**Q1.**Catalase is used in a number of industrial processes. It is normally obtained from a fungus called *Aspergillus niger*. Scientists produced a mutant strain of *A*. *niger* called K30. They wanted to know if this mutant strain produced more catalase than the normal strain of *A*. *niger*.

•        The scientists grew samples of the normal strain of the fungus and of the K30 strain on jelly in separate Petri dishes. The jelly contained a blue substance which is turned colourless by catalase.

•        They incubated the dishes for 3 days then measured the diameter of the colourless zone around the fungus.

•        They calculated the ratio of the diameter of the colourless zone to the diameter of the fungus.

The diagram shows the dishes after incubation.

**Normal
strain**

 

**K30 strain**

 

(a)     The scientists grew both strains of fungi on dishes kept at 30 °C. Keeping the dishes at a temperature of 15 °C would affect the results. Use your knowledge of kinetic energy to explain why.

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**(2)**

(b)     (i)      The scientists gave their results as ratios. Explain the advantage of giving the results of this investigation as a ratio.

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**(2)**

(ii)      For the normal strain the ratio of the diameter of the colourless zone to the diameter of the fungus was 1.1 : 1.

Calculate the ratio of the diameter of the colourless zone to the diameter of the fungus for the K30 strain. Show your working.

Ratio = ...................................................

**(2)**

(c)     The catalase produced by the K30 strain of the fungus is mainly an extracellular enzyme. This means that the fungus secretes catalase from its cells into the jelly in the Petri dish.

Describe and explain the evidence from the investigation which shows that the catalase is an extracellular enzyme.

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**(2)**

**(Total 8 marks)**

**Q2.**Some mice have diabetes. The diabetes causes the blood glucose concentration to become very high after a meal. Scientists investigated the use of an inhibitor of amylase to treat diabetes.

The scientists took 30 mice with diabetes and divided them into two groups, **A** and **B**.

•        **Group A** was given yoghurt **without** the inhibitor of amylase each day.

•        **Group B** was given yoghurt **with** the inhibitor of amylase each day.

Apart from the yoghurt, all of the mice were given the same food each day.

The scientists measured the blood glucose concentration of each mouse, 1 hour after it had eaten. This was done on days 1, 10 and 20 after the investigation started.

The following figure shows the scientists’ results.

 
        Days after the investigation started

(a)     **Group A** acted as a control in this investigation.

Explain the purpose of this group.

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**(2)**

(b)     Apart from the yoghurt, it was important that all of the mice were given the same food each day.

Give **two** reasons why it was important that all of the mice were given the same food each day.

1 .....................................................................................................................

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2 .....................................................................................................................

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**(2)**

(c)     The scientists’ hypothesis was that adding the inhibitor of amylase to the food would lead to a lower blood glucose concentration.

Use your knowledge of digestion to suggest how the addition of the inhibitor could lead to a lower blood glucose concentration.

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**(2)**

(d)     Give **one** reason why these results may **not** support the use of the inhibitor of amylase to treat diabetes in mice.

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**(2)**

**(Total 8 marks)**

**Q3.**          (a)     Give **two** ways in which active transport is different from facilitated diffusion.

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2 ...................................................................................................................

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**(2)**

Scientists investigated the effect of a drug called a proton pump inhibitor. The drug is given as a tablet to people who produce too much acid in their stomach. It binds to a carrier protein in the surface membrane of cells lining the stomach. This carrier protein usually moves hydrogen ions into the stomach by active transport.

The scientists used two groups of people in their investigation. All the people produced too much acid in their stomach. People in group **P** were given the drug. Group **Q** was the control group.

The graph shows the results.



(b)(i)      The scientists used a control group in this trial. Explain why.

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**(1)**

(ii)     Suggest how the control group would have been treated.

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**(2)**

(c)Describe the effect of taking the drug on acid secretion.

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**(1)**

**(Total 6 marks)**

**Q4.**A group of students carried out an investigation to find the water potential of potato tissue.

The students were each given a potato and 50 cm3 of a 1.0 mol dm−3 solution of sucrose.

•        They used the 1.0 mol dm−3 solution of sucrose to make a series of different concentrations.

•        They cut and weighed discs of potato tissue and left them in the sucrose solutions for a set time.

•        They then removed the discs of potato tissue and reweighed them.

The table below shows how one student presented his processed results.

|  |  |  |
| --- | --- | --- |
|   | **Concentration of sucrose solution / mol dm−3** | **Percentage change in mass of potato tissue** |
|   | 0.15 | +4.7 |
|   | 0.20 | +4.1 |
|   | 0.25 | +3.0 |
|   | 0.30 | +1.9 |
|   | 0.35 | −0.9 |
|   | 0.40 | −3.8 |

(a)     Explain why the data in the table above are described as **processed** results.

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**(1)**

(b)     Describe how you would use a 1.0 mol dm−3 solution of sucrose to produce 30 cm3 of a 0.15 mol dm−3 solution of sucrose.

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**(2)**

(c)     Explain the change in mass of potato tissue in the 0.40 mol dm−3 solution of sucrose.

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**(2)**

(d)     Describe how you would use the student’s results in the table above to find the water potential of the potato tissue.

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**(3)**

**(Total 8 marks)**

**Q5.**          (a)     A student investigated the effect of pH on the activity of the enzyme amylase.
She set up the apparatus shown in the diagram.



The tubes were made from Visking tubing. Visking tubing is partially permeable.
She added an equal volume of amylase solution and starch to each tube.

•        She added a buffer solution at pH2 to tube **A**.

•        She added an equal volume of buffer solution at pH8 to tube **B**.

After 30 minutes, she measured the height of the solutions in both tubes.
She then tested the solutions in tubes **A** and **B** for the presence of reducing sugars.

Describe how the student would show that reducing sugars were present in a solution.

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*(Extra space)* .................................................................................................

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**(3)**

(b)     After 30 minutes, the solution in tube **B** was higher than the solution in tube **A**.

(i)      Explain why the solution in tube **B** was higher.

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**(3)**

(ii)     The student concluded from her investigation that the optimum pH of amylase was pH8. Is this conclusion valid? Explain your answer

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**(1)**

**(Total 7 marks)**

**Q6.**The figure below shows a test that has been developed to find out if a person has antibodies to the human immunodeficiency virus (HIV) antigen.

|  |  |  |
| --- | --- | --- |
|   | **Step 1** | HIV antigens are attached to a test well in a dish. |
|   |  |  |
|   | **Step 2** | A sample of blood plasma is added to the well.If HIV antibodies are present, they bind to the HIV antigen. |
|   |  |  |
|   | **Step 3** | The well is washed.A second antibody with an enzyme attached is then added.This binds specifically to the HIV antibody. |
|   |  |  |
|   | **Step 4** | The well is washed again.A yellow solution is added, which changes to blue if the enzyme is present. A blue colour shows that the person has HIV antibodies. |

(a)     This test only detects the presence of HIV antibodies. Give **two** reasons why it cannot be used to find out if a person has AIDS.

1 .....................................................................................................................

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2 .....................................................................................................................

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**(2)**

(b)     The solution will remain yellow if a person is **not** infected with HIV. Explain why.

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**(2)**

(c)     A mother who was infected with HIV gave birth to a baby. The baby tested positive using this test. This does not prove the baby is infected with HIV.
Explain why.

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**(2)**

(d)     A control well is set up every time this test is used. This is treated in exactly the same way as the test wells, except that blood plasma is replaced by a salt solution.

Use information from the figure above to suggest **two** purposes of the control well.

1 .....................................................................................................................

