BTEC AAQ MEDICAL SCIENCE TRANSITION WORK BOOKLET

Welcome

How does a Level 3 course compare to GCSE? In simple terms, there is no comparison! While there are relatively small advances between key stage 3 up to GCSE's, there is a huge leap from GCSE's to Level 3. In addition, the way you study changes. You must be more responsible for your own learning and work independently out of lessons to help consolidate what you have learnt.

As a rule of thumb, if you are finding Level 3 qualifications easy, then you are not working hard enough! Some successful strategies…. Your GCSE knowledge will be assumed knowledge i.e. you already know and understand this knowledge completely. The aim is not to re-teach GCSE so that you finally understand it; the aim is to use this knowledge as the starting point for a higher level. Attending lessons is not enough. You will be expected to spend at least the same amount of time studying outside of timetabled lessons. Use your free periods wisely to recap content we have been over in lessons and read ahead, and it is important you keep up with coursework deadlines. Notes that you take during lessons will not be sufficient. These notes will only provide a framework. You will be expected to add to them and enhance them from your independent study. You should do as much background reading as possible.

Session 6 may take place once a week and many students find this important to attend to address any areas they are unsure of and get help. If you get behind with your work you may be asked to attend after school, or lunchtime catch up sessions – so keep up and let your teachers know as soon as issues arise.

What NOT TO DO if you want to succeed!!

Do so little over the summer so that not only have you forgotten most of the biology, but you can also barely remember how to write!

Carry on working at the same rate as you did for your GCSEs. It worked for them, so it is bound to be OK for Sixth Form?

Use private study lessons for social time.

Give yourself a couple of months to ease yourself back into schoolwork.

Weblink to the course website (Pearson) Medical Science (AAQ) | Pearson qualifications

Course Structure

These are the details of the 4 units to be completed over the 2 years:

Assessment Structure

Pearson Level 3 Alternative Academic Qualification BTEC National in Medical Science (Extended Certificate)

Mandatory units, learners complete all units				Assessments
1	Principles of Human Physiology, Anatomy and Pathology	90 GLH	External	• An external examination set and marked by Pearson • 80 marks • Assessment Availability: January and June • First assessment June 2026
2	Health Issues and Scientific Reporting	120 GLH	External	• An external examination set and marked by Pearson • 80 marks • Available January and June • First assessment June 2026
3	Practical Microbiology and Infectious Diseases	90 GLH	Internal	• Pearson sets the assignment for the assessment of this unit • The PSAB will take approximately 19 hours to complete, and consists of 4 tasks • The PSAB will be marked by centres and verified by Pearson • You will make assessment decisions for the PSAB using the assessment criteria provided in the specification • The PSAB will be valid for the lifetime of this qualification.
6	Human Reproduction and Fertility	60 GLH	Internal	• Pearson sets the assignment for the assessment of this unit. • The PSAB will take approximately 11 hours to complete, and consists of 3 tasks • The PSAB will be marked by centres and verified by Pearson. • You will make assessment decisions for the PSAB using the assessment criteria provided in the specification • The PSAB will be valid for the lifetime of this qualification.

How does this transition pack work?

Some work is outlined within this pack which is required to be completed over the course of the summer. The purpose of this is to build on GCSE knowledge you already have and extend it to Level 3. We also want to get an idea of how well you work independently and how well you can answer exam questions.

Summer Tasks

1. **Write a 250-word essay/extended answer explaining why you have chosen to study the AAQ Medical science course.**
2. **Research and complete the cell structure poster – the extra articles/websites at the end of the pack will help.**
3. **Answer the cell structure exam questions**
4. **Read and make notes on the bio fact sheet about enzyme activity**
5. **Answer the enzyme exam questions**
6. **Watch any two of the weblinks and provide evidence (a 50 word summary on their content)**

1. **Write an extended answer/essay of around 250 words** explaining why you have chosen to study the course. Include any ideas you have of what career/job/further study you may want to undertake (even if not related to Medical Biology). Also explain what you find interesting about Biology and what you think you need to do to be successful.

