"Substituted Sammy": An Exercise in Defining Life

"Substituted Sammy" was a normal, healthy boy. There was nothing in his life to indicate that he was any different from anyone else. When he completed high school, he obtained a job in a factory, operating a press. On this job he had an accident and lost his hand. It was replaced with an artificial hand that looked and operated almost like a real one.

Soon afterward, Sammy developed a severe intestinal difficulty, and a large portion of his lower small intestine had to be removed. It was replaced with an elastic silicone tube.

Everything looked good for Sammy until he was involved in a serious car accident. Both of his legs and his good arm were crushed and had to be amputated. He also lost an ear. Artificial legs enabled Sammy to walk again, and an artificial arm replaced the real arm. Plastic surgery and the use of silicone plastic enabled doctors to rebuild the ear.

Over the next several years Sammy was plagued with internal disorders. First, he had to have an operation to remove his aorta and replace it with a synthetic vessel. Next, he developed a kidney malfunction, and the only way he could survive was to use a kidney dialysis machine. (No donor was found to give him a kidney transplant.) Later, his digestive system became cancerous and was removed. He received his nourishment intravenously. Finally, his heart failed. Luckily for Sammy, a donor heart was available, and he had a heart transplant.

It was now obvious that Sammy had become a medical phenomenon. He had artificial limbs. Nourishment was supplied to him through his veins; therefore, he had no solid wastes. The kidney dialysis machine removed all waste material. The heart that pumped his blood to carry oxygen and food to his cells was not his original heart.

But Sammy’s transplanted heart began to fail. He was immediately placed on a heart-lung machine. This supplied oxygen and removed carbon dioxide from his blood, and it circulated blood through his body.

The doctors consulted bioengineers about Sammy because almost all his life-sustaining functions were being carried on by machines. They thought it might be possible to compress all these machines into one mobile unit, which could be controlled by electrical impulses from the brain. This unit would be equipped with mechanical arms to enable him to perform manipulative tasks. A mechanism to create a flow of air over his vocal cords might enable him to speak. To do all this, they would have to amputate at the neck and attach his head to the machine, which would then supply all nutrients to his brain. Sammy consented, and the operation was successfully performed.

Sammy functioned well for a few years. However, slow deterioration of his brain cells was observed and was diagnosed as terminal. So, the medical team that had developed around Sammy began to program his brain. A miniature computer was developed; it could be housed in a machine that was humanlike in appearance, movement, and mannerisms. As the computer was installed, Sammy’s brain cells completely deteriorated. Sammy was once again able to leave the hospital with complete assurance that he would not return with biologic illnesses.
**Question:** Substituted Sammy began as a normal, healthy boy. By the end of the story he is a robot. Many times, in science, there is no “easy” answer. **Fill in the chart below, then answer the question at the bottom: At what point did Sammy become non-living?**

<table>
<thead>
<tr>
<th>List the Characteristics of Life</th>
<th>Give the paragraph number in the story where he loses this characteristic of life.</th>
<th>Give 1 SPECIFIC example of why you chose that paragraph to explain why he lost that characteristic of life.</th>
</tr>
</thead>
</table>
| **Organization:** All living things are made of cells. Either unicellular or multicellular. Different parts of a cell perform different functions. | 1 | his hand was replaced with an artificial hand  
*Sammy no longer had specialized cells where his hand had once been.* |
| **The ability to grow and develop:** Cells continue to divide. Most organisms grow and increase in size. | 1 | his hand was replaced with an artificial hand  
*Sammy’s hand could no longer grow and develop.* |
| **The ability to respond to the environment:** They detect and respond to stimuli (both internal and external). They adapt to change in their environment. They interact with other organisms. Obtain raw materials and energy from the environment or another organism. | 1 | his hand was replaced with an artificial hand  
*Sammy’s hand could no longer respond to stimuli.* |
| **The ability to reproduce:** All organisms produce new organisms through reproduction. | 7 | amputate at the neck and attach his head to the machine  
*Sammy’s body was discarded so he could no longer reproduce.* |
| **The ability to maintain homeostasis:** All organisms must maintain a stable internal environment. | 4 | the only way he could survive was to use a kidney dialysis machine  
*Sammy’s body could no longer get rid of toxic waste when his kidneys stopped working to filter his blood.* |
| **The ability to get and use energy:** All organisms must have a means to get energy and to use it for all of life’s processes. | 4 | digestive system became cancerous and was removed  
*Sammy’s body could no longer digest food, which is the body’s source of energy.* |

If Sammy is not alive at the end of the story, exactly when did Sammy stop being alive? Sammy is no longer alive when he becomes a robot in paragraph 8. He had no living cells when his brain was programmed into a computer and put on Sammy’s mechanical body.