

NATURAL SCIENCES (SAT)

This passage has been adapted from US Department of Energy "How 3D Printers Work."

A decade ago, printing three-dimensional (3D) objects at home might have sounded like something out of a science fiction film. But in just a few short years, 3D printing has exploded, shifting from a niche technology to a game-changing innovation that captures the imagination of manufacturers and hobbyists alike. 3D printing has the potential to revolutionize manufacturing. Products can be designed and produced in ways that reduce waste, save energy, and shorten the time needed to bring products to market.

3D printing, also known as additive manufacturing, involves making an object by depositing material one tiny layer at a time. The basic idea can be observed in underground rock formations. Stalactites and stalagmites, types of rock structures, form over thousands of years as dripping water deposits thin mineral layers deep in the earth. A more modern example is an inkjet printer, which lays down a series of individual ink dots to form images on paper. Similarly, 3D printers add material where it is needed to form an object, based on a digital source file.

In comparison, many conventional manufacturing processes involve cutting away excess materials to make desired products. This process is sometimes called subtractive manufacturing. It is inefficient, as up to 30 pounds of material may be discarded for each pound of useful material created. Additive processes, on the other hand, can use up to 98 percent of the raw material in the finished product. Plus, additive processes enable manufacturers to create new shapes and lighter parts that require less raw material and fewer manufacturing steps. This can translate into lower energy use for 3D printing processes—in some cases, up to 50 percent less energy when compared to conventional manufacturing.

Additive manufacturing technology comes in many shapes and sizes but follows the same basic steps. First, a 3D blueprint is created using computer-aided design (CAD) software. Next, the printer is filled with the raw material to be used, such as plastic, metal powder, or a binding solution. The build platform is prepared to make it appropriate for the item. For example, the user may need to clean it or apply an adhesive to prevent movement and warp from the heat generated during the printing process.

Finally, the printer is engaged, and it automatically builds the desired object. The printing material is heated until it liquefies. It is then extruded through the print nozzle, which deposits the material in thin layers. The layers quickly solidify, bonding successively to layers below. During the process, the build platform lowers as each additional layer is added. Depending on the size and complexity of the object, the entire process might take minutes or even days. Once printing is complete, post-processing activities may be required, such as unsticking the object from the build platform or removing any support structures that were used.

Additive manufacturing processes are currently used to build small, relatively costly components made of plastics and metal powders. Examples of objects manufactured from these printers include everything from robots to prosthetic limbs to custom shoes to musical instruments. However, as the price of desktop 3D printers drops, some innovators are experimenting with the production of objects using other types of materials, such as chocolate and other food items, wax, ceramics, and biomaterial similar to human cells. The possibilities seem endless.

Source: U.S. Department of Energy. "How 3D Printers Work." June 19, 2014. <http://energy.gov/articles/how-3d-printers-work>

1. The use of the word “revolutionize” in line 10 impacts the tone of the text by creating a sense of

- A) revolt.
- B) movement.
- C) excitement.
- D) treachery.

2. The author includes the rock formation analogy (lines 18-22) in order to

- A) show that inventions often mimic unrelated activities in nature.
- B) make the concept behind 3D printing easier to understand by comparing it to a likely familiar process.
- C) compare the speed of a human-made object against other processes.
- D) clarify that the fundamental idea behind 3D printing is nothing new.

3. Based on the passage, 3D printing is similar to inkjet printing in that both processes

- A) rely on the use of common desktop printing technology.
- B) require a substantial amount of raw material to operate.
- C) use paper and ink to produce images from digital files.
- D) use selective placement of material to create a specific end result.

4. Based on the passage, additive manufacturing reduces waste by

- A) allowing users to specify the size of their desired result.
- B) making more efficient use of raw material.
- C) taking less time to complete the process.
- D) using fewer resources to create more parts.

5. Which choice provides the best evidence for the answer to the previous question?

- A) Lines 4-9 (“But in ... hobbyists alike”)
- B) Lines 35-37 (“Additive ... finished product”)
- C) Lines 46-48 (“Additive ... basic steps”)
- D) Lines 54-58 (“For example, ... process”)

6. The purpose of the fourth and fifth paragraphs (lines 46-74) is mainly to

- A) note a common misconception about how to operate a 3D printer.
- B) summarize the options available with 3D printing technologies.
- C) explain why a user would choose to produce an object in 3D.
- D) describe the sequence of steps in the process of creating an object with a 3D printer.

7. In line 59, the word “engaged” most nearly means

- A) battled.
- B) retained.
- C) chartered.
- D) activated.

8. According to the passage, after a 3D object is printed, it may be necessary to

- A) clean the build platform.
- B) empty the printer of excess raw materials.
- C) remove support structures.
- D) apply an adhesive to the build platform.

9. Which choice provides the best evidence for the answer to the previous question?

- A) Lines 50-53 (“Next, the . . . solution”)
- B) Lines 53-55 (“The build . . . clean it”)
- C) Lines 56-58 (“apply an . . . process”)
- D) Lines 70-74 (“Once printing . . . were used”)

10. According to the passage, what has been the relationship between the cost of 3D printers and the types of objects that 3D printer users produce?

- A) As 3D printers have become more affordable, users have begun to create objects using alternative materials.
- B) As 3D printers have become more affordable, users have begun to create objects using plastics and metal powders.
- C) As 3D printers have become less affordable, users have begun to diversify the objects they create.
- D) As 3D printers have become less affordable, users have begun to create objects using household materials.