Candidate Name	Centre Number					Candidate Number				

A LEVEL BIOLOGY

COMPONENT 1

Energy for Life

SPECIMEN PAPER

2 hours

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**13**	
2.	**10**	
3.	**10**	
4.	**11**	
5.	**16**	
6.	**16**	
7.	**7**	
8.	**8**	
9.	**9**	
Total	**100**	

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

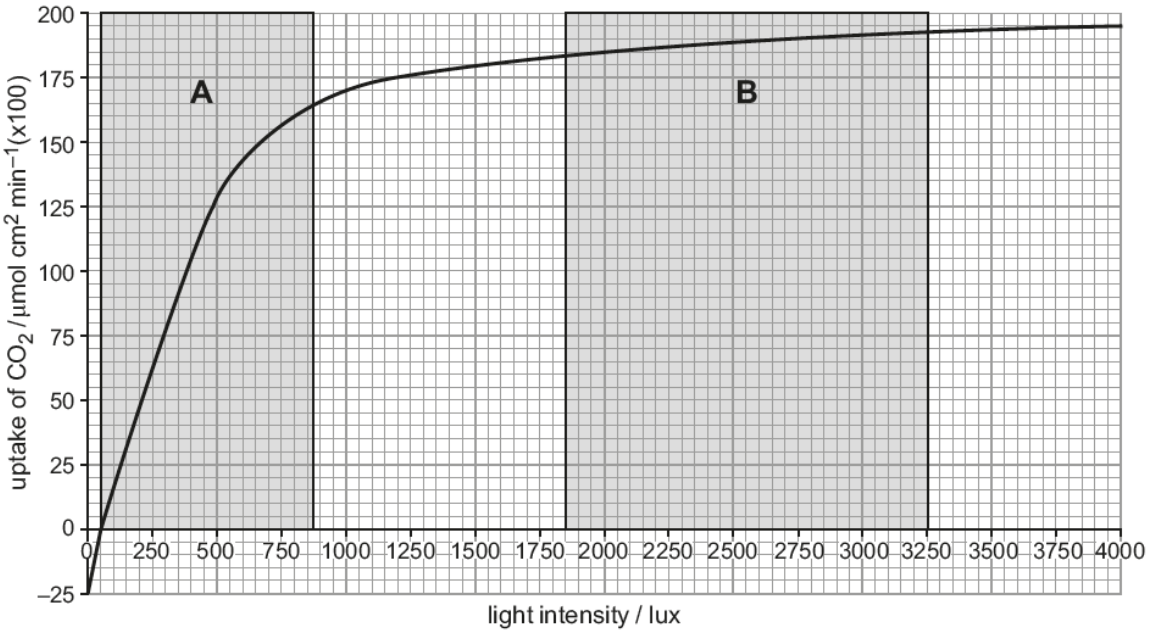
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

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 9.

*Answer **all** questions.*

1. The diagram below shows the rate of uptake of carbon dioxide for a species of grass at different light intensities. Measurements were taken at a constant external carbon dioxide concentration and a temperature of 15 °C.



(a) Calculate the rate of uptake of carbon dioxide between 250 and 750 lux. Express your answer in standard form. [2]

Rate of uptake of carbon dioxide = ... µmol cm^{-2} min^{-1} lux^{-1}

(b) Explain the differences in the rate of uptake of carbon dioxide between parts A and B of the graph. [2]

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(c) Below a light intensity of 50 lux, photosynthesis takes place even though there is no uptake of carbon dioxide. What conclusions can be made regarding the rates of photosynthesis and respiration taking place at light intensities up to and including 50 lux? [2]

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(d) Diuron is a weed-killer which is a very specific and sensitive inhibitor of photosynthesis.
It blocks the electron carrier binding site on Photosystem II. This stops the electron flow from where it is generated in Photosystem II, to the electron carrier. This reduces the ability of the plant to convert light energy into chemical energy.
Diuron only blocks electron flow from Photosystem II. It has no effect on Photosystem I or other reactions in photosynthesis, such as light absorption or carbon fixation in the Calvin cycle.

