

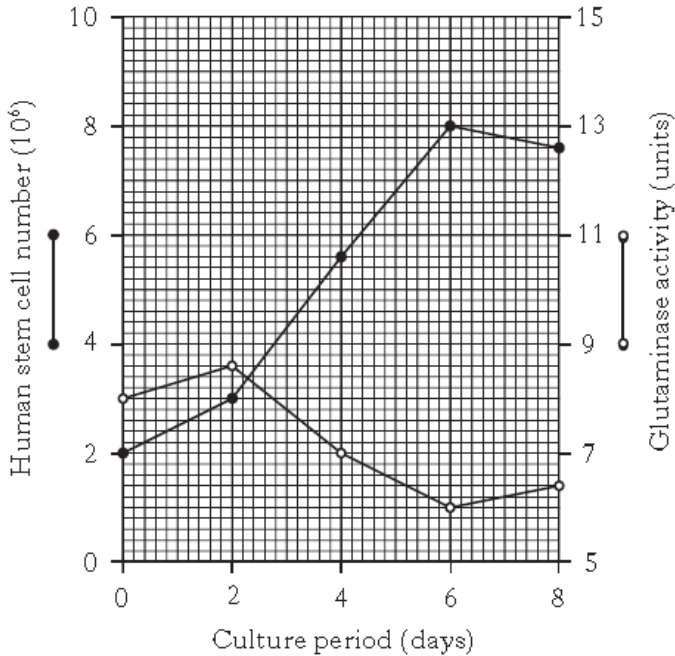
CfE Higher Biology



Problem Solving Questions

Section A

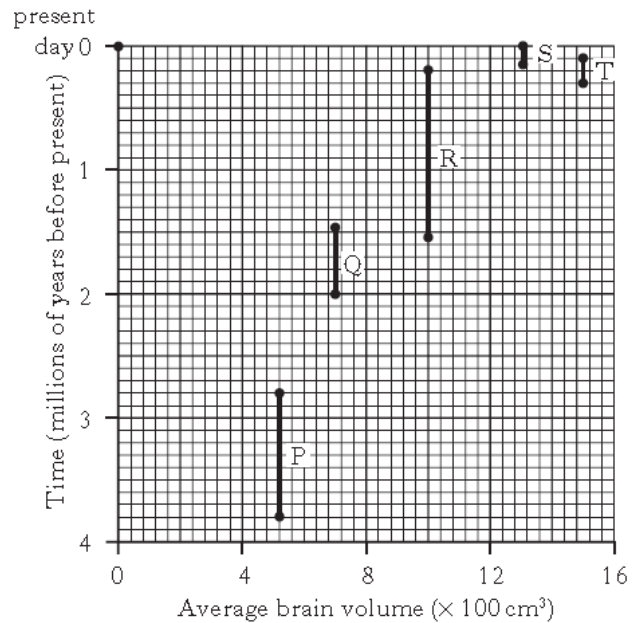
- 1 The graph below shows the changes in number of human stem cells in a culture. The activity of the enzyme glutaminase present in the cells over an eight day period is also shown.



How many units of glutaminase activity were recorded when the cell number was 50% of its maximum over the eight day period?

- A 3
- B 4
- C 8
- D 9

- 2 The graph below shows the average brain volume of several related species of hominid and the time periods during which they lived.



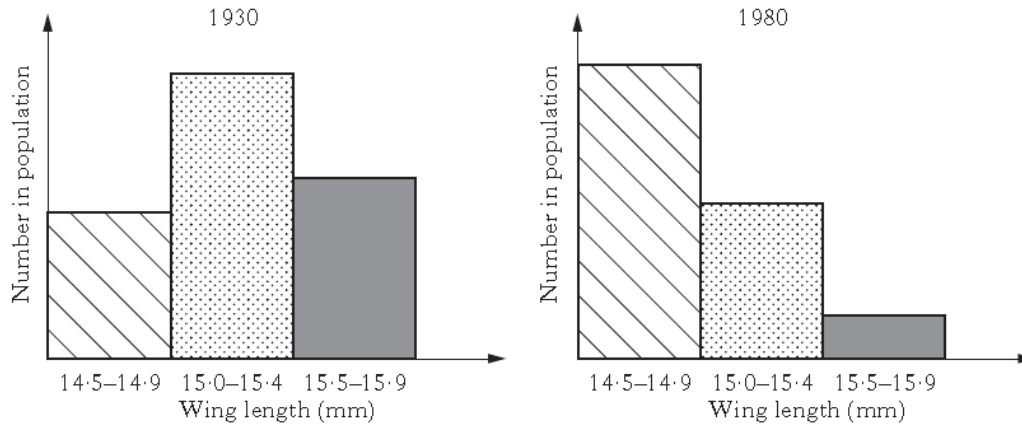
Key

- P – *Australopithecus afarensis*
- Q – *Homo habilis*
- R – *Homo erectus*
- S – *Homo sapiens* (modern humans)
- T – *Homo neanderthalensis*

Which conclusion can be drawn from the graph?

- A *Homo sapiens* is the most intelligent species.
- B *Homo neanderthalensis* had the largest brain.
- C *Homo sapiens* evolved from *Homo erectus*.
- D The more recently the species lived the larger its brain volume.

- 3 The graphs below show the effects of natural selection pressure on wing span in a population of house sparrows between 1930 and 1980.

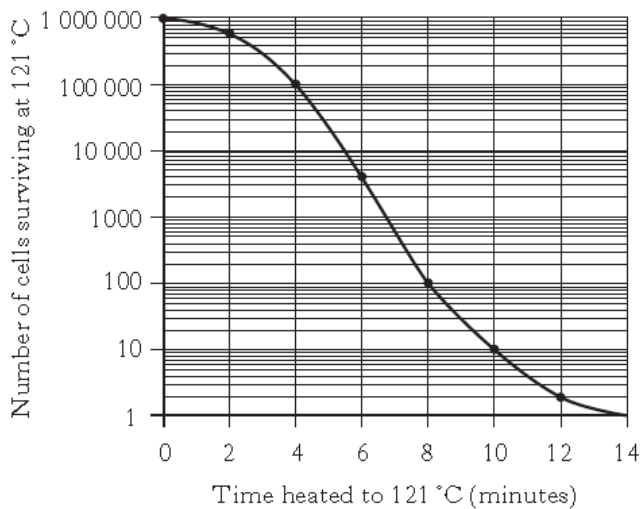


Which line in the table below correctly compares the statistical data in the two graphs?

	<i>Mean</i>	<i>Range</i>
A	same	same
B	same	different
C	different	same
D	different	different

- 4 Bacterial cells were heated to 121 °C for increasing lengths of time to determine the number of live cells left after treatment.

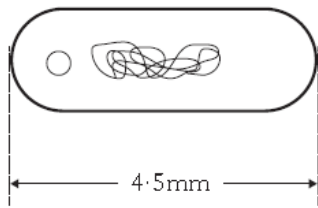
The graph below shows the number of bacterial cells which survived.



How many cells survive after 6 minutes?

- A 1300
- B 4000
- C 5000
- D 5500

- 5 The diagram below shows an image of a bacterial cell that has been magnified 1500 times.



What is the actual length of the cell in micrometres (μm)?

- A 0.003
- B 3.000
- C 6750
- D 6.750

- 6 Mink is a naturalised mammal in many parts of the UK.

A program designed to control mink numbers in a region of Scotland was started at the end of May 2009. The population of adult animals was surveyed every three months for a year and the results are shown in the table below.

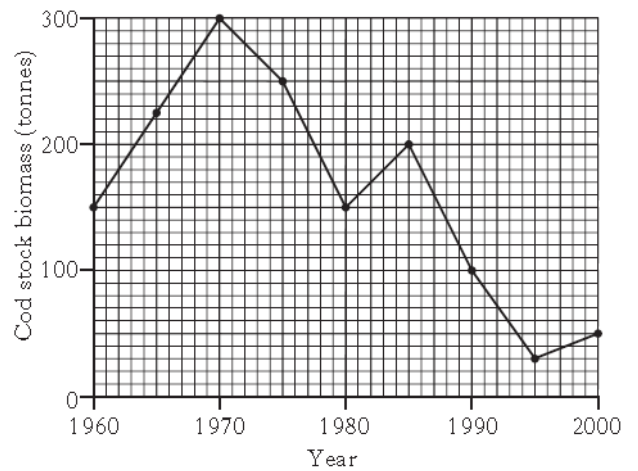
<i>Survey date</i>	<i>Population of adult mink</i>
End May 2009	1250
End August 2009	750
End November 2009	520
End February 2010	340
End May 2010	50

What was the average decrease in number of adult mink per month during the programme?

- A 100
- B 240
- C 243
- D 582

- 7 Cod is an important fish species which is caught for human food.

The graph below shows changes in the estimated biomass of cod stocks in a region of the North Sea between 1960 and 2000.



Which line in the table correctly shows the overall decrease in estimated cod biomass in this region in the ten year periods shown?

	<i>Ten year period</i>	<i>Decrease in estimated cod biomass in the region (tonnes)</i>
A	1960 and 1970	150
B	1970 and 1980	100
C	1980 and 1990	100
D	1990 and 2000	50

- 8 A DNA molecule contained 8000 nucleotides of which 20% contained adenine.

How many nucleotides would have contained guanine?

- A 1600
- B 2400
- C 3200
- D 4800

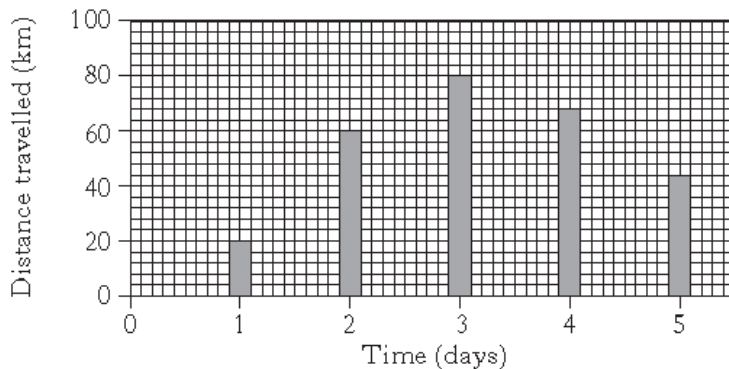
- 9 The hooded crow and the carrion crow can hybridise in parts of Scotland where both species are found. During an investigation within the zone of hybridisation, the numbers of each species and any hybrids found were estimated at each of three counting stations.

Counting station	Crows		
	Hooded	Carrion	Hybrid
1	90	70	40
2	40	30	30
3	40	10	50

What percentage of the crows at counting station 1 were hybrids?

- A 10%
 B 20%
 C 25%
 D 40%
- 10 The buff-breasted pipit is a bird which migrates into parts of the USA each spring.

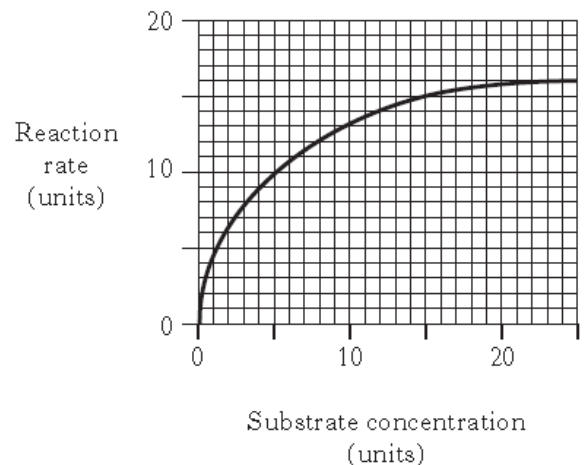
The chart below shows the average distance travelled by the birds in the first five days of their migration.



The greatest distance travelled by the pipit is on days

- A 1 and 2
 B 2 and 3
 C 3 and 4
 D 4 and 5.

- 11 The graph below shows the effect of substrate concentration on the rate of an enzyme-catalysed reaction.



At which substrate concentration is the reaction rate equal to 75% of the maximum rate?