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**(2)**

**(Total 8 marks)**

**Q7.**(a)     Explain how oxygen is loaded, transported and unloaded in the blood.

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**(6)**

Midges are very small insects. The early stages of the life cycle of midges are called larvae. Midge larvae live in water. A biologist investigated the uptake of oxygen by the larvae of two species of midge. He measured the rate of uptake of oxygen by the larvae in water containing different concentrations of oxygen. The table shows his results.

|  |  |  |
| --- | --- | --- |
|   | **Concentration ofoxygen in water/ cm3dm-3** | **Mean rate of oxygen uptake / cm3g-1h-1** |
|   | *Chironomus longistylus* | *Tanytarsus brunnipes* |
|   | 1 | 220 | 141 |
|   | 2 | 285 | 246 |
|   | 3 | 304 | 342 |
|   | 4 | 313 | 362 |
|   | 5 | 320 | 367 |
|   | 6 | 318 | 430 |
|   | 7 | 320 | 469 |

(b)     The larvae in this investigation were kept at a temperature of 17 °C. Why was it important that the larvae of both species were kept at the same temperature?

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**(2)**

(c)     Describe the effect of an increase in oxygen concentration on the mean rate of oxygen uptake in *Chironomus longistylus*.

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**(2)**

(d)     *Chironomus longistylus* lives in still water whereas *Tanytarsus brunnipes* lives in fast running streams. The water in fast running streams has a higher concentration of oxygen than in still water. Use the table in part (a) to suggest how *Chironomus longistylus* is better adapted than *Tanytarsus brunnipes* to living in still water.

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**(2)**

(e)     Lungfish are freshwater fish which have gills and lungs. Scientists investigated how Australian and African lungfish use their lungs and gills for gas exchange. The graphs show the results of this investigation.



(i)      Describe the difference in the way carbon dioxide is lost from the body of an Australian lungfish and an African lungfish.

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**(1)**

(ii)     African lungfish are likely to survive for longer than Australian lungfish when living in pools that dry up. Explain why.

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**(2)**

**(Total 15 marks)**

**Q8.**Scientists investigated the effect of drinking tea and coffee on reducing the risk of developing one type of brain cancer. The investigation involved 410 000 volunteers and was conducted in 10 European countries over a period of 8.5 years.

(a)     (i)      Apart from age, suggest **two** factors that the scientists should have considered when selecting volunteers for this trial.

1 ............................................................................................................

2 ............................................................................................................

**(2)**

(ii)     Give **two** features of the design of this investigation that would ensure the reliability ofthe results obtained.

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2 ............................................................................................................

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**(2)**

(b)     The incidence for this type of brain cancer is 6 cases per 100 000 per year.
Use this information to calculate the expected number of volunteers developing this cancer during the 8.5 year period of this investigation. Show your working.

                Answer..................................................................................

**(2)**

(c)     In analysing the results of this investigation, the scientists took into account the age of the volunteers. Suggest why.

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**(1)**

(d)     During the investigation, the volunteers were asked to estimate the volume of tea and/or coffee that they drank each day. The types of tea and coffee consumed in different countries varied. When the data from all the countries were collected there was a correlation between drinking more than 100 cm3of tea or coffee each day and a reduced risk of developing this type of brain cancer.

Tea and coffee contain caffeine. A newspaper reported the results of this investigation under the headline ‘Caffeine helps cut cancer risk’. Explain why scientists could **not** support this view solely on the basis of this investigation.

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*(Extra space)* .................................................................................................

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**(4)**

(e)     Another group of scientists investigated the effect of caffeine on blood flow to certain parts of the brain. Volunteers were given different concentrations of caffeine solution to drink. A control group was also set up.

(i)      Describe how the control group should have been treated.

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**(2)**

(ii)     Volunteers who drank the same concentration of caffeine solution often had different concentrations of caffeine in their blood. Suggest **one** reason for the difference in concentration of caffeine in the blood of volunteers.

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**(1)**

(iii)    The investigation showed that caffeine reduces the blood flow to certain parts of the brain. Suggest **one** way in which this could lead to a reduced risk of brain cancers.

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**(1)**

**(Total 15 marks)**

**Q9.**          A student investigated the effect of putting cylinders cut from a potato into sodium chloride solutions of different concentration. He cut cylinders from a potato and weighed each cylinder. He then placed each cylinder in a test tube. Each test tube contained a different concentration of sodium chloride solution. The tubes were left overnight. He then removed the cylinders from the solutions and reweighed them.

(a)     Before reweighing, the student blotted dry the outside of each cylinder. Explain why.

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**(2)**

The student repeated the experiment several times at each concentration of sodium chloride solution. His results are shown in the graph.



(b)     The student made up all the sodium chloride solutions using a 1.0 mol dm–3 sodium chloride solution and distilled water.

Complete the table to show how he made 20 cm3 of a 0.2 mol dm–3 sodium chloride solution.

|  |  |  |
| --- | --- | --- |
|   | **Volume of 1.0 mol dm–3 sodium chloride solution** | **Volume of distilled water** |
|   |   |   |

**(1)**

(c)     The student calculated the *percentage* change in mass rather than the change in mass. Explain the advantage of this.

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**(2)**

(d)     The student carried out several repeats at each concentration of sodium chloride solution. Explain why the repeats were important.

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**(2)**

(e)     Use the graph to find the concentration of sodium chloride solution that has the same water potential as the potato cylinders.

.............................. mol dm–3

**(1)**

**(Total 8 marks)**

**Q10.**A student investigated the rate of transpiration from a leafy shoot. She used a potometer to measure the rate of water uptake by the shoot. The diagram shows the potometer used by the student.



(a)     Give **one** environmental factor that the student should have kept constant during this investigation.

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**(1)**

(b)     The student cut the shoot and put it into the potometer under water. Explain why.

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**(1)**

(c)     The student wanted to calculate the rate of water uptake by the shoot in cm3 per minute. What measurements did she need to make?

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**(2)**

(d)     The student assumed that water uptake was equivalent to the rate of transpiration.

Give **two** reasons why this might **not** be a valid assumption.

1 ...................................................................................................................

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2 ...................................................................................................................

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**(2)**

(e)     The student measured the rate of water uptake three times.

(i)      Suggest how the reservoir allows repeat measurements to be made.

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**(1)**

(ii)     Suggest why she made repeat measurements.

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**(1)**

**(Total 8 marks)**

**Q11.**          Some strains of the bacterium that causes gonorrhoea are resistant to antibiotics. This makes the disease difficult to treat. One way of testing the effectiveness of antibiotics is to use discs of paper soaked in antibiotic. These are placed in the centre of an agar plate covered by bacteria. A clear zone forms around the disc if the antibiotic is effective.

The table shows some results of an investigation into the effect of four different antibiotics on gonorrhoea bacteria.

|  |  |  |
| --- | --- | --- |
| **Antibiotic** | **Diameter of clear zone / mm** | **Minimum diameter of clear zone if antibiotic is effective / mm** |
| **A** | 47 | 52 |
| **B** | 30 | 28 |
| **C** | 22 | 40 |
| **D** | 33 | 34 |

(a)     Give **two** reasons why it would be important to use sterile techniques during this investigation.

1 ...................................................................................................................

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2 ...................................................................................................................

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**(2)**

(b)     (i)      The antibiotic reached the bacteria by diffusion. Suggest why an effective antibiotic may produce only a small clear zone.

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**(1)**

(ii)     Which antibiotic used in the investigation would be most useful for treating gonorrhoea? Explain your answer.

Antibiotic ...............................................................

Explanation .........................................................................................

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**(2)**

**(Total 5 marks)**

**Q12.**Students investigated the effect of different concentrations of sodium chloride solution on discs cut from an apple. They weighed each disc and then put one disc into each of a range of sodium chloride solutions of different concentrations. They left the discs in the solutions for 24 hours and then weighed them again. Their results are shown in the table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | **Concentration of sodium chloride solution / mol dm–3** | **Mass of disc at start / g** | **Mass of disc at end / g** | **Ratio of mass at start to mass at end** |
|   | 0.00 | 16.1 | 17.2 | 0.94 |
|   | 0.15 | 19.1 | 20.2 | 0.95 |
|   | 0.30 | 24.3 | 23.2 | 1.05 |
|   | 0.45 | 20.2 | 18.7 | 1.08 |
|   | 0.60 | 23.7 | 21.9 |   |
|   | 0.75 | 14.9 | 13.7 | 1.09 |

(a)     (i)      Calculate the ratio of the mass at the start to the mass at the end for the disc placed in the 0.60 mol dm–3 sodium chloride solution.