Describe the effects of Diuron on non-cyclic photophosphorylation and explain why cyclic photophosphorylation is not affected. [4]

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(e) Explain why a plant would die when the weed-killer Diuron is sprayed onto it. [3]

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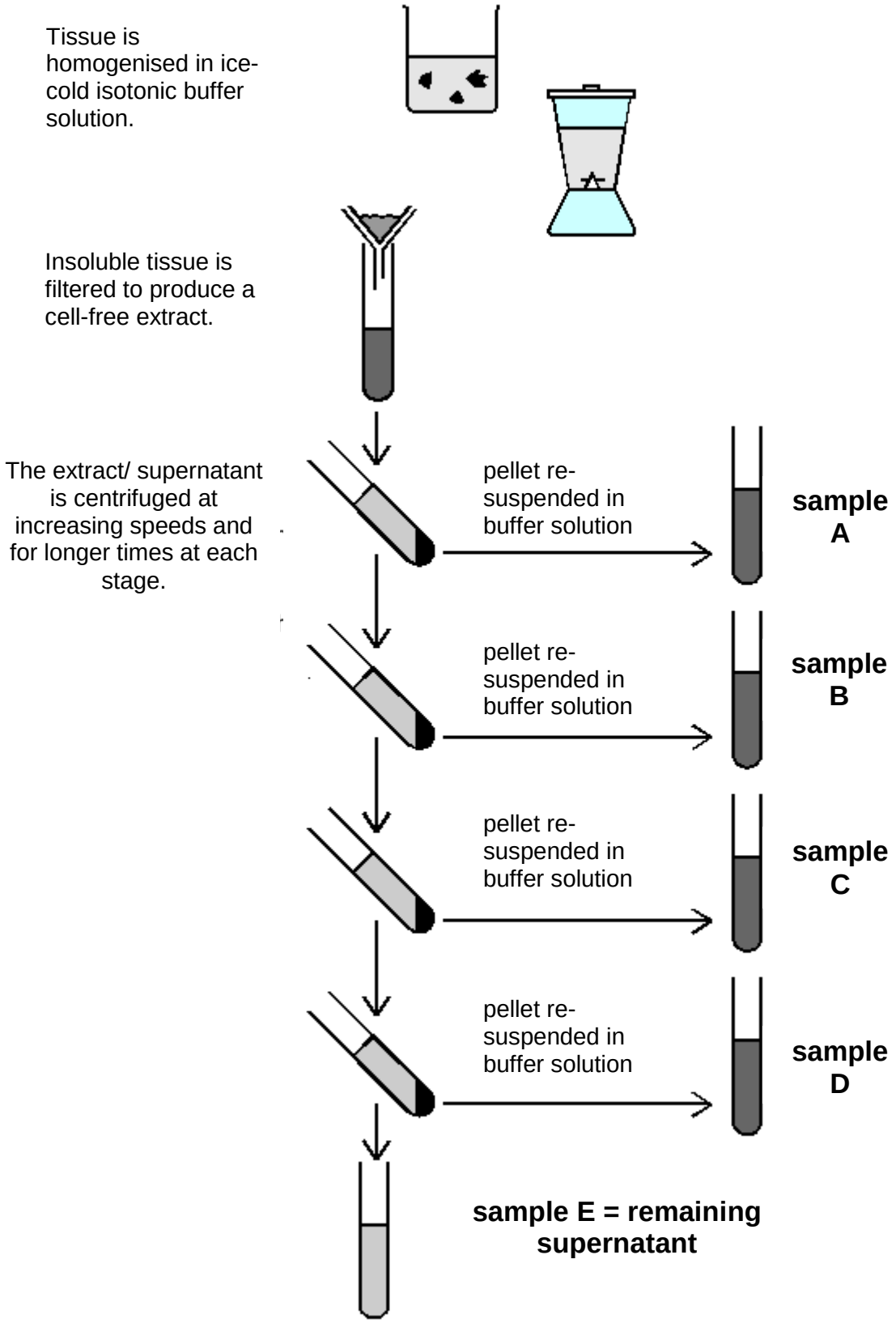
2. The process shown in the diagram below shows the preparation of animal cell fractions. Each fraction contains only one type of cell component.



