Paper 1

(4)

Name: [redacted]

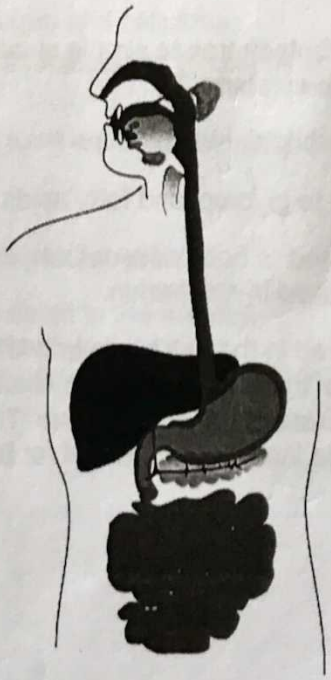
Form:

Teacher: Mrs Masters

[redacted]

GCSE Biology:

Digestion and Metabolism



Homework may be marked on Firefly – check your feedback and make corrections to your work! This is your responsibility!

4.2.2.1 The human digestive system

Content	Key opportunities for skills development
This section assumes knowledge of the digestive system studied in Key Stage 3 science. The digestive system is an example of an organ system in which several organs work together to digest and absorb food. Students should be able to relate knowledge of enzymes to Metabolism. Students should be able to describe the nature of enzyme molecules and relate their activity to temperature and pH changes.	
Students should be able to carry out rate calculations for chemical reactions. Enzymes catalyse specific reactions in living organisms due to the shape of their active site.	MS 1a, 1c
Students should be able to use the 'lock and key theory' as a simplified model to explain enzyme action. Students should be able to recall the sites of production and the action of amylase, proteases and lipases. Students should be able to understand simple word equations but no chemical symbol equations are required. Digestive enzymes convert food into small soluble molecules that can be absorbed into the bloodstream. Carbohydrases break down carbohydrates to simple sugars. Amylase is a carbohydrase which breaks down starch. Proteases break down proteins to amino acids. Lipases break down lipids (fats) to glycerol and fatty acids. The products of digestion are used to build new carbohydrates, lipids and proteins. Some glucose is used in respiration. Bile is made in the liver and stored in the gall bladder. It is alkaline to neutralise hydrochloric acid from the stomach. It also emulsifies fat to form small droplets which increases the surface area. The alkaline conditions and large surface area increase the rate of fat breakdown by lipase.	WS 1.2 Students should be able to use other models to explain enzyme action.

Required practical activity 4: use qualitative reagents to test for a range of carbohydrates, lipids and proteins.

To include: Benedict's test for sugars; iodine test for starch; and Biuret reagent for protein.

AT skills covered by this practical activity: AT 2 and 8.

This practical activity also provides opportunities to develop WS and MS. Details of all skills are given in Key opportunities for skills development.

Required practical activity 5: investigate the effect of pH on the rate of reaction of amylase enzyme.

Students should use a continuous sampling technique to determine the time taken to completely digest a starch solution at a range of pH values. Iodine reagent is to be used to test for starch every 30 seconds. Temperature must be controlled by use of a water bath or electric heater.

AT skills covered by this practical activity: AT 1, 2, 5 and 8.

4.4.2.3 Metabolism

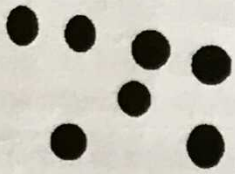
Content	Key opportunities for skills development
Students should be able to explain the importance of sugars, amino acids, fatty acids and glycerol in the synthesis and breakdown of carbohydrates, proteins and lipids. Metabolism is the sum of all the reactions in a cell or the body. The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism that synthesise new molecules. Metabolism includes: • conversion of glucose to starch, glycogen and cellulose • the formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids • the use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins • respiration • breakdown of excess proteins to form urea for excretion. All of these aspects are covered in more detail in the relevant specification section but are linked together here.	

Homework

15/10/20

Food Groups

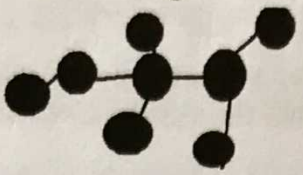
Small Carbohydrates – Sugars



reacts with oxygen in Respiration ~~occurs~~ Energy released in the mitochondria

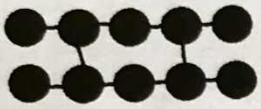
1. Good source – Glucose
2. Why you body needs that – Quickly broken down to make glucose. Absorbed into bloodstream to provide a short-lasting energy boot.

Long Carbohydrates – Starch



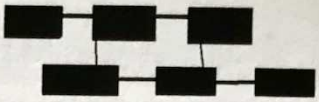
1. Foods like bread, rice, potatoes
2. Harder to break down into glucose. Releases energy slower. Known as a slow-release carbohydrate

Long Carbohydrates – Fibre (Cellulose)



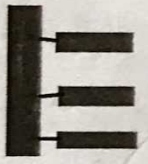
1. Cellulose – Brown rice
2. Dietry fibre helps the digestive system to move the food we eat through the intestines and push the waste material out of the body

Proteins



1. Eggs, fish — hormones, muscle cells
2. Your body uses proteins to make new cells for growth, and repair damaged tissues.

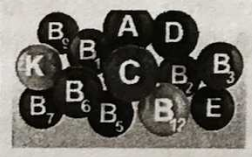
Lipids (Fats and Oils)



Long term energy source

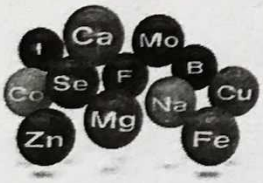
1. Butter, oils from nuts, seeds.
2. Some hormones are made from a lipid called cholesterol. Fat is important energy store. Layer of fat under skin provides insulation

Vitamins



1. Vitamin A, Vitamin K
2. Vit A – vital for good eyesight
   Vit K – helps the blood to clot.

Minerals



1. Iron, Calcium, Zinc
2. Iron – needed to transport oxygen in blood
   Calcium – for bones and teeth
   Zinc – to help heal wounds.

