newcollaborative Learning Trust

Opening doors to a brighter future

BTEC Applied Science

Extended Certificate

SIL

Y12 into Y13

Part 1 – Core knowledge

There are 3 sections to the core knowledge (Biology, Physics and Chemistry)

For each section.

1. Watch the videos and use to make flashcards / similar resources, so you can use them to test yourself (metacognition)
2. Complete the follow up questions
3. Mark the questions (mark scheme at the end of the document)
4. Prepare for an assessment on this content at the beginning of Y13. Watch this metacognition for advice for how to prepare: https://www.youtube.com/watch?v=wrDOoBuP9A8

Part 2 – Maths and practical skills

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Part 1 – Core knowledge

Section A - Biology – Enzymes

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?

Enzymes

https://www.bbc.co.uk/bitesize/guides/z88hcj6/revision/1

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

Interpreting enzyme graphs.

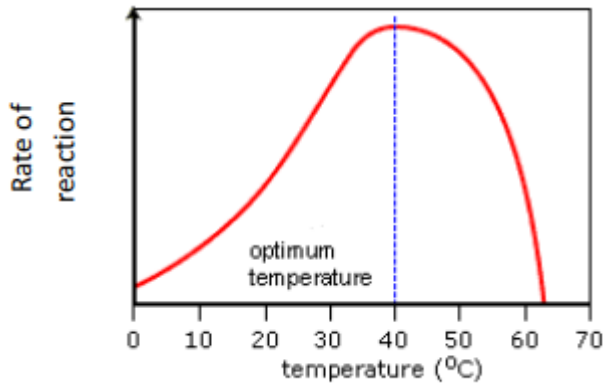
This section requires you to explain how different conditions affect enzyme activity.

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.



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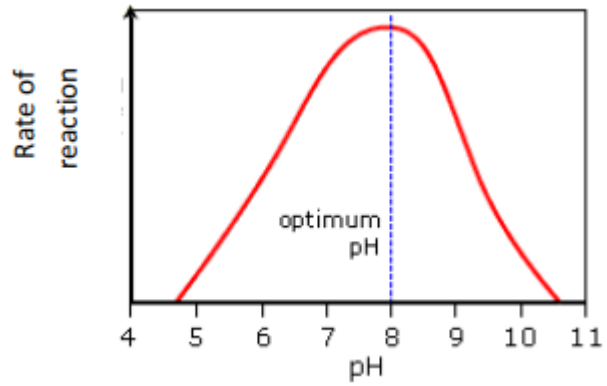
Q2. Change in pH.



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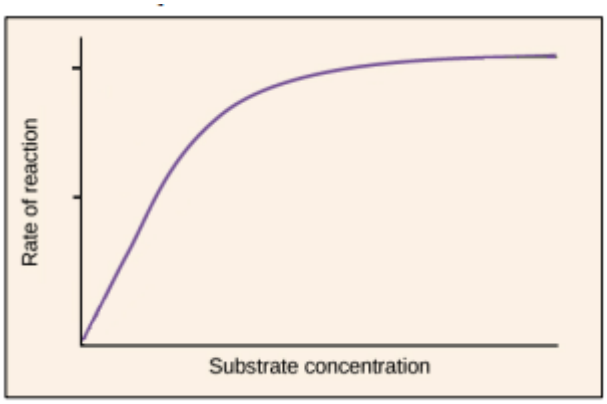
Q3. Change substrate concentration.



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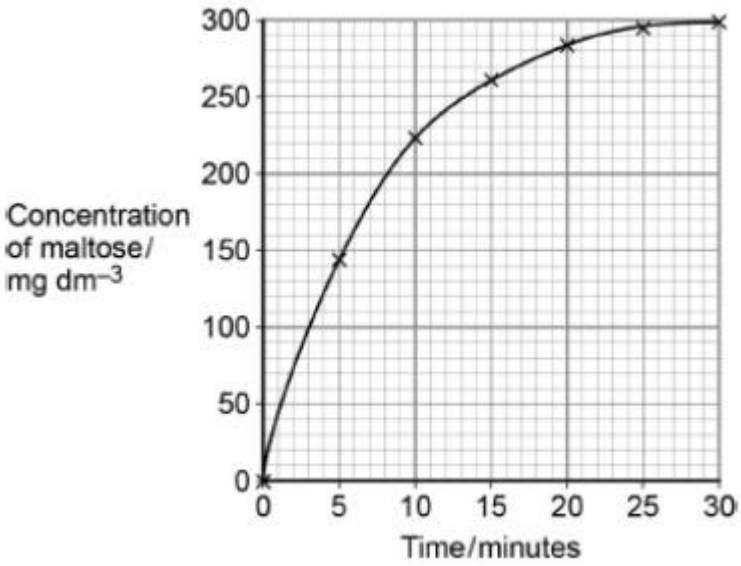
Q4. A scientist investigated the hydrolysis of starch. He added amylase to a suspension of starch and measured the concentration of maltose in the reaction mixture at regular intervals.

