tpo_29_passage_2

Moving water was one of the earliest energy sources to be harnessed to reduce the workload of people and animals. No one knows exactly when the waterwheel was invented, but irrigation systems existed at least 5,000 years ago, and it seems probable that the earliest waterpower device was the noria, a waterwheel that raised water for irrigation in attached jars. This device appears to have evolved no later than the fifth century B.C., perhaps independently in different regions of the Middle and Far East. The earliest waterpower mills were probably vertical-axis mills for grinding corn, known as Norse or Greek mills, which seem to have appeared during the first or second century B.C. in the Middle East and a few centuries later in Scandinavia. In the following centuries, increasingly sophisticated waterpower mills were built throughout the Roman Empire and beyond its boundaries in the Middle East and northern Europe. In England, the Saxons are thought to have used both horizontal- and vertical-axis wheels. The first documented English mill was in the eighth century, but three centuries later about 5,000 were recorded, suggesting that every settlement of any size had its mill. Raising water and grinding corn were by no means the only uses of the waterpower mill, and during the following centuries, the applications of waterpower kept pace with the developing technologies of mining, iron working, paper making, and the wool and cotton industries. Water was the main source of mechanical power, and by the end of the seventeenth century, England alone is thought to have had some 20,000 working mills. There was much debate on the relative efficiencies of different types of waterwheels. The period from about 1650 until 1800 saw some excellent scientific and technical investigations of different designs. They revealed output powers ranging from about 1 horsepower to perhaps 60 for the largest wheels and confirmed that for maximum efficiency, the water should pass across the blades as smoothly as possible and fall away with minimum speed, having given up almost all of its kinetic energy. (They also proved that, in principle, the overshot wheel, a type of wheel in which an overhead stream of water powers the wheel, should win the efficiency competition.) But then steam power entered the scene, putting the whole future of waterpower in doubt. An energy analyst writing in the year 1800 would have painted a very pessimistic picture of the future for waterpower. The coal-fired steam engine was taking over, and the waterwheel was fast becoming obsolete. However, like many later experts, this one would have suffered from an inability to see into the future. A century later the picture was completely different: by then, the world had an electric industry, and a quarter of its generating capacity was water powered. The growth of the electric-power industry was the result of a remarkable series of scientific discoveries and developments in electrotechnology during the nineteenth century, but significant changes in what we might now call hydro (water) technology also played their part. In 1832, the year of Michael Faraday's discovery that a changing magnetic field produces an electric field, a young French engineer patented a new and more efficient waterwheel. His name was Benoît Fourneyron, and his device was the first successful water turbine. (The word turbine comes from the Latin turbo: something that spins). The waterwheel, unaltered for nearly 2,000 years, had finally been superseded. Half a century of development was needed before Faraday's discoveries in electricity were translated into full-scale power stations. In 1881 the Godalming power station in Surrey, England, on the banks of the Wey River, created the world's first public electricity supply. The power source of this most modern technology was a traditional waterwheel.

Unfortunately this early plant experienced the problem common to many forms of renewable energy: the flow in the Wey River was unreliable, and the waterwheel was soon replaced by a steam engine. From this primitive start, the electric industry grew during the final 20 years of the nineteenth century at a rate seldom if ever exceeded by any technology. The capacity of individual power stations, many of them hydro plants, rose from a few kilowatts to over a megawatt in less than a decade.

question 1

The word “harnessed” in the passage is closest in meaning to

A known

B depended on

C recognized

D utilized

question 2

In paragraph 1, uncertainty is expressed about all of the following aspects of the early development of waterpower EXCEPT

A when exactly the very first waterpower devices were invented

B where exactly the very first waterpower devices were developed

C whether water was one of the earliest sources of power to be used by humans

D whether the very earliest waterpower devices arose independently

question 3

According to paragraph 2, what was true of the waterpower mills built throughout the Roman Empire?

A Most had horizontal-axis wheels.

B Their design was based on mills that had long been used in Scandinavia.

C Their design was more popular beyond the empire’s boundaries than it was within the empire.

D They were more advanced than the mills used in the Middle East at an earlier time.

question 4

The phrase “the applications of waterpower” in the passage is closest in meaning to

A the uses to which waterpower was put

B the improvements made to waterpower

C the methods by which waterpower was supplied

D the sources of waterpower available

question 5

According to paragraph 4, which of the following was discovered as a result of scientific and technical investigations of waterpower conducted between 1650 and 1800?

A Some types of small waterwheels can produce as much horsepower as the very largest wheels.

B Waterwheels operate more efficiently when water falls away from their blades slowly than when water falls away quickly.

C Waterwheel efficiency can be improved by increasing the amount of kinetic energy water contains as it passes over a waterwheel’s blades.

D Unlike other types of waterwheels, the overshot wheel is capable of producing more than 60 horsepower units of energy.

question 6

The term “by then” in the passage refers to

A by the time steam power entered the scene

B by the year 1800

C by the year 1900

D by the time the waterwheel was becoming obsolete

question 7

According to paragraph 5, why did waterpower become more important by 1900?