Water

Hydrate the cells

1. H_2O
2. helps maintain the balance of body fluids

GCSE REQUIRED PRACTICAL 4: TESTING FOR CARBOHYDRATES, LIPIDS AND PROTEINS

- Solid foods must be ground up in a pestle and mortar and mixed with some water for these tests to work
- These tests are qualitative – they only tell you if a chemical is present or absent, not how much there is. The concentration tell you the strength
- Colour changes are subjective ← own opinion
- Wear safety goggles when handling the reagents

Benedict's

Sugars tell you quality

Food Group	Reagent used to test	Start Colour	Positive Result
Carbohydrates (Sugars)	Benedict's + heat Solution	~~Colourless~~ Blue	orange / red
Carbohydrates (Starch)	Iodine	Brown	Dark blue / black
Proteins	Biuret Solution	Pale blue	Purple / lilac
Lipids	~~Ethanol~~ ~~Water~~ Ethanol	if mixed, water and lipids with ethanol	there are two seperate layers, water and salt and should be clear
Lipids (alternative test)	Sudan III	~~Red~~ Colourless	red layer forming on top

Your results:

Food Group	Food					
	Rynita	Potato				
Carbohydrates (Sugars)	X	✓				
Carbohydrates (Starch)	✓	✓				
Proteins	X	X				
Lipids	✓	X				

* The start colour is blue

A nutritional drink was said to contain simple sugars and protein.

Describe how you could find out if these food substances were present in the drink.

To test for sugars you will need a bit of the drink and mix with Benedict's solution ✓ (make sure to wear eye protection while doing test) To make sure the test works, you will leave the solution over some heat ✓ to speed up the reaction *. To know the results, sugar is the only substance that will show the quality/concentration in different colours. A strong sugar solution will go red ✓, a weak solition will go green ✓. To test for proteins you will again need a bit of the drink and mix with Biuret solution ✓ (make sure to wear eye protection as) The start colour will be a pale blue ✓ and if proteins are present the solution will turn purple ✓ [6]

2/3 3/3 5/6 5

Describe how you would safely test samples of green leaves and meat to find out which has more fat.

Firstly, you'll need to grind the two samples into pulp ✓. When doing the test you'll need to wear eye protection for safety ✓. The reagents used for testing fats or lipids is Sudan III ✓ ~~water~~. You'll pour the green leaf pulp/solution into a test tube, and the same with the meats. You will pour Sudan III ~~water~~ into both, put thumb over the mouth of the tube and mix. When settled, if a red ✓ layer forms on the top of the surface, you'll know if fats are present. To know which has more fats, it will be the larger red ✓ layer on top of surface showing which has more fats. ✓

[6] (5)

Potato crops are grown for their carbohydrate content.

Describe how you could safely test the two species of potato to compare their carbohydrate content.

test for starch you'll need to grind the two spuds into a pulp with water. Wear goggles eye protection for safety. Put the different potato solutions into two different test tubes. The reagent to test for starch is iodine and when poured in with potato solution, the start colour should be brown. If left, the stronger starch is shown when a darker blue / black is seen. (3)

spelling: absorb- absorption

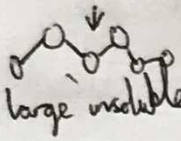
Human Digestive System

- The digestive system is an example of an organ system in which several organs work together to digest and absorb food.
- Digestion can be chemical (acid and enzyme) or it can be mechanical (teeth and muscle churning food).
- Enzymes are small proteins which act as catalyst in living things – they speed up reactions)
- Digestive enzymes convert food into small soluble molecules that can be absorbed into the blood

Human Digestive System

Mouth + Salivary Glands

- Starch → broken down into → sugar.



Amylase enzyme

small soluble

Saliva contains amylase.
Teeth = mechanical digestion
↳ increases surface area for enzymes to work.

Made in:
- salivary glands
- pancreas

OESOPHAGUS

Muscles push food down in a wave = peristalsis

Cells that line it constantly regenerate.

Stomach

Gastric juice
↳ HCl
↳ Enzymes

Made in:
- stomach
- pancreas

protein → (enzyme protease enzyme) → amino acids

large insoluble → small soluble

~~small intestine~~

muscles = churning = mechanical digestion

Liver + Gall bladder

Bile is made in the liver + stored in the gall bladder.
- neutralise stomach acid
- bile released into the small intestine
- bile emulsifies fats

Pancreas

Produces extra
- amylase
- protease
- lipase

+ Secretes them into the small intestine to complete digestion.

Small Intestine

breaking down

lipase enzyme

lipid (fat) → 1 glycerol + 3 Fatty acids

Made in:
- pancreas

DIGESTION FINISHED!

↓

absorption of small, soluble molecules
- villi + microvilli
- blood supply

Large Intestine

- water absorbed into the blood by osmosis
- faeces = fibre

Carbohydrase e

carbohydrates | amylase | ~~amino~~ sugars

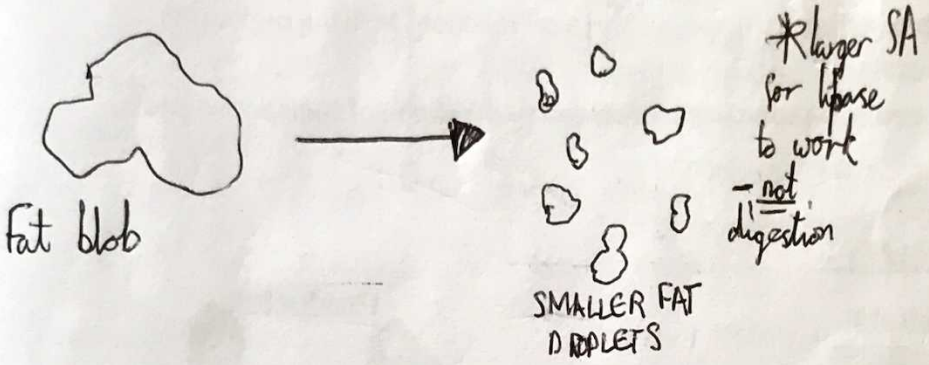
Protease enzy

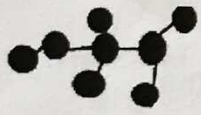
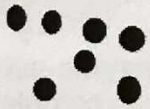
protein | protease | amino acids