2. **Cell Structure Poster: Marked out of 25**

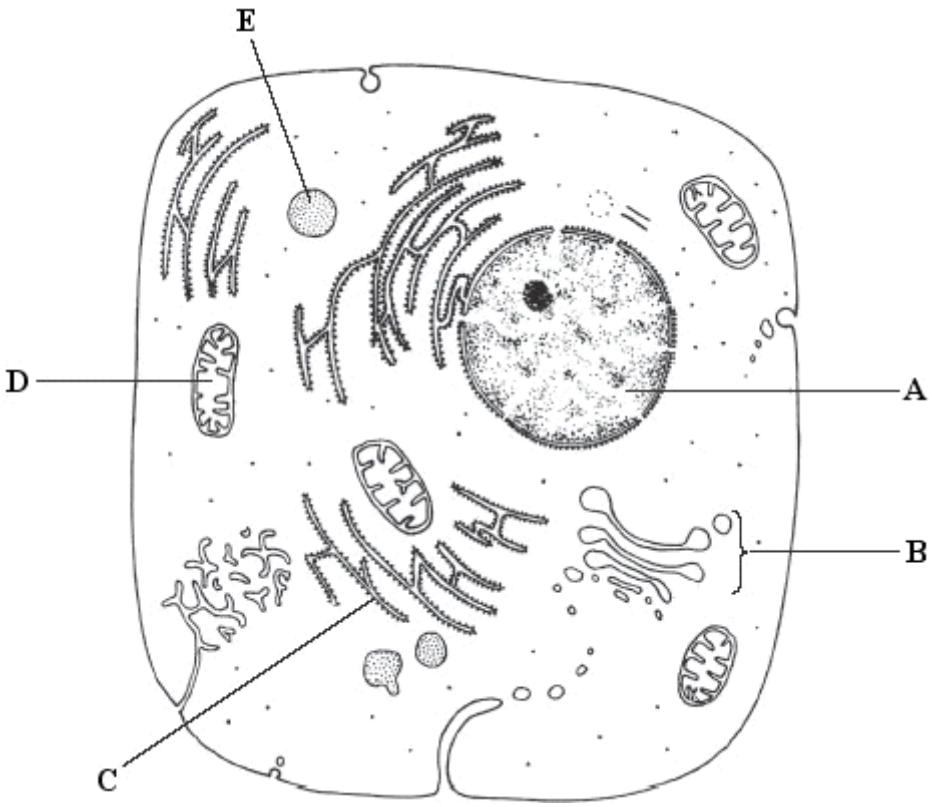
Research the structure of a plant and animal cell. You must make a poster including a labelled diagram of both types of cell and explain the **structure** and **function** of the following organelles:

- Nucleus
- Nucleolus
- Rough Endoplasmic Reticulum
- Smooth Endoplasmic Reticulum
- Golgi Apparatus
- Cell Surface membrane
- Chloroplast
- Mitochondria
- Vacuole in plant cell
- Cell wall

You should also find out about the structure of a prokaryotic cell to help with the questions below.

Cells Exam Questions:

1. Below is a drawing of an animal cell as seen under an electron microscope.



Complete the following table by:

- identifying the parts of the cell **A** to **E**
- naming the part of the cell responsible for the function stated.

The first one has been done for you.

function	part of cell	label
controls activities of the cell	*nucleus*	***A***
carries out aerobic respiration		
attaches to mRNA in protein synthesis		
produces secretory vesicles		
contains digestive enzymes		

(Total 8 marks)

2. The following table compares some of the features of prokaryotic cells and eukaryotic **animal** cells.

Complete the table by placing a tick (✓) or a cross (✗) in each box. The first one has been done for you.

	prokaryotic cells	eukaryotic **animal** cells
DNA present	✓	✓
nuclear envelope (membrane) present		
cell wall present		
plasmids present in cytoplasm		
naked DNA present		

(Total 4 marks)

Bio Factsheet

Number 43

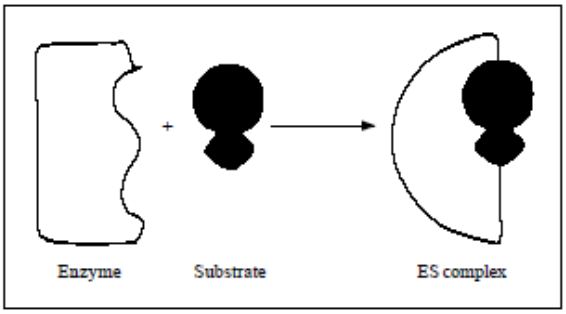
Factors Affecting Enzyme Activity

Enzymes are globular proteins which act as biological catalysts. This means that they speed up the rate of reaction by lowering the activation energy, that is the energy required to break bonds. Enzymes are a complex tertiary and sometimes quaternary shape and catalyse reactions by forming a complex (known as the enzyme substrate complex) at a specific region of the enzyme called the active site.