His results are shown in the graph below.



Explain the results shown in the graph.

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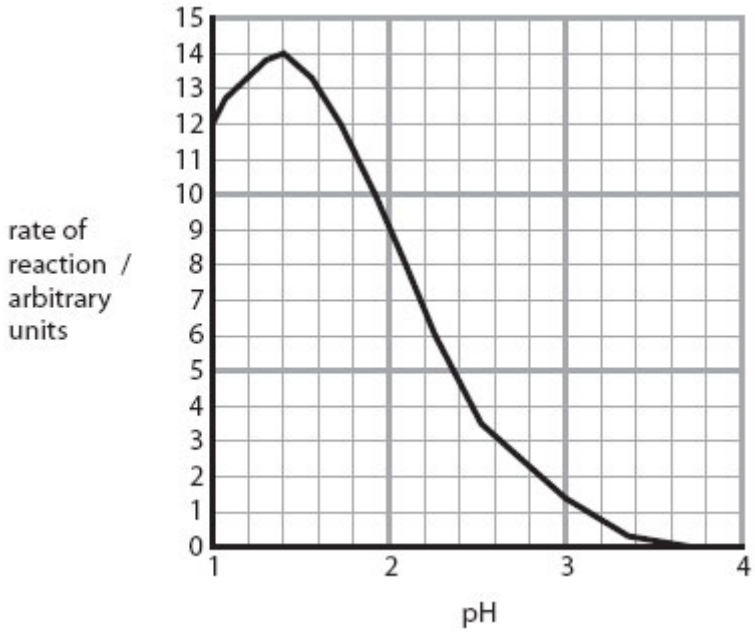
(2)

Questions

Q1.

The graph shows how pH affects the rate of the reaction catalysed by enzyme R.



(i) Name enzyme R.

(1)

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(ii) The rate of reaction can be determined by measuring how quickly molecule W is formed. Name molecule W.

(1)

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(iii) Calculate the difference in the rate of the reaction between pH 1 and pH 2.

(2)

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(iv) Suggest why this enzyme works better at pH 1 than at pH 2.

(2)

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Q2. Complete the sentences by putting a cross (☒) in the box next to your answer.

(i) Enzymes are

(1)

- ☒ **A** cells
- ☒ **B** hormones
- ☒ **C** proteins
- ☒ **D** sugars

(ii) An enzyme is a biological catalyst that

(1)

- ☒ **A** slows down all chemical reactions
- ☒ **B** speeds up a chemical reaction
- ☒ **C** prevents all chemical reactions taking place
- ☒ **D** has no effect on a chemical reaction

Q3.

(a) Complete the sentences by putting a cross (☒) in the box next to your answer.

(i) Enzymes are

(1)

- ☒ **A** cells
- ☒ **B** hormones
- ☒ **C** proteins
- ☒ **D** sugars

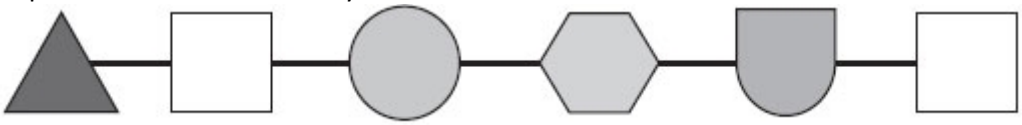
(ii) An enzyme is a biological catalyst that

(1)

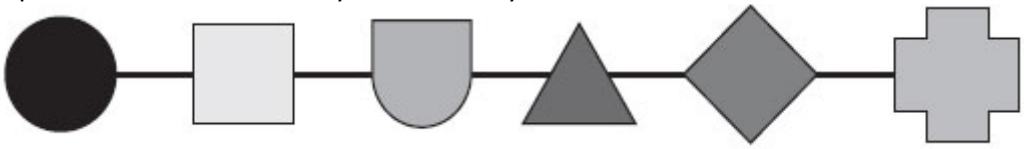
- ☒ **A** slows down all chemical reactions
- ☒ **B** speeds up a chemical reaction
- ☒ **C** prevents all chemical reactions taking place
- ☒ **D** has no effect on a chemical reaction

(b) The diagrams show two sequences of six amino acids.

Sequence 1 is found in an enzyme called catalase.



Sequence 2 is found in an enzyme called amylase.



(i) Suggest how the structures of the enzymes, catalase and amylase, are different from each other.