Lipase enzyn

lipids | lipase | fatty acid glycerol

Bile

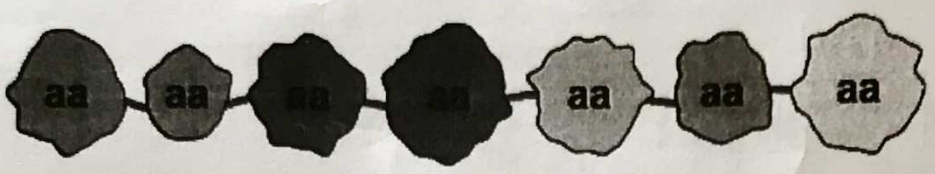


Large molecule (polymer)	Enzyme	Small Molecule (monomer)	Site of production	Site of digestion
Starch 	Amylase	Sugars 	Salivary gland, pancreas & small intestine	Mouth + Small intestine
Protein 	Proteases	Amino acids 	Stomach, pancreas & small intestine	Stomach + Small intestine
Lipids (Fats & Oils) 	Lipases	Fatty acids and glycerol 	Pancreas & Small intestine	Small intestine

Enzymes & Proteins

Proteins: — Binding together

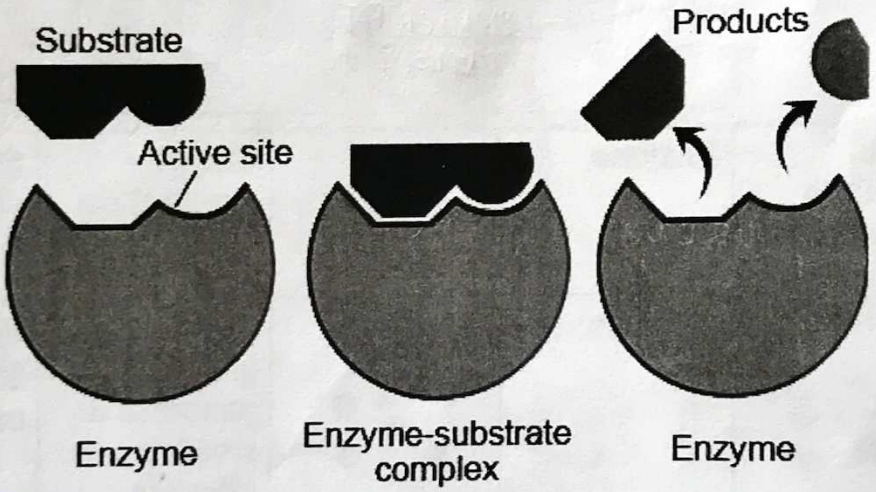
- Proteins are really important molecules in living things - they are used to make muscle, enzymes, skin, hair, nails, antibodies, hormones etc!
- Protein molecules are made up of long chains of amino acids
- There are 20 different amino acids needed to build the proteins in a human
- These long chains are folded to produce a specific shape that enables other molecules to fit into the protein.



Enzymes:

- Biological catalysts that increase the rate of chemical reactions in living organisms
- Enzymes are large proteins.
- Enzymes catalyse (speed up) a specific reaction due to the shape of their active site

Lock and Key Theory:

