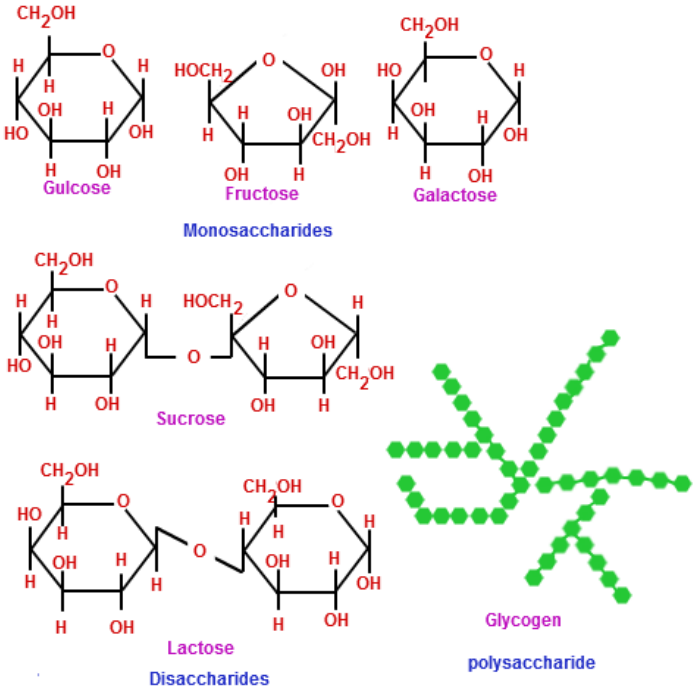
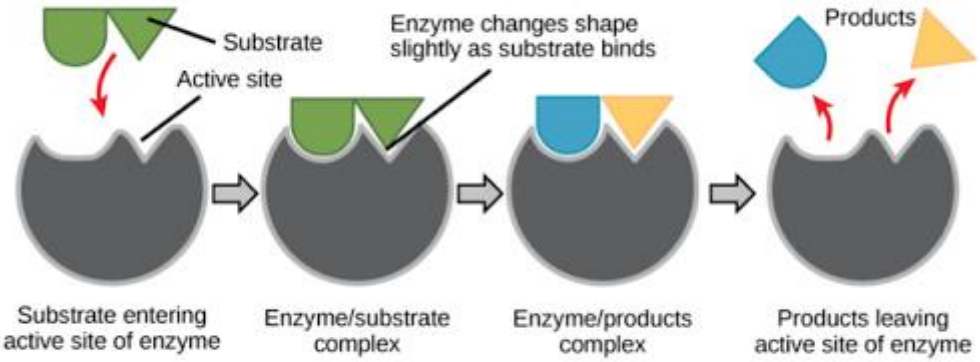
AQA A Level Biology

Summer Independent Learning





A Level Biology Summer Independent Learning Activity.

Welcome to A Level Biology, please complete **ALL** of the following tasks ready for your first day at New College.

There are 2 things we are expecting of you from your SIL. Teachers will be checking that this has been completed in the first week back in September.

Core Content

1. Complete the questions, and self-mark (mark scheme at the back of the paper)
2. Test yourself on the content, in preparation for an assessment on your return to college

Highly recommended content will assist you in future topics covered in Y12

You can print the booklet, write on the PDF file or answer the questions on paper. The Mark Scheme follows the sections at the end of the document.

Core Content

Part 1: Structure of Carbohydrates, Lipids and Proteins

Task 1: Carbohydrate Structure

Task 2: Lipid Structure

Task 3: Protein Structure

Part 2: Enzymes

Task 4: Enzyme definitions.

Task 5: Interpreting enzyme graphs.

Task 6: Enzyme inhibition.

Highly recommended

Part 3: Maths

Task 7: Calculating percentage change.

Task 8: Calculating rates.

Task 9: Calculating ratios

Task 10: Standard form

Task 11: Drawing graphs

Core Content

Part 1

Task 1: Structure of carbohydrates

Use the following video links to support with your answers:

https://www.youtube.com/watch?v=dSJGCGQ_9vA&list=PL0Mjub5NT755dp8xUfC-yoXlbPTcjVM1i&index=7&t=0s

https://www.youtube.com/watch?v=wuDxoneoPnY&list=PL0Mjub5NT755dp8xUfC-yoXlbPTcjVM1i&index=5

What is a monomer?

What is a polymer?

Can you describe what a condensation reaction is?

Can you describe what a hydrolysis reaction is?

Can you describe how larger carbohydrates are made from monosaccharide monomers?

Can you list some common monosaccharides?

Can you describe how disaccharides are formed?

What are maltose, sucrose and lactose formed from?

Draw a diagram to show how a condensation reaction occurs between two monosaccharides to form maltose. Label the bond that forms.

Can you explain how glycogen and starch are formed?

Task 2: Lipid Structure

https://www.youtube.com/watch?v=TOFjqpzbMZU&list=PL0Mjub5NT755dp8xUfC-yoXlbPTcjVM1i&index=3

Video from 10:50 to 12:50

https://www.youtube.com/watch?v=QFq9o72Qal8&list=PL0Mjub5NT755dp8xUfC-yoXlbPTcjVM1i&index=7

Can you explain how triglycerides are formed? Draw a diagram to show this happening. Label the molecules involved, the type of reaction and the types of bonds formed.

Can you explain that the R-group of a fatty acid may be saturated or unsaturated? What do these terms mean?

Task 3: Protein structure

Watch the videos:

From 7:20 – 10:50

https://www.youtube.com/watch?v=QFq9o72Qal8&list=PL0Mjub5NT755dp8xUfC-yoXlbPTcjVM1i&index=7

What is the general structure of an amino acid?

How do two amino acids form a dipeptide?

Describe the following protein structures:

Primary Structure

Secondary Structure

Tertiary Structure

Can you describe the role of hydrogen bonds, ionic bonds and disulfide bridges in the structure of proteins?

Part 2: Enzymes

Task 4: Enzyme definitions.

This section revises many of the key terms for GCSE to do with enzyme structure and function. A GCSE level question follows to assess your understanding. Whilst most of the definitions are from the GCSE specification you may find that some are unfamiliar to you.

Define these key words.

Enzyme:

Active site:

Substrate:

Activation energy:

Denature:

Q1. (a) Enzymes are used in body cells.

(i) What is an enzyme?

Draw a ring around the correct answer.

antibody	**biological catalyst**	**hormone**

(1)

(ii) All enzymes are made of the same type of substance.
What is this substance?
Draw a ring around the correct answer.

carbohydrate	**fat**	**protein**

(1)

(iii) Where is the enzyme amylase produced in the human body?
Draw a ring around the correct answer.

liver	**salivary glands**	**stomach**

(1)

(b) Enzymes are sometimes used in industry.

Draw **one** line from each enzyme to the correct industrial use of that enzyme.

Enzyme	**Industrial use**
	Changes starch into sugars
Carbohydrase	
	Removes grease stains from clothes
Isomerase	
	Pre-digests proteins in some baby foods
Protease	
	Changes glucose syrup into fructose syrup

Task 5: Interpreting enzyme graphs.

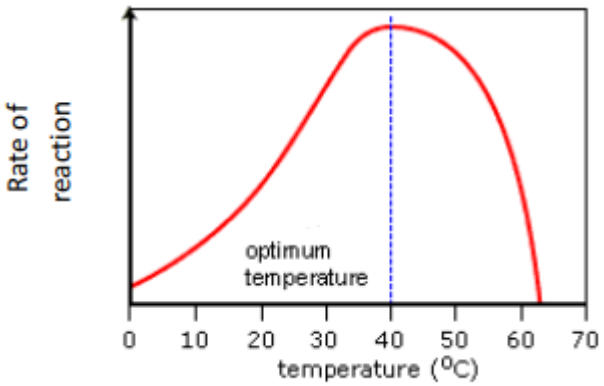
This section requires you to explain how different conditions affect enzyme activity.

Using the following link from our YouTube channel, watch the video and annotate each of the graphs.

You need to ***explain*** the shape of each graph in terms of enzyme activity.

https://www.youtube.com/watch?v=Pk3Lb2UHVcA&list=PL0Mjub5NT755dp8xUfC-yoXlbPTcjVM1i&index=9&t=0s

Q1. Change in temperature.



……

……

……

……

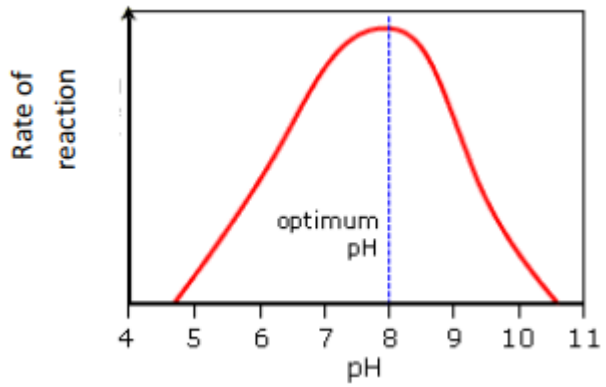
……

……

……

……

Q2. Change in pH.



……

……

……

……

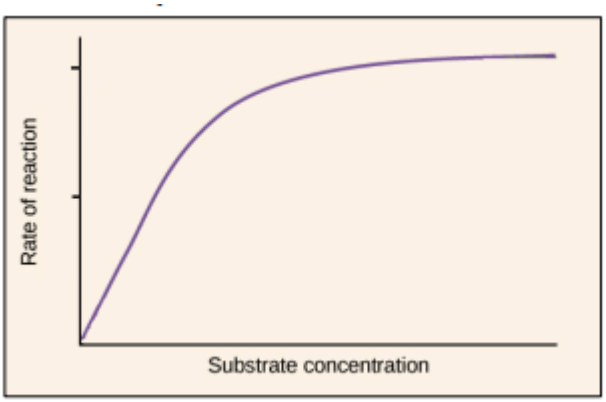
……

……

……

……

Q3. Change substrate concentration.



……

……

……

……

……

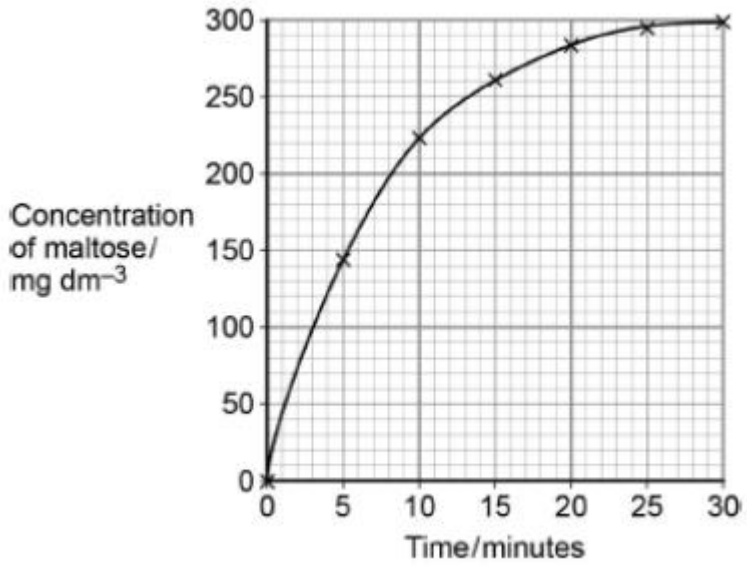
……

……

……

Q4. A scientist investigated the hydrolysis of starch. He added amylase to a suspension of starch and measured the concentration of maltose in the reaction mixture at regular intervals.

His results are shown in the graph below.



Explain the results shown in the graph.

……

……

……

……

……

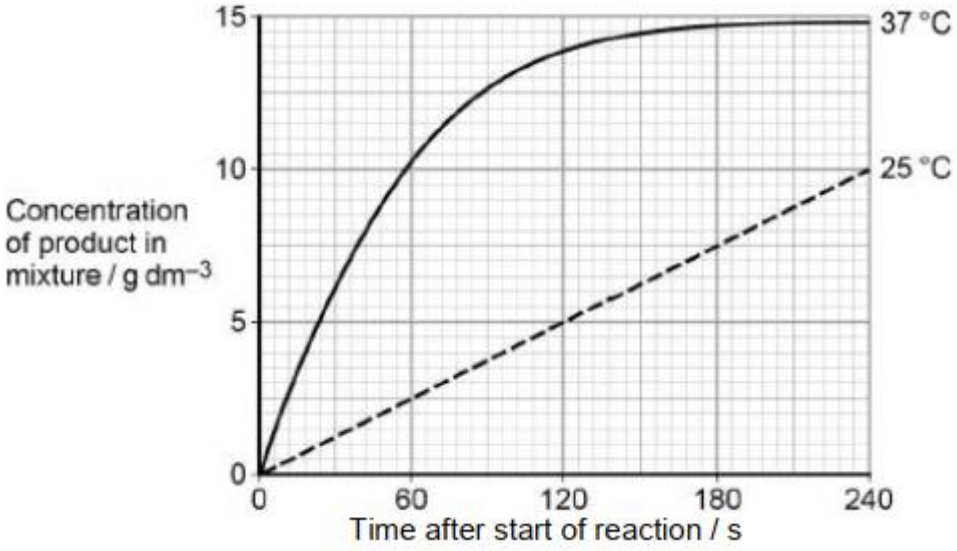
……

……

(2)

Q2. A technician investigated the effect of temperature on the rate of an enzyme-controlled reaction. At each temperature, he started the reaction using the same volume of substrate solution and the same volume of enzyme solution.