Enzyme + substrate → enzyme substrate complex → product

Enzymes are specific; any individual enzyme can usually only catalyse one particular reaction. The **induced fit hypothesis** has been put forward to explain how enzymes work. The key points of the induced fit hypothesis are as follows (Fig1):

Fig 1. Induced fit hypothesis



1. Substrate approaches the active site of the enzyme.
2. The shape of the active site then changes to fit precisely around the substrate – in other words, the substrate **induces** the active site to change shape.
3. The reaction is catalysed and products form.
4. The products are a different shape from the substrate and therefore diffuse away from the active site. As they do, the active site reverts to its original shape.

Factors affecting enzyme activity

1. Temperature

Enzymes have an optimum temperature – this is the temperature at which they work most rapidly. Below the optimum temperature, increasing temperature will increase the rate of the reaction. This is because temperature increases the kinetic energy of the system, effectively increasing the number of collisions between the substrate and the enzyme's active site.

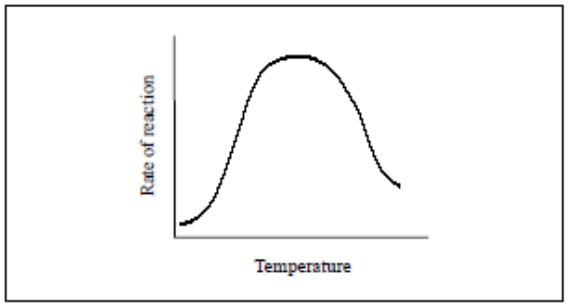
Temperatures above the optimum will lead to **denaturation**. This occurs because the hydrogen bonds and disulphide bridges which maintain the shape of the active site are broken. Thus, enzyme substrate complexes can no longer be formed.

The effect of temperature on the rate of a chemical reaction is described by the term "temperature coefficient" (Q_{10}).

$$Q_{10} = \frac{\text{rate of reaction at T + 10°C}}{\text{rate of reaction at T°C}}$$

Many enzymes have a Q_{10} of between 2 and 3. In other words, provided that the temperature is not so high that it causes denaturation, an increase in temperature of 10°C will speed up the reaction by a factor of 2-3, that is it will double or treble it (Fig 2).

Fig 2. Effect of temperature on enzyme activity

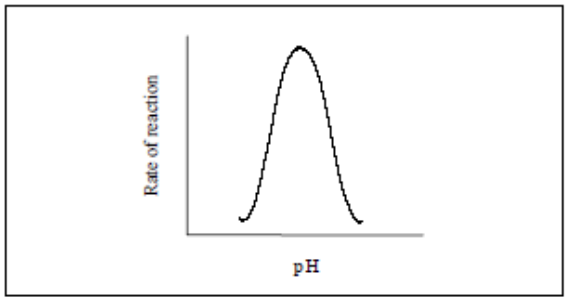


2. pH

The effect of a change in pH on enzyme activity is shown in Fig 3. As with temperature, each enzyme has an optimum pH. If pH increases or decreases much beyond this optimum, the ionisation of groups at the active site and on the substrate may change, effectively slowing or preventing the formation of the enzyme substrate complex. At extreme pH, the bonds which maintain the tertiary structure – hence the active site – are disrupted and the enzyme is irreversibly denatured.

Since most human enzymes are intracellular, most have a pH optimum of 7.3-7.4. However, pepsin, which works in the acidic environment of the stomach, has an optimum of 2.4 (Fig 3).

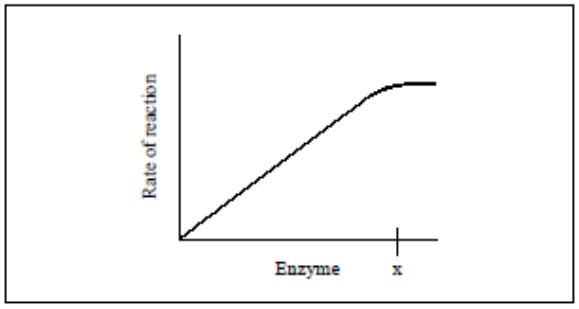
Fig 3. Effect of pH on enzyme activity



3. Enzyme concentration

The effect of enzyme concentration on the rate of reaction is shown in Fig 4. At low enzyme concentrations there are more substrate molecules than there are available active sites. Increasing the number of active sites by increasing the concentration of the enzyme, therefore, effectively increases the rate of the reaction. Eventually, at point x, increasing the enzyme concentration has no effect on the rate of reaction. This is because it is now the number of substrate molecules which has become the limiting factor.