(2)

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(ii) Suggest why the action of these two enzymes will be different.

(2)

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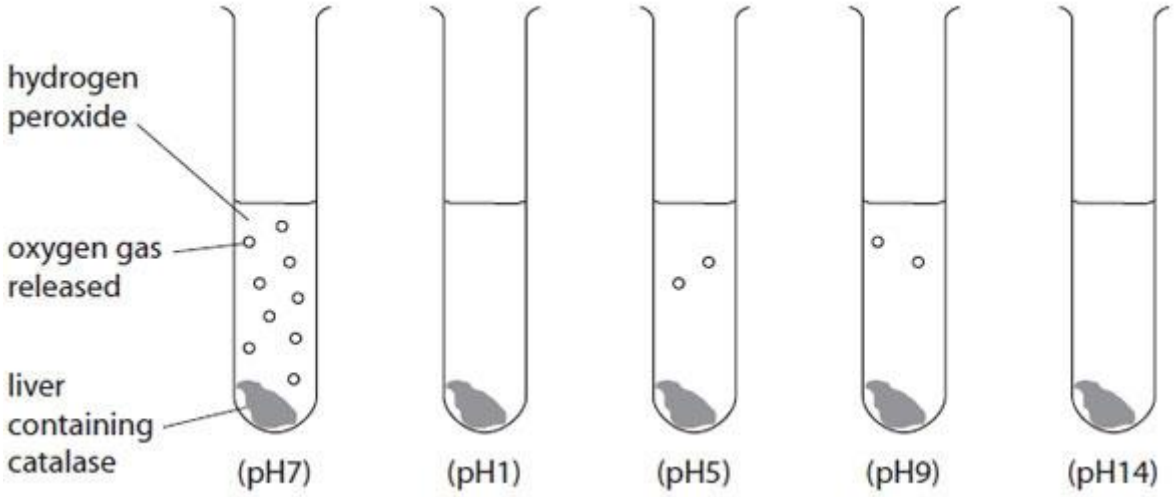
*(c) A student carried out an investigation to study the effect of pH on the activity of catalase.
In the presence of catalase, hydrogen peroxide breaks down to release oxygen gas.
The student set up five test tubes, as shown in the diagram, and observed the amount of oxygen gas released.



Explain the effect of pH on the enzyme catalase in this investigation.

(6)

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Q4.

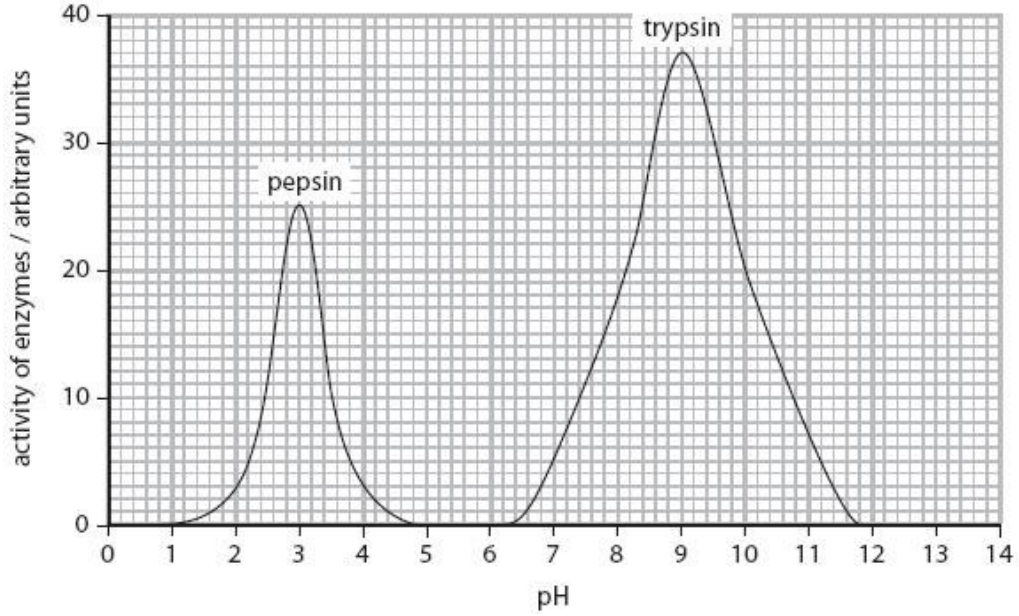
(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

Pepsin is an enzyme that digests protein into (1)

- ☒ **A** amino acids
- ☒ **B** fatty acids
- ☒ **C** glucose
- ☒ **D** glycerol

(ii) An experiment was carried out to investigate the effect of pH on the activity of pepsin and another enzyme called trypsin.