The figure below shows his results.

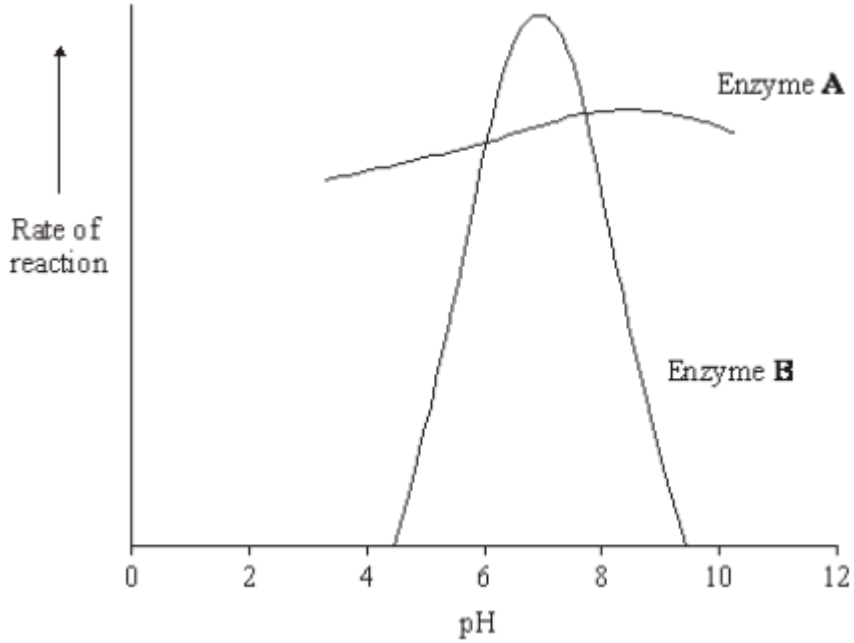


(a) Describe and explain the differences between the two curves.

……
……
……
……
……
……
……
……
……
……
……
……
……

(5)

Q3. Enzymes **A** and **B** digest protein. The graph shows the effect of pH on the rates of reaction of these enzymes.



(a) Pepsin is a protein-digesting enzyme found in the stomach. It has an optimum pH of 2 and is fully denatured at pH 6. Sketch a curve on the graph to show the effect of pH on the rate of reaction of pepsin.

(1)

(b) Explain why the rate of reaction of enzyme **B** is low at pH 5.

……

……

……

……

……

……

……

(3)

Task 6: Enzyme inhibition.

This section requires you to explain how different inhibitor molecules affect enzyme activity, together with how you can identify which type of inhibition is present.

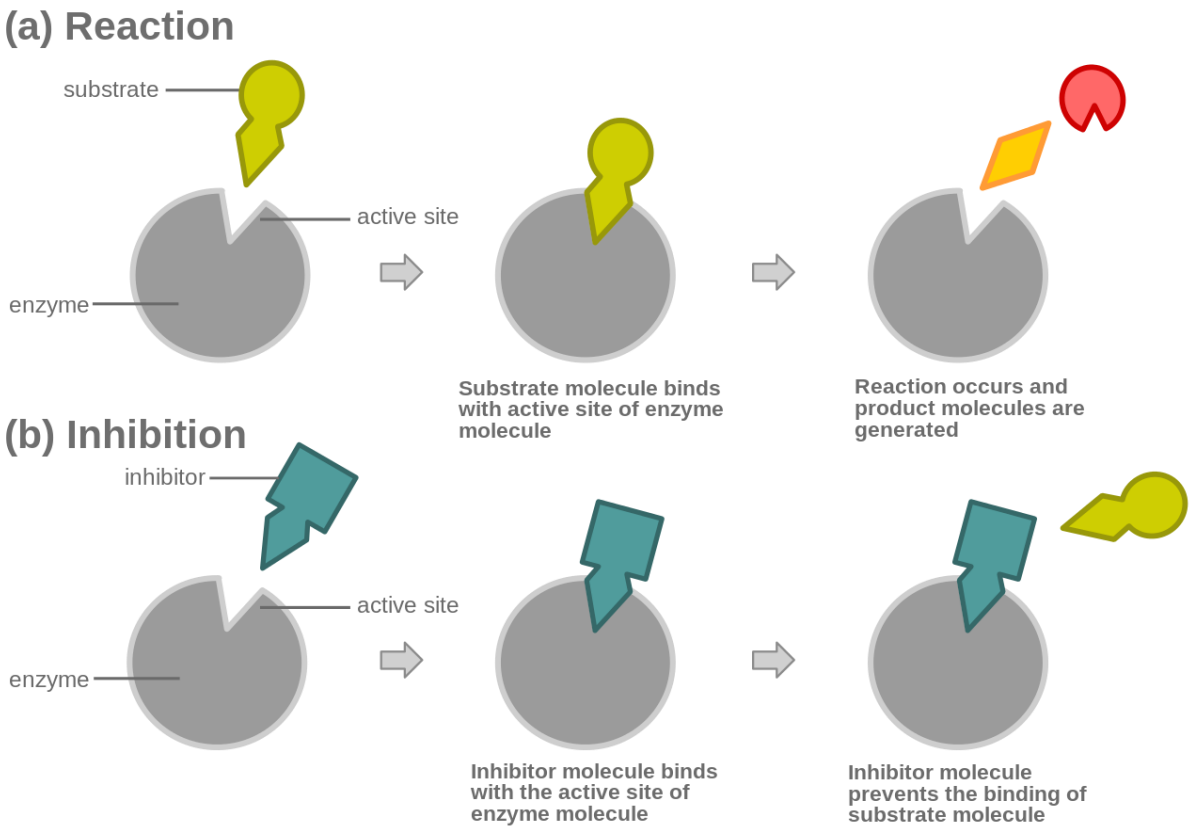
A Level exam questions follow to assess your understanding.

Using the following link watch the video and annotate each of the diagrams.

You need to ***explain*** how each inhibitor affects enzyme activity.

https://www.youtube.com/watch?v=aJF6yIYahAQ

Competitive inhibition



……

……

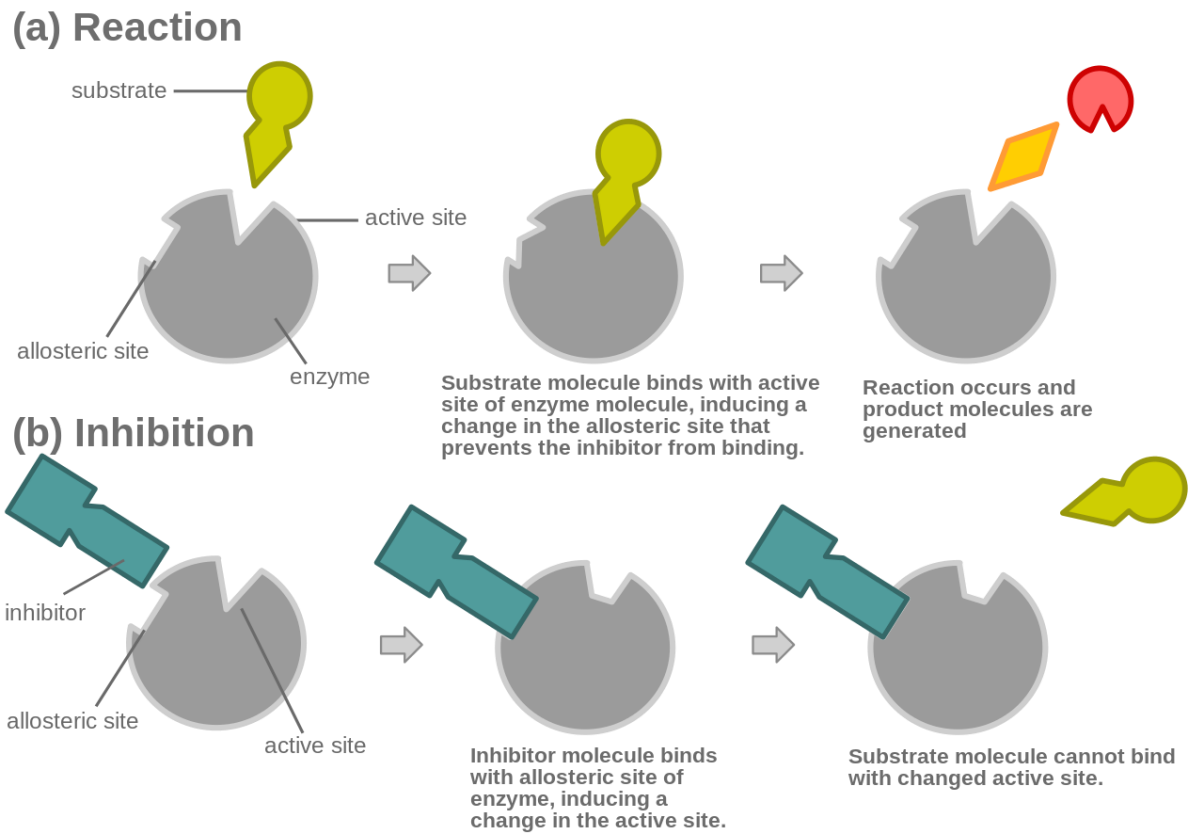
……

……

……

……

Non-competitive inhibition.



……

……

……

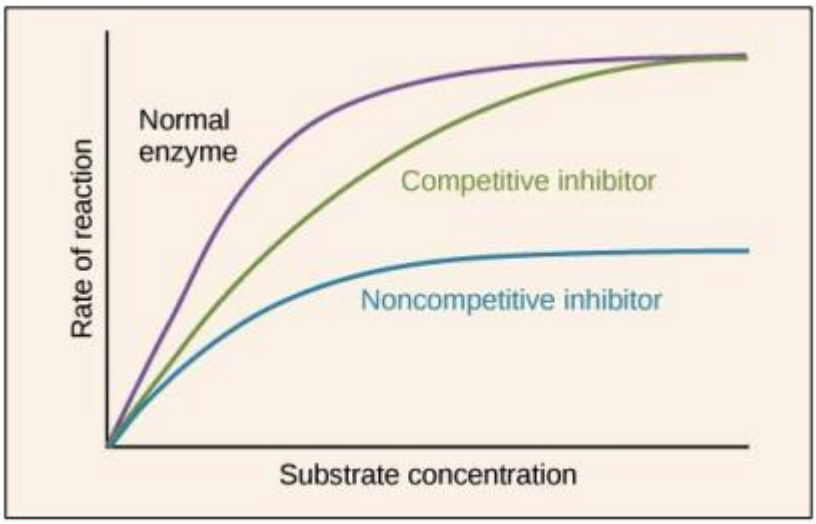
……

……

……

……

Explain the shape of both inhibitor lines, including how you can identify the type of inhibition.



Competitive inhibitor:

……
……
……
……
……
……
……
……

Non-competitive inhibitor:

……
……
……
……
……
……
……
……

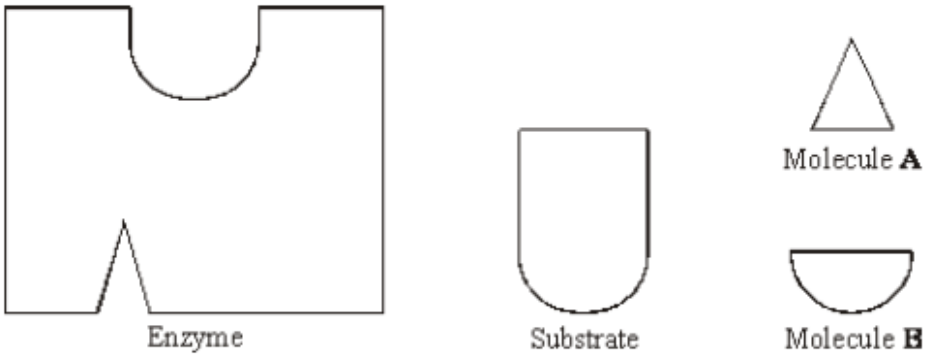
Q1. Scientists have investigated the effects of competitive and noncompetitive inhibitors of the enzyme maltase.

Describe competitive and non-competitive inhibition of an enzyme.

……
……
……
……
……
……
……
……

(5)

Q2. The diagrams represent an enzyme, its substrate and two other molecules, **A** and **B**.

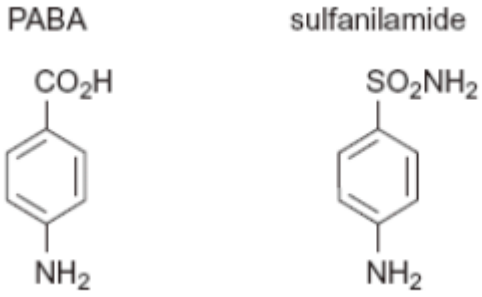


The addition of a non-competitive inhibitor will prevent the formation of an enzyme-substrate complex. Draw a labelled diagram based on relevant molecules selected from the diagram above to explain how this occurs.

