FOR OFFICIAL USE

C

KU	PS

Total Marks

0300/402

NATIONAL QUALIFICATIONS 2009

THURSDAY, 28 MAY
10.50 AM – 12.20 PM

BIOLOGY
STANDARD GRADE
Credit Level

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Date of birth
Day Month Year

Scottish candidate number

Number of seat

1 All questions should be attempted.

2 The questions may be answered in any order but all answers are to be written in the spaces provided in this answer book, and must be written clearly and legibly in ink.

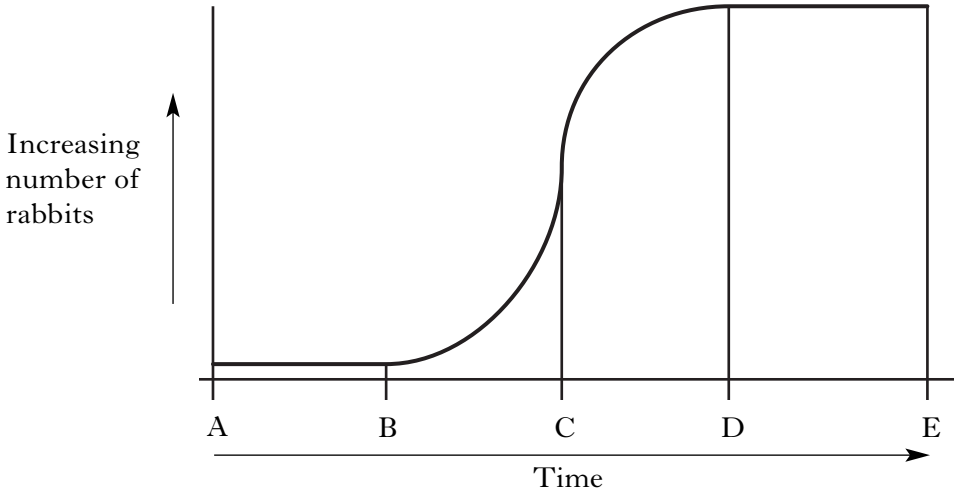
3 Rough work, if any should be necessary, as well as the fair copy, is to be written in this book. Additional spaces for answers and for rough work will be found at the end of the book. Rough work should be scored through when the fair copy has been written.

4 Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.

DO NOT WRITE IN THIS MARGIN

Marks	KU	PS

1. (*a*) Rabbits were first brought to Australia by European settlers.
The graph below shows the change in rabbit population in Australia since their introduction.



(i) Describe the changes in the rabbit population between times A and E.

2

(ii) Suggest one reason for the population change between times B and C.

1

(*b*) To control over-grazing by rabbits, a disease was introduced in 2005 which was fatal to rabbits but not to other species.
If this disease had wiped out the rabbit population, what effect could it have had on the population of:

(i) Eastern wallabies which are herbivores?

(ii) Dingoes which are carnivorous wild dogs?

Explain your answers.

(i) Effect on Eastern wallabies

Explanation

(ii) Effect on Dingoes

Explanation

2

DO NOT WRITE IN THIS MARGIN

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2. (*a*) Coal-burning and nuclear power stations are used to produce electricity in Britain.

Draw lines to connect each type of power station with features considered to be adverse effects of their operation.

Type of power station	*Features*
coal burning	• Waste can cause high levels of acid rain
	• Waste must be sealed before it is stored
nuclear	• High volume of greenhouse gas production
	• Waste is dangerous for hundreds of years

2

(*b*) Environmental protection analysis was carried out on water samples from three burns.

The Mains Burn had the highest pH at 8·0. It also had the highest oxygen saturation at 94% compared to Bell's Burn which had the lowest at 65%.

The Hatchery Burn had the lowest value for suspended solids at 4·0 mg/l, with an oxygen saturation of 91·5%.

Bell's Burn had a suspended solids reading of 5·6 mg/l and the lowest pH at 7·7 compared to a value of 7·9 for the Hatchery Burn. The highest reading for suspended solids was recorded in the Mains Burn with a value of 6·0 mg/l.

(i) Complete the following table with the data in the passage using suitable column headings.

Analysis site			
Hatchery Burn			
Bell's Burn			
Mains Burn			

3

(ii) Calcium in the water of the burns raises the pH.

Water snails need calcium for shell growth. Which burn would you expect to have the highest number of water snails?

1

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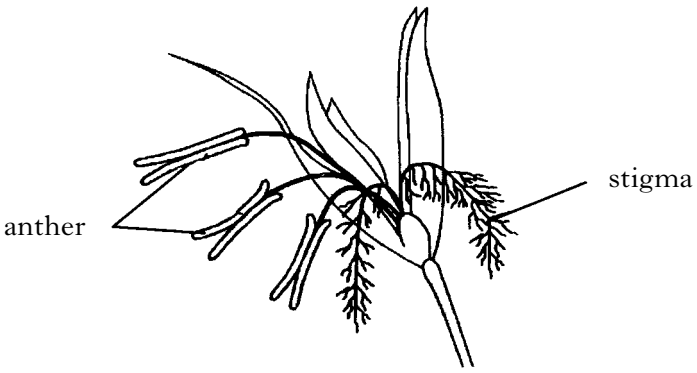
3. (*a*) The diagram below represents a wind-pollinated flower.



Explain how each of the labelled structures contributes to wind pollination.

Anther

Stigma

2

(*b*) The chart below shows the peak times for airborne pollen from six wind-pollinated plants.