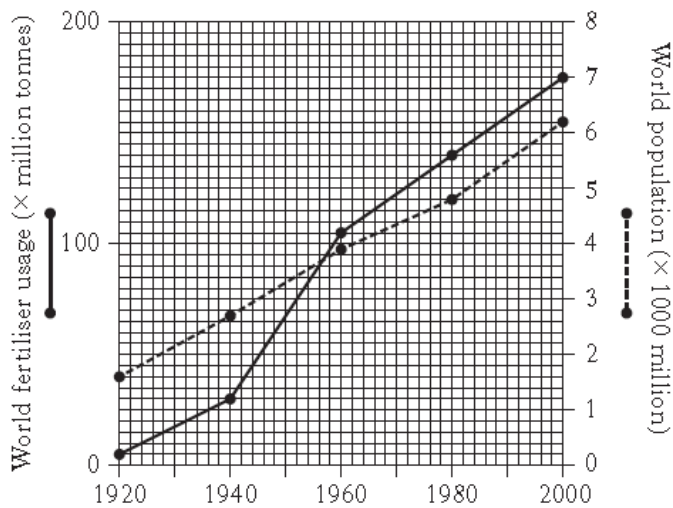
- A 5 units
 B 8 units
 C 12 units
 D 15 units

- 12 The energy content of a glucose molecule is 2900 kilojoules. A glucose molecule entering aerobic respiration transfers 1160 kilojoules of the energy to ATP.

What percentage of energy in glucose is transferred to ATP?

- A 40
 B 60
 C 150
 D 250

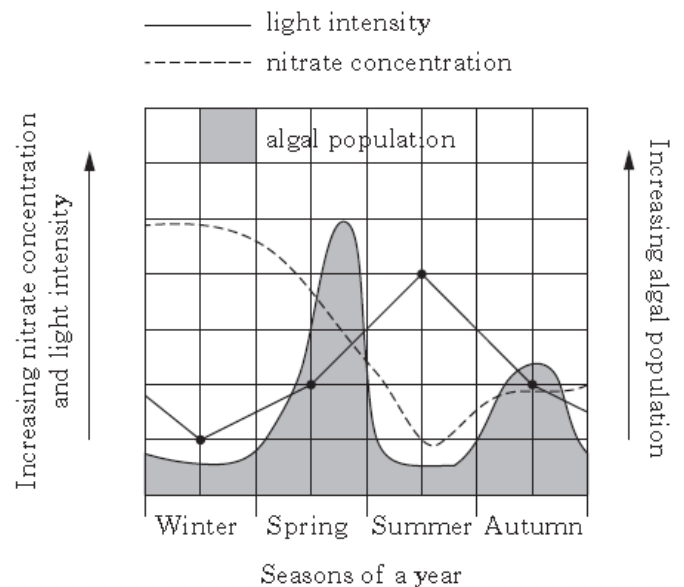
- 13 The graph below shows how world population and fertiliser usage changed between 1920 and 2000.



Which of the following conclusions can be drawn from these results?

- A World fertiliser usage was 55 million tonnes in 1930.
- B World population increased steadily between 1960 and 2000.
- C World fertiliser usage was 140 million tonnes in 1980.
- D World fertiliser usage first increased more rapidly than the population growth in 1956.

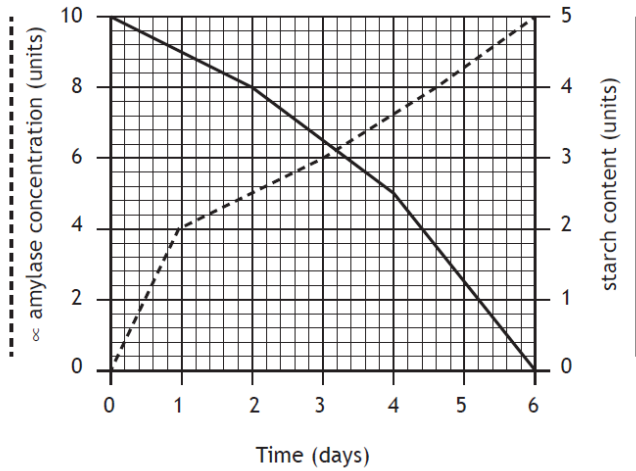
- 14 The graph below shows how the population of algae in a fresh water loch was affected by the concentration of nitrate ions in the loch water and by light intensity through the seasons of a year.



Which of the following statements can be deduced from the graph?

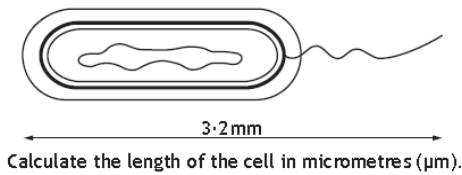
- A The increase in algal population in spring is triggered by an increase in concentration of nitrate ions in the water.
- B The size of the algal population depends directly on the level of light intensity.
- C The increase in nitrate ion concentration in late summer is followed by an increase in algal population.
- D The algal population decreases when light intensity decreases.

- 15 The graph below shows changes in the α -amylase concentration and the starch content of a barley grain during early growth and development.



Identify the time by which the starch content of the barley grains had decreased by 50%.

- A 2.0 days
 B 3.2 days
 C 4.0 days
 D 6.0 days
- 16 The diagram below shows a bacterial cell that has been magnified 800 times.



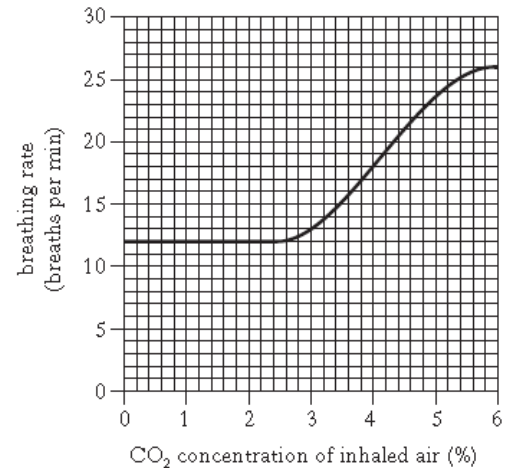
- A 0.004
 B 0.04
 C 0.4
 D 4.0
- 17 Maximum oxygen uptake per kg body mass can be used as a measure of fitness. Four athletes were weighed then given a fitness test during which their maximum oxygen uptake was measured.

Which line in the table below shows results for the least fit athlete?

Athlete	Body mass (kg)	Maximum oxygen uptake (litres per minute)
A	60	3.6
B	55	3.6
C	60	3.7
D	55	3.7

- 18 If ten percent of the bases in a molecule of DNA are adenine, what is the ratio of adenine to guanine in the same molecule?
- A 1:1
 B 1:2
 C 1:3
 D 1:4

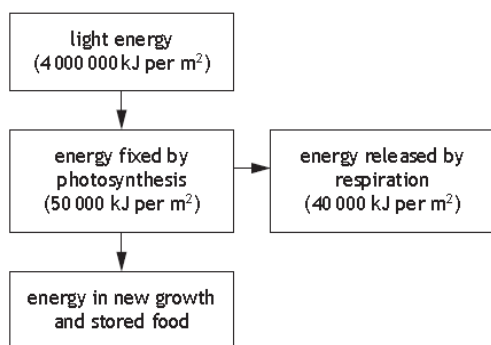
- 19 The graph below shows the effect of the carbon dioxide concentration of inhaled air on the breathing rate of an individual.



If the volume of one breath is 0.5 litre, what volume of air will be breathed in one minute when the CO₂ concentration is 4%?

- A 6 litres
 B 9 litres
 C 18 litres
 D 36 litres

20 The flow chart below shows the energy flow in a field of potatoes during one year.



What is the percentage of the available light energy present in new growth and stored food in the potato crop?

- A 2.25
- B 1.25
- C 0.25
- D 1.00

21 An eel was transferred from salt water to fresh water.

The table shows how the drinking rate of the eel changed in the six hour period after transfer.

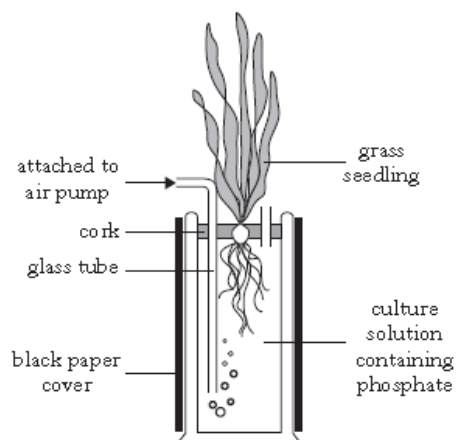
Time after transfer (hours)	Drinking rate (cm ³ per kg body mass per hour)
0	20
1	17
2	15
3	12
4	10
5	8
6	2

What is the average hourly decrease in drinking rate over the six hour period after transfer?

- A 3 cm³ per kg body mass per hour
- B 12 cm³ per kg body mass per hour
- C 14 cm³ per kg body mass per hour
- D 18 cm³ per kg body mass per hour

22 The apparatus shown below was used to investigate the effects of phosphate on the growth of grass seedlings.

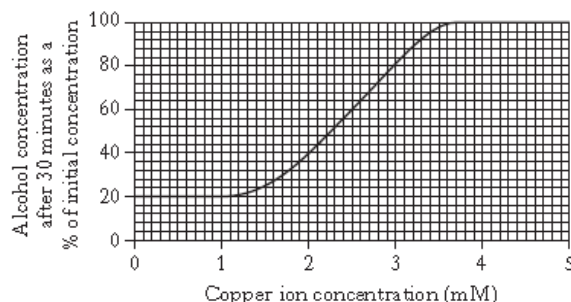
The experiment was repeated using different concentrations of phosphate and the height of the seedlings was recorded after 6 weeks of growth.



Two variables that must be kept the same are

- A temperature and concentration of phosphate in the culture solution
- B concentration of phosphate in the culture solution and light intensity
- C light intensity and temperature
- D temperature and the height of the seedlings.

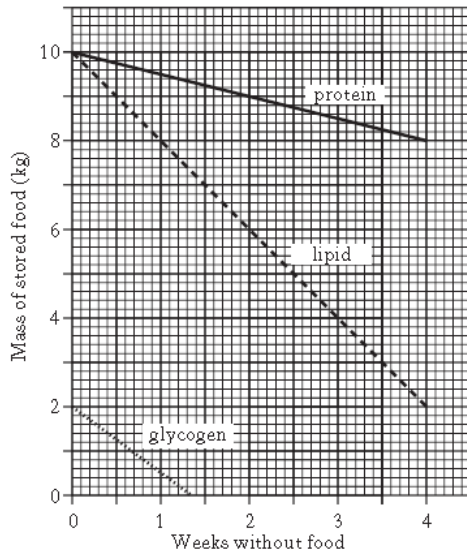
23 Liver tissue contains an enzyme which breaks down alcohol. The graph below shows the effect of different concentrations of copper ions on the breakdown of alcohol by this enzyme over a 30 minute period.



Which of the following conclusions can be drawn from the graph?

- A 4.5mM copper has no effect on enzyme activity.
- B 2.5mM copper halves the enzyme activity.
- C 0.5mM copper completely inhibits enzyme activity.
- D Enzyme activity increases when copper concentration is increased from 1mM to 2mM.

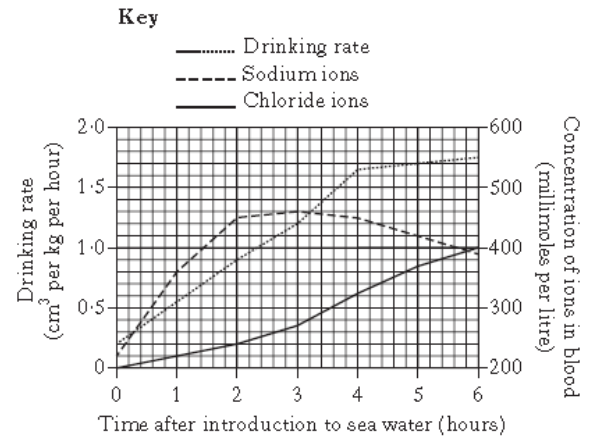
- 24 The graph below shows changes in food stores in a human body during four weeks without food.



Which of the following conclusions can be drawn from the graph?

