TOEFL Listening Lesson 27

Setting: A college-level *Chemistry* class.

Questions

1. What is the main function of a catalyst in a chemical reaction?

A. To change the products formed in a reaction

B. To increase the temperature needed for the reaction

C. To speed up the reaction without being consumed

D. To neutralize impurities in the reactants

2. What example does the professor give of a process that uses an iron-based catalyst?

A. Catalytic cracking in petroleum refining

B. Conversion of ammonia into nitrogen gas

C. The Haber-Bosch process for ammonia production

D. Enzyme reactions in the pharmaceutical industry

3. What is a key advantage of using heterogeneous catalysts in industrial processes?

A. They produce no toxic by-products

B. They require extremely high temperatures

C. They are easier to separate and reuse

D. They always offer higher yields than homogeneous catalysts

4. Why does the professor mention enzyme catalysis?

A. To explain how catalysts can be harmful to the environment

B. To illustrate a form of catalysis used in high-temperature industries

C. To show how catalysts are applied in automotive engineering

D. To highlight a greener and more specific type of catalysis

5. Why does the professor mention catalyst poisoning?

A. To explain why some catalysts are rarely used in industry

B. To describe a challenge associated with long-term catalyst use

C. To introduce a new type of synthetic catalyst

D. To suggest that impurities can speed up reaction rates

Script

Professor:

Today we're going to focus on catalysts and their critical role in industrial chemical reactions. Catalysts are substances that speed up chemical reactions without being consumed in the process. That last part is important—they facilitate the reaction but aren't permanently changed by it. This means they can be used repeatedly, making them invaluable in industrial applications where efficiency and cost-effectiveness are key.

Let's begin with the basics. A catalyst works by providing an alternative reaction pathway with a lower activation energy. In other words, it makes it easier for reactant molecules to interact and form products. This leads to a faster reaction without needing to increase temperature or pressure significantly, both of which would otherwise require more energy.

In industrial settings, catalysts are especially important because many of the desired chemical reactions are naturally slow or require extreme conditions. By introducing a catalyst, companies can lower energy costs, increase yield, and reduce reaction times—all while producing fewer by-products. This makes catalytic processes not just economically beneficial, but often more environmentally sustainable as well.

One classic example is the Haber-Bosch process for producing ammonia. This reaction combines nitrogen and hydrogen gases under high pressure and temperature in the presence of an iron-based catalyst. Without the catalyst, the formation of ammonia would proceed far too slowly to be commercially viable. With it, the reaction rate is significantly increased, and ammonia can be produced on a massive scale. Ammonia, as you may know, is essential in fertilizers and has numerous other applications.

Another major example is the catalytic cracking process used in petroleum refining. Long-chain hydrocarbons in crude oil are broken down into shorter, more useful hydrocarbons like gasoline and diesel. This reaction typically uses solid acid catalysts, such as zeolites. Not only does this make the process faster and more efficient, but it also allows refiners to better control the distribution of products based on market demand.

There are two main categories of catalysts used industrially: homogeneous and heterogeneous. Homogeneous catalysts are in the same phase as the reactants, usually in a liquid solution. An advantage of homogeneous catalysis is that it can offer high selectivity and yield. However, separation of the catalyst from the product can be challenging and expensive.

Heterogeneous catalysts, by contrast, are in a different phase than the reactants—typically solid catalysts interacting with liquid or gas-phase reactants. These are much easier to recover and reuse, making them ideal for continuous industrial processes. For example, the platinum and rhodium used in automotive catalytic converters are heterogeneous catalysts. These devices convert harmful emissions like carbon monoxide and nitrogen oxides into less toxic gases before they exit the exhaust system.

Now, one of the growing areas of research in catalysis is green chemistry. Scientists are exploring how catalysts can help reduce environmental impact by improving energy efficiency, minimizing waste, and avoiding toxic reagents. For instance, enzyme catalysis—which uses biological molecules to speed up reactions—has become increasingly important in pharmaceutical and food industries due to its specificity and environmentally friendly conditions.

Catalysts can also be selective, meaning they influence not just the rate of a reaction but also which products are formed. In reactions where multiple outcomes are possible, a catalyst can guide the process toward a desired product while minimizing unwanted by-products. This is crucial in fields like drug manufacturing, where purity and yield are both vital.

However, catalysts are not perfect. Over time, they can lose their effectiveness due to a process known as catalyst poisoning. This occurs when impurities bind to the active sites of the catalyst, rendering them inactive. This is a major issue in industrial operations, which is why maintaining catalyst purity and regeneration is a key aspect of chemical engineering.

To sum up, catalysts are fundamental to modern chemical industry. They make processes faster, more efficient, and often more environmentally responsible. Understanding how they work—and how to optimize their use—is essential knowledge for any chemist or chemical engineer.

Answers

1. What is the main function of a catalyst in a chemical reaction?

✅ **Correct Answer:** C. To speed up the reaction without being consumed

2. What example does the professor give of a process that uses an iron-based catalyst?

✅ **Correct Answer:** C. The Haber-Bosch process for ammonia production

3. What is a key advantage of using heterogeneous catalysts in industrial processes?

✅ **Correct Answer:** C. They are easier to separate and reuse

4. Why does the professor mention enzyme catalysis?

✅ **Correct Answer:** D. To highlight a greener and more specific type of catalysis

5. Why does the professor mention catalyst poisoning?

✅ **Correct Answer:** B. To describe a challenge associated with long-term catalyst use