(2)

Q3. Folic acid is a substance required by bacteria for cell growth. Bacteria produce folic acid by the following reaction.

The diagram shows the structure of a molecule of PABA. It also shows the structure of a molecule of a drug called sulfanilamide, which can be used to treat bacterial infections. Sulfanilamide prevents bacteria producing folic acid.



Use the diagram and your knowledge of enzymes to explain how sulphanilamide prevents bacteria producing folic acid.

……
……
……
……
……
……
……
……

(Total 3 marks)

Highly recommended content

Part 3: Maths

Task 7: Calculating percentage change.

This section requires you to understand how to calculate percentage change from given data. This is a common skill required in A Level Biology exams. Read the worked examples and complete the questions.

You **MUST** show your working.

https://www.youtube.com/watch?v=CbfxFBfB7kk&list=PL0Mjub5NT756MyHewhXhdRSIygaF_woF3&index=4&t=0s **from 2:10** on the NCP Biology You tube channel in order to help you with the follow section.

$$\text{Percentage change} = \frac{\text{Change}}{\text{Original}} \times 100$$

Worked example.

The mean height of some seedlings is 12mm at day 6 and 18mm at day 12.
What is the % change in height?

$$\%\ \text{change} = \frac{(18-12)}{12} \times 100 = 50\%$$

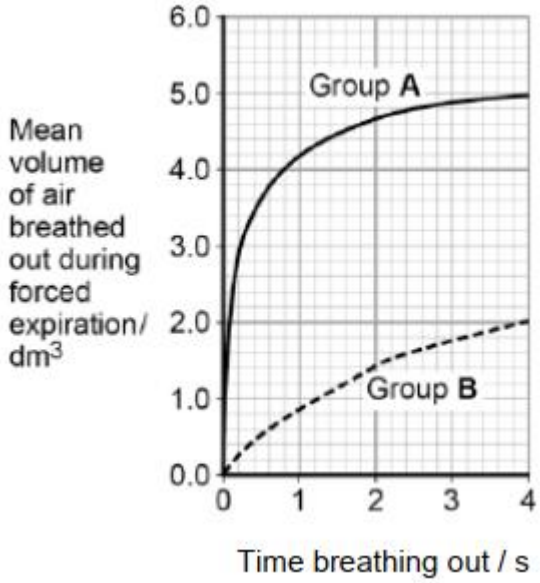
1. The table shows how environmental temperature affects the food intake, water intake and milk production of cows in a fixed period of time.

Environmental temperature / °C	Food intake / kg	Water intake / dm3	Milk production / dm3
20	18.2	81.8	27.0
25	17.7	88.6	25.0
30	17.0	95.0	22.9
35	16.7	144.1	18.0

Calculate the percentage decrease in milk production between the temperatures of 30 °C and 35 °C. Show your working. Answer

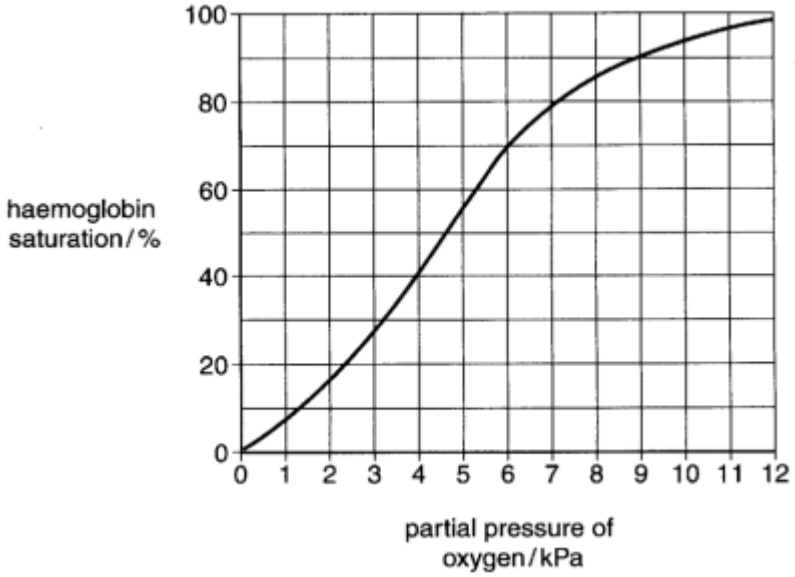
..... %

Q2. Forced expiration volume (FEV) is the volume of air a person can breathe out in 1 second.
Using data from the first second of forced expiration, calculate the percentage decrease in the FEV for group **B** compared with group **A**.



..... %

Q3. What is the **percentage change** in the saturation of haemoglobin between 4 and 9 kPa O2?



Answer ..... %

Task 8: Calculating Rate

This section requires you to understand how to calculate rates change from given data. This is a common skill required in A Level Biology exams. Read the worked examples and complete the questions.

You **MUST** show your working.

You may wish to watch the https://www.youtube.com/watch?v=CbfxFBfB7kk&list=PL0Mjub5NT756MyHewhXhdRSIygaF_woF3&index=4&t=0s **from 3:55** video on the NCP Biology You tube channel in order to help you with the follow section.

Rate just means 'change per unit time'. To calculate rate, you divide by time.

Worked Examples:

A. A heart beats 3240 times in 45 minutes. Calculate the heart rate in beats/min.

$$\text{Heart rate} = \frac{3240}{45} = 72 \text{ beats/min}$$

B. In an experiment to demonstrate water uptake by a leaf, volume of water taken up over a 12 hour period was measured over 5 days. The results were: 24 cm3; 21 cm3; 30 cm3; 28 cm3 and 26 cm3. Calculate the mean rate of water uptake per hour.

Mean rate of water uptake = total volume taken up / time

= (24 + 21 + 30 + 28 + 26) / (5x12) = 21.5 cm^3

Calculating the rate when the line is a curve

Sometimes the rate of a reaction changes **over time** eg. as substrate is used up in an enzyme controlled reaction. To calculate rate at a point on a curve we need to draw a tangent to the curve at that point. We can then calculate rate using the tangent line

Draw a tangent to the curve. To calculate the gradient, change in Y axis divided by change in time (shown on the X axis).

https://www.youtube.com/watch?v=CbfxFBfB7kk&list=PL0Mjub5NT756MyHewhXhdRSIygaF_woF3&index=4&t=0s **from 19:30**

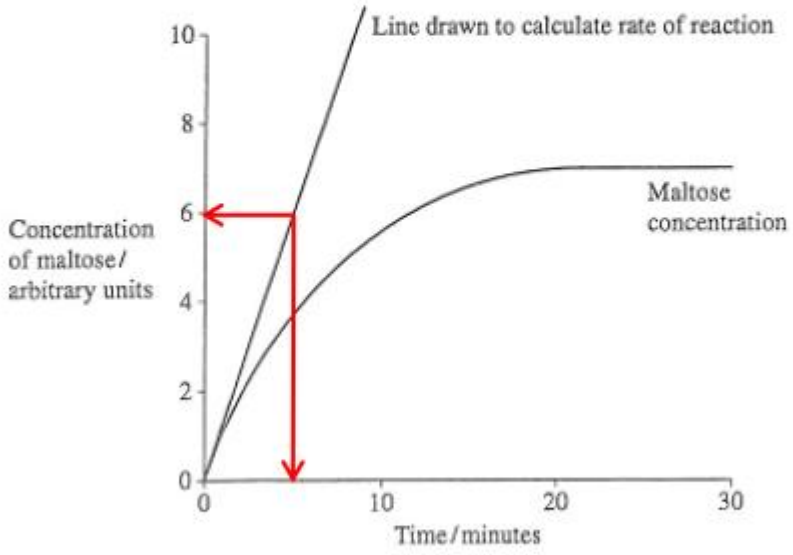
Example

8 Amylase is an enzyme. It catalyses the reaction

$$\text{starch} \xrightarrow{\text{amylase}} \text{maltose}$$

Students mixed a starch solution with amylase. They recorded the concentration of maltose at intervals for 30 minutes. **Figure 1** shows their results.

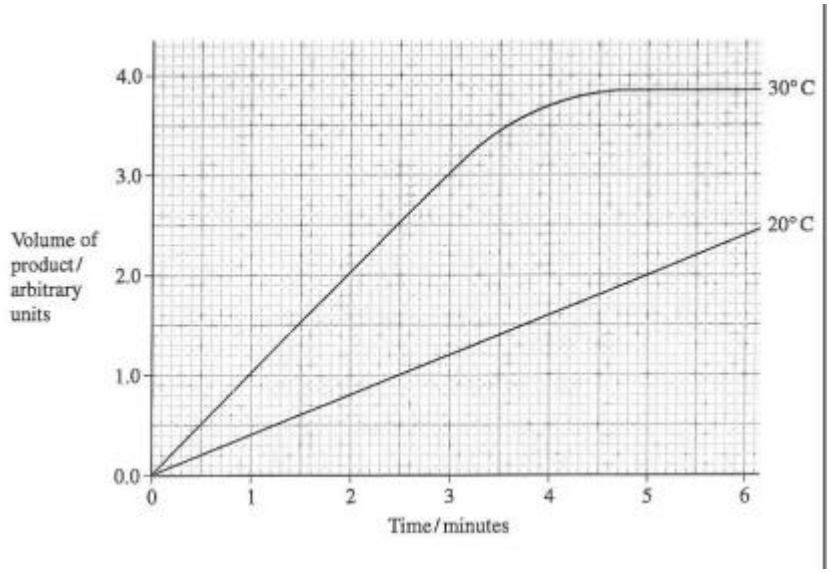
Figure 1



Rate = $\frac{\text{value on y axis}}{\text{time on x axis}} = \frac{6 \text{ AU}}{5 \text{ mins}} = 1.2 \text{ AUmin}^{-1}$

Practise Questions

Q1.



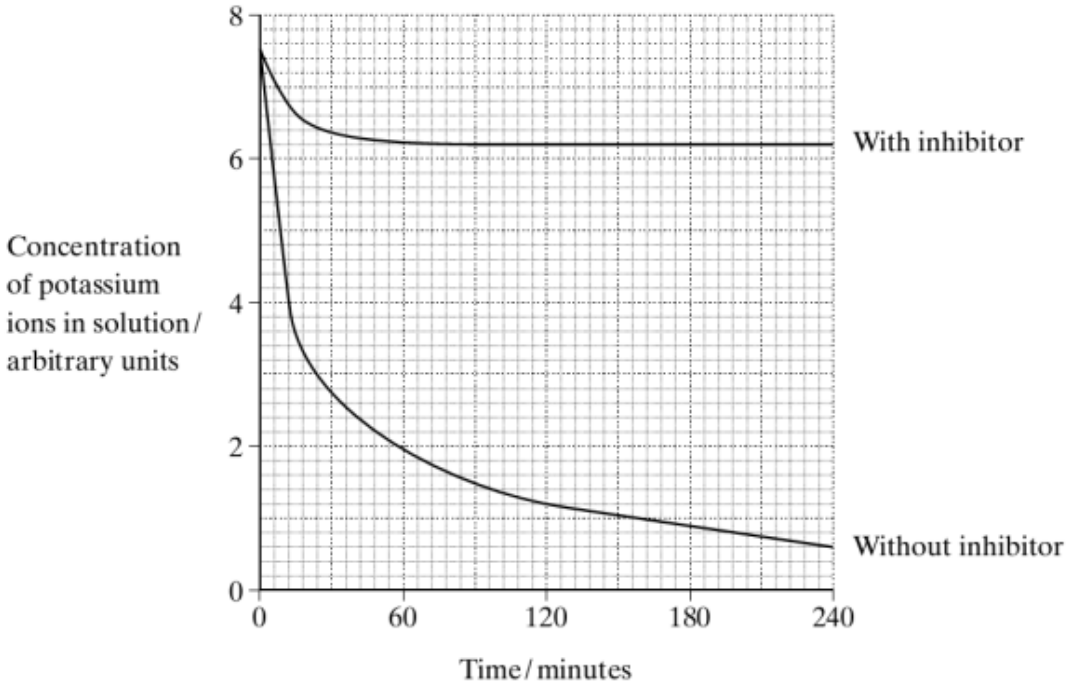
Calculate the rate of reaction of the enzyme at 4 minutes at

i) 20oC

ii) 30oC

Q2.

Two samples of the roots of pea plants were placed in solutions containing potassium ions. An inhibitor to prevent respiration was added to one solution. The concentrations of potassium ions in the two solutions were measured at regular intervals. The graph shows the results.



i) Calculate the initial rate of uptake of potassium ions without inhibitor.

