date: 20/4/20

introduction

name: sienna Hill
category: scientific inquiry
school: our lady of the sacred heart
OSA co-ordinator: caroline Beekman

rules of scientific inquiry

- groups of up to 3.
- must be own work.
- science journal must include notes, raw data, ongoing ideas and risk assessments when applicable.

report must include:

- questioning and predicting
  - what is the question you are trying to answer? What do you predict will happen?
- planning and concluding
  - explain method for investigation
  - what variables are present? Independent variables / dependent variables.
  - is it a fair test?
- equipment and materials:
  - equipment and materials used.
  - possible risks + how they were controlled?
- processing / analysing data and information
  - present measurements and observations.
  - analyse results; what patterns occur? what conclusions can be drawn?
- evaluating:
  - how can this investigation be improved?
  - how can findings help others? how are they relevant?

date: 21/04/20

the scientific method

- the scientific method is a process that is used to explore observations and answer questions. But, not all scientists have to follow this method.
- Almost all scientific investigations follow ~~a~~ this process. It is defined as a method of research in which a problem is identified, relevant data is gathered, a hypothesis is formed and then tested.

steps to the scientific method:

1. Purpose / Question
- All science begins with a person wondering why a natural phenomenon occurs the way that it does. The first step is to ask a question.

2. Research
- The next step is to do background research. A good idea is to write down your sources, so that you can site your references. The more that scientists know about their subject, the easier that it is to conduct the experiment.

3. Hypothesis
- The third step is to propose a hypothesis. This is an educated guess written as a statement, that is used to predict the outcome of an experiment. Usually, a hypothesis is written in terms of cause and effect.

IF ___, THEN ___, BECAUSE ___

date: 21/04

the scientific method

steps continued:

4. Experiment
- Next, an experiment is designed and performed. The experiment must have an independent and dependent variable. An experiment should be repeated once or twice to ensure the data is reliable.

5. Data / Analysis
- The fifth step is to record observations and analyse the meaning of the data. Often, data is presented in a table or graph. If the results of the experiment are not what is predicted by the hypothesis, then the theory is disproven.

6. Conclusion
- the final step is to accept or reject your hypothesis. There is no right or wrong outcome to an experiment, so either result is fine. Another part to this step is also communicating your results!

Sources accessed:

- https://www.sciencebuddies.org/science-fair-projects/science-fair/steps-of-the-scientific-method
- https://www.thoughtco.com/steps-of-the-scientific-method-p2-606045

date: 24/04/20

planning for inquiry

ideas for experiments:

chemistry

- does adding salt to water have any effect on how fast it evaporates?
- will chilling an onion before cutting it prevent us from crying?
- what type of plastic wrap prevent evaporation the best?
- do white candles burn at a different rate than coloured candles?
- does the level of Vitamin C in an orange change overtime?
- does the shape of an icecube effect how quickly the ice cube melts?
- does storage temperature effect the juice's pH?
- how does sugar concerntration vary in different brands of apple juice?

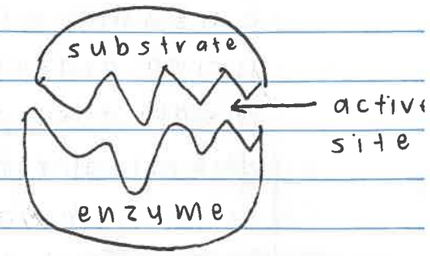
biology

- do magnetic fields affect plant growth?
- does the salinity level of water affect plant growth?
- what types of food grow mould quickest?
- does our nose have anything to do with taste?
- does the heartrate of an animal decrease when being petted? Does ours?
- does temperature effect enzyme activity?
- in what conditions does mould grow fastest?
- how does the type of fertiliser effect the growth of a plant?
- how much energy is stored in different foods?
- does the intensity of light affect plant growth? how about sounds and music?

date: 24/04

further planning!

chosen question: how does temperature effect enzyme activity?



enzymes

experiment ideas:

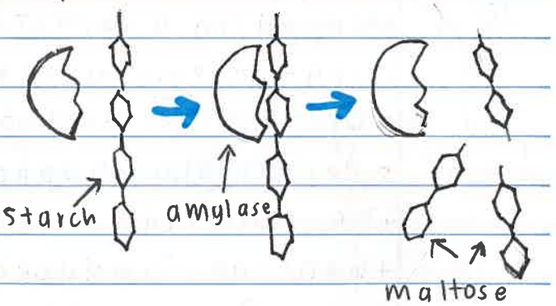
- pepsin and egg whites
- starch and saliva
- rennin and milk
- papain and gelatine
- potato juice, HCl, NaOH

chosen experiment: starch and enzyme salivary amylase.

This involves saliva and starch, with the enzyme salivary amylase being present in the saliva. In this experiment, I am going to use dilute iodine solution to test the presence of starch.

Materials needed:

- Beaker (x3)
- Test tubes (x3)
- cornstarch (tbc)
- 2% iodine solution
- enzyme salivary amylase
- palate
- thermometer



fun fact!
Enzyme production decreases with age!

Components to report

- Aim, hypothesis, materials, method
- Results
- Discussion
- conclusion
- Risk Assessment

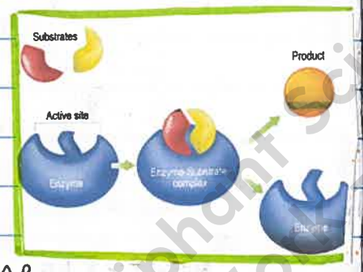
enzymes

date: 27/04

research on enzymes

What is an enzyme?

Enzymes are proteins that are produced by any living organism. Enzymes act as catalysts, which mean they speed up chemical reactions. A chemical reaction is a process that converts one or more substances to another type of substance. These catalysts can speed this up, without being altered themselves. "Enzymes can facilitate the same chemical reaction over and again". [1]
Enzymes are made up of amino acids, in the form of a chain. Each enzyme has a unique sequence of amino acids, and the sequence is determined by a gene in the cell's nucleus.



Enzyme structure + function

Enzymes have a special area that is shaped in a certain way, called the active site. Substrates can bind in the active site, and all enzyme's active area is specifically shaped for the substrate. Usually the substrate is held in place by weak bonds, and then an "induced fit" happens, where the enzyme can alter its shape so that the substrate can fit perfectly. From there, the enzyme can build or break down the substrate. The resulting item is called a product.