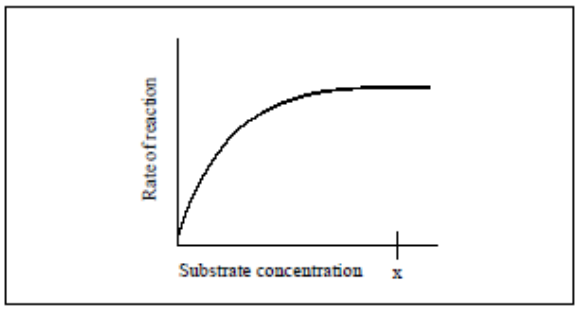
Fig 4. Effect of enzyme concentration on enzyme activity



4. Substrate concentration

Fig 5 shows the effect of substrate concentration on the rate of reaction.

Fig 5. Effect of substrate concentration on enzyme activity



At low substrate concentration the reaction proceeds slowly. This is because there are not enough substrate molecules to occupy all of the active sites on the enzyme. As substrate concentration increases, the rate increases because there are more enzyme substrate complexes formed. At point x, however, increasing the substrate concentration will have no further effect on the rate of reaction. This is because all of the enzyme's active sites are now occupied by substrate molecules – increasing the substrate concentration further will have no effect, because no more enzyme substrate complexes can form. The rate of reaction now depends on the turnover rate of the enzyme, i.e. the number of substrate molecules transformed by one molecule of enzyme per second. Carbonic anhydrase has the highest turnover rate of any known enzyme (Table 1).

Table 1. Enzyme turnover rates

Enzyme	Turnover rate
Carbonic anhydrase	36×10^6
Catalase	5.6×10^6
Lysozyme	60

5. Cofactors

Many enzymes require cofactors to function properly. There are three main types of cofactor; co-enzymes, inorganic ions and prosthetic groups.

1. **Coenzymes** are organic molecules which often contain a vitamin molecule as part of their structure. Coenzymes become loosely bound to the enzyme and move away from the enzyme once the reaction is completed. One coenzyme, e.g. NAD^+ may react with many different enzymes in many different types of reaction. NAD^+ transfers hydrogen in reactions involving dehydrogenase enzymes.
2. **Inorganic** metal ions are also known as enzyme activators. They change the charge in the active site, enabling the enzyme substrate complex to form. Some become intimately bound to the enzyme, e.g. Fe^{2+} in catalase. Most others accelerate the binding between the enzyme and the substrate, e.g. Mg^{2+} in phosphotransferases.
3. **Prosthetic** groups are coenzymes that bind permanently to the enzyme molecule and remain there even after the reactions are complete, e.g. FAD (flavin adenine dinucleotide). Like NAD^+ it carries hydrogen atoms, this time with oxidase enzymes.

6. Inhibitors

Inhibitors slow down the rate of reaction. As such, they are an essential form of cellular control, allowing enzyme reaction rate to be slowed when necessary. Some enzymes are inhibited by the end product of the reaction they catalyse (see Factsheet 31 Enzyme control of metabolic pathways).

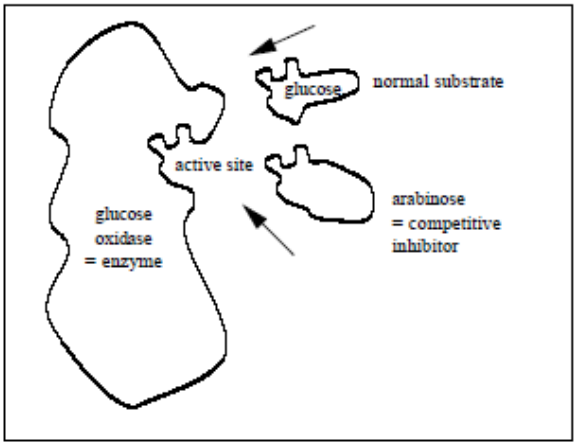
(a) Reversible inhibitors

There are two types of reversible inhibitor:

- competitive reversible inhibitor
- non-competitive reversible inhibitor

Competitive reversible inhibitors are structurally similar to the normal substrate and compete with the normal substrate for the active sites (see Fig 6).