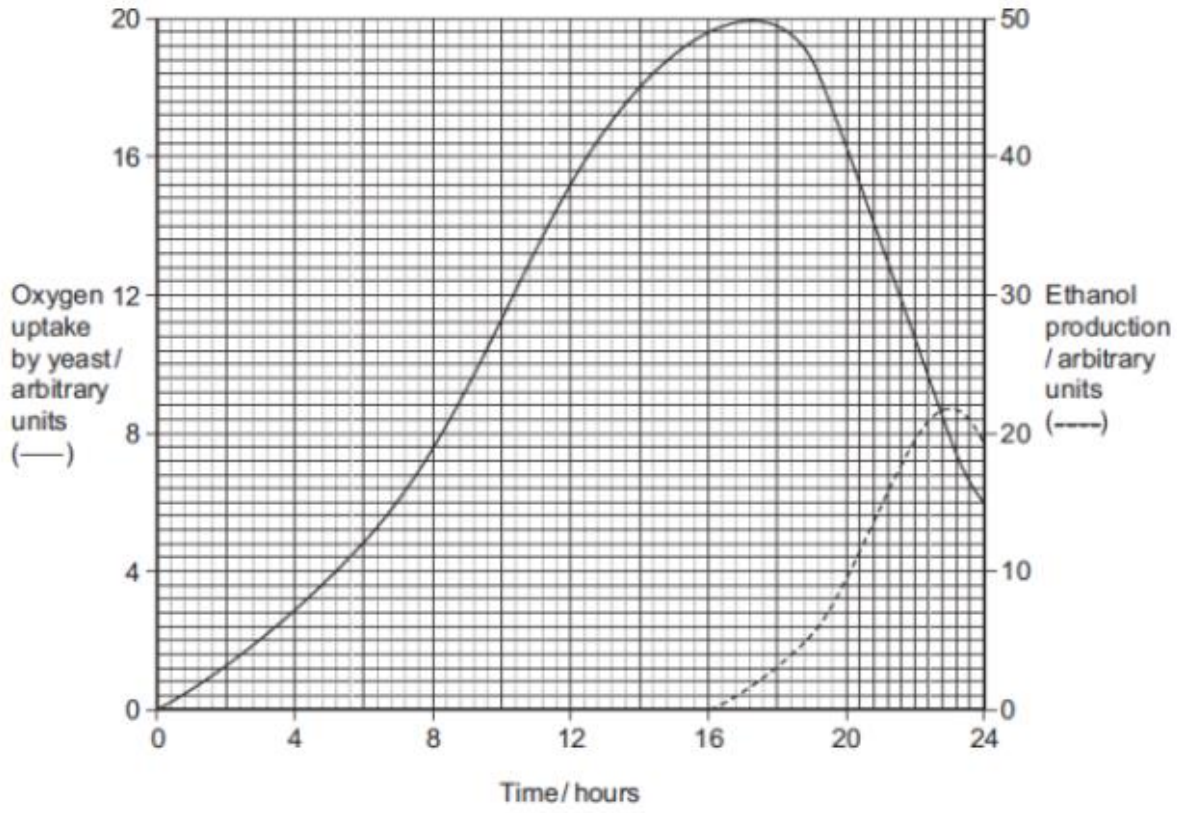
(1)

ii) Calculate the rate of uptake of potassium ions without inhibitor at 60 minutes.

(1)

Q3.

Yeast is a single-celled organism. A student investigated respiration in a population of yeast growing in a sealed container. His results are shown in the graph.



(a) Calculate the rate of oxygen uptake in arbitrary units per hour between 2 and 4 hours.

Answer ..... arbitrary units per hour

(1)

Task 9: Calculating ratios.

This section requires you to understand how to calculate ratios from given data.

This is a common skill required in A Level Biology exams. Read the worked examples and complete the questions.
You **MUST** show your working.

You may wish to watch the https://www.youtube.com/watch?v=CbfxFBfB7kk&list=PL0Mjub5NT756MyHewhXhdRSIygaF_woF3&index=4&t=0s **from 0:30** video on the NCP Biology You tube channel in order to help you with the follow section

A ratio is a way to compare amounts of something. Recipes, for example, are sometimes given as ratios. To make pastry you may need to mix 2 parts flour to 1 part fat. This means the ratio of flour to fat is 2:1

When calculating a ratio divide the first value by the second value then divide the second value by itself.

Worked example.

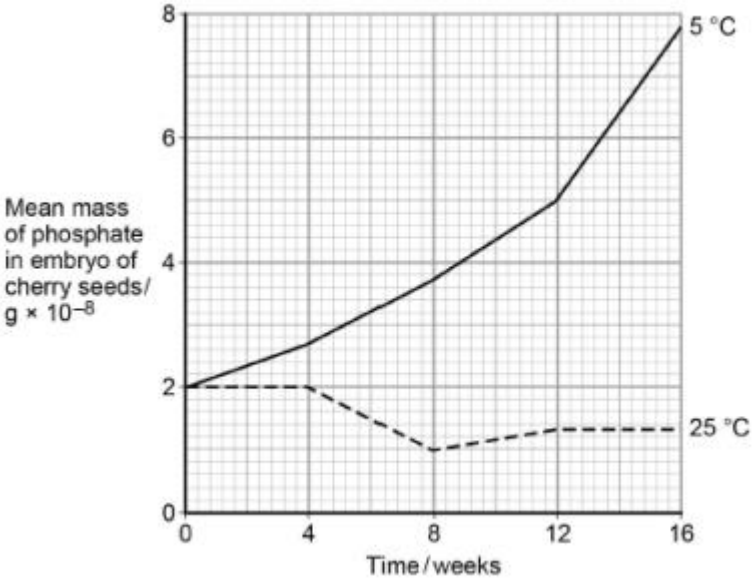
A zoo has a population of monkeys. 56 are female and 19 are male. What is the ratio of females to males?

$\frac{56}{19} = 1.3$ $\frac{19}{19} = 1$ *the ratio is 1.3:1*

It is important that the number are presented in the same order as the question. In this case it is female's first them males.

Q1. The seeds of some plant species require chilling (exposure to low temperatures) before the embryos they contain grow into plants. During chilling, storage molecules in the seed that contain phosphate are broken

down and phosphates are transported to the embryo. Scientists investigated the change in the mass of phosphate in the embryos of cherry seeds exposed to two different temperatures for 16 weeks.
The following graph shows their results.

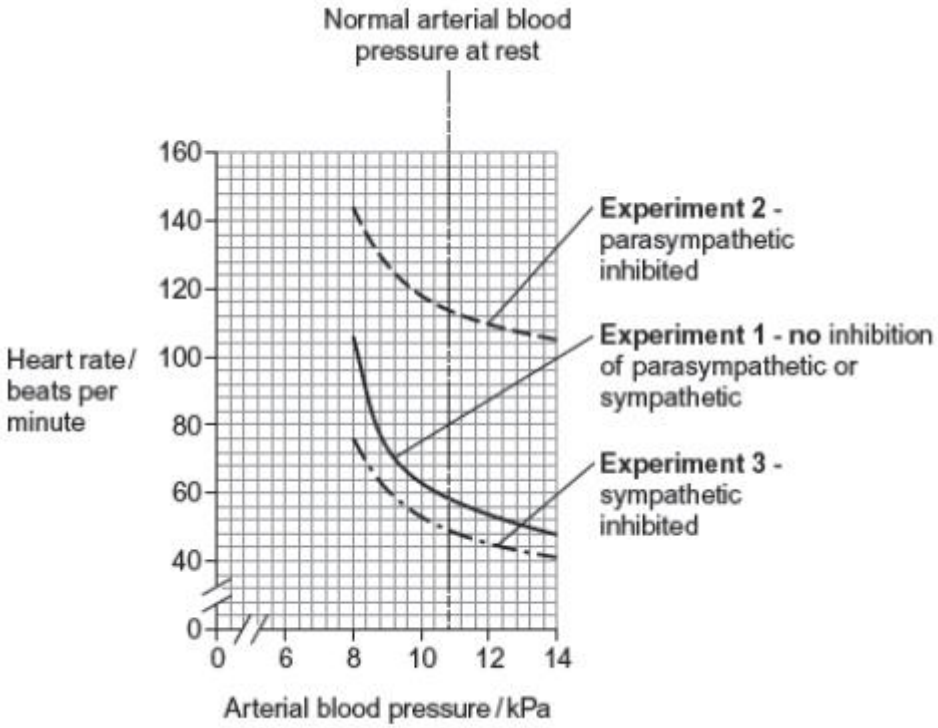


Calculate the ratio of the mean mass of phosphate found at 5 °C to the mean mass of phosphate found at 25 °C after 9 weeks of chilling.

Ratio = ...**(1)**

Q2. Doctors investigated the relationship between heart rate and arterial blood pressure. They recruited healthy volunteers. For each volunteer, they recorded their normal arterial blood pressure at rest. With each

volunteer, they then carried out the following experiments.
The graph shows the results for one volunteer.



Calculate the ratio of heart rate in **experiment 2** to heart rate in **experiment 3** at an arterial blood pressure of 10 kPa.
Show your working.

Answer = ...
(2)

Q3. Researchers investigated some characteristics of people from different parts of England. In the north of England they selected 200 people and recorded their phenotypes for three different

characteristics.
Their results are shown in the figure below.

Phenotype produced by dominant allele	**Number of people**	**Phenotype produced by recessive allele**	**Number of people**
Tongue roller	131	Non-tongue roller	58
Right-handed	182	Left-handed	14
Straight thumb	142	Hitch-hiker thumb	50

Calculate the ratio of straight thumb to hitch-hiker thumb in this study.

Ratio = ... **(1)**

Task 10: Standard Form

The Rules of Standard Form Calculation

Multiplying numbers in standard form

Multiply the main numbers first then add the powers together.

Dividing numbers in standard form

Divide the main numbers first then subtract the second power from the first.

The Rules of Working with Negative and Positive numbers

Adding a negative number is the same as subtracting:

eg 7 + (−3) is the same as 7 − 3 = 4

Subtracting a negative number is the same as adding:

eg (−5) − (−2) is the same as (−5) + 2 = −3

- Positive × positive = **positive**
- Positive × negative = **negative**
- Negative × positive = **negative**
- Negative × negative = **positive**

If the signs are the **same**, the answer is **positive**. If the signs are **different**, the answer is **negative**.

Note - you can use a scientific calculator in all A level Biology exams so make sure you can carry out calculations involving standard form on a calculator.

CONVERTING SCIENTIFIC NOTATION TO STANDARD FORM:

2.4×10^9

1. THIS NUMBER IS WRITTEN IN SCIENTIFIC NOTATION.
2. TO CHANGE IT TO STANDARD FORM, SIMPLY MOVE THE DECIMAL 9 PLACES TO THE RIGHT BECAUSE THE EXPONENT OR POWER OF 10 IS 9.

0.0000000024

0.0050 mol dm–3

is equivalent to

5.0 × 10–3 mol dm–3

E.g. $0.56 = 5.6 \times 10^{-1}$

$0.0564 = 5.64 \times 10^{-2}$

$0.005648 = 5.648 \times 10^{-3}$

$0.00231 = 2.31 \times 10^{-3}$

Standard Form Worksheet

[C] indicates a calculator can be used

1. Write these ordinary numbers in Standard Index Form

a. 30000 b. 420000 c. 545000 d. 26750.7 e. 105000000

f. 0.0078 g. 0.00000672 h. 780.5 i. 0.0603 j. 0.00000901

2. Write these numbers that are in Index Form as an ordinary number

a. 3×10^4 b. 6.5×10^7 c. 12.6×10^6 d. 0.6×10^2 e. 6.251×10^8

f. 4×10^{-5} g. 7.21×10^{-4} h. 0.03×10^{-3} i. 9.887×10^{-6} j. 12.999×10^{-6}

3. Work out the following giving your answer in Standard Index Form **[C]**

a. $3.4 \times 10^5 \times 2.5 \times 10^7$ b. $8.4 \times 10^3 \times 2.1 \times 10^4$ c. $5.8 \times 10^{-3} \times 0.25 \times 10^7$

d. $0.034 \times 10^4 \times 7.1 \times 10^9$ e. $13.4 \times 10^5 \times 3.1 \times 10^7 \times 3$

4. Work out the following giving your answer in Standard Index Form

a. $\dfrac{8\times10^7}{2\times10^3}$ b. $\dfrac{6.2\times10^7}{3.1\times10^{-2}}$ c. $\dfrac{26\times10^{-6}}{2\times10^{-3}}$ d. $\dfrac{10\times10^{10}}{0.01\times10^{-4}}$