- A Each food store decreases at the same rate during week one.
- B Between weeks three and four the body gains most energy from protein.
- C The lipid food store decreases at a faster rate than the other food stores during week one.
- D Between weeks one and four, the body only gains energy from lipid and protein.

- 25 The drinking rate and concentrations of sodium and chloride ions in blood were measured over a six hour period after a salmon was transferred from freshwater to sea water. The results are shown in the graph below.



Which line in the table correctly shows the results after three hours?

	<i>Drinking rate</i> (cm ³ per kg per hour)	<i>Sodium ion concentration</i> (millimoles per litre)	<i>Chloride ion concentration</i> (millimoles per litre)
A	1.4	270	460
B	1.2	460	270
C	1.2	270	460
D	1.4	460	270

Section B

- 1 Different varieties of banana can have different numbers of chromosome sets in their cells. Banana flesh contains carotenoids and different varieties have different carotenoid contents. Extracts of five different varieties of banana were placed in a colorimeter to measure the transmission of light through them. The darker the flesh the lower the percentage of light transmitted.

The results are shown in the table below.

<i>Banana variety</i>	<i>Number of sets of chromosomes</i>	<i>Carotenoid content (mg per kg banana flesh)</i>	<i>Light transmitted through extract (%)</i>
Tuugia	2 (diploid)	1.6	82
Khai	2 (diploid)	9.4	64
Figo Cinza	3 (triploid)	2.8	72
Saney	3 (triploid)	19.2	52
Porp	4 (tetraploid)	2.2	76

- (a) Describe the relationship between carotenoid content and darkness of flesh.

1

- (b) (i) Express as the simplest whole number ratio the average carotenoid content of the diploid to that of the triploid varieties.

Space for calculation.

_____ : _____
diploid triploid

1

- (ii) It has been suggested that additional carotenoid content in the diet gives humans increased protection against certain cancers.

Calculate the mass of carotenoid which would be found in a 125 g sample of Figo Cinza flesh.

Space for calculation.

_____ mg 1

- (iii) Using the information given, decide if the statement in the table below is true or false.

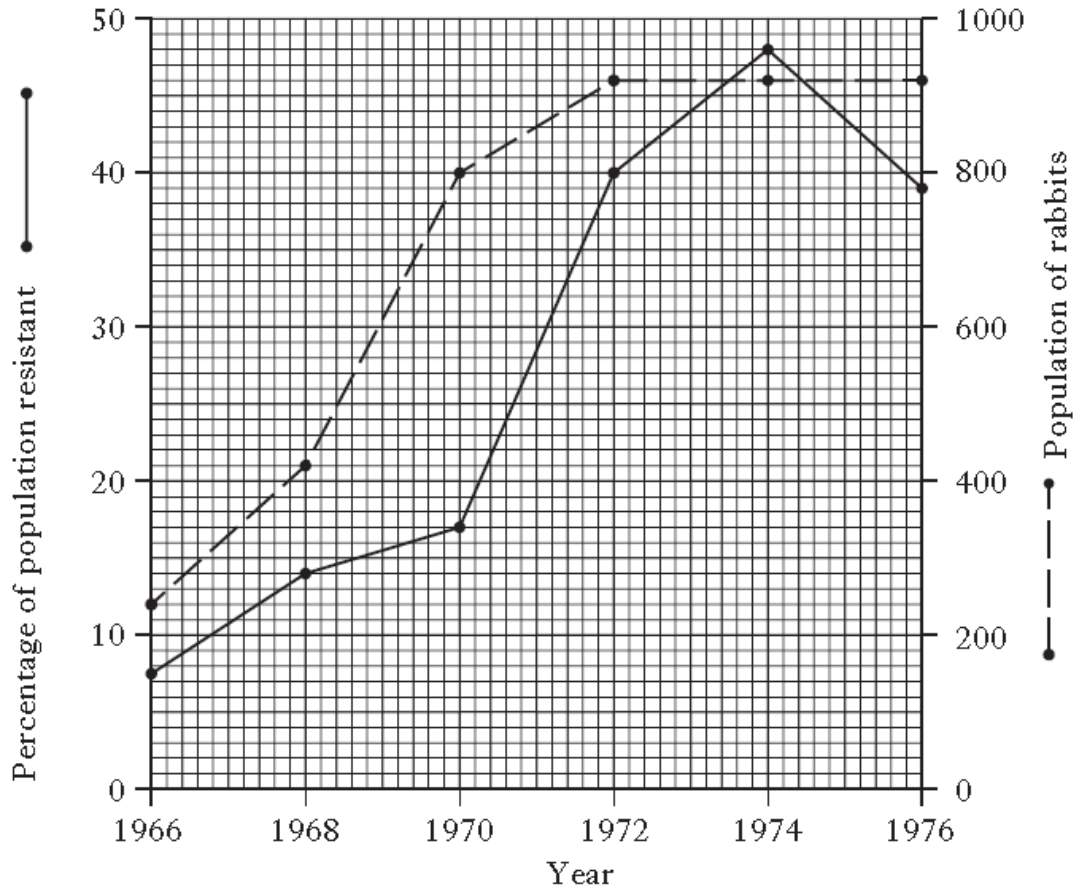
Add your choice to the table and give a reason for your answer.

<i>Statement</i>	Banana varieties with increased numbers of chromosome sets have increased carotenoid content in their cells.
<i>True (T) or False (F)</i>	
<i>Reason</i>	

- 2 Myxomatosis is a viral disease to which some rabbits are resistant and survive while others die.

A rabbit population was monitored for 10 years. The percentage of the population which was resistant was recorded.

The results are shown in the graph below.



- (a) (i) Calculate the number of rabbits which were resistant in 1972.

Space for calculation.

_____ rabbits 1

- (ii) Calculate the average increase in the rabbit population per year between 1966 and 1970.

Space for calculation.

_____ rabbits per year 1

- (iii) Identify the two year period during which there was the greatest change in the percentage of the population resistant to myxomatosis.

Tick (✓) the correct box below.

1966–1968

1968–1970

1972–1974

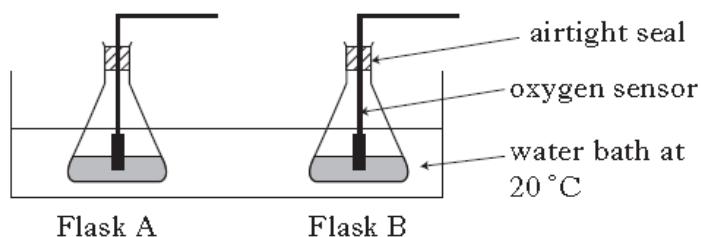
1974–1976

1

- 3 In an investigation into the effect of lead ion concentration on respiration in yeast, two flasks were set up as described below.

<i>Flask</i>	<i>Contents</i>
A	200cm ³ glucose solution + 5cm ³ 0.2% lead nitrate solution
B	200cm ³ glucose solution + 5cm ³ 1.0% lead nitrate solution

The flasks were placed in a water bath at 20 °C for 10 minutes. After this time 2.5cm³ of yeast suspension was added to each and oxygen sensors fitted as shown in the diagram below.



The flasks were left for a **further** 10 minutes and then oxygen concentration was measured in each flask every 20 seconds for 2 minutes.

The results are shown in the table below.

<i>Time (s)</i>	<i>Oxygen concentration (mg per litre)</i>	
	<i>Flask A</i> <i>0.2% lead nitrate</i>	<i>Flask B</i> <i>1.0% lead nitrate</i>
0	10.2	10.8
20	8.4	9.3
40	6.1	7.6
60	3.8	6.2
80	1.7	5.1
100	0.2	4.0
120	0.0	3.2

- (a) (i) Identify the independent variable in this investigation.

- (ii) Identify **one** variable, not already mentioned, which would have to be kept constant so that valid conclusions could be drawn.

1

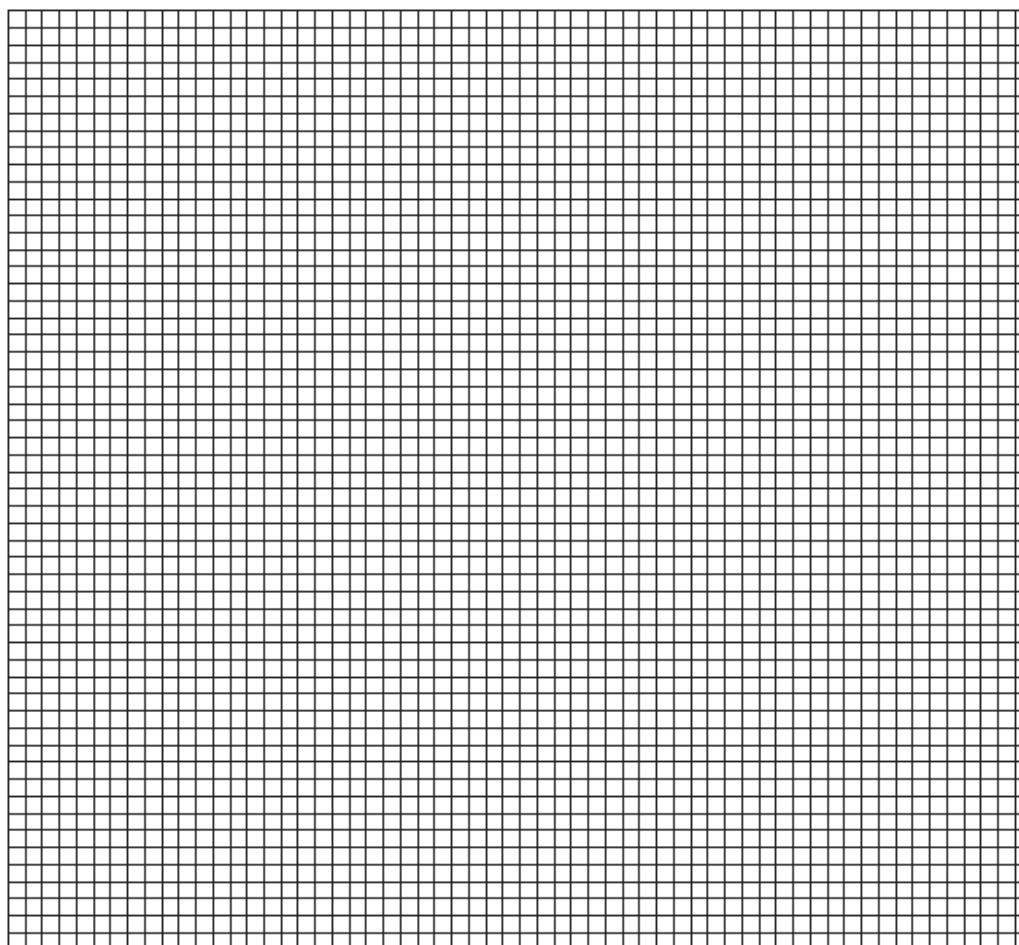
- (iii) Explain why the flasks were left for 10 minutes **before** the yeast suspension was added.

1

- (iv) Explain why the flasks were left for a **further** 10 minutes **after** the yeast suspensions were added before measurements of oxygen concentrations were taken.

1

- (b) On the grid provided, draw a line graph to show the oxygen concentration in **Flask A** against time. Use appropriate scale to fill most of the grid.



- (c) Using information from the table, state the effect of increasing lead ion concentration on the aerobic respiration of yeast.