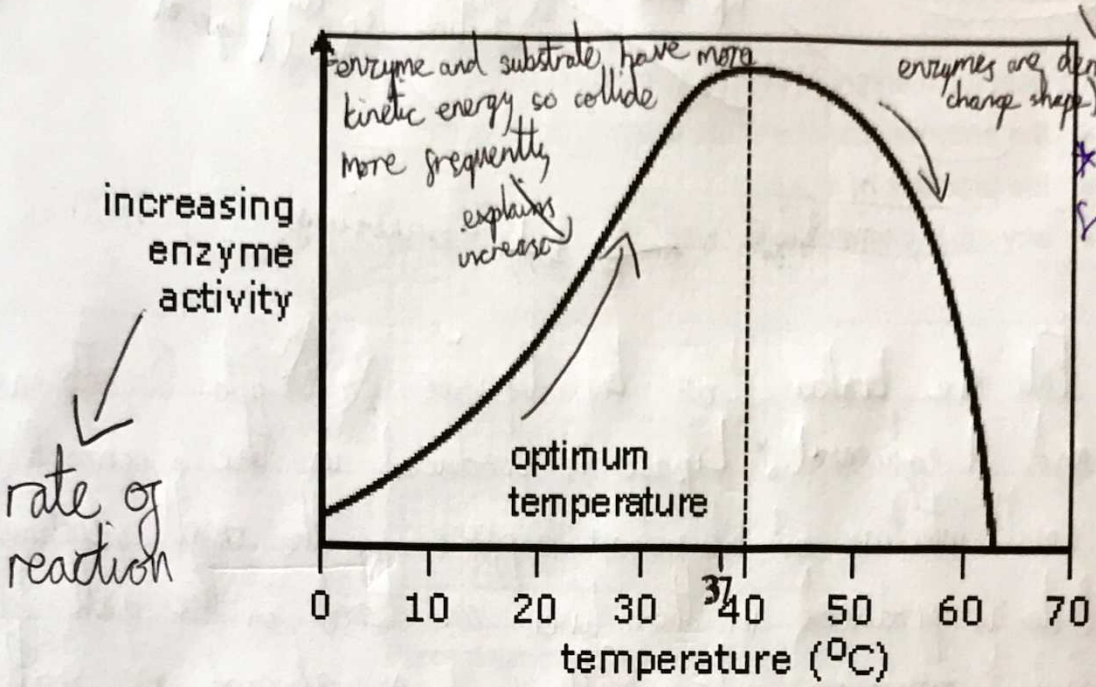


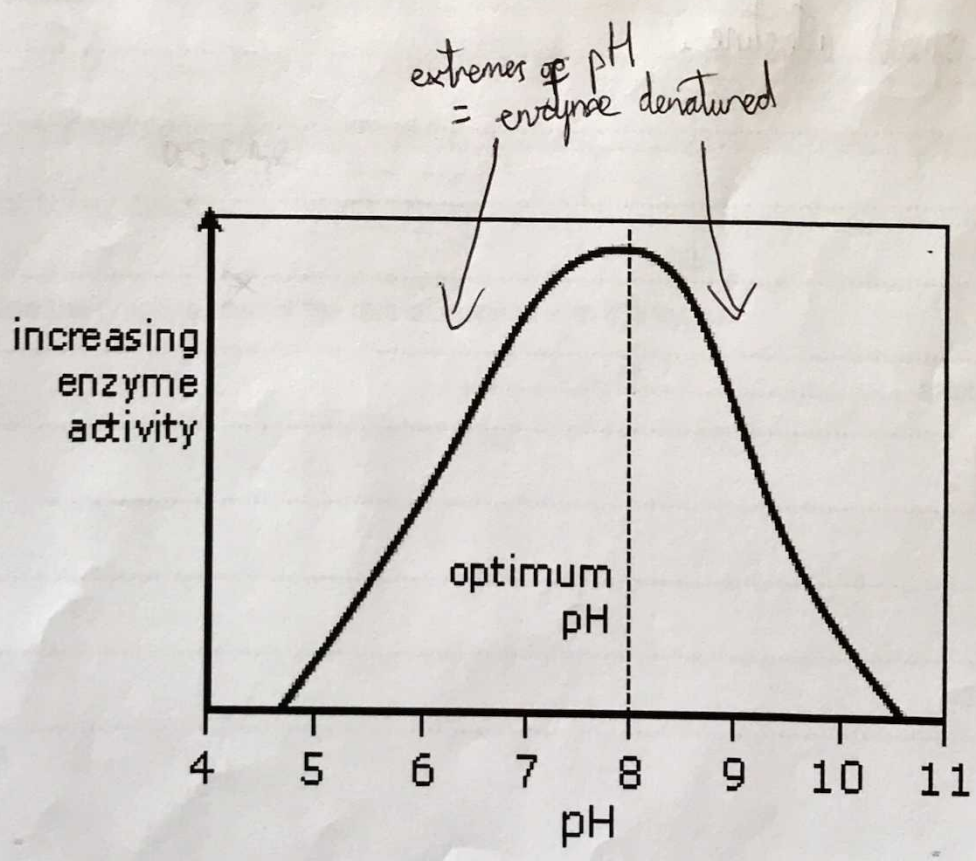
- Enzymes are denatured by high temperature and extremes of pH due to changes in the shape of the active site.
- They have an optimum temperature and an optimum pH

The effect of temperature and pH on enzyme activity:

so no substrate can lock to enzyme

active site permanently changes shape





Questions: Enzymes

Q1)

Different parts of the human digestive system help to break down molecules of fat so that they can be absorbed into the body.

Describe how.

To gain full marks you should refer to:

- the enzyme and where the enzyme is produced
- the products of digestion
- any other chemicals involved.

Fats are broken down by lipases into 3 fatty acids and 1 glycerol. Lipase is produced in the pancreas & small intestine and digestion happens in the small intestine. Bile is produced in the liver and stored in the gall bladder and it emulsifies fats. Fatty acids + glycerol are small + soluble and are absorbed over the villi + microvilli in the small intestine.

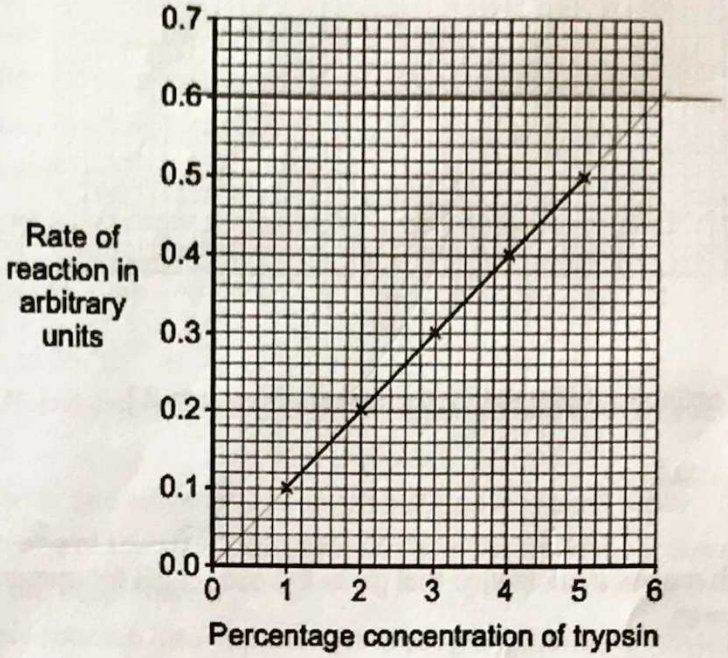
(6 marks)

2 Trypsin is a protease enzyme. Trypsin will digest a protein called gelatine which covers the surface of photographic film.

Some students investigated the time taken to digest the gelatine with trypsin.
The students used five different concentrations of trypsin.

The rate of reaction was calculated from the time taken for the gelatine to be digested.

The graph shows the students' results.



2 (a) (i) Describe the relationship between the concentration of trypsin and the rate of reaction.

The trypsin and the rate of reaction in arbitary units is directly proportional to each other. They are increasing at the same speed, 0.1% rise per 1% rise.

(2 marks)

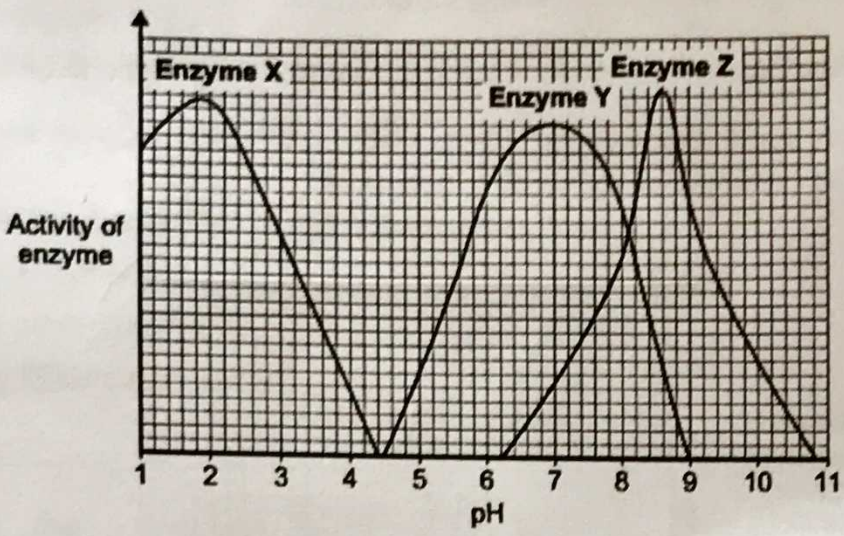
2 (a) (ii) Use the graph to predict the rate of reaction with 6% trypsin.

0.6 arbitrary units

(1 mark)

3

3 (a) The graph shows the effect of pH on the activities of three enzymes, X, Y and Z.
These enzymes help to digest food in the human digestive system.
Each enzyme is produced by a different part of the digestive system.



3 (a) (i) What is the optimum (best) pH for the action of enzyme Z?