5. If $p = 3.41 \times 10^6$ and $q = 12.1 \times 10^{-2}$. Find in standard Index Form **[C]**

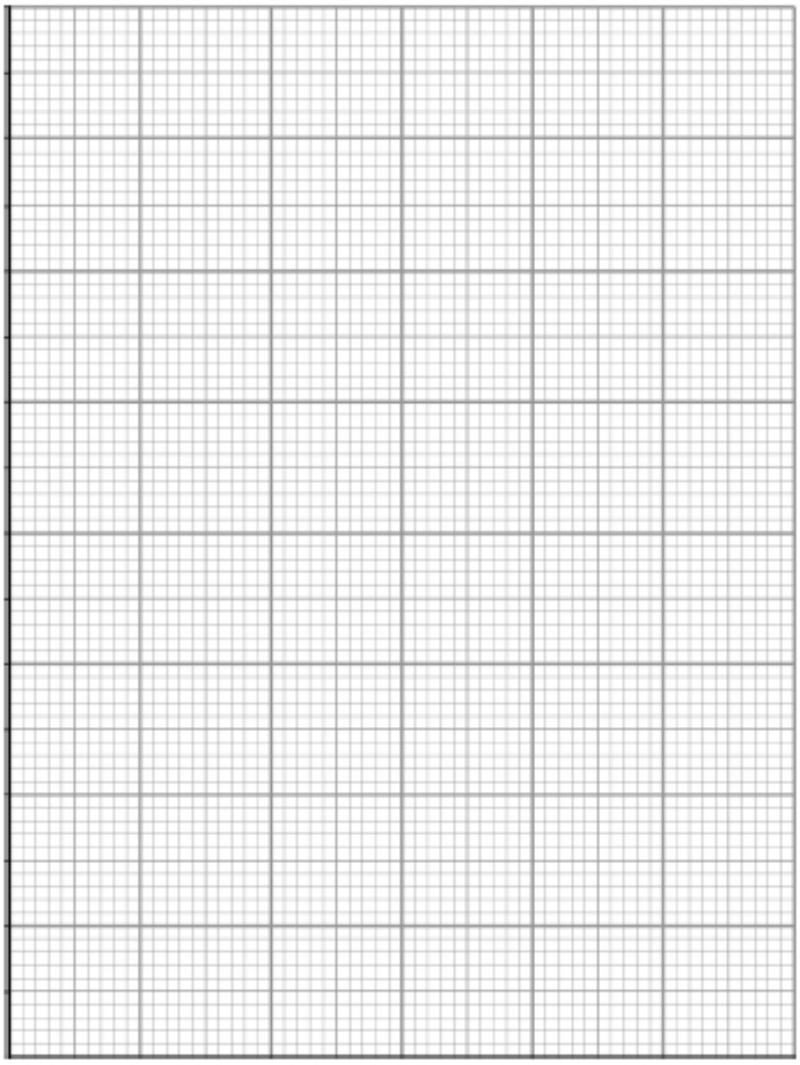
a. $p \times q$ b. $p \div q$ c. $2p \times 6q$ d. $p^2 \div q$

Task 11: Graph drawing

The enzyme catalase reacts with hydrogen peroxide to produce oxygen.

a) Calculate the rate of reaction and fill in the table.
b) Plot a graph of concentration against rate.
c) Describe your results

Concentration of Enzyme / mol dm^{-3}	Volume of oxygen produced in 5 minutes / cm^3	Rate of reaction / cm^3 min^{-1}
0	0	
0.05	2	
0.1	4	
0.2	8	
0.5	10	
1.0	10	



A Level Biology Summer Independent Learning Activity – Answers

Part 1

Task 1: Structure of carbohydrates

What is a monomer?

- **Single subunit. Many are joined together to form a polymer.**

What is a polymer?

- **Made from many monomers joined together**

Can you describe what a condensation reaction is?

- **Formation of a bond with the removal of water**

Can you describe what a hydrolysis reaction is?

- **Breaking a bond using water**

Can you describe how larger carbohydrates are made from monosaccharide monomers?

- **Condensation of monosaccharides forming a glycosidic bond**

Can you list some common monosaccharides?

- **Glucose, Fructose, Galactose**

Can you describe how disaccharides are formed?

- **2 monosaccharides join by a glycosidic bond together via condensation reaction.**

What are maltose, sucrose and lactose formed from?

Maltose made from: 2 x alpha glucose monomers

Sucrose made from: 1 x glucose and 1 x fructose

Lactose made from: 1 x glucose and 1 x galactose

Draw a diagram to show how a condensation reaction occurs between two monosaccharides to form maltose. Label the bond that forms.

See video

Can you explain how glycogen and starch are formed?

- **Many alpha glucose monomers join by a glycosidic bond together via condensation reaction.**
- **Starch forms a helix held together by hydrogen bonds**
- **Glycogen is branched**

<u>Task 2: Lipid Structure</u>

Can you explain how triglycerides are formed? Draw a diagram to show this happening. Label the molecules involved, the type of reaction and the types of bonds formed.

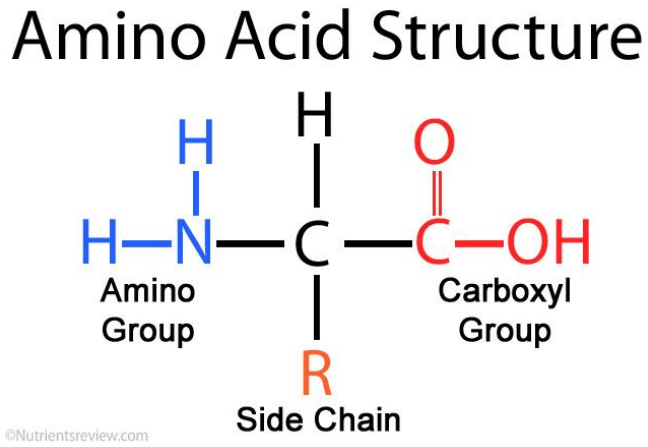
See the video

Can you explain that the R-group of a fatty acid may be saturated or unsaturated? What do these terms mean?

Saturated – when there are no C=C bonds in the hydrocarbon chain (i.e. the R group part)

Task 3: Protein structure

What is the general structure of an amino acid?



How do two amino acids form a dipeptide?

- **2 amino acids join via condensation reactions. Held together by a peptide bond**

Describe the following protein structures:

Primary structure: The sequence/order of amino acids that makes up the polypeptides of a protein.

Secondary structure: The way in which the chain of amino acids in a protein is folded. This forms alpha helix and Beta sheets. Structure held in place by hydrogen bonds

Tertiary structure: The further folding and coiling of the secondary structure to give the protein its 3D shape. Held in place by hydrogen, ionic and disulphide bonds. The tertiary structure is important e.g. the shape of an enzymes active site must be complementary shape to the substrate so they can fit.

Can you describe the role of hydrogen bonds, ionic bonds and disulfide bridges in the structure of proteins?

- Hydrogen bonds hold the alpha helix and Beta sheets in place in the secondary structure.
- **hydrogen bonds, ionic bonds and disulfide bridges hold the tertiary structure in place (keeps the protein in that shape)**

Task 4: Enzyme definitions.

This section revises many of the key terms for GCSE to do with enzyme structure and function. A GCSE level question follows to assess your understanding. Whilst most of the definitions are from the GCSE specification you may find that some are unfamiliar to you.

Define these key words.

Enzyme: A protein that acts as a biological catalysts lowering the activation energy of a reaction to alter its speed.

Active site: The shape specific region of an enzyme that is complimentary to the substrate.

Substrate: A substance that is acted on by an enzyme. It is complimentary to the enzymes active site.

Activation energy: The energy required to bring about a reaction.

Denature: Permanent change in a proteins 3D shape due to unravelling of the amino acid chain.

Q1. (a) Enzymes are used in body cells.

(i) What is an enzyme?

Draw a ring around the correct answer.

an antibody **(a catalyst)** **a hormone** **(1)**

(ii) All enzymes are made of the same type of substance.

What is this substance?

Draw a ring around the correct answer.

carbohydrate **fat** **protein**

(1)

(iii) Where is the enzyme amylase produced in the human body?

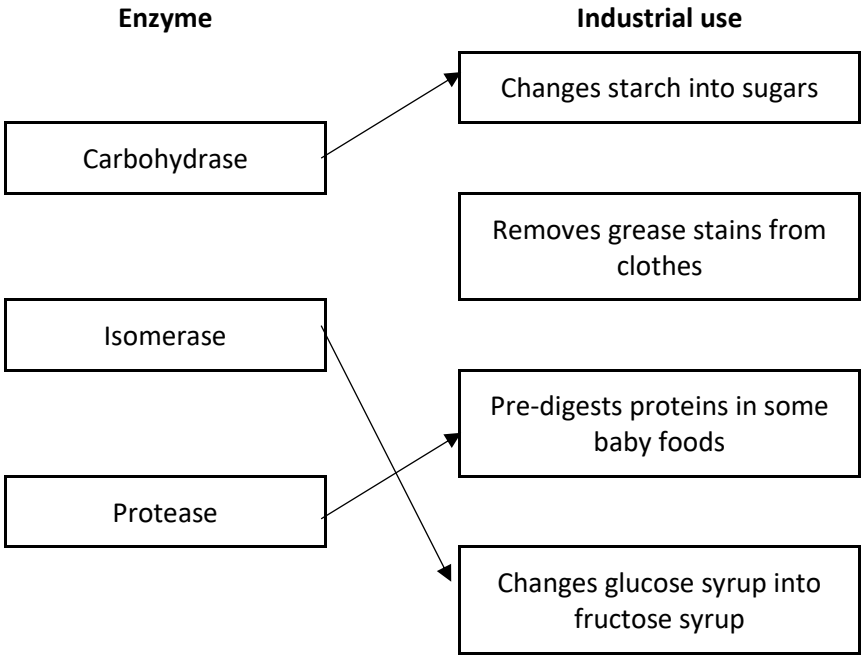
Draw a ring around the correct answer.

liver **salivary glands** **stomach**

(1)

(b) Enzymes are sometimes used in industry.

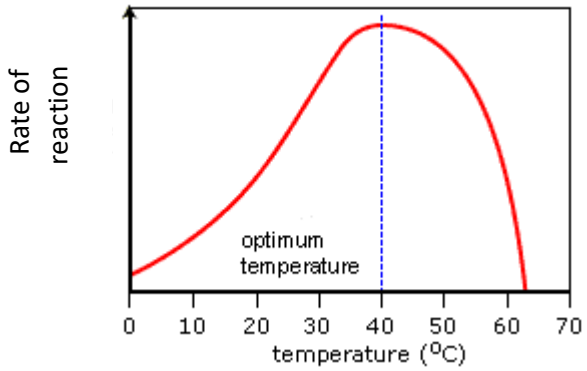
Draw **one** line from each enzyme to the correct industrial use of that enzyme.



(3)(Total 6 marks)

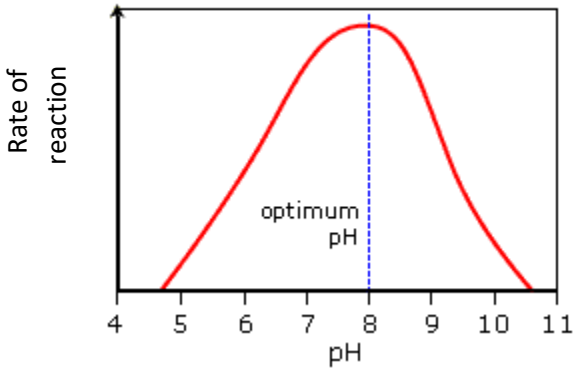
Task 5: Interpreting enzyme graphs.

Q1. **Change in temperature.**



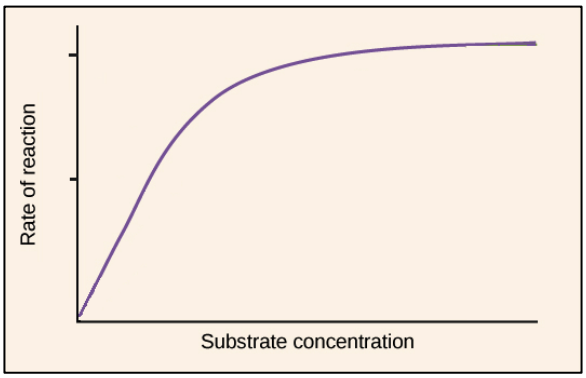
As temperature increase the enzyme & substrate gain more kinetic energy. There are more frequent successful collision, this increases the rate of reaction to its optimum at 400C. After this the increase in temperature causes H bonds to break. This means both the secondary and tertiary structures are lost and the enzymes active site is no longer complimentary to the substrate. The enzyme is denatured and the rate of reaction drops. No Enzyme substrate complexes can form.

Q2. **Change in pH.**



Any change in pH causes H bonds to break. This means both the secondary and tertiary structures are lost and the enzymes active site is no longer complimentary to the substrate. The enzyme is denatured and the rate of reaction drops. No Enzyme substrate complexes can form.

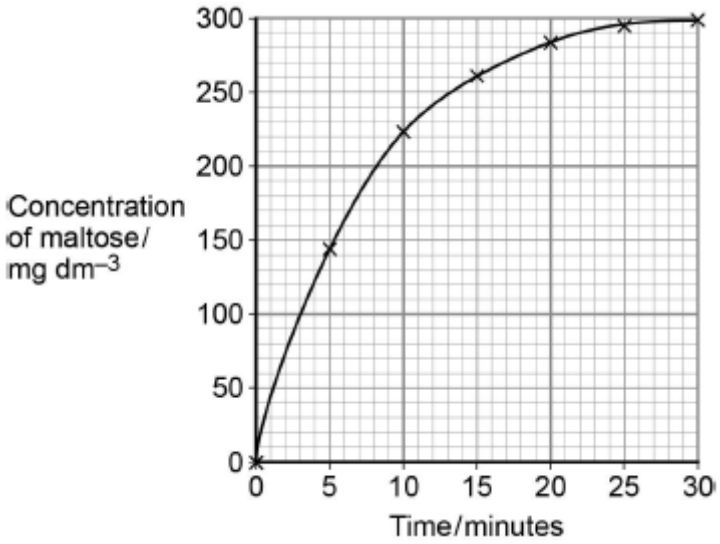
Q3. **Change substrate concentration.**



An increase in substrate increases rate of reaction as there is an increased chance in enzymes substrate complexes forming. At a certain substrate concentration the rate of reaction plateaus. This is due to the enzymes actives sites becoming saturated with substrate.