1

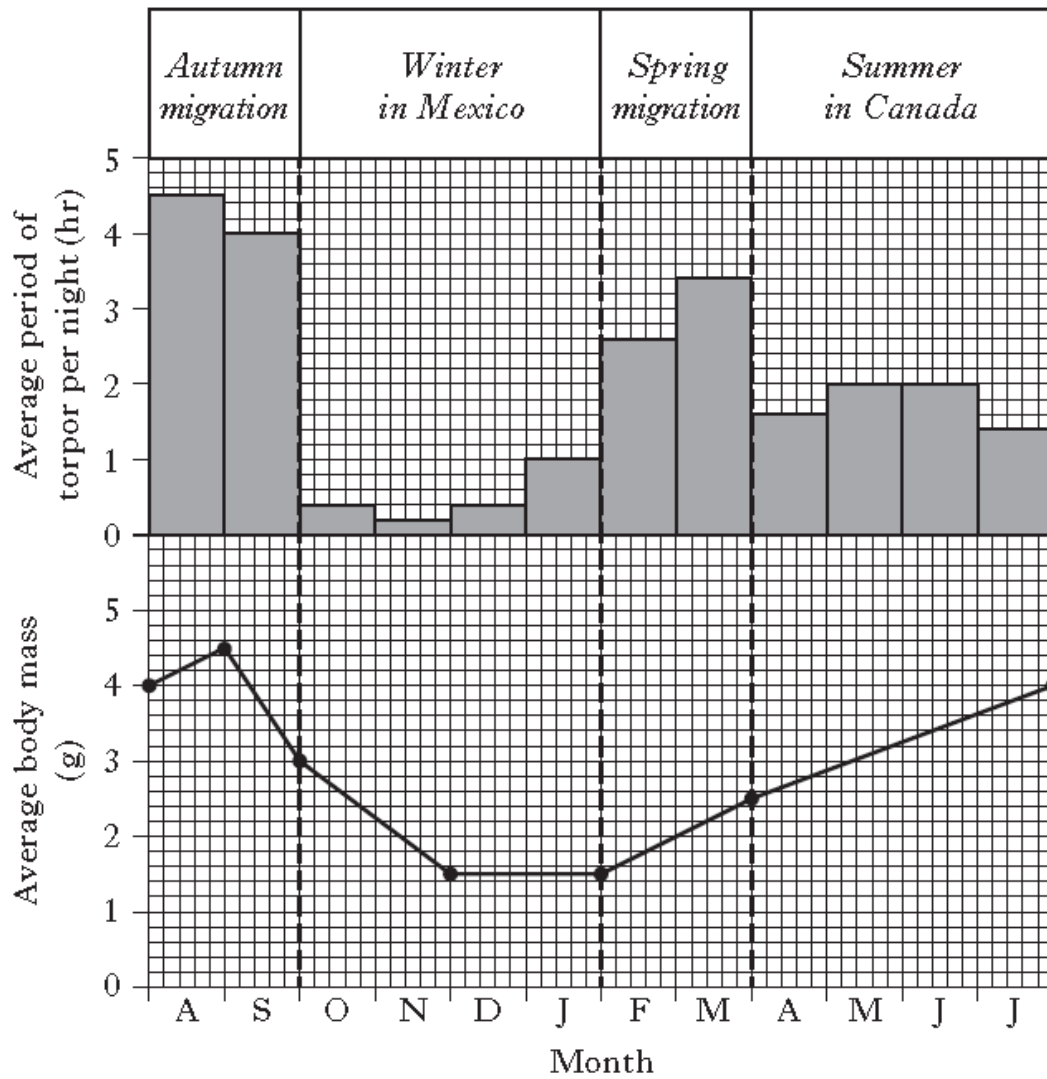
- (d) Bubbles of carbon dioxide appeared in both flasks throughout the investigation. Explain why this gas continued to be produced in **Flask A** after 120s.

1

- 4 Rufous hummingbirds migrate thousands of kilometres each year between their summer breeding areas in Canada and their wintering areas in Mexico.

They feed on nectar throughout the year and save energy at night by entering a temporary state known as torpor in which body temperature and respiration rate are greatly reduced.

The **chart** below shows the average body mass of the hummingbirds and the average number of hours per night spent in torpor throughout the year.



- (a) (i) Use values from the chart to describe the changes in average body mass of the hummingbirds from the beginning of August until the end of January.

2

- (ii) Calculate the percentage increase in average body mass during the summer in Canada.

Space for calculation

_____ %

1

- (iii) Suggest **one** reason for the increase in body mass of the birds during the summer in Canada.

1

- (b) (i) Suggest why the increased time spent in torpor during migration is an advantage to the birds.

1

- (ii) Calculate the average period of torpor per month throughout the winter in Mexico.

Space for calculation

_____ hours per night

1

- (c) The **table** below shows how the average oxygen consumption of the birds at rest is affected by their body temperature.

<i>Body temperature</i>	<i>Average oxygen consumption at rest</i> (cm ³ per gram of body mass per hour)
Normal	15.0
Lowered during torpor	2.0

Using information from the **chart** and the **table**, calculate the average volume of oxygen consumed per hour by a hummingbird at the end of September at normal body temperature.

Space for calculation

_____ cm³ **1**

- 5 Red Fife and Coteau are cultivars of wheat. Their grain is grown for bread-making. A field trial was carried out to compare their economic and biological yields. Equal numbers of plants of each cultivar were grown in 16 field plots for six months as shown in the **diagram** below.

The **graph** below shows the average economic yield of grain and the average yield of the remaining plant biomass from samples of each cultivar.

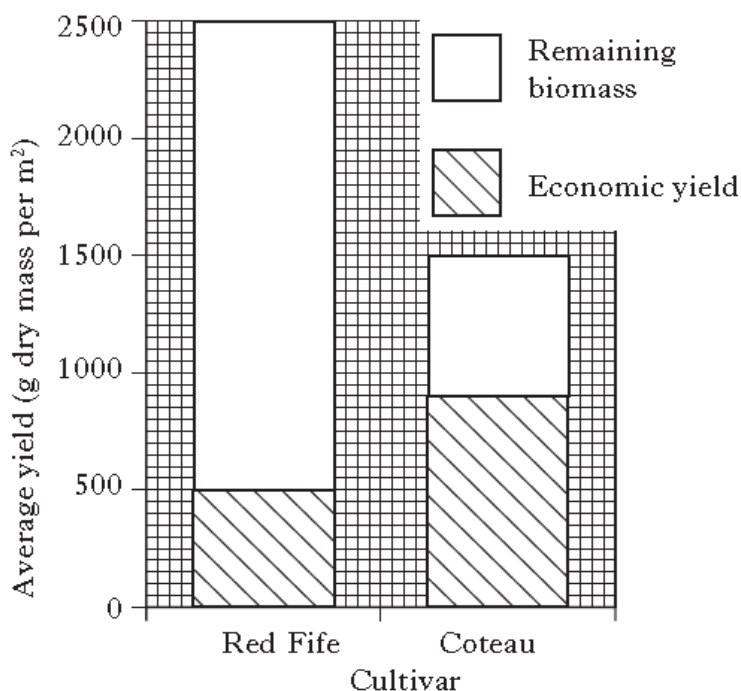
Diagram

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Key

	Red Fife plot
	Coteau plot

Graph



(a) In designing a field trial, account should be taken of the factors in the list below.

- A selection of treatments
- B number of replicates
- C randomisation of treatments

Complete the table below using letters from the list to match the reasons for taking the factors into account.

<i>Factor to be taken into account</i>	<i>Reason</i>
	To take account of the variability within samples.
	To ensure fair comparisons.
	To eliminate bias when measuring the treatment effects.

2

(b) Give **one** precaution, not already mentioned, which would have to be taken so that the comparison of the yields from each cultivar was valid and explain the reason for it.

Precaution _____

Reason _____

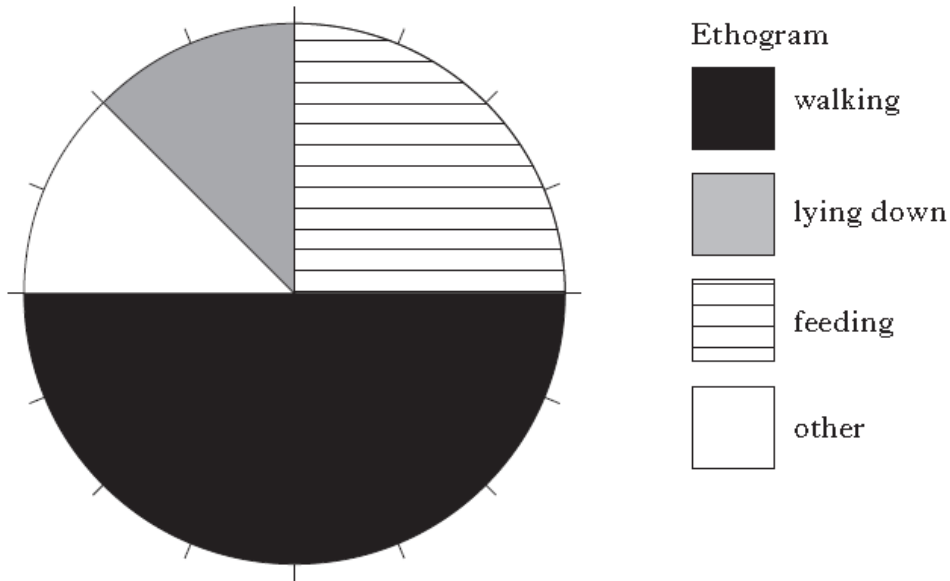
2

(c) (i) Red Fife has a harvest index of 0.2.
Calculate the harvest index of Coteau.

Space for calculation

1

- 6 In an investigation, the behaviour of a group of pigs in an enclosure was observed. Each pig's behaviour was observed initially and then every ten seconds for twenty minutes. The behaviours observed were allocated to different categories and the results shown in the pie chart below.



- (a) Calculate how long the pigs spent feeding.

Space for calculation

_____ minutes **1**

- (b) Express as the simplest whole number ratio the proportion of time spent walking, lying down and feeding.

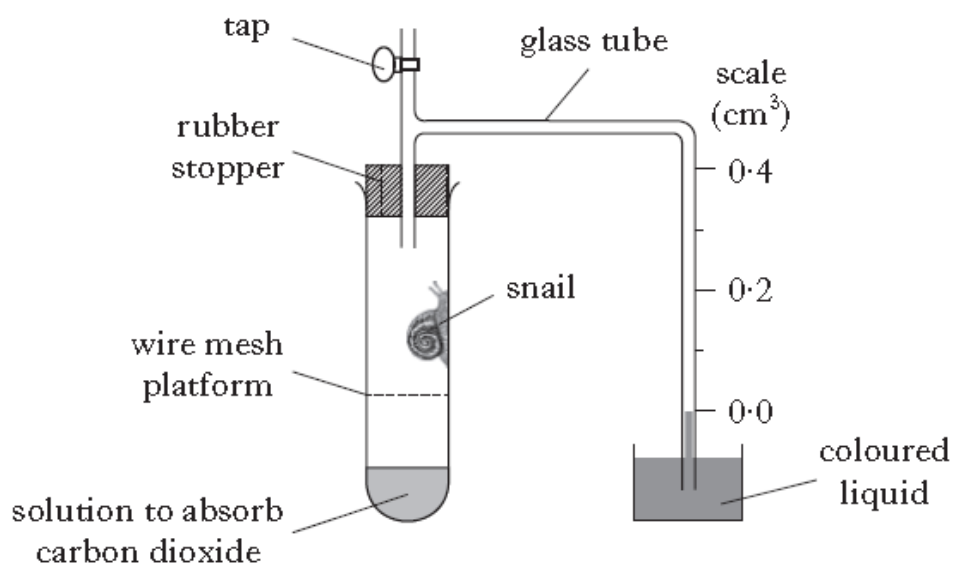
Space for calculation

_____ walking: _____ lying down: _____ feeding **1**

- (c) Suggest **one** improvement which could be made to this investigation to improve the reliability of the results.

 _____ **1**

- 7 In an investigation into the metabolic rate of a snail at rest, its oxygen uptake was measured using the apparatus shown in the diagram below.



The apparatus was kept at 10 °C with the tap open for 15 minutes. To start the experiment, the tap was closed and the reading on the scale recorded.

Every 2 minutes for 10 minutes, the oxygen uptake was recorded by taking readings from the scale.

The results are shown in the table below.

<i>Time after tap closed (minutes)</i>	<i>Oxygen uptake (cm³)</i>
0	0.00
2	0.04
4	0.08
6	0.12
8	0.18
10	0.20

- (a) (i) Explain why the apparatus was left for 15 minutes with the tap open before readings were taken.

- (ii) To ensure validity, identical apparatus was set up without the snail.
Explain why this ensures valid results.