Answer ......................................

**(1)**

(ii)     The students gave their results as a ratio. What is the advantage of giving the results as a ratio?

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**(2)**

(iii)    The students were advised that they could improve the reliability of their results by taking additional readings at the same concentrations of sodium chloride.

Explain how.

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**(2)**

(b)     (i)      The students used a graph of their results to find the sodium chloride solution with the same water potential as the apple tissue. Describe how they did this.

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**(2)**

(ii)     The students were advised that they could improve their graph by taking additional readings. Explain how.

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**(2)**

**(Total 9 marks)**

**Q13.**          **S**       Penstemon plants have mechanisms that regulate the amount of nectar produced by their flowers. Nectar is a solution containing sucrose which attracts insect pollinators. The diagram shows a section through a penstemon flower.



To investigate these mechanisms the volume of nectar produced was determined. A thin strip of filter paper was dipped into the nectar until all the nectar was absorbed. The distance the nectar moved up the paper was measured. The actual volume of nectar was found by reading the value from a calibration curve on a graph. A sucrose solution similar to nectar was used to produce this calibration curve.

(a)     (i)      The solution contained 22% by mass of sucrose. Describe how you would make 50 cm3 of this solution.

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**(1)**

(ii)     Describe how you would use the solution to produce the calibration curve.

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**(2)**

In one experiment the effect of removing nectar at regular intervals was investigated. First all the nectar was removed from two penstemon flowers. From one flower (**A**) all the nectar produced was removed each hour for the next six hours. In the second flower (**B**) the nectar was allowed to accumulate for six hours. Each time the nectar was removed, the sugar was extracted from the strip of filter paper and its mass was measured. The graphs show the results.



(b)     (i)      Describe the effects on nectar production and on sucrose secretion of removing the nectar every hour compared with removing it after 6 hours.

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**(2)**

(ii)     How would the nectar collected after 6 hours from plant **B** differ from that collected after 6 hours from plant **A**.

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**(1)**

(iii)     Pollinating insects such as bees visit flowers and collect nectar. Suggest **one** advantage for penstemon flowers of the response to regular removal of nectar.

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**(1)**

(c)     In a different experiment the nectar was removed from two penstemon flowers. In one flower the nectar was replaced with 5 mm3 of a solution containing a total of 120 µg of sucrose. The second flower was left empty as a control. The two flowers were protected from insects. After three hours the nectar solutions in the flowers were removed. The table shows the results.

|  |  |  |
| --- | --- | --- |
|   | **Volume of solution / mm3** | **Mass of sucrose in solution / µg** |
| **Time / h** | **Experimental** | **Control** | **Experimental** | **Control** |
| 0 | 5.00 | 0.00 | 120 | 0 |
| 3 | 5.75 | 1.65 | 104 | 20 |

Describe the effect of the addition of sucrose solution on the volume of nectar produced and on the movement of sucrose.

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**(3)**

(d)     Nectar is formed by specialised cells in the flower which synthesise sucrose.
Describe how sucrose is moved against a concentration gradient from these cells into the nectar.

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**(2)**

**(Total 12 marks)**

**Q14.**          An agar plate was flooded with a culture of a species of bacterium usually found in the mouth. Four sterile paper discs, **A**, **B**, **C** and **D**, each containing a different brand of mouthwash, were then placed on the agar plate. The drawing shows the appearance of the plate after it had been incubated at 37°C for three days.



(a)     Describe the aseptic techniques that would be used when flooding the agar plate with bacteria.

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**(3)**

(b)     The effectiveness of a mouthwash can be measured by calculating the total area of a paper disc and the clear zone around it. The area of a circle is given by *πr*2, where *r* is the radius of the circle. Calculate how many times more effective mouthwash **C** is than mouthwash **B**. Show your working.

Mouthwash **C** is .................................... times more effective than mouthwash **B**.

**(2)**

**S**       (c)     Several factors affect the rate at which the antiseptic in the mouthwash from each paper disc diffuses through the agar. Describe the effect of **three** named factors on this rate.

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**(3)**

**(Total 8 marks)**

**Q15.**          (a)     Describe how water is moved through a plant according to the *cohesion-tension* hypothesis.

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**(4)**

(b)     The mass of water lost from a plant was investigated. The same plant was used in every treatment and the plant was subjected to identical environmental conditions. In some treatments, the leaves were coated with a type of grease. This grease provides a waterproof barrier. The results of the investigation are given in the table.

|  |  |
| --- | --- |
| **Treatment** | **Mass lost in 5 days / g** |
| No grease applied | 10.0 |
| Grease applied only to the upper surface of every leaf | 8.7 |
| Grease applied to both surfaces of every leaf | 0.1 |

(i)      What is the advantage of using the same plant in every treatment?

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**(1)**

(ii)     Why was it important to keep the environmental conditions constant?

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**(1)**

(iii)     What is the evidence that the grease provides a waterproof barrier?

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**(1)**

(c)     (i)      Calculate the mass of water lost in 5 days through the upper surface of the leaves.

Answer ................................................................

**(1)**

(ii)     Use your knowledge of leaf structure to explain why less water is lost through the upper surface of leaves than is lost through the lower surface.

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**(2)**

**(Total 10 marks)**

**Q16.**          The diagram shows a carrot.



A group of students investigated the effect of sucrose concentration on the length of cylinders cut from a carrot.

(a)     The students used a cork borer to cut cylinders from the carrot. Describe how the students should cut these cylinders to make sure that this was a fair test and would produce reliable results.

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**(2)**

(b)     They measured the initial length of each cylinder then placed the cylinders into test tubes containing different concentrations of sucrose solution. Bungs were placed in the tubes and the tubes were left overnight. Explain why the bungs were placed in the tubes.

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**(2)**

(c)     The students then measured the final lengths of the carrot cylinders. Their results are shown in the table.

|  |  |
| --- | --- |
| Concentration of sucrose / mol dm–3 |  |
| 0.0 | 1.4 |
| 0.2 | 1.4 |
| 0.4 | 1.2 |
| 0.6 | 1.1 |
| 0.8 | 0.9 |

(i)      The students used these results to find the concentration of sucrose that has the same water potential as the carrot cylinders. Describe how they could have done this.

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**(2)**

(ii)     Was it important in this investigation that the carrot cylinders had the same initial length? Explain your answer.

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**(1)**

**(Total 7 marks)**

**Q17.**          A student investigated the stages of mitosis in a garlic root. The root tip was placed on a microscope slide with a stain. A cover slip was placed on top and the root tip was firmly squashed.

(a)     Explain why

(i)      a root tip was used;

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**(1)**

(ii)     a stain was used;

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**(1)**

(iii)     the root tip was firmly squashed.

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**(1)**

(b)     The student examined the cells in the garlic root tip under the microscope, and obtained the following data.

|  |  |  |
| --- | --- | --- |
|   | **Stage** | **Number of cells** |
|   | Interphase | 872 |
|   | Prophase | 74 |
|   | Metaphase | 18 |
|   | Anaphase | 10 |
|   | Telophase | 8 |

(i)      Calculate the percentage of these cells in which the chromosomes are visible and would consist of a pair of chromatids joined together. Show your working.

Answer .........................................

**(2)**

(ii)     A different set of results was obtained when the count was repeated on another occasion with a different garlic root tip. Give **two** reasons for the difference in results.

