Energy and the Industrial Revolution

For years historians have sought to identify crucial elements in the eighteenth-century rise in industry, technology, and economic power known as the Industrial Revolution, and many give prominence to the problem of energy. Until the eighteenth century, people relied on energy derived from plants as well as animal and human muscle to provide power. Increased efficiency in the use of water and wind helped with such tasks as pumping, milling, or sailing. However, by the eighteenth century, Great Britain in particular was experiencing an energy shortage. Wood, the primary source of heat for homes and industries and also used in the iron industry as processed charcoal, was diminishing in supply. Great Britain had large amounts of coal; however, there were not yet efficient means by which to produce mechanical energy or to power machinery. This was to occur with progress in the development of the steam engine.

In the late 1700s James Watt designed an efficient and commercially viable steam engine that was soon applied to a variety of industrial uses as it became cheaper to use. The engine helped solve the problem of draining coal mines of groundwater and increased the production of coal needed to power steam engines elsewhere. A rotary engine attached to the steam engine enabled shafts to be turned and machines to be driven, resulting in mills using steam power to spin and weave cotton. Since the steam engine was fired by coal, the large mills did not need to be located by rivers, as had mills that used water- driven machines. The shift to increased mechanization in cotton production is apparent in the import of raw cotton and the sale of cotton goods. Between 1760 and 1850, the amount of raw cotton imported increased 230 times. Production of British cotton goods increased sixtyfold, and cotton cloth became Great Britain’s most important product, accounting for one-half of all exports. The success of the steam engine resulted in increased demands for coal, and the consequent increase in coal production was made possible as the steam-powered pumps drained water from the ever-deeper coal seams found below the water table.

The availability of steam power and the demands for new machines facilitated the transformation of the iron industry. Charcoal, made from wood and thus in limited supply, was replaced with coal-derived coke (substance left after coal is heated) as steam-driven bellows came into use for producing of raw iron. Impurities were burnt away with the use of coke, producing a high-quality refined iron. Reduced cost was also instrumental in developing steam-powered rolling mills capable of producing finished iron of various shapes and sizes. The resulting boom in the iron industry expanded the annual iron output by more than 170 times between 1740 and 1840, and by the 1850s Great Britain was producing more tons of iron than the rest of the world combined. The developments in the iron industry were in part a response to the demand for more machines and the ever-widening use of higher-quality iron in other industries.

Steam power and iron combined to revolutionize transport, which in turn had further implications. Improvements in road construction and sailing had occurred, but shipping heavy freight over land remained expensive, even with the use of rivers and canals wherever possible. Parallel rails had long been used in mining operations to move bigger loads, but horses were still the primary source of power. However, the arrival of the steam engine initiated a complete transformation in rail transportation, entrenching and expanding the Industrial Revolution. As transportation improved, distant and larger markets within the nation could be reached, thereby encouraging the development of larger factories to keep pace with increasing sales. Greater productivity and rising demands provided entrepreneurs with profits that could be reinvested to take advantage of new technologies to further expand capacity, or to seek alternative investment opportunities. Also, the availability of jobs in railway construction attracted many rural laborers accustomed to seasonal and temporary employment. When the work was completed, many moved to other construction jobs or to factory work in cities and towns, where they became part of an expanding working class.

Paragraph 1: For years historians have sought to identify crucial elements in the eighteenth-century rise in industry, technology, and economic power known as the Industrial Revolution, and many give prominence to the problem of energy. Until the eighteenth century, people relied on energy derived from plants as well as animal and human muscle to provide power. Increased efficiency in the use of water and wind helped with such tasks as pumping, milling, or sailing. However, by the eighteenth century, Great Britain in particular was experiencing an energy shortage. Wood, the primary source of heat for homes and industries and also used in the iron industry as processed charcoal, was diminishing in supply. Great Britain had large amounts of coal; however, there were not yet efficient means by which to produce mechanical energy or to power machinery. This was to occur with progress in the development of the steam engine.

1. Why does the author provide the information that “Great Britain had large amounts of coal”? (C)

○ To reject the claim that Britain was facing an energy shortage in the eighteenth century

○ To explain why coal rather than other energy resources became the primary source of heat for homes and industries in eighteenth-century Britain

○To indicate that Britain’s energy shortage was not the result of a lack of fuel

○ To explain why coal mining became an important industry in nineteenth-century

2. What was “the problem of energy" that had to be solved to make the Industrial Revolution of the eighteenth century possible? (B)

○ Water and wind could not be used efficiently.

○ There was no efficient way to power machinery.

○ Steam engines required large amounts of coal, which was in short supply.

○ Neither humans nor animals were strong enough to provide the power required for industrial application.

Paragraph 2: In the late 1700s James Watt designed an efficient and commercially viable steam engine that was soon applied to a variety of industrial uses as it became cheaper to use. The engine helped solve the problem of draining coal mines of groundwater and increased the production of coal needed to power steam engines elsewhere. A rotary engine attached to the steam engine enabled shafts to be turned and machines to be driven, resulting in mills using steam power to spin and weave cotton. Since the steam engine was fired by coal, the large mills did not need to be located by rivers, as had mills that used water- driven machines. The shift to increased mechanization in cotton production is apparent in the import of raw cotton and the sale of cotton goods. Between 1760 and 1850, the amount of raw cotton imported increased 230 times. Production of British cotton goods increased sixtyfold, and cotton cloth became Great Britain’s most important product, accounting for one-half of all exports. The success of the steam engine resulted in increased demands for coal, and the consequent increase in coal production was made possible as the steam-powered pumps drained water from the ever-deeper coal seams found below the water table.

3. Which of the following is NOT mentioned in paragraph 2 as a development in cotton mills brought about by Watt’s steam engine? (D)

○ The importing of huge quantities of raw cotton by Britain

○ Increased mechanization

○ More possibilities for mill location

○ Smaller mills

4. The phrase “apparent in” in the passage is closest in meaning to(A)

○ clearly seen in

○ aided by

○ associated with

○ followed by

5. According to paragraph 2, what was Britain’s most important export by 1850? (B)

○ Raw cotton

○ Cotton cloth

○ Steam-powered pumps

○ Coal

6. The word “consequent” in the passage is closest in meaning to (A)

○ resulting

○ encouraging

○ well documented

○ immediate

7. What is the role of paragraph 2 in the passage as a whole? (D)

○ It explains how by increasing the supply of raw materials from other countries, British industries were able to reduce costs and increase production.

○ It explains how the production of mechanical energy and its benefits spread quickly across countries that were linked commercially with Great Britain.

○ It demonstrates why developments in a single industry could not have caused the Industrial Revolution.

○ It illustrates why historians have assigned great importance to the issue of energy in the rise of the Industrial Revolution.

Paragraph 3: The availability of steam power and the demands for new machines facilitated the transformation of the iron industry. Charcoal, made from wood and thus in limited supply, was replaced with coal-derived coke (substance left after coal is heated) as steam-driven bellows came into use for producing of raw iron. Impurities were burnt away with the use of coke, producing a high-quality refined iron. Reduced cost was also instrumental in developing steam-powered rolling mills capable of producing finished iron of various shapes and sizes. The resulting boom in the iron industry expanded the annual iron output by more than 170 times between 1740 and 1840, and by the 1850s Great Britain was producing more tons of iron than the rest of the world combined. The developments in the iron industry were in part a response to the demand for more machines and the ever-widening use of higher-quality iron in other industries.

8. According to paragraph 3, why was the use of coke important for the iron industry? (C)

○ It helped make wood into charcoal.

○ It reduced the dependency on steam-powered machines used for the production of iron.

○ It replaced charcoal in the production of raw and refined iron.

○ It powered the machines used to extract coal in coal mines.

9. According to paragraph 3, all of the following were true of the iron industry in Great Britain during the 1800s EXCEPT: (D)

○ Steam-driven bellows were used to produce raw iron.