1

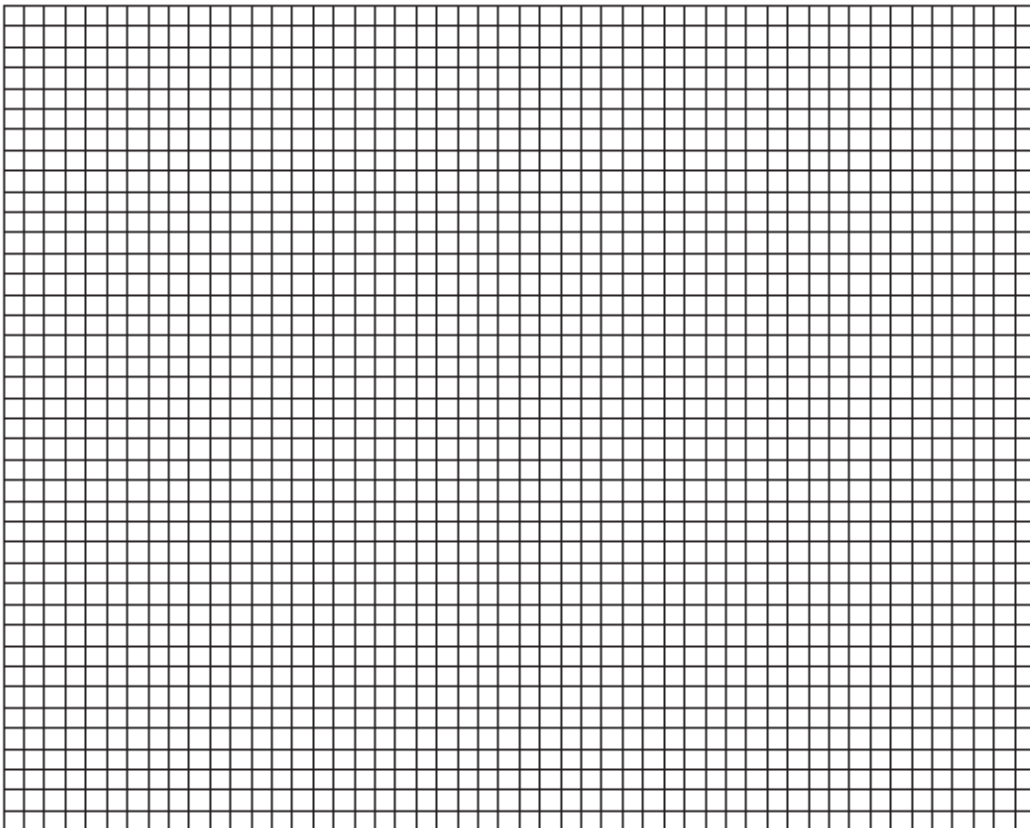
- (b) (i) Identify the dependent variable in this investigation.

1

- (ii) To increase the reliability of results, the experiment was repeated several times.

Identify **one** variable, **not already mentioned**, which would have to be kept the same each time to ensure that the procedure was valid.

- (c) On the grid below, draw a line graph to show the oxygen uptake against time.



2

(d) The mass of the snail was 5.0 g.

Use the results in the table to calculate the average rate of oxygen uptake per gram of snail per minute over the 10 minute period.

Space for calculation

_____ cm³ per gram per minute **1**

(e) Predict the effect of an increase in temperature to 15 °C on the oxygen uptake by the snail and justify your answer.

Prediction _____

Justification _____

_____ **1**

(f) Explain how the respiration of the snail and the presence of the solution in the test tube results in the movement of liquid on the scale.

_____ **2**

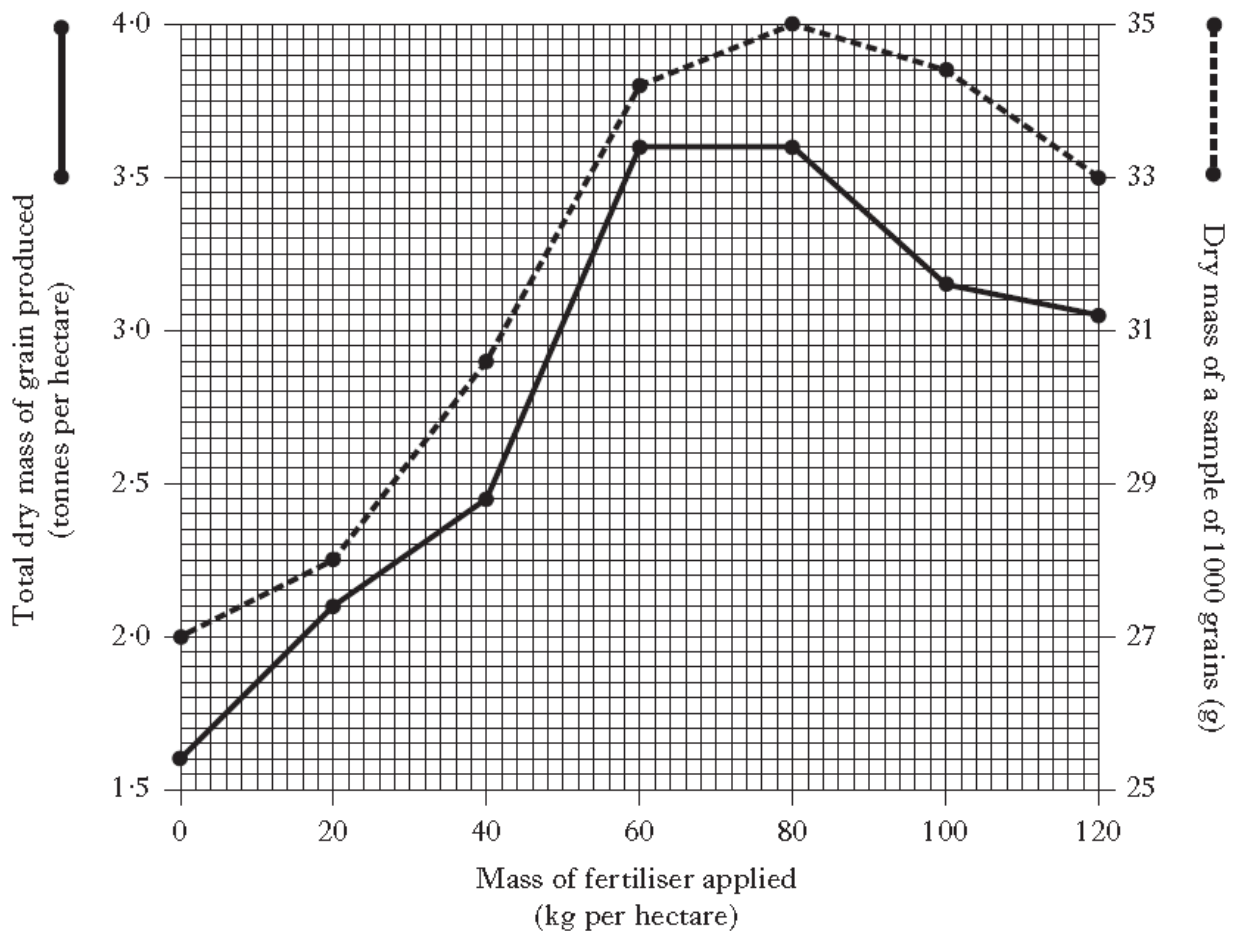
- 8 Human food production can be increased by the use of fertiliser which improves crop growth.

A field trial was carried out to show how the mass of fertiliser applied per hectare affected the growth of a wheat crop and to determine the level of fertiliser which should be recommended for use with this crop.

After the harvest of the wheat at each fertiliser level the following measurements of plant growth were made.

- Total dry mass of grain produced per hectare
- Dry mass of a sample of 1000 grains

The results are shown in the graph below.



- (a) (i) Use values from the graph to describe the changes in the total dry mass of grain produced as the fertiliser application increased from 40 kg to 120 kg per hectare.

2

- (ii) Calculate the **average increase** in total dry mass of grain produced for every additional kg of fertiliser applied from 0 kg to 80 kg per hectare.

Space for calculation

_____ tonnes per hectare 1

- (b) (i) Calculate the simplest whole number ratio of the dry mass of 1000 grains produced at 0 kg fertiliser per hectare to that at 120 kg fertiliser per hectare.

Space for calculation

_____ : _____
 At 0 kg per hectare At 120 kg per hectare

- (ii) Calculate the **percentage increase** in the dry mass of 1000 grains when the fertiliser level was increased from 20 kg to 80 kg per hectare.

Space for calculation

_____ %

- (c) At which fertiliser level is the average dry mass of an individual wheat grain the greatest.

Tick (✓) the correct box.

60 kg per hectare

80 kg per hectare

100 kg per hectare

120 kg per hectare

(d) The table below shows information about fertiliser level and yields of the wheat crop.

Complete the table by:

- (i) inserting the missing term to complete the column heading; 1
- (ii) inserting the missing fertiliser level using information from the graph; 1
- (iii) calculating and inserting the missing harvest index. 1

Space for calculation

<i>Fertiliser level</i> (kg per hectare) <i>(total plant biomass)</i> (tonnes per hectare)	<i>Economic yield</i> (total dry mass of grain) (tonnes per hectare)	<i>Harvest index</i>
	4.0	3.0	0.75
60	4.5	3.6	

(e) As a result of the field trial, the recommended level of fertiliser was 60 kg per hectare.

Suggest **two** reasons why this level was recommended.

- 1 _____ 1
- 2 _____ 1

9 White blood cell counts in humans normally range from 5000 to 10 000 cells per μl of blood.

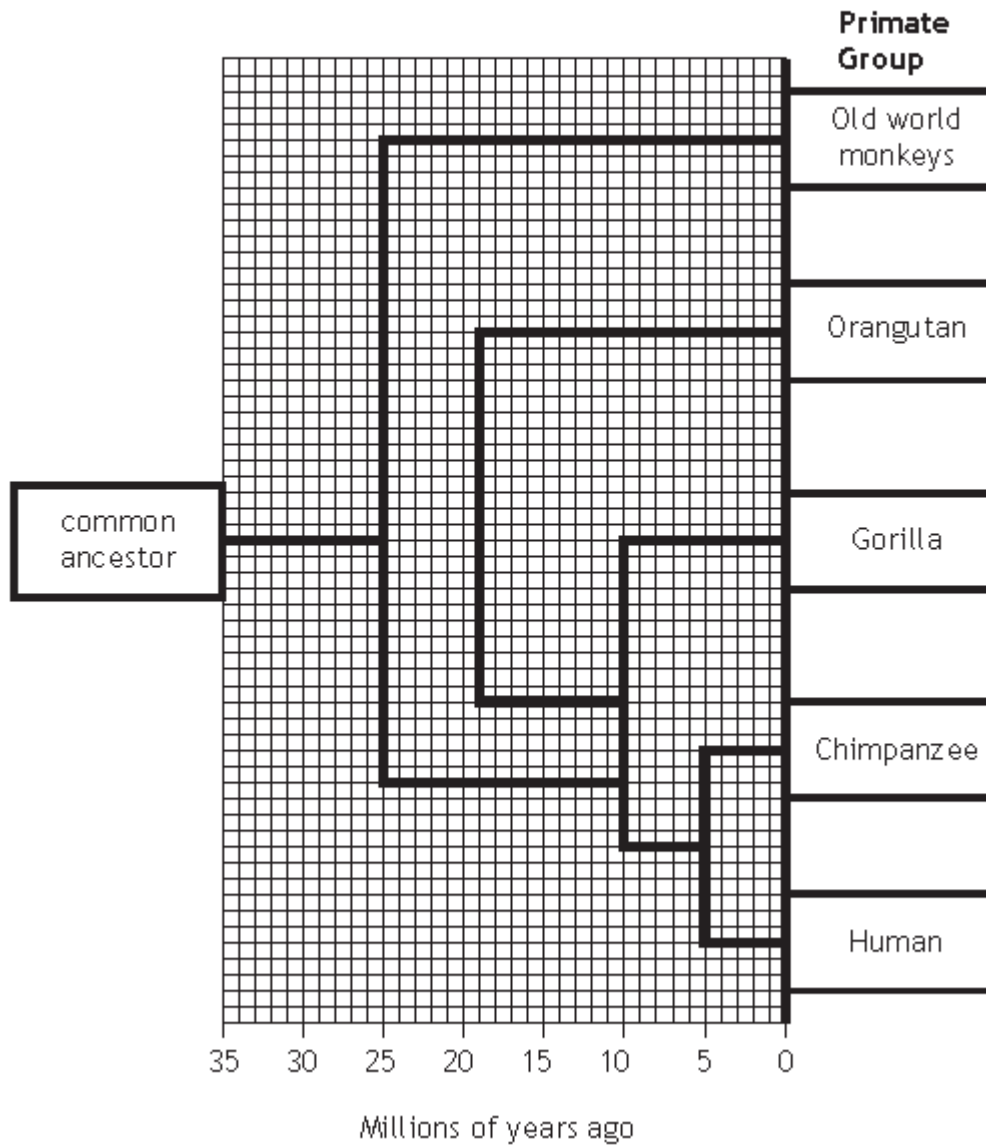
The table below shows the white blood cell counts from a patient with leukaemia before and after treatment with this drug.