The graph shows the results of the experiment.



Complete the sentence by putting a cross (☒) in the box next to your answer.

The graph shows that

(1)

- ☒ **A** pepsin only works at a pH of 3
- ☒ **B** pepsin has an optimum pH of 3
- ☒ **C** trypsin only works at a pH of 3
- ☒ **D** trypsin has an optimum pH of 3

(iii) Using the graph, describe **two** ways in which the activity of pepsin is different to the activity of trypsin.

(2)

1 . . . . . .

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(iv) Explain why the activity of trypsin is different at pH 11 compared to pH 9.

(2)

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Section B – Biology – Plants

Factors affecting distribution of organisms - quadrats

https://www.youtube.com/watch?v=yk5kUDZrvr8

Q1. How do you take a random sample with a quadrat and why is it important?

Q2. What analysis would you carry out on your data?

Using a transect

https://www.youtube.com/watch?v=ZQQHM6h1pDs

Q3. What is a line transect?

Q4. What is systematic sampling?

Q5. How do you calculate % cover using a gridded quadrat?

Q6. How do you use a point frame to estimate % cover?

Section C – Physics – Circuits

GCSE bitesize

https://www.bbc.co.uk/bitesize/guides/zgvq4qt/revision/1

Intro to circuits

https://www.youtube.com/watch?v=R3hdaLpq2AA

V=IR

https://www.youtube.com/watch?v=hRojfU77c38

Power = work done / time

https://www.youtube.com/watch?v=kCJUzdCBOk0&list=PLidqqIGKox7UVC-8WC9djoeBzwxPeXph7&index=7

Q1.

Figure 1 shows a person using an electric lawn mower.

Figure 1

(a) The lawn mower is connected to the mains electricity supply.

What is the frequency of the mains electricity supply in the UK?

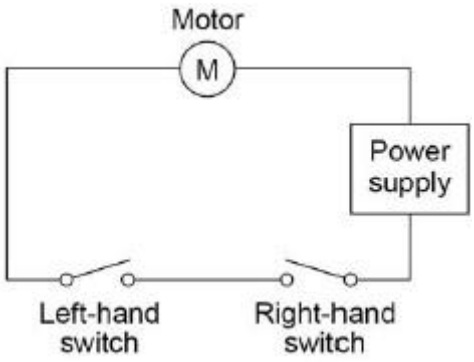
Frequency = _____ Unit _____

(2)

The lawn mower has a switch on each side of the handle.

Figure 2 shows the circuit diagram for the lawn mower.

Figure 2



(b) The motor in the lawn mower can only be turned on when the person using it holds the handle of the lawn mower with both hands.

Explain why.

_____

_____

_____

_____

(2)

(c) The power input to the motor is 1.8 kW

The resistance of the motor is 32 Ω

Calculate the current in the motor.

_____

_____

_____

_____

Current = _____ A

(3)

(d) The useful power output from the motor is 1.5 kW

Calculate the time it takes for the motor to transfer 450 000 J of useful energy.

_____

_____

_____

Time = _____ seconds

(3)

(Total 10 marks)

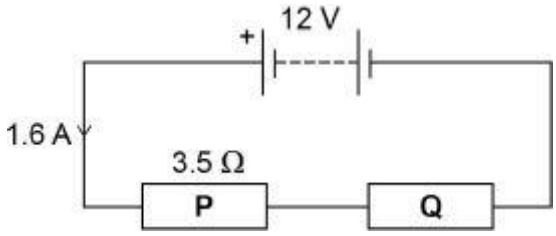
Q2.

(a) Draw a diagram to show how 1.5 V cells should be connected together to give a potential difference of 4.5 V.

Use the correct circuit symbol for a cell.

(2)

A student built the circuit shown in the diagram below.



(b) Calculate the total resistance of the circuit in the diagram above.

Use the equation:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

_____

_____

_____

_____

Total resistance = _____ Ω

(2)

(c) The resistance of **P** is 3.5 Ω.

Calculate the resistance of **Q**.

_____

_____

_____

_____

Resistance of **Q** = _____ Ω

(1)

(d) The student connects the two resistors in the diagram above in parallel.

What happens to the total resistance of the circuit?

Tick **one** box.

It decreases ☐

It increases ☐

It does not change ☐

(1)

Give a reason for your answer.

