Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL

A400U10-1

S19-A400U10-1

BIOLOGY – A level component 1
Energy for Life

THURSDAY, 6 JUNE 2019 – MORNING

2 hours

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	17	
2.	14	
3.	16	
4.	15	
5.	18	
6.	11	
7.	9	
Total	100	

A400U101
01

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **7**.

The quality of written communication will affect the awarding of marks.

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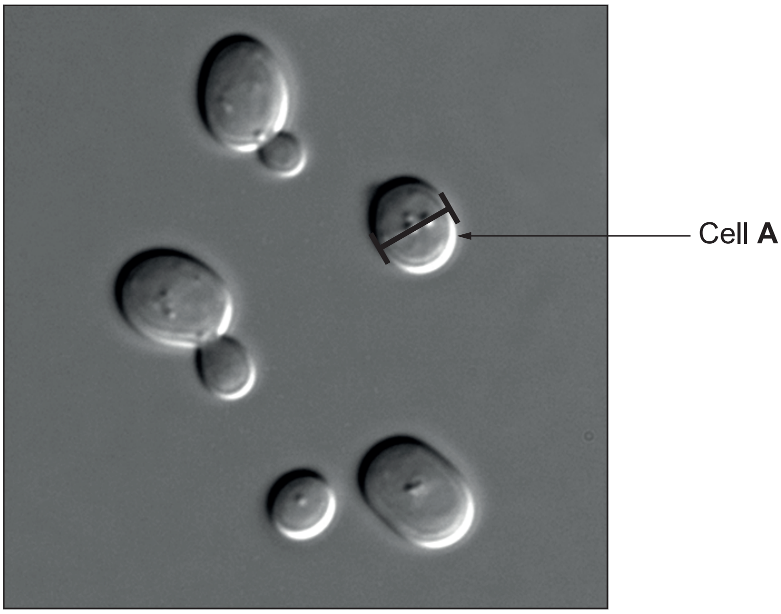
Answer **all** *questions.*

1. Yeast *(Saccharomyces cerevisiae)* is a eukaryotic organism which undergoes sexual reproduction when under environmental stress, forming resistant spores, but under normal conditions reproduces asexually by budding, as shown in the photograph below.



Magnification × 1000

(a) (i) Calculate the actual size of yeast cell **A** shown above. [2]

Actual size = ... μm

(ii) Give **two** reasons why yeast would be classified as a eukaryotic organism. [1]

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A400U101 03

Turn over.

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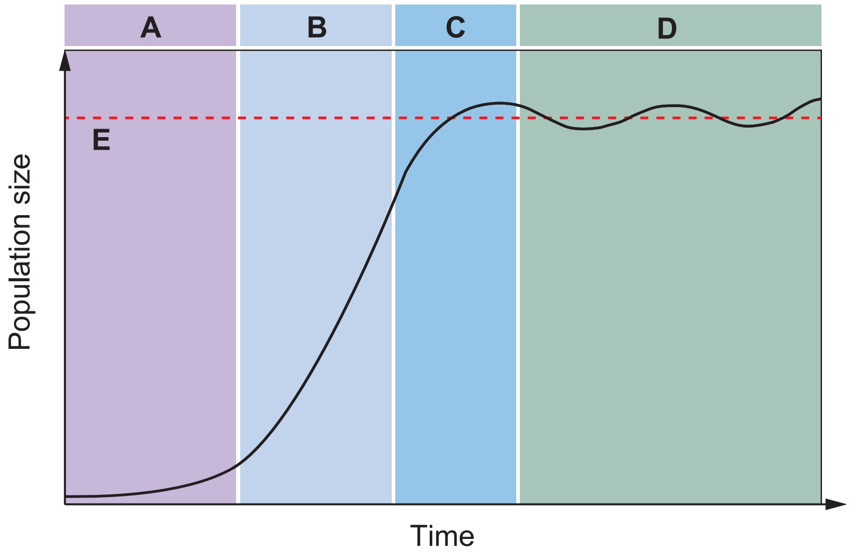
Population growth curves can be modelled using simple organisms such as yeast. One such growth curve using yeast is shown below.
Dried yeast cells were placed in a nutrient solution in an anaerobic fermenter with excess glucose as a respiratory substrate. Samples were taken at intervals and the number of cells determined. The results of this work are shown below.