1 ..........................................................................................................

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2 ..........................................................................................................

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**(2)**

**(Total 7 marks)**

**Q18.**          Mitochondria were isolated from the liver tissue using differential centrifugation. The tissue was chopped in cold, isotonic buffer solution. A buffer solution maintains a constant pH. The first stages in the procedure are shown in the diagram.

Tissue chopped               Homogenised                                      Centrifuged

 in cold isotonic                                                                          at low speed

  buffer solution                                                                        for 10 minutes



**Stage 1                          Stage 2                                              Stage 3**

(i)      The tissue was chopped in cold, isotonic buffer solution. Explain the reason for using

a *cold* solution;

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an *isotonic* solution;

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a *buffer* solution.

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**(3)**

(ii)      Why is the liver tissue homogenised?

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**(1)**

(iii)     Describe what should be done after **Stage 3** to obtain a sample containing only mitochondria.

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**(2)**

**(Total 6 marks)**

**Q19.**          Lactose is a disaccharide sugar which can be broken down by the enzyme lactase into two monosaccharides, glucose and galactose.

lactase

lactose+ water  glucose + galactose

(a)     The formula for galactose is C6H12O6. What is the formula for lactose?

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**(2)**

(b)     A solution containing the enzyme lactase was added to a lactose solution. The solution was incubated at 40 °C for one hour. Sample **A** was removed from the tube before incubation. Sample **B** was removed after one hour.

(i)      Describe a chemical test you could carry out on sample **A** to show that lactose is a reducing sugar.

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**(2)**

(ii)     This chemical test was carried out on samples **A** and **B**. All experimental variables were the same in the testing of the two samples. Both tubes were left for ten minutes to allow the precipitate to settle. The diagram shows the result.



Is galactose a reducing sugar? ....................

Explain how the results in the diagram support your answer.

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**(2)**

**(Total 6 marks)**

**Q20.**          (a)     In an investigation, two sterile agar plates were inoculated with bacteria from the same culture. Then, using a syringe, 2 cm3 of an antibiotic solution were added to plate **1** and 2 cm3 of sterile water were added to plate **2**. The diagram shows the plates after 24 hours.



(i)      At the start of the investigation, the agar was sterilised. Explain why.

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**(1)**

(ii)     The water was added to plate **2** as a control. Explain why this control was necessary.

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**(1)**

(b)     Explain why some bacteria were able to grow on plate **1**.

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**(1)**

**(Total 3 marks)**

**Q21.S**       Urease is an enzyme which hydrolyses urea to ammonia and carbon dioxide. The ammonia produces an alkaline solution.

In an experiment, a solution of urease was placed in tubing made from a partially permeable membrane. This tubing was put into a large test tube containing urea solution, as shown in the diagram. A control was set up with urease solution in the tubing and water outside.



After 5 minutes, samples were taken from inside and outside the tubing in each of the test tubes. The samples were tested with an indicator that is yellow below pH 8.0 and blue above pH 8.0. The results are shown in the table.

|  |  |  |
| --- | --- | --- |
| **Tube** | **Contents** | **Colour with indicator after 5 minutes** |
|   | **Inside tubing** | **Outside tubing** | **Inside tubing**  | **Outside tubing** |
| **A****B** | Urease solutionUrease solution | Urea solutionWater | BlueYellow | YellowYellow |

(a)     Explain the result for tube **A**.

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**(3)**

(b)     The solutions inside and outside the tubing in tube **B** were tested after 30 minutes for the presence of protein.

(i)      Describe how the presence of protein in a sample of a solution could be detected.

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**(2)**

(ii)     What results of the tests for protein would you expect for tube **B**? In each case explain your answer.

Inside the tubing

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Outside the tubing

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**(2)**

(c)     Describe how you would carry out an investigation to find the optimum temperature for the activity of urease.

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**(3)**

**(Total 10 marks)**

**M1.**(a)     ***EITHER***

*Answer either based on*

1.      Molecules move at slower speeds;

*2 diffusion or*

2.      Decreases rate of diffusion;

*4 enzymes.*

***OR***

3.      Molecules move at slower speed;

4.      Fewer collisions between enzymes and substrates / fewer enzyme-substrate complexes formed;

*Accept converse answers if clearly in context of “If it stayed at 30 C”.*

**2 max**

(b)     (i)      1.      Allows comparison;
2. Different amounts of fungus added / fungus is different size at start;

**2**

(ii)     Two marks for correct answer in range 1.7 : 1 to 1.3 : 1;;

*Answer must be expressed this way round and must give the diameter of the fungus as 1.*

One mark for unsimplified answer in range 29 : 19 to 27 : 21;

*Calculations are based on tolerance limits for measurements of ± 1 mm. If the actual measurements are other than 28 and 20, marking guidelines should be adjusted accordingly.*

**2**

(c)     1.      Colourless zone around fungus / colourless zone outside fungus;

2.      No fungus growing here / must be enzyme here;

*Accept any alternative wording clearly relating to colourless zone.*

**2**

**[8]**

**M2.**(a)     1.      To show the effect of the inhibitor / drug;

2.      To show the effect of yoghurt (on its own does not affect blood
glucose);

**2**

(b)     1.      Food is a factor affecting blood glucose / different foods contain
different amounts of starch / glucose / sugar / carbohydrate;

*Accept converse*

2.      To keep starch / fibre intake the same / similar;

*Accept something in food which affects the inhibitor*

**2**

(c)     1.      Fewer E-S complexes formed;

2.      (With inhibitor) less / no starch digested to maltose ;

*Require knowledge that maltose comes from starch*

3.      (So) less / no glucose from maltose;

*Require knowledge that glucose comes from maltose*

*Accept no glucose*

4.      (So) less absorption of glucose (from gut);

**2 max**

(d)     **Suitable reason; with explanation;**

Paired responses – do not mix and match

*Ignore references to correlation does not prove causation,
it could be due to other factors*

Examples,

1.      Need larger sample / only 30 mice / only 15 mice in each group;

*Accept small sample size*

2.      Might not be representative / anomalies might have a bigger or smaller effect;

*Accept mean not reliable*

***OR***

3.      Investigation only lasted 20 days;

*Experiment was not long enough*

4.      Can’t see what longer term effects are;

***OR***

5.      Fall in blood glucose is small / numbers from graph;

6.      Mice with inhibitor still have a large rise in blood glucose / so don’t know if differences significant;

*Accept differences are due to chance*

***OR***

7.      No stats / SDs / SEs;

8.      So don’t know if differences significant;

***OR***

9.       Blood glucose could continue to fall;

10.     which could be harmful;

***OR***

11.     No group without yoghurt;

12.     So cannot compare to other groups;

**2 max**

**[8]**

**M3.**          (a)     1.      Uses energy / ATP;

2.      Against concentration gradient / low to high concentration;

3.      Does not use channel proteins / only uses carrier proteins;

*Assume “it” refers to active transport.*

*1. Facilitated diffusion is passive - neutral*

*2. Along / across concentration gradient - neutral*

*Accept up / down concentration gradient*

*Accept AT does not need concentration gradient.*

**2 max**

(b)     (i)      To see the effect of the drug / effect not due to anything else in the tablet;

*Neutral “to compare results”*

**1**

(ii)     Placebo / dummy drug / tablet without drug;

(Otherwise) treated the same;

*No drug - neutral*

*Accept: Example e.g. tablet given at same time*

**2**

(c)     Decrease for 3 hours;

*Accept decreases from 1 - 4 hours*

**1**

**[6]**

**M4.**(a)     Calculations made (from raw data) / raw data would have recorded initial and final masses;

**1**

(b)     Add 4.5 cm3 of (1.0 mol dm–3) solution to 25.5 cm3 (distilled) water;

*If incorrect, allow 1 mark for solution to water in a proportion of 0.15:0.85*

**2**

(c)     1.      Water potential of solution is less than / more negative than that of potato tissue;