Example from real life - Lactase + Lactose

"Lactose is a disaccharide, which means that it contains 2 sugar molecules bound together." [2]
The enzyme Lactase (enzymes usually end in "ase," while sugars usually end in "ose") can break down

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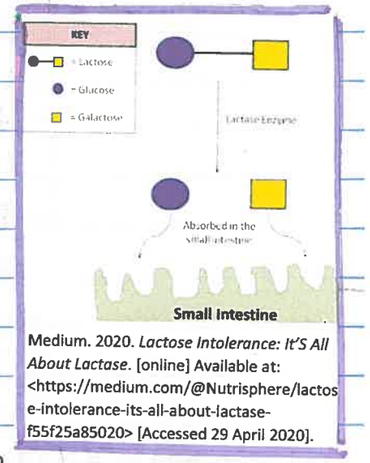
enzyme research

Lactose into smaller bits that our body can digest. With the enzyme Lactase, Lactose can be broken down a lot quicker than waiting for it to happen naturally. Some people don't produce enough Lactase meaning that eating food, or drinking liquids like milk, can make them very ill. We call these people "Lactose Intolerant".

Our digestive system uses all kinds of enzymes.
Lipase → lipids (fat)
Amylase → starch
protease → proteins.

ENZYMES



Medium. 2020. *Lactose Intolerance: It'S All About Lactase.* [online] Available at: <https://medium.com/@Nutrisphere/lactose-intolerance-its-all-about-lactase-f55f25a85020> [Accessed 29 April 2020].

Enzymes don't work alone!
Sometimes, enzymes require the help of cofactors and co-enzymes. Cofactors are typically metal ions (ie. iron) and coenzymes are organic molecules (ie. vitamins). They could be found next to the substrate, or on the active site. They help enzymes build up, or break down substrates into products. Cofactors serve the same purpose as coenzymes, and the only difference is that coenzyme are organic substances (contain carbon) and cofactors are inorganic substances (lacks carbon-hydrogen bonds)

Why do we need enzymes?

Without enzymes, the chemical reactions in our body wouldn't happen fast enough, and enzymes are important because they help cells communicate with eachother, and they help cell growth and keep life and death of cells under control.

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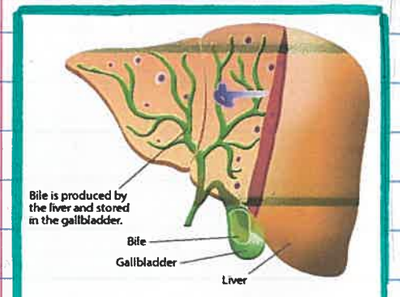
roles of enzymes + the types

Roles of enzymes in our digestive system

"Chemical digestion would not take place without the help of digestive enzymes. Digestive enzymes are released, or secreted, by the organs of the digestive system. These enzymes include proteases that digest proteins, and nucleases that digest nucleic acids" [3] some examples of digestive enzymes are:

- amylase; breaks down starch into sugar. Amylase can be found in our saliva.
- pepsin; breaks down proteins into amino acids. Pepsin can be found in our stomach.
- trypsin; also help break down proteins. Trypsin can be found in the pancreas.
- pancreatic lipase can also be found in the pancreas, and it is used to break down fats.

"Bile salts are bile acids that help break down fat, and bile acids are produced in the liver. When we eat food, bile is released into the intestine, where it breaks down fat". [3]



2020. Enzymes In The Digestive System. [image] Available at: <https://www.ck12.org/c/life-science/digestive-system-enzymes/lesson/enzymes-in-the-digestive-system-ms-ls/> [Accessed 29 April 2020].

In this image, the arrows point out where the bile is stored, and where bile is in relation to our gallbladder. Bile is made in our liver, and it is a dark green or yellowish-brown fluid secreted to digest fat. Bile, is not an enzyme. It acts as an emulsifier; instead of a catalyst.

- Enzymes don't get used up after their job.
- Many drugs are inhibitors to enzymes. (including snake venom).

date: 27/04

enzyme salivary amylase

+ starch

Amylase acts as a catalyst for digestion, and it breaks down large starch molecules into smaller sugar molecules. Amylase is released in the mouth and it is found in our saliva. As amylase mixes with food, amylase begins to work. But, starch is only partially broken down as the remainer of the digestion occurs in the small intestine. starches and sugar are broken down into maltose, and then they are converte to glucose which is used for energy. Amylase is a digestive enzyme that helps our body break down carbohydrates. Both the salivary glands and the pancreas produce amylase.

starch

starch is a carbohydrate that is present in a lot of foods, and it is very important for the human body. starch can be found in bread, potatoes, pasta and beans. starch is stored in plants and is used as an energy source. starch is kept in the organelle chloroplasts, and amyloplasts. starch is made up of 2 specific glucose polymers; they are amylopectin and amylose. Like stated before, sugar normally ends in "ose" and enzymes normally end in "ase". Amylase is the enzyme that breaks down amylose, found in starch. Amylopectin makes up 70-80% of a starch granule. Amylose and amylopectin are formed in a coil, and the coils can be digested by humans to glucose, which can be used as energy. In our small intestine, starch encounters digestive enzymes, which break it down into glucose molecules.

date: 28/4

28/4

bibliography for research

bibliography for research;

[1] = Sisters, Amoeba, 2016, Enzymes (updated). [video] Available at: <https://www.youtube.com/watch?v=qgVfkRn8f107 [Accessed 27 April 2020].

[2] = study.com. 2020-[online] Available at: <https://study.com/academy/lesson/what-are-enzymes-definition-lesson-quiz-html> [Accessed 27 April 2020].

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date: 6/5

brainstorming experiments

Brainstorming ideas to make my experiment better;

experiment ideas;

- amylase in toothpaste
- amylase in laundry detergent
- amylase in wheat flour
- amylase in rice
- amylase in oat milk.

chosen experiment; amylase in laundry detergent. Aim: to determine the optimum concerntration of amylase that best eliminates starch stains in materials.

Materials needed;

- different types of laundry detergent
- 8x different pieces of fabric
- dilute iodine solution
- 2% starch
- amylase?

Idea of experiment;

- to find out the optimum concerntration of amylase that best breaks down starch stains.
- then, compare the effectiveness of the optimum solution of amylase to some current washing detergents; radiant, omo, cold power.
- part 1 = finding optimum concerntration of amylase
- part 2 = comparing different laundry detergents.

date: 7/5

7/5 amylase in laundry detergent

In some detergents, proteases, lipases and amylases can be found to improve the detergency. The detergent is made with amylase to help breakdown starchy stains." Most of the solid and liquid detergents that are currently manufactured contain alkaline enzymes. The advantages of using alkaline enzymes in the detergent formulation are that they aid in removing tough stains and the process is environmentally friendly since they reduce the use of toxic detergent ingredients" [1]. When you wash your clothes at a low temperature, you reduce the amount of energy consumption. Most microbial alkaline amylases are used in detergent ingredients.

