also invented to replace horse-drawn carriages (see Source 3). As travelling conditions improved, people travelled more and lived less isolated lives. Later, new communication technologies like telegraph and telephone systems were also introduced.



Source 2 Population change in Britain, 1700–1840

The growth of cities and industries also saw the emergence of a new social class that became known as the 'middle class'. This new group of people came from a broad range of backgrounds and were neither wealthy aristocratic landowners nor impoverished factory workers. Instead, they included wealthy industrialists and merchants, as well as bankers, shopkeepers, teachers, doctors, lawyers, and the increasing number of managers, clerks and government officials. People earning middle class salaries could afford fine clothing, furniture, ceramics and other household items. It was this class of people that drove the demand for mass-produced consumer goods. They also drove the need for more schools, universities and libraries. The political power of the British middle class increased throughout the 1800s.

Source 3 This painting from 1831, *The Progress of Steam, A View in Regent Park 1831*, humorously shows suggested replacements for horse-drawn carriages.

Check your learning 8.2

Remember and understand

1. When and where did the Industrial Revolution begin?
2. List five key features of British society in the century before the Industrial Revolution began.

Apply and analyse

3. Write a paragraph explaining how life changed for British people between the mid 1700s and the late 1800s.
4. Using Source 2, describe the changes that took place in Britain from 1700 to 1840.
5. Before the Industrial Revolution, 80 per cent of people lived and worked on the land. How had this trend changed by 1850?

Evaluate and create

6. Historians still argue about why Britain became such a powerhouse of the Industrial Revolution, while other European countries were slower to modernise. The Netherlands and France were two other countries that might have had an Industrial Revolution first. Conduct some Internet research to identify some of the reasons why this didn't happen.

8.3 Why the Industrial Revolution began in Britain

One of the key factors that led to the start of the Industrial Revolution in Britain was its authority and wealth as an **empire**.

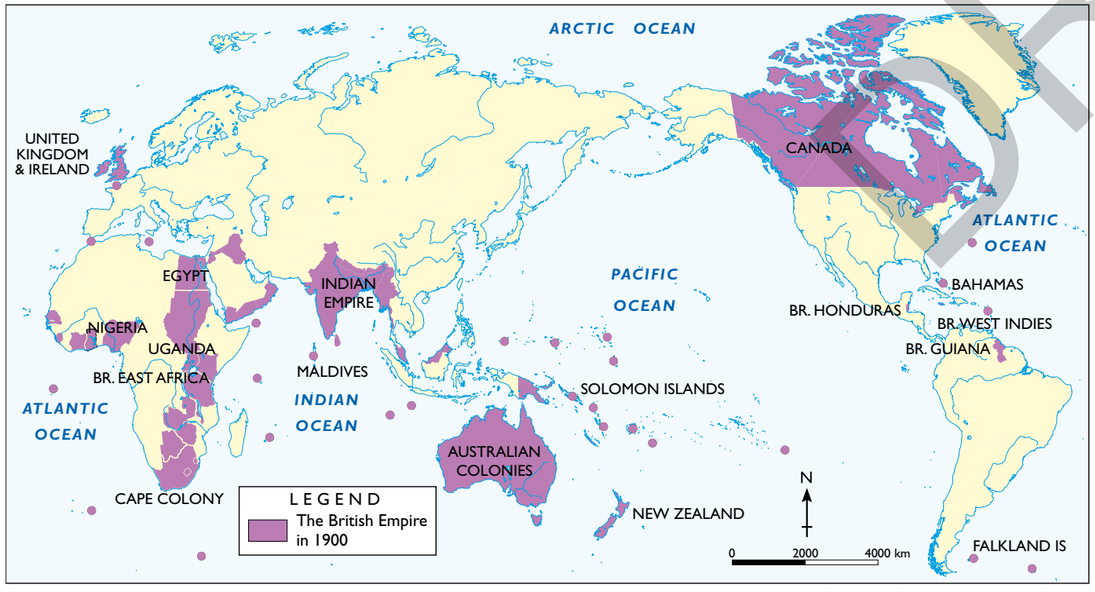
Rise of the British Empire

The expansion of the British Empire took place in two phases:

- the first phase was the establishment of the earliest British **colonies** in North America in the 1600s. Over the next 200 years Britain, France, Spain, the Dutch and Portuguese all laid claims to new territories around the world, including the Americas, Asia, Africa and the Pacific.
- the second phase was linked to a series of wars fought between the European powers in the 18th century and early part of the 19th century. Britain's superior naval strength ensured that it succeeded in becoming the dominant imperial power, despite the loss of many of its American colonies in the **American War of Independence** in 1865.

By 1900, the British Empire had expanded to cover around a quarter of the Earth's surface and ruled over a quarter of the world's population (see Source 1). Many of Britain's colonies provided the raw materials, workforce (in the form of slaves) and customers needed to drive the Industrial Revolution. Britain controlled more colonies, and therefore had access to more raw materials than any other country, including sugar from Australia and the West Indies, wool from Australia and New Zealand, cotton and tea from India, rubber from Malaya, gold from Australia and South Africa, coffee from Jamaica and Africa, wheat from Australia and Canada, and timber from the vast pine forests of Canada.

WORLD: BRITISH EMPIRE 1900



Source 1

Source: Oxford University Press

Source 2 Britain relied heavily on a strong navy and experienced fleets of merchant trading ships.

Other factors

In addition to the power of the British Empire, historians have proposed a range of reasons why Britain was the first country to experience the Industrial Revolution and why it became the world's leading economic and industrial power for a time. The answer lies in a combination of factors related to Britain's history, geography and culture. Some of these are discussed briefly below:

- *Britain's coal supplies* – Britain was fortunate to have large supplies of coal, a vital fuel for the steam power that drove the Industrial Revolution. None of the other European powers had such large quantities of accessible coal.
- *naval power and trading power* – as an island nation, Britain had always relied on skilled sailors, a strong navy and experienced fleets of merchant ships. Its largest merchant trading company was the East India Company (EIC). At its peak, the EIC rivalled many smaller European powers in terms of wealth and influence.
- *individual freedom and the capitalist spirit* – unlike many of the other European powers, there was a greater measure of individual and intellectual freedom in Britain. These freedoms provided a fertile ground for those willing to try new methods and take risks. In other parts of Europe, government restrictions and less individual freedom limited opportunity.
- *stable government* – before the start of the Industrial Revolution, Britain had enjoyed a prolonged period without much political or social conflict, compared to many other countries in Europe. This sense of stability and order encouraged the growth of business.
- *superior banking system and capital for investment* – increased trade meant that financial services in England – such as banking, investment and insurance – expanded to support and protect that trade. Britain's banking sector was more advanced and modern than those of other European countries. There was a ready supply of capital (money) available at very low rates of interest. This meant that money was available to start up new businesses and pay for experiments to develop new inventions. Two of the key inventions of the Industrial Revolution, the steamship and the telegraph, were important in helping Britain administer their colonies around the world.

Check your learning 8.3

Remember and understand

1 List the main changes that took place across Britain between 1750 and 1850.
2 Why were large coal deposits in Britain so significant during the Industrial Revolution?
3 What was the name of the largest British merchant trading company?
4 List three colonies under British rule and the raw materials they provided to fuel the growth of industries in Britain during the Industrial Revolution?

Apply and analyse

5 What percentage of the Earth's surface was under British rule by 1900?
6 Use Source 1 and your own research online to answer the following:
   a By 1900, 25 per cent of the world's total population was ruled by the British. How many people was this?

8.4 Developments in agriculture

From the mid-1600s, changes in farming and agriculture across Britain paved the way for the Industrial Revolution. Many historians believe that without these changes industrialisation would not have been possible from 1750 onwards. The changes that took place in agriculture were brought about by demands for more food to support Britain's growing population. Collectively, these changes are referred to as the **Agricultural Revolution**.

During the Agricultural Revolution, forests were cleared, grazing pastures were turned over to crop growing, and low-lying marshes were drained to grow even more crops. Small plots of farmland were consolidated into larger, more efficient fields under the **enclosures.** As a result, over 100 years Britain increased its farmlands by 30 per cent.

For the first time, agriculture became a business. Instead of just growing food to eat, farms began producing surplus amounts of food with the goal of selling it for profit. Landowners began investing more money in better livestock, fences and farming equipment. They also moved to growing high-yield crops such as wheat and barley. Improved farming techniques and equipment led to increases in crop production. For example, the amount of wheat produced in Britain increased by 75 per cent between 1700 and 1800.

The enclosures

More than 4000 Enclosure Acts (laws) were passed by the British Parliament during the Agricultural Revolution. These Acts transferred areas of common land that had previously been worked by small groups of local farmers into the hands of private landowners. These smaller areas of land were then joined together to create large farms that were enclosed by hedges or stone walls. This meant that local famers could no longer graze their animals or farm the land (see Source 1). Other land, which until then had been known as 'waste land', was also enclosed. By 1790, three-quarters of all farming land in Britain was enclosed by wealthy landlords. These landlords then rented this land to tenant farmers.

The process caused a great deal of social unrest as many poor people were forced off the land they had farmed free of charge for generations. Many flooded into the cities and became part of the new industrial working classes, while others sought new lives abroad.

Source 1 Stone walls like these were built to enclose what was once common land.

Crop rotation

Despite the hardship it caused for many poor farmers, the new commercial approach to farming led to improved management of the crops. For centuries, farmers had practised a process known as crop rotation, which involved leaving a field fallow (unused) for a period in order to avoid exhausting the soil. However, in 1730 a landowner by the name of Charles Townshend introduced a new method of crop rotation on his farm that became known as the 'four-field system'. He grew wheat in the first field, barley in the second, root vegetables (such as carrots and turnips) in the third and clover in the fourth. Each season, the crops were rotated (shifted around), which meant that no field was left fallow and the soil in each field was kept high in minerals and nutrients (like nitrogen). Wheat and barley were harvested for humans, while the fallow period was now replaced by clover, which could be used for grazing animals. The development of the four-field system earned Charles Townshend the nickname Turnip Townshend.

Improved farm machinery and methods

By the early to mid-1800s, new farming machinery was in use. There were new mechanical drills for planting seed, reaping machines for harvesting crops (see Source 2) and threshing machines to separate the valuable grain from the stalks of wheat and barley plants. These machines made farming more efficient and increased the profits that could be earned from the land. Each year, the amount of land that could be prepared, farmed and harvested in a season increased. By the 1840s, fertilisers were widely used, once again raising the productivity of the land.

Along with improvements in crop production came improvements in animal breeding and rearing. From the late 1700s onwards, the agriculturalist Robert Bakewell began selective breeding of livestock on his property. He developed a new breed of quick-fattening sheep with finer wool and tastier meat, called the New Leicester. Bakewell also bred cattle for beef production. His ideas produced stronger animals that were noted for their larger size and better quality.

Source 2 Cyrus McCormick's reaping machine of 1831 led to huge improvements in how grain was harvested.

key concept: Empathy

The effects of the enclosures

By applying the key concept of empathy, historians are able to understand the effects of the enclosures from the point of view of all those involved. While many wealthy landowners saw the enclosures as a way of increasing in productivity and profits, many thousands of ordinary farmers in Britain saw them as the destruction of their way of life. The enclosures denied them access to the lands that had supported their families for centuries and in many cases their property was destroyed. Some landlords permitted their tenants to dismantle their houses and take the wood away to build elsewhere. Others simply burned the homes and property of their tenants.

Between 1775 and 1850, over 25 000 Scots were forced from their homes in the Highlands of Scotland by landowners wanting to enclose the land. This process became known as the 'Highland Clearances'. These farmers were left homeless and without the ability to grow their own food (see Source 3).

Source 3

> Their wretchedness was so great that [they] … were obliged to subsist upon broth made of nettles, thickened with a little oatmeal. Those who had cattle [resorted to] bleeding them and mixing the blood with oatmeal, which they afterwards cut into slices and fried.
>
> James Loch, *The Sutherland Improvements*, 1820

For more information on the key concept of empathy refer to page XX of 'The history toolkit'.

Check your learning 8.4

Remember and understand

1 What did the 'enclosure' of land mean?
2 Approximately how many Acts did the British parliament pass that related to enclosure in the 1800s and 1900s?
3 What innovation led to Charles Townshend's nickname Turnip Townshend? Why was this innovation important?
4 What was Robert Bakewell known for?

Apply and analyse

5 Write a short paragraph explaining how new machinery affected the harvesting of crops.

Evaluate and create

6 The Enclosure Acts resulted in improvements in the farming industry, but it also led to a number of social problems for farmers who had previously had free access to land. With a partner, write and role-play a conversation between a landowner who has benefited from the Enclosure Acts and a farmer who has lost both land and income as a result of the Enclosure Acts. In this conversation, ensure each person describes and explains the effect the Enclosure Acts have had on their lives and livelihood.

8.5 Developments in cotton, wool and iron production

Some of the most important developments and innovations of the Industrial Revolution took place in the production of cotton, wool, coal and iron. However, arguably the most important 'invention' of the Industrial Revolution was not a single item of equipment or technology at all. Instead, it was a way of producing goods on a large scale using many workers and specialised machinery on one site. This method of production became known as the **factory system**.

The factory system

Before the introduction of the factory system, manufacturing often took place in small workshops or in local workers' cottages (hence the term 'cottage industries'). Local trades and crafts people such as blacksmiths, wheelwrights (wheel makers), cartwrights (cart makers), potters, millers and weavers used their skills, muscle power or water power to largely hand-make items. In contrast, the factory system brought together large numbers of workers in a single site or factory. Few of these workers were skilled because most of the manufacturing was done by machines. Instead, the many workers performed tasks that were repetitive and required little skill. The machines were powered at first by water with waterwheels, then by steam and next by electricity. The factory system itself was made possible by a combination of the technological innovations and knowledge that emerged during this period.