.....8.6..... ✓

(1 mark)

3 (a) (ii) The stomach makes a substance that gives the correct pH for enzyme action in the human stomach.

Name this substance. .....Protease ✗ Hydrochloric acid.....

0 (1 mark)

3 (a) (iii) Which enzyme, X, Y or Z, will work best in the human stomach?

..... X ✗

(1 mark)

GCSE REQUIRED PRACTICAL 5: INVESTIGATING THE EFFECT OF PH ON THE RATE OF REACTION OF AMYLASE ENZYME

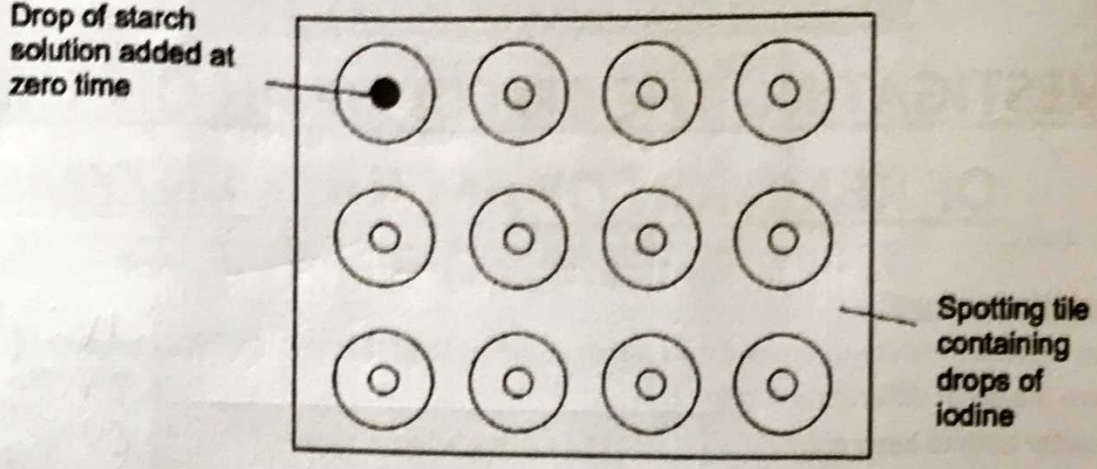
In this practical you will:

- use the enzyme amylase to break down starch at different pH values
- measure the pH of different solutions
- use a water bath to keep reacting solutions at a constant temperature
- use a continuous sampling technique
- use iodine solution as an indicator of the breakdown of starch into sugars.

IV: pH
DV: Time taken for starch to be broken down.
CV: - temperature
- volume of amylase
- starch
- buffer
- iodine

Method

1. Heat your water bath to 35 °C.
2. Put 2 cm3 of each buffered solution into individual, separate test tubes. Label each tube with the pH of the solution.
3. Label 5 test tubes 'Starch' and add 4 cm3 of starch solution into each tube.
4. Put a thermometer in one of the starch test tubes to monitor the temperature. Leave the thermometer in this tube throughout the experiment.
5. Add 10 cm3 of Amylase solution into another test tube. Label the tube 'amylase'.
6. Put all the test tubes into the water bath.
7. Allow the solutions to reach 35 °C.
8. While the solutions are reaching the required temperature, put one drop of Iodine solution into each depression on your spotting tile. Put a drop of starch solution in the first depression of the tile. This is your 'zero time' mixture. You will use this as a comparison of colour for your test buffers. Starch gives a blue-black colour with iodine, and the iodine stays brown if all the starch has broken down to glucose.
9. When all the tubes have reached 35 °C take one of the tubes of starch from the water bath and add the 2 cm3 of your first pH buffered solution. Stir the mixture with a glass rod.
10. Use the pipette to add 2 cm3 of amylase solution to the mixture. Start the stopclock as soon as you add the amylase. Keep stirring the mixture with the glass rod.
11. After 10 seconds, remove one drop of the mixture with a glass rod.



12. Put this drop on the second depression of your spotting tile.
13. Rinse the glass rod with water.
14. Every 10 seconds, use the glass rod to remove one drop of the mixture. Put each drop onto the iodine solution in the next depression on the spotting tile. Remember to rinse the glass rod with water after putting each drop on the spotting tile.
15. Keep sampling every 10 seconds until the iodine does not change colour.
16. Record your results in a table

pH of Buffer IV	Time take for starch to be broken down (minutes) seconds My Results / Class Average DV	
5		30
6		10
7		57
8		43

Questions to think about:

What is a buffer?

A chemical that maintains a constant pH.

What is a water bath? Why are they used? Different types?

Piece of equipment which maintains a constant temperature.

- Maintains water at a constant temperature
- Electronic water bath.

Does the iodine give you quantitative or qualitative information about the presence of starch?

Qualitative, as it only tells you if starch is present

Is this test objective (always true – no matter who does it) or subjective (open to peoples' interpretation)?

Subjective

This is a continuous sampling technique – what is the advantage to this? What is a disadvantage of this?

Disadvantage - run out of solution

Advantage - less equipment needed

What can you do to ensure the drop of liquid you take from the reaction tube is representative of the contents of the tube?

Keep stirring solution

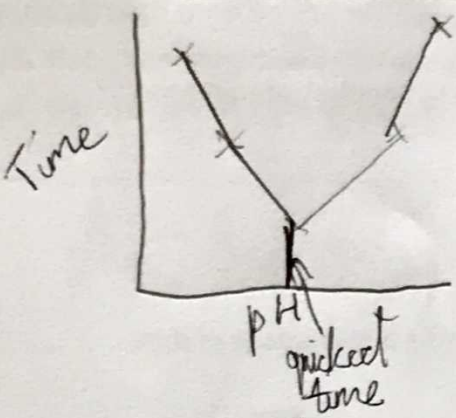
What health and safety issues might there be with this experiment?