Fig 6. Competitive reversible inhibition

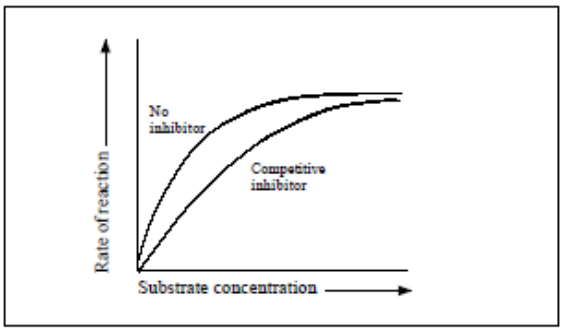


Typical Exam Questions

1. Describe and explain the effect of pH, temperature, enzyme concentration etc. on rate of reaction
2. Explain the induced fit hypothesis
3. Explain the role of cofactors

However, if the concentration of the normal substrate is increased, reversible inhibitors are displaced from the active site and the normal enzyme substrate complex can form (Fig 7).

Fig 7. Effect of increased substrate concentration on reversible competitive inhibition



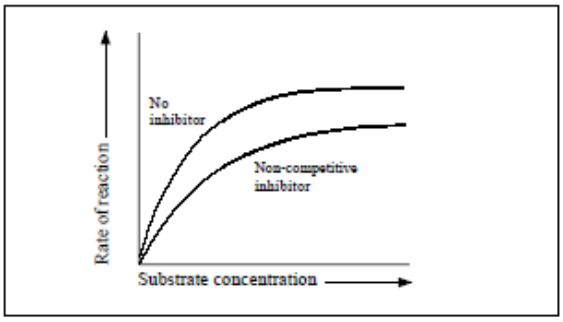
Example 1: arabinose competes with glucose for the active sites on glucose oxidase.

Example 2: oxaloacetate, malonate and pyrophosphate all compete with succinate for the active site of the enzyme succinate dehydrogenase.

Example 3: an individual who swallows methanol is in danger of becoming blind. This is because the methanol – which itself is not toxic – will be metabolised to formaldehyde which is extremely toxic and will cause blindness. At hospital, the individual will be treated with ethanol. The ethanol is structurally similar to methanol and will compete with methanol for the enzyme's active sites. Thus, the metabolism of methanol is slowed down.

Non-competitive reversible inhibitors react with the enzyme but not at the active site. They change the shape of the whole enzyme, including the shape of the active site, hence the reaction cannot proceed and no products are formed on those enzymes (Fig 8).

Fig 8. Effect of increased substrate concentration on non-competitive inhibition



(b) Irreversible inhibitors

Irreversible inhibitors bind covalently and permanently to the enzyme, preventing normal enzyme function. For example, Aspirin is an irreversible inhibitor of cycloxygenase, an enzyme involved in the synthesis of prostaglandins. Substances such as mercury, iron and arsenic bind irreversibly to the SH (sulphydryl) group on enzymes.

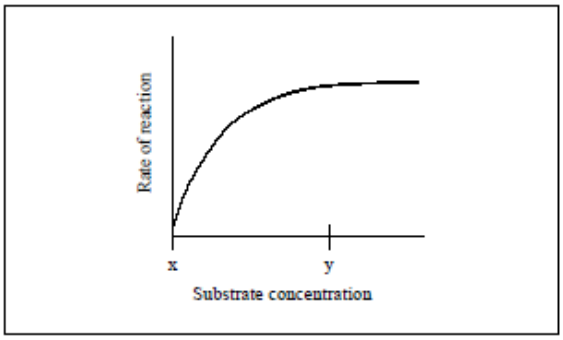
Practice Questions

1. Define the following terms:

   (a) induced fit hypothesis (3 marks)

   (b) denaturation (3 marks)

2. The graph show the effect of increasing substrate concentration on the rate of an enzyme controlled reaction.



   (a) Explain the shape of the curve between points x and y (2 marks)

   (b) Describe and explain the effect which a competitive reversible inhibitor would have on the rate of this reaction (2 marks)

Answers

Semicolons indicate marking points

1. (a) substrate approaches active site;
   causes shape of active site to change;
   allows formation of enzyme/substrate complex;
   products do not fit active site therefore diffuse away;