(b) (i) Suggest a unit for time on the x-axis. [1]

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(ii) State what is represented by line **E**. [1]

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(c) (i) Identify phases **A**, **B** and **D** labelled on the graph and explain what is happening to the yeast population in each phase. [3]

A ....

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B ....

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D ....

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(ii) Suggest **one** factor that has caused the change in the shape of the graph in phase **C** and suggest what you would expect to have happened to the population at the end of phase **D**. [2]

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(d) Identify the phases during which you would expect sexual reproduction of the yeast cells to be occurring. Explain why sexual reproduction would be an advantage to the yeast. [3]

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(e) A knowledge of population numbers is very important in ecology so that changes can be detected quickly. To estimate the populations of mobile animals, a method of mark and recapture is commonly used. The photograph below shows a marked Chittenango snail *(Novisuccinea chittenangoensis)*, which is classified as an endangered species.

The table below shows the method used to estimate the population and the results obtained.

Method		Result
1.	Capture and count animals.	430 snails
2.	Mark/tag them.	
3.	Release them back into the community.	
4.	Capture a second sample and count them.	410 snails
5.	Record the number of marked/tagged individuals re-captured.	100 snails

The population can be estimated using the following equation.

$$\frac{M}{P} = \frac{R}{n}$$

P is the population size to be estimated.
M is the number of members of the population that are captured initially and tagged.
n is the number of members of the population that are captured subsequently.
R is the number of members of this re-captured population that are tagged.

Use the equation to calculate the population of snails. [2]

Population = ... snails

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(f) Suggest **two** assumptions that must be made when using this technique to estimate snail population numbers. [2]

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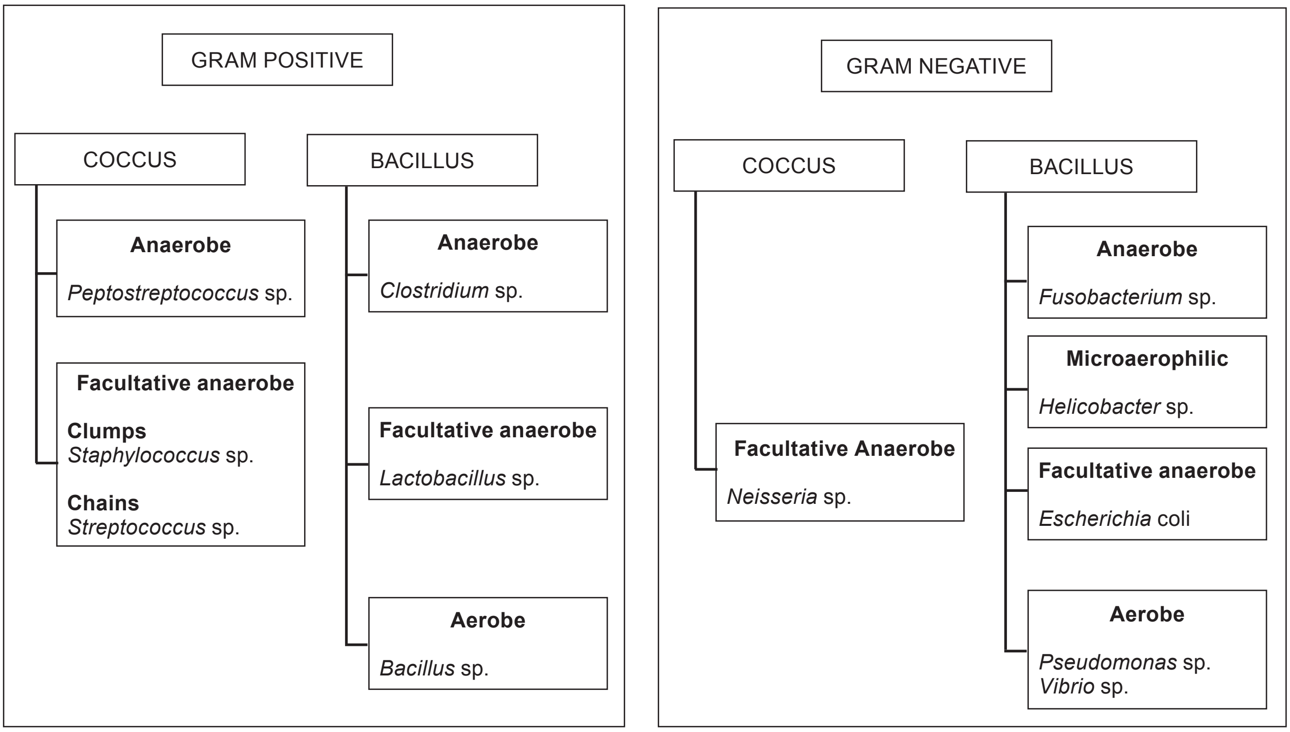
2. Accurate and definitive bacterial identification is essential for disease diagnosis, treatment and the trace-back of outbreaks associated with microbial infections. Bacterial identification is also used in a wide variety of other applications including microbial forensics, criminal investigations, bio-terrorism threats and environmental studies.