Each sample was then incubated with glucose and pyruvate and the production of carbon dioxide and lactate was noted.

	Incubated with glucose		Incubated with pyruvate	
Sample	**Carbon dioxide produced**	**Lactate produced**	**Carbon dioxide produced**	**Lactate produced**
A	**NO**	**NO**	**NO**	**NO**
B	**NO**	**NO**	**YES**	**NO**
C	**NO**	**NO**	**NO**	**NO**
D	**NO**	**NO**	**NO**	**NO**
E	**NO**	**YES**	**NO**	**NO**

(a) Based on these results, identify the cell components which are present in samples **B** and **E**? Explain how you reached these conclusions. [5]

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(b) Cyanide inhibits the enzyme cytochrome oxidase and prevents the regeneration of NAD. Explain why cyanide could be used to confirm which sample contained resuspended mitochondria. [3]

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(c) Explain why the preparation of the cell fractions was carried out using an isotonic solution rather than pure water. [2]

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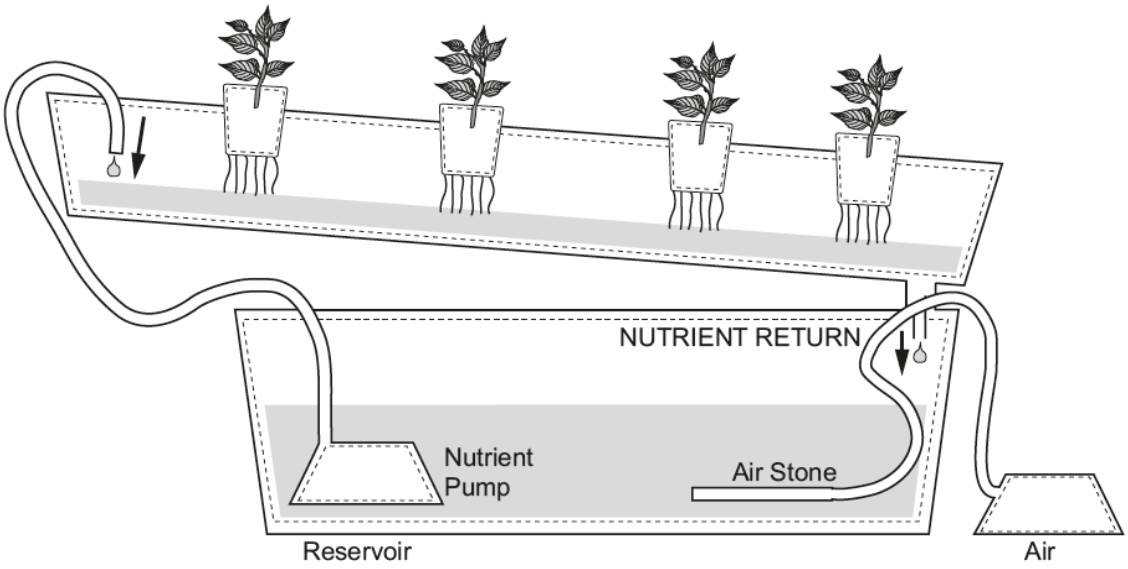
3. Hydroponics is a method used to grow crops without soil. It involves growing plants in an aerated solution of nutrients as shown in the diagram below.



(a) Tomatoes are often grown using hydroponic systems. A commercially available hydroponic nutrient solution contained the following concentrations of six of the elements essential for plant growth.

element	concentration (mg dm^{-3})
N	70
P	50
K	120
Ca	11
Mg	40
S	55

Explain why the concentration of nitrogen and magnesium would need to be increased during the growing period of the tomato plants. [2]

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(b) Explain how ions pass from the soil water into the xylem and why the solution must be aerated for this to take place. [4]

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(c) A tomato grower who used a hydroponic system was concerned over reports that nitrate levels in the nutrient medium either lower or higher than an optimum could have a negative impact on root growth and subsequently, a reduced yield. He adapted his hydroponic system to determine the optimum nitrate levels needed to achieve maximum yield.