   (b) loss of quaternary/tertiary structure;
   loss of active site/permanent change in shape of active site;
   enzyme-substrate complex unable to form;
   caused by above optimum temperatures/pH above or below optimum;

2. (a) substrate concentration is limiting factor;
   as concentration increases more enzyme substrate complexes form;

   (b) slow it down;
   competitive inhibitor will occupy active sites;
   reducing number of enzyme-substrate complexes;

Acknowledgements;
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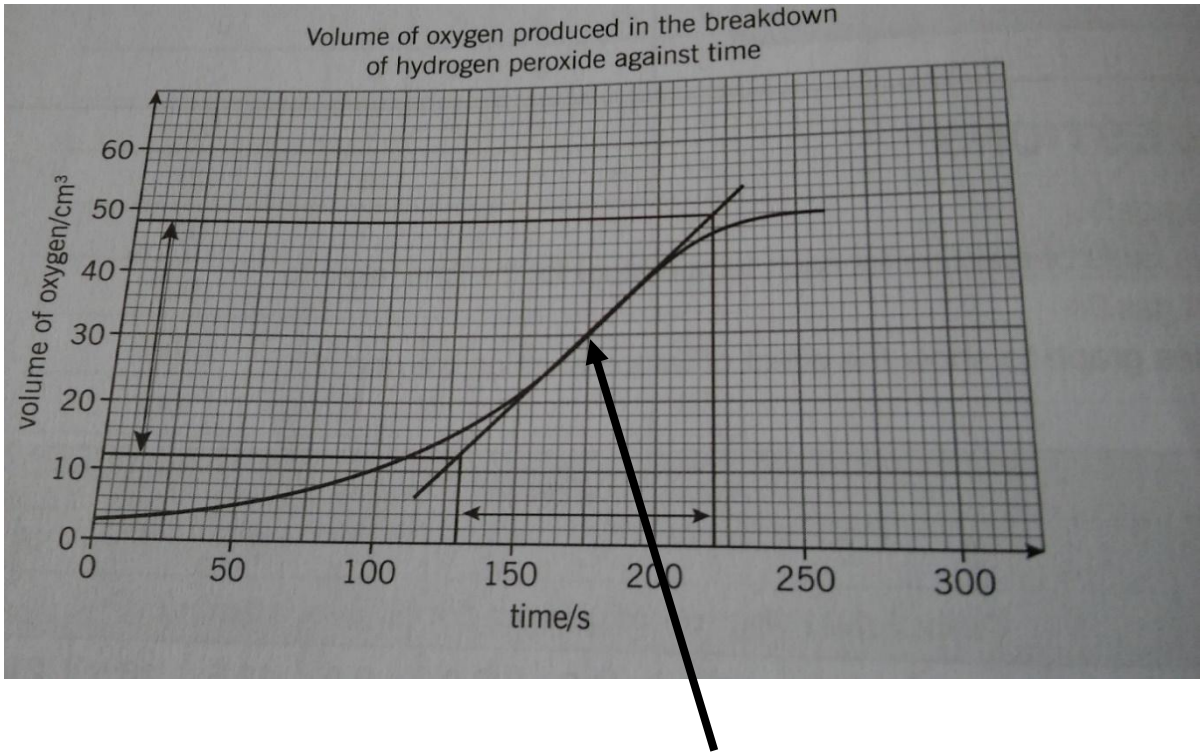
Questions on Enzymes