The simplified key shown below can be used to identify bacteria given some of their features.



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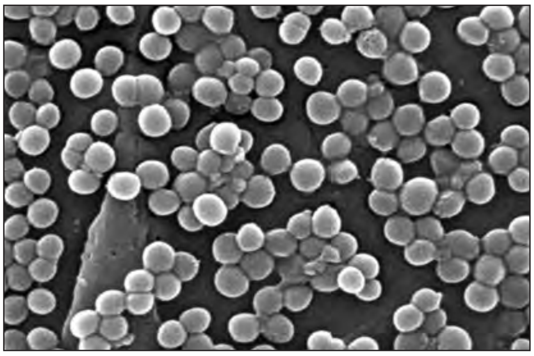
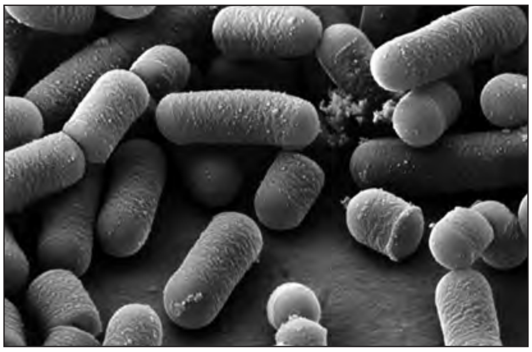
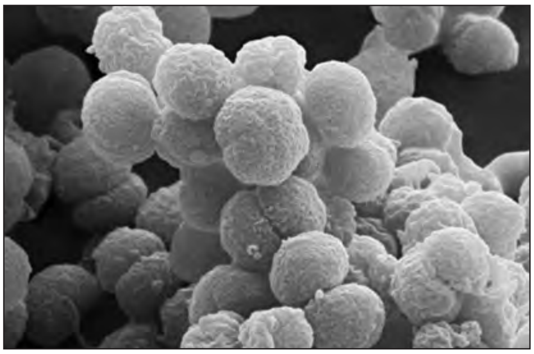
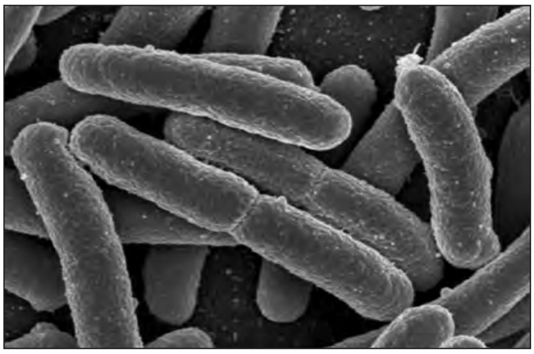
The images below show four different bacteria together with information about their oxygen requirements and the results of Gram staining.

A	B
	
Facultative anaerobe Gram positive	Facultative anaerobe Gram positive

C	D
	
Facultative anaerobe Gram negative	Facultative anaerobe Gram negative

(a) Using the key provided, identify the **four** bacteria in the images. [4]

A ....