*Allow Ψ as equivalent to water potential*

2.      Tissue loses water by osmosis;

**2**

(d)     1.      Plot a graph with concentration on the *x*-axis and percentage change in mass on the *y*-axis;

2.      Find concentration where curve crosses the *x*-axis / where percentage change is zero;

3.      Use (another) resource to find water potential of sucrose concentration (where curve crosses *x*-axis);

**3**

**[8]**

**M5.**          (a)     1.      Add Benedict’s;

*Hydrolyse with acid negates mp1*

2.      Heat;

*Accept warm, but not an unqualified reference to water bath*

3.      Red / orange / yellow / green (shows reducing sugar present);

*Accept brown*

**3**

(b)     (i)      1.      Starch hydrolysed / broken down / glucose / maltose produced;

*Neutral: Sugar produced*

2.      Lower water potential;

3.      Water enters by osmosis;

**3**

(ii)     Only 2 pHs studied / more pHs need to be tested;

*Accept: different amylase may have a different optimum pH*

**1**

**[7]**

**M6.**(a)     (To diagnose AIDS, need to look for / at)

1.      (AIDS-related) symptoms;

2.      Number of helper T cells;

*Neutral: ‘only detects HIV antibodies’ as given in the question stem*

**2**

(b)     1.      HIV antibody is not present;

*Accept HIV antibodies will not bind (to antigen)*

2.      (So) second antibody / enzyme will not bind / is not present;

**2**

(c)     1.      Children receive (HIV) antibodies from their mothers / maternal antibodies;

2.      (So) solution will always turn blue / will always test positive (before 18 months);

*Allow 1 mark for the suggestion that the child does not produce antibodies yet so test may be negative*

**2**

(d)     (Shows that)

1.      Only the enzyme / nothing else is causing a colour change;

2.      Washing is effective / all unbound antibody is washed away;

**2**

**[8]**

**M7.**(a)     1.      Haemoglobin carries oxygen / has a high affinity for oxygen / oxyhaemoglobin;

2.      Loading / uptake / association in lungs;

3.      at high p.O2;

4.      Unloads / dissociates / releases to respiring cells / tissues;

5.      at low p.O2;

6.      Unloading linked to higher carbon dioxide (concentration);

*6. Ignore reference to incorrect pH in relation to effect of higher carbon dioxide concentrations for marking point*

**6**

(b)     1.      Allows comparison;

*Do not credit 'temperature affects results' on its own;*

2.      (Different temperature) affects enzymes;

*2. Allow reference to denaturation of enzymes.*

3.      (Different temperature) affects respiration / metabolism;

4.      (Different temperature) affects amount of dissolved oxygen;

**2 max**

(c)     1.      Increases then levels out / stops increasing / fluctuates slightly;

2.      At 5 (cm3 dm-3) / 320 (cm3 g-1h-1);

*Allow description of 'fluctuates slightly' in terms of candidate quoting figures after 320.*

**2**

(d)     1.      *Chronimus longistylus* has higher uptake at low (oxygen) concentrations;

*Chronimus longistylus has higher uptake to (oxygen concentration of) 2 / lower uptake after 2; (= 2 marks)*

2.      (Higher uptake) up to 2 cm3 dm-3;

*2. Award mark if candidate uses figures from table e.g. higher at concentration 1 (220) or concentration 2 (285).*

*Higher uptake at concentration 1 or 2 = 2 marks.*

**2**

(e)     (i)      More (than in African) lost via gills in Australian lungfish / less (than African) lost via lungs in Australian lungfish;

**1**

(ii)     1.      More / most exchange is via lungs (in African lungfish);

*1. Allow converse for first point.*

2.      Gills will not function / function less efficiently (in air);

*2. Allow water is required for gills to function.*

**2**

**[15]**

**M8.**(a)     (i)      1.      Sex;

2.      Lifestyle;

*Stress, smoking, diet etc are examples of lifestyle.*

3.      Body mass;

*3. Allow weight for mark point 3.*

4.      Health;

*Reject: height.*

5.      Ethnicity;

6.      Genetic factors / family history;

**2 max**

(ii)     1.      Large sample / number / 410 000;

*Reject: random*

2.      Long time period / 8.5 / many years;

3.      Different countries / more than one country;

**2**

(b)     Correct answer of 209 / 209.1 = 2 marks;

*Answer of 210 = one mark*

Incorrect answer but multiplies by 8.5 = 1 mark;

**2**

(c)     Age affects risk of cancer;

*Must relate to cancer not just to illness*

**1**

(d)     1.      Correlation does not mean causal relationship;

*1. Reject casual for point 1.*

*Reference to 'due to other factors' on its own is not enough for a mark*

2.      Tea / coffee contains other substances / different amounts of caffeine / estimated intake (of tea / coffee);

3.      No control group;

4.      Only one type of cancer studied / further studies required / only one investigation / study / group;

**4**

(e)     (i)      1.      Treated the same;

*2. Accept decaffeinated*

2.      No caffeine;

*2. Reject placebo.*

**2**

(ii)     1.      Absorb different amounts;

*Reject: Different body masses*

2.      Broken down by enzymes / digested;

3.      Different blood volumes;

4.      Differences in metabolism;

5.      Caffeine from a different source;

**1 max**

(iii)    1.      Less oxygen / glucose to (cancer) cells;

*'Reduces cell division' on its own should not be credited.*

2.      Less carcinogens;

3.      Reduces spread of cancer (cells);

**1 max**

**[15]**

**M9.**          (a)     Water will affect the mass / only want to measure water taken up or lost;

Amount of water on cylinders varies / ensures same amount of water on outside;

*Neutral: removes water*

*Accept: ‘(sodium chloride) solution’ for water*

*Do not accept ‘sodium chloride’*

*Neutral: refs. to fair testing*

**2**

(b)     4 cm3 (of 1.0 mol dm–3 sodium chloride solution) and 16 cm3 (of distilled water);

*Reject: factors and multiples of these figures e.g. 2 cm3 and 8 cm3, as final volume should be 20 cm3*

**1**

(c)     Allows comparison / shows proportional change;

Idea that cylinders have different starting masses / weights;

*Reject: if comparison is in context of the start and final mass of the same cylinder*

*Neutral: different masses*

*Neutral: different starting sizes*

**2**

(d)     (Allows) anomalies to be identified / ignored / effect of anomalies to be reduced / effect of variation in data to be minimised;

Makes the average / mean / line of best fit more reliable / allows concordant results;

*Accept: ‘outliers’ instead of anomalies*

***Q*** *Reject: abnormalities*

*Reject: idea of not recording anomalies / preventing anomalies from occurring*

*Accept: ‘cancels out anomalies’ as bottom line response*

***Q*** *Reject: makes the average / mean more accurate*

*Neutral: makes the average / mean more valid*

*Neutral: makes ‘it’ / results / conclusion more reliable*

**2**

(e)     0.35 (mol dm–3)

**1**

**[8]**

**M10.**(a)     Light (intensity) / temperature / air movement / humidity;

**1**

(b)     Prevent air entering / continuous water column;

*Allow answer in context of shoot, xylem or potometer.*

**1**

(c)     Distance and time;

*Reject ‘amount bubble moves’*

**1**

Radius / diameter / area (of capillary tube);

**1**

(d)     (used to provide) turgidity / support / description of;

(used in) photosynthesis / (produced in) respiration;

Apparatus not sealed / ’leaks’;

**2 max**

(e)     (i)      Returns bubble (to start);

**1**

(ii)     Increases reliability (of results) / anomalous result can be identified;

***Q*** *Ignore references to validity / precision / accuracy etc.*

**1**

**[8]**

**M11.**          (a)     To prevent contamination of apparatus with other microorganisms / bacteria;
To prevent personal contact with bacteria;
To prevent release of bacteria into air;