En.wikipedia.org. n.d. *Amylase*. [online] Available at: <https://en.wikipedia.org/wiki/Amylase> [Accessed 7 May 2020].

While proteases are the most used enzyme in detergent, amylase is not far behind. Amylase removes a variety of common food stains containing starch. Protease acts on stains that contains proteins. The detergents containing protease turn proteins into peptides. Typical stains include blood stains, grass and soil stains found near the collar and cuffs. Amylase in detergent degrades starch to short-chain sugars. Typical stains include sauces, gravy and ice-cream. Lipases break down lipids (fats) and common stains include oil and grease. Cellulases act on dust and mud stains.

date: 7/5

enzymes in detergents

"The use of enzymes in detergent formulations is now common in developed countries, with over half of all detergents presently available containing enzymes. In spite of the fact that the detergent industry is the largest single market for enzymes at 25-30% of total sales. [2] proteins, starchs and lipids can be found in many forms of dirt." Using detergents in water at high temperatures and with vigorous mixing, it is possible to remove most types of dirt stains but the cost of heating the water is high and lengthy mixing or beating will shorten the life of clothing and other materials. The use of enzymes allows lower temperatures to be employed." [2]

The more cost effective choice would be to choose detergents with enzymes." Once released from its granulated form, the enzyme must withstand anionic and non ionic detergents and soaps. Although one effect of incoporating enzymes is that lower washing temperatures may be employed with consequent savings in energy consumption, the enzymes must retain activity up to 60°c." [2]

"Once enzymes have done their job, the broken down particles can easily be washed away with warm water in the washing machine" [3]

date: 16/05

enzymes in cleaning

"The building block for each enzyme are the 20 naturally occurring amino acids".[4] Many different areas use enzymes, including paper processing, food manufacturing, medical device sterilisation, and many household cleaning items, including dishwashing and laundry detergent. "since one enzyme molecule can act on many substrate molecules (such as soils and stains), a small amount of enzyme added to laundry detergent can provide a significant cleaning benefit to the consumer".[5]

Amylases

"Amylase accelerates the breakdown of starch. Starch is a long chained carbohyrdate consisting of glucose molecules bound together by alpha-1,4-glycoside bonds. During wash, certain amylases catalyse the hydrolysis of alpha-1,4-glycoside bonds in starch, which breaks starch down into soluble dextrins. Unlike starch, dextrins are easily dissolved in water."[4]

Production methods

Originally, the enzymes that were used in cleaning products came from glands, that were extracted from animals. But now, enzymes are produced through fermentation of fungi and bacteria. There are 3 steps involved in enzyme production; fermentation (the process where a substance breaks down into a simpler substance), recovery and standardisation. The fermentation in which-

date: 17/5

17/5

production + formulation

Production method continued

- industrial enzymes are produced, begins with a vial of either dried or frozen microorganisms are used is called a production strain. The microorganism is kept at optimal pH, temperature and nutrient conditions during fermentation. After this, the next stage is recovery. During this step, the enzyme solution is separated from the biomass. Then, the enzyme is concerntrated through removal of water and extra impurities. Finally, standardisation occurs, which involves preparing the final cleaning product.

Common formulations

Granulates are the standard formulations for the detergent industry. "They are produced using a unique combination of high-shear granulation and various coating technologies This results in an effective encapsulation of the enzyme, which isolates it from the environment until the moment the detergent product is dissolved into the washing solution."[4] Majority of detergents are created as liquid.

Sustainable solution

The sustainability repute of detergents is adequate because of the use of enzymes. Many 'cold wash' products rely on enzymes to provide good cleaning performances at low temperatures, providing economical and environmental benefits.

date: 17/5

reference list

reference list

1 = SS, N, n.d. Detergent-compatible Bacterial Amylases - pubmed - NCBI. [online] Ncbi.nlm.nih.gov. Available at <https://www.ncbi.nlm.nih.gov/pubmed/25129040> [Accessed 7 May 2020].

2 = www1.lsbu.ac.uk. n.d. The use of enzymes in detergents [online] Available at <https://www1.lsbu.ac.uk/water/enztech/detergent.html/>[Accessed 7 May 2020]

3 = Home Laundry Tips and guide, n.d. Enzymes in biological detergents and how they work. [online] OMO Global. Available at <https://www.persil.com/uk/laundry-tips/washing-tips/enzymes-in-biological-detergents.html> [Accessed 7 May]

4 = About cleaning products. nd. Enzyme science [online]. Available at <https://www.aboutcleaningproducts.com/science/enzyme-science/> [Accessed 16 May 2020].

other sources accessed

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- Science, school. n.d. Which laundry enzymes work best? Available at <https://www.scienceinschool.org/content/which-laundry-enzymes-work-best> [Accessed 17 May 2020]. [online].

date: 21/05

planning for experiment.

planning for experiment

aim: to determine the optimum concentration of amylase that best eliminates starch. The presence of starch will be tested using dilute iodine solution.

hypothesis: it is hypothesised that if the 10% amylase concentration is mixed with 1% starch, then it will best break down the starch because the reaction rate increases as the concentration of the catalyst increases.

controlled variables

- amount of amylase (10mL)
- amount of starch (10mL)
- amount of iodine used to detect the presence of starch (1 drop)
- size of spotting tile dimples
- temperature at which the hydrolysis occurs in (37°C)
- the pH of the amylase (pH = 7)
- time intervals at which the colour of the iodine is recorded (every 2 minutes)
- type of amylase (alpha-amylase)
- the amount of starch/amylase solution (0.5ml)

independent variables

- the concentration of the amylase (0.5%, 1%, 5%, 10%).

dependent variables

- the time taken for the enzyme/starch mixture to give a yellow colour with iodine.

Part A: finding the optimum concentration of amylase that best breaks down starch.

Part B: the comparison of laundry detergents against each other, and against the optimum concentration.

date: 21/05

materials and method

materials

- 1 spotting tile
- 1% starch
- dilute iodine solution
- 2 x pipettes
- stopwatch
- 2 x measuring cylinders
- marker
- alpha-amylase (1%, 5%, 10%)
- 2 x thermometers
- 3 x 50ml beakers
- 2 x 250ml beakers
- stirring rod
- heating block.

method

1. the equipment was collected and set out on the bench. The heating block was plugged in and set to 50°C.
2. the spotting tile was prepared, with a drop of iodine in each dimple.
3. two water baths were prepared by filling up two 250ml beakers with 50ml of water and were placed on the heating block. Thermometers were inserted into the beakers to monitor the temperature.
4. 10ml of starch and 10ml of 10% amylase were measured out using two different measuring cylinders to prevent cross-contamination, and then placed into 50ml beakers.

method and fair test.

method continued

5. the starch and amylase were both placed into a water bath, and were placed on the heating block. A thermometer was inserted into each beaker.
6. The starch and amylase were heated to 37°, the optimum temperature for enzyme activity.
7. Once the solutions reached 37°c, they were mixed together into a third 50ml beaker, and a pipette was used to extract 0.5ml of the starch/amylase solution, and was placed into the first dimple of the spotting tile.
8. The colour of the iodine solution was recorded.
9. Every 2 minutes, 0.5ml of the starch/amylase solution was added to the iodine on the spotting tile.
10. steps 1-9 were repeated with the 5% amylase and 1% amylase.