Calculating rates of reaction

Worked example

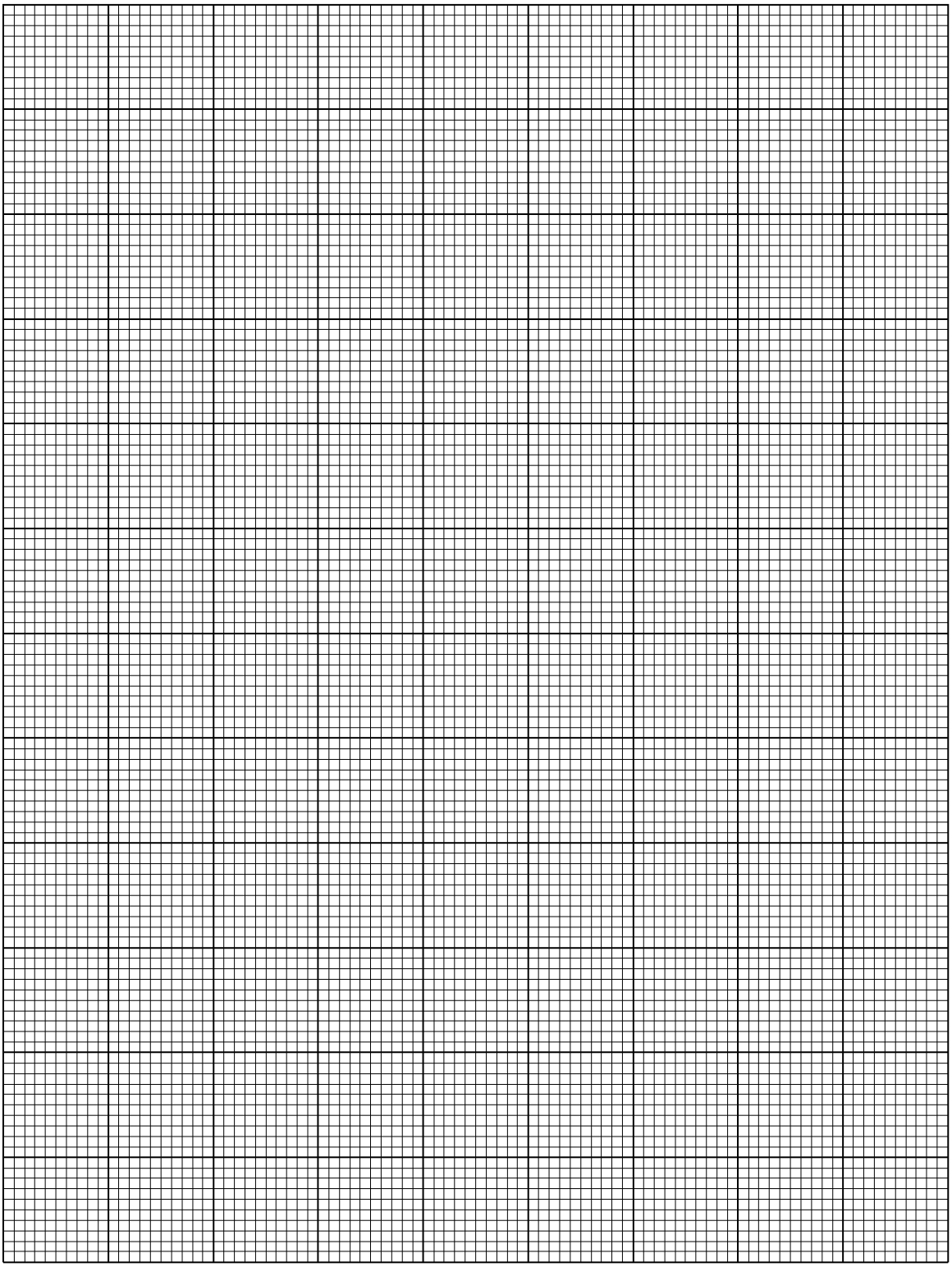
The graph below shows data collected during the reaction between catalase and hydrogen peroxide. The volume of gas collected is plotted against time. What is the maximum reaction rate?



First construct a tangent line by drawing a line using a ruler. The tangent line should touch the curve at the steepest point. Next use construction lines to find the values of x and y at ant two selected points on the tangent as shown.

Find the change in y and the change in x between the two selected points. In the example y goes from 12 to 48, a change of 36 cm^3 oxygen while x changes from 128 to 220 s, a change of 92 s.

Calculate the rate by dividing the change in y by the change in x. In the example 36/92 = 0.39 cm^3s^{-1}.



1. The table shows data from an experiment in which glucose was being released by the digestion of starch.
   a. Plot the data on a line graph (previous page) (4)
   b. Use a tangent to calculate the maximum rate of reaction (2)
   c. Find the rate of reaction at: (i) 8 minutes (ii) 32 minutes (2)

Table 1.

Time/min	**Glucose produced / mmol dm $^{-3}$**
5	2
10	6
15	12
20	22
25	25
30	28
35	29

2. Amylase is an enzyme. It catalyses the breakdown of starch to maltose.

Students mixed a starch solution with amylase. The concentration of amylase and the concentration of starch were controlled. They recorded the concentration of maltose at intervals for 30 minutes. **Figure 2** shows their results.

