

Inventions That Changed the World Name: _____ Prd: ____ Score: ____/20

Directions: Highlight the answer in the text on the left *before* answering the questions on the right.

Mrs. Richard Arkwright was fed up with her husband! *Why didn't the fool stick to his trade?* As a barber he would never get rich, but at least he could support his family. Why, then, did he waste all his time making models of machines to spin cotton? The man was a dreamer...& his family would certainly starve to death if he didn't stop this nonsense! *So, in a rage, she smashed some of the machines!*

But **Richard Arkwright** went right on with his experiments. In time he **invented a spinning machine** that helped bring about the factory system in England. He became very rich, & King George III even made him a knight!

Arkwright was one of a number of skilled mechanics whose inventions spurred the **Industrial Revolution**. Mechanics were **craftsmen** who were skilled at working with machinery. Arkwright was born the youngest of 13 children in Preston, England in 1732. His parents could not afford to keep him in school for long, so he was barely able to write when his formal education ended. Later, he would learn the trade of barber for he made a good living dyeing hair for wigs. *But Arkwright was a born mechanic.* His interest in spinning cotton by machine *soon* caused him to neglect his business.

Other men were also trying to develop spinning machines, & there was good reason for it. Weavers could make cloth faster than spinners could make the thread they needed. Often a weaver had to stop while he waited for the spinner to catch up!

About 1765, a weaver-carpenter named **James Hargreaves** invented the "**spinning jenny**." This was a simple wooden machine that could spin a number of threads at the same time. A traditional spinning wheel could produce *only one* thread at a time.



Arkwright is *credited* with inventing the

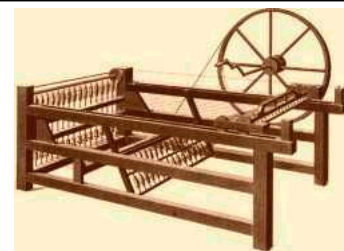
_____ that brought about the _____ system.

Recalling past knowledge: What was the purpose of having *many, many children* during this time period? _____

_____ are **artisans** skilled at working with machinery.

Why was there such a *push to invent* a spinning machine? _____

What made Hargreaves' invention so unique for its time? _____



On the other hand, Hargreaves' spinning jenny was small enough to be used in a cottage. It was also cheap enough to make & did not require much strength to turn the handle. Ironically, soon the weavers could not keep up with the spinners!

Meanwhile, Arkwright was trying to develop a more advanced method for spinning cotton. About 1768, he built a machine that spun cotton into thread by means of high-speed rollers. Arkwright's "spinning frame" produced a cheap thread that brought down the cost of cotton cloth. Consequently, the demand for cotton fabrics went way up!

Arkwright's spinning frame was much different from Hargreaves' spinning jenny. The spinning frame was too big to fit into a worker's cottage & too expensive for a cottage worker to buy alone. It needed more power than human muscle could provide. Arkwright & his business partners built a number of large **mills**, or cotton-spinning **factories**, to house his machines. At first, the machines were driven by water power, but later, when James Watt perfected the steam engine, they were adapted to steam power!

Arkwright's mills marked the beginning of the factory system in England & the gradual ending of the cottage industry. Arkwright became known as the "father of the factory system."

James Watt's steam engine did more to advance the Industrial Revolution than any other invention!! Actually, Watt did not invent the steam engine, but he produced the first one that was practical & efficient. But what a difference it made! His steam engine was used to power machines of most every kind. It pumped water, drove looms, hammered iron, sawed timber, & even propelled ships & railroad locomotives (trains). It made possible a flood of inexpensive goods that raised living standards for most people.

What advantages did Hargreaves' machine have over others? 1) _____

2) _____

(There are 3, choose 2.)

Cause & Effect:

If the **cost of thread decreases**, therefore, **cost of cotton cloth** _____.

(Does what, cost-wise?)

& **demand for cotton fabric** _____.

These **mills were housed** for Arkwright's spinning frame in **cotton-spinning** _____.

- a. mills
- b. machines
- c. factories
- d. manors



Arkwright became known as the

- a. "father of England"
- b. "father of the factory system."
- c. "man!"
- d. "father of machinery & mills."

What invention did more than any other to advance the Industrial Revolution?

- a. spinning jenny
- b. steam engine
- c. spinning machine
- d. water frame

Watt's machine was responsible for:

- 1) _____ water
- 2) driving _____
- 3) hammering _____
- 4) sawing _____
- 5) propelling _____ & _____ (2 pts)

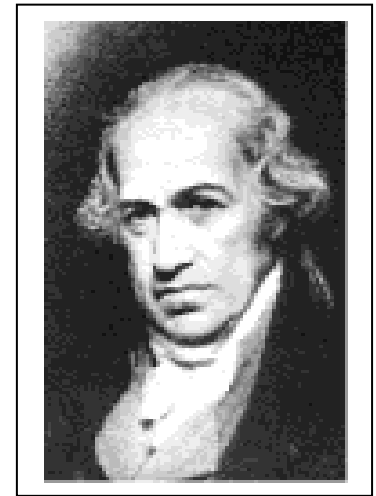
James Watt was born in *Greenock*, Scotland in 1736. As a child, his health was poor & he could not go to school. His father, a carpenter, built a workshop for James in the attic. The young boy soon showed great skill working with his hands. He built all kinds of mechanical gadgets. He also made drawings to illustrate problems of mathematics. Eventually, he went to school, graduating when he was 17. However, his family could not send him to a university, so he had to go to work & support himself.

In London he worked in the shop of an instrument-maker & learned that trade. After a year, he was hired by the University of *Glasgow* in Scotland. His job was to make & repair mathematical instruments. His workshop attracted teachers & students eager to talk to him about their scientific ideas. These talks were almost like a college education for Watt. His knowledge of math, physics & chemistry grew.