Why this experiment is a fair test.

This experiment was a fair test because the pH of the amylase concerntration was consistent, and the temperature at which the ~~e~~ reaction occured in. The reason why it was ensured that the pH was a consistent 7 for all the amylase concerntrations was ~~to~~ because changes in the pH of the enzyme would effect the hydrogen and ionic bonds that hold the enzyme together.

date: 21/05

risk assessment

OSA RISK ASSESSMENT FORM

for all entries in (✓) ☐ Models & Inventions and ☐ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

NAME: Sienna Hill ID:

SCHOOL: Our Lady of the Sacred Heart College

Activity: Give a brief outline of what you are planning to do.

The purpose of this investigation is to determine the optimum concentration of amylase that best breaks down starch and to compare different brands of laundry detergent for the hydrolysis of starch. Through the comparison of laundry detergents, the most effective detergent at eliminating starch will be established, and the ideal temperature for this reaction. The optimum concentration of amylase will be discovered through heating starch and amylase to 37 degrees and then mixing them. The presence of starch was detected using iodine, and a similar method was followed for finding the best laundry detergent, except the reaction will be compared at two different temperatures (20°C and 40°C)

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Type of Risk	What is the risk?	How will I manage/control the risk?
Chemical risks: α-amylase solution (1%, 5% 10%), starch solution (1%), iodine solution (potassium triiodide)	Amylase: low toxicity. Liquid droplets may cause allergy or asthma symptoms or breathing difficulties, if inhaled. Lung-irritant vapour of iodine evolved from the concentrated solution. Toxic. May cause an allergic reaction on skin. Solution of iodine in potassium iodide solution, containing mostly triiodide ions. Toxicity depends on the concentrations of iodine and potassium iodide. Starch has low toxicity, as has very low risks.	Avoid inhalation of aerosol droplets while handling solutions and a well ventilated area will be used to conduct the experiment. When placing drops of iodine in the spotting tile, extra precautions will be taken to protect skin from coming in contact with iodine.

date: 21/05

risk assessment

Type of Risk	What is the risk?	How will I manage/control the risk?
Thermal Risks: Electric hotplate	Possibility of burns during heating and even after hotplate is turned off because the hotplate retains heat. Electric cord may be damaged by heat and cause electric shock.	Inspect regularly for signs of damage to cord, cord loose in plug, cord loose at entry to hotplate, or any signs of corrosion or other damage. Test and tag at regular intervals. I will ensure that the hotplate has a heat-proof cord.
Sharps risks: Glassware (250 mL beaker, 50 mL beaker & 10 mL measuring cylinder, spotting tile, alcohol thermometer)	Breakage of beaker, cuts from chipped rims. Breakage of thermometer, glass cylinder may break; possibility of cuts from broken glass. Tile can break to form sharp fragments, which may cause injury.	Sweep up broken glass with brush and dustpan; do not use fingers. Inspect and discard any chipped or cracked beakers, no matter how small the damage. Discard any cracked or broken measuring cylinders. Do not heat any liquid in a measuring cylinder, since not designed for heating. Inspect and discard any chipped or cracked tiles. Sweep up ceramic fragments from a broken tile with brush and dustpan; do not use fingers.
Electrical Risks: Electric hotplate	Possibility of burns during heating and even after hotplate is turned off because the hotplate retains heat. Electric cord may be damaged by heat and cause electric shock.	Inspect regularly for signs of damage to cord, cord loose in plug, cord loose at entry to hotplate, or any signs of corrosion or other damage. Test and tag at regular intervals. I will ensure that the hotplate has a heat-proof cord.
Other hazards: Marker pen	Inhaling the contents may be harmful, due to toxic volatile solvents. May cause severe irritation, if used on skin as a cosmetic. An allergic reaction is possible. Pen liquid may be flammable.	Marker will be recapped tightly after use. Extra precautions will be taken to ensure I do not inhale the fumes. I will consult the safety data sheet from the manufacturer before use.

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Sienna Hill

SIGNATURE(S): sienna

☑ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: Caroline Beekman

SIGNATURE: DATE: 14/5/2020

date: 22/05

putting plan into fruition!

- Today was the day of the practical. I was not sure how the results were going to turn out, but you can only try!
- we started by collecting all the equipment, and displayed it on the bench.
- We put iodine drops into the dimples on the spotting tile, and labelled them 0-22.
- After that, 10ml of starch and iodine were measured out into beakers and placed on the water bath. I waited until they had heated to 37°C (the optimum temperature for enzyme activity) and then mixed them together.
- Straight after mixing them together, I used a pipette to insert 0.5ml of the starch/amylase solution into the first dimple. The results looked like this:

- 10% amylase

time (min)	colour
0	dark blue
2	dark blue
4	dark blue
6	dark blue
8	dark blue
10	dark blue
12	dark blue
14	dark blue.

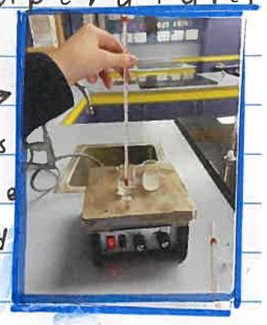
the colour might have been a dark purple?

- clearly, something had gone wrong :(
- After 16 minutes, the colour of the iodine had not changed.

date: 26/05

results?

- There were a few reasons why this experiment could have gone wrong. After some research, I found out that it was best to use a water bath because it is more efficient in keeping temperatures constant - as water temperatures flacuate less than air. This was before the water baths →



- Another reason for the results was because the drops of iodine were quite large, and this would have affected the colour. The

← large drops of iodine.

- And I think a final error made was dropping the starch/amylase solution in really quickly. It didn't give the iodine much time to react, which could have affected the colour?
- So, I decided to try again, and here were the results.