_____

_____

_____

_____

(1)

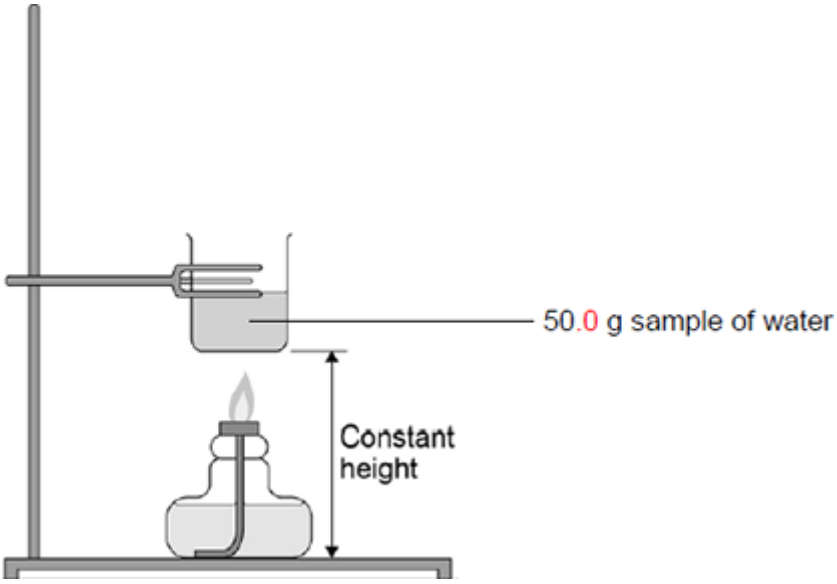
(Total 7 marks)

Section D – Chemistry – Fuels

https://www.youtube.com/watch?v=weKJ3_WbZ0Q

Q1.

The figure below shows apparatus used in an experiment to determine the enthalpy of combustion of leaf alcohol.



The alcohol is placed in a spirit burner and weighed. The burner is lit and the alcohol allowed to burn for a few minutes. The flame is extinguished and the burner is re-weighed. The temperature of the water is recorded before and after heating.

The following table shows the results obtained.

Initial mass of spirit burner and alcohol / g	56.38

Final mass of spirit burner and alcohol / g	55.84
Initial temperature of water / °C	20.7
Final temperature of water / °C	40.8

(b) Use the results from the table above to calculate a value for the enthalpy of combustion of leaf alcohol. Give units in your answer.
(The specific heat capacity of water is 4.18 J K^{-1} g^{-1})

Enthalpy of combustion = _____ Units = _____

(4)

(c) State how your answer to part (b) is likely to differ from the value quoted in reference sources.
Give **one** reason for your answer.

_____

_____

_____

_____

_____

(2)

(d) A 50.0 g sample of water was used in this experiment.

Explain how you could measure out this mass of water without using a balance.

_____

_____

_____

_____

_____

(2)

(Total 9 marks)

Section E – Chemistry – pH scale and indicators

- Read the revise section, watch the video and have a go at the test on the BBC bitesize webpage

Questions

0 2 This question is about acids and alkalis.

0 2 . 1 Which ion do all acids produce in aqueous solution?

[1 mark]

Tick (✓) **one** box.

H^+ ☐

H^- ☐

O^{2-} ☐

OH^- ☐

0 2 . 2 Calcium hydroxide solution reacts with an acid to form calcium chloride.

Complete the word equation for the reaction.

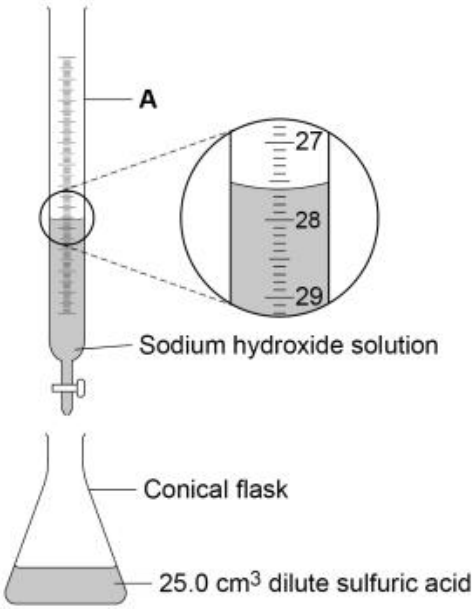
[2 marks]

calcium hydroxide + _____ acid → calcium chloride + _____

A student investigates the volume of sodium hydroxide solution that reacts with 25.0 cm^3 of dilute sulfuric acid.

Figure 2 shows the apparatus the student uses.

Figure 2



Use **Figure 2** to answer Questions **02.3** and **02.4**

0 2 . 3 Name apparatus **A**.

[1 mark]

_____

0 2 . 4 What is the reading on apparatus **A**?

[1 mark]

_____ cm^3

0 2 . 5 The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid.

The student tested two samples of dilute sulfuric acid, **P** and **Q**.

Describe how the student could use titrations to find which sample, **P** or **Q**, is more concentrated.

[6 marks]

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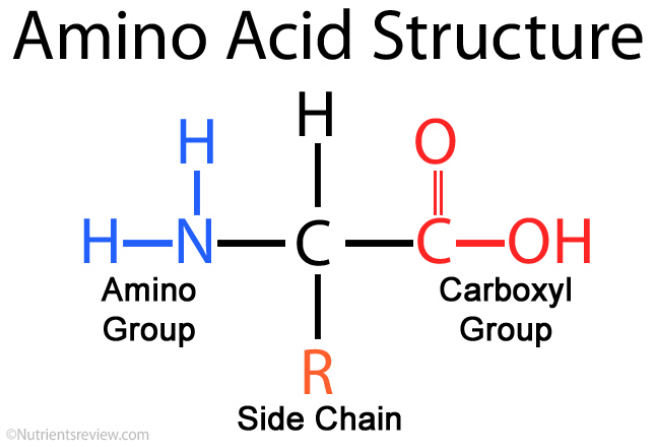
Mark Scheme

Part 1

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.

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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)**

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?

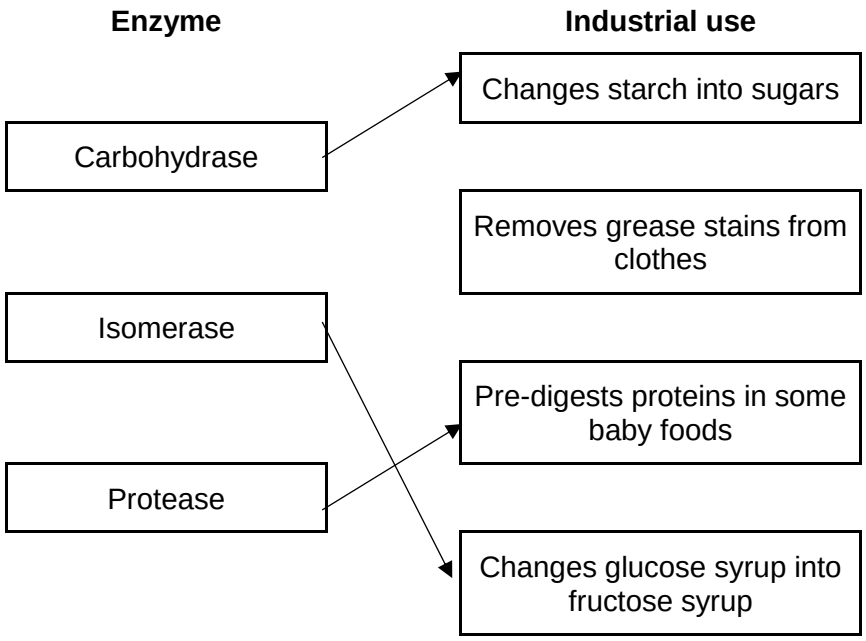
Draw a ring around the correct answer.

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

(1)

(b) Enzymes are sometimes used in industry.

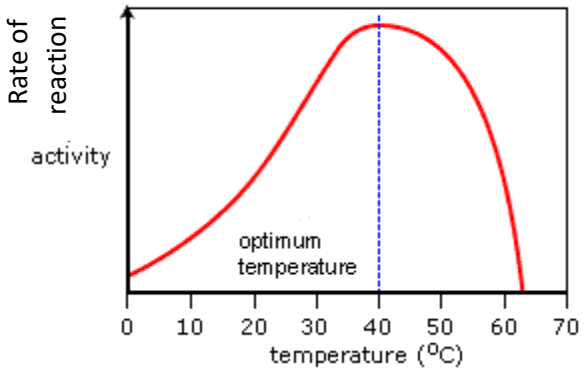
Draw **one** line from each enzyme to the correct industrial use of that enzyme.



(3)(Total 6 marks)

Interpreting enzyme graphs.

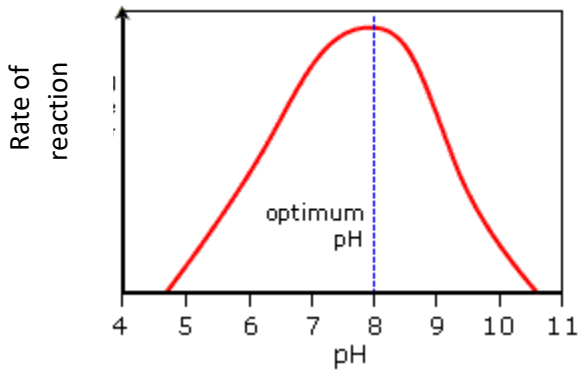
Q1.



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.