Sensitive skin

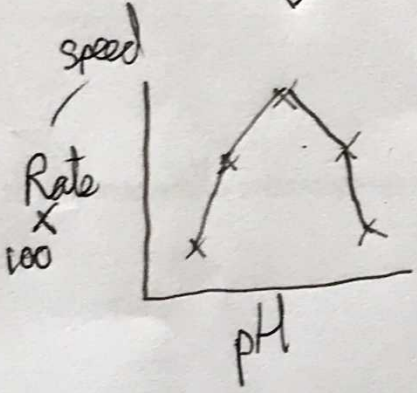
Calculating the rate of reaction

With a time graph it should make a smile face. It makes the quickest time look rubbish and slowest look the best
So we divide ~~(1 ÷ t)~~ 1 ÷ time = rate to make the quickest time have the largest rate.

$$\frac{\text{amount of stuff produced}}{\text{time take}} \quad \text{OR} \quad \frac{1}{\text{time taken}}$$



dot-to-dot



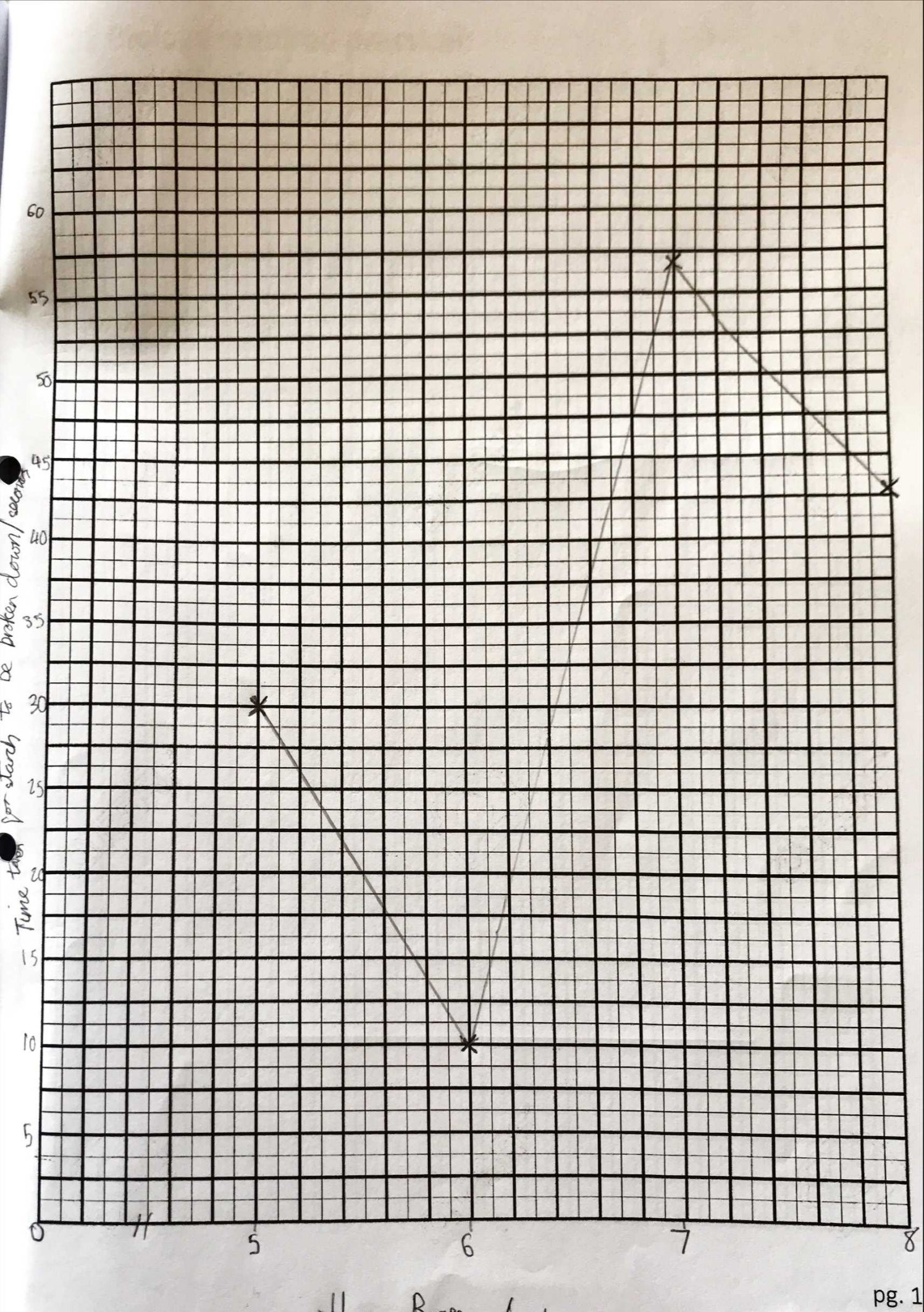
pH	time
5	30
6	20
7	10
8	20
9	30

1 ÷ time

pH	Time
5	0.033
6	0.05
7	0.10
8	0.05
9	0.033

→ rate x 100

3.3
5.0
10.0
5.0
3.3


Time taken for starch to be broken down/seconds
60
55
50
45
40
35
30
25
20
15
10
5
0
5
6
7
8
pH of Buffer /mol

GCSE Biology required practical:
Enzymes (Effect of pH on digestion of starch by amlyase)

6 Starch is broken down into sugar by amylase. Amylase is produced in the salivary glands.

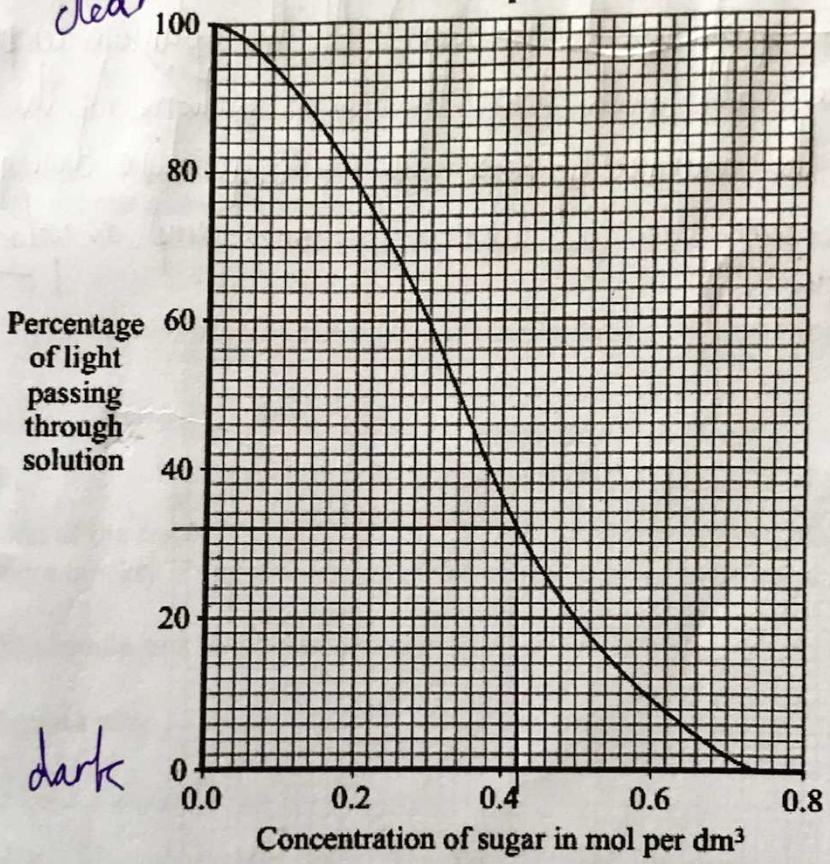
6 (a) Name **two** other organs in the digestive system which produce amylase.