- 10% amylase

time (min)	colour
0	1
2	1
4	2
6	1
8	2
10	3
12	1
14	—

scale used for results ←

1 2 3 4 5

results from second experiment ←

date: 27/05

trial number 3

- In the last results, the colour became lighter but then went back to a dark purple (8-12 minutes). I believe that the reason for this was because I ~~might have~~ left the beaker on the hotplate for too long, and the temperature surpassed 40°.
- I thought that I might have ruined the results, as I did not want to denature the enzyme, so I left the beaker on the bench. The temperature ducked below 35°, and I think that is where I went wrong: I let the temperature drop too low.
- Although from this, I learnt that when the temperature was around 40°, a change in pattern (the pattern being - a dark purple colour that was ~~showing for each~~ repeating), as the purple became lighter! (8 min).
- So the next day, we repeated the experiment, but this time with a water bath! I also made the drops of iodine smaller. The results looked like this:

10% amylase

time (min)	colour
0	5
2	7
4	7
6	8

I had to get creative :)

1 2 3 4 5 6 7 8

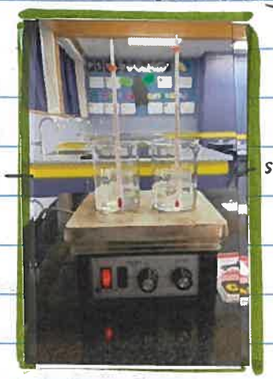
experiment 3 results ←

- Once again, something went wrong! :(

date: 28/05

10% starch, trial 4!

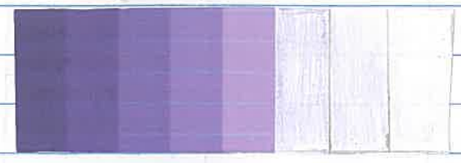
- In those results, something went wrong again! I used the water baths, although I think I might have squeezed the pipette too hard, as the starch/amylase solution flooded in really fast.



- A way to tell these results are unreliable are because the colour at 0 was already starting to lighten. This colour should be dark purple, because if this experiment is conducted correctly: the starch should be present at 0 minutes.
- One thing about this experiment was that it was really difficult to keep the temperature constant. If I left the water bath and starch/amylase beaker on for too long, the temperature would increase too much. And, if I took it off for too long, the temperature would drop too low. But nevertheless, here is the 4th trial:

10% amylase

time (min)	colour
0	1
2	1
4	2
6	3
8	5
10	7
12	8



1 2 3 4 5 6 7 8

experiment 4 results! :)

IT WORKED! :)

date: 29/05

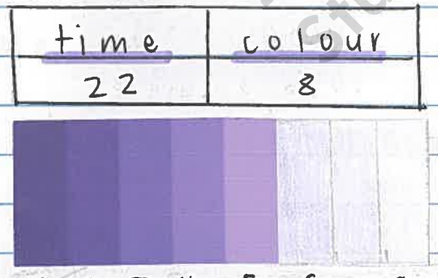
5% amylase experiment

- After this success, the next day the same experiment was completed with 5% amylase. A water bath was used because it was efficient in the other experiment.

- Although that was one aspect that was really difficult was keeping the temperature of the starch/amylase solution consistent. The heating block's lowest temperature was 50°, which was really inconvenient for this experiment!
- Another problem with this experiment is that the observation of the iodine is subjective, as this ~~is~~ the colour interpretation may vary from person to person. Plus, we are looking for the time where the iodine does not go blue-black, and this might not always be obvious. The colour change tends to be gradual. Nonetheless, here are the results for 5%:

5% amylase!

time	colour
0	1
2	1
4	2
6	3
8	4
10	4
12	5
14	5
16	5
18	6
20	7
22	8



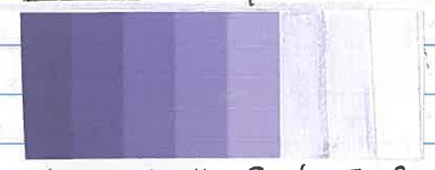
5% amylase results ☺

date: 1/06

1% amylase experiment

- The 5% amylase worked really well! Using the water baths was definitely the way to go. Although during this experiment, I have been thinking about the possible errors made
- Another one that came to mind was the fact that we were only taking samples every 2 minutes, meaning that the results show an approximate time for the reaction, as the reaction could have finished between a certain time interval.
- The 1% amylase experiment also went quite well, with reasonable results.
- I think that the reason for the higher concentrations of amylase more effective hydrolysis of starch is because there are more active sites to fill, resulting in a faster digestion of starch.
- ~~Results~~ for 1% amylase:

time	colour
0	1
2	1
4	1
6	1
8	2
10	2
12	3
14	3
16	3
18	4
20	5
22	6
24	7
26	8
28	8



1% amylase

date: 03 / 06

planning for part B

- Now that Part A of the experiment was finished, it was time to start planning part B.

aim: to compare several brands of laundry detergent to determine the best detergent for breaking down starch, and to find the optimum temperature for this hydrolysis. The effectiveness of the solution will be tested using iodine solution to detect the presence of starch.

hypothesis: it is hypothesised that if different types of detergent are compared, ~~then~~ including Almat, Dynamo and Radiant, then the dynamo detergent in the hot temperature will be the most effective detergent because dynamo is renowned for using enzymes in their formula as a cleaning aid?

controlled variables

- amount of starch (10ml)
- amount of laundry detergent (10ml)
- amount of iodine (1 drop)
- size of spotting tile dimples
- time intervals at which the colour of the iodine is recorded (every 2 min).

independent variables

- detergents used to break down starch (Dynamo, Radiant, Almat).
- temperature at which the experiment occurs in (21°C and 37°C)

(added after results for 37°)

dependent variables

- time taken for the solutions to best break down starch ~~stains~~.

date: 04 / 06.

materials and method

materials

- 1 spotting tile
- 1% starch
- iodine solution
- 2 x pipettes
- stopwatch
- 2 x measuring cylinder
- marker
- detergents (Almat, Dynamo and Radiant)
- 2 x thermometers
- 3 x 50ml beakers
- 2 x 250ml beakers
- stirring sticks
- heating block.

method

1. the materials were collected and set out on the bench, and the heating block was set to 50°C.
2. the spotting tile was prepared, with a drop of iodine in each dimple.
3. two water baths were prepared. (one for the starch, one for the almat detergent) by filling up two 250ml beakers with 50ml water and were placed on the heating block.
4. 10ml of starch and 10ml of almat were measured using two different measuring cylinders, and then placed into two 50ml beaker.
5. The starch and almat were each placed into a water bath, and a thermometer was placed into each beaker. They were both heated to 37°C.

date: 05/06

the method

method continued

6. Once they were both 37°C, the starch and almat were mixed in a 50ml beaker, and a pipette was used to place 0.5ml of the starch/almat solution into the first dimple on the spotting tile. The colour of the iodine was recorded.
7. Every 2 minutes, a 0.5ml drop of the starch/almat solution was added to the iodine on the spotting tile and the colour was recorded.
8. Another spotting tile was prepared, with a drop of iodine in each dimple.
9. 10ml of starch and 10ml of almat were measured out using a measuring cylinder and then placed into a 50ml beaker together.
10. A pipette was used to place 0.5ml of the solution into the first spotting tile dimple.
11. Every 2 minutes, a drop of the solution was added to the iodine.
12. steps 1-12 were repeated with Dynamo and Radiant.

this was written after results for hot temperature were determined.

