

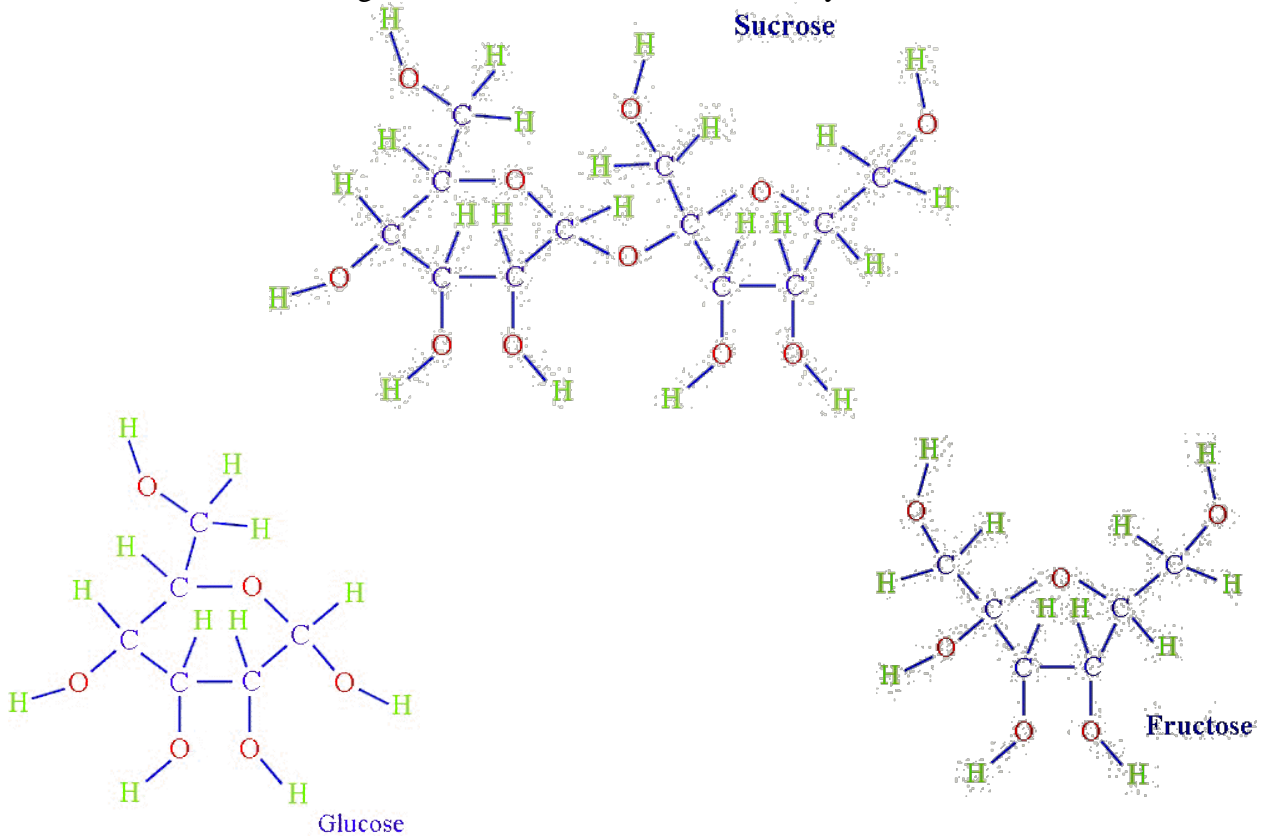
## Exercises

### Photosynthesis

1. TRUE? or FALSE?
  - a. The reaction catalyzed by chlorophyll is the one that converts carbon dioxide and water into sugars. **TRUE**
  - b. Chlorophyll is not a true catalyst because it is consumed in photosynthesis. **FALSE**
  - c. The oxygen that is released by plants comes from the breakdown of water. **TRUE**
  - d. Ultimately electrons are returned to chlorophyll by the breakdown of water. **TRUE**

### Enzymes

2. a. What is an enzyme? **An enzyme is a biological catalyst—usually a protein with a specific shape that attracts reactants and ensures that they will react with the proper orientation.**
- b. How are the following 3 molecules related to what an enzyme does?



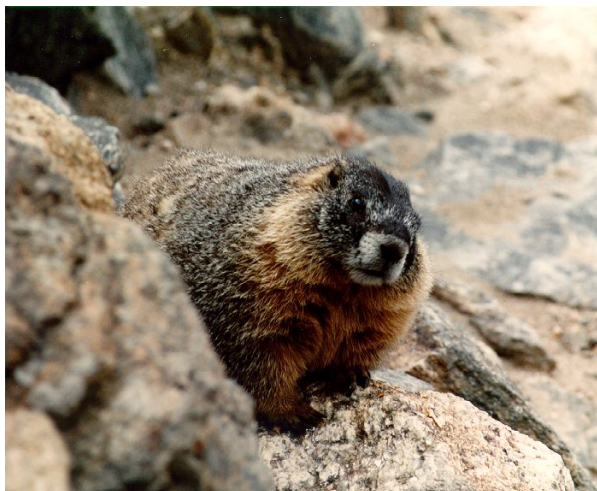
The right enzyme (sucrase) will convert sucrose to glucose and fructose.

## Hibernation

4. To be a true hibernator, an animal must be able to lower its body temperature to near freezing and then generate enough warmth to revive itself and wake up again. Most of the true hibernators are bats and rodents such as ground squirrels, marmots, and dormice.

Do such organisms need more oxygen and glucose while hibernating? Or less? Explain.

At lower temperatures true hibernators need less oxygen and glucose since a lower temperature means lower reaction rates.



## Refrigeration

5. If every 10°C increase in temperature causes the rate of food spoilage to double, how long will an apple stay fresh in the fridge(5°C) if it begins to lose its flavour after 6 days at 25 °C?

If this relationship held true for this situation, then the rate of decomposition would slow down by a factor of  $2^{(25-5)/10} = 4$  at lower temperatures. So the apple would last  $4 * 6 = 24$  days in the fridge.

## Converters, Preservatives and Soaps

6. What role does surface area play in catalytic converters?

By increasing the surface area of the rhodium catalyst in the converter( honey comb shape), more nitrogen dioxide and CO can be decomposed in a given unit of time.

7. a. Why are BHT and SO<sub>2</sub> (used to preserve the colour of white wine) not true inhibitors?

They are consumed by oxygen. A true inhibitor is recycled.

- b. In what way are they similar to inhibitors?

They slow down the rate of oxidation.

8. How do some soaps make use of biological catalysts? They add enzymes to detergents in order to break down fats and proteins that are stuck to fabric.

9. In 1953 it was discovered that aluminum and titanium allowed ethylene to polymerize (make long chains) into polyethylene at normal atmospheric pressure. Previously high pressures were necessary for the reaction to occur. How did Al and Ti make the reaction more feasible? (What were Al and Ti acting as?)

**They were acting as catalysts. Catalysts sparked the plastics revolution of the 1950s and 60s.**

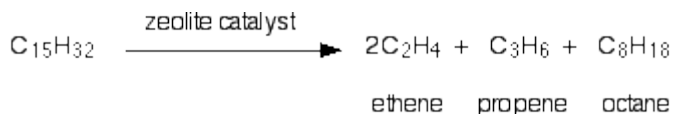
### Extra Questions from an Industrial Point of View

10. Cracking is the name given to breaking up large hydrocarbon molecules from petroleum into smaller and more useful bits. This is achieved by using high pressures and temperatures without a catalyst, or lower temperatures and pressures in the presence of a catalyst.

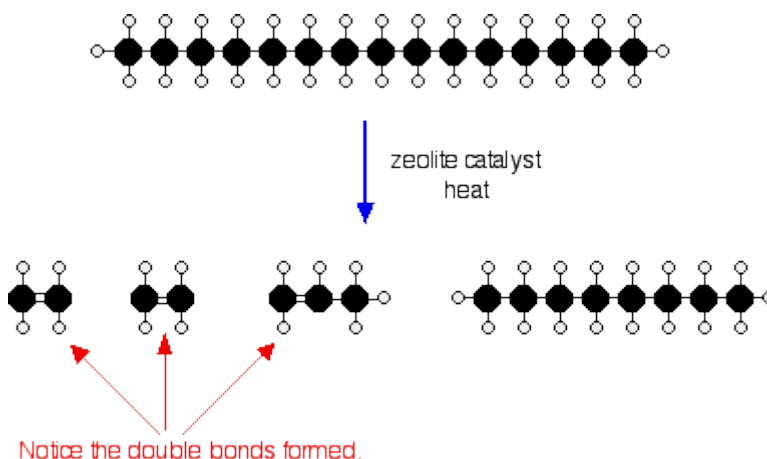
**From industry's point of view, what advantage would the second option have if the catalyst is not too expensive?**

**It saves money because lower temperatures and pressures demand less energy**

11. One possible catalyzed reaction involving the petroleum hydrocarbon  $C_{15}H_{32}$  might be:



Or, showing more clearly what happens to the various atoms and bonds:



This is only one way in which this particular molecule might break up. The ethene and propene are important materials for making plastics or producing other organic chemicals. The octane is one of the molecules found in petrol (gasoline).

- a) Why is the catalyst shown on the side of the arrow? In other words, why is it not included among the reactants?

It's not consumed by the reaction.

- b) *Flashback*: which of the three products would have the highest per mole heat of combustion and why?

**Octane(C<sub>8</sub>H<sub>18</sub>); it has the most bonds and will lead to more of the water and carbon dioxide products which have a low potential energy**

12. The enzyme lactase is used in the manufacture of ice cream. Lactase converts the milk sugar lactose into the sugars glucose and galactose. Why do you think they go through the expensive trouble of adding an enzyme? Think of two ways that it pays off.

- (1) **It makes it possible for lactose –intolerant customers to eat ice cream without getting sick.**
- (2) **The glucose and galactose produced by the enzymatic breakdown of lactose are sweeter than latter.**

<b>Relative Sweetness Scale - Sucrose = 100</b>	
<b>Compound</b>	<b>Rating</b>
Sucrose	100
Fructose	140
High Fructose Corn Syrup	120-160
Glucose	70-80
Galactose	35
Maltose	30-50
Lactose	20