**max 2**

(b)     (i)      Diffuses slowly;

**1**

(ii)     B;
Produces inhibition zone greater than the minimum diameter;

**2**

**[5]**

**M12.**(a)     (i)      1.08;

*Must be to 3 significant figures, as in the table*

**1**

(ii)     Allows comparison / shows proportional change;

*Neutral: sizes / amounts*

         Idea that discs had different starting masses / weights;

*Neutral: different masses*

**2**

(iii)    (Allows)

*Accept: outliers instead of anomalies*

Anomalies to be identified / effect of anomalies to be reduced / effect of variation in data to be minimised;

*Reject: idea of not recording anomalies / preventing anomalies from occurring*

         A mean to be calculated;

*Neutral: average*

**2**

(b)     (i)      Plot (sodium chloride) concentration against ratio / draw line of best fit;

*Reject: if wrong axes or type of graph*

Find (sodium chloride concentration from the graph) where the ratio is 1 / there is no change in mass;

**2**

(ii)     Line / curve of best fit is more reliable / precise;

*Neutral: graph*

         Intercept / point where line crosses axis is more reliable / precise;

*Reject: references to ‘more accurate’*

         **OR**

         Can plot SD values / error bars;

(To show) variability about the mean / how spread out the results are;

**2**

**[9]**

**M13.**          (a)     (i)      11g sucrose dissolved in water (and made up to) 50 cm3 / 50g;

**1**

(ii)     make a series of volumes of 22% sucrose solutions;
measure how far each travels up the chromatography paper;

**2**

(b)     (i)      both (volume) of nectar and (mass) of sucrose / sugar increased by
regular removal;
(proportionately) greater effect on nectar than sucrose;

**2**

(ii)     nectar from flower B has greater concentration of sugar;

*(accept references to figures (A has 6.2 – 6.6 μg mm–3,
B has 12 – 12.4 μg mm–3))*

**1**

(iii)     nectar always available for insects;

**1**

(c)     (adding sucrose solution) decreases nectar secretion / less nectar
produced than control;

*(allow correct processed figures)*

**1**

adding sucrose solution results in reabsorption of sugar

*(gains 2 marks);;*

*(BUT adding sucrose solution reduces secretion
of sugar in nectar / sugar moved out gains 1 mark);*

**2**

(d)     via (intrinsic) proteins;

*(reject channel proteins)*

using ATP / active transport / energy;

**2**

**[12]**

**M14.**          (a)     sterilisation of equipment (*once*);
use of pipette / syringe to transfer culture suspension to plate;
use of spreader / shake ;
detail regarding lid, e.g. keeping over plate during transfer / spreading;

**3 max**

(b)     2.25 = 2 marks
(*general principle (1.52 ÷ 12) gains 1 mark*)

**2**

(c)     increased temperature increases rate;
increased concentration increases rate;
increased molecule size decreases rate;

*(allow increased distance decreases rate)*

**3 max**

**[8]**

**M15.**          (a)     1. water evaporates / transpires from leaves;
2. reduces water potential in cell / water potential / osmotic gradient across
    cells *(ignore reference to air space)*;
3. water is drawn out of xylem;
4. creates tension *(accept negative pressure, not reduced pressure)*;
5. cohesive forces between water molecules;
6. water pulled up as a column;

**4 max**

(b)     (i)      same surface area of leaf / number of leaves / age / thickness of
cuticle;

**1**

(ii)     (environmental conditions) affect rate of transpiration / evaporation;

**1**

(iii)     presence of grease reduces water loss;

**1**

(c)     (i)      1.2 / 1.3g;

**1**

(ii)     more stomata on the lower surface;
(thicker) waxy cuticle on the upper surface;

**2**

**[10]**

**M16.**          (a)     Lengthways / down the root;

Through one tissue only / through same part / same proportion of tissues;

**2**

(b)     To prevent the water from evaporating / prevent evaporation;

Changing the concentrations / water potential (of solution);

**2**

(c)     (i)      Plot data on a graph;

Find (sucrose concentration) from the graph where the ratio is 1;

**2**

(ii)     No, because the results are given as a ratio / as a proportion of initial length;

**1**

**[7]**

**M17.**          (a)     (i)      where mitosis / division / growing / occurs
*(reject growing cells)*

**1**

(ii)     to distinguish chromosomes / chromosomes not visible
without stain;

**1**

(iii)     to let light through / thin layer;

**1**

(b)     (i)      74 + 18 / 982;
= 9.4% / 9%;

**2**

*(allow 1 mark for identifying prophase & metaphase i.e.92 or correct method using wrong figures)*

(ii)     genetic differences / different types of garlic;
time of day;
chance;
age of root tip;
water availability;
temperature;
nutrient availability;

*(environmental factors = 1 but cannot be awarded in addition to a named environmental factor)*

**2 max**

**[7]**

**M18.**          (i)      cold - no / reduced enzyme action / e.g. stops autolysis;

*(reject “cell activity reduced”)*

isotonic - stops osmotic effects / description of effect on
cells or organelles;

buffer - prevents damage to enzymes / proteins;

**3**

(ii)      break open the cells / release the cell contents;

**1**

(iii)     supernatant / liquid above the pellet;
spun at a high(er) speed;

*(mark as independent points)*

**2**

**[6]**

**M19.**          (a)     C12 ; H22O11 ;

**2**

(b)     (i)      heat with Benedict’s;
yellow / brown / orange / red;

**2**

(ii)     (yes)

*(may appear on second line)*

more precipitate in sample **B**;
both sugars are reducing sugars / give a positive test;

**2**

**[6]**

**M20.**          (a)     (i)      to ensure that no unwanted bacteria will be present;

**1**

(ii)     to check that bacteria cells do not die anyway / to show
water / solvent has no effect on growth;

**1**

(b)     some bacteria are resistant / some areas of dish have no antibiotic /
antibiotic not spread evenly;

**1**

**[3]**

**M21.**          (a)     urea diffused into / entered the tubing and was hydrolysed / broken down (inside tubing);
ammonia increases pH / makes (solution) more alkaline and indicator turns blue as pH above 8 / due to alkalinity / due to ammonia;
idea that outside stays yellow because urease does not pass out;

**3**

(b)     (i)      add biuret solution / add sodium hydroxide + copper
sulphate (solution);

*(disqualify heat / boil, but accept warm)*

violet / lilac / purple colour;

**2**

(ii)     inside: protein present, as enzyme is protein;
outside: no protein, as urease / enzyme / protein unable to pass
through membrane / out;

*(accept correct result of biuret test as indicator of protein)*

**2**

(c)     method to maintain range of temperatures, e.g. water baths;
method to measure rate of activity - e.g. time taken to turn indicator blue;

*(principle - measure rate of activity over range of temperatures = 1 mark, if neither point)*

other conditions kept constant / named examples,
e.g. volumes of solutions,
starting pH, sample time;
method of refining optimum, e.g. repeats at narrower range;

**3 max**

**[10]**

**E1.**(a)     Students were provided with “kinetic energy” as a starting point for their answers to this question and therefore should not have expected credit merely for stating that it decreased. They were expected to go beyond this and link the decrease in kinetic energy to the slower speed of molecular movement and, if they approached the question from an enzyme standpoint, fewer collisions between enzymes and substrates. In general, there was a clear understanding of principles but responses often lacked the necessary detail to secure full credit.

(b)     (i)      While it was widely appreciated that the use of ratios allowed comparisons to be made, fewer students could explain why their use was important in the context of this investigation. The key feature was that it took into account differences in the initial amount of fungus, not just the amount of fungus.

(ii)     The majority of students used the model provided and expressed the results of their calculations appropriately.

(c)     It was again clear from the responses to this question that many of the less able students experienced difficulties with a question that required explanation. It was apparent to the moderating team that while most understood the relatively simple idea underpinning the question only the better students were able to explain this logically and unambiguously.