Why was this method chosen?

- This method was chosen because past scientists have followed a similar method in which starch and amylase (for this part of the experiment, the amylase is substited with detergents) are mixed, and then iodine is used to detect the presence of starch. Part B's method is similar to part A's, to keep this a fair test.

p. 30

date: 06/06

risk assessment

OSA RISK ASSESSMENT FORM

for all entries in (✓) ☐ Models & Inventions and ☑ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

NAME: Sienna Hill ID:

SCHOOL: Our Lady of the Sacred Heart

Activity: Give a brief outline of what you are planning to do.

The purpose of this investigation is to determine the optimum concentration of amylase that best breaks down starch and to compare different brands of laundry detergent for the hydrolysis of starch. Through the comparison of laundry detergents, the most effective detergent at eliminating starch will be established, and the ideal temperature for this reaction. The optimum concentration of amylase will be discovered through heating starch and amylase to 37 degrees and then mixing them. The presence of starch was detected using iodine, and a similar method was followed for finding the best laundry detergent, except the reaction will be compared at two different temperatures (20°C and 40°C)

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Type of Risk	What is the risk?	How will I manage/control the risk?
Chemical risks: Laundry detergents (Almat, Dynamo, Radiant), starch solution (1%), iodine solution (potassium triiodide)	Laundry detergents may cause allergic reactions, but have low risks and very low toxicity. Lung-irritant vapour of iodine evolved from the concentrated solution. Toxic. May cause an allergic reaction on skin. Solution of iodine in potassium iodide solution, containing mostly triiodide ions. Toxicity depends on the concentrations of iodine and potassium iodide. Starch has low toxicity, as has very low risks.	Avoid inhalation of aerosol droplets while handling solutions and a well ventilated area will be used to conduct the experiment. When placing drops of iodine in the spotting tile, extra precautions will be taken to protect skin from coming in contact with iodine.

Type of Risk	What is the risk?	How will I manage/control the risk?
Thermal Risks: Electric hotplate	Possibility of burns during heating and even after hotplate is turned off because the hotplate retains heat. Electric cord may be damaged by heat and cause electric shock.	Inspect regularly for signs of damage to cord, cord loose in plug, cord loose at entry to hotplate, or any signs of corrosion or other damage. Test and tag at regular intervals. I will ensure that the hotplate has a heatproof cord.
Sharps risks: Glassware (250 mL beaker, 50 mL beaker & 10 mL measuring cylinder, spotting tile, alcohol thermometer)	Breakage of beaker, cuts from chipped rims. Breakage of thermometer, glass cylinder may break; possibility of cuts from broken glass. Tile can break to form sharp fragments, which may cause injury.	Sweep up broken glass with brush and dustpan; do not use fingers. Inspect and discard any chipped or cracked beakers, no matter how small the damage. Discard any cracked or broken measuring cylinders. Do not heat any liquid in a measuring cylinder, since not designed for heating. Inspect and discard any chipped or cracked tiles. Sweep up ceramic fragments from a broken tile with brush and dustpan; do not use fingers.
Electrical Risks: Electric hotplate	Possibility of burns during heating and even after hotplate is turned off because the hotplate retains heat. Electric cord may be damaged by heat and cause electric shock.	Inspect regularly for signs of damage to cord, cord loose in plug, cord loose at entry to hotplate, or any signs of corrosion or other damage. Test and tag at regular intervals. I will ensure that the hotplate has a heatproof cord.
Other hazards: Marker pen	Inhaling the contents may be harmful, due to toxic volatile solvents. May cause severe irritation, if used on skin as a cosmetic. An allergic reaction is possible. Pen liquid may be flammable.	Marker will be recapped tightly after use. Extra precautions will be taken to ensure I do not inhale the fumes. I will consult the safety data sheet from the manufacturer before use.

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Sienna Hill

SIGNATURE(S): Sienna

☑ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

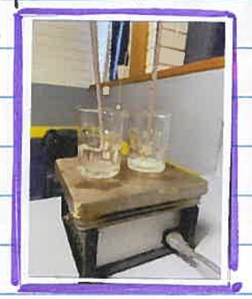
TEACHER'S NAME: Caroline Beekman

SIGNATURE: _____ DATE: 14/5/2020

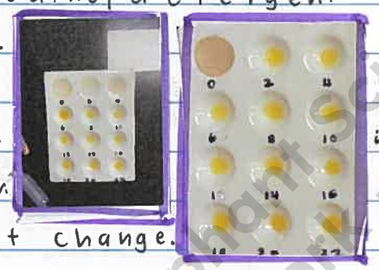
date: 09/06

almat. detergent vs starch 1

- I wasn't too sure how this experiment would turn out, but it was worth a shot! I started by heating the Almat (a nice smelling Aldi detergent) and starch to 37°C.



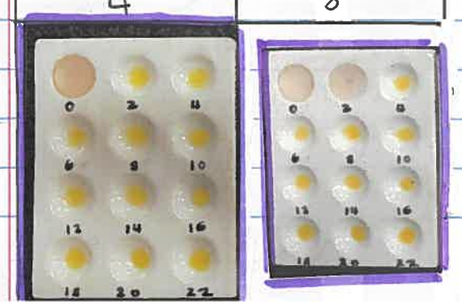
- After they were heated, I mixed them together and started the observations.
- It went surprisingly well!! Especially for my first experiment. Although something Ms Beekman (my OSA coordinator) and I realised was that the colour of the iodine/detergent solution was fading overtime.
- The reason for this could have been because the substances continued to react. It wasn't a major change, just a slight change.



before

- Also, the iodine/almat solution turned a brown colour. The reason for this might have been because I wasn't using pure chemicals, and the detergent contained a variety of substances.
- Almat results:

time	colour
0	2
2	5
4	8



ALMAT:

Almat results

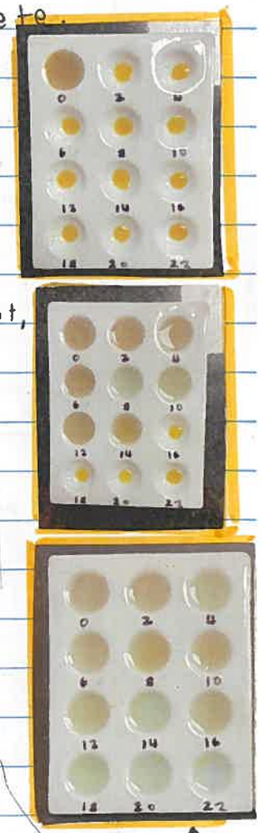
1 2 3 4 5 6 7 8

pg. 32

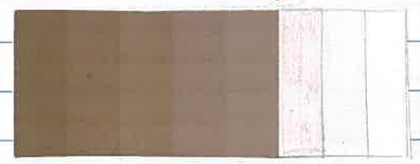
date: 10/06

dynamo experiment

- The experiment was a success! The reactio Was finished around the 8 minute mark, although I kept going for good measure
- That experiment shows that if you soak your clothes at 37°C; and then wash them with almat, you will get the best results
- Now it was time to do the Dynamo! Dynami is renowned for using enzymes in their formula, so I had high hopes for this detergent!
- Although, I was a bit disappointed with the results! Dynamo didnot perform as well as the Almat, although it is a blue liquid, so that made it harder to tell when the hydrolysis was complete.
- The experiment started well, with promising results. The Dynamo was heated to 37°C before the experiment started, along with the starch. Although the Dynamo was not as efficient as the Almat, it still did it's job. Here are some pictures taken during →



- Dynamo results:



1 2 3 4 5 6 7 8

time	colour
0	1
2	2
4	3
6	3
8	5
10	5
12	~~6~~
14	6

time	colour
16	7
18	8
20	8
22	8

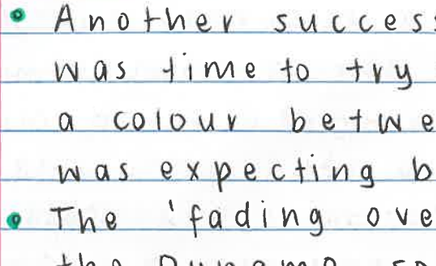
final results

pg. 33

date: 11/06

radiant experiment

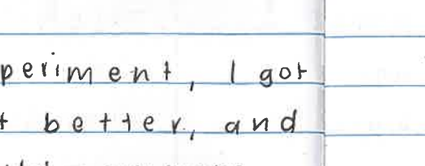
- Another successful experiment! Now it was time to try the radiant. Radiant is a colour between white and blue, so I was expecting better results from radiant!
- The 'fading overtime' thing happened with the Dynamo, so I resulted in taking photos every 2 minutes.
- Whilst I was completing this experiment, I got to thinking about ways to make it better, and then the idea struck me! I could compare detergent hydrolysis of starch at 37°C (the optimum temperature for enzyme activity) to the normal temperature that detergent is.
- It was a bit of a crazy idea, and Ms Beekman said that most good experiments only have 1 independent variable, but I was really curious to see if the results would change', so it went ahead.
- But first the 'hot' radiant results:



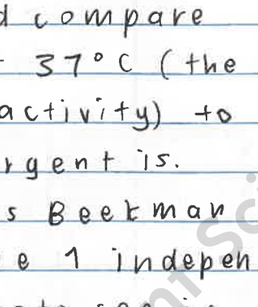
← photos from experiment. Notice how the 0 dimple was already fading after only 10 min??

time	colour
0	2
2	2
4	3
6	5
8	6
10	6
12	7

time	colour
14	8
16	8
18	8
20	8



results from radiant →



date: 12/06

almat again - but with a twist

- So now it was time to put this crazy 'hot' and 'cold' experiment into action. Today at lunch time, I trialled the almat and what can I say? The results were great!
- The only thing I did differently was that I didn't use a water bath and for this modified experiment: I just mixed the detergent and starch without heating them.
- The results turned out really well, and for today's experiment I trialled cold almat and cold starch. By 'cold', I mean the temperature at which the starch and detergent naturally settled at (20°C).
- From the results of this trial, it was evident that the Almat is a very efficient detergent. I did a little bit of research and found that Aldi's detergents have been consistently performing well.
- The 'cold' almat experiment:

time	colour
0	1
2	4
4	6
6	7
8	8
10	8
12	8
14	8
16	8
18	8

during

final.

reaction was finished ;)

date: 15/06

'cold' dynamo experiment

- After the success of the cold almat experiment, it was time to do the cold dynamo experiment. As the dynamo was a blue liquid, it was slightly difficult to tell when the reaction was finished.
- So far, not many mistakes had been made! The whole keeping the temperature consistent fiasco was solved (well, not entirely), as I had gotten used to keeping the flactuation of temperature to a minimum (not that it mattered for the cold experiments).
- So far almat was in the lead: being able to hydrolyse starch within 4 minutes! (which is faster than the 10% amylase).
- The reason it was probably quicker might have been because of the extra chemicals that are added to detergents.
- Here are the results:

time	colour
0	1
2	1
4	1
6	2
8	3
10	5
12	6
14	7
16	8
18	8
20	7
22	8

final results

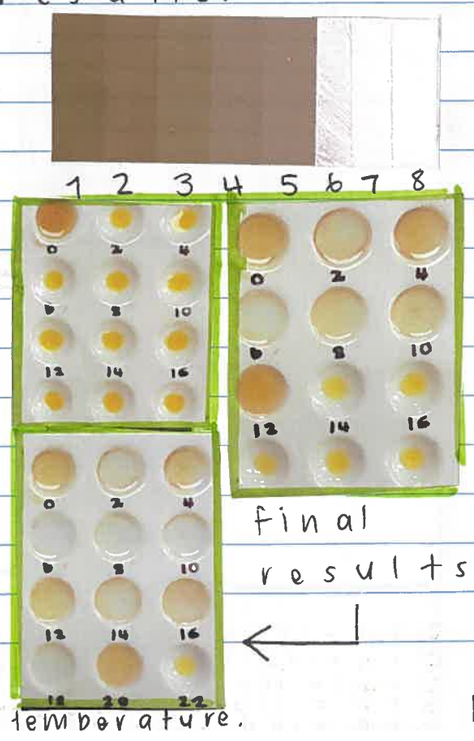
date: 16/06

cold radiant

- The time had come for the final experiment! This time, I did the radiant but without heating the starch or detergent
- Something I noticed was that the cold radiant results were quite similar to the hot radiant results.
- This just showed that when you are washing your clothes with radiant, it doesn't matter too much about the temperature.
- The radiant was quite effective, it didn't work as well as the Almat but it performed better than Dynamo.
- Now that I had completed all of the experiments, I had to do the controls. But there will be more information on them after!
- Here are the results:

time	colour
0	1
2	3
4	4
6	7
8	8 (reaction done)
10	8
12	7
14	7
16	8
18	7
20	8

error with temperature.



final results

date: 17/06

the controls

- Now that all the experiments with dynamo were complete, it was time to do the controls! The controls serve as a benchmark for colour when the starch is completely digested in experimental samples.
- These controls were essential because some of the detergents contained a colour dye.
- The controls completed for this experiment are: iodine + starch, iodine + amylase, iodine + almat, iodine + dynamo, iodine + radiant. The iodine and starch showed that amylase is essential for starch breakdown.
- I did the controls at 20°C (not heated) and 37°C, because that was the temperatures the experiment was completed at.
- The cold controls looked very similar to the hot controls!