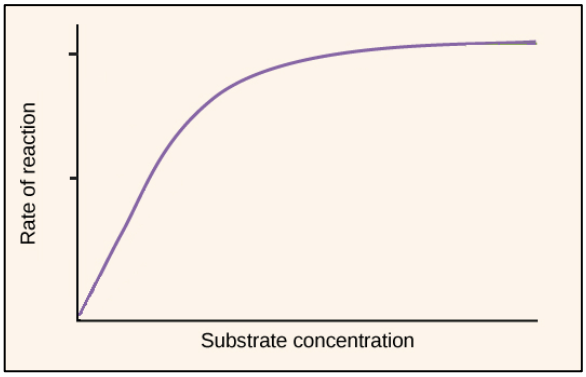
Q2.



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.

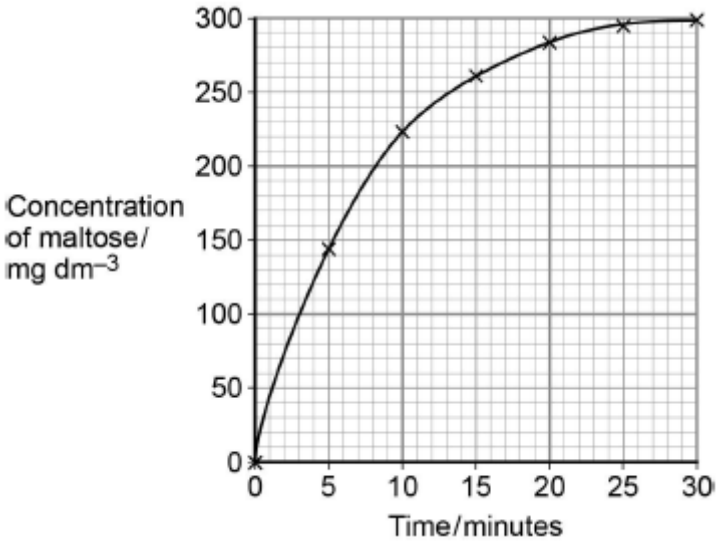


Change substrate concentration.

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)

Biology questions

Q1.

	Answer	Acceptable answers	Mark
(i)	protease / pepsin	**Reject** any other	**(1)**

		enzyme given	
(ii)	amino acid / amino acids		**(1)**
(iii)	• correct values read from graph (= 12 and 9) (1) • 3 arbitrary units (1)	award 2 marks for correct answer with no working ecf ignore + and - signs	**(2)**
(iv)	Any **two** of the following points • at pH 2 the active site is distorted / enzyme changes shape / enzyme is denatured (1) • so less successful collisions / less enzyme substrate complexes /enzyme cannot bind to substrate (1) • optimum pH is 1.4 (1) • pH 1 is closer to the enzyme's optimum pH (1)	ignore any names of enzymes	**(2)**

Q2.

	Answer	**Acceptable answers**	**Mark**
(a)(i)	**C** proteins		**(1)**
(a)(ii)	**B** speeds up a chemical reaction		**(1)**

Q3.

	Answer	Acceptable answers	Mark
(a)(i)	**C** proteins		**(1)**
(a)(ii)	**B** speeds up a chemical reaction		**(1)**
(b)(i)	Any **two** from the following points • contain different amino acids (1) • different sequence/order (of amino acids) (1)	State a difference in an amino acid e.g. black circle in amylase	**(2)**
(b)(ii)	Any **two** from the following points • different shape (enzyme/protein) • work with different substrates • ref to active sites/lock and key (1)	named substrates enzymes are specific	**(2)**

		Indicative Content	Mark
QWC	*** (c)**	An explanation including some of the following points • more oxygen given off at pH 7 • pH 7 is the optimum pH for this enzyme • reaction is faster/enzyme more active in neutral solution • very little oxygen given off at pH 5 and pH 9 • enzyme / catalase less active • no oxygen given off at pH 1 and pH 14 • no enzyme activity • enzyme denatured • shape of active site is	**(6)**

		changed • due to strong acid / low pH/strong alkali / high pH • no longer binds to hydrogen peroxide / substrate	
Level	**0**	No rewardable content	
1	**1 - 2**	• a limited description is given on the results of the investigation that covers one aspect of the results e.g. identifies best pH or recognises when a reaction has or has not taken place. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy	
2	**3 - 4**	• a simple explanation is given on at least one aspects of the results of the investigation **and** links this to enzyme activity e.g. enzymes work better at pH7 as more bubbles are released or inactive at pH1 as no bubbles are released. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy	
3	**5 - 6**	• a detailed explanation of how pH affects enzyme activity (linking this to number of bubbles/oxygen production) including reference to denaturation and/or shape change of enzyme/active site • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors	

Q4.