Pancreas ✓ and Small intestine ✓ (2 marks)

6 (b) A colorimeter measures colour intensity by measuring the percentage of light that passes through a solution.
Graph 1 shows the percentage of light passing through sugar solutions of different concentrations to which a test reagent has been added.

clear

Graph 1



dark

Students used a colorimeter to compare the starch-digesting ability of amylase enzymes obtained from two organs, **P** and **Q**.

- The students collected 5cm^3 samples of amylase from **P** and **Q** and placed them into a water-bath at 40 °C.
- Two test tubes containing 10cm^3 samples of starch solution were also placed into the water-bath.
- All the tubes were left in the water-bath for 10 minutes.
- Each amylase sample was added to one of the tubes containing the starch solution.
- The test tubes were placed back into the water-bath.
- Every minute, a few drops were taken from each tube, the test reagent was added and the percentage of light passing through this solution was measured in the colorimeter.

The tubes containing amylase samples and starch solution were left in the water-bath for ten minutes before the amylase was added to the starch.

Explain why.

~~(This is to speed up the reaction)~~ At the optimum temperature the amylase will break down the starch solution. As the kinetic energy of the amylase increase due to temperature change.

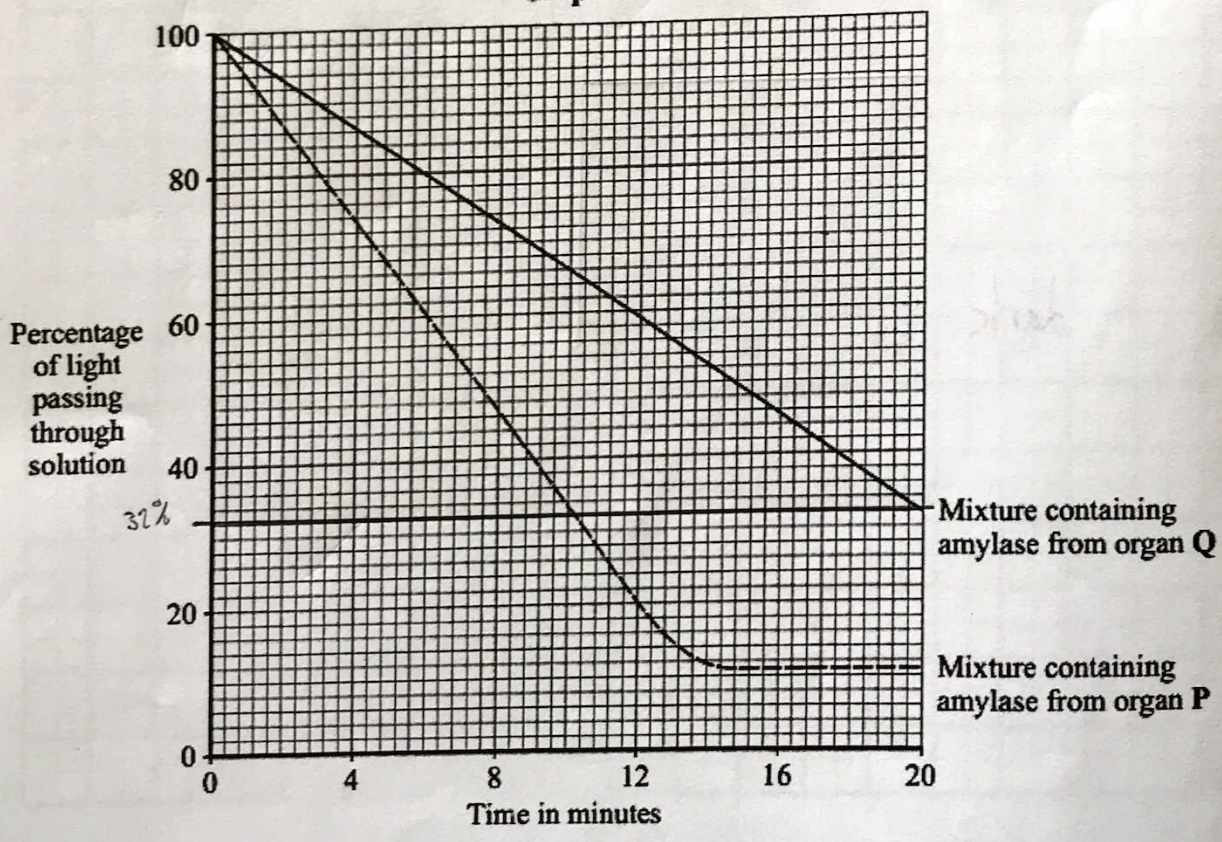
- To make sure the test tube is the same temp as water bath

(2 marks)

- For a fair test.

6 (c) **Graph 2** shows how the readings from the colorimeter changed over the next 20 minutes.

Graph 2



6 (c) (i) Use **Graph 1** and **Graph 2** to determine the concentration of sugar in the mixture from organ **Q** after 20 minutes.

Graph 2 after 20 minutes = 32% – 32% on Graph 1 reached 0.42mol

Answer 0.42 mol per ~~dm^3~~ *(1 mark)*

6 (c) (ii) Use your answer to 6(c)(i) to calculate the rate at which sugar was produced in the mixture containing amylase from organ **Q**. speed

Show clearly how you work out your answer.

20 ÷ 0.42 = 47.62 mol per dm^3

$\frac{\text{mole}}{\text{time}} = \frac{0.42}{20} = 0.021$

Answer 47.62 mol per dm^3 per minute ~~(2 marks)~~

6 (c) (iii) Suggest why the amount of light passing through the mixture from organ **P** did not change after 16 minutes.