**E2.**The examiners noted that many students appeared not to have read the main stem of the question carefully.

(a)     Quite a large number wrote about amylase in yoghurt, rather than an inhibitor of amylase. About two thirds identified that **Group A** allowed the effect of the inhibitor to be seen. Very few noted that it also allowed the effect of yoghurt on its own to be seen. Quite a large number simply stated that the group ‘allowed for comparison’.

(b)     60% identified that different foods might affect glucose intake. Very few went on to identify that they could also contain different amounts of starch, the substrate of amylase. Quite a few simply wrote about ‘removing a variable’.

(c)     A third of students obtained both marks. These students displayed a clear understanding of the digestion of starch, including the enzymes involved, the products produced and the impact of the inhibitor. About 40% failed to score, with the commonest error being a statement that starch is ‘broken down’ directly into glucose.

(d)     The examiners had identified six different reasons why the results might not support the use of the inhibitor, based on the context of this question. Many students resorted to rote How Science Works answers about correlation not causing causation, or bias. Nearly half of students failed to score.

**E3.**          (a)     Most candidates were well prepared for this question and were able to differentiate between active transport and facilitated diffusion with many gaining both marks. Some candidates were unclear when referring to concentration gradient. Phrases such as ‘along the gradient’ or ‘across the gradient’ were not accepted. The specification terms ‘carrier protein’ and ‘channel protein’ were often not used.

(b)     (i)      The question asked why a control group was used „in this trial’. Candidates needed to apply their knowledge to an unfamiliar context and were required to do more than simply define the term. It was, therefore, not enough to say ‘to allow comparison’.

(ii)     This question was well answered with many candidates gaining both marks. A large number referred to a placebo tablet being used, although this term was not required. Some candidates failed to gain the first marking point as they stated that no drug would be given without appreciating that a tablet would still need to be administered. Most explained that both groups should be treated in the same way.

(c)     This question required the candidates to look carefully at the graph and describe it. Many incorrectly stated or implied that the volume of acid secreted per hour would decrease for 4 hours, failing to notice that the treatment started 1 hour after volumes were recorded. More able candidates realised that the acid secretion would decrease for 3 hours, or from 1 – 4 hours.

**E5.**          (a)     The Benedict’s test for reducing sugars was well known with most students gaining all three marks. The main problem here was that many students failed to heat the solution, either by not mentioning heating at all or simply saying ‘put it in a water bath’ without specifying a temperature - water baths can be at any set temperature. There was a significant number who confused the tests for reducing and non-reducing sugars and a small number who described other biochemical tests.

(b)     (i)       It was encouraging to see that the best students were able to apply their knowledge of several different parts of the unit and explain their answers well. These answers were often concise, explaining that more maltose would be produced, lowering the water potential so that water entered by osmosis.

There were many confused answers, however, and it was evident that some students were unsure as to whether pH 2 was acidic or alkaline. Most understood that amylase would hydrolyse the starch into maltose but then went on to write at length about the effect of pH on the rate of enzyme action.

(ii)     Most students gained this mark, realising that you need to look at a range of pH values to be able to conclude what the optimum pH is, but some obviously thought that optimum simply meant the best of those considered. There was a surprising number of students who inexplicably referred to the optimum temperature.

**E7.**(a)     This question produced a good spread of marks. Most students referred to haemoglobin combining with oxygen in red blood cells and appreciated that loading took place in the lungs. Some students then described the unloading of oxygen at respiring tissues and these students often linked this to the increase in carbon dioxide. Generally, only better students referred to high and low partial pressures of oxygen and gained maximum marks. A significant minority of responses ignored loading and unloading of oxygen and described the passage of oxygenated blood through the circulatory system.

(b)     Almost half the students failed to gain a mark as they often simply referred to it being a 'fair test' without an explanation. Most answers gaining credit mentioned enzymes and better students linked this to respiration to gain two marks. Answers relating to the temperature affecting the amount of dissolved oxygen were fairly infrequent as were references to enabling 'comparisons' between the larvae of both species.

(c)     Most students appreciated that the mean rate of oxygen uptake increased and then levelled out with an increase in oxygen concentration in the water. However, only better students specifically referred to where oxygen uptake levelled out. Students gaining zero marks often stated that there was a positive correlation between the variables.

(d)     Many students noted, for one mark, that Chironomus longistylus has a higher oxygen uptake at lower concentrations of oxygen. However, less than 25% of students used the data to support their observation and gain a second mark.

(e)     (i)       Almost 80% of students gained this mark, often by stating that more oxygen is lost via the gills in Australian lungfish than in African lungfish.

(ii)     Most students were aware that more exchange is via the lungs in African lungfish. However, far fewer students gained a second mark by mentioning that gills would not function in air.

**E8.**(a)     (i)      Over 80% of students had little difficulty obtaining both marks in this question. Students who obtained one mark often provided two examples of lifestyles or referred to age which was excluded in the stem of the question.

(ii)     This was also well answered with over 70% of students gaining both marks. Most students referred to the large sample size and that the study took place over a long period of time. Some weaker students incorrectly answered the question in terms of additional features which may have been desirable in this investigation.

(b)     Approximately half the students obtained both marks for this calculation. 20% of students obtained a single mark for their method of calculation or provided an answer of 210 rather than 209 / 209.1.

(c)     Most students made the link between age and the risk of getting cancer. Answers which linked age to caffeine consumption were not credited.

(d)     The majority of students obtained at least two marking points often for stating that a correlation does not mean a causal relationship and for mentioning that tea /coffee contains other substances. All the other marking points were seen by examiners but surprisingly few responses included a reference to the lack of a control group in this investigation.

(e)     (i)      The vast majority of students gained at least one mark by stating that the control group would be treated in exactly the same way as the experimental group. Over 50% of these students gained a second mark by mentioning that the control group should not have caffeine. Answers which were limited to using a placebo without mentioning lack of caffeine were not credited.

(ii)      Almost two thirds of students gained this mark often by referring to different rates of absorption, different sources of caffeine or to people having different blood volumes.

(iii)     Slightly less than half the students obtained this mark usually by referring to a lack of oxygen supplied to the cancer cells or to the spread of cancer cells being reduced.

**E9.**          (a)     60% of candidates gained one mark for the idea that water on the outside of the cylinders would affect the mass, or that only the water taken up or lost should be measured. Only the very best candidates were aware that the amount of water on the cylinders would vary. A common response by weaker candidates was that water on the outside of the cylinders would allow further osmosis before reweighing. This was not credited. Vague responses that referred to greater reliability or accuracy were common.

(b)     One third of candidates gave the correct volumes of 4cm3 and 16cm3.

(c)     It was encouraging to note that candidates did better on this question than they did on a comparable question in January 2010. One third of candidates gained full credit. Many were aware that expressing a change as a percentage allows a comparison to be made. However, it was usually only better candidates who wrote that the cylinders would have different starting masses. The stem of the question made it clear that both the starting and final masses of the cylinders were recorded. It therefore had to be clear to which of these the candidates was referring. Weaker candidates often referred to ‘different sizes’ or ‘different masses’. These responses were not credited.

(d)     Two thirds of candidates gained one mark for the idea that anomalies could be identified. However, some thought that repeats prevented anomalies from occurring or being recorded. It was only the very able candidates who wrote that repeats allow a more reliable mean to be calculated. Taking additional readings does not necessarily allow results to be closer to the true value. Hence, references to ‘a more accurate mean’ were not credited. Weaker candidates often referred to ‘the results’ being more reliable or more accurate without qualifying their answers.

(e)     70% of candidates correctly read off the intercept on the *x*-axis at 0.35 mol dm–3.

**E10.**(a)     The vast majority of candidates was able to give one correct environmental factor that the student should have kept constant during the investigation.