B ....

C ....

D ....

A400U101
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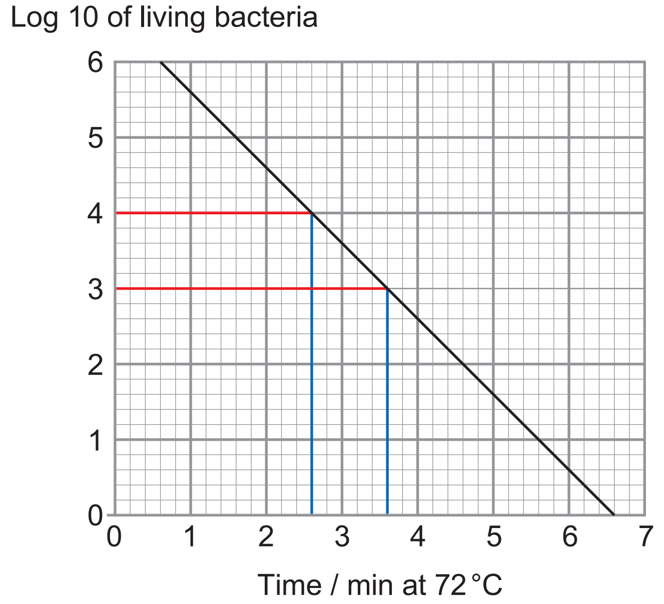
Each bacterial species has its own particular heat tolerance. During a process such as pasteurisation, the rate of cell destruction is logarithmic. Bacteria subjected to heat are killed at a rate that is proportional to the number of bacteria present. The process is dependent both on the temperature of exposure and the time required at this temperature to accomplish the desired rate of destruction.

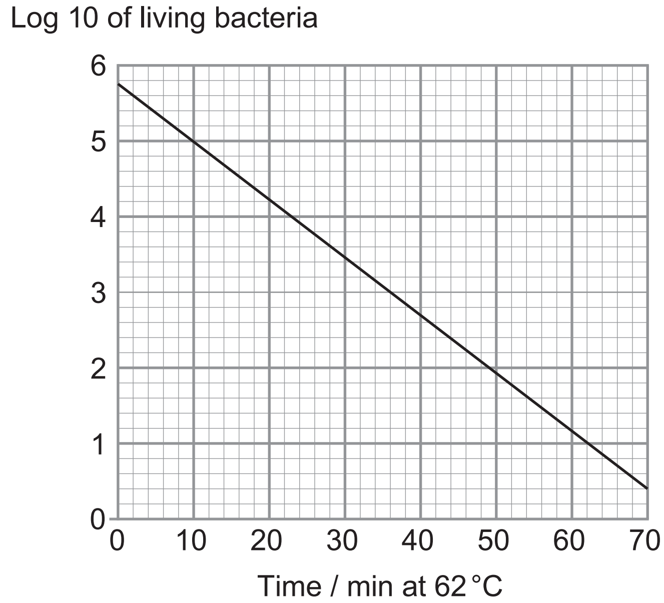
The D value is the time in minutes at a given temperature required to destroy 90% of the bacterial population.

Graph 1



In the example shown above at 72 °C, the D value = 1 minute. This means that for each minute of processing at 72 °C the bacterial population will be reduced by 90%.

Graph 2



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(b) Follow the method shown on graph **1** to calculate the D value for 62 °C (graph **2**). [3]

D Value = ...

(c) Describe a method that you could use to determine the number of living bacteria in the original sample prior to heat treatment. No reference to aseptic technique is required. [4]

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(d) Describe the effect of heat in the process of pasteurisation on the proteins in the bacteria. [3]

