Name: _____ Period: _____

Elephant's Toothpaste!

Introduction:
Millions of chemical reactions, like **cellular respiration**, are occurring in your body all the time. Cellular respiration is how organisms break down food and release energy to a usable form: ATP. Hydrogen peroxide, H_2O_2, is a toxic (poisonous) by-product of cellular respiration. Most living things, including yeast, contain an **enzyme** that helps the breakdown of hydrogen peroxide into other substances that are not poisonous.

The reaction between hydrogen peroxide and yeast is similar to the breakdown of hydrogen peroxide that can occur in the cells of your body.

$$H_2O_2 \xrightarrow{\text{Yeast}} H_2O + O_2$$

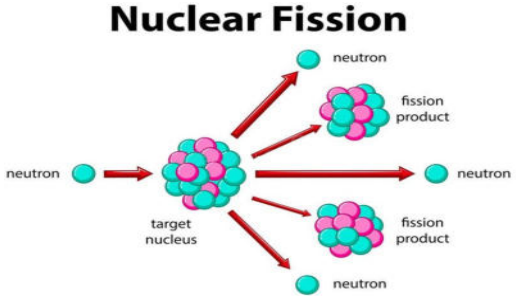
When yeast goes through the process of cellular respiration, some unintended hydrogen peroxide is produced. Since this is toxic to the cells, it must be quickly converted into other, less dangerous, chemicals. Hydrogen peroxide is broken down using an enzyme (a type of protein) called catalase. It is called because it works as a 'catalyst' (or a helper) in this reaction. A **catalyst** is a substance that speeds **catalase** up the rate of a chemical reaction without changing its products.

Humans must de-toxify hydrogen peroxide produced in the process of our metabolism. We use *catalase* for this purpose. Under normal conditions, the breakdown of H_2O_2 happens very slowly in our cells. In this experiment, the yeast is added to the hydrogen peroxide to speed up the reaction. The catalase in the yeast speeds up the process of breaking down the H_2O_2 and produces O_2 and H_2O more quickly. The oxygen gets trapped by the dishwashing detergent as many tiny bubbles. That is also why H_2O_2 foams when poured onto a cut: the catalase in our tissues breaks the H_2O_2 down to water and oxygen.

Chemical reactions that release energy are **exothermic**. In exothermic reactions, more energy is released when the bonds are formed in the products than is used to break the bonds in the reactants. Exothermic reactions are accompanied by an increase in temperature of the reaction mixture. **Endothermic** reactions occur when energy is needed to be absorbed from the surrounding environment to form chemical bonds. This causes the temperature to decrease.

Other exothermic reactions include:

1) Cellular Respiration: This happens in the mitochondria of cells.
   sugar + oxygen → carbon dioxide (g) + water + energy (ATP)
2) Hot Hands:
   iron + oxygen (charcoal and vermiculite as catalysts) → iron oxide + heat
3) Glow sticks:
   cyalume + hydrogen peroxide → trichlorophenol +carbon dioxide (g) + light
4) Hindenburg Blimp Explosion:
   hydrogen + oxygen → water + energy
5) Change of state:
   Condensation from rain → water vapor
6) Nuclear fission (see image on the right)
7) Cement and Concrete setting



Name: _____ Period: _____

Pre-Lab Questions: These must be answered before completing the lab. Write your answer using complete sentences (restate the question within your answer).

1. What types of elements form ionic bonds?

2. What types of elements form covalent bonds?

3. What is the difference in how ionic bonds and covalent bonds form? *Hint: think about the electrons that are in the chemical bonds.*

4. What does a catalyst do in a chemical reaction?

5. How will the energy flow in this reaction as hydrogen peroxide breaks down, what is that called, and how will you know as you record observations?

6. The chemical equation for peroxide decomposition is below. **Balance the equation** by adding coefficients for this reaction so that it follows the Law of Conservation of Matter. Label the parts of the equation by using the terms: **catalyst**, **products**, **reactants**, and **yields**.

$$H_2O_2 \xrightarrow{\text{Yeast}} H_2O + O_2$$

Experimental Question: How does the reaction rate change when yeast is added to hydrogen peroxide?

Write a hypothesis, which is a cause-effect statement. Finish the hypothesis below.
Hypothesis: If yeast is added to the peroxide mixture, then _____

_____

because _____.

Experiment: SAFETY GOGGLES MUST BE WORN FOR THIS EXPERIMENT! HYDROGEN PEROXIDE CAN IRRITATE SKIN AND EYES, PUT THEM ON BEFORE YOU GO ANY FURTHER. Immediately wash hands and report any spills.

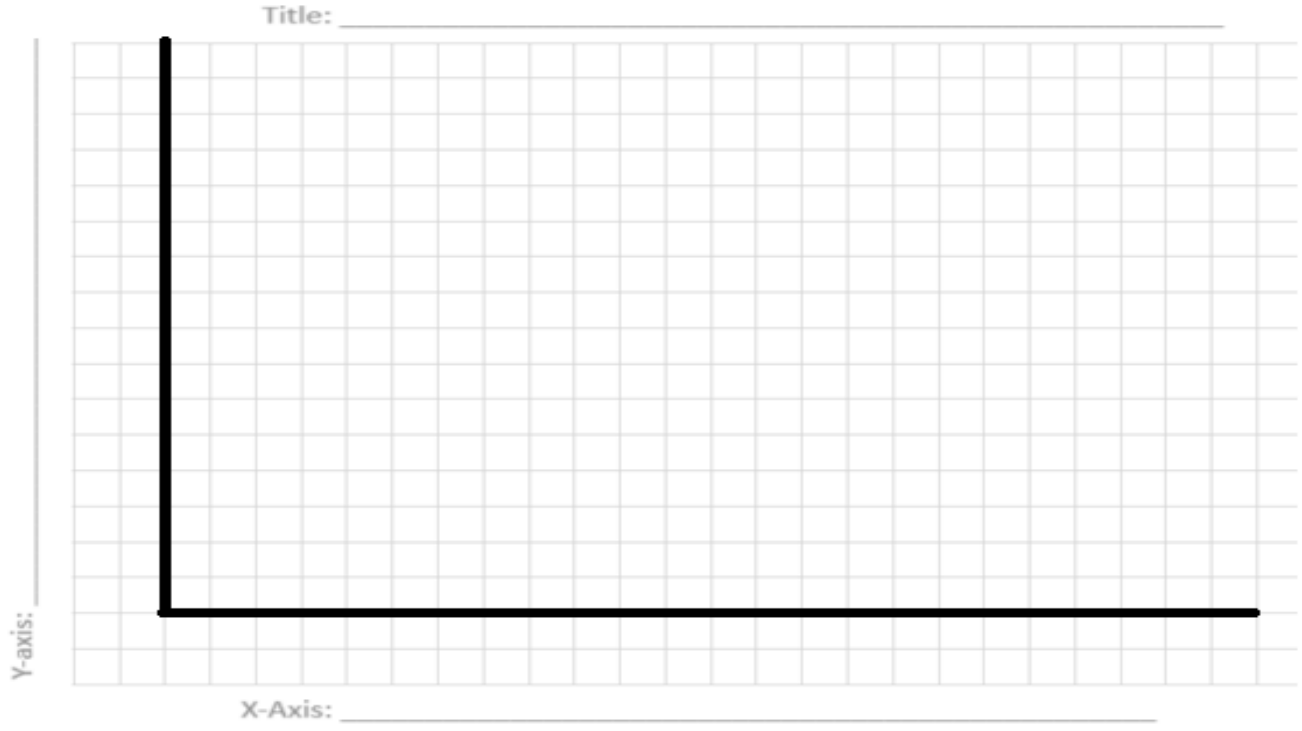
1. In a small cup, add 5 g of yeast and about 25 ml of warm water. Mix for about 30 seconds and set aside. This should be a pourable mixture, not super thick nor very runny either.
2. Place a graduated cylinder into your experiment pan and carefully pour 25 ml 6% Hydrogen peroxide (H_2O_2) into the graduated cylinder.
3. Add 3-4 full eyedroppers of liquid dish soap into the cylinder and swirl it around a bit to mix it.
4. Add 5 drops of food coloring.
5. Pour the H_2O_2 with soap and food coloring into an Erlenmeyer flask and record the starting temperature of the H_2O_2 mixture in the provided data table and if you see any reaction in the "other observations" table.
6. Place a funnel on top of the flask. Pour the yeast-water mix into it and <u>quickly</u> remove the funnel.
7. Observe what happens. Record the temperature every 20 seconds for 2 full minutes (120 s).
8. Plot the data on the graph. *Be sure to follow the SULTAN Graphing Expectations.*
9. Thoroughly rinse out all containers and return equipment back to the lab tray. Clean up & wash hands before leaving the classroom.

Name: _____ Period: _____

Observations: Data Table, Graph

Write a title here:	
Time (s)	**Temperature (°C)**
0	
20	
40	
60	
80	
100	
120	

Other Observations: *Reaction rate*
H_2O_2 with soap and food coloring:
H_2O_2 with yeast added:



Guided observations	**Observation**	**Description, measurements** (include appropriate units)
Speed of reaction	Fast / slow?	
Foam production	A lot / little?	
Energy flow	Released/absorbed	
Change in Temperature (°C)	Calculate from data	

Name: _____ Period: _____

Reflection Questions: All questions should be answered using complete sentences. Restate the question in your answer.

1. What toxic product is produced during cellular respiration?

2. A. What is a catalyst?

B. Would you have had the same result if a catalyst were not present. Why or why not?

3. In the reaction, hydrogen peroxide is broken down (decomposed) to form water and oxygen: $2H_2O_2 \rightarrow 2H_2O + O_2$. What type of chemical bond is broken? How do you know this?

4. Was this an exothermic or endothermic reaction? Explain what that means and how you know this.

5. We know we shouldn't pour most chemicals down the drain. After the reaction occurred, why is it ok to pour this experiment down the sink? *Hint: read the equation.*

6. Explain what the purpose of adding soap in this experiment.

7. What happens when you pour hydrogen peroxide on a cut? Why does this happen? (Hint: reread the introduction).

8. Write down one variable from the reaction you would like to change that would affect the amount of foam produced.