Plan

The aim of my investigation is to investigate the effect temperature has on the anaerobic respiration in yeast.

The independent variables in my investigation that I could choose to change are the quantity of glucose used, the amount of water used and the temperature of the water.
The dependent variables that I could choose to measure would be the amount of Carbon Dioxide produced, the change in the temperature and the amount of Ethanol produced.
As I have chosen to investigate the effect of temperature, the variable that I am going to change is the temperature of the water, this is the independent variable. The dependent variable that I am going to measure is the amount of Carbon Dioxide produced (in bubbles).
To ensure that my test is fair I will make sure that all the other variables that could influence my experiment are kept the same. I will make sure that
The amount of yeast (1.5g)
The amount of sugar (3g)
The amount of water (50ml)
Are all kept the same. I will also repeat my experiment twice for each temperature and take an average of the results so that my results are more accurate.

Preliminary work

Before I conducted my experiment I decided to conduct a preliminary experiment to test whether it would work. I wanted to see whether the bubbles of Carbon Dioxide were produced and could be detected by the method I was planning to use. I set up the equipment like I would in the experiment and put 3g of sugar, 1.5g of yeast and 100ml of water at 40 C (roughly body temperature) into a test tube. I then put the bung with the delivery tube into the top of the test tube, shook the test tube and put the other end of the test tube into a beaker full of lime water. In my experiment the lime water turned milky and so I knew that I would be able to detect the Carbon Dioxide produced in my other experiment.

Method

Equipment:
Water bath at 40 C
Kettle
Test tube
Test tube holder
Bung and delivery tube
Beaker
Sugar
Yeast
Water
Thermometer
Stopwatch

What I will do:
1.) The equipment will be set up as shown

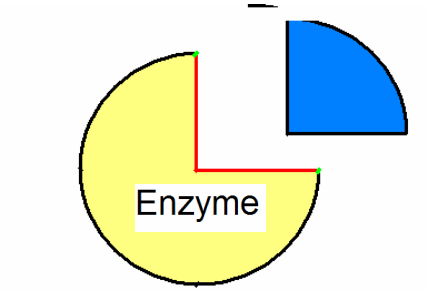
2.) 50ml of water will be taken from the 40 C water bath and allowed to cool until it reaches 20 C.
3.) 3 grams of sugar, 1.5 grams of yeast and the 50ml of water will be put in the test tube and the bung with the delivery tube will be put in the top.
4.) The test tube will be shaken to start the reaction and put in the test tube holder.
5.) The stopwatch will be started and the number of bubbles in the beaker counted over 10 minutes.
6.) After 10 minutes the stopwatch will be stopped and reset and the number of bubbles recorded in the results table on page .
7.) The test tube will be emptied, washed and dried.
8.) Steps 1-7 will be repeated twice for water at 20 C, the results being recorded each time.
9.) An average of the three results will be calculated and recorded in the results table.
10.) Steps 1-9 will be repeated for the water at 30 C
11.) Steps 1-9 will be repeated for 40 C water temperature, but in Step 1 the water will not need to be allowed to cool.
12.) For temperatures 50 C and 70 C the kettle will be used to eat the water and then it will be allowed to cool until it has reached the desired temperature. Once the desired temperature has been reached 50ml of the water will be measured out, and Steps 2-9 will be followed for each temperature.

<u>My hypothesis</u>

The equation for anaerobic respiration in yeast is

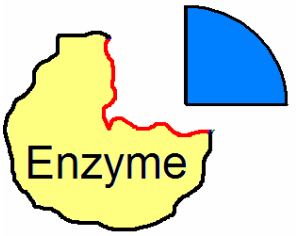
Glucose ⟶ Ethanol + Carbon Dioxide + Energy

Carbon Dioxide is a product released when the yeast respires anaerobically, and so if more Carbon dioxide is released, then it shows that the yeast is respiring more. This is how I hope to use the amount of Carbon dioxide released to measure how much the yeast is respiring.
The enzyme that aids in anaerobic respiration in yeast is called zymase. This enzyme works by the substrate fitting neatly into the active site of the enzyme and the reaction taking place.



This is a diagram representing the way the zymase works. The substrate (shown in blue) fits perfectly into the active site of the enzyme (the red line). Then the reaction takes place, the reaction cannot take place if the substrate does not fit the active site perfectly.

The substrate is moved around by kinetic energy until it fits into the active site of the enzyme. The greater the temperature the enzyme is working in the greater the chances of a substrate being moved into the active site of an enzyme. This is because when the particles of the substrate are heated they begin to vibrate more and so have more kinetic energy, therefore they move around more and increase the likelihood that they will move into the active site of the enzyme.
However, if the temperature becomes too high the zymase can become denatured. This means that the shape of the enzyme becomes distorted and so the substrate no longer fits the active site and the reaction can no longer take place. For the enzyme zymase, it becomes denatured at around 55 C.



This diagram is the representation of a denatured enzyme. As you can see the blue substrate no longer fits the red active site of the enzyme and so no reaction can take place and the enzyme is useless.

I predict that the amount of Carbon Dioxide released by the yeast will rise or stay quite high as the temperature rises up to approximately 50 C. After this I think that the amount released will begin to drop as

more and more of the zymase enzymes become denatured and useless and the respiration reaction cannot take place. I think that the amount released will rise before that because as the temperature increases, so will the kinetic energy of the substrate and therefore so will the probability of a substrate moving into the active site of the enzyme. I think the optimum temperature will be a little before the enzymes become denatured as there is most kinetic energy at this point. I think perhaps around 37 C as this is body temperature as most enzymes work at their best at this temperature because they are designed to work in the body.