Cotton and wool production

The first factories of the Industrial Revolution were cotton mills. Inventions such as the flying shuttle, spinning jenny, water frame (Source 1) and Crompton's mule (Source 2) in Britain paved the way for the mass production of cotton and wool.

The flying shuttle

The flying shuttle, invented by John Kay in 1733, introduced a more efficient way of weaving on hand-looms. It only required one weaver to shoot the yarn from one side of the width of the loom to the other.

Source 1 Arkwright's water frame

This was especially useful for very wide looms. Weavers could produce cloth much more quickly, increasing the demand for spun yarn.

The spinning jenny

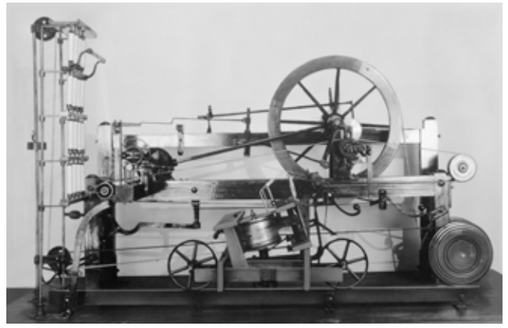
The spinning jenny, a machine invented by James Hargreaves in 1765, helped increase the supply of yarn. It could spin eight threads at once, whereas the traditional spinning wheel could only spin one thread at a time.

The water frame

The water frame, invented by Richard Arkwright in 1768, was a spinning frame that improved on James Hargreaves' invention, as it could be powered by a waterwheel and produce yarns of any type.

Crompton's mule

Crompton's mule was invented in 1779 by Samuel Crompton by combining the spinning jenny's carriage and the water frame's rollers. It allowed a single power source to spin multiple machines, and worked with wool



Source 2 Crompton's mule

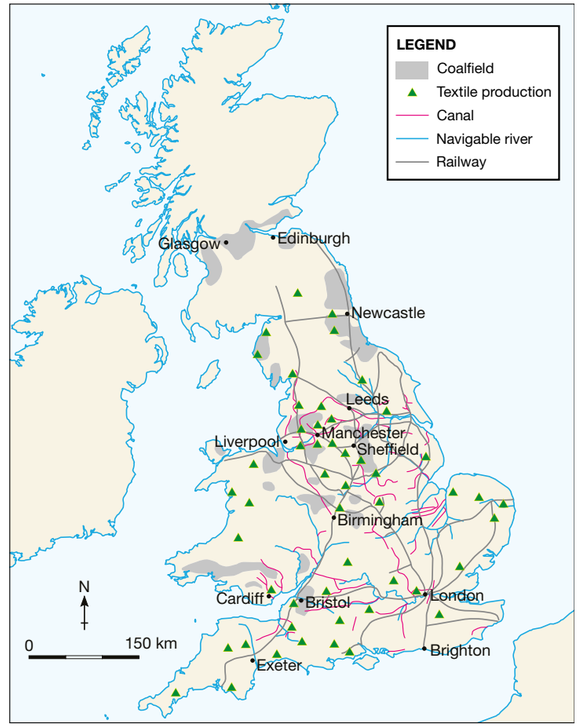
or cotton yarns. However, it still required a skilled weaver to operate. These spinning mules were developed further so they could be operated by unskilled workers. Steam power was later applied to the spinning mules for use in cotton-spinning factories.

By the middle of the 1760s, Britain had become the centre of cotton production, importing raw cotton from India and the United States. The raw cotton went to the mills where machines were used to spin the raw cotton into yarn, and then weave the yarn into cloth. The very first mills were powered by waterwheels, so they needed to be located close to strong-flowing rivers and streams. After the development of steam power, mill owners were able to build mills in cities – closer to a constant supply of workers and potential customers.

As a result of these developments, over time the skills of traditional weavers (see Source 4) were no longer needed. Weavers were replaced by workers who were only required to feed the raw cotton or cotton yarn into machines. Many mill owners, keen for increased profits, wanted their machines running all of the time. This meant long working hours – up to 16-hour working days – and shift work for labourers. Because mill workers did not need to be skilled, women and young children became part of the workforce as they were cheaper to employ.

Overall, conditions for workers during the first decades of the Industrial Revolution were poor. Brutally long hours for low pay, in badly lit and uncomfortable conditions became commonplace. Although harsh working conditions for the men, women and children working in factories and mines were common, there were also exceptions. For example, at the cotton mills operated by Robert Owen in New Lanark in Scotland, the children of workers were well cared for and educated.

BRITAIN: TEXTILE PRODUCTION AND COALFIELDS, EARLY 19TH CENTURY



Source 3 Source: Oxford University Press

Source 4 Weavers originally worked from their homes, using their own looms, rather than in factories.

Iron production

Before the Industrial Revolution, iron producers had to heat (smelt) the iron ore (rock) to extract the raw metal or 'pig iron' from it. Generating the necessary heat to smelt the iron ore required charcoal, but making charcoal was time-consuming and demanded large quantities of wood. Because of this, wood supplies across Britain were dwindling. In 1709, Abraham Darby, an iron producer at Coalbrookdale in Derbyshire, England (see Source 5), found a way to bake coal to make a substance known as coke. Coke was a new, smokeless fuel that burned much hotter than ordinary coal. Quickly, coke replaced charcoal as the fuel used to smelt iron ore. Iron foundries were established near coalfields (rather than forests), and the iron and coal industries became strongly linked.

Other innovations also made the smelting process more efficient. In 1784, iron producer Henry Cort was able to combine two processes, known as 'puddling' and 'rolling', which made the large-scale production of pig iron possible. The amount of pig iron smelted in Britain rose from 25 000 tonnes in 1728 to 60 000 tonnes in 1788. By 1796, Britain was producing was 125 000 tonnes.

As production increased, new uses were found for iron. Iron utensils such as knives and forks became common, as did iron pots and pans for household kitchens. Iron was also used as a building material in factories and houses, transforming the design of buildings. For example, in 1851, London's Crystal Palace had a roof and walls made of iron frames and giant panes of glass. By this time, British pig-iron production was 2.25 million tonnes, 18 times as much as in 1796. Similarly, the French put iron to use in 1889 building Gustave Eiffel's famous tower (see Source 6). The Eiffel Tower is an iron lattice structure created as the centrepiece of the 1889 World's Fair in Paris. It is 324 metres tall – as high as an 81-storey building – and remained the tallest structure in the world until 1930.

Source 6 The Eiffel Tower under construction, 1889

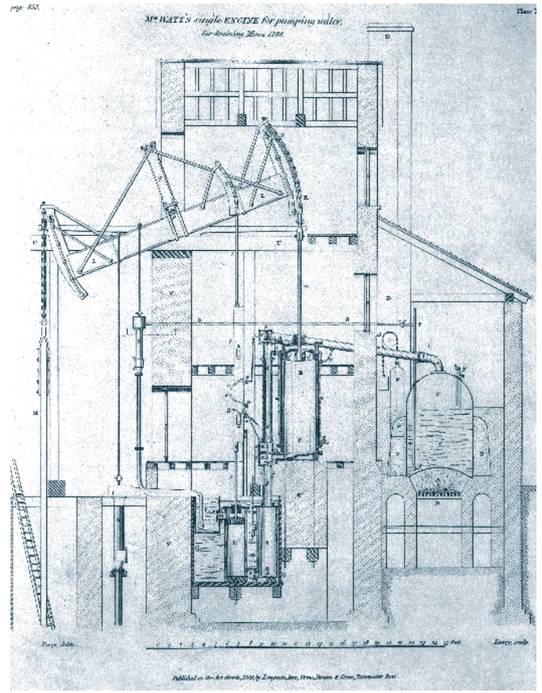
Source 5 Coalbrookdale ironworks operating at night, 1801

Source 7 Foundry workers using a large steam hammer to shape red-hot iron, Manchester, England, 1832

The development of the steam engine

The invention of the steam engine revolutionised manufacturing and transport, and was later used to generate electricity. Coal supplies were vital to fuel the Industrial Revolution, and the ever-increasing demand for coal led to the opening of new mines and the deepening of older mines. The digging of deeper mines in turn required better pumping systems to keep water from flooding lower levels. Two inventors, Thomas Savery (around 1698) and Thomas Newcomen (around 1710) developed early steam engines to pump water from mines.

While repairing a Newcomen steam engine, engineer James Watt realised that he could greatly increase its efficiency. Watt did not invent the steam engine but in 1769, he developed an improved version that was more practical and powerful. In 1775, Watt formed a partnership with Matthew Boulton to manufacture the new steam engines (see Source 8). Over the next 25 years, their firm manufactured almost 500 steam engines. They were used not only in the mining industry, but also in cotton-spinning factories, flour mills, breweries and sugar cane crushing mills around the country.



Source 8 James Watt's steam engine for pumping water from mines

Check your learning 8.5

Remember and understand

1 What were some of the problems with using charcoal in the process of extracting iron from iron ore?
2 What is coke, and what difference did it make to the iron-making process?
3 Name some of the new uses and products that developed from the availability of mass-produced iron.
4 What was one of the major reasons for the increase in demand for coal during the 1700s?
5 List three effects of the increased demand for coal during the 1700s and early 1800s.
6 Why was the cotton industry regarded as a 'cottage industry' prior to the Industrial Revolution?

Apply and analyse

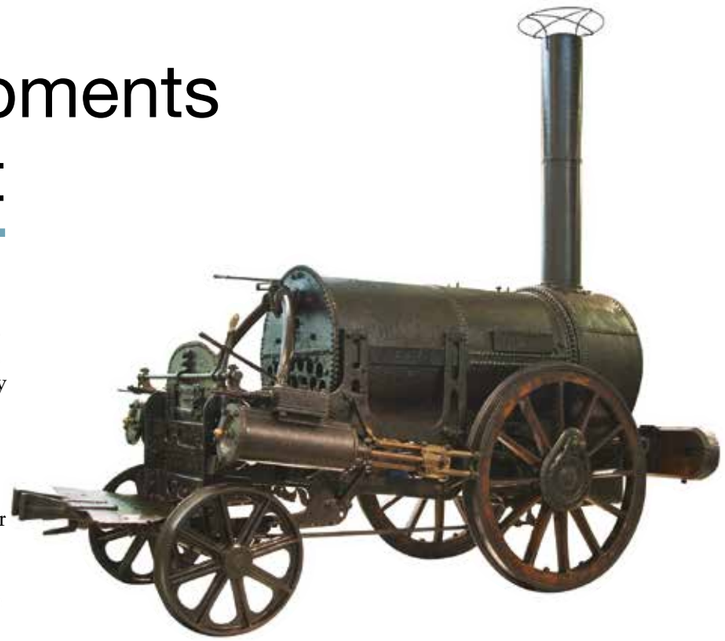
7 Explain why the iron production and coal-mining industries became so closely linked during the Industrial Revolution.
8 Why was James Watt's invention so important at this time in history?
9 In your opinion, which of the four inventions discussed was the most important for the textile industry in Britain? Justify your response.

Evaluate and create

10 Create a poster which shows how new inventions transformed the textile industry during the Industrial Revolution. Make sure you include labelled diagrams or illustrations.
11 Imagine you are an 80-year-old weaver in the late 1700s. Write a short account of how your life and work practices have changed over your lifetime because of new inventions in the textile industry.

8.6 Developments in transport

At the start of the Industrial Revolution, transport in Britain was slow and costly, regardless of whether people travelled by road, river or sea. From 1750 onwards, growing numbers of wealthy merchants and **industrialists** started demanding quicker and cheaper forms of transport to move coal to their factories, ship their products to markets and speed up travel between cities. As a result, a number of new inventions and improvements were made in the area of transport.



Source 1 The original Stephenson's 'Rocket' locomotive, from 1829, now housed at the Science Museum in London

New inventions

Steam locomotives

The first steam locomotive was built by English engineer Richard Trevithick in 1801. Unlike modern locomotives, it was driven on roads rather than rails. In 1804, Trevithick was the first person to drive a steam locomotive on the rails of a tramway.

The first locomotive built and used for commercial purposes was known as the Stephenson's Rocket. It was invented by George Stephenson (see Source 1) in 1829 and remains one of the most famous steam locomotives. From this point on, the designs of steam locomotives became more sophisticated. They also became far more powerful and capable of reaching greater speeds.

Source 2 The launch of SS *Great Britain* in Bristol in 1843

Steamships

The first commercial steamship was developed by an American named Robert Fulton in 1807. Like the steam locomotive, the steamship went through many different designs and improvements over the next 100 years. For example, the more resilient screw-propellers were developed to replace the easily damaged paddle-wheels of the early steam ships. By 1838, ships were crossing the Atlantic Ocean driven purely by steam power. In 1843, the great British engineer Isambard Kingdom Brunel (see the Significant Individual section on pages XX–XX) launched the SS *Great Britain*, the first iron-hulled steamship with a screw propeller designed to cross oceans. Steamships quickly began to replace sailing ships as the preferred means of ocean-going transport. Although their cargo space was reduced by the large amount of space required for storing coal, they were faster and more reliable.

The internal combustion engine

While the steam engine was useful for factories, trains and ships, it was too large to use in smaller businesses and smaller vehicles. In 1859, Belgian engineer Etienne Lenoir developed an engine that sucked coal gas and air into a cylinder, where it was ignited by a spark, pushing down a metal piston that turned a wheel. This invention became the basis for the internal combustion engine – the same engine that is used in all modern cars and engines.

German engineers Gottlieb Daimler and Wilhelm Maybach experimented with an engine that used a new fuel, which later became known as gasoline or petrol. Daimler first used it in 1885 to power a wooden bike called the Daimler *Reitwagen* (see Source 3). A year later, another German designer and engineer named Karl Benz patented the world's first petrol-powered car known as the *Benz Patent-Motorwagen* (see Source 4).