Q4. A scientist investigated the hydrolysis of starch. He added amylase to a suspension of starch and measured the concentration of maltose in the reaction mixture at regular intervals.

His results are shown in the graph below.



Explain the results shown in the graph.

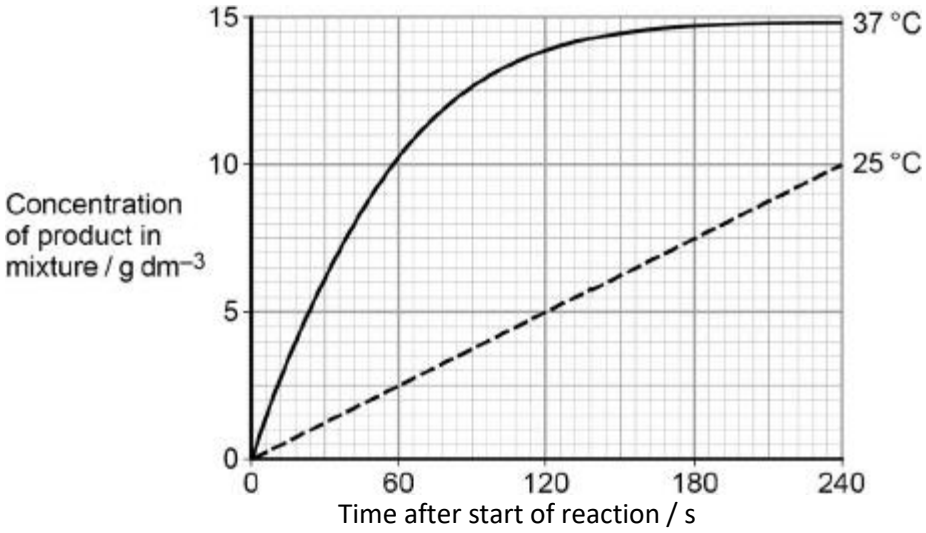
1. (Rate of) increase in concentration of maltose slows as substrate/starch is used up
   OR
   High initial rate as plenty of starch/substrate/more E-S complexes;
   Reject ref. to amylase being used up

2. No increase after 25 minutes/at end/levels off because no substrate/starch left;
   Accept 'little'
   Ignore references to substrate a limiting factor

(2)

Q2. A technician investigated the effect of temperature on the rate of an enzyme-controlled reaction. At each temperature, he started the reaction using the same volume of substrate solution and the same volume of enzyme solution.

The figure below shows his results.



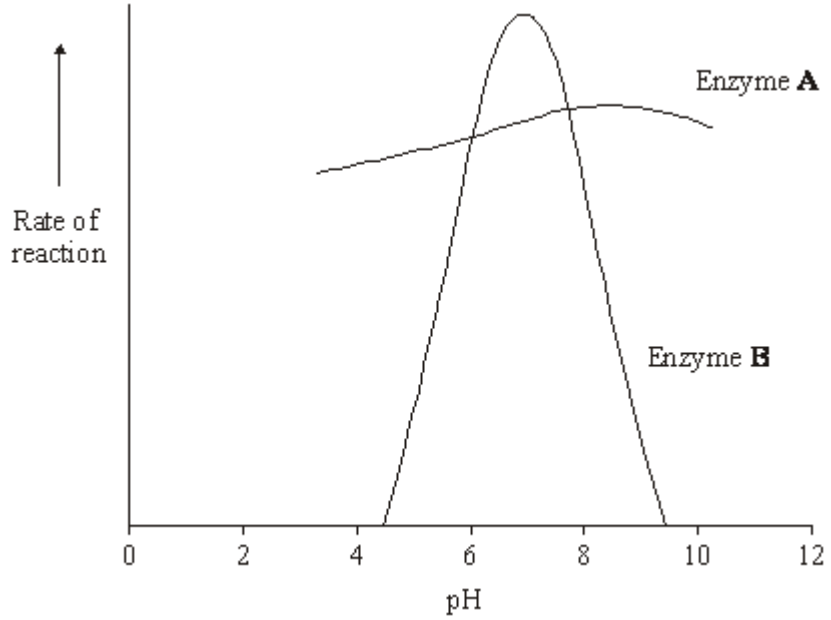
(a) Describe and explain the differences between the two curves.

1. Initial rate of reaction faster at 37 °C;
2. Because more kinetic energy;
3. So more E–S collisions / more E–S complexes formed;
4. Graph reaches plateau at 37 °C;
5. Because all substrate used up.

Allow converse for correct descriptions and explanations for curve at 25 °C

(5)

Q3. Enzymes **A** and **B** digest protein. The graph shows the effect of pH on the rates of reaction of these enzymes.



(a) Pepsin is a protein-digesting enzyme found in the stomach. It has an optimum pH of 2 and is fully denatured at pH 6. Sketch a curve on the graph to show the effect of pH on the rate of reaction of pepsin.

curve rising to peak at pH 2 and falling to zero by pH 6;

(1)

(b) Explain why the rate of reaction of enzyme **B** is low at pH 5.

(change in pH) leads to breaking of bonds holding tertiary structure / changes charge on amino acids; enzyme / protein / active site loses shape / denatured; substrate will not bind with / fit active site / fewer / no ES complexes formed;

(3)

Task 6: Enzyme inhibition.

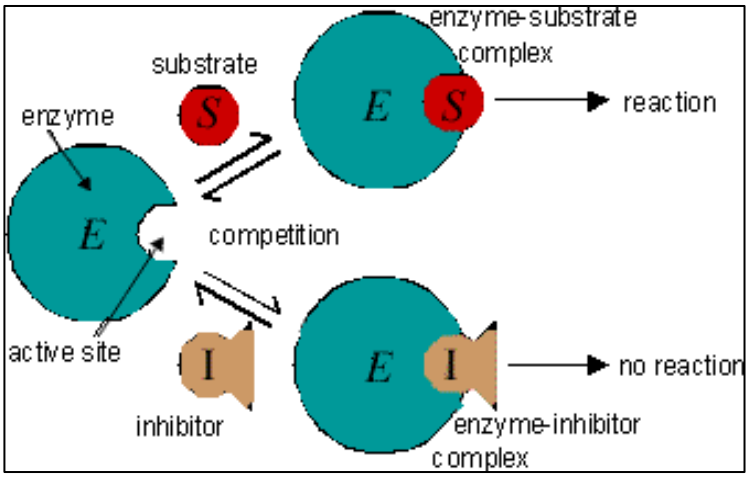
This section requires you to explain how different inhibitor molecules affect enzyme activity, together with how you can identify which type of inhibition is present.

A Level exam questions follow to assess your understanding.

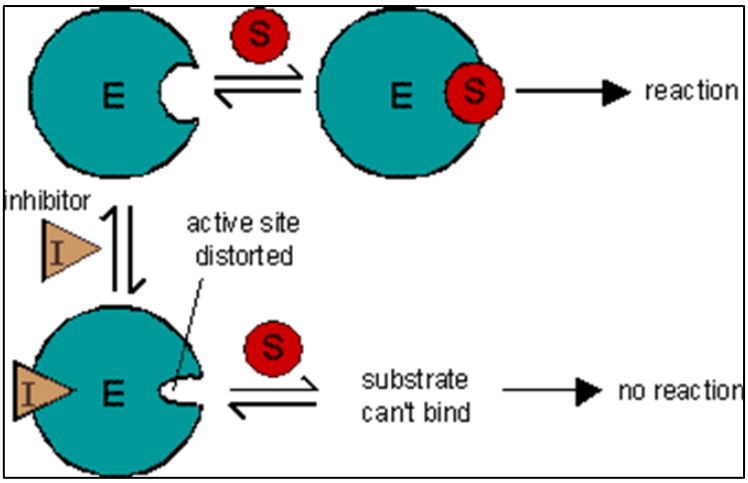
Using the following link watch the video and annotate each of the diagrams. You need to ***explain*** how each inhibitor affects enzyme activity.

https://www.youtube.com/watch?v=aJF6yIYahAQ

Competitive inhibition



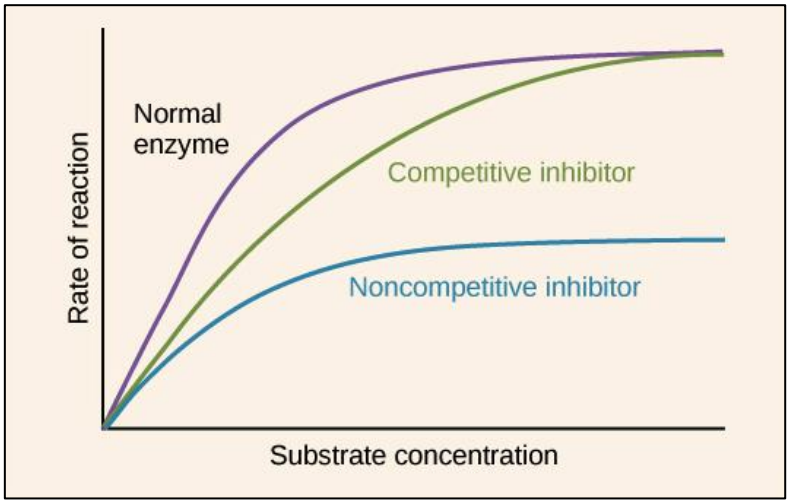
The inhibitor molecule is a SIMMILAR shape to the substrate. It binds to the active site meaning enzyme substrate complexes are unable to form. This decreases the rate of reaction. This is a reversible reaction. Adding more substrate will increase the rate of reaction as there is more chance of enzyme substrate complexes forming rather than the inhibitor binding to the active site.



Non-competitive inhibition.

The inhibitor molecule binds to the inhibitor site on the enzyme. This changes the shape of the active site so that it is no longer complementary to the substrate. The substrate is unable to bind with the enzymes active site and no enzyme substrate complexes form. The rate of reaction decreases. This is a reversible reaction. Adding more substrate will not increase the rate of reaction as the chance of the inhibitor binding to the inhibitor site is not affected.

Explain the shape of both inhibitor lines, including how you can identify the type of inhibition.



Competitive inhibitor:
The rate or reaction is lower than an enzyme without an inhibitor. This is because. The inhibitor molecule is a SIMMILAR shape to the substrate. It binds to the active site meaning enzyme substrate complexes are unable to form. This decreases the rate of reaction. The inhibitor can be identified because adding more substrate will increase the rate of reaction as there is more chance of enzyme substrate complexes forming rather than the inhibitor binding to the active site.

Non-competitive inhibitor:
The rate of reaction is lower than both normal and competitive inhibitor lines. This is because the inhibitor molecule binds to the inhibitor site on the enzyme. This changes the shape of the active site so that it is no longer complementary to the substrate. The substrate is unable to bind with the enzymes active site and no enzyme substrate complexes form. The rate of reaction is lower. Adding more substrate will not increase the rate of reaction because the chance of the inhibitor binding to the inhibitor site is not affected be the concentration of substrate

Q1. Scientists have investigated the effects of competitive and non-competitive inhibitors of the enzyme maltase.

Describe competitive and non-competitive inhibition of an enzyme.

1. Inhibitors reduce binding of enzyme to substrate / prevent formation of ES complex;

   Max 3 if only one type of inhibition dealt with. Accept maltase and maltose as examples of enzyme and substrate (and others)

   Only once, for either inhibitor

(Competitive inhibition),

2. Inhibitor similar shape (idea) to substrate;

3. (Binds) in to active site (of enzyme);

   Accept allows max rate of reaction to be reached / max product will eventually be formed

   Accept complementary to active site

4. (Inhibition) can be overcome by more substrate;

(Non-competitive inhibition),

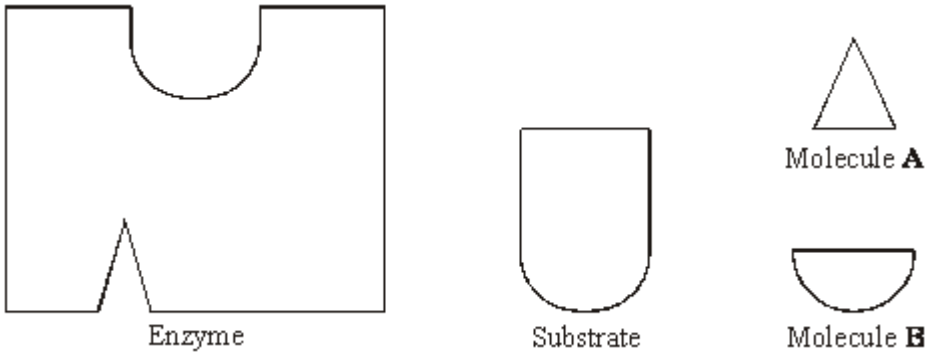
5. Inhibitor binds to site on enzyme other than active site;

6. Prevents formation of active site / changes (shape of) active site;

   Accept does not allow max rate of reaction to be reached / max product will not be formed

7. Cannot be overcome by adding more substrate; **(5)**

Q2. The diagrams represent an enzyme, its substrate and two other molecules, **A** and **B**.