	<i>Number of white blood cells</i> (per μl blood)
Before treatment	150 000
After treatment	7500

Calculate the percentage decrease in the number of white blood cells after treatment with this drug. 1

Space for calculation

- 10 The phylogenetic tree below illustrates the evolutionary relationships between primate groups.

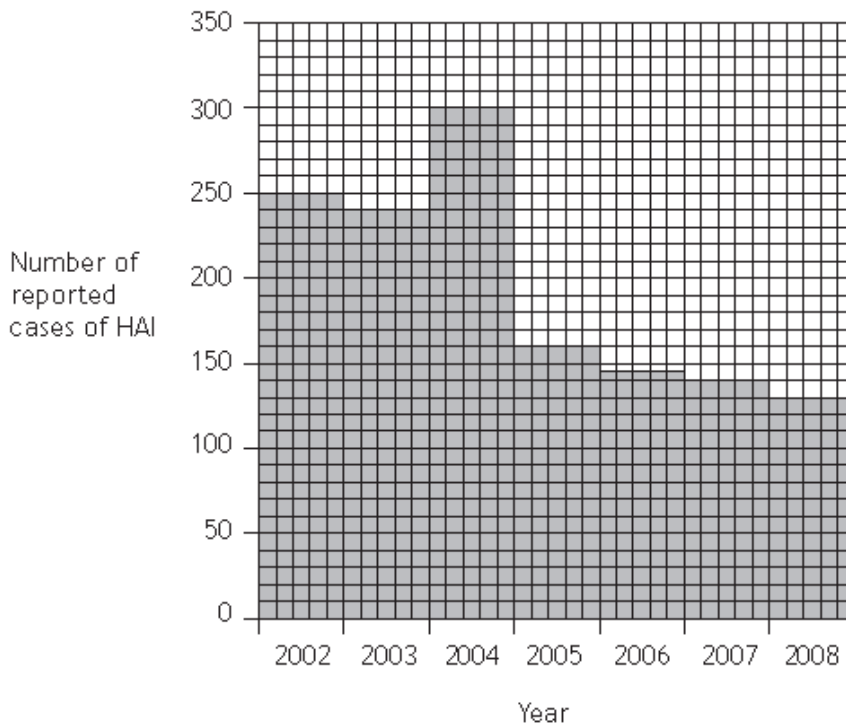


- (i) State how long ago the last common ancestor of gorillas and old world monkeys existed.

1

_____ million years ago

- 11 The graph below shows the number of reported cases of hospital acquired infections (HAI) in one hospital between 2002 and 2008. The overall number of patients remained constant during this time.



- (a) Using information from the graph, calculate the average decrease per year in reported cases of HAI between 2002 and 2008. 1

Space for calculation

_____ cases per year

- (b) The decrease in the number of cases in 2005 was due to introduction of a new hand washing procedure at the hospital.

Predict what would happen to the number of reported cases of HAI in 2009.

Circle **one** answer and give a reason for your choice. 1

increase decrease stay the same

Reason _____

- (c) The table below shows the percentage of cases of HAI in the hospital attributed to two types of bacteria, *Clostridium* and *Staphylococcus*, between 2002 and 2008.

		Percentage of cases of HAI in each year attributed to bacterial types					
Bacterial types	2002	2003	2004	2005	2006	2007	2008
<i>Clostridium</i>	32	30	30	51	54	57	59
<i>Staphylococcus</i>	34	32	33	30	31	33	33

Using information in the table, compare the overall trend in the percentage of *Clostridium* cases with that of *Staphylococcus* cases.

2

- (d) Using information from the graph and the table, draw a conclusion about the effectiveness of the hand washing procedure against *Staphylococcus*. Justify your answer.

2

Conclusion _____

Justification _____

- (e) Some bacteria form endospores to survive adverse conditions. Identify which of the two types of bacteria in the table forms endospores and give a reason for your answer.

1

Bacterial type _____

Reason _____

- 12 The average yield, fat and protein content of the milk from each of three breeds of dairy cattle were determined.

The results are shown in the table below.

<i>Breed</i>	<i>Average milk yield per cow</i> (kg per day)	<i>Average fat content of milk</i> (%)	<i>Average protein content of milk</i> (%)
Pure bred Holstein	44.80	4.15	3.25
F ₁ hybrid Holstein × Normande	48.64	4.25	3.10
F ₁ hybrid Holstein × Scandinavian Red	51.52	4.25	3.15

- (a) Calculate the percentage increase in average milk yield per cow from the F₁ hybrid Holstein × Scandinavian Red compared to pure bred Holstein cattle.

1

Space for calculation

_____ %

- (b) The fat content of milk is important for butter production.

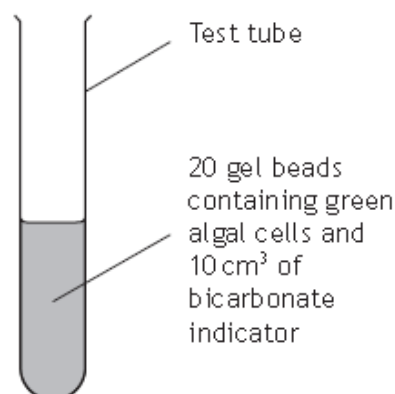
Calculate the total fat content in the milk produced in a day from a herd of 200 F₁ hybrid Holstein × Normande cattle.

1

Space for calculation

_____ kg per day

- 13 An investigation was carried out to compare the rate of photosynthesis, at different light intensities, of green algal cells immobilised into gel beads.



Seven tubes were set up as shown in the diagram and each positioned at a different distance from a light source to alter the light intensity.

Photosynthesis causes the bicarbonate indicator solution to change colour.

After 60 minutes, the bicarbonate indicator solution was transferred from each tube to a colorimeter.

The higher the colorimeter reading, the higher the rate of photosynthesis that has occurred in the tube.

Results are shown in the table.

<i>Tube</i>	<i>Distance of tube from light source (cm)</i>	<i>Colorimeter reading (units)</i>
1	25	92
2	35	92
3	50	83
4	75	32
5	100	14
6	125	6
7	200	0

- (a) Identify the dependent variable in this investigation.

1

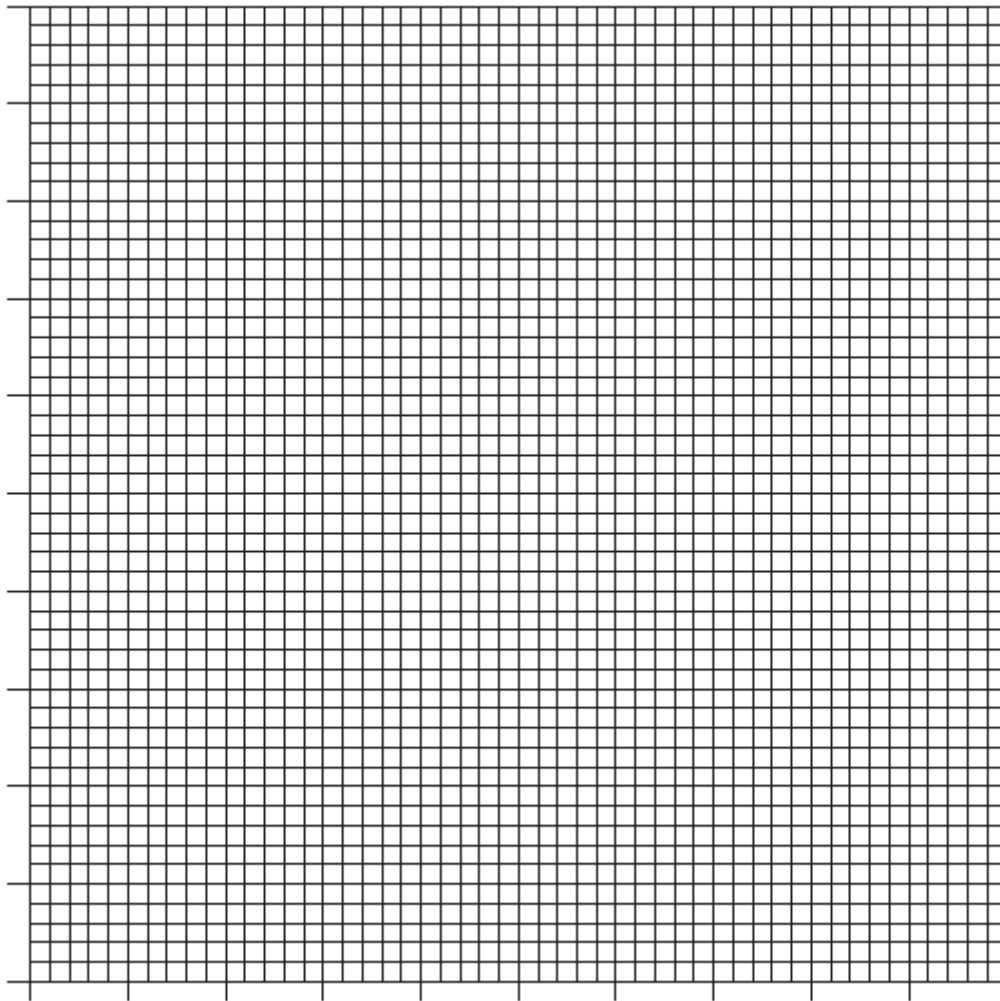
- (b) Describe how the apparatus could be improved to ensure that temperature was kept constant.

1

(c) State an advantage of using algae immobilised into gel beads. 1

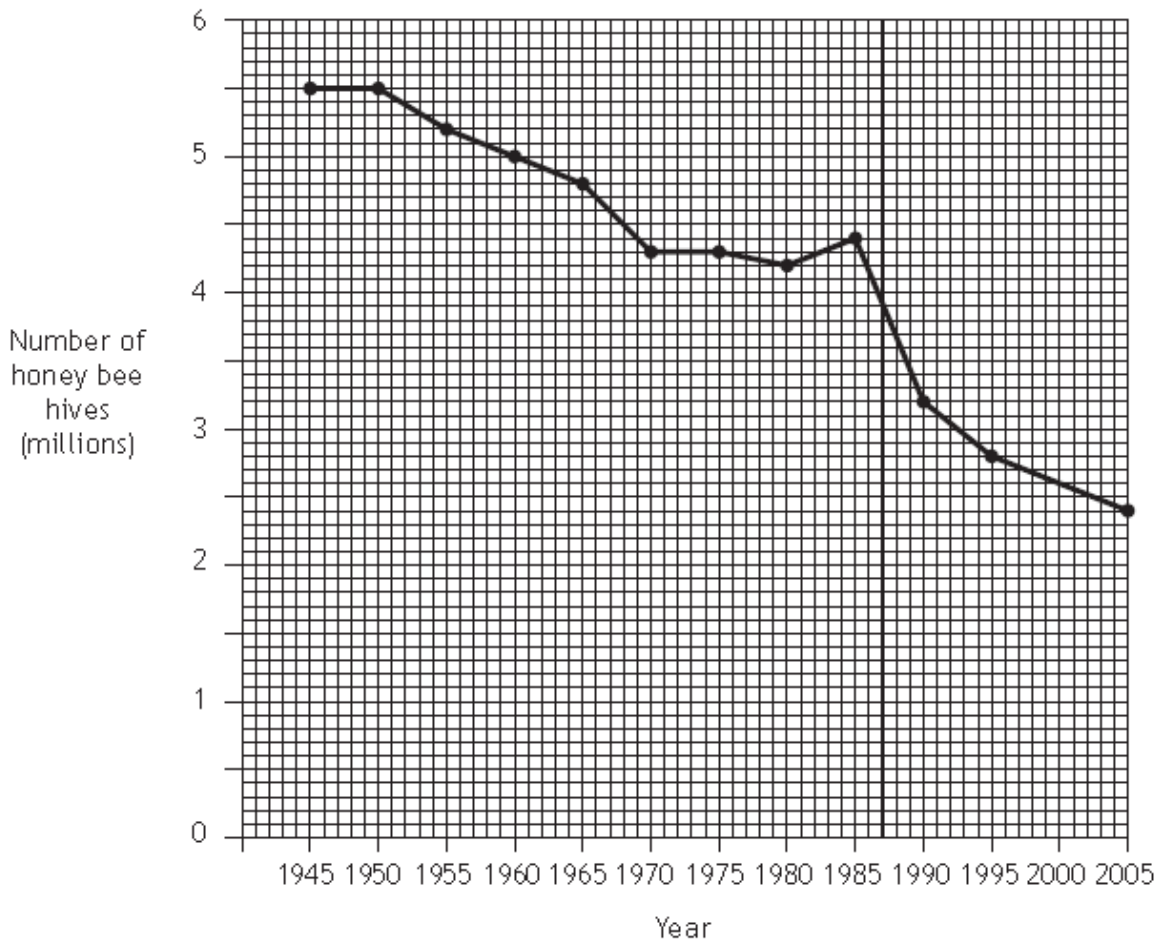
(d) Describe how the experimental procedure could be improved to increase the reliability of the results. 1