As internal combustion engines became more reliable and powerful, cars became more and more common. At first, private cars were painstakingly built by hand. Their high cost meant they became the toys of the very rich. It was not until 1908 that Henry Ford made the dream of owning a car possible for the common man. He did this by adapting the factory system to create an affordable car known as the Ford Model T. By using an **assembly-line** technique with a sequence of specialised workers who repeated the same task on a series of components, he was able to produce cars much more cheaply and quickly.

Source 3 The world's first motorcycle built by Gottlieb Daimler, 1855

Source 4 The first Mercedes Benz motorcar, 1886

The internal combustion engine also allowed for the development of an engine that would be light yet strong enough to power flying machines. American brothers Wilbur and Orville Wright used a petrol engine connected to two propellers fitted onto a wooden glider to fly for 59 seconds in 1903. Powered flight was to develop rapidly, triggered by World War I.

Other transport improvements and innovations

As new modes of transport became available, demand for new and improved roads, bridges, canals, and railway lines grew rapidly.

Improved roads and bridges

In the early 1700s, most roads in Britain were built and maintained by local inhabitants who carried out repairs only when absolutely necessary. This meant that most roads outside London were in very poor condition. A few roads were managed by turnpike trusts – agencies that collected fees from travellers in return for keeping the roads in good condition (see Source 7). By the early 1800s, pressure from industrialists such as Josiah Wedgwood (ceramics), John Wilkinson (iron) and Matthew Boulton (coin minting) led to a dramatic increase in the number of turnpike trusts. By the 1830s there were more than 1000 such trusts. As a result, roads improved and travel times decreased.

As roads improved, demand for more reliable and convenient ways of crossing rivers grew. In 1779, Abraham Darby began building the world's first cast-iron bridge to link a small mining town with nearby factories in the town of Coalbrookdale. A toll was charged for using the bridge which became known as the Iron Bridge (see Source 6). The bridge became famous in 1795 when it remained standing after a major flood. After that, many more bridges were built using iron rather than stone.

Railways

The world's first railway line was built in 1825 between the coalfields in Darlington and the seaport of Stockton in north-east England. It combined two innovations – the steam engine (formerly used to pump water from mines) and rail-mounted mining trucks (formerly pulled by horses).

Railways added a whole new phase to the Industrial Revolution. In 1830, a new track linking the Manchester cotton industry to the port of Liverpool opened to transport goods for export. This was the first railway to link two major cities. Throughout the 1830s and 1840s, the building of rail tracks and strong, iron bridges for new train routes meant that iron production doubled at this time.

Development of railways in Britain grew rapidly, with permission for the construction of 438 new lines granted by Parliament between 1844 and 1846. More workers were needed in the iron factories to meet railway orders, and another 200000 men were employed, just for laying railway tracks. By 1848, over 40 million train journeys were made in Britain.

Before the Industrial Revolution, the journey from London to Edinburgh – just over 640 kilometres – took between 10 and 12 days by horse-drawn coach. By 1836, the travel time had dropped to just under two days by train. By 1850 – when all of Britain was linked by rail – this had dropped to around 12 hours (see Source 5).

Travel for holidays became more common and some commodities became more readily available. These included fresh flowers and milk, delivered to London on early morning 'milk trains' from Cornwall and Devon in the south-west.

Source 5 Changes in travel times (in hours) between London and other key cities, 1836 and 1850

CITY	1836	1850
Edinburgh	43	12.5
Liverpool	24	6.6
Exeter	18	4.75
Birmingham	11	3
Brighton	6	1.25

Source 6 This bridge in the town of Ironbridge, England, designed by Thomas Pritchard and built by Abraham Darby in 1779, is the world's first iron structure.

Source 7 An artist's impression of Tyburn Turnpike in London in 1813 showing the toll house and a toll being collected from a horseman passing through the gate.

Source 8 The Forth Railway Bridge in east Scotland under construction. By the time of its completion in 1890, it was the longest bridge of its kind.

Just like roads, these new railway lines required strong, reliable bridges that could carry locomotives and their cargo across wide rivers and gorges. The designs of iron bridges – already being used to carry cars and other small vehicles – were modified so they would be strong enough to carry much larger, heavier loads over larger distances (see Source 8). The surge in demand for these types of railway bridges in turn led to increased demand for iron production.

Canals

Over 100 canals were dug across Britain from 1760 to 1820, linking the major rivers and creating a transport network for the transportation of food and freight. One of the longest canals was the Liverpool to Leeds canal at 204 kilometres long. Work on it was begun in 1770 and finished in 1816.

Source 9 Canals, such as this one in Leeds, played an important role linking mills with the sources of their raw materials.

Initially, barges pulled by horses walking beside canals transported crops from the country the city and manufactured goods from the city back to the country. The canals were also used to move coal and other heavy goods, replacing the slower method of coastal shipping. As the high price of coal was mainly due to the costs of moving it (rather than mining it), new canals caused the price of coal to drop by half. The new lower price fed even faster growth in cotton mills. Cheaper coal transport also dropped the price of cotton weaving, increasing the profits for mill owners.

Check your learning 8.6

Remember and understand

1 How did developments in the use of canals lead to a drop in coal prices?
2 Use the information provided to answer the following:
   - **a** How were roads maintained in Britain before the Industrial Revolution?
   - **b** What led to better upkeep of roads during the early 1800s?
   - **c** Where and when was the world's first railway line built?
3 What commodities became more easily available as a result of improvements to the railway network in Britain?
4 How were ships powered prior to steam power?

Apply and analyse

5 What evidence is there in Source 2 to suggest that the launch of the SS *Great Britain* was a significant historical event? In groups, construct a list of modern events that you believe to be equally significant. Discuss your lists as a class and decide which characteristics or impacts of both events make them significant.
6 Why was steam power regarded as 'more reliable' than earlier forms of transport? What role did it play in furthering the Industrial Revolution?

Evaluate and create

7 Conduct some additional online research in order to design a poster advertising the advantages and benefits of one of the following inventions:
   - the Stephenson's Rocket
   - the Daimler *Reitwagen*
   - *Benz Patent-Motorwagen*.

8.7 Significant individual: Isambard Kingdom Brunel

Isambard Kingdom Brunel was a British engineer, builder and inventor who lived during the Industrial Revolution. During his lifetime, Brunel worked on the first-ever tunnel under the River Thames; engineered the Great Western Railway, along with all its bridges and tunnels; and designed the world's first iron-hulled, steam-powered and propeller-driven ship. For these reasons he is often described as one of the most significant individuals in British history.

Early life

Brunel was born in 1806 in the town of Portsmouth in south-east England. His father was a French civil engineer who taught him technical drawing and observational techniques from the age of four. When Brunel was 15, his father was sent to prison for failing to pay debts of more than £5000. After three months, however, the British government ended up paying off his debts to keep him from offering his engineering skills to the Russians.

Although Brunel received a traditional education, his main hobby was building model boats. After completing an apprenticeship as a clockmaker in France, Brunel returned to Britain, where he worked with his father on a ground-breaking engineering project – the Thames Tunnel – a railway line under the river. This project was plagued by accidents and challenging engineering problems, but eventually resulted in success. It also provided many opportunities for Brunel to develop his skills.

Bridges and railways

Although there was strong competition from other engineers, the young Brunel's plans for the Clifton Suspension Bridge (see Source 3) in south-west England beat all other contenders. Brunel replaced old-fashioned designs with a modern look. He believed that innovation and experimentation was important and would be welcome: 'I am opposed to the laying down of rules or conditions to be observed in the construction of bridges lest the progress of improvement tomorrow might be embarrassed or shackled by recording or registering as law the prejudices or errors of today.'

Source 1 Isambard Kingdom Brunel, in front of the launching chains of the SS *Great Eastern*, *c.* 1850

At the age of 27, Brunel was appointed the chief engineer for the Great Western Railway, whose tracks eventually stretched 230 kilometres from London to Exeter. Brunel surveyed the route himself in order to ensure the trains would have the smoothest passage. He also designed numerous iron bridges to carry the trains, as well as massive iron-supported train sheds and buildings, such as the vast Paddington station in London. Brunel was personally involved in the design of the railway itself, claiming that the 'standard gauge' was a relic from the days when rails were only used for mining carts, and that better speeds could be obtained by using wider rails.

A new kind of ship

Before the Great Western Railway was complete, Brunel announced that he had a vision of an even greater project – the construction of a steam-powered ship that would allow passengers to continue their journey all the way from the English coast to New York. In 1838, his paddle steamer the SS *Great Western*, made of wood but reinforced with iron, crossed the Atlantic in 15 days. By 1843, Brunel's ship the SS *Great Britain* was the first truly 'modern' ship, built entirely of iron, and with a six-bladed screw propeller instead of a paddle wheel. Late in his life, Brunel began work on the SS *Great Eastern* (see Source 2), the largest steamship built before the 20th century. It was designed for the long return journey to India and Australia without refuelling, as it was believed at this time that there was no coal in Australia.

Brunel's legacy

Brunel hoped to retire to Brunel Manor, a house and garden that he had designed himself to enjoy in his old age. However, he died from a stroke in 1859, and did not live to see it finished. Brunel is remembered as one of the pioneers of the Industrial Revolution, although history largely remembers his successes, not his failures. Many Victorian critics hated his noisy trains, and thought his bridges were eyesores. His proposed 'broad gauge' rail size, although more efficient and comfortable for passengers, was eventually phased out because it did not match other lines in the country. He was nearly killed during the construction of the Thames Tunnel and, although the SS *Great Eastern* was the largest ship ever built at the time, it ran over budget and struggled to make a profit once launched. Also Brunel did not live to see some of his most famous monuments. Neither the Clifton Suspension Bridge nor the SS *Great Eastern* were completed until after his death.

Source 2 The SS *Great Eastern* steamship, designed by Isambard Kingdom Brunel

Source 3 Clifton Suspension Bridge, as it stands today in Bristol

Despite this, Brunel's achievements were so long-lasting that many of them are still in use today. The Thames Tunnel is part of the London railway network, and dozens of Brunel's British bridges are not only still standing, but also carrying modern trains and traffic.

Check your learning 8.7

Remember and understand

1. What did Brunel train as before taking a job with his father's firm?
2. Why did the British government bail Brunel's father out of prison?
3. What two design innovations set the SS *Great Britain* apart from earlier ships?
4. Which of his creations have stood the test of time?

Apply and analyse

5. Conduct some research to discover why Brunel's first steamship was called the SS *Great Western*.
6. What evidence is there to suggest that things did *not* always go Brunel's way?

Evaluate and create

7. Isambard Kingdom Brunel was a brilliant engineer who designed and built ships, bridges and tunnels. Conduct some research to find out more about Brunel and create a PowerPoint (or other kind of visual display with words and images) presentation to inform others about his work and influence.

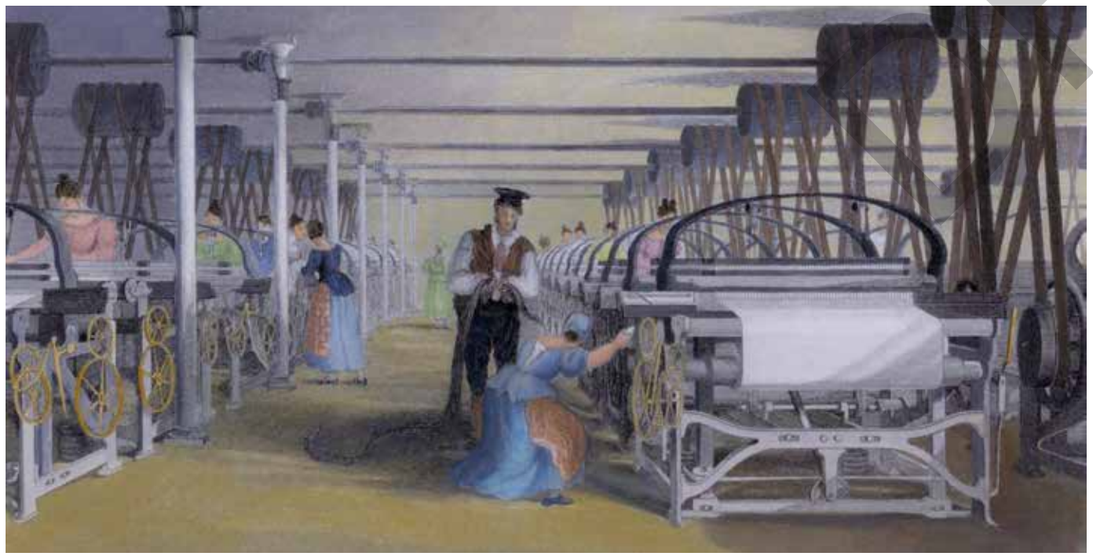
8.8 Expansion of factories and mass production

Progress and developments from the 1850s brought about advances in engineering and machine tools. Machinery both shortened the time required to make a product and reduced the number of people that were necessary for its production. Workers were needed to look after the machines, but they did not need to be as skilled. Instead, production became focussed on producing large volumes of machine-made goods at far lower prices – a system known as mass production.

Cotton became Britain's chief export, replacing wool. British cotton goods accounted for 5 per cent of all national income. People such as Richard Arkwright, the inventor of the water frame in 1768, had predicted that production would become centralised, with all workers in the process being housed in one location. Many production centres turned into factory towns, with housing for the workers located close to the mill. Manchester was one of the largest, with a population that grew from 25 000 to 300 000 between 1777 and 1851.