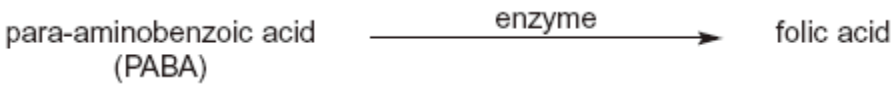


The addition of a non-competitive inhibitor will prevent the formation of an enzyme-substrate complex. Draw a labelled diagram based on relevant molecules selected from the diagram above to explain how this occurs.

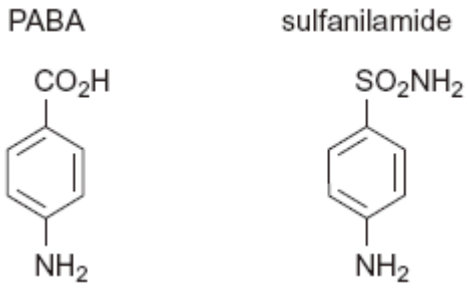
diagram showing molecule **A** fitting in inhibition site; distortion of active site;

(2)

Q3. Folic acid is a substance required by bacteria for cell growth. Bacteria produce folic acid by the following reaction.



The diagram shows the structure of a molecule of PABA. It also shows the structure of a molecule of a drug called sulfanilamide, which can be used to treat bacterial infections. Sulfanilamide prevents bacteria producing folic acid.



Use the diagram and your knowledge of enzymes to explain how sulphanilamide prevents bacteria producing folic acid.

Similar structure / shape (to PABA) / both complementary;

Competes for / binds to active site / competitive inhibitor;

Less PABA binds / less E-S complexes;

OR

Specific reference to different structure / shape (to PABA) using the diagram;

Binds to position other than active site / binds to allosteric site / binds to inhibitor site / non-competitive inhibitor;

Changes the active site so substrate cannot bind / less PABA binds / less E-S complexes **(Total 3 marks)**

Task 7: Calculating percentage change.

This section requires you to understand how to calculate percentage change from given data. This is a common skill required in A Level Biology exams. Read the worked examples and complete the questions.

You **MUST** show your working.

You may wish to watch the **"General maths you need to know"** video on the NCP Biology You tube channel in order to help you with the follow section.

$$\text{Percentage change} = \frac{\text{Change}}{\text{Original}} \times 100$$

Worked example.

The mean heigh of some seedlings is 12mm at day 6 and 18mm at day 12. What is the % change in height?

$$\%\ \text{change} = \frac{(18-12)}{12} \times 100 = 50\%$$

1. The table shows how environmental temperature affects the food intake, water intake and milk production of cows in a fixed period of time.

Environmental temperature / °C	Food intake / kg	Water intake / dm^3	Milk production / dm^3
20	18.2	81.8	27.0
25	17.7	88.6	25.0
30	17.0	95.0	22.9
35	16.7	144.1	18.0

Calculate the percentage decrease in milk production between the temperatures of 30 °C and 35 °C. Show your working.

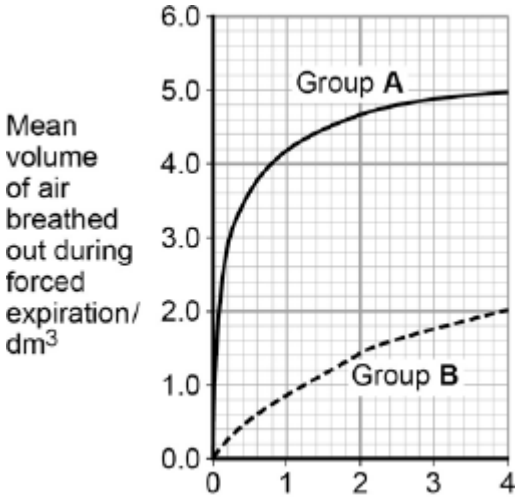
18-22.9

22.9 x100 = 21.4%

Answer ..... %

Q2. Forced expiration volume (FEV) is the volume of air a person can breathe out in 1 second.

Using data from the first second of forced expiration, calculate the percentage decrease in the FEV for group **B** compared with group **A**.

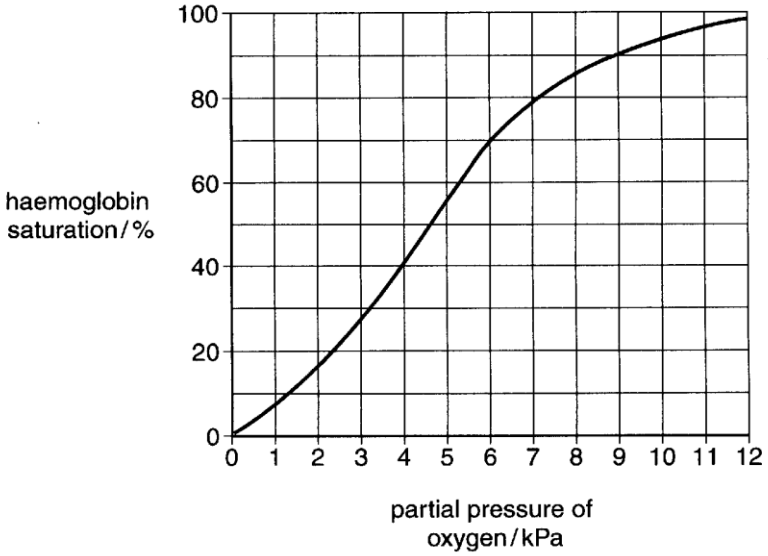


0.8-4.2

4.2 x100 = 80%

Answer ..... %

Q3. What is the **percentage change** in the saturation of haemoglobin between 4 and 9 kPa O_2?



90-40 = 50%

Answer ..... %

Task 8: Calculating Rate

This section requires you to understand how to calculate rates change from given data. This is a common skill required in A Level Biology exams. Read the worked examples and complete the questions.

You **MUST** show your working.

You may wish to watch the **"General maths you need to know"** video on the NCP Biology You tube channel in order to help you with the follow section.

Rate just means 'change per unit time'. To calculate rate, you divide by time.

Worked Examples:

A. A heart beats 3240 times in 45 minutes. Calculate the heart rate in beats/min.

$$\text{Heart rate} = \frac{3240}{45} = 72 \text{ beats/min}$$

B. In an experiment to demonstrate water uptake by a leaf, volume of water taken up over a 12 hour period was measured over 5 days. The results were: 24 cm^3; 21 cm^3; 30 cm^3; 28 cm^3 and 26 cm^3. Calculate the mean rate of water uptake per hour.

$$\text{Mean rate of water uptake} = \frac{\text{total volume taken up}}{\text{Time}} = \frac{24 + 21 + 30 + 28 + 26}{5x12}$$

$$= 21.5 \text{ cm}^3$$

Calculating the rate when the line is a <u>curve</u>

Sometimes the rate of a reaction changes **over time** eg. as substrate is used up in an enzyme controlled reaction. To calculate rate at a point on a curve we need to draw a tangent to the curve at that point. We can then calculate rate using the tangent line

Draw a tangent to the curve. To calculate the gradient, change in Y axis divided by change in time (shown on the X axis).

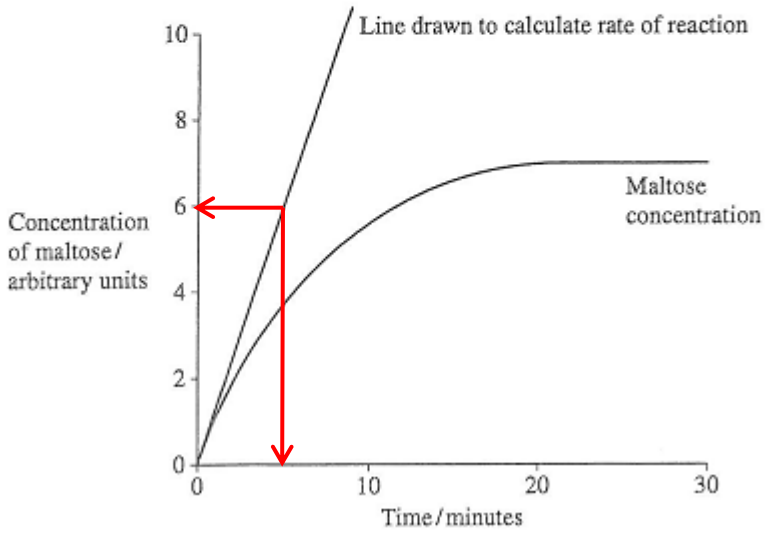
Example

8 Amylase is an enzyme. It catalyses the reaction

$$\text{starch} \xrightarrow{\text{amylase}} \text{maltose}$$

Students mixed a starch solution with amylase. They recorded the concentration of maltose at intervals for 30 minutes. **Figure 1** shows their results.

Figure 1



Rate = $\frac{\text{value on y axis}}{\text{time on x axis}} = \frac{6 \text{ AU}}{5 \text{ mins}} = 1.2 \text{ AUmin}^{-1}$

Practise Questions

Q1. Calculate the rate of reaction of the enzyme at 4 minutes at

i) 20°C

<u>1.6</u>

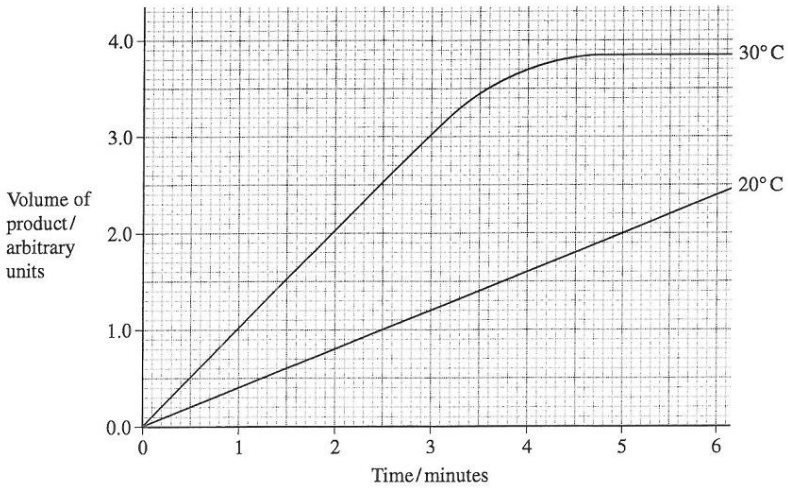
4 = 4

ii) 30°C

<u>3.7 – 2.2</u>

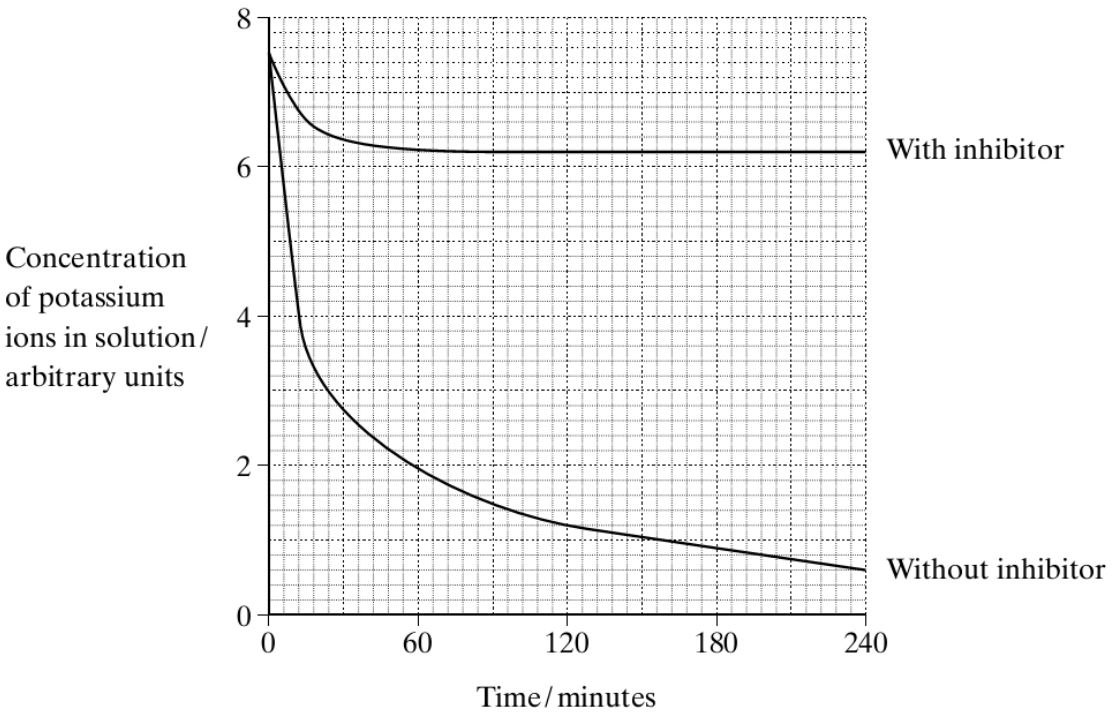
4 =0.37

4 (a) A student carried out an investigation into the volume of product formed in an enzyme-controlled reaction at two different temperatures. Temperature was the only variable that was changed. The graph shows the results.