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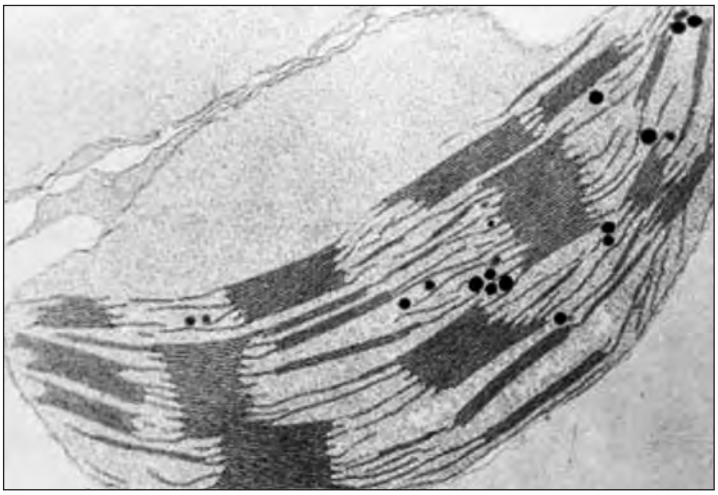
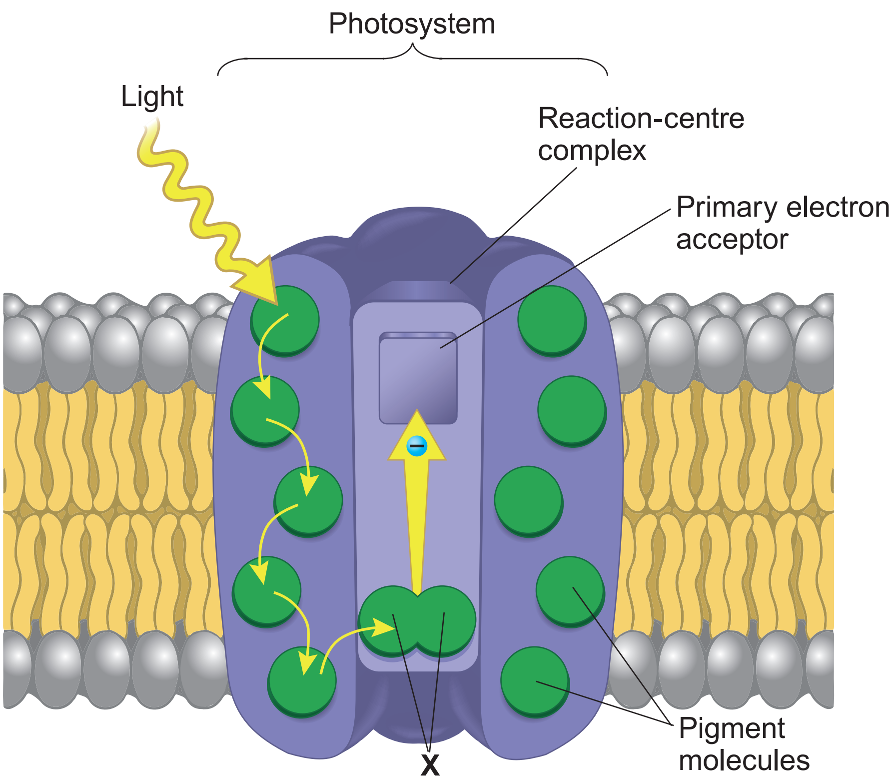
3. The electron micrograph below shows a chloroplast, taken from a eukaryotic organism.



(a) (i) **Identify using a clearly labelled arrow** where photosystems are found on the electron micrograph above. [1]

The diagram below represents one photosystem.



(ii) Identify the pigment found at **X**. [1]

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(b) Explain the role of photosystems in the light dependent stage of photosynthesis. [3]

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Many micro-organisms living in dark regions of the oceans use chemosynthesis to produce organic molecules. Some deep sea vent bacteria oxidise hydrogen sulfides. This releases energy which is used to combine carbon dioxide and hydrogen to synthesise carbohydrates. Sulfur and water are released in this process as shown in the equation below.

$$CO_2 + 4H_2S + O_2 \longrightarrow CH_2O + 4S + 3H_2O$$

(c) Complete the table to state **four** differences between chemosynthesis and photosynthesis. [4]

Chemosynthesis	Photosynthesis

A400U101 13

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(d) Following the synthesis of carbohydrate, a number of inorganic ions are needed to synthesise other biological molecules.