Identify the independent, dependent and controlled variables he could have used in his investigation. (You are not expected to provide values for the variables.) [4]

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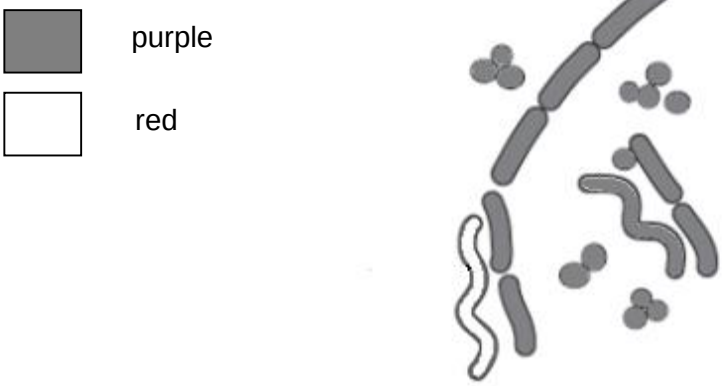
4. Following an outbreak of food poisoning in a school, samples were taken from infected patients. The Gram staining technique was used, in conjunction with the shape of bacterial cells, to identify potentially pathogenic bacteria in the samples.

The diagram below shows part of a bacterial smear stained using the Gram staining technique.



Tests showed that the bacterium responsible for the food poisoning was *Campylobacter jejuni*. This helical, Gram negative bacterium colonises the digestive tract of many birds and cases of food poisoning by this bacterium are usually associated with poor preparation of poultry.

(a) (i) On the diagram above label a bacterium that could be *C. jejuni*. Explain your choice of bacterium. [1]

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(ii) Explain why this bacterium might be resistant to treatment by antibiotics. [2]

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(iii) Birds have a higher body temperature than mammals. One diagnostic tool used to identify *C.jejuni* involves culturing samples from infected people at 42°C. Explain how this helps identify *C.jejuni* from a mixture of bacteria. [1]

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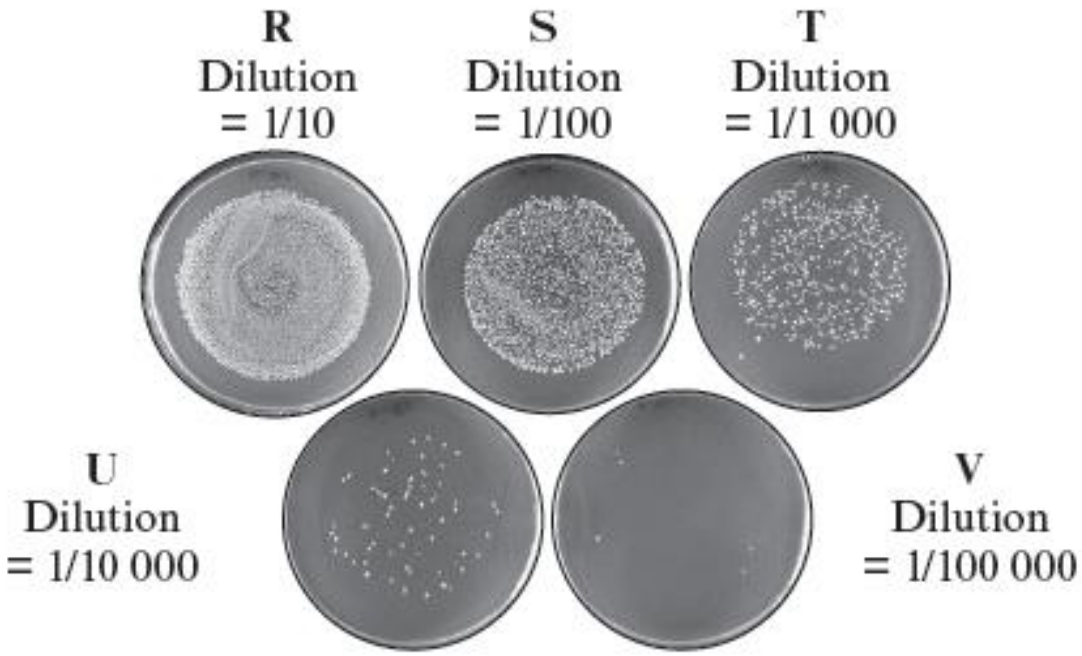
(b) The source of the infection was traced to a poultry dish that had been prepared in the school canteen. Using the viable count method Environmental Health Officers made an estimate of the number of bacteria in a sample of the food. Dilutions of 1/10, 1/100, 1/1 000, 1/10 000 and 1/100 000 were prepared and 0.5 cm^3 of each dilution were spread evenly over the surface of agar plates. The plates were incubated at 35°C for 24 hours. A photograph of the results is shown below.