	Month											
Type of plant	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Hazel												
Yew												
Willow												
Oil seed rape												
Grass												
Nettle												

(i) How many months are shown to be free of pollen?

1

(ii) The above plants account for most pollen allergy in Britain.

Most allergy sufferers are affected for 3–4 months each year.

Give a conclusion which can be drawn about pollen allergy from these facts.

1

DO NOT WRITE IN THIS MARGIN

	Marks	KU	PS

3. (*b*) (continued)

(iii) In summer, air carries an average of 100 pollen grains per litre.

If a person inhales 12·6 litres of air per minute, calculate the total number of pollen grains inhaled each hour.

Space for calculation

grains per hour **1**

(*c*) What essential stage in plant reproduction must take place after pollination and before fertilisation?

1

(*d*) Give one example of a plant which relies on wind for seed dispersal and describe how its seeds are adapted to dispersal in this way.

Plant

Description _____

2

(*e*) The list below describes groups of organisms.

1 a patch of strawberry plants produced from the runners of one plant
2 a field of barley grown from seeds
3 a litter of pedigree West Highland Terrier puppies
4 a group of potato tubers harvested from the same plant
5 all the pea plants grown from peas from the same pod

Use the numbers from the list to identify each of the groups which form a clone.

Numbers **1**

[Turn over

DO NOT WRITE IN THIS MARGIN

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4. (*a*) The table below shows some features of five British butterflies.

Butterfly species	*Wing shading*	*Wing tip*	*Wing spots*
Large White	pale	black	yes
Orange Tip	pale	orange	no
Peacock	dark	blue	yes
Red Admiral	dark	white	yes
Wood White	pale	black	no

Complete the key using the information given in the table.

1 Pale wing shading . . . . . go to 2

Dark wing shading . . . . . [ ]

2 [ ] . . . . . [ ]

Orange wing tip . . . . . **Orange Tip**

3. Spots on wings . . . . . **Large White**

No spots on wings . . . . . [ ]

4. Blue wing tip . . . . . **Peacock**

[ ] . . . . . [ ]

3

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4. (continued)

(*b*) The earliest sighting of these butterflies in Britain was recorded in 1956 and again in 2006. The information is shown in the table below.

	Earliest sighting	
Butterfly species	1956	2006
Large White	mid June	early June
Orange tip	late May	mid May
Peacock	mid March	early March
Red Admiral	early June	late May
Wood White	mid May	early May

(i) What evidence suggests that the average temperatures in 2006 were higher than in 1956?

1

(ii) What name is given to organisms, such as these butterflies, which can be used to provide information about environmental factors?

1

[Turn over

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5. (*a*) The table below shows information on the number of eggs fertilised and the survival of offspring for four different animals.

Animal	*Average number of eggs fertilised at one time*	*Average number of surviving offspring*	*Percentage survival rate*
Dog	5	4	
Human	1	1	100
Bird	4	3	75
Trout	1000	20	2

(i) Calculate the percentage survival rate for the dog and complete the table with the result.

Space for calculation

1

(ii) Explain the difference in the survival rates between humans and trout.

1

(*b*) Embryos of mammals exchange substances with their mother through the placenta.

Name a substance which passes through the placenta from an embryo to its mother.

1

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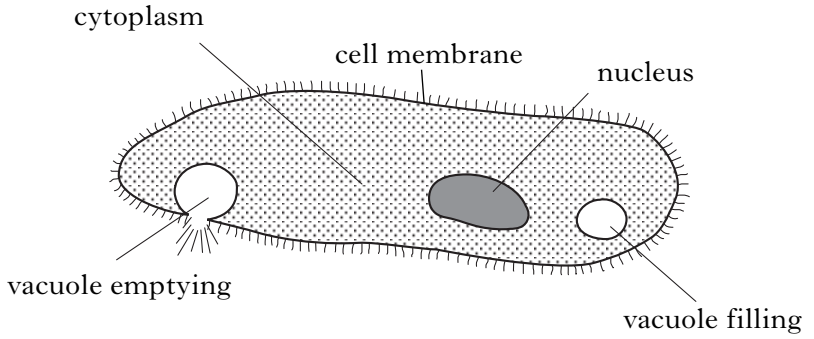
Marks	KU	PS

6. The diagram below shows *Paramecium,* a single-celled organism which lives in water.



(*a*) The water concentration outside the cell is higher than the water concentration of the cytoplasm. This causes water to enter the cell constantly.

(i) What is the name for this movement of water?

1

(ii) From the information given, state whether *Paramecium* is likely to live in fresh water or salt water.

1

(*b*) *Paramecium* must get rid of excess water. Pure water is collected in the vacuoles by removing it from the cytoplasm. The vacuoles are emptied to the surrounding water as soon as they are full.

(i) What would happen to the *Paramecium* cell if the vacuoles stopped working properly?

1

(ii) The vacuoles are not filled by the diffusion of water.

What evidence is there to support this statement?

1

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks	KU	PS

7. (*a*) Underline one word in each bracket to make the paragraph about water balance correct.