There were some obvious benefits. The overall standard of living improved, and salaries increased from £25 in 1750 to £44 in 1860. However, the new production methods also created new problems, leaving many skilled cottage workers jobless, and encouraging a factory system that only valued large-scale production at low cost. Furthermore, the role of the worker became closely linked to ensuring that the machinery produced a certain quantity of goods or material rather than ensuring it was of a certain quality. Employment was offered to women and children because they could be paid less. Factories became notorious for poor safety conditions and harsh working environments. Until parliamentary reform began to regulate these working conditions, workers had to endure long hours and mindless repetitive tasks, unsanitary work areas, and conditions in which they either froze or roasted depending on the season of the year.

Portrayals of the period often show the workers as if they themselves were machines or part of machines churning out their products in gloomy, smoke-ridden environments.

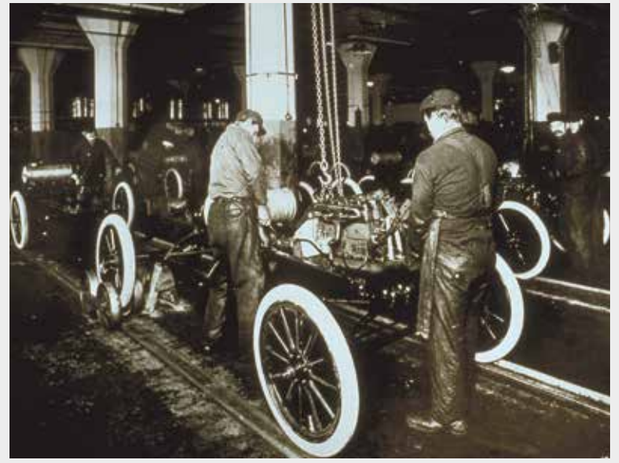


Source 1 An illustration of power-loom weaving in a textile factory, 1834

key**concept:** Continuity and change

The assembly line

Henry Ford (1863–1947) was an American industrialist who introduced the concept of the assembly line for mass production of consumer goods. Although it has changed significantly because of advances in technology, it is still used in many factories today. The assembly line adapted the factory system to a new purpose with a sequence of specialised workers repeating the same task on a series of components. The Ford Model T (1908) was the first affordable automobile. It was initially available in grey, green, blue or red. By 1914, Ford had famously insisted on a new policy, that his car should be available in 'any colour … so long as it is black'.



Source 3 The assembly-line production of the Ford Model T, as seen here in a photo from the early 20th century, made automobile ownership more than a dream for many.

Source 2

> I will build a car for the great multitude. It will be large enough for the family but small enough for the individual to run and care for. It will be constructed of the best materials, by the best men to be hired, after the simplest designs that modern engineering can devise. But it will be so low in price that no man making a good salary will be unable to own one and enjoy with his family the blessing of hours of pleasure in God's great open spaces.
>
> Henry Ford, *My Life and Work,* 1922

Ford was unusual for his time, in that he promoted high wages for workers and low prices for consumer goods. This approach would become known as Fordism. This, he believed, would allow ordinary people, not just those who were well off, to take part in what he imagined would be the peace-enhancing qualities of consumerism.

For more information on the key concept of continuity and change refer to page XX of 'The history toolkit'.

Check your learning **8.8**

Remember and understand

1. Why were women and children popular choices as factory workers?
2. Why did workers need less skill to work in factories in the Industrial Revolution?
3. What were two of the benefits of new production methods and two of the drawbacks?
4. What innovation allowed Henry Ford to manufacture the first truly affordable automobile?

Apply and analyse

5. Write a short paragraph explaining how industrialisation led to the creation of 'factory towns'.
6. Using the information provided as your own research, define the term 'Fordism' in your own words.

Evaluate and create

7. Imagine you are a worker in an 18th-century factory. Write a short account of a typical day in your life, making sure you highlight the advantages and disadvantages of factory work in those times.

8.9 The spread of the Industrial Revolution

The Industrial Revolution in Britain marked a major turning point in human history. Almost every aspect of daily life was influenced in some way. At around 1850, a whole series of new developments in technology led to even greater technological and economic progress. Many historians describe the period from 1850 to 1914 as the Second Industrial Revolution. The discovery of electricity offered yet another source of power for industry and further changes in lifestyle (see Source 1). It also led to new forms of communication, such as the telegraph and the telephone.

Recognising the potential for earning money from new inventions and markets, investors gave strong financial support to the new technologies. Although Britain attempted to stop the spread of industrial knowledge beyond its borders, it was not successful. Ideas, machines and designs were soon copied abroad. Britain began to regard technology itself as a new export. Manufacturing spread across Europe and then into other parts of the world.

Source 1 With the discovery and harnessing of electricity, people quickly found ways to use it that made their lives easier.

Europe

One of the first countries abroad to be affected by the industrial developments in Great Britain was Belgium. Belgium was similar to Great Britain in many ways, with a strong textile trade and many potential investors. It also benefited from the large reserves of coal as a source of energy. Belgium's iron exports to the rest of Europe grew as it built blast furnaces (furnaces for melting ore to produce metals such as iron) and developed railways to transport goods.

France's development was slower. France had a primarily agricultural economy until much later in the 1800s. In coastal areas such as Normandy, however, the textile industries modernised in reaction to competition from Britain and Belgium.

Germany had large deposits of coal and iron ore, and these were quickly exploited using the new technologies. Between 1870 and the start of World War I in 1914, Germany developed at such a rate that its manufacturing output outstripped Britain's.

Source 2 France's emergence as an 'industrial' country, with industries such as large-scale coal mining, came later than Britain's.

USA

After the birth of the United States of America following the War of Independence, American industry began to grow rapidly, especially in the north east of the USA. By 1900, the USA had a larger percentage of world manufacturing than Britain. The USA was rich in natural resources and as settlements expanded into the western regions of the country, more and more of these raw materials became available to American manufacturers. American inventors and inventions proved to be as important as any in Britain in moving the world into the modern era.

Japan

By 1868, Japan had been effectively cut off from Western influences for 260 years, after the shogun (military leader) expelled all Christian missionaries from the country and closed the borders to all foreigners. The arrival of American warships in the 1850s led to the Meiji Restoration – a period in Japanese history when the emperor was returned to power as the figurehead of a new, modern government, and trade with the West increased dramatically. Initially, large quantities of goods were imported from Europe and the Americas. Over time, however, Japan became the first country in Asia to become industrialised, as it swiftly adopted Western ideas and inventions. Japanese goods became highly sought after overseas, particularly tea, silk, cotton fabrics and buttons. Japan also imitated the West in its adoption of an aggressive policy of overseas expansion, seizing territory in China and Korea in the late 19th century.

Australia

The British decision to establish a penal colony in Australia in 1788 was largely an attempt to solve some of the problems faced by Great Britain that were a consequence of the Industrial Revolution. Rising prison populations were the result of increased crime rates in the new factory towns and among unemployed farm labourers. It was thought that this problem could be resolved by transporting criminals to a distant land.

By 1813, a steam mill was operating in Sydney, major roads had been constructed to transport goods to and from the seaports and a strong pastoral (stock-raising) industry had developed inland. By the mid-1830s, Australia had also become a colonial destination for free British migrants. As other colonies were settled, the development of transport links increased. Railways were in use in Australia by the 1850s, as well as steamship travel along the coast and major rivers. Wealth from the discovery of gold gave the Australian colonies opportunities to develop new railways and take advantage of new technologies such as the electric telegraph and electric lighting.

Source 3 The settlement of Sydney, *c.* 1870

Despite these advances, Australia's industrial development was in many ways hectic and unplanned. This became apparent after **Federation** in 1901, when the new country was found to have three different rail gauges, which made it impossible to transport goods across state borders without changing trains. In addition to this, the states had conflicting ideas about industry (and its development or protection) and disagreed about tariffs (taxes) and their use.

Check your learning **8.9**

Remember and understand

1 List some of the countries that were affected by the Industrial Revolution after Britain.

Apply and analyse

2 Write a short paragraph comparing and contrasting the 'first' Industrial Revolution in the 1750s and the 'second' Industrial Revolution 100 years later.

3 Explain how the Industrial Revolution differed in Britain and one other European country.

4 Name three areas in which Japan's modernisation followed a Western model, and name the countries from which it copied.

Evaluate and create

5 What evidence was there in 1901 that the development of Australia had been hectic and unplanned?

8.10 Later developments in technology and science

Chemistry

Prior to the Industrial Revolution, scientific thought worked on the theory that four basic elements – fire, earth, water and air – were the components of all things. Scientists began to extend this with the first creation of a table of chemical elements in 1789. This marked the beginnings of the modern periodic table. French chemist Antoine Lavoisier identified 23 elements. He named different chemical compounds made by the combination of these chemical elements and developed a system that recognised the weight of atoms.

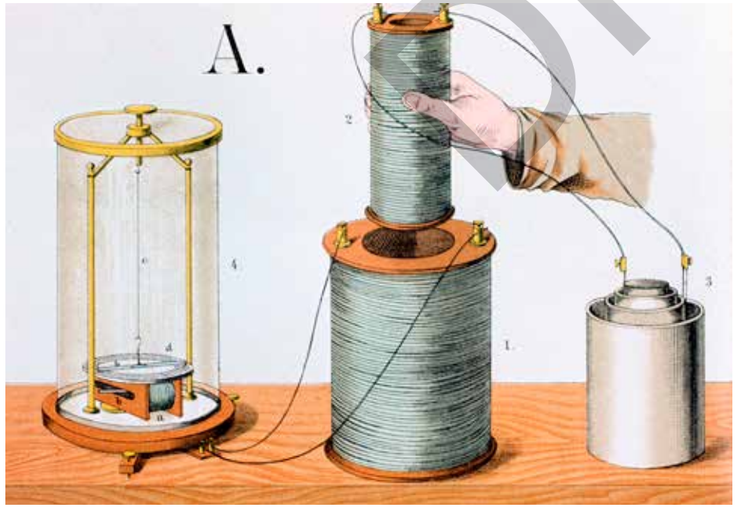
During the 1800s, other scientists broke down over 70000 chemical compounds, often in search of new materials for inventions or for improvements to existing materials. In the process, they discovered how to make petroleum, vulcanised rubber, Portland cement and synthetic dyes. Polish–French researcher Marie Curie (see Source 1) isolated the element radium and coined the term 'radioactivity', which would become a controversial source of power after the Industrial Revolution.

Electricity

In 1791, Italian scientist Luigi Galvani discovered that he could make a dead frog's legs twitch if he struck them with a spark. His fellow experimenter Alessandro Volta recognised the potential of Galvani's discovery, and developed a technology to store the energy ('electricity') in a cell or battery. This ability to store and use power was to be successfully developed over the following few years, creating a new energy source.

In the 1880s, electric power stations were built. These stations offered an alternative to steam engines for driving machines and to gas for lighting. Electricity was not the work of one person or nation. The English scientist Michael Faraday produced the first continuous flow of electric current. His work in electromagnetic induction (see Source 2) was the basis for dynamos and other electric motors. He produced current by rotating a coil between the two poles of a horseshoe magnet. A dynamo turned the mechanical power needed to rotate the coil into electric current. This current could then drive a machine by using the energy.

Source 1 Physicist and chemist Marie Curie in her laboratory

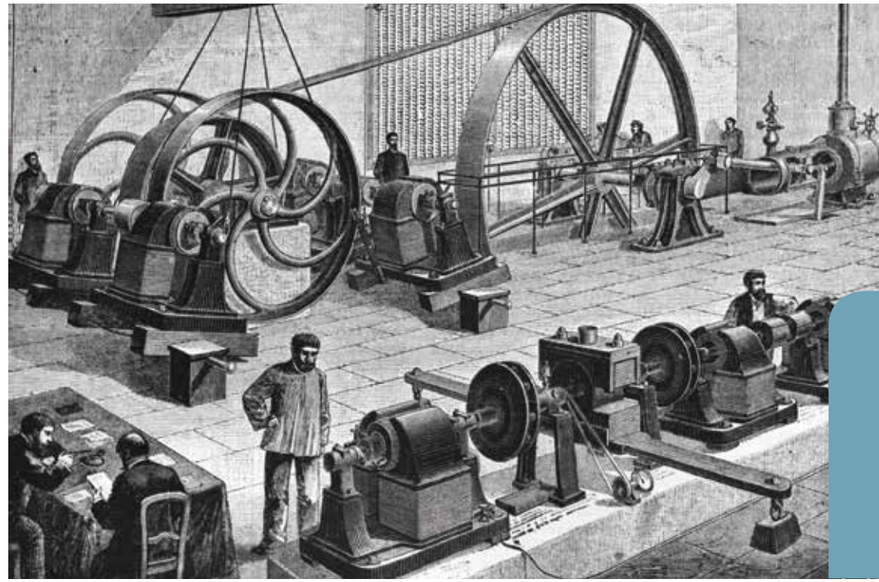


Source 2 Faraday's electromagnetic induction experiment, 1882

Power stations were first built as a source of power for electric lighting. Developed through the work of Joseph Swan, an Englishman, and Thomas Edison, an American, they produced 'Ediswan' bulbs to light houses and streets.

Power stations initially used steam engines to turn the dynamos to generate electricity. In 1884, Charles Parsons invented the steam turbine, which allowed for a greater speed of rotation by forcing a blast of steam along a tube, turning a rotor at great speed.

Factories driven by electricity were cleaner and safer, as they did not require the large belts used to drive machinery like those in steam-powered stations. Newer industries mainly used this new power source, and, unlike coal-powered industries, they could be located anywhere, as long as there were power lines to carry the electric current. In some areas water was used to drive the electric turbines (hydroelectric power), so factories could be built in areas such as Scotland where there was limited coal.



Source 3 An 1887 woodcut showing an early power station

Wires were strung around Britain to carry power to factories and homes. Power grids were created to share the electricity produced and to service high demand areas such as cities. A reliable supply of electricity meant that factories no longer relied on a supply of coal to power them. As a result, they were free to move away from coal mines in the north and west of Britain closer to cities in the south like London.