(b)     Answers to this question were generally disappointing with only a third of candidates appreciating that it was important to prevent air entering the shoot, xylem or potometer.

(c)     Approximately half the candidates obtained a mark for indicating that distance and time have to be measured. Very few candidates obtained a second mark by indicating that the radius, diameter or area of the capillary tube had to be measured.

(d)     Surprisingly, this proved the most difficult question on the paper. Seventy five percent of candidates scored zero with many candidates simply stating that not all the water is used in transpiration. Candidates obtaining one mark often referred to water being used in photosynthesis. Very few candidates obtained a second mark by indicating that water is used to provide support or that it may evaporate or ‘leak’ from the apparatus.

(e)     (i)      Most candidates simply suggested that the reservoir would allow water to be added. Fewer candidates gained the mark by linking this to moving the position of the bubble.

(ii)     Most candidates gained this mark by indicating that repeat measurements would enable the reliability of the results to be assessed.

**E11.**          In part (a), there were large numbers of answers which lacked specificity, such as preventing the bacteria escaping. There were the inevitable references to ‘fair tests’ and suggestions that bacteria entering the dish might somehow negate the effect of the antibiotics. In (b)(i), many poor answers were seen. Few commented on slow diffusion. Many simply stated that an antibiotic with a small clear zone could still be effective. In part (ii), most candidates identified **B** and gave a suitable answer. A few candidates chose **A** because it had the biggest clear zone, and some even gave a named antibiotic such as streptomycin or chloramphenicol.

**E12.**(a)     (i)      Almost three quarters of candidates gave the correct answer of 1.08. However, some answers showed an excessive number of decimal places. Similarly, some candidates subtracted the final mass from the starting mass to give an answer of 1.8.

(ii)     Most candidates were aware that a ratio enabled a comparison to be made between different sets of data. Unfortunately, some gave this in the wrong context by referring to a comparison of the start and final mass of the same disc. Similarly, it was usually only the better candidates who wrote that the discs had different starting masses. Some candidates narrowly missed out on this mark through a lack of detail e.g. ‘different sizes’ and ‘different masses’. The table showed the start and final masses of each disc. It therefore had to be clear which of these was being referred to. As was the case last year, weaker candidates had difficulty in understanding the concept of a ratio. Their answers usually made reference to a ratio allowing ‘a better graph to be plotted’ or ‘it being easier to draw conclusions’.

(iii)     Many candidates gained one mark for the idea that anomalies could be identified. However, some mistakenly thought that additional readings prevented anomalies from occurring or being recorded. These were not credited. Relatively few candidates mentioned that a mean could be calculated. There was also widespread failure by weaker candidates to read the stem of the question. This usually resulted in descriptions of methods that could be used to take additional readings.

(b)     (i)      This question was asked in the first paper of the series and it is encouraging to note that candidates did much better this time. Most candidates scored one mark for describing the correct graph to be plotted. There were, however, some suggestions to plot sodium chloride concentration against water potential. The second mark proved to be a good discriminator. It was usually only the better candidates who appreciated the concept of using a ratio of 1. Some candidates clearly remembered doing this practical but were let down by a lack of detail e.g. ‘read off where line crosses x-axis’, with no mention of a ratio. Once again, the concept of a ratio was too much for weaker candidates. Similarly, a minority of candidates were aware that there would be no change in mass but then disqualified this mark by using a ratio of 0.

(ii)     Only the most able candidates scored one mark on this question. This was either for mentioning a more reliable line of best fit or that error bars could be plotted. However, there was widespread failure by most candidates to distinguish between the terms ‘accurate’ and ‘reliable’. Taking additional readings does not necessarily allow results to be closer to the true value. Hence, references to ‘accuracy’ were not credited. The term ‘precise’ was rarely used. However, credit was given if this term was used in the correct context as highly precise and highly reliable results both have very little spread about the mean value.

**E13.**          Whilst a full range of marks was seen on this question, few candidates gained twelve marks and zero was rarely seen. Even the best candidates seemed to find it hard to score more than eight or nine marks. These candidates usually did well on parts (b) and (c), (data interpretation), but lost marks in part (a), (practical techniques).

(a)     Not many correct answers were seen in part (i). The most common answer was ‘dissolve 11cm3 of sucrose in 39cm3 of water’. In general, there was a disappointing failure to use mass rather than volume in this context. There were a reasonable number of correct responses in part (ii). The most common errors involved references to colorimetry or chromatography. Often, candidates referred to different concentrations of sucrose rather than different volumes.

(b)     In part (i), the majority of candidates obtained one mark for references to increased nectar and sucrose production, but only a small minority referred to the greater effect on nectar secretion. Only a minority of candidates provided the correct answer in part (ii), the majority opting for a lower concentration of sucrose in B. A majority of students correctly suggested that increased nectar production might lead to more frequent visits by pollinators in (iii).

(c)     Most candidates obtained two marks, for references to less nectar and a lower mass of sucrose. Quite a large number obtained the third mark, for reference to reabsorption. This question discriminated very well.

(d)     Most candidates obtained one mark with references to active transport, or the use of ATP. Only a minority made reference to protein being involved, and some of these failed to gain the second mark, because of references to ‘channel’ proteins.

**E14.**          (a)     A majority of candidates failed to refer to ‘…when flooding the agar plate with bacteria’ required by the question. Thus, the examiner was given long accounts of mopping benches with disinfectant, autoclaving of dishes and safe disposal of dishes. Reference to use of a spreader was comparatively rare.

(b)     Many candidates achieved the correct answer, but few realised that ‘π‘ cancelled out and went on to do unnecessarily long calculations.

(c)     Many candidates realised that factors such as concentration, temperature and molecule size would affect the rate, but failed to state how the rate would be affected by these. Weaker candidates gave explanations in terms of bacteria, or of the strength of the antiseptic.

**E15.**          (a)     There were some very good answers achieving maximum marks. However, many answers used very vague language, such as ‘water is pulled up by cohesion-tension’, with no description of what cohesion involves, or what creates the tension. Water was said by many to be ‘sticky’. This was the lowest level of answer accepted for a mark about cohesion. Root pressure was often included in the description of cohesion-tension, which cost candidates time but gained no credit.

(b)     (i)      Many candidates appear to confuse the concept of fair testing with reliability; both terms being used interchangeably.

(ii)     More able candidates answered in terms of how an environmental variable could affect the rate of transpiration, or the rate of evaporation, rather than just stating ‘to keep water loss the same’.

(iii)     Most candidates gave the correct answer.

(c)     (i)      Most candidates calculated the mass of water lost accurately.

(ii)     Many candidates missed marks by failing to give a comparison between the upper and lower surfaces of leaves. There were many references to ‘pores’ rather than ‘stomata’, or a ‘waxy layer’ rather than a ‘cuticle’, indicating a poor knowledge of leaf structure.

**E16.**          This unit requires practical work to be undertaken that includes the effect of solute concentration of water uptake by plant tissue. In this question, therefore, candidates were required to demonstrate their understanding of such prescribed practical techniques. It was evident from the responses to this question that although many candidates had some experience of related practical investigations, they had little understanding of the procedures involved. Many otherwise sound candidates gained very little credit on this question.

(a)     The diagram clearly showed two different tissues, but only the best candidates based their answers on this information and described cutting the cylinders in such a way as to ensure that they consisted of the same tissue. Many of the answers did little more than reiterate what have become standard responses in past practical assessments without attempting to apply general principles to a novel situation. In this particular case, references to the same cork borer or the same length were irrelevant. There were also a number of vague references to ensuring that this would be a fair test. Candidates would be well advised not to use this term without appropriate amplification.

(b)     It was immediately apparent from marking this question that many of the less able candidates had undertaken practical investigations without any understanding of what they were trying to do. Thus there were numerous responses that indicated confusion with investigations of enzyme activity or respiration. Where candidates did appreