SC1 Experiment to investigate what effects the rate of respiration in yeast

Aim
To investigate the effect of temperature on the rate of respiration in yeast

Glucose + Oxygen ⟶ Carbon Dioxide + Energy + Water

Introduction
Respiration is catalysed by enzymes. Enzymes are proteins, the structure of which is affected by temperature. Most enzymes optimum temperature is 40 ºC. All matter is made of particles, which move around. When heat is present the particles move around faster, colliding into each other, so they respire more. The hotter the water, the more they move around and vice versa.

Prediction
I predict that the highest rate of respiration will be at 40 ºC. Above 40 ºC, the rate of respiration will decline; this is because enzymes start to break down. This is called denaturing. I also predict that the yeast will not respire at a temperature of below 15 ºC because the particles are not moving around enough.

Apparatus

Possible Variables
- Temperature
- Volume of Water
- Concentration of Glucose solution
- Mass of Yeast
- Volume of Glucose solution

Variable to be altered
Temperature

Safety
So that the experiment is safe, I will make sure the following things are present and to the right standard:

- Goggles
- Hot Water
- Flat Surface
- Hair tied back
- Safe Equipment

Fair Test

It will be a fair test because I will keep all the following variables to their correct standards:

- Volume of glucose solution: 20cm²
- Strength of glucose solution: 10%
- Mass of yeast: 3g
- Volume of water (in yeast beaker): 250ml
- Volume of water (in C0² collection beaker): 400ml
- Time for bung to be in tube for actual experiment: 3 minutes

Preliminary Method

After setting the equipment as shown, I did a test at 10 ºC, 30 ºC, 40 ºC and 55 ºC. I decided that at 10 ºC the water wasn't hot enough to activate the respiration of the yeast. So I decided to start at 15 ºC. At 55 ºC the rate of respiration fell again, this was because it was too hot for the enzymes and they were denaturing. So I decided to stop recording results at 50 ºC. Stopping the experiment at this point will prove that the enzymes break down after 40ºC.

I found that it was difficult to keep the water at a set temperature because it kept cooling down, so I put a plastic beaker outside the glass one, filling them both with the hot water. This method makes a double jacket, therefore keeping the water at a set temperature. The diagram below demonstrates the improved apparatus.

Improved Apparatus

Method

- Set up apparatus as shown
- Fill the boiling tube beaker up with 250 ml of water that is over 50 ºC
- Fill the CO² bowl up with 400 ml of water that is over 50 ºC
- Wait 10 minutes for the water to cool down to 50 ºC

- Measure out 3g of yeast and put it in the boiling tube
- Measure out 15cm³ of glucose solution and pour it on top of the yeast
- Place the rubber tube up the boiling tube
- Place the tube in the beaker and the bung in the tube
- Start the timer
- After 3 minutes measure how much CO^2 there is in the boiling tube, you can do this by just looking how much water is gone
- Record your results in the table
- Repeat this method for 50 ºC, 45 ºC, 40 ºC, 35 ºC, 30 ºC, 25 ºC, 20 ºC and 15 ºC

Results

Temperature ºC	Volume of CO^2 (cm^3) (1)	Volume of CO^2 (cm^3) (2)	Volume of CO^2 (cm^3) (3)	Average CO^2 produced
50	6.1	9.5	7.5	7.7
45	9.5	10.0	10.0	9.8
40	15.0	15.5	15.0	15.1
35	10.0	11.0	10.5	10.5
30	8.5	3.0	8.0	3.0
25	4.5	5.0	4.0	4.5
20	3.0	3.0	0.5	2.1
15	1.0	1.0	1.5	1.1

Graph
See separate sheet

Conclusion
I have found that the rate of respiration is affected by temperature. At a low temperature of 15 ºC the rate of respiration is very slow. However at 40 ºC the rate of respiration is much faster. I have discovered that the rate slows down after 40 ºC and conclude that this is because the enzymes are broken down by too much heat, which as I said before is called denaturing.

I can see from the graph that the amount of CO^2 at 15 ºC is only 1.1 cm^3.
See graph

However, at 35 ºC it has rapidly increased to 10.5 cm^3.
See graph

And then at 50 ºC the rate of respiration falls to 7.7 cm^3 again.
See graph

This proves that my prediction was accurate.

Evaluation
Overall I think the experiment went fairly well. The main points of error were in the reading of the amount of CO^2 collected as this was very difficult to judge and inaccuracies in timing. On the second set of results for 30 ºC the result goes lower even though it should have been ascending like the rest of the results. This was because the stop watch was pressed at the wrong time. The double jacket worked well for maintaining the heat however time was still wasted waiting for the water to get down to its correct temperatures. As I said before reading the CO^2 collection tube was difficult, as was reading the thermometer