Communications

The discovery of electricity helped to develop an invention that revolutionised mass communications – the telegraph. The telegraph allowed text messages to be transmitted long distances without the need to physically deliver a letter. Telegraphs were sent using a coded system of sounds to represent the alphabet. For example, Morse code used short electrical impulses (dots) and slightly longer ones (dashes) to spell out the letters of messages.

In 1851, London and Paris were linked by an undersea cable and by 1858, the first transatlantic cable was laid, stretching from Europe to North America. By 1866, this transatlantic cable allowed rapid communication between Britain and the USA. The telegraph helped to bind together the distant parts of the British Empire and was an important part of the development of Australia. From 1858, the Australian capital cities were all linked by telegraph. The Australian overland telegraph from Darwin to Port Augusta in South Australia was completed in 1872. This, together with new undersea cables, provided an instant communication channel between Australia, Britain and Europe for the first time.

Check your learning 8.10

Remember and understand

1 In what year was the modern periodic table first developed?
2 Which scientist was responsible for the discovery of the element radium?

Apply and analyse

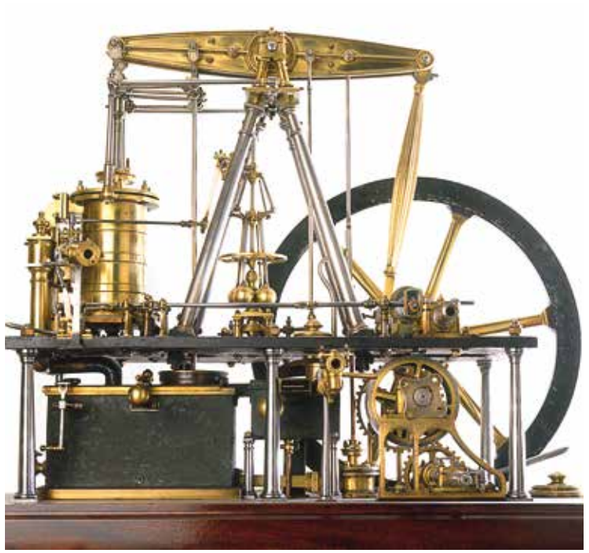
3 Describe some of the advantages of the first electric power stations.
4 Why was the development of the battery so important for users of electricity?
5 How did the growth of electricity-powered factories lead to a general movement of population from the north to the south?

8A: rich task

Inventions of the Industrial Revolution

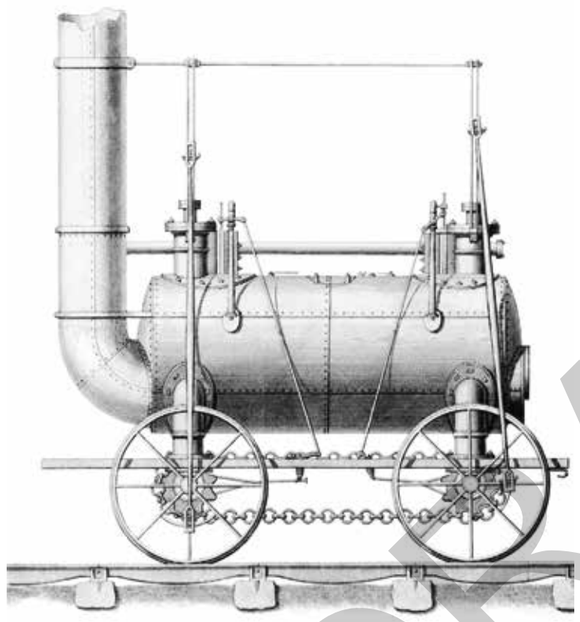
During the Industrial Revolution, new technologies and inventions transformed the way that people lived and worked. Major changes in farming, mining, agriculture, communication and manufacturing changed almost all aspects of life.

In this chapter, you have learned about many significant inventions from The Industrial Revolution such as the flying shuttle, the spinning jenny, the steam engine, the internal-combustion engine, electricity and the telegraph. These are only a few of the many inventions and discoveries that changed the way people lived and worked at the time. Others include the sewing machine, the telephone, the light bulb, the phonograph, the circular saw, the battery, the typewriter and even the first revolver. All of these inventions contributed to the modern world in some way.



Source 1 A reconstruction of James Watt's steam engine

Source 2 The flying shuttle allowed the thread to be shot back and forth across a wider weaving bed, producing much wider lengths of cloth, much faster.



Source 3 George Stephenson's locomotive *Blucher* was the first successful steam-powered train. It was completed and tested on the Cillingwood Railway on 25 July 1814.

skill**drill:** Historical significance

Creating and delivering an audiovisual presentation

You have probably created several PowerPoint presentations already. You may have also tried out some other audiovisual presentation software, such as Prezi, which is freely available on the Internet. Whichever program you choose, it is important to use it effectively, and avoid some common problems of these types of presentations. Use the following steps to help you avoid these issues.

Step 1 Design your presentation

- Plan your presentation carefully so it has a clear beginning, middle and end.
- Make sure you present the content in clear, concise dot-point form, *not* as large slabs of text.
- Don't fill up your PowerPoint with lots of random pictures that are not related to the content. Make sure each visual is accompanied by a caption that explains why it is relevant to the presentation.
- A common mistake is to have objects and text moving on the screen in a way that just distracts the audience. Use graphics, sounds, video, animations and transitions only if they add value to the point being made, not just because you think they will look or sound good.
- Use a design that ensures your audience can clearly see and read the slides. Make sure there is enough contrast between the text colour and the background colour on the slide, and make sure your font size is large enough.

Step 2 Deliver your presentation

- When delivering a PowerPoint presentation to an audience, you should do more than just stand up and read out the text on each slide. Instead, talk in a way that develops and expands on the points on each slide. Carefully plan in advance what you are going to say during each slide. Record this plan on cue cards, and refer to these cards during your speech to remind you what to say.
- One thing at a time! At any moment, what is on the screen should be the thing you are talking about. Your audience will quickly read every slide as soon as it's displayed. If there are four points on the slide, they'll have read all four points while you are still talking about the first point. Plan your presentation so just one new point is displayed at any given moment. Navigate to the next point only when you are ready to talk about that next point.
- Speak clearly – not too fast, not too slow. Vary your tone and pitch to make your presentation more interesting.
- Make eye contact with different members of your audience. *Do not* just look down at your cue cards.

Apply the skill

1 Research, prepare and present an audiovisual presentation about three significant inventions created during the Industrial Revolution that were not discussed in this section. Use the following questions to structure your presentation:
   - **a** Who invented it?
   - **b** When was it invented?
   - **c** How did it work?
   - **d** Why was it significant?

2 Your presentation should be well researched and based on relevant and reliable sources. For detailed information on this skill, refer to page XX of 'The history toolkit'.

Extend your understanding

As you listen to the presentations of your classmates, complete the peer assessment proforma below. Ask your teacher to photocopy several copies so that you can complete one for each presentation you listen to.

Name of presenter:		**Name of person completing peer assessment:**
Component of presentation:	What did the presenter do well in this regard?	What could the presenter improve upon in this regard?
PowerPoint design:		
Oral presentation:		

Give each classmate your completed peer assessment. Collect the peer assessments that your classmates completed as they listened to your presentation. Read their feedback, and then complete a short self-assessment by responding to the following questions:

- What did I do well in terms of my PowerPoint design?
- What could I improve in terms of my PowerPoint design?
- What did I do well in terms of my oral presentation?
- What could I improve in terms of my oral presentation?

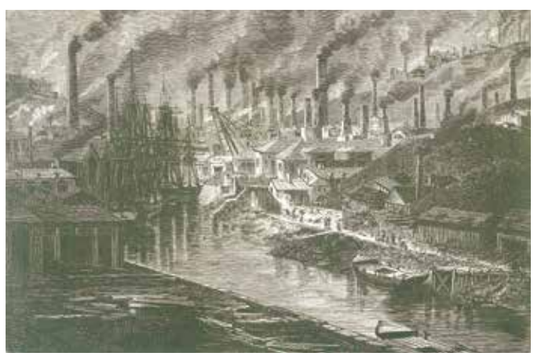
8.11 Working conditions

While it cannot be denied that the Industrial Revolution improved living standards of most people across Britain, these improvements came at a high price. The obvious winners were the industrialists, the people who owned the mills, the factories and the mines. The new middle class also benefited from technological advances, making their lives more comfortable. However, many more people were forced to give up their traditional rural lifestyle for a life in one of the new industrial cities – working long hours and living in cramped and unsanitary conditions.

Britain's 'dark satanic mills'

The working conditions and experiences of men, women and children during the Industrial Revolution varied from person to person and from one industry to the other. The proportion of people in Britain working in manufacturing in 1801 was estimated at 40 per cent. By 1871, this had risen to 60 per cent. Many people across Britain were still employed in agriculture, construction, domestic service or smaller workshops, and their working lives remained largely unchanged. However, life was very different for those in the factories and who struggled to survive on low wages and were forced to work in harsh conditions, as owners operated for a time without any government regulation.

Factory and mine owners often cut corners with safety and conditions in the pursuit of higher profits. This included enforcing long working hours and using cheaper labour in the form of women and children.



Source 1 A 19th-century engraving showing copper foundries in Swansea, Great Britain

Long working days took their toll on families, and children were dragged into working life with little opportunity for education.

The phrase 'dark satanic mills' was first used by the English poet William Blake in 1808. It was frequently used in the 19th century to refer to the miserable working conditions of labourers in Britain. Many writers of the time were appalled by the plight of poor people whose work seemed endless and unrewarding, and whose lives were cut short by poverty, disease and injury. One of these concerned individuals, Friedrich Engels, a German industrialist and philosopher, wrote extensively about this situation (see Source 2).

Source 2

> … a mass of children work the whole week through in the mills or at home, and therefore cannot attend school. The evening schools, supposed to be attended by children who are employed during the day, are almost abandoned or attended without benefit. It is asking too much, that young workers who have been using themselves up twelve hours in the day, should go to school from eight to ten at night. And those who try it usually fall asleep, as is testified by hundreds of witnesses in the Children's Employment Commission's Report. Sunday schools have been founded, it is true, but they, too, are most scantily supplied with teachers, and can be of use to those only who have already learnt something in the day schools. The interval from one Sunday to the next is too long for an ignorant child to remember in the second sitting what it learned in the first, a week before.

Friedrich Engels, *The Condition of the Working-Class in England in 1844*

Child labour

When the Industrial Revolution began, children were seen as ideal employees. They were small enough to fit between the new machinery, they were cheap to employ and their families were grateful for the extra income. At the time, there was no real concern about their education being affected as education was not compulsory. Most working-class families could not afford to send their children to school anyway.

Source 3 An artist's impression of a group of mill workers in Manchester, *London Illustrated News*, 1840

Source 4 Children working in factories were frequently exploited and injured.

Children often started work at the age of four or five. Their jobs were often simple, but physically demanding and dangerous. They included collecting dropped fluff from underneath the weaving machines or acting as helpers in coal mines. In many cases, child workers were orphans provided to the factories or mills by the local authorities.

Children's pay was well below that of adults – often about 20 per cent of the full adult wage. Wages for children were sometimes paid in the form of vouchers that could only be used at stores owned by the factory owner. There, the children could use them to purchase clothing or basic foods such as flour. This system allowed the factory owner to avoid paying wages in cash and helped them to make extra profits on sales.

Even with long hours and low pay, children could still earn more in the factory towns than in the country. Over time, social reforms raised the minimum age, shortened the working day, increased wages and introduced some form of education.

Child labour in factories also declined as complex machinery became more difficult for children to handle. In other areas, such as mining, their use as labourers was limited or barred. It is hard for us now to imagine their lifestyles or the conditions in which these children worked. Source 5 comes from evidence given to a British government inquiry into child labour in factories in 1833.

Source 5

> I work at Mr Wilson's mill. I think the youngest child is about seven. I daresay there are 20 under 9 years. It is about half past five by our clock at home when we go in … We come out at seven by the mill. We never stop to take our meals, except at dinner.
>
> William Crookes is overlooker in our room. He is cross-tempered sometimes. He does not beat me; he beats the little children if they do not do their work right … I have sometimes seen the little children drop asleep or so, but not lately. If they are catched asleep they get the strap. They are always very tired at night … I can read a little; I can't write. I used to go to school before I went to the mill …

Evidence from a young textile worker, Factory Inquiry Commission, Great Britain, Parliamentary Papers, 1833

Check your learning 8.11

Remember and understand

1 Why did women and children make up a large part of the industrial working population in the early years of the Industrial Revolution?

Apply and analyse

2 In Source 5, what do you believe the young worker is trying to say about working conditions in the factory and the treatment of other child workers?

Evaluate and create

3 Summarise Friedrich Engels' findings in Source 2 about the condition of the working class in England.

4 Why might a writer such as Friedrich Engels be biased in his view? Carry out some research into his political beliefs and show how they might have influenced his writing.

5 Write a newspaper report in the role of a 19th-century reporter investigating child labour in a cotton mill. Describe what the children's work day is like and make recommendations for reform.

8.12 Living conditions

In the 1750s, before the Industrial Revolution began, only 15 per cent of the population of Great Britain lived in towns or cities. By 1850, the urban population had risen to 50 per cent. By 1880 it had risen again to 80 per cent. This process of **urbanisation** was due to changes in farming practices, production methods and the lure of new jobs in the factory towns. Between 1801 and 1871, the proportion of the British population working in manufacturing rose from 40 per cent to 66 per cent. All of these changes had dramatic effects on how people lived.

Conditions for the rich and poor

Huge differences between the living conditions of the rich and poor in Britain existed long before the start of the Industrial Revolution. Prior to 1750, Britain's feudal history and strict class system dictated how people lived and where they worked. From 1750 onwards, rapid changes in technology and society gave birth to a new social class (known as the 'middle class'). Despite this change, the Industrial Revolution was initially responsible for widening the gap between rich industrialists and poor factory workers even further. Some key facts about living conditions for different social classes in the 1800s are included in Source 3.

On top of the social hierarchy were the **aristocracy.** These people included people of royal blood – dukes, earls, lords and barons – with strong family traditions and reputations. They were often land owners who lived off rental income and led privileged lives as members of 'high society' who lived in manors and stately homes. They possessed enormous wealth, land and political influence. In this world, good breeding and a title were seen as more important than wealth – this was assumed.

The middle classes included factory owners, industrialists, doctors and lawyers whose generous incomes allowed them to establish their homes on the outskirts of the new towns and cities where the air was clean and there was more space for larger homes. These areas grew as a result of new railway lines that allowed the rich to commute from home to work in the city.

By contrast, the majority of the working class lived closer to the factories, in slum areas with poor sanitation. Houses were built back-to-back to save space. New apartment blocks were also built quickly and cheaply to meet demand. There were very few building or fire regulations so accidents and house fires were common. There was no proper sewerage, no fresh water and little or no garbage disposal. In Liverpool in 1865, 40 per cent of young children died in such conditions, and the average life expectancy was just 29 years. Birth rates were low, but population continued to grow due to the constant flow of people from the countryside. Those who endured such conditions often turned to alcohol and other drugs to help them cope with the harsh conditions. Crime was widespread, particularly in the slums of the larger cities such as London (see Source 2).

Source 1 There were enormous differences between the living conditions of the rich and poor in Britain prior to the Industrial Revolution.

Source 2

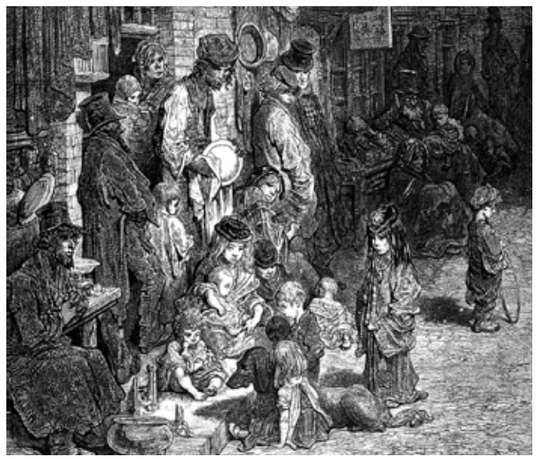
> … the social order makes family life almost impossible for the worker. In a comfortless, filthy house, hardly good enough for mere nightly shelter, ill-furnished, often neither rain-tight nor warm, a foul atmosphere filling rooms overcrowded with human beings, no domestic comfort is possible. The husband works the whole day through, perhaps the wife also and the elder children, all in different places; they meet night and morning only, all under perpetual temptation to drink; what family life is possible under such conditions? Yet the working-man cannot escape from the family, must live in the family, and the consequence is a perpetual succession of family troubles …
>
> Friedrich Engels, *The Condition of the Working-Class in England in 1844*

Source 3 Conditions for British social classes during the 1800s

Living conditions for the aristocracy (nobility)	Living conditions for the middle class	Living conditions for poor
• Birth mattered more than income. The poor and lazy cousin of a duke would be acceptable in high society over a millionaire industrialist from a lower class. • Some lords had large country houses, and town houses in London. They were waited on by servants. • During the 1800s, members of the aristocracy dominated all levels of government. • A young aristocratic lady who was eligible for marriage would 'come out' as a debutante, when she was presented to Queen Victoria. On this special occasion she wore a white dress and a headdress. • Boys of the nobility had governesses and nannies, then attended elite schools. Girls were mostly educated at home then prepared for marriage. Some girls went to boarding school. By the late 1800s, a small number were able to go to university.	• Many middle-class people aspired to join the upper classes. Wealthy middle-class businessmen would socialise with the aristocracy. Some donated large sums of money to be granted a knighthood. • Middle-class people lived in houses in the suburbs and commuted to work in the city. Even the poorest middle-class home would have a servant. • Many middle-class Victorian women enjoyed shopping – the first department store opened in London in 1863. • Over time, some middle-class women sought a university education. They also became involved in the women's **suffragette** movement. • Many middle-class boys went to grammar schools. Girls increasingly went to school, but were still expected to find a husband and learn how to run a home.	• Working class people lived in cramped houses in city slums and had no access to running water or sewerage systems. • Crime in the slums was rife and overcrowding led to the spread of many diseases. • At the start of the 19th century, few poor people received an education. In 1880, a new law made primary school compulsory for all children. • Working-class leisure activities included playing or watching football, bicycling clubs, reading the newspaper and attending the music hall.

As urban areas grew, new technologies were applied in building, even in workers' housing. Planned, drained and uncluttered new urban settlements replaced slums. Public transport allowed workers to live further away from their work places. Cities began to develop suburbs. In 1863, the first part of London's underground railway network opened, linking suburban trains to the city centre. By the 1870s, the ability to create skyscrapers allowed for even denser retail and office areas in city centres, where land was more expensive.

Better street lighting helped transform the atmosphere of the cities at night, encouraging leisure activities later in the day and after dark, as people felt safer.



Source 4 An artist's impression of poor people in Whitechapel, a London slum

Check your learning 8.12

Remember and understand

1. Why did people move from rural areas to the towns and cities during the Industrial Revolution?
2. Where did most unskilled workers live in Britain during the Industrial Revolution and in what sort of conditions?
3. Why did the population of factory cities continue to grow, despite low birth rates?

Apply and analyse

4. What was the average life expectancy in Liverpool in 1865? Did people tend to actually die at this age, or was there another factor that lowered life expectancy?
5. Write a paragraph describing how, after a bad start, the Industrial Revolution started to improve living conditions for city dwellers.

Evaluate and create

6. Using the statistics provided and information gathered on the Internet, create three graphs that illustrate the key changes in urban populations that took place in Britain from 1750 to 1880.

8B: rich task

Working conditions for children during the Industrial Revolution

Many of the early textile factory owners employed large numbers of children. Children were seen as good workers because they were paid less, and were small enough to crawl under the machines to repair broken threads. They were often forced to do this when the machines were operating, and many children were injured as a result. The factory owners paid **overseers** to make sure the children worked as hard as they could. The more work the children did, the more the overseers were paid.

It was not until the 1830s when certain politicians, concerned about the working conditions that had developed as a result of industrialisation, began introducing laws to regulate the factories in terms of conditions like the use of child labour and the length of the workday.

Each of the following sources provides different views about the nature of working conditions for children during the Industrial Revolution.

Source 2

Q: Explain what you had to do.

A: When the frames are full, they have to stop the frame, and take the flyers off, and take the full bobbins off, and carry them on to the roller, and then put the empty ones on.

Q: Suppose you slowed down a little, what would they do?

A: Strap us. The girls had black marks on their skin many a time, and their parents dare not come in about it, they were afraid of losing their work.

Q: What part of the mill did you work in?

A: In the card-room. It was very dusty. The dust got up my lungs, I got so bad in health. When I pulled the baskets all heaped up, the basket pulled my shoulder out of its place and my ribs have grown over it. I am now deformed.

An extract from an interview with Elizabeth Bentley, who began working in factories at the age of six. The interview was conducted as part of a parliamentary inquiry into conditions in the textile factories in 1832.

Source 1 This photograph, taken in 1908, shows a young barefoot girl standing next to a spinning frame in her workplace, a North Carolina cotton mill.

Source 3

I have visited many factories, both in Manchester and the surrounding districts, during a period of several months and I never saw a single instance of corporal punishment inflicted on a child. The children seemed to be always cheerful and alert, taking pleasure in using their muscles. The work of these lively elves seemed to resemble a sport. Conscious of their skill, they were delighted to show it off to any stranger. At the end of the day's work they showed no sign of being exhausted.

An extract from 'The Philosophy of Manufactures', 1835, by Dr Andrew Ure. Dr Ure was a supporter of the new industries.

Source 4

… In such an establishment [i.e. a factory] … between 700 to 1400 persons, of all ages and both sexes, almost all working by the piece, and earning wages of every amount between two shillings and 40 shillings a week, are engaged in producing one ultimate effect, which is dependent on their combined exertions. Any stoppage, even any irregularity in one department, deranges the whole. A strict and almost superstitious discipline is necessary to keep this vast instrument going for a single day. Now how, ask the mill-owners, could this discipline be kept up, if the sub-inspectors were at liberty to walk over our establishments at all hours; listen to the complaints and jealousies of all our servants, and at their instigation [urging] summon us as criminals before the magistrates?

An extract from a letter of complaint by Nassau Senior, a factory owner, to Parliament after the Factory Act of 1833 was introduced to give some protection to child workers. He believed that the Act would allow government inspectors to interfere with the smooth running of cotton factories.

skill**drill:** Historical sources as of evidence

Using information from a range of sources as evidence in a historical argument

The primary sources that historians use to form opinions and arguments about the nature of working conditions for children in the early 19th-century factories tell different stories. It is the job of historians to analyse these sources, identify what evidence they provide to support or refute (not support) particular arguments, and come to a conclusion about their usefulness and reliability.
It is important to:

- identify who created each source and the reason why it was created
- identify any potential bias
- write your argument, using the sources as evidence
- explain why each particular source supports your argument
- give reasons why you consider the sources that do not support your argument to be not as important or as valid.

Apply the skill

1 Examine Sources 2–4 carefully and complete a copy of the table below in your notebook.

	Source 2	Source 3	Source 4
What evidence does this source provide about conditions in factories for children during the Industrial Revolution?			
Who wrote or created it?			
Why was the source created?			
Is the source reliable?			

2 Once you have completed the table, use the information you have gathered to write an historical argument about the working conditions for children in the early 19th century, using the plan provided below.

- **Title:** What were conditions like for children in Britain working in 19th-century factories?
- **Introduction:** The Industrial Revolution led to a massive increase in … (introduce the context of your piece and the focus on the working conditions of children within that context).
- **Paragraph 1:** Some sources say … (explain which sources indicate that conditions were bad. Give examples of some of the bad conditions).
- **Paragraph 2:** However, other sources say … (explain which sources indicate that conditions were acceptable or necessary. Give examples of some of the arguments provided).
- **Paragraph 3:** We have to be careful about which sources we use because … (explain the problems with some of the sources in terms of reliability and bias).
- **Conclusion:** Overall, the evidence suggests … (summarise the evidence and give your informed opinion about the nature of working conditions for children in this period).

Extend your understanding

1 Some important people were strongly opposed to the use of child labour in factories during the Industrial Revolution. Eventually, Parliament passed several Acts that attempted to impose regulations that would lead to improved conditions for children. Use the Internet to find out about this legislation, and complete a new table in your notebook:

Name of Act	Year it was introduced	How did it attempt to improve conditions for children?	How effective was it?

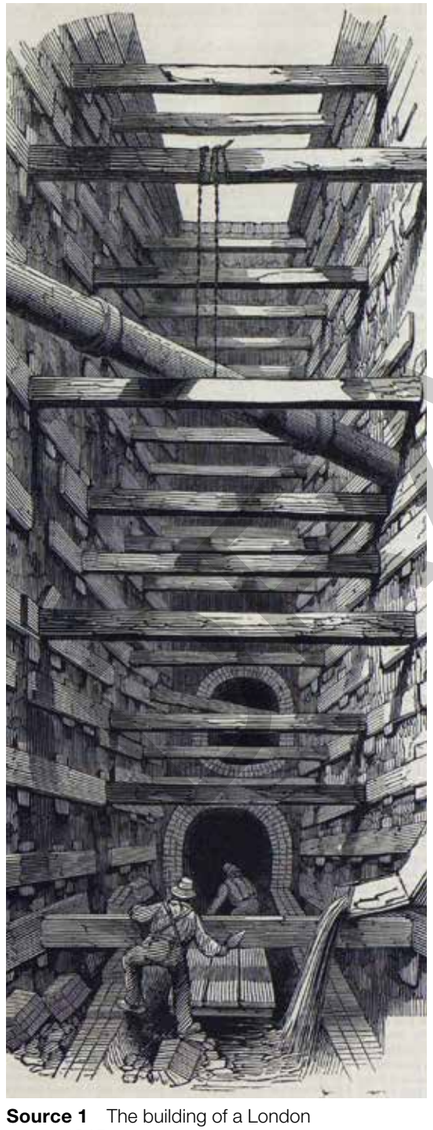
8.13 Short-term impacts of the Industrial Revolution

Between the 1750s and 1914, Britain, the USA and most countries in Europe transformed into industrial societies. New technologies and production methods changed societies in positive and negative ways in both the short and long term. Growth in the development of cities, changes in living and working conditions and the introduction of new laws became apparent fairly quickly. Other changes took place over much longer periods and were not initially obvious. Indeed, many argue that we are only now beginning to see many of the long-term effects of the Industrial Revolution.

Population growth and urban planning

One of the most obvious short-term impacts of the Industrial Revolution was the dramatic increase in world population. In 1750, the population of England and Wales was around 5.5 million people. By 1900, this figure was around 32.5 million. Throughout Great Britain and the rest of Europe, there was a mass movement of people from the rural areas to the growing cities. In 1801, only 17 per cent of the population of Europe lived in the cities. By 1891, this had grown to 54 per cent. In Britain, the growth cities were Leeds, Manchester and Birmingham, as well as London. After terrible initial problems with disease caused by poor or non-existent sanitation, city reform began with the introduction of some **urban planning**. Over time, conditions in the urban slums of factory towns and cities improved. The tenements (overcrowded rooming houses) were pulled down and replaced with new urban settlements, with positive consequences for residents. For example:

- residents in new housing, who previously had no running water and shared an outside toilet, now had access to running water, central heating and improved sewerage systems (see Source 1) that included their own toilets. Health conditions improved and there were fewer outbreaks of disease.
- planned, drained, and uncluttered and open spaces were created for sport and entertainment.
- gas-powered (see Source 2), and then electric, street lighting helped transform the atmosphere of the cities at night, reducing the gloomy, dangerous streets and encouraging leisure activities after dark, such as visits to theatres and music halls.
- cities began to develop suburbs (outlying communities) and new public transport systems allowed workers to live further away from the factories in which they worked. First there were horse-drawn trams and then came cable trams or electric trolley systems. The opening of London's underground railway network in 1863 encouraged more people to use public transport to move between their homes in the suburbs and work. As the population increased, so did the transport capacity and new lines were developed to service growing areas.