Q2.

Two samples of the roots of pea plants were placed in solutions containing potassium ions. An inhibitor to prevent respiration was added to one solution. The concentrations of potassium ions in the two solutions were measured at regular intervals. The graph shows the results.



i) Calculate the initial rate of uptake of potassium ions without inhibitor

<u>7.4 – 0</u> = 0.62 AUmin -1

12

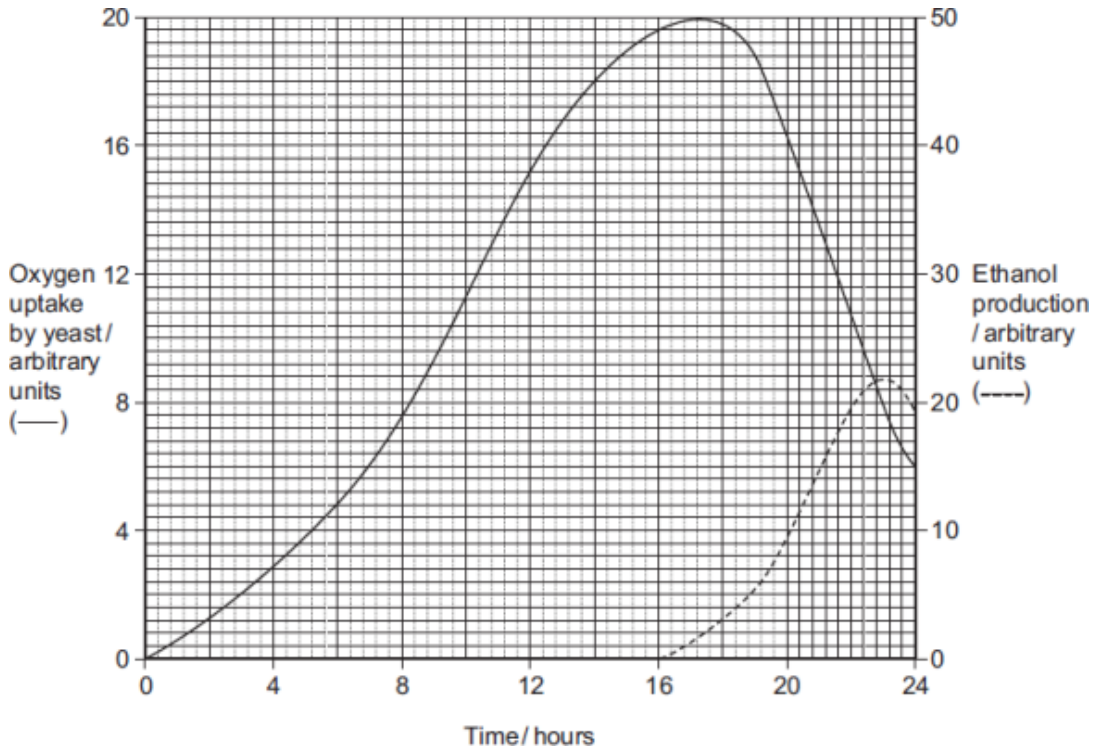
(1)

ii) Calculate the rate of uptake of potassium ions without inhibitor at 60 minutes.

$\frac{3-0}{156} = 0.02$ AUmin -1

(1)

Q3. Yeast is a single-celled organism. A student investigated respiration in a population of yeast growing in a sealed container. His results are shown in the graph.



(a) Calculate the rate of oxygen uptake in arbitrary units per hour between 2 and 4 hours.

$\frac{2.8 - 1.2}{2} = 0.8$

Answer ..... arbitrary units per hour

(1)

Task 9: Calculating ratios.

This section requires you to understand how to calculate ratios from given data. This is a common skill required in A Level Biology exams. Read the worked examples and complete the questions.

You **MUST** show your working.

You may wish to watch the **"General maths you need to know"** video on the NCP Biology You tube channel in order to help you with the follow section

A ratio is a way to compare amounts of something. Recipes, for example, are sometimes given as ratios. To make pastry you may need to mix 2 parts flour to 1 part fat. This means the ratio of flour to fat is 2:1

When calculating a ratio divide the first value by the second value then divide the second value by itself.

Worked example.

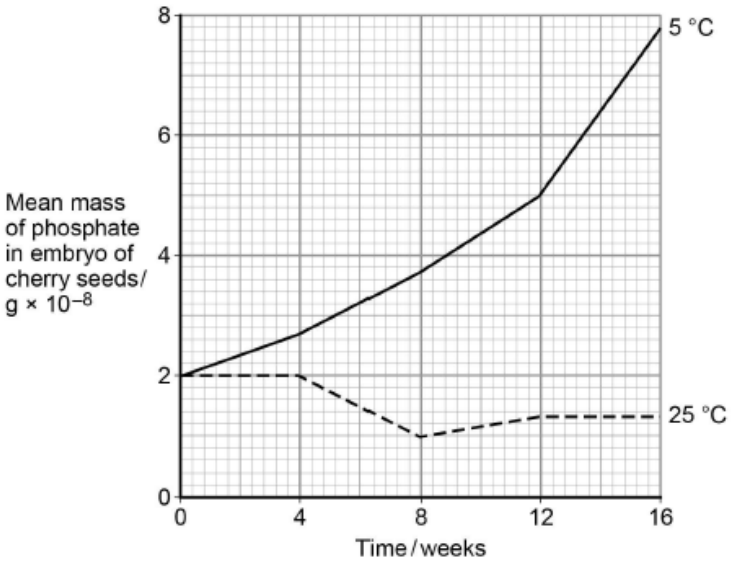
A zoo has a population of monkeys. 56 are female and 19 are male. What is the ratio of females to males?

56	*19*
19 = 1.3	*19= 1 the ratio is 1.3:1*

It is important that the number are presented in the same order as the question. In this case it is female's first them males.

Q1. The seeds of some plant species require chilling (exposure to low temperatures) before the embryos they contain grow into plants. During chilling, storage molecules in the seed that contain phosphate are broken down and phosphates are transported to the embryo. Scientists investigated the change in the mass of phosphate in the embryos of cherry seeds exposed to two different temperatures for 16 weeks.

The following graph shows their results.



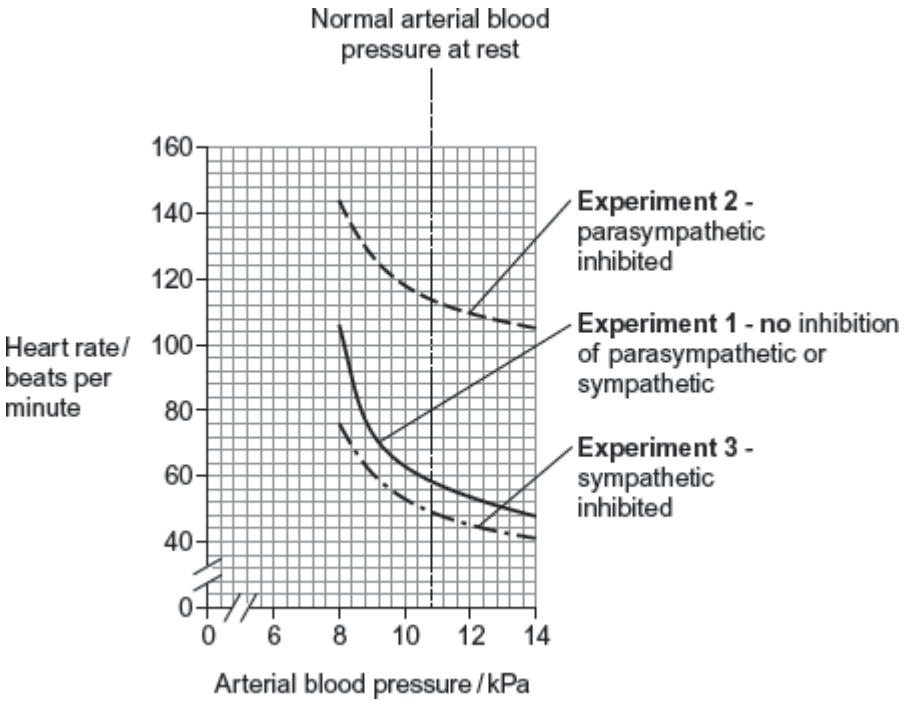
Calculate the ratio of the mean mass of phosphate found at 5 °C to the mean mass of phosphate found at 25 °C after 9 weeks of chilling.

4.4	1.2
1.2	1.2

Ratio 3.67:1.....**(1)**

Q2. Doctors investigated the relationship between heart rate and arterial blood pressure. They recruited healthy volunteers. For each volunteer, they recorded their normal arterial blood pressure at rest. With each volunteer, they then carried out the following experiments.

The graph shows the results for one volunteer.



Calculate the ratio of heart rate in **experiment 2** to heart rate in **experiment 3** at an arterial blood pressure of 10 kPa.
Show your working.

116 52

52 52

Answer = ...2.23:1.....

(2)

Q3. Researchers investigated some characteristics of people from different parts of England. In the north of England they selected 200 people and recorded their phenotypes for three different characteristics.

Their results are shown in the figure below.

Phenotype produced by dominant allele	Number of people	Phenotype produced by recessive allele	Number of people
Tongue roller	131	Non-tongue roller	58
Right-handed	182	Left-handed	14
Straight thumb	142	Hitch-hiker thumb	50

Calculate the ratio of straight thumb to hitch-hiker thumb in this study.

142:50

Ratio = ..2.84:1..... **(1)**

1. The enzyme catalase reacts with hydrogen peroxide to produce oxygen.

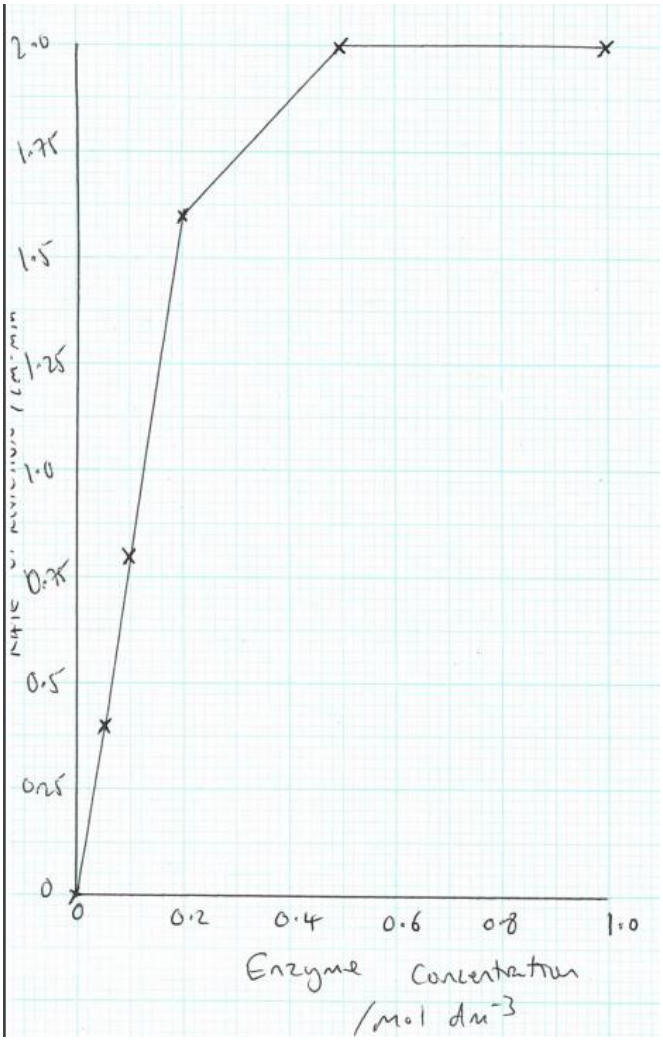
a) Calculate the rate of reaction and fill in the table.

b) Plot a graph of concentration against rate.

c) Describe your results

As concentration of enzyme increases, the rate of reaction increases up to 0.5 mol dm-3 after this the rate levels off.

Concentration of Enzyme / mol dm^{-3}	Volume of oxygen produced in 5 minutes / cm^3	Rate of reaction / cm^3 min^{-1}
0	0	0
0.05	2	0.4
0.1	4	0.8
0.2	8	1.6
0.5	10	2.0
1.0	10	2.0


2.0
1.75
1.5
1.25
1.0
0.75
0.5
0.25
0
0
0.2
0.4
0.6
0.8
1.0
Enzyme Concentration
/mol dm⁻³