Name _____ Date _____

CHAPTER 29
Section 2

SCIENCE & TECHNOLOGY

Industrial Technology Creates Poison Gas

Many new technologies introduced during World War I were developed with military uses in mind. However, some new weapons were developed from peacetime industrial discoveries.

Poison gas in Germany during World War I was manufactured using a variation of the process that had originally been developed to produce fertilizer for farmers. Fritz Haber, a German chemist, invented this method of using nitrogen from the air in 1909. He was awarded the Nobel Prize for Chemistry in 1918 for this discovery.

Nitrogen makes up over 78 percent of our atmosphere and is the basis of fertilizers. Prior to the 20th century, nitrogen to make fertilizers had been taken from either minerals or other materials. However, there was not enough nitrogen available from these sources to satisfy the increasing demand from farms and factories.

Haber thought of tapping the virtually endless supply of nitrogen in the air. His idea was to capture it as a gas by combining it with hydrogen to form ammonia. Three parts hydrogen would combine with one part nitrogen (NH_3). The problem he came across was that high temperatures, around 1200 degrees Fahrenheit, were needed to make this process work. Unfortunately, these high temperatures slowed down the production of the ammonia he was attempting to manufacture.

The solution to Haber's problem was to use a catalyst. A catalyst is a substance that speeds up a chemical reaction but is not part of the reaction itself. The hydrogen and nitrogen were combined at high pressure, more than 200 times normal atmospheric pressure. This mixture of gases was placed in contact with a catalyst, mainly composed of iron, which then produced ammonia gas in large quantities. Nitrogen, in the form of ammonia, could then be combined with other chemicals to produce fertilizer and other materials.

During World War I, Germany was cut off from its mineral supplies of nitrogen, making this discovery extremely important to its war effort. Carl Bosch, another German chemist, refined Haber's process to make it easier to manage on an industrial scale. The Haber-Bosch process was used by Germany to manufacture both fertilizers and, with alterations, poison gas. The Haber-Bosch process underlies the method of production in almost every ammonia factory in the world today.

Archive Photos.

Chemical warfare was used by both sides during World War I. Here, two British soldiers advance during a German poison gas attack.

Questions

1. ***Clarifying*** What process did Fritz Haber invent?
2. ***Analyzing Causes and Recognizing Effects*** What impact did a catalyst have on Haber's creation?
3. ***Drawing Conclusions*** Why was the Haber-Bosch process so important to Germany's war effort?