Source 1 The building of a London sewer, 1845

Source 2 'A peep at the lights in Pall Mall' is a satirical look at people's reactions to the new invention of gas-burning streetlights in London in 1807.

Improvements in living standards

There were other positive consequences of the Industrial Revolution on the lives of many people.

- Improvements in agriculture throughout the period of the Industrial Revolution reduced the risk of famine through crop failure. Increased food production also meant that people could afford better food in larger quantities, which in turn helped them stay healthier.
- Sport was encouraged in 'leisure time' in order to keep workers healthy. Sport and recreation became more important as working hours reduced during the 19th century.
- Mass entertainment, such as theatres and spectator sports, developed alongside newspapers and magazines for people of all classes. Literature was no longer just for the wealthy and learned.
- The development of railways meant that travel times were speedier. It also meant that travel for leisure was affordable, even for the working classes.
- Mass-produced consumer goods, such as clothing and crockery, became more affordable.
- The use of the telegraph and telephone meant that news could quickly be reported from around the world. Industrialists, merchants and ordinary people benefited from these more immediate ways of communicating, as well as from faster postal times from improved road and rail networks.

Historians and economists agree that standards of living did improve in the 19th century, although they disagree about the timing of its benefits to the working class. For example, were large improvements in the lives of working-class people evident in the early or mid-1800s? Some studies have shown that workers' incomes grew rapidly from the 1820s. However, others contest whether this indicator of improvement balanced out the negative consequences of the Industrial Revolution, such as the harsh working conditions, high rents and crowded living conditions, and pollution.

Check your learning 8.13

Remember and understand

1 Identify the ways in which cities began to change in the second half of the 19th century.
2 Explain why sport and entertainment became more popular in this period.

Apply and analyse

3 Using Source 2 outline the ways in which the introduction of street lighting changed people's way of life.

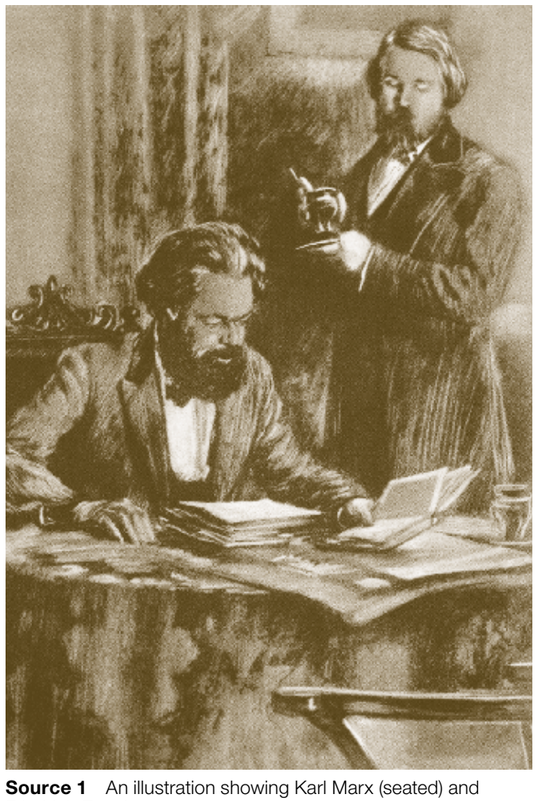
Evaluate and create

4 In two columns, list the positive and negative aspects of the Industrial Revolution for working-class Britons in the 19th century. Decide whether it was a positive or negative development for the working class, giving reasons for your decision.

8.14 The emergence of socialism and trade unions

Urbanisation brought with it new social classes and social divisions. Investors (**entrepreneurs**) could earn vast fortunes. Their luxurious lifestyles and homes reflected their new status, a world removed from the poverty-stricken conditions of many of their employees.

Many workers found it hard to adapt to their new lives in the city. Some embittered workers began to demand better conditions and political rights. The result was a rising interest in social revolution, with philosophers and activists such as Karl Marx and Friedrich Engels gaining a following among the working classes.



Source 1 An illustration showing Karl Marx (seated) and Friedrich Engels

In his influential book, *Capital: A Critique of Political Economy* (1867), German philosopher Karl Marx suggested that the Industrial Revolution was driven by an economic system known as **capitalism**. Marx argued that capitalism was based on the exploitation of the workers by the owners of land, factories, railways and roads, shops and banks for profit. For capitalism to work, it relied on an 'army' of urban workers who would work for less than the value of their labour. Later theorists would build on Marx's work to promote alternative systems that they argued would deliver a fairer distribution of wealth.

These ideas were the beginning of **socialism**. They laid the foundations for the **welfare state** (under which the state took responsibility for all its subjects, rich or poor) and also for **communism** (under which the state attempted to abolish ownership of private property).

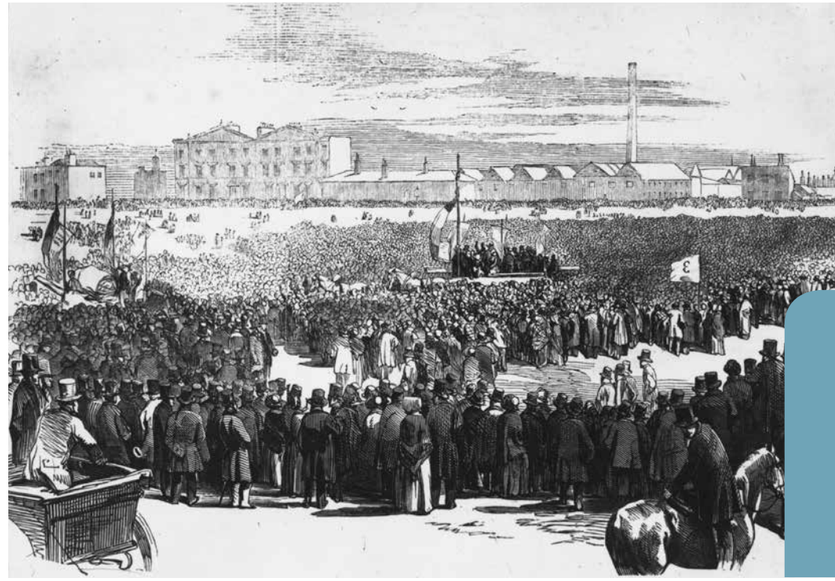
Luddites

The first violent reaction to the Industrial Revolution occurred in Britain in 1811, when factory owners and manufacturers in Nottingham received threatening letters signed by 'General Ned Ludd and the Army of Redressers'. In protest at wage reductions and job losses caused by the adoption of stocking frames and automated looms in textile mills, former weavers attacked factories, smashed machines and killed the owner of one cotton mill. In response, the British Parliament made it a capital offence (a crime punishable by death) to destroy machines. Twenty-three **Luddites** (as the protestors became known) were executed in 1812 and many more were transported to Australia as punishment.

The Luddites were stamped out, but their actions showed that there was a need for political action that would benefit workers and improve the conditions that they were forced to accept.

Poor Laws and the rise of Chartism

In 1834, the British Parliament attempted to deal with changing social and economic conditions by reforming the 233-year-old Poor Law. The *Poor Law Amendment Act 1834* decreed that any poor or homeless person requiring assistance from the state (except for the old and sick) had to enter a government workhouse. These institutions kept people off the streets but often fed their residents poorly, worked them extremely hard and broke up families.



Source 2 An illustration of a Chartist meeting in 1848

Widespread discontent over the Poor Law Amendment Act reminded many people that they had little say in government. Reform bills in 1832 had extended the right to vote, but only to about 600 000 out of 3 million men over the age of 21. At this time, all members of parliament were required to own property, which limited the number of men who could afford to stand for office. In 1838, a group of reformists published a People's Charter written as a bill that could be presented to Parliament, demanding a better life for people through the use of parliamentary change (see Source 3).

The movement in support of the People's Charter became known as **Chartism**. It spread through Great Britain and in June 1837, Chartists held a general meeting at the British Coffee House in Cockspur Street, London. One faction wanted to use peaceful persuasion while another suggested physical force, even revolt.

The House of Commons rejected the Chartist petition, even though it had 1.2 million signatures. The Chartists suggested that a general strike be called on 12 August but then called it off. Other groups were involved in destroying factory machinery and in strikes, often clashing with police and soldiers. By 1840, over 500 Chartists had been put in prison.

A second petition was drawn up in 1842 and presented to Parliament in May, this time with over 3 million names. Again it was rejected by Parliament. A third petition was drawn up in 1848, when revolutions in Europe encouraged a revival of the Chartist ideas. This petition was signed by two million people but again it was ignored. As a result, many Chartists gave up on Britain and **emigrated** to other countries such as the USA, Italy and Australia.

Source 3 The Chartist claims

The six points of the People's Charter

1. A VOTE for every man twenty-one years of age, of sound mind, and not undergoing punishment for crime.
2. THE SECRET BALLOT—To protect the elector in the exercise of his vote.
3. NO PROPERTY QUALIFICATION for members of Parliament—thus enabling the constituencies to return the man of their choice, be he rich or poor.
4. PAYMENT OF MEMBERS, thus enabling an honest tradesman, working man, or other person, to serve a constituency, when taken from his business to attend to the interests of the country.
5. EQUAL CONSTITUENCIES, securing the same amount of representation for the same number of electors, instead of allowing small constituencies to swamp the votes of larger ones.
6. ANNUAL PARLIAMENTS, thus presenting the most effectual check to bribery and intimidation, since though a constituency might be bought once in seven years (even with the ballot), no purse could buy a constituency (under a system of universal suffrage) in each ensuing twelve-month; and since members, when elected for a year only, would not be able to defy and betray their constituents as now.

Source 4 An artist's impression of Robert Owen's cotton mill at New Lanark in 1818. Unlike many industrialists at the time, Owen supported the rights of workers at his mills and established one of the largest trade unions.

Emergence of trade unions

Over time, workers found ways of banding together to protect their interests. Skilled workers realised that they needed to protect their jobs and incomes (in case of illness or injury) so they would not become victims of the Poor Laws. As a result, many formed Friendly Societies. Workers each paid a weekly subscription to their Friendly Society that would provide them with a small income during illness, an old-age pension, or money for a funeral when they died.

Some industries developed trade clubs, which quickly developed into unions that fought for common aims, such as higher wages. A union's main weapon against employers and industrialists was the threat of work stoppages known as strikes. The Combination Acts of 1799 and 1800 banned workers in Britain from meeting to demand increased wages or shorter working hours. If caught, the punishment for this crime was three months in jail.

After protests and debate, **trade unions** were legalised in 1825, swiftly leading to the establishment of groups such as the National Association for the Protection of Labour, with over 100 000 members. The largest union was the Grand National Consolidated Trades Union, established in 1833 by a mill owner, Robert Owen. Unlike many other mill owners, Owen supported the welfare of his workers. He abolished child labour in his mills (for those under the age of 10), provided schooling and good housing. He also paid good wages, including sick pay.

The Factory Acts

The Factory Acts were inspired by complaints about the employment of child labourers, who worked long days in appalling conditions. In 1802 and 1819, British politician and industrialist Robert Peel was instrumental in passing laws that restricted the hours that children had to work. Unfortunately, many mill owners had influence over local judges, so these laws were not enforced. By 1830, most of the 250 000 mill workers in Britain were still under the age of 18.

In a push to reduce the working day to ten hours, social reformer Lord Ashley succeeded in making it illegal for children under the age of nine to work at all. Those under 13 could work only a 48-hour week and, those aged 14–18, a 69-hour week. In addition, all children were to receive two hours of schooling per week, and inspectors were appointed to enforce the new rules.

In 1840, the Royal Commission on Children's Employment discovered that women and children were expected to carry loads of coal of up to 150 kilograms either on their shoulders or dragged behind them through narrow, low passages. A Mines Act was passed in 1842, banning all females as well as boys younger than ten from working underground. Other European countries introduced similar laws: in France in 1841 and in Prussia in 1839, laws limited the working hours of people under the age of 16 and banned the employment of children under nine in mines and factories.

In 1847, women in factories were restricted to a ten-hour day, which effectively reduced many of the men's hours as well. The final major change for this period came in 1874, when a maximum of 56 hours' work a week was introduced – ten hours a day from Monday to Friday, and six hours on Saturdays.

Emergence of modern lifestyles

Robert Owen was not the only factory owner who came to see that happier workers would work harder. Titus Salt, an industrialist and politician from the English town of Bradford began experimenting with the idea of providing well-built homes with drainage for his employees, as well as a local hospital, public baths, churches and schools.

In France, workers were allowed to gradually buy the cottages in which they lived. These workers' cities also had schools, hospitals and baths. Similar 'cities' were developed in other European nations.

Improving health conditions led to fewer outbreaks of disease and more efficient workers. Even the harshest of mill owners began to clear slums. Cesspools were removed, tenements (overcrowded rooming houses) were pulled down, and open spaces were created for sport and entertainment. Sport was encouraged in 'leisure time' in order to keep workers healthy.

Increased leisure time led to other changes. Mass entertainment, such as theatres and spectator sport, developed alongside newspapers and magazines for people of all classes – not just literature for the well educated.