When a large volume of water is taken into the body, the water

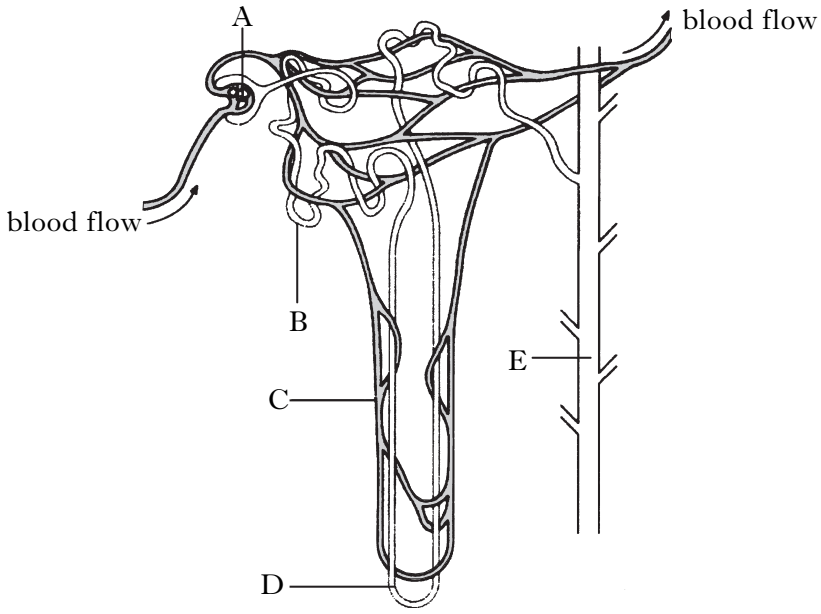
concentration of the blood { increases / decreases }. The volume of ADH

released into the blood by the pituitary gland { increases / decreases }.

This causes water reabsorption by the kidneys to { increase / decrease }

and the volume of urine produced increases. **2**

(*b*) The diagram below represents a nephron from a kidney.



(i) Which letter on the diagram shows where filtration occurs? **1**

(ii) Which letter on the diagram shows a collecting duct? **1**

DO NOT WRITE IN THIS MARGIN

7. (continued)

Marks | KU | PS

(*c*) The table below shows the concentration of some substances found in samples taken from the blood, the kidney filtrate and the urine of a volunteer.

Substance	*Concentration in blood* ($g/100cm^3$)	*Concentration in filtrate* ($g/100cm^3$)	*Concentration in urine* ($g/100cm^3$)
urea	0·25	0·25	2·00
glucose	0·10	0·10	0·00
protein	7·50	0·00	0·00
salts	0·62	0·62	1·50

(i) Which substance was present in the blood but was not filtered out of it?

1

(ii) Which substance was filtered from the blood and then completely reabsorbed back into it?

1

(*d*) A person produces an average of 1·8 litres of urine per day and this is 1% of the kidney filtrate.

What is the average volume of filtrate reabsorbed daily?

Space for calculation

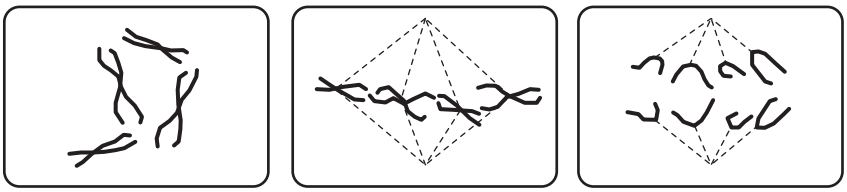
litres **1**

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks	KU	PS

8. (*a*) Stages of mitosis are shown in their correct order in the diagrams below.



Stage A Stage B Stage C

(i) Label the spindle on one of the diagrams. **1**

(ii) Stage C would be followed by stage D. Describe what would happen in stage D.

1

(*b*) Typical timings of the stages of mitosis are shown in the table below.

Stage	A	B	C	D
Time (minutes)	88	33	25	54

What percentage of the total time for mitosis is taken by stage C?

Space for calculation

% **1**

(*c*) Scientists can grow liver tissue in the laboratory. This is done by making a few liver cells divide by mitosis to form a large mass of cells.

Why is it important that the daughter cells contain the same number of chromosomes as the original mother cells?

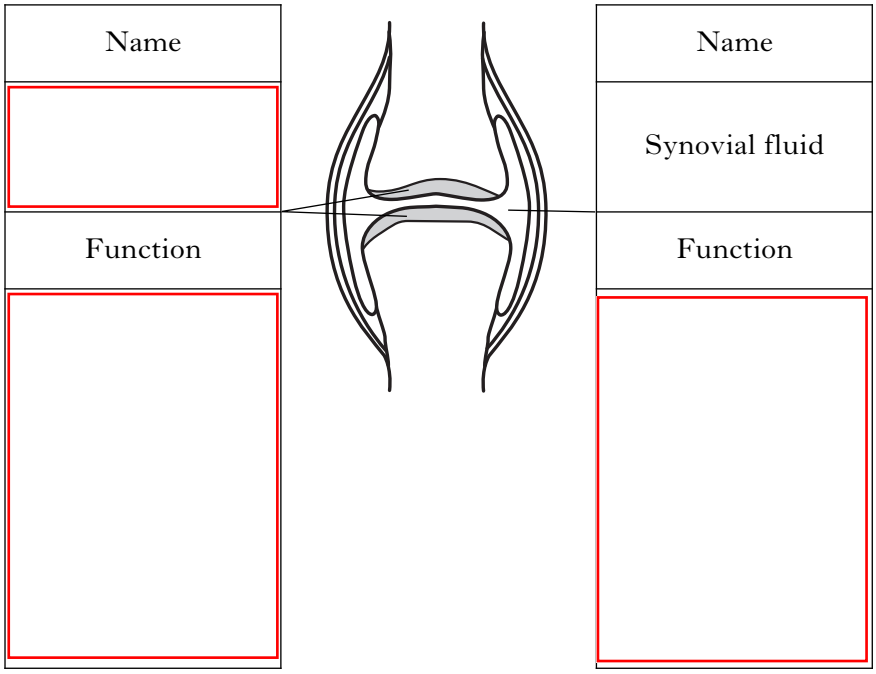
1

DO NOT WRITE IN THIS MARGIN

Marks	KU	PS

9. (*a*) The diagram below represents a hinge joint.