	Answer	**Acceptable answers**	**Mark**
(i)	**A** amino acids		**(1)**
(ii)	**B** pepsin has an		**(1)**

	optimum pH of 3		
(iii)	A description including two from the following points • pepsin has a lower activity • pepsin works at a lower pH • pepsin works within a narrower pH range • the optimum pH of pepsin is lower	ORA Accept: pepsin works in acidic conditions	**(2)**
(iv)	A explanation linking the following points • it is less active/activity only 6 arbitrary units (1) • (starting to) denature (1) • active site is changing shape (1) • cannot bind to its substrate as well at this pH (1)	Accept: reference to pH9 being the optimum/pH11 is not the optimum	**(2)**

Biology – plants questions

Q1. Lay out 2 tape measures. Use a random number generator to generate coordinates. Place the corner of the quadrat at the coordinates given. Count the number of plants in the quadrat. Repeat minimum 10 times.

Q2. Calculate a mean number of plants. Calculate standard deviation. Calculate t value.

Q3. A tape measure or long piece of string with meter markings.

Q4. Taking a sample at set points along a transect.

Q5. Count the number of squares that contain the plant species. Divide by the total number of squares and x100.

Q6. Count the number of points that hit the plant species, divide by the number of points and x100.

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Physics questions

Q1.

(a) 50

1

Hz / hertz

allow Hertz

1

(b) (both) switches need to be closed / on

1

to complete the series circuit
or
to allow charge to flow
or
so there is a current in the circuit

1

(c)

*an answer of 7.5 (A) scores **3** marks*
*an answer of 0.237(A) scores **2** marks*

$1800 = I^2 \times 32$

this mark may be awarded if P is incorrectly or not converted

1

$I^2 = \frac{1800}{32}$

or

$I^2 = 56.25$

this mark may be awarded if P is incorrectly or not converted

1

$I = 7.5$ (A)

this answer only

1

(d)

*an answer of 300 (s) scores **3** marks*
*an answer of 300 000 (s) scores **2** marks*

$1500 = \frac{450\ 000}{t}$

this mark may be awarded if P is incorrectly or not converted

1

$t = \frac{450\ 000}{1500}$

this mark may be awarded if P is incorrectly or not converted

1

t = 300 (s)

this answer only

1

[10]

Q2.

(a) correct circuit symbol

1

3 cells joined in series in correct orientation

e.g.

ignore absence of + symbol

1

(b) $R = \frac{12}{1.6}$

1

R = 7.5 (Ω)

1

*an answer of 7.5 (Ω) scores **2** marks*

(c) 4.0 (Ω)

*allow their answer to part **(b)** − 3.5 correctly calculated*

1

(d) it decreases

1

the current would be higher (for the same p.d.)

reason only scores if correct box is chosen

or

more than one path for charge to flow

allow current for charge

or

total resistance is always less than the smallest individual resistance

1

[7]

Chemistry questions - fuels

Q1.

(b) Temperature rise = 20.1

q = 50.0 × 4.18 × 20.1 = 4201 (J)

1

Mass of alcohol burned = 0.54 g and M_r alcohol = 100.0

∴ mol of alcohol = n = 0.54 / 100 = 0.0054

1

Heat change per mole = q / 1000n **OR** q / n

= 778 kJ mol^{-1} **OR** 778 000 J mol^{-1}

1

ΔH = –778 kJ mol^{-1} **OR** –778 000 J mol^{-1}

M4 is for answer with negative sign for exothermic reaction

Units are tied to the final answer and must match

1

(c) Less negative than the reference

1

Heat loss **OR** incomplete combustion **OR** evaporation of alcohol **OR** heat transferred to beaker not taken into account

1

(d) Water has a known density (of 1.0 g cm^{-3})

1

Therefore, a volume of 50.0 cm^3 could be measured out

1

[9]

Chemistry questions – pH and indicators

02.1	H^+		1
02.2	hydrochloric (acid) water	allow HCl allow H_2O	1 1
02.3	burette	do **not** accept biuret	1
02.4	27.6 (cm^3)	allow 27.60 (cm^3)	1

02.5	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2
	No relevant content	0
	Indicative content allow converse using acid added to alkali Key steps • measure the volume of acid • add indicator to the acid • add sodium hydroxide solution • until the colour changes • record volume of sodium hydroxide solution added • repeat procedure with the other acid Use of results • compare the two volumes of sodium hydroxide solution to find which sample **P** or **Q** is more concentrated Other points • pipette to measure volume of acid • use a few drops of indicator • swirl • use a white tile • rough titration to find approximate end point • add dropwise near the endpoint • read volume from bottom of meniscus • repeat and take a mean	