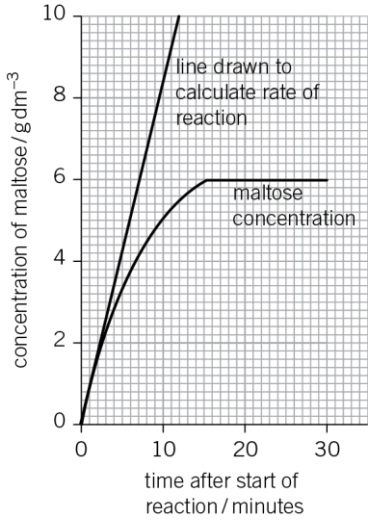


Figure 2

b Suggest **two** other factors the students would have controlled.

.....

.....

(*2 marks*)

c Describe how the concentration of maltose changed over the period shown in **Figure 2**.

.....

.....

(*2 marks*)

d **i** A tangent has been drawn to the curve in **Figure 2**. Explain how you could use this line to calculate the initial rate of reaction.

.....

(*1 mark*)

ii The rate of reaction was lower after 10 minutes than it was at the start. Explain why.

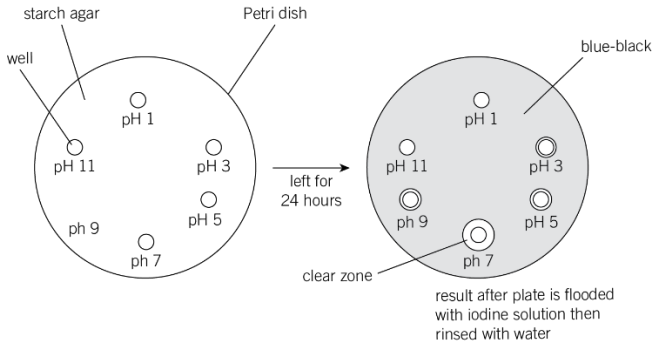
.....

.....

(*2 marks*)

3. A student carried out an investigation using salivary amylase. Six wells (holes) of the same size were cut in a starch agar plate. Each well was filled with the same concentration and volume of amylase solution. An equal volume of buffer solution was added to produce a different pH in each well. The plates were incubated at 25 °C for 24 hours and then covered with iodine solution. The iodine turned the starch blue-black. It was observed that there were clear rings around some wells. The width of these clear rings is shown in the table.

i.



pH	Width of clear ring / mm
1	0
3	2
5	6
7	11
9	5
11	0

a There are clear rings around some of the wells. Explain why.

.....

.....

(*2 marks*)

b Calculate the rate of reaction at pH 7. Show your working.

.....

.....

(*2 marks*)

c The student concluded that the optimum pH for amylase activity was pH 7. This conclusion may not be valid. Explain why.

.....

(*1 mark*)

d Use your knowledge of enzyme structure to explain the result obtained at pH 11.

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.....

(*3 marks*)

e Describe a control experiment for this investigation.

.....

.....

(*2 marks*)

There are some great TV series and box sets available too, you might want to check out: Blue Planet, Planet Earth, The Ascent of Man, Catastrophe, Frozen Planet, Life Story, The Hunt and Monsoon.

If you have 30 minutes to spare, here are some great presentations (and free!) from world leading scientists and researchers on a variety of topics. They provide some interesting answers and ask some thought-provoking questions. Use the link or scan the QR code to view:

A New Superweapon in the Fight Against Cancer
Available at :
http://www.ted.com/talks/paula_hammond_a_new_superweapon_in_the_fight_against_cancer?language=en
Cancer is a very clever, adaptable disease. To defeat it, says medical researcher and educator Paula Hammond, we need a new and powerful mode of attack.

Why Bees are Disappearing
Available at :
http://www.ted.com/talks/marla_spivak_why_bees_are_disappearing?language=en
Honeybees have thrived for 50 million years, each colony 40 to 50,000 individuals coordinated in amazing harmony. So why, seven years ago, did colonies start dying en-masse?

Why Doctors Don't Know About the Drugs They Prescribe
Available at :
http://www.ted.com/talks/ben_goldacre_what_doctors_don_t_know_about_the_drugs_they_prescribe?language=en
When a new drug gets tested, the results of the trials should be published for the rest of the medical world — except much of the time, negative or inconclusive findings go unreported, leaving doctors and researchers in the dark.

Growing New Organs
Available at :
http://www.ted.com/talks/anthony_atala_growing_organs_engineering_tissue?language=en
Anthony Atalla's state-of-the-art lab grows human organs — from muscles to blood vessels to bladders, and more.