Complete each of the boxes with the missing name or function of the part labelled.



2

(*b*) Tendons attach muscle to bone.

Explain why it is important that tendons are inelastic.

2

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks | KU | PS

10. (*a*) The following statements refer to breathing.

1 ribs move up and out
2 ribs move down and in
3 diaphragm relaxes
4 diaphragm contracts
5 chest volume decreases
6 chest volume increases
7 lung pressure decreases
8 lung pressure increases

Complete the box by inserting the statement numbers which refer to breathing in.

Statements referring to ***breathing in***

2

(*b*) The table below shows how exercise at different work rates affects heart rate, breathing rate and the lactic acid concentration in the blood.

Work rate (watts)	*Heart rate* (beats/min)	*Breathing rate* (breaths/min)	*Lactic acid concentration* (mg/l)
0	76	12	1·0
40	92	13	1·5
80	112	15	1·8
120	132	16	3·5
160	156	18	4·5
200	172	30	9·0

(i) Calculate the percentage increase in lactic acid concentration as the work rate increases from 0 to 200 watts.

Space for calculation

% **1**

DO NOT WRITE IN THIS MARGIN

	Marks	KU	PS

10. (*b*) (continued)

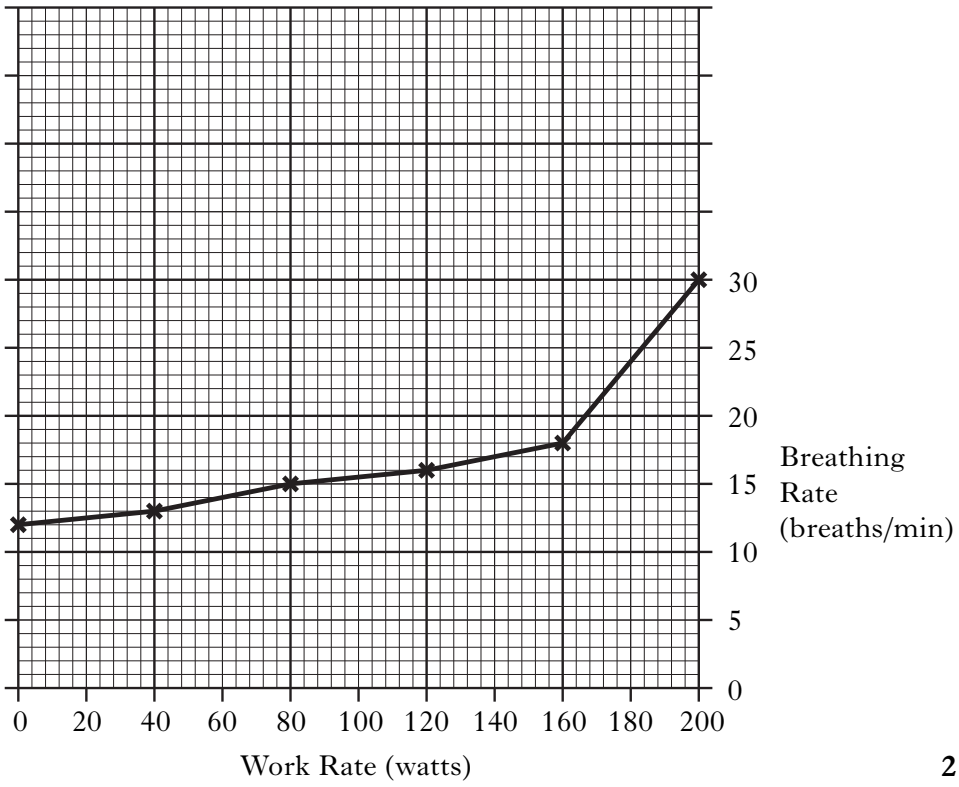
(ii) Explain why the lactic acid concentration increases as the work rate increases.

1

(iii) The graph uses information from the table to show how the breathing rate varies with work rate.

On the same grid, add a scale and label to the vertical axis on the **left side** and plot a line graph to show how the heart rate varies with work rate.

(An additional graph, if needed, will be found on *Page twenty-six*.)



2

(iv) Describe the relationship between work rate and both breathing and heart rates.