(e) On the grid below, complete the line graph to show the colorimeter reading against distance of tube from light source. 2



(f) From the results of this investigation, draw a conclusion about the effect of light intensity on the rate of photosynthesis. 2

- 14 The graph below shows the changes in the number of honey bee hives kept by bee-keepers in the USA from 1945 to 2005.



- (i) **Using values from the graph**, describe changes in the number of bee hives from 1980 to 1995. 1

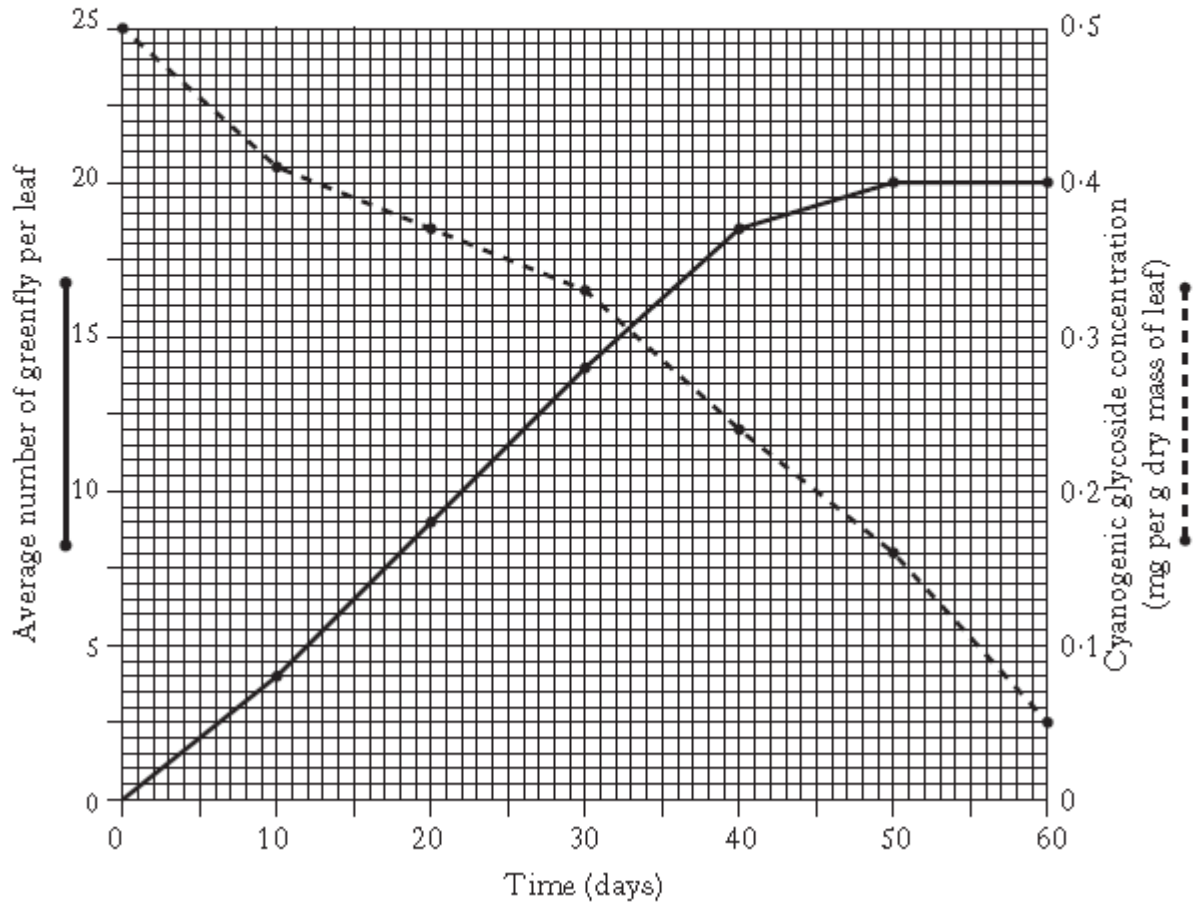
- (ii) Calculate the simplest whole number ratio of the number of bee hives in 1965 and 2005. 1

Space for calculation

_____ hives in 1965 : _____ hives in 2005

- 15 (a) Cherry tree leaves are attacked by greenfly. The leaves contain cyanogenic glycosides which are broken down to release cyanide when greenfly damage them. The cyanide acts as a defence against **most** greenfly species.

The graph below shows the average number of individuals of a species of greenfly per leaf and the concentration of cyanogenic glycosides in the leaves of a cherry tree over a 60 day period.



- (iii) Calculate the average increase **per day** in the number of greenfly per leaf between day 10 and day 50.

Space for calculation

Average increase per day _____ 1

- (iv) State the cyanogenic glycoside concentration when the average number of greenfly per leaf was 14.

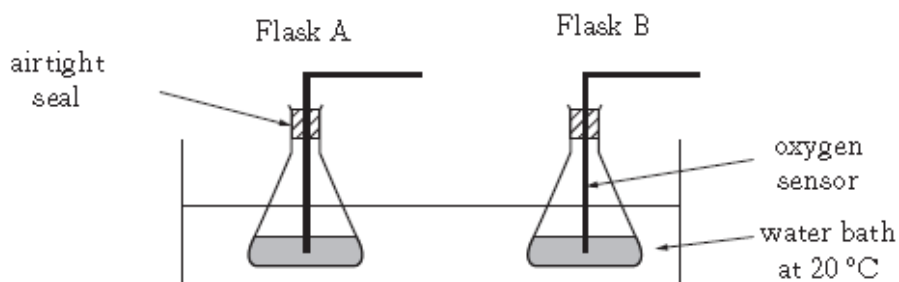
_____ mg per gram dry mass of leaf 1

16

In an investigation into the effect of lead ion concentration on respiration in yeast, two flasks were set up as described below.

<i>Flask</i>	<i>Contents</i>
A	200 cm ³ glucose solution + 5 cm ³ 0.2% lead nitrate solution
B	200 cm ³ glucose solution + 5 cm ³ 1.0% lead nitrate solution

The flasks were placed in a water bath at 20 °C for 10 minutes. After this time 2.5 cm³ of yeast suspension was added to each and oxygen sensors fitted as shown in the diagram below.



The flasks were left for a **further** 10 minutes and then oxygen concentration was measured in each flask every 20 seconds for 2 minutes.

The results are shown in the table below.

<i>Time (s)</i>	<i>Oxygen concentration (mg per litre)</i>	
	<i>Flask A 0.2% lead nitrate</i>	<i>Flask B 1.0% lead nitrate</i>
0	10.2	10.8
20	8.4	9.3
40	6.1	7.6
60	3.8	6.2
80	1.7	5.1
100	0.2	4.0
120	0.0	3.2

- (a) (i) Identify **one** variable, not already mentioned, which would have to be kept constant so that valid conclusions could be drawn.

_____ 1

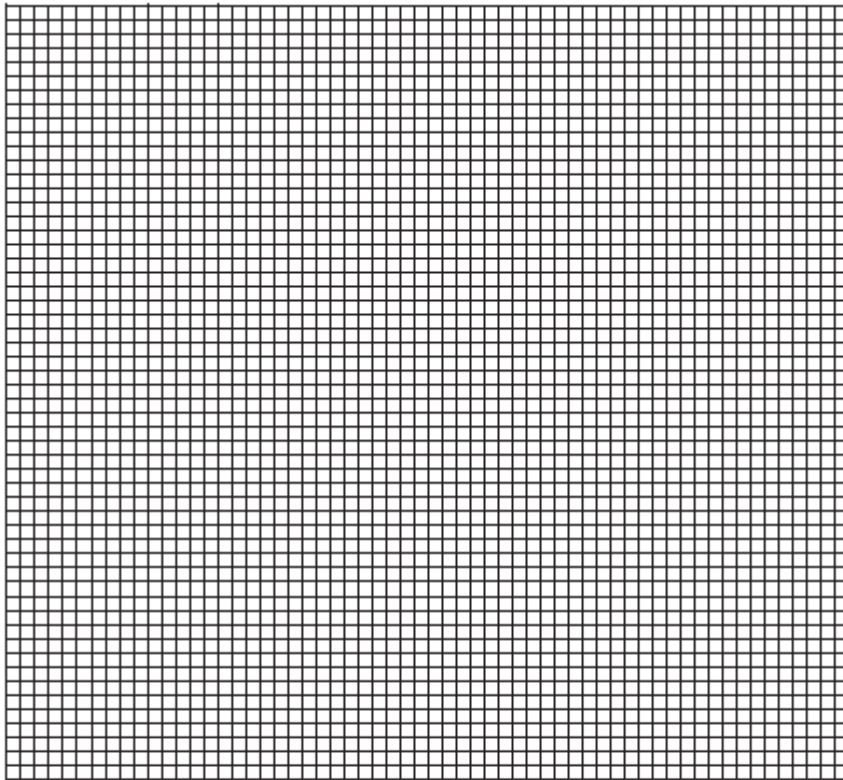
- (ii) Explain why the flasks were left for 10 minutes **before** the yeast suspension was added.

_____ 1

- (iii) Explain why the flasks were left for a **further** 10 minutes after the yeast suspensions were added before measurement of oxygen concentrations were taken.

1

- (b) On the grid provided, draw a line graph to show the oxygen concentration in **Flask A** against time. Use an appropriate scale to fill most of the grid.



2

- (c) Using information from the table, state the effect of increasing lead ion concentration on the aerobic respiration of yeast.