(i) Explain why it was decided to use Plate U to estimate the number of bacteria in the food rather than the other plates. [3]

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(ii) It was found that 69 bacterial colonies were growing on Plate U. Use the information provided to estimate the number of *C.jejuni* bacteria present per cm^3 in the actual food. Show how you reached your answer. [2]

Estimated number of bacteria = ... per cm^3

(iii) Explain why this is likely to be an underestimate of the actual number present in the food. [2]

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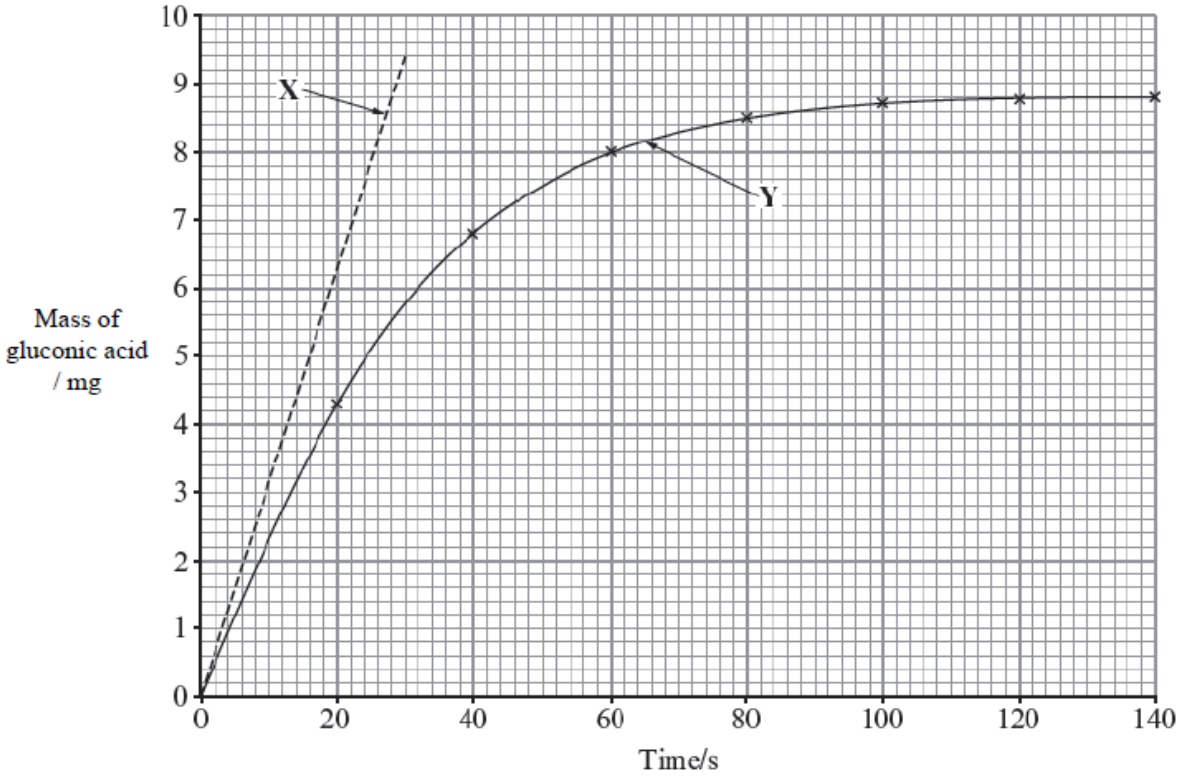
5. Glucose oxidase (GOx) is an enzyme that is used in biosensors to determine glucose levels in blood. It converts glucose to gluconic acid and hydrogen peroxide.