1

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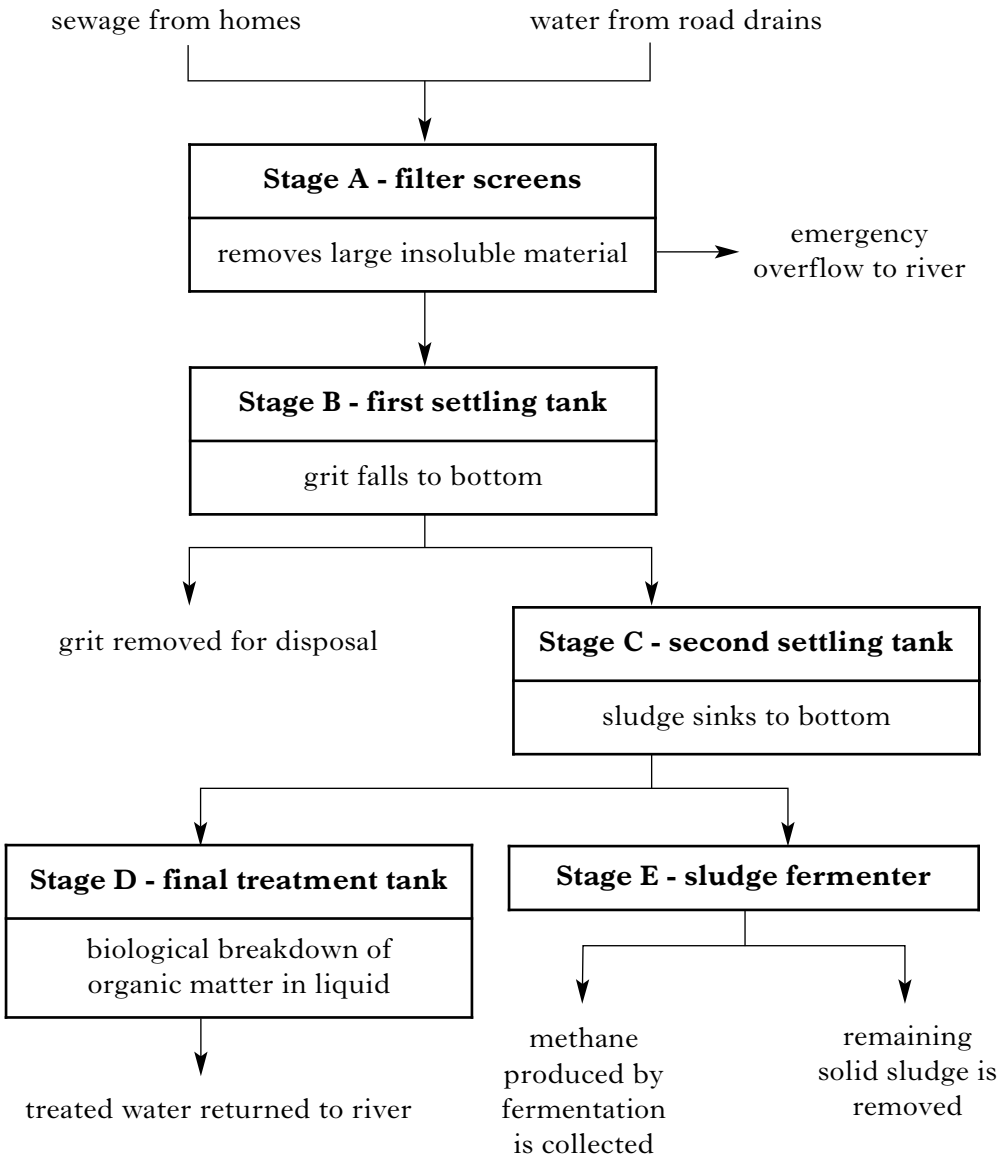
Marks	KU	PS

11. The flow chart shows what happens in a typical sewage treatment works.



(*a*) What material, which passes through the screens in **Stage A**, does not reach the tank in **Stage C**?

1

(*b*) Name the gas needed for the final treatment in **Stage D** and explain why the gas is needed for this process.

Gas _____

Explanation _____

2

DO NOT WRITE IN THIS MARGIN

	Marks	KU	PS

11. (continued)

(*c*) When liquid from **Stage D** was sampled, it was found to contain over 80 different species of micro-organisms. Explain why this was seen as a good result.

1

(*d*) Under what environmental conditions could untreated sewage enter the river, even if the sewage treatment plant was working correctly?

1

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks	KU	PS

12. Read the following passage and answer the questions using information from it.

Salve Imperator

Adapted from "The Life of Birds" by David Attenborough.

Reproduction for Emperor penguins involves extreme hardship. They start their breeding cycle in March at the beginning of the Antarctic winter. At this time the fringe of ice that surrounds the Antarctic continent is at its narrowest. The penguins walk across it for several miles to the permanent ice which is their breeding ground. Up to 25 000 penguins gather and mating takes place in April.

As the temperature falls, the sea ice expands by 2 miles per day. In May the female produces one large egg which she places on the top of her feet. The male takes the egg, juggles it onto the top of his feet and covers it with a fold of his densely feathered abdomen to keep it warm. Producing the egg has taken a significant proportion of the female's body reserves. She needs to replenish them urgently and heads back to sea to feed.

As the winter winds begin to blow, the temperature falls. The male Emperors huddle closer together for warmth and shelter. They use their tiny stump of a tail as the third leg of a tripod and rest on their heels. Their upwardly turned toes keep their precious eggs off the ice. There is nothing to eat and for a month there is total darkness.

After 60 days the eggs hatch. The males, close to starvation, manage to produce a little milky secretion from their gullets for their chicks. At this critical moment the females reappear. They have had a long journey as the ice has extended considerably. The females regurgitate their chicks' first real meal. The males now start the long trek back to the sea to feed for the first time in four months.

Three weeks later, the males are back to take over the care of the chicks, allowing the females to return to the sea. As winter slackens its grip, the ice begins to break up. The journey to the sea gets shorter and the parents can increase the frequency of feeding. In November the parents stop feeding the young and long processions of adults and young waddle down to the sea.

(*a*) Why is it necessary for the females to leave their eggs and return to the sea?

1

DO NOT WRITE IN THIS MARGIN

Marks | KU | PS

12. (continued)

(*b*) By how much has the distance to the sea increased in the time between laying and hatching?

Space for calculation

miles **1**

(*c*) How does a male keep his egg off the ice?

1

(*d*) The following list describes events in the life of Emperor penguins.

List

1 walk to breeding grounds
2 mating
3 egg laying
4 eggs hatch and females return
5 parents and chicks waddle to the sea

Complete the time line below by placing the number of each event in the correct month.