State **three** different biological molecules **and** the inorganic ions required to synthesise them. [3]

I. ....

II. ....

III. ....

(e) Herbicides inhibit photosynthesis in many ways.
One group of herbicides block electron transport, so chlorophyll continues to absorb light energy but cannot pass this energy on.
Light energy not used in electron emission damages chlorophyll leading to chlorosis.
Desiccation occurs because of the formation of oxygen free-radicals, which are highly destructive to cell membranes.

Use the information given and your own knowledge to explain how blocking electron transport from photosystems with this herbicide could lead to the death of a plant. [4]

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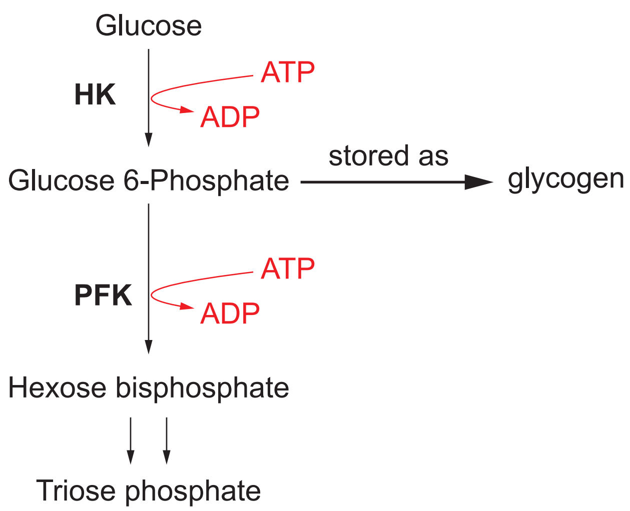
4. Glycolysis is the initial stage of respiration and involves hydrolysis of glucose and the production of ATP. The diagram below shows part of glycolysis.



Control of glycolysis is largely by end-product inhibition:

- High levels of ATP allosterically inhibit the enzyme PFK in the liver thus lowering its affinity for its substrate.
- PFK is the main regulatory enzyme in glycolysis, but it is not the only one.
- HK, the enzyme catalysing the first step of glycolysis, is inhibited by its product, glucose 6-phosphate.

(a) Explain the term *allosteric inhibition*. [2]

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(b) (i) Explain why the cell uses inhibition of PFK as the main method of slowing glycolysis, rather than using the inhibition of HK. [2]

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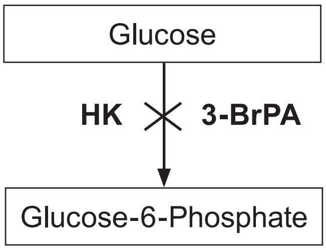
3-BrPA is a chemical which is an inhibitor of HK. It appears to add a small chemical group to the enzyme thus changing its shape.



3-BrPA has been shown to stop ATP production and cause severe depletion of cellular ATP.

3-BrPA exhibits potent cytotoxic activity against cancer cells. It is currently undergoing trials as an anti-cancer agent, particularly in cancer cell types which rely heavily on ATP from glycolysis.

(ii) Explain how 3-BrPA acts as a potential anti-cancer agent. [3]

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(c) NAD is a hydrogen acceptor used in many stages of respiration. Methylene blue can be used as an artificial hydrogen acceptor. It decolourises when reduced and can be used to give an indication of the rate of respiration.

An experiment was set up using isolated liver mitochondria extracted in ice-cold, isotonic buffer. The same volume and concentration of pyruvate, mitochondrial suspension and methylene blue was added to each experiment. The temperature was changed for each experiment and the experiment repeated three times. Thermostatic water baths were used throughout.

(i) Explain why the mitochondria were initially suspended in **ice cold**, **isotonic buffer**. [3]

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(ii) Explain why pyruvate was used as the respiratory substrate and not glucose. [2]

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The results of the experiment are shown in the table below.