In 1764, Watt was asked to repair a model of a **steam engine** invented by **Thomas Newcomen**. The Newcomen engine was used mainly to pump water out of mines. But even for this job, it was not very good. It used a lot of fuel, but did not produce much power. And it was expensive to run!

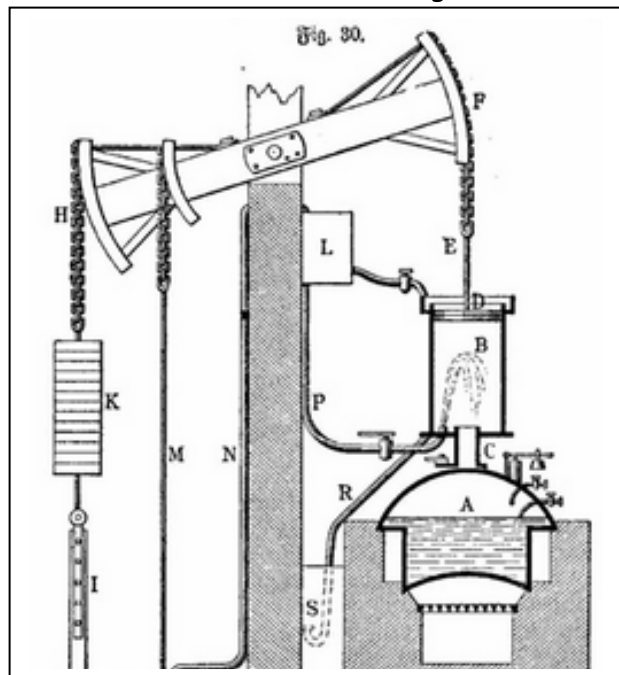
Watt began to study everything there was to know about steam. Soon he knew why Newcomen's engine worked so poorly. In any steam engine, water is boiled until it turns into steam. The steam *expands & pushes* with great force. The Newcomen engine let steam into the bottom of a cylinder. The steam pushed a piston to the top of the cylinder. At this point, cold water was sprayed into the cylinder. The steam was cooled & condensed into water again. This allowed air pressure at the top of the cylinder to push the piston back down to the bottom. Then the process was repeated. As the piston moved up & down, it powered a pump.

What skill did Watt's father *encourage* James to develop *in lieu of* a formal education?



Making inferences: How was talking with other teachers & students "almost like a college education" for Watt? _____

Newcomen's steam engine



Recognize this from science class?

What **scientific fact** did you *learn* about steam in this paragraph? *When water is boiled...*

- | | |
|----------------------------------|------------------|
| a. steam pushes with great force | d. it cools |
| b. steam expands | e. all the above |
| c. it floats to the bottom | f. a & b only |
| | g. d & e only |

The trouble was that the water cooled off the cylinder with each stroke of the piston. Then it took a lot steam ~ & time ~ to heat it back up again. A way *had* to be found to keep the cylinder as hot as the steam that was let in.

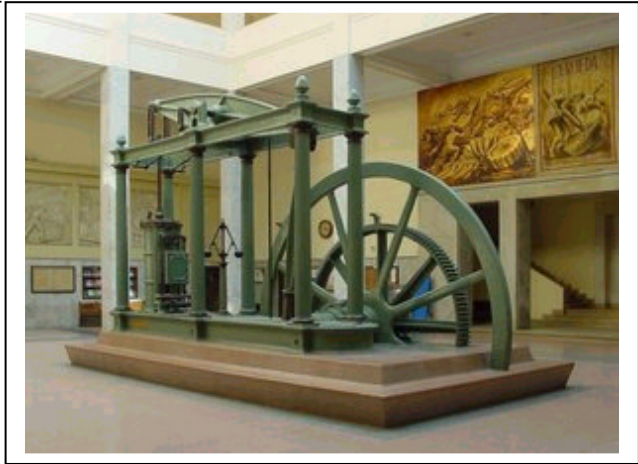
How, then, would there be a solution to the problem? How would it be done? The answer came to Watt one day in 1765 as he was walking through a park. The steam must be cooled & condensed in a separate chamber. By pumping the air out of the condensing chamber, steam from the cylinder would be drawn into it. That way there would be no loss of heat within the cylinder itself.

Watt began building a model of his steam engine. It worked as he expected, & in 1769 he took out a **patent** on it. A patent is a document giving an inventor the exclusive right to make or use his/her invention. But Watt still wanted to improve his steam engine. There were many delays before he was satisfied with his engine. Not until 1774 was it perfected.

Like Newcomen's engine, it was used mainly to pump water out of mines. But later, Watt designed a steam engine that turned a wheel. This made it possible to power all kinds of machines in factories. Gradually, these machines took over the work that used to be done by hand. Watt's steam engine *made* the Industrial Revolution happen.

Watt became famous. He had friends all over the world with whom he exchanged scientific ideas. He studied medicine, architecture, law & music. When he was past 70 years of age, he learned several languages. By that time, the Industrial Revolution was well under way.

And because of the Industrial Revolution & its great number of mills & factories, densely populated & polluted environments sprung up all over Great Britain creating new industrial cities. The factory system was, in & of itself, largely responsible for the rise of the modern city (urban life) as workers *migrated from* country farming communities (rural life) in search of jobs.



Watt's steam engine

What is a **patent**? _____

What does it *mean* to be "exclusive"?

- | | |
|---|---------------------------------|
| a. to invite participation | c. to be inclusive |
| b. to not allow membership or participation by others | d. to be divided amongst others |

Watt's steam engine is *credited with igniting* the _____ Revolution!



What *negative consequences came with* the Industrial Revolution? _____

& _____

MIGRATION analogy:
farming : rural life :: cities : _____