(An additional time line will be found, if needed, on *Page twenty-six*).

Time line

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

2

(*e*) How many months of the year are **not** spent breeding and rearing young?

1

[Turn over

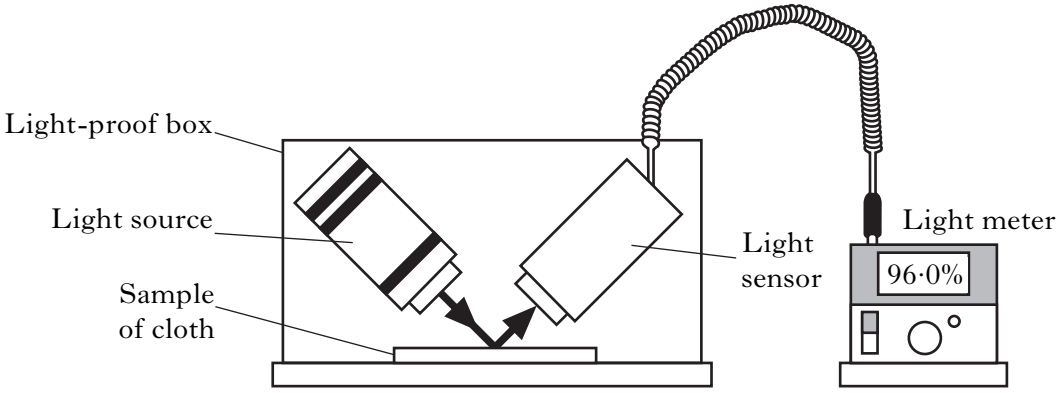
DO NOT WRITE IN THIS MARGIN

Marks	KU	PS

13. The following apparatus was used to investigate the effectiveness of washing powders.

Identical pieces of stained cloth were washed using different washing powders.

The cloths were dried and the degree of stain removal was measured by recording light reflected from the cloth with a light meter. The meter was set to read 100% when the cloth was perfectly clean. Any stain left on the cloth reduced the intensity of light recorded.



(*a*) (i) Various precautions were taken to ensure that the experimental procedure was valid.

Identify the point(s) which contributed to this.

Tick (✓) *the correct box(es)*.

The procedure used gave appropriate information about the effectiveness of washing powders. ☐

All significant variables were controlled and were identical except the one being investigated. ☐

Several results were collected and used to calculate an average. ☐

1

(ii) Explain why it was necessary to carry out the investigation in a light-proof box.

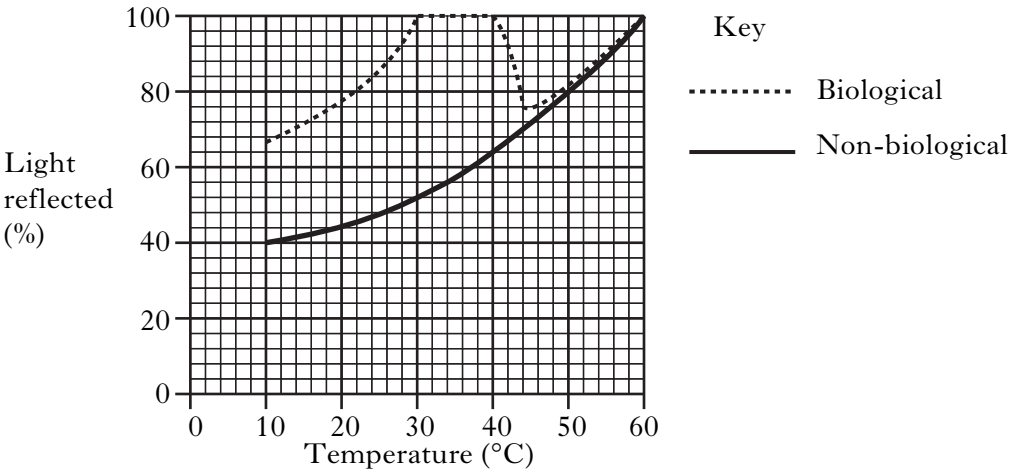
1

DO NOT WRITE IN THIS MARGIN

Marks	KU	PS

13. (continued)

(*b*) The results obtained using two different washing powders at various temperatures are shown below.



(i) At which temperature was there the greatest difference between the effectiveness of the two washing powders?

[ ] °C **1**

(ii) Each one degree Celcius reduction in the washing temperature saves 2p in the cost of electricity used to heat the water for each wash.

Calculate the annual saving in the electricity costs to achieve 100% stain removal with biological washing powder compared to a non-biological one, for a household which does one wash per week.

Space for calculation

annual saving = £ [ ] **1**

(iii) What type of biological substance gives biological washing powders their properties?

[ ] **1**

(iv) Explain why the effectiveness of the biological washing powder decreases between 40°C and 45°C.

[ ] **1**

[Turn over

DO NOT WRITE IN THIS MARGIN

Marks	KU	PS

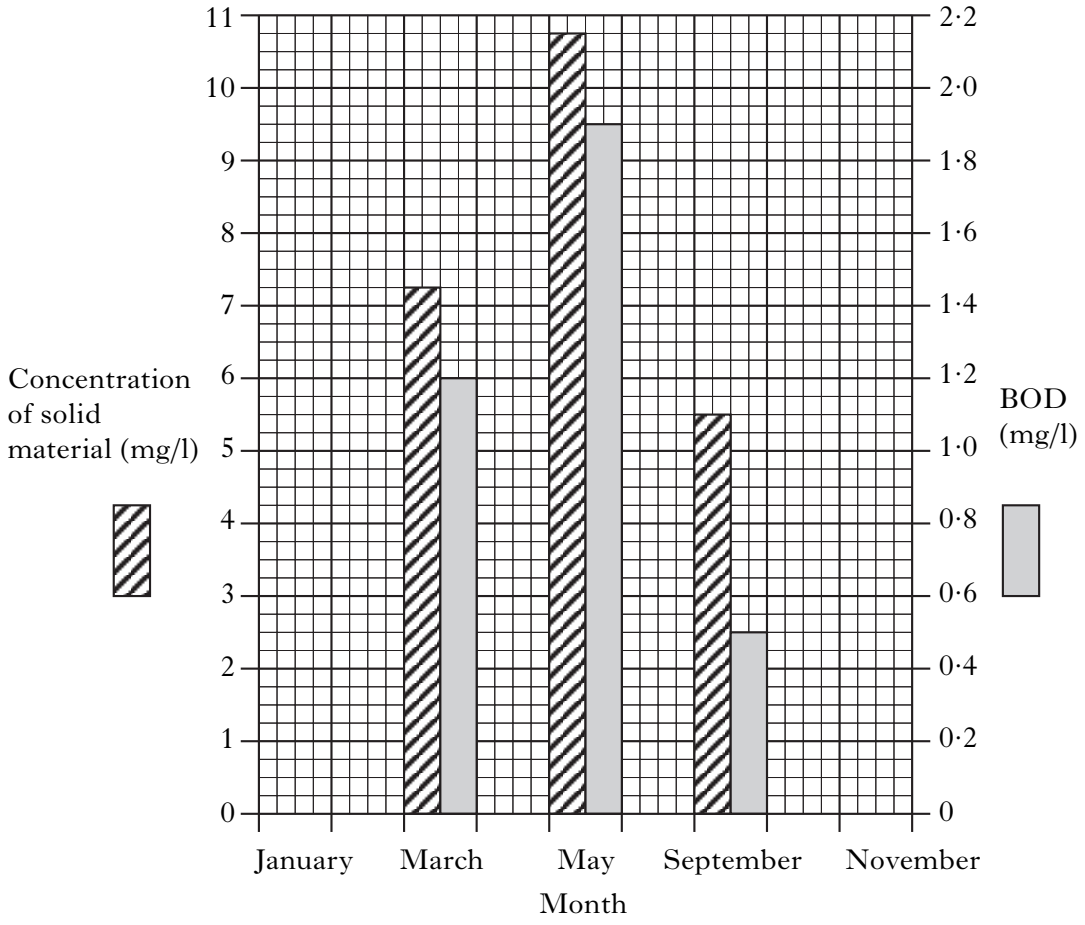
14. Micro-organisms living in water use dissolved oxygen for respiration.

The mass of oxygen they use is called the Biochemical Oxygen Demand (BOD).

The table below shows the BOD of a river and the concentration of solid material carried by the river during five months of the year.

Month	*Concentration of solid material* (mg/l)	*BOD* (mg/l)
January	6·75	1·0
March	7·25	1·2
May	10·75	1·9
September	5·50	0·5
November	9·00	1·5

(*a*) Use the information in the table to complete the bar chart below for January and November.
(An additional chart, if needed, will be found on *Page twenty-seven*.)



1

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14. (continued)

Marks | KU | PS

(*b*) Describe the relationship between the concentration of solid material in the river water and the BOD.

1

(*c*) After heavy rains in December, the concentration of solid material in the water was found to be 10·0 mg/l.

What would be the expected BOD for this sample?
Tick (✓) *the correct box*.

7·5 mg/l ☐

5·0 mg/l ☐

1·75 mg/l ☐

1·25 mg/l ☐

1

[Turn over

DO NOT WRITE IN THIS MARGIN

	Marks	KU	PS

15. Candytuft is a plant with white or pink flowers. The two forms of the gene responsible for the flower colour are:

P = pink flowers and **p** = white flowers.

(*a*) A plant breeder crossed two pink flowered plants as shown below.

Parents **Pp** × **Pp**

(i) What is the expected ratio of pink to white flowered plants in the offspring?

_____ : _____ **1**

pink : white

(ii) If 48 offspring had been produced, how many white flowered plants would have been expected?

Space for calculation

_____ white flowered plants **1**

(iii) The offspring actually consisted of 24 pink flowered and 16 white flowered plants.

What is the simplest whole number ratio of pink to white flowered plants in the offspring?

Space for calculation

_____ : _____ **1**

pink : white

(iv) Suggest a reason for the difference between the expected ratio and the observed ratio.

1

DO NOT WRITE IN THIS MARGIN

Marks	KU	PS

15. (continued)

(*b*) What name is given to two different forms of a gene?

1

(*c*) Some plant characteristics show discontinuous variation. What is meant by "discontinuous variation"?