	Time taken for methylene blue to decolourise / seconds				
Temperature / °C	Trial 1	Trial 2	Trial 3	Mean	Standard deviation
10	320	290	385	332	±48.6
20	280	275	282	279	±3.6
30	165	172	159	165	±6.5
40	102	105	98	102	±3.5
50	156	162	148	155	±7.0
60	330	355	342	342	±12.5

(iii) State **one** conclusion you can draw from this experiment and comment on the reliability of the results in the table shown. [3]

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5. The sea rises and falls twice a day; this is called tidal movement. In river estuaries there is still tidal movement but little wave action. As the seawater on a rising tide moves across bare rock it brings sand, mud particles and detritus. The lack of wave action in estuaries results in this material settling out when the tide stops moving. These materials build-up and in time raise the level of mud and eventually form soil. This habitat is called a saltmarsh where rooted plants grow. Higher land, frequently used for agriculture, drains through the saltmarsh into the river.

(a) State the term used to describe the

I. process by which the saltmarsh community is formed. [1]

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II. first organisms to colonise the mud. [1]

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III. the final group of organisms which inhabit the area which was once mud. [1]

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(b) A saltmarsh is an extreme environment for organisms trying to survive.

Using the information given, identify **three** abiotic factors which cause this to be an extreme environment for plant survival. Explain each of your answers. [6]

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II. ....

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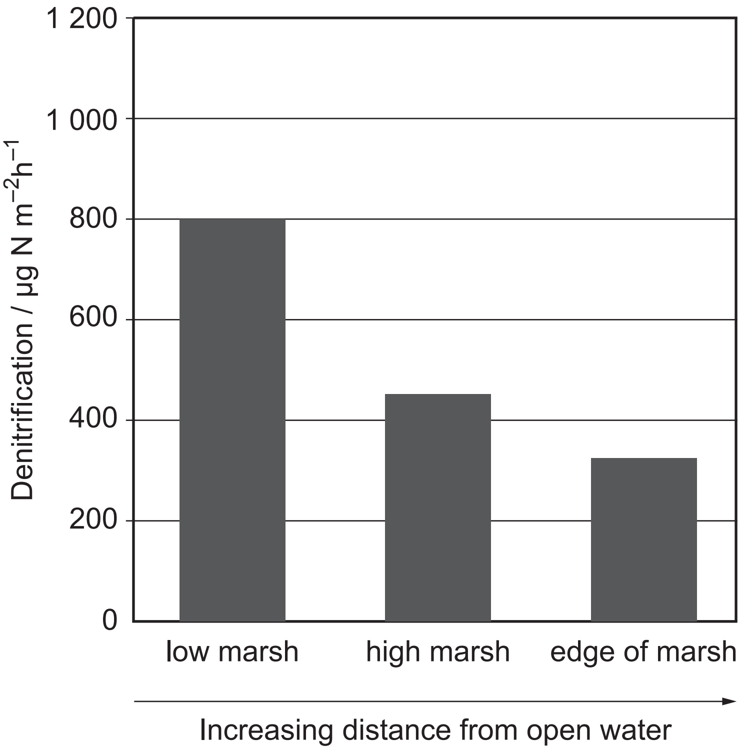
Denitrification is a biotic factor which affects saltmarsh ecology. The results of an investigation into rates of denitrification are shown in the chart below. Further investigations also showed that denitrification varied through the year. It was higher in the summer than the winter months.



(c) (i) State why denitrification is classed as a biotic factor. [1]

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(ii) Using the information given and your own knowledge, identify **two** factors affecting denitrification. Explain each of your answers. [3]

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(d) Describe a practical method which you could carry out on the saltmarsh to investigate the **change in vegetation over time**. [5]

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6. In the past, Red Kites *(Milvus milvus)* almost became extinct in the UK and by 1905 there were estimated to be only three breeding pairs in the UK, all of which were in West Wales.

It has taken a century for the UK Red Kite population to recover from the few remaining birds. In 1986 the recovery was helped by the re-introduction of some Red Kites from Wales to England and Scotland. Although they are still rare, between 2008 and 2011 they were found breeding in over 700 areas that were sampled across the UK.

The population recovery has involved keeping nest sites secret and round-the-clock protection by volunteers.