Compulsory education for children eventually grew into educational opportunities for other workers, with Mechanics' Institutes offering courses in technology and self-improvement. Eventually, these broadened to offer other subjects, including literacy and arithmetic.

Improvements in agricultural production gave people better diets and reduced the risk of famine through crop failure. Workers could now afford more and better food that, in turn, helped them stay even healthier.

Source 5 Young American boys working as mine helpers, *c.* 1900, before the introduction of child labour laws in the USA

Check your learning 8.14

Remember and understand

1 What did Karl Marx think was the driving force behind the Industrial Revolution?
2 Look at the first point of the People's Charter in Source 3. What large group was left out of their demands for voting rights?
3 In your own words define the term 'Luddite'.
4 Prior to 1825, what was the legal punishment if workers gathered to discuss demands for higher wages?

Apply and analyse

5 Read Source 3. In your own words, explain what a 'property qualification' was. Why did the Chartists want to abolish the property qualification for Members?
6 Explain how workers benefited from joining Friendly Societies.

Evaluate and create

7 Many people today who avoid using computers or new technology are called 'Luddites'. Given what you have learned, describe how the original 'Luddites' differ from modern-day 'Luddites'.
8 Create a poster advertising a Chartist meeting. Include the six proposals shown in Source 3 on your poster, ensuring that you explain each proposal in your own words so that they can be understood by young people today.

8.15 Long-term impacts of the Industrial Revolution

Although it is impossible to accurately identify a date on which the Industrial Revolution came to an end, many historians argue that this coincided with the beginning of World War I in 1914. In the century since then, many of the long-term impacts of the Industrial Revolution have started to become apparent. Some of these long-term impacts are positive while others are negative.

Long-term population growth and global inequality

Although rapid population growth was one of the major short-term effects of the Industrial Revolution, in the 100 years since then world population has continued to rise. Today, this growth has slowed in the industrialised nations but continues to increase rapidly in the developing world. In 1801, world population was approximately 1 billion people. By 2027, this number is estimated to exceed 8 billion. Many academics now argue that this number of people is unsustainable and is placing the world's resources at risk from overuse.

In the short-term, the advantages brought by the Industrial Revolution – including higher standards of living, education, better food and medical treatment – only benefited the industrialised world. Other areas of the world – such as the colonies of major European powers – were left behind or exploited for their resources. Today, these countries are striving to bring themselves into line with the first-world countries and former imperial powers that controlled them in the past.

In many ways, increased levels of global trade have allowed the industrialised world to export many of the problems of the Industrial Revolution – long hours, poor working conditions, child labour – to developing countries.

Source 1 An abandoned 19th-century lead mine

Environmental impacts

One of the most significant long-term impacts of the Industrial Revolution is related to the environment. New sources of air and water pollution were introduced that we are only now beginning to acknowledge as directly linked to 19th-century industrial processes. Coal burnt in the production of steam power produced heavy layers of smog that hung over the factory towns and cities. Evidence of the effects of this pollution was found when modern scientists tested hair samples from famous people such as Isaac Newton and Napoleon Bonaparte. They discovered high concentrations of lead and mercury.

Today, not much has changed. The modern world is still heavily dependent on fossil fuels such as coal and oil. Not only do we use petroleum products in our cars, ships and planes, we also use them in the manufacture of our iPads, smart phones, computers and similar devices. The only difference is that these fuels we burn to maintain our affluent lifestyles are running out.

Air pollution

The British were aware of the soot and dirt that hung over their industrial towns, but they could not foresee the long-term effects of their industry into the 21st century. They did not realise fossil fuels such as coal and oil could run out or have a global environmental impact. The Industrial Revolution left humanity dependent on carbon fuels (such as petrol and gas). In recognition of this, governments worldwide are encouraging the search for greener energies through policies aimed at limiting carbon production or taxing those that produce it.

The developing world and its growing economies, particularly those of India and China, have copied the example of the industrialised nations by becoming large producers of pollution as they strive to improve the living conditions and wealth of their populations (see Source 3).

Source 2 The effects of industrialisation are seen in scenes such as this, where chemicals from a nearby chemical plant have killed the trees.

By the mid 1900s, the effects of these changes to the Earth's atmosphere were becoming apparent. In the 1960s, a new environmental movement sought to stem the tide of pollutants flowing into the planet's ecosystem. It is now widely accepted that pollution has changed the Earth's climate and could lead to further unexpected changes.

Source 3 Today, modern China follows the example set by Britain in the 1800s.

Water pollution and sewage difficulties

The Industrial Revolution led to the building of many factories, tanneries and industrial buildings along the banks of the Thames. Waste from these industries, along with the flow of the London cesspits, badly polluted the river. By 1833, salmon could no longer be found upstream from London Bridge. The Building Acts of 1844 and 1847 improved sanitation in the city *itself,* but only by dumping more sewage into the river.

The river was toxic to fish but was still used to provide drinking water for people. This led to four serious outbreaks of cholera between 1831 and 1866. Pollution continued as the city's population grew and more industries developed. This problem was not resolved until late in the 20th century. The first salmon in 150 years returned to the Thames in 1974.

It was not until the 1960s, long after the Industrial Revolution, that people truly came to recognise the problems caused by industrial waste and ground contamination from new industries. Leftovers from production, by-products and waste were dumped or burned off. Large areas of land were damaged or poisoned by unknown or unrecognised chemicals dumped without any special care or consideration. The run-off from some of these chemicals often entered the water supply. Rivers, creeks and underground water supplies were affected, while dangerous elements such as lead entered the food chain through animals' drinking the water or through infected food.

Source 4 Modern cleaning of the Thames; this device collects floating rubbish, such as plastic and wood.

Source 6 A modern example of the effects of deforestation in Haiti

Deforestation and land clearance

During the Industrial Revolution, forests were cleared to an ever greater extent, at first for fuel and building materials, then to make space for new farmland. A rising population required more buildings; railways required miles of wooden sleepers. Land was also cleared to build the new factories and mills, and to create the housing areas around them where the workers could live. In many cases, the forests lost contained old-growth trees that had stood for decades. These trees had held together soil on mountain slopes or soaked up rainwater. The loss of these trees led to landslides and to floods downstream.

key**concept:** Significance

'Smellbourne'

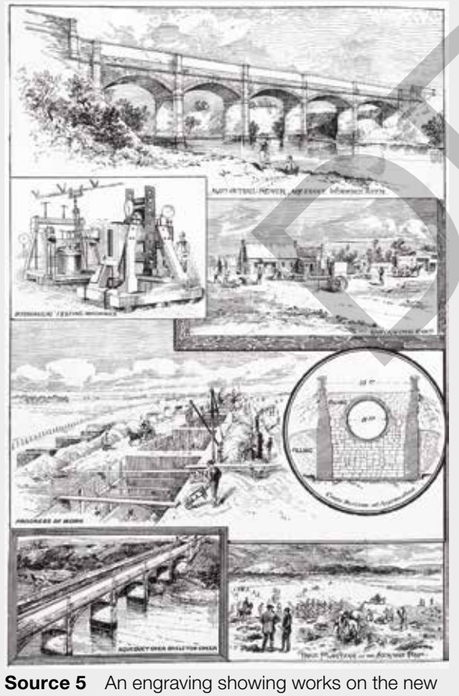
In the 1850s, the majority of sewage and human waste from houses across Melbourne was emptied into open drains that flowed into street channels. This waste mixed with other waste from stables and industries making these open street channels extremely smelly. As a result, Melbourne was given the nickname 'Smellbourne'.

Although there was a collection system (waste products collected from outhouses or 'dunnies' behind city homes by 'nightmen') it was disorganised and often resulted in the outbreak of diseases like typhoid.

After hundreds of people died, the Melbourne and Metropolitan Board of Works (MMBW) was established to build an underground sewerage system and a treatment plant at Werribee. This treatment plant still operates today.

The system was opened in February 1898, when the chairman of the MMBW, Mr Fitzgibbon, proudly stated, it 'was not a question of how much the scheme was going to cost, but how much it was going to save in the lives of the citizens'.

For more information on the key concept of significance refer to page XX of 'The history toolkit'.



Source 5 An engraving showing works on the new sewerage scheme for Melbourne, 1892

Check your learning **8.15**

Remember and understand

1 In what ways did the Industrial Revolution encourage an increase in overall world population?
2 Use the information provided to complete the following tasks:
   - **a** Why was Melbourne nicknamed 'Smellbourne'?
   - **b** How did Melbourne resolve its difficulty with sewage?
   - **c** Why is the Melbourne sewerage system still considered significant to this day?
3 What effect did industrialisation have on waterways such as the Thames?
4 What were the unexpected consequences of the removal of trees from some mountain areas?

Apply and analyse

5 Write a paragraph describing some of the long-term environmental effects of the Industrial Revolution.
6 Explain why the Industrial Revolution did not benefit developing countries such as India.
7 Over the centuries, what has been the relationship between industrialisation and outbreaks of serious diseases and illnesses? Use examples from this text and from your own research to answer this question. Provide examples to support your answer.

Evaluate and create

8 Create a poster that advises people how to limit their pollution of waterways.
9 Write a letter to the newspaper arguing the need to investigate alternative energy sources of industrial and domestic power.

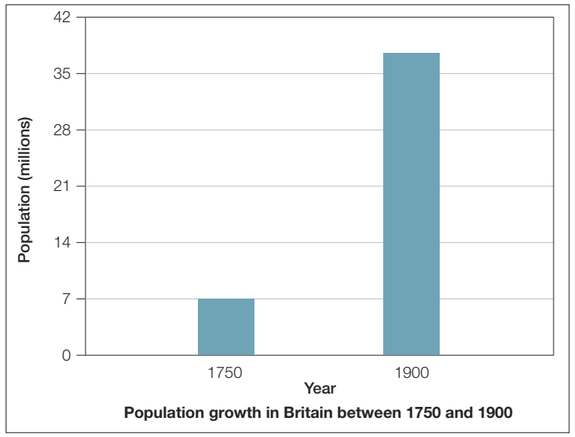
8C: rich task

Population growth in Britain during the Industrial Revolution

The Industrial Revolution meant the transformation of countries' populations from being predominantly rural to being predominantly urban. In England, millions of people migrated from farming areas to the cities springing up near the coal and iron fields. The population of Manchester, England, grew from 25 000 in 1772 to 303 000 by 1850. Overall in Britain, the number of cities with populations of 50 000 or more rose from three in 1785 to 31 in 1860. By 1850, Britain had become the first nation in history to have a larger urban than rural population.

Source 1

Britain	1750	1900
Population	7 million	37 million
People living in towns	13%	87%
Life expectancy	Men: 31 years Women: 33 years	Men: 45 years Women: 48 years
Deaths at birth	Deaths at birth: 65%	Deaths at birth: 15%



Source 2 Graph showing population growth in Britain between 1750 and 1900.

skill**drill:** Continuity and change

Using graphs to communicate historical information

Sometimes, complicated numerical information presented in writing or in tables can be difficult to understand. Historians need to be able to read and interpret this information and communicate it visually. Graphs can be a very effective communication form for historians. They can condense information, make a point clearly and concisely, and show relationships and trends visually.

Bar graphs are very useful for showing how something has changed over time. Use the following steps when constructing a bar graph:

Step 1 Decide upon a title for the bar graph. The title should say what the graph is about in a very specific and concise way. For example, when graphing the information in the first row of the table in Source 1, the title 'Population of Britain between 1750 and 1900' is more specific than the title 'Population of Britain', or the title 'Population between 1750 and 1900'. It is also more concise than the title 'The changing population of Britain between the years 1750 and 1900'.

Step 2 Determine the labels for the *x*-axis (the horizontal axis). The *x*-axis is usually used to show items, categories or time periods. To determine the labels, you need to consider the data you are using to make your graph. For example, when graphing the information in the first row of the table in Source 1, we have put two labels on the *x*-axis: 1750 and 1900.

Step 3 Draw the *x*-axis and mark where the bars will be.

Step 4 Determine the scale for the *y*-axis (the vertical axis). The *y*-axis is usually used to show the frequency of something happening or the amount. Again, you need to consider the data you are using to make your graph. (For example, when graphing the information in the first row of the table in Source 1, we have used a numerical scale which goes from zero to 37 million). You then need to choose an appropriate scale interval (e.g. 1 cm = 10 million).

Step 5 Draw the *y*-axis and mark your chosen intervals with the appropriate numerical labels (e.g. 10 million, 20 million).

Step 6 Write an appropriate *y*-axis title beside the *y*-axis and an appropriate *x*-axis title underneath the x-axis. For example, when graphing the information in the first row of the table in Source 1, the *y*-axis title is 'Population' and the *x*-axis title is 'Years'.

Step 7 After looking closely at your data, draw each bar. If the value falls between two of your marked intervals on the *y*-axis, approximate where the correct value would lie.

Step 8 Each graph should be uniquely numbered, for example, 'Figure 1'. (Note that all other images such as diagrams, pictures, photos and maps are also included in this numbering series.)

Step 9 Whether creating your own graph using another source's data, adapting their graph, or reproducing their graph as a whole, you must quote (cite) the source. Place the citation below the graph, and precede it by either 'Source:' (for an exact reproduction) or 'Data source:' (when you have modified the original).

Apply the skill

Using the information in Source 1, follow the steps outlined above to create three bar graphs in your notebook which show:

1. The difference in life expectancy of men and women in Britain in 1750 and 1900.
2. The difference in the number of babies that died at birth in 1750 compared to 1900.
3. How many more people were living in towns in 1900 compared to 1750.

Extend your understanding

1. Conduct some independent Internet research to find out why populations increased so rapidly during the Industrial Revolution, both generally and within cities. Using the information you have gathered, write a historical explanation of 200 words describing the population boom and the reasons why it occurred.

Source 3 Manchester's population grew rapidly between 1772 and 1850.