An investigation into the action of this enzyme produced the results shown in the graph below.



(a) (i) Use tangent **X** to calculate the **initial** rate of reaction for this enzyme. Express your answer in terms of rate of production of mass of gluconic acid per minute. Show your workings. [2]

Initial rate of reaction = ...

(ii) Explain why the rate calculated for the first 30 seconds would be lower than the initial rate. [2]

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(b) Part of the mechanism for the conversion of glucose to gluconic acid by GOx is shown by the equations below. In these reactions FAD is acting as a co-factor to the enzyme.

Step 1 glucose + GOx – FAD → gluconolactone + GOx-$FADH_2$

Step 2 GOx-$FADH_2$ + oxygen → GOx-FAD + hydrogen peroxide

(i) Suggest the function of FAD in this series of reactions. [1]

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(ii) One type of glucose biosensor involves the detection of oxygen concentrations in a sample of body fluid. Name **two** body fluids that could be analysed. [1]

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(iii) With reference to the information above, explain how an oxygen electrode could be used to give a quantitative measurement of the glucose concentration in a sample of a body fluid. [2]

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(iv) When using a glucose biosensor explain why it is important to maintain a constant temperature and use a buffer. [3]

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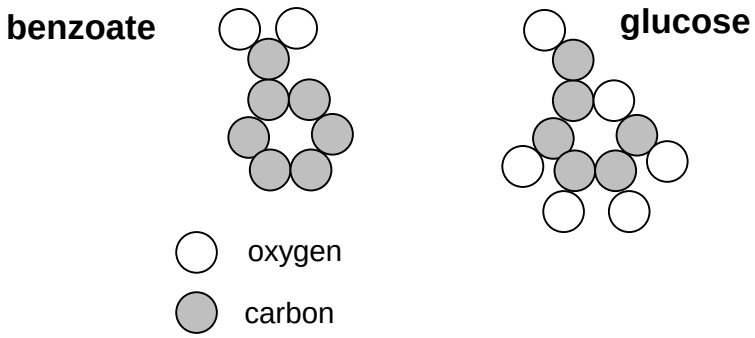
(c) Experiments have shown that sodium benzoate, a commonly used preservative, can inhibit GOx and affect the accuracy of a glucose biosensor.

The diagrams below show the arrangement of carbon and oxygen atoms in a molecule of glucose and a benzoate ion (hydrogen atoms are not shown).



Using the information provided in part (b) and the diagram above explain why contamination of a sample with sodium benzoate would affect the accuracy of the biosensor. [5]