(a) In 1995 there were 284 Red Kites in the UK with numbers increasing to 1025 per cent of the original population between 1995 and 2017. Calculate the approximate **number of breeding pairs** of Red Kites present in 2017. [3]

.... breeding pairs

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(b) In areas where Red Kites were absent and then re-introduced the numbers increased much more rapidly than in areas where they were already established. Explain the reasons for this. [3]

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(c) Explain why the location of nest sites needed to be kept secret with round-the-clock protection. [1]

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Many Red Kite chicks are tagged so that their survival and lifespan can be monitored. Survival rates in Northern Scotland are poorer than elsewhere, mainly because of illegal poisoning and shooting on grouse-shooting estates.

(d) Suggest **two** ways in which society could improve the survival rates of Red Kites. [2]

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Red Kites have often bred successfully in woodland SSSI's.

(e) State what is meant by an SSSI and why Red Kites may breed more successfully in these sites. [2]

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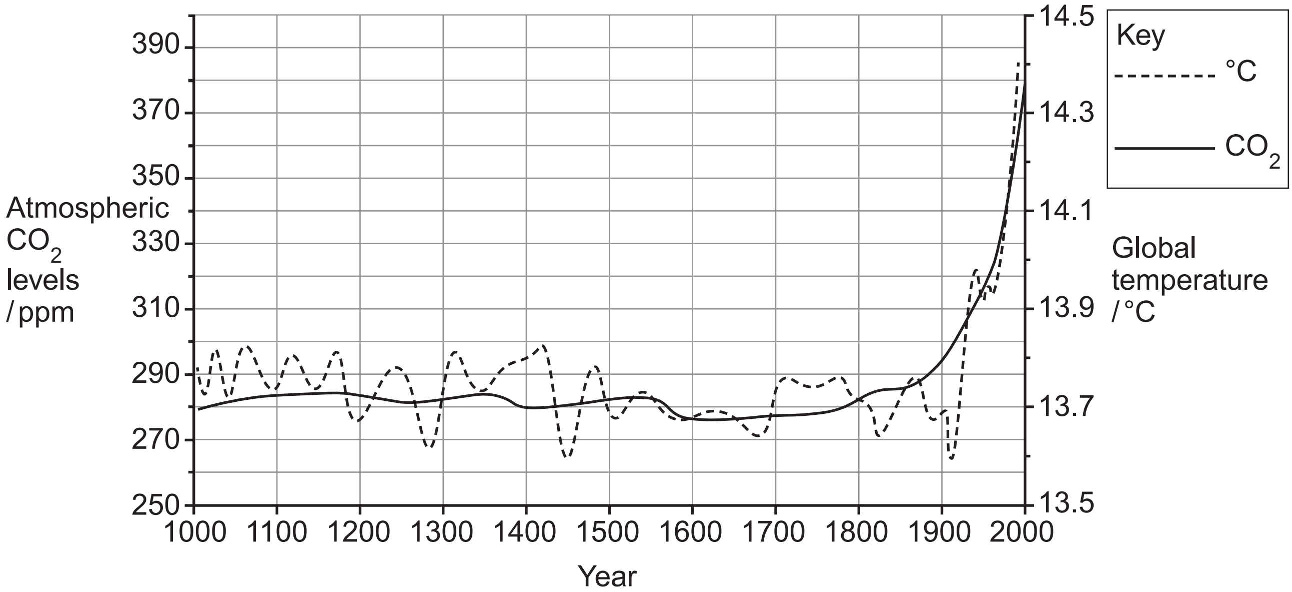
7. Since the beginning of the Industrial Revolution (250 years ago), carbon dioxide concentration in the atmosphere has risen from about 280 parts per million to 408 parts per million in 2018. This means that for every million molecules in the atmosphere, 408 of them are now carbon dioxide, the highest concentration in two million years. Ice samples provide a record of the Earth's atmospheric temperature and CO_2 levels. The data below shows how global temperatures and atmospheric CO_2 levels have changed from the year 1000.



Use your knowledge of the carbon cycle to explain how humans have affected global carbon dioxide levels and temperature levels. Use the information and data provided to support your answer.
Describe the effects of increasing carbon dioxide levels and global temperatures on aquatic environments. [9 QER]

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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