Here are the pictures:

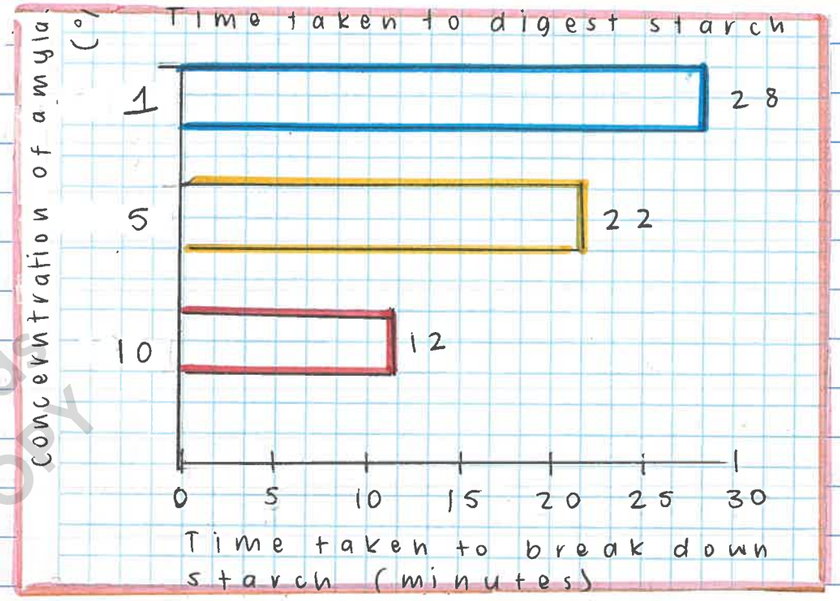
cold

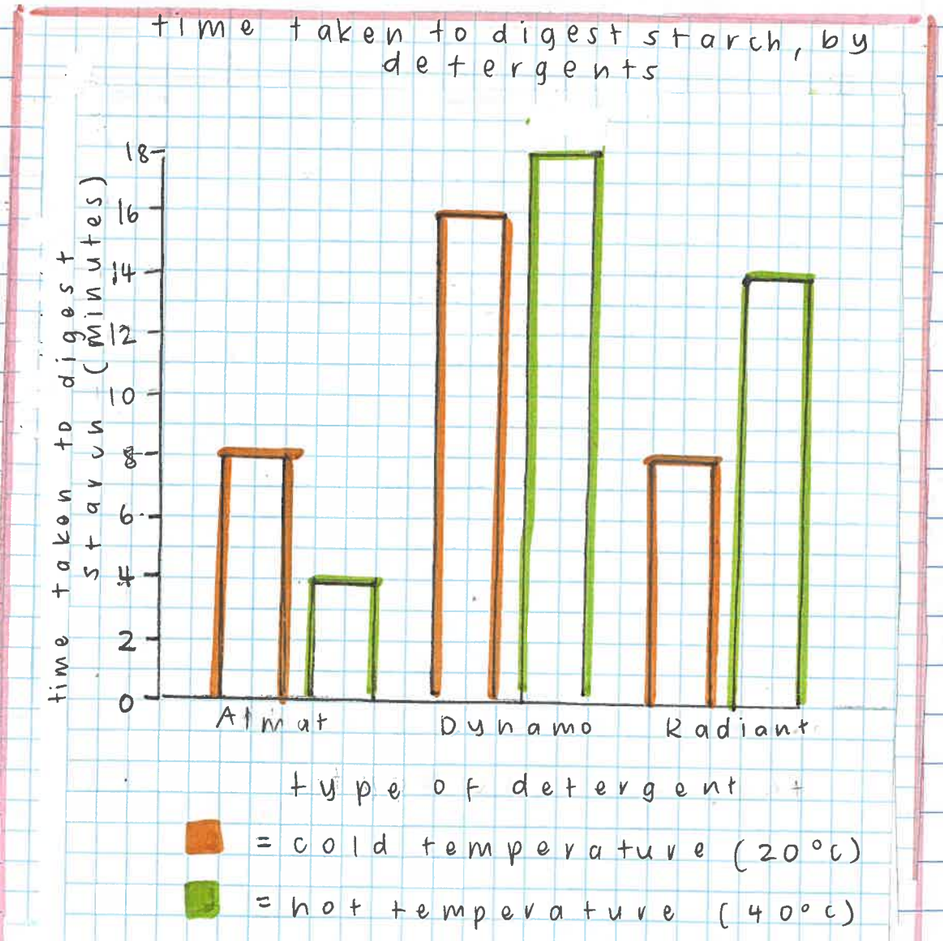
hot

I + S = iodine + starch
I + A = iodine + 10% amylase
I + Al = iodine + Almat
I + D = iodine + dynamo
I + R = iodine + Radiant

date: 18/06

graphs for experiment





date: 18/06.

the controls P2

- so I accidentally forgot to include the controls from Part A (the amylase concerntrations), so here they are.
- Once again, the purpose of these controls were to serve as a benchmark for colour, which shows when starch is completely digested.
- Because Part A was completed only at 40°C, the controls were only done in the 'hot' temperature. The starch and amylases were heated in a waterbath to 40°C.
- They controls prepared during the Part A experiment were: iodine and starch, iodine and 1% amylase, iodine and 5% amylase and finally, 10% amylase.
- The iodine and starch showed that amylase is essential for the hydrolysis of starch.
- Here are some images of the controls:

I + S = Iodine + Starch.

I + 1% A = iodine + 1% amylase

I + 5% A = iodine + 5% amylase

I + 10% A = iodine + 10% amylase.

- this experiment was useful to society because it determines the most efficient detergent. This information can be put into use because it informs buyers of the most effective detergent, so that they can make informed decisions.

controls

date: 19/06

assistance

assistance

- Caroline Beekman (my OSA co-ordinator) provided guidance and support in optimising the method for Part A of the experiment, and Part B of this scientific investigation.
- She also supervised me whilst I conducted Part A of the experiment, and Part B.
- Caroline Beekman also gave her assistance in providing a structure for the practical report. (which was aim, hypothesis, variables, materials, method, results, discussion, conclusion, and bibliography.