1

[*END OF QUESTION PAPER*]

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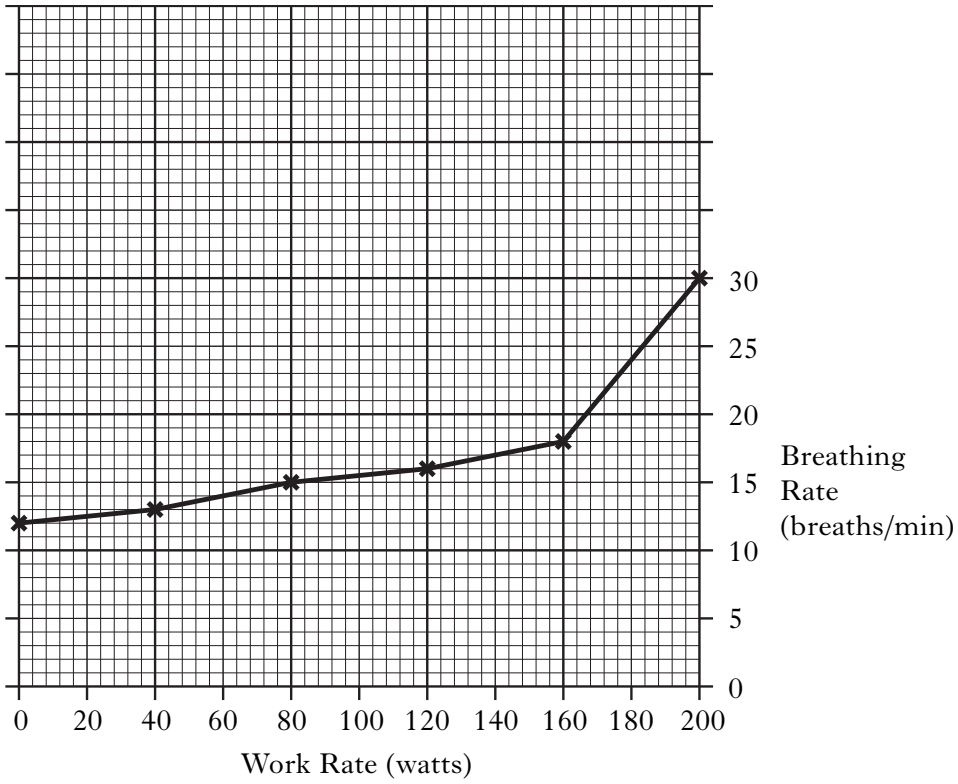
ADDITIONAL GRAPH FOR QUESTION 10 (*b*) (iii)



ADDITIONAL TIME LINE FOR QUESTION 12 (*d*)

Time line

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

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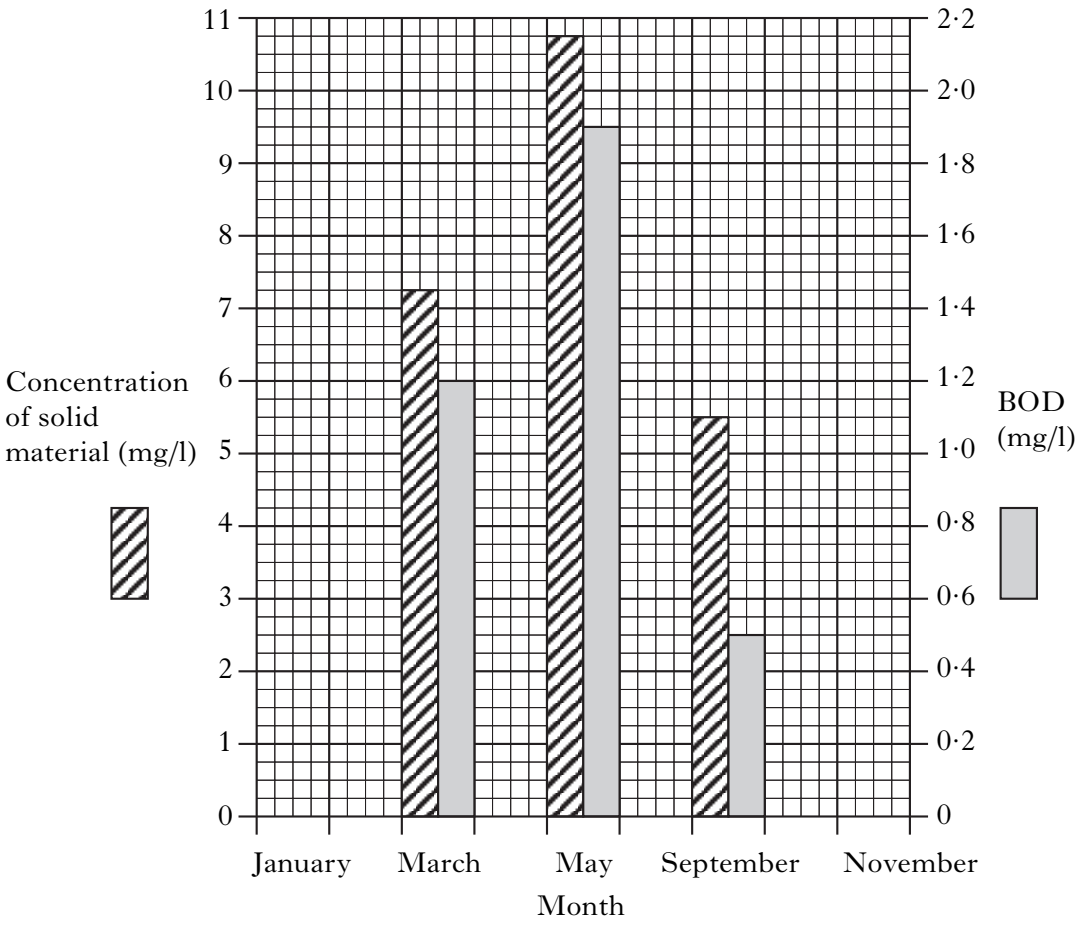
ADDITIONAL CHART FOR QUESTION 14 (*a*)



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KU	PS

SPACE FOR ANSWERS
AND FOR ROUGH WORKING