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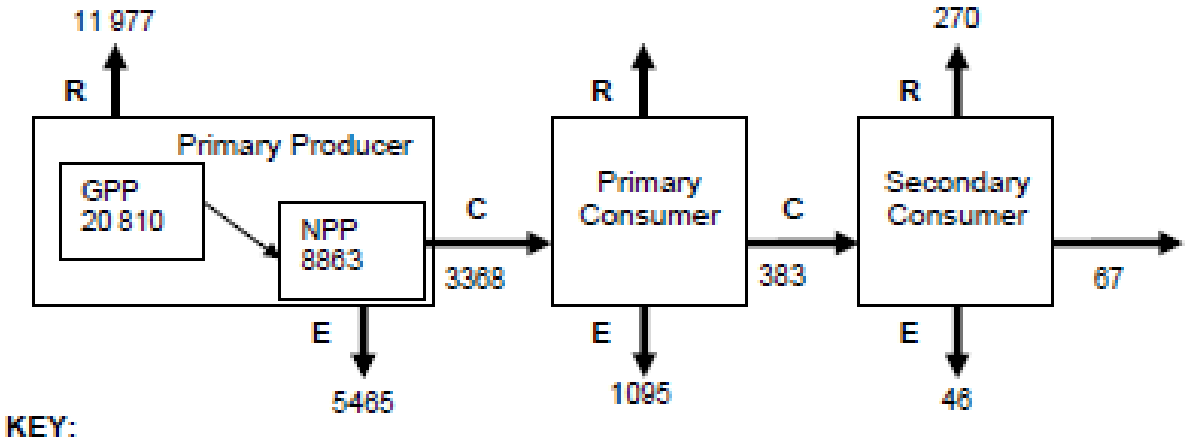
6. The diagram shows the transfer of energy through an ecosystem.

All values given are in kJ m^{-2} yr^{-1}.



KEY:
R = respiratory loss
C = consumed
E = expelled

(a) (i) State what is meant by the abbreviations **GPP** and **NPP** shown in the diagram and explain the difference between them. [3]

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(ii) What term is used to describe the transfer of energy between consumers? [1]

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(iii) Calculate the percentage energy lost through respiration by primary consumers. Give your answer to two significant figures. [2]

Answer …… %

(b) The values given are for marshland. Energy is expelled from the system at each trophic level.

(i) Identify **three** ways that energy could be expelled from the system. [2]

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(ii) The values given in kJ m^{-2} yr^{-1}. The area of the marshland is 17 000 m^2.

Calculate the total amount of energy 'expelled' by this ecosystem in one year. Express your answer in standard form. [2]

Answer ……..

(iii) Describe what happens to this expelled energy. [2]

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(c) The principles of energy transfer through food chains can be employed to compare the efficiency of different farming methods. With reference to the information provided, explain the increase in the use of factory farms for rearing herbivores such as cattle. [4]

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7. In 2009, a group of 28 internationally renowned scientists identified and quantified a set of nine planetary boundaries.
The table below shows the planetary boundaries for some of these global processes.

Global Process	Variable	Units of measurement	Boundary	Pre-industrial value	Recent data
Biodiversity loss	Extinction rate	species becoming extinct per million species per year	10	1	100 - 1 000
Climate change	Atmospheric carbon dioxide	ppm (parts per million)	350	280	390
Land use	Land used for crops	%	15	5	12
Fresh water	Use of fresh water	km^3 per year	4 000	415	2 600

(a) Explain what you understand by the term planetary boundary. [2]

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(b) Define the term biodiversity and describe **one** action that could delay biodiversity loss. [2]