The mixture in organ P did not change after 16 minutes because all the starch had been broken down by the amylase. *(1 mark)*

6 (c) (iv) One of the students suggested that they could have completed their experiment more quickly if the temperature of the water-bath had been set at 80 °C.

This would **not** have been the case.

Explain why.

This temperature would be to high of a temperature for the amylase, as it disrupts / denatures the active site, of which disrupts the lock & key system.

~~*~~ enzyme denatured

~~*~~ starch can no longer fit in active site.

1 ~~(2 marks)~~

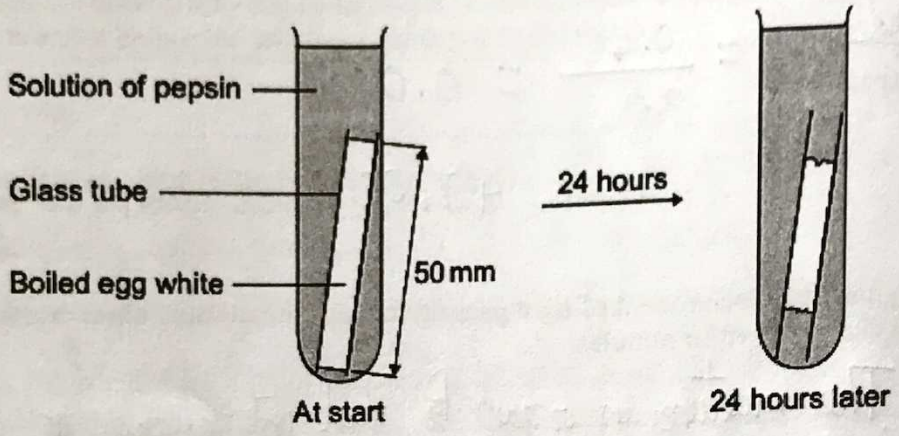
1 Some students investigated the effect of pH on the digestion of boiled egg white by an enzyme called pepsin. Egg white contains protein.

The students:

- put a glass tube containing boiled egg white into a test tube
- added a solution containing pepsin at pH 7
- set up six more tubes with solutions of pepsin at different pH values
- left the test tubes for 24 hours at room temperature.

Figure 1 shows one of the test tubes, at the start and at the end of the 24 hours.

Figure 1



1 (a) (i) Name the product of protein digestion.

[1 mark]

Amino acids ✓

1 (a) (ii) What type of enzyme digests protein?

Tick (✓) **one** box.

[1 mark]

amylase ☐

lipase ☐

protease ☑

1 (b) The egg white in each tube was 50 mm long at the start of the investigation. **Table 1** shows the students' results.

Table 1

pH	Length in mm of boiled egg white after 24 hours
1	38
2	20
3	34
4	45
5	50
6	50
7	50

1 (b) (i) At which pH did the pepsin work best?

[1 mark]

pH ..... 2 .....

1 (b) (ii) The answer you gave in part (b)(i) may not be the exact pH at which pepsin works best.

What could the students do to find a more accurate value for this pH?

1 ~~[2 marks]~~

They could do the test a few more times to get more results, and then find the mean average. This would be a more fair test.

* Tests the egg whites in different pH, to see which works best between pH 1 & 3.

1 (b) (iii) There was no change in the length of the egg white from pH 5 to pH 7.

Explain why.

~~[2 marks]~~

As egg whites are alkaline, the suggestion that pH 5 to pH 7 didn't work is because it neutralises it. (acid neutralises the alkaline) Then, at a ~~more~~ stronger acidic pH it will change.

* Denatured enzyme
* substrate no longer fits in ~~enzyme~~ active site.

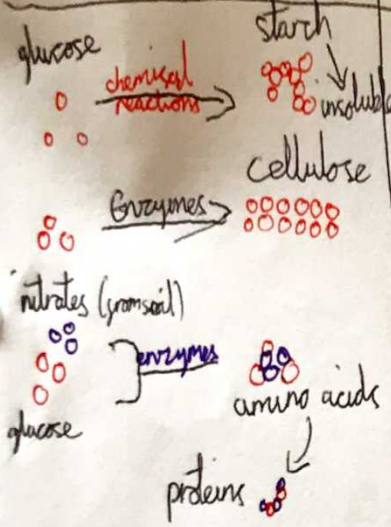
4.4.2.3 Metabolism

Content	Key opportunities for skills development
Students should be able to explain the importance of sugars, amino acids, fatty acids and glycerol in the synthesis and breakdown of carbohydrates, proteins and lipids. Metabolism is the sum of all the reactions in a cell or the body. The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism that synthesise new molecules. Metabolism includes: • conversion of glucose to starch, glycogen and cellulose • the formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids • the use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins • respiration • breakdown of excess proteins to form urea for excretion. All of these aspects are covered in more detail in the relevant specification section but are linked together here.	

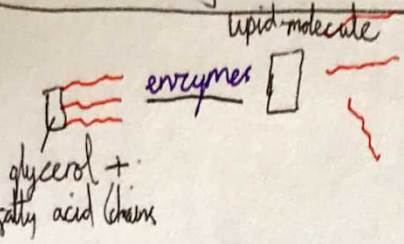
Metabolism Notes

the sum of all the reactions happening in a cell or in the whole body.

Plants

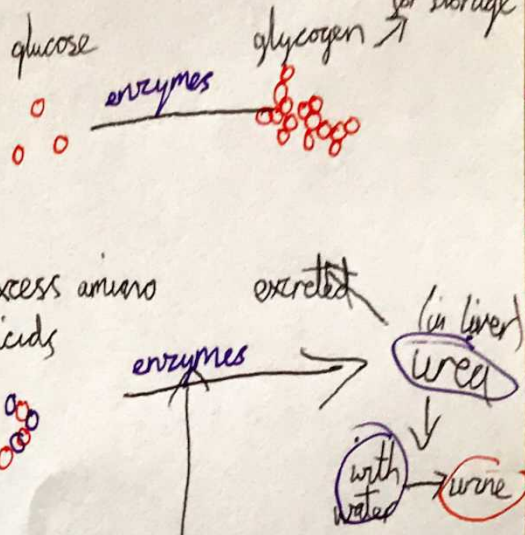


Plants + Animals



RESPIRATION

Animals



factor effects enzymes affects reactions: temperature
pH