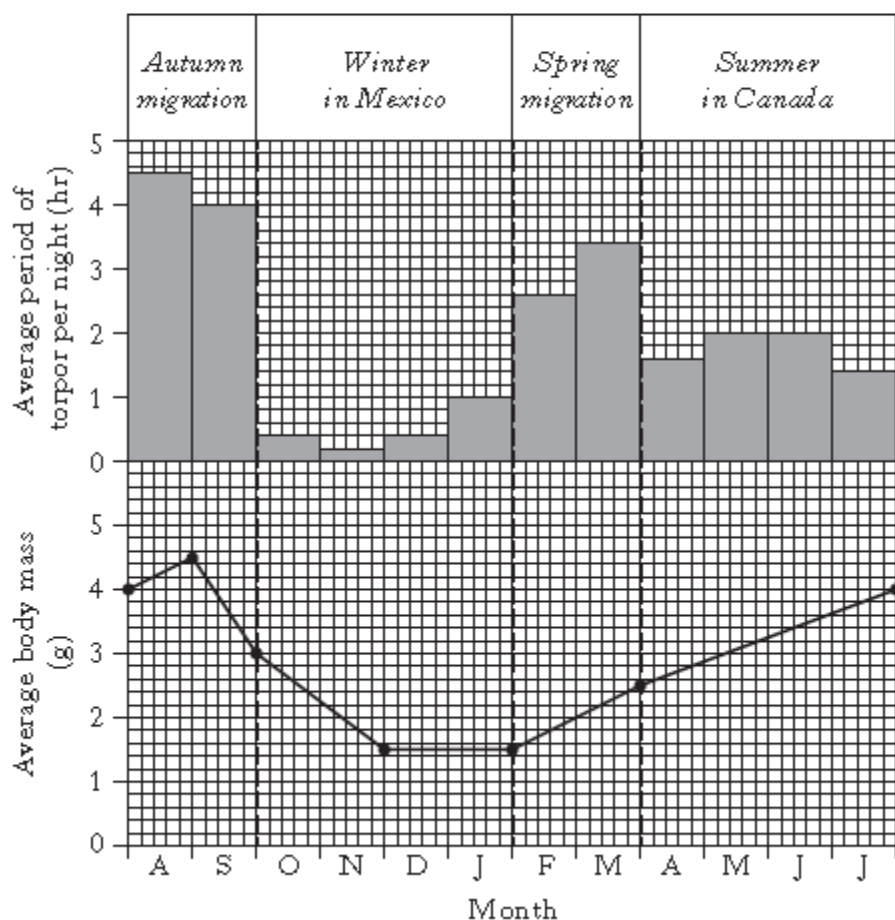
1

- 17 Rufous hummingbirds migrate thousands of kilometres each year between their summer breeding areas in Canada and their wintering areas in Mexico.

They feed on nectar throughout the year and are strongly territorial even on migration.

The birds save energy at night by entering a temporary state known as torpor in which body temperature and respiration rate are greatly reduced.

The **chart** below shows the average body mass of the hummingbirds and the average number of hours per night spent in torpor throughout the year.



- (a) (i) Use values from the chart to describe the changes in average body mass of the hummingbirds from the beginning of August until the end of January.

2

- (ii) Calculate the percentage increase in average body mass during the summer in Canada.

Space for calculation

- 18 At the start of an investigation, the blood glucose and insulin concentrations of a healthy adult human were measured and found to be normal. The individual then immediately drank a glucose drink and his blood glucose and insulin levels were re-measured at intervals over a period of 5 hours without further food or drink intake.

The results are shown in the table below.

<i>Time after glucose drink was taken (hours)</i>	<i>Glucose concentration (mg per 100 cm³)</i>	<i>Insulin concentration (units)</i>
0 (start)	80	50
0.5	90	550
1	120	500
2	100	400
3	80	100
4	80	50
5	70	45

- (a) Calculate the simplest whole number ratio of blood glucose concentration at the start to the maximum level recorded.

Space for calculation

_____ at start : _____ at maximum level

1

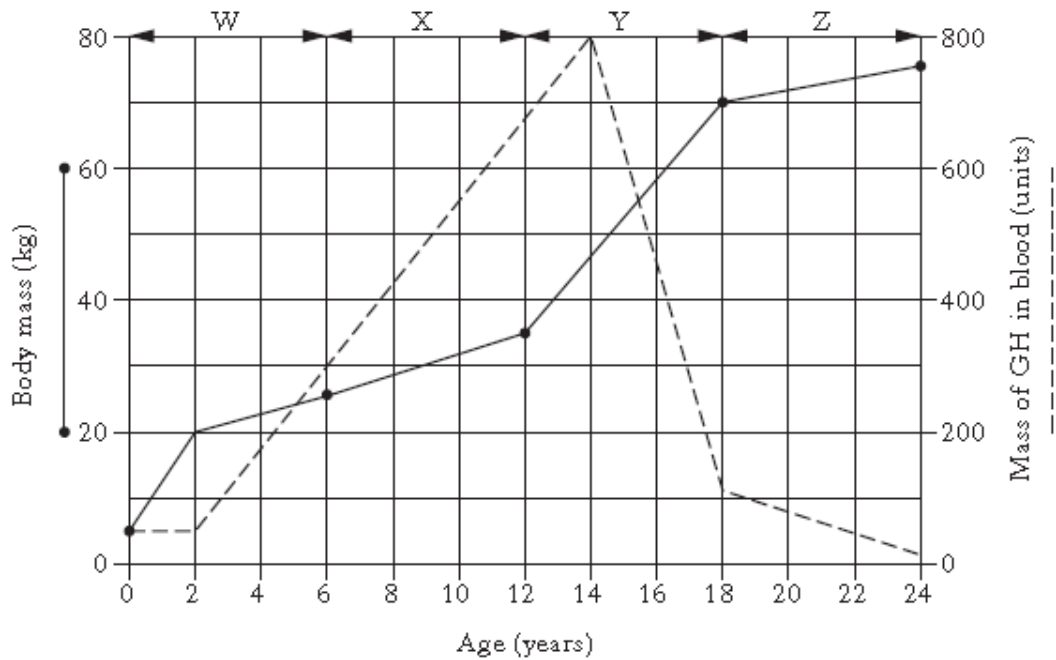
- (b) Calculate how long it took for blood insulin concentration to return to the start level from its maximum concentration.

Space for calculation

_____ hours

1

- 19 (a) The graph below shows the changes in body mass and mass of growth hormone (GH) in the blood of a human from birth to age 24 years.



- (i) Tick (✓) the box to show the age range during which the most rapid increase in body mass occurred.

0–2 years	2–12 years	12–18 years	18–24 years
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1

- (ii) An increase in growth hormone (GH) causes an increase in mass of muscle and bone tissues.

Tick (✓) the box to show the region of the graph which **best** supports this statement.

W	X	Y	Z
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

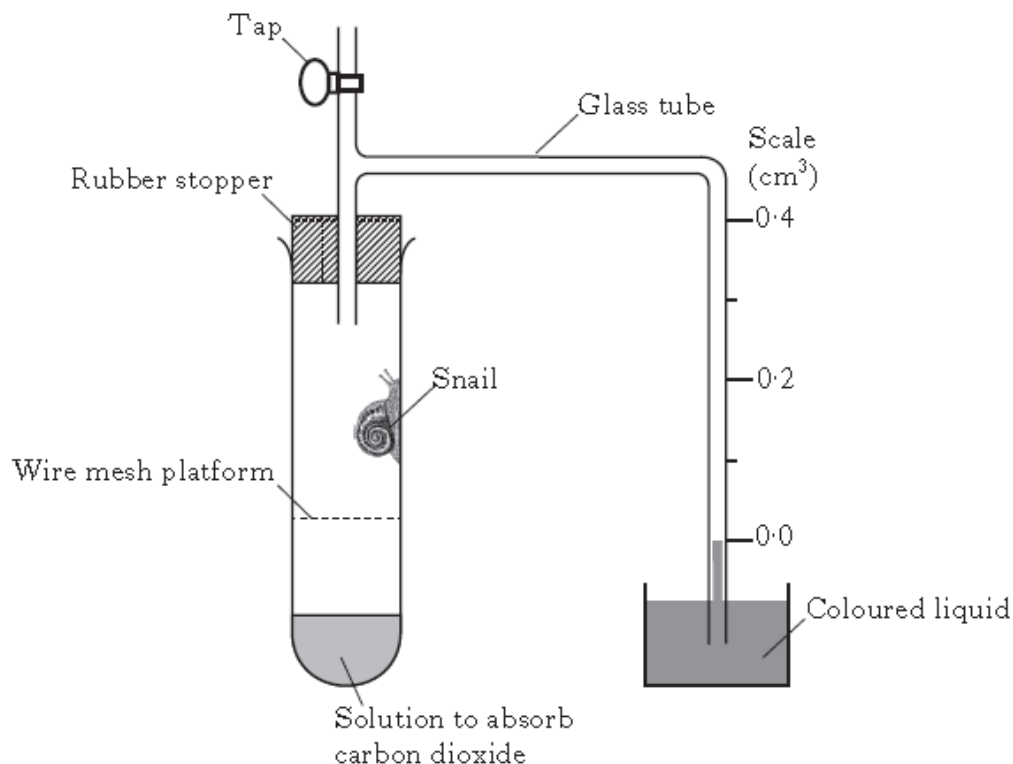
1

- (iii) Factors other than growth hormone (GH) are involved in increases in body mass in humans.

Describe how the graph supports this statement.

1

- 20 The diagram shows apparatus used in an investigation of aerobic respiration in snails.



The tap was kept open to the air for 15 minutes, and to start the experiment the tap was closed and the reading on the scale recorded. Every 2 minutes for 10 minutes the reading on the scale was again recorded and the results shown in the table below. The apparatus was kept at 20°C throughout.

<i>Time after tap closed (minutes)</i>	<i>Reading on scale (cm³)</i>
0	0.00
2	0.04
4	0.08
6	0.12
8	0.16
10	0.20

- (a) State why the apparatus was left for 15 minutes with the tap open before readings were taken.

_____ 1

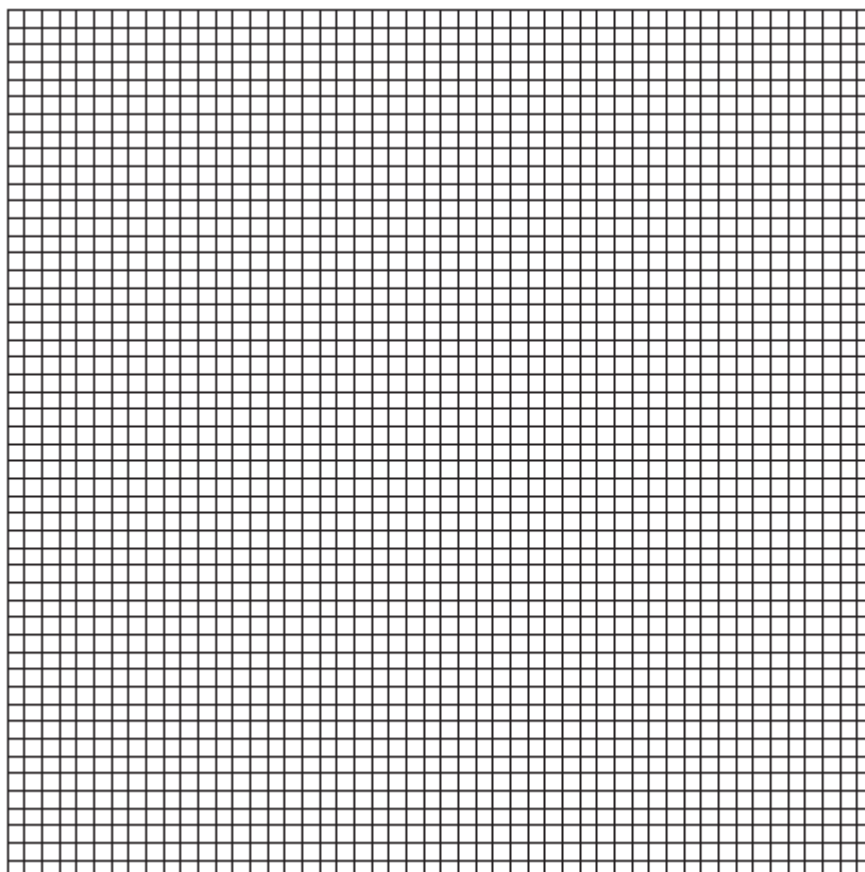
- (b) Describe a suitable control for this investigation.

 _____ 1

- (c) To increase the reliability of results, the experiment was repeated several times. Identify **one** variable, not already mentioned, that would have to be kept the same each time to ensure that the procedure was valid.

1

- (d) On the grid below, draw a line graph to show the reading on the scale against time, choosing appropriate scales so that the graph fills most of the grid.



2

- (e) The mass of the snail was 5.0 g.

Use results in the table to calculate the rate of oxygen uptake by the snail over the 10 minute period.

Space for calculation

_____ cm³ oxygen per minute per gram of snail 1