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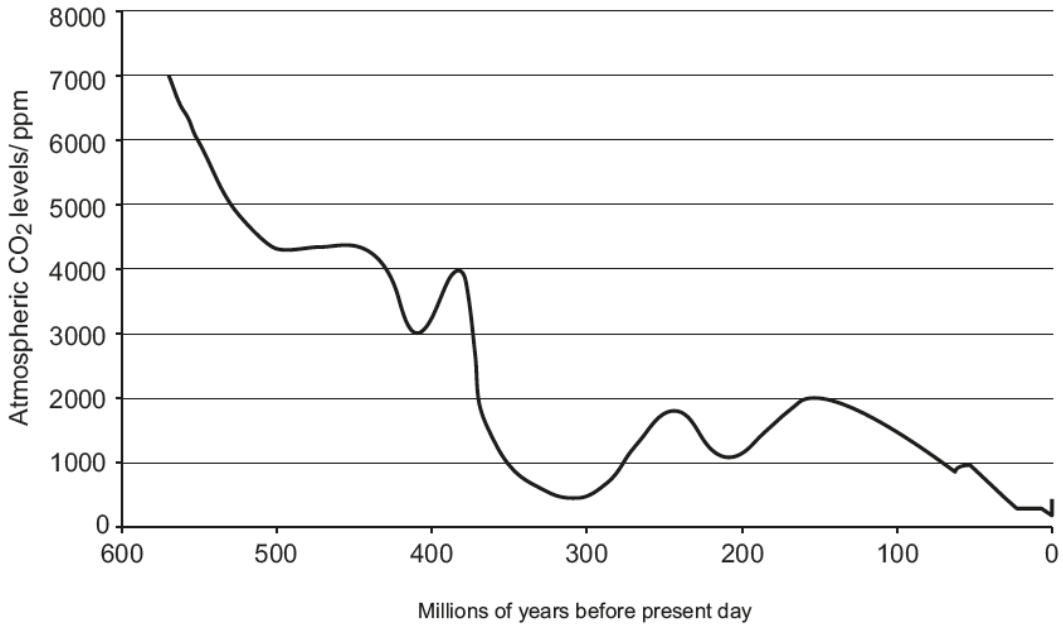
(c) It has been claimed that the increase in extinction rate observed in recent years is purely down to increasing atmospheric carbon dioxide levels. However, the graph below shows that carbon dioxide levels in the past have far exceeded current levels and in addition to this the extinction rate at those times was significantly lower.



Analyse the data given in the table and draw alternative conclusions as to the possible causes of the increasing extinction rate. Explain how you reached these conclusions. [3]

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8. Nucleic acids are formed from units called nucleotides. Each nucleotide contains an organic base and a phosphate group bonded to a pentose sugar.

Erwin Chargaff analysed the percentage composition of the different bases found in DNA. Some of his results are shown in the table below.

organism	**Percentage composition of DNA**				$\frac{\text{A+T}}{\text{C+G}}$	$\frac{\text{C+T}}{\text{A+G}}$
	A	**G**	**T**	**C**		
maize	26.8	22.8	27.2	23.2	1.17	1.02
human liver	29.3	20.6	30.0	20.1	1.45	1.01

(a) (i) Identify the types of bases represented by A, G, T and C and use this information to explain why the **C+T : A+G** ratio is approximately 1.0 in both maize and humans but the **A+T : C+G** ratio is different. [3]

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(ii) Suggest why the C+T:A+G ratio is not exactly 1.00. [1]

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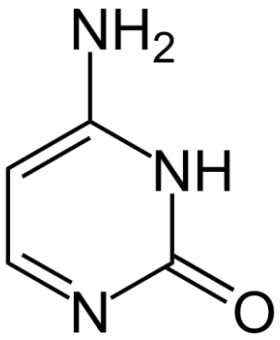
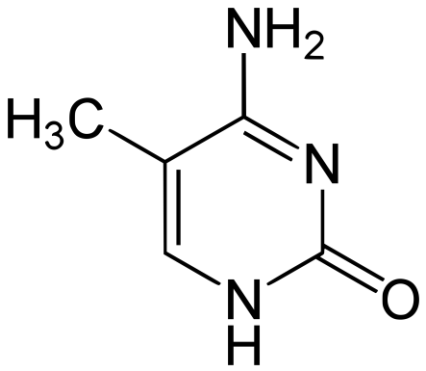
(b) The diagrams below show the structures of the base cytosine and a modified version called 5-methyl cytosine.

cytosine



5-methyl cytosine



Exposure to some chemicals can cause the modification of cytosine bases to 5-methyl cytosine. Genes with a high proportion of these modified bases may not be transcribed.

(i) Explain why this modification to the DNA would not result in a change to the structure of a protein. [2]

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(ii) Explain how this change could have an effect on the phenotype of a person. [2]

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9. Human activity and bacteria play a vital role in making nitrogen available to increase the yield of crops.
Explain the ways that human activity and bacterial action can influence nitrogen availability and the negative impacts that this may have on the environment.
(The quality of your extended response will be assessed in this question.) [9QER]

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