○ By the 1850s Britain was the world’s largest producer of iron.

○ Steam-powered mills made it possible to produce iron of different shapes and sizes.

○ Greater demand for higher-quality iron increased its price.

Paragraph 4: Steam power and iron combined to revolutionize transport, which in turn had further implications. Improvements in road construction and sailing had occurred, but shipping heavy freight over land remained expensive, even with the use of rivers and canals wherever possible. Parallel rails had long been used in mining operations to move bigger loads, but horses were still the primary source of power. However, the arrival of the steam engine initiated a complete transformation in rail transportation, entrenching and expanding the Industrial Revolution. As transportation improved, distant and larger markets within the nation could be reached, thereby encouraging the development of larger factories to keep pace with increasing sales. Greater productivity and rising demands provided entrepreneurs with profits that could be reinvested to take advantage of new technologies to further expand capacity, or to seek alternative investment opportunities. Also, the availability of jobs in railway construction attracted many rural laborers accustomed to seasonal and temporary employment. When the work was completed, many moved to other construction jobs or to factory work in cities and towns, where they became part of an expanding working class.

10. The word “initiated” in the passage is closest in meaning to(D)

○anticipated

○accelerated

○spread

○ started

11. Paragraph 4 implies which of the following about the transformation in rail transportation? (C)

○ Because railway construction employed mostly rural laborers, unemployment increased among urban workers.

○ It resulted in more trade within the country, but less trade with markets that could be reached only by ocean shipping.

○ It made shipping freight overland to distant markets less expensive.

○ It resulted in higher wages for factory workers.

12. The phrase “accustomed to" in the passage is closest in meaning to (B)

○ in need of

○ used to

○ tired of

○ encouraged by

Paragraph 4: Steam power and iron combined to revolutionize transport, which in turn had further implications. Improvements in road construction and sailing had occurred, but shipping heavy freight over land remained expensive, even with the use of rivers and canals wherever possible. Parallel rails had long been used in mining operations to move bigger loads, but horses were still the primary source of power. ■However, the arrival of the steam engine initiated a complete transformation in rail transportation, entrenching and expanding the Industrial Revolution. ■As transportation improved, distant and larger markets within the nation could be reached, thereby encouraging the development of larger factories to keep pace with increasing sales. ■Greater productivity and rising demands provided entrepreneurs with profits that could be reinvested to take advantage of new technologies to further expand capacity, or to seek alternative investment opportunities. ■Also, the availability of jobs in railway construction attracted many rural laborers accustomed to seasonal and temporary employment. When the work was completed, many moved to other construction jobs or to factory work in cities and towns, where they became part of an expanding working class.

13. Look at the four squares [■] that indicate where the following sentence could be added to the passage. (B)

**The first steam-powered locomotives were slow but they rapidly improved in speed and carrying capacity.**

Where would the sentence best fit? Click on a square to add the sentence to the passage.

14. **Directions:** An introductory sentence for a brief summary of the passage is provided below. Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some sentences do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. **This question is worth 2 points.**

The coming of the Industrial Revolution in eighteenth-century Britain depended on the development of the steam engine to power machinery. (B) (D) (E)

Answer Choices

○ For years, historians disregarded the issue of energy as a major element in the rise of the Industrial Revolution and focused instead on technological developments and increased production.

○ The introduction and growth of steam-powered rail transport was a major factor in Britain's economic expansion during the Industrial Revolution.

○ An expansion of the Industrial Revolution outside Great Britain occurred when British industries began to import raw cotton and high-quality iron.

○ By 1850, the use of steam power in Britain's mills, mines, and iron industry made Britain a world leader in the production of cotton cloth and iron.

○ Since the basic infrastructure was in place, the Industrial Revolution fueled itself with enlarging markets requiring ever more expansion of factories and workforce.

○ By the end of the 1800s, railway construction attracted so many laborers that factories could not find enough workers to keep up with increasing sales.