A Better waterwheel designs improved the efficiency of waterpower.

B Waterpower was needed to operate steam engines.

C Waterpower was used to generate electricity.

D Waterwheels became more efficient than coal-powered engines.

question 8

According to paragraph 7, what problem did the early power station in the town of Godalming in Surrey, United Kingdom, face in providing electricity?

A The traditional waterwheel it used was not large enough to meet the demand for energy.

B The flow of the River Wey, on which the power station depended, was unreliable.

C The operators of the Godalming power station had little experience with hydro technology.

D The steam engine that turned the waterwheel was faulty and needed to be replaced.

question 9

Look at the four squares [ ] that indicate where the following sentence could be added to the passage.

Moving water was one of the earliest energy sources to be harnessed to reduce the workload of people and animals. No one knows exactly when the waterwheel was invented, but irrigation systems existed at least 5,000 years ago, and it seems probable that the earliest waterpower device was the noria, a waterwheel that raised water for irrigation in attached jars. This device appears to have evolved no later than the fifth century B.C., perhaps independently in different regions of the Middle and Far East. The earliest waterpower mills were probably vertical-axis mills for grinding corn, known as Norse or Greek mills, which seem to have appeared during the first or second century B.C. in the Middle East and a few centuries later in Scandinavia. In the following centuries, increasingly sophisticated waterpower mills were built throughout the Roman Empire and beyond its boundaries in the Middle East and northern Europe. In England, the Saxons are thought to have used both horizontal- and vertical-axis wheels. The first documented English mill was in the eighth century, but three centuries later about 5,000 were recorded, suggesting that every settlement of any size had its mill. Raising water and grinding corn were by no means the only uses of the waterpower mill, and during the following centuries, the applications of waterpower kept pace with the developing technologies of mining, iron working, paper making, and the wool and cotton industries. Water was the main source of mechanical power, and by the end of the seventeenth century, England alone is thought to have had some 20,000 working mills. There was much debate on the relative efficiencies of different types of waterwheels. [] The period from about 1650 until 1800 saw some excellent scientific and technical investigations of different designs. [] They revealed output powers ranging from about 1 horsepower to perhaps 60 for the largest wheels and confirmed that for maximum efficiency, the water should pass across the blades as smoothly as possible and fall away with minimum speed, having given up almost all of its kinetic energy. [] (They also proved that, in principle, the overshot wheel, a type of wheel in which an overhead stream of water powers the wheel, should win the efficiency competition.) [] But then steam power entered the scene, putting the whole future of waterpower in doubt. An energy analyst writing in the year 1800 would have painted a very pessimistic picture of the future for waterpower. The coal-fired steam engine was taking over, and the waterwheel was fast becoming obsolete. However, like many later experts, this one would have suffered from an inability to see into the future. A century later the picture was completely different: by then, the world had an electric industry, and a quarter of its generating capacity was water powered. The growth of the electric-power industry was the result of a remarkable series of scientific discoveries and developments in electrotechnology during the nineteenth century, but significant changes in what we might now call hydro (water) technology also played their part. In 1832, the year of Michael Faraday's discovery that a changing magnetic field produces an electric field, a young French engineer patented a new and more efficient waterwheel. His name was Benoît Fourneyron, and his device was the first successful water turbine. (The word turbine comes from the Latin turbo: something that spins). The waterwheel, unaltered for nearly 2,000 years, had finally been superseded. Half a century of development was needed before Faraday's discoveries in electricity were translated into full-scale power stations. In 1881 the Godalming power station in Surrey, England, on the banks of the Wey River, created the world's first public electricity supply. The power source of this most modern technology was a traditional waterwheel. Unfortunately this early plant experienced the problem common to many forms of renewable energy: the flow in the Wey River was unreliable, and the waterwheel was soon replaced by a steam engine. From this primitive start, the electric industry grew during the final 20 years of the nineteenth century at a rate seldom if ever exceeded by any technology. The capacity of individual power stations, many of them hydro plants, rose from a few kilowatts to over a megawatt in less than a decade.

question 10

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.

A. The first water-powered machines were probably used to grind corn, and as technology advanced, waterwheels were used as the main source of power in many industries.

B. Waterpower mills were probably invented about the same time in the Middle East and Scandinavia and then spread to England by about the second century B.C.

C. Almost every large town in England had a waterpower mill, allowing England to become the world' s leader in industries that depended on water for their power.

D. In the seventeenth and eighteenth centuries, design improvements in waterwheels led to discoveries of how to increase their efficiency and power output.

E. In the late nineteenth century an electric power station in England began using water power from a nearby river, creating a dependable source of power that quickly replaced the steam engine.

F. After declining in importance in the early 1800' s, waterpower came back into demand by the end of the century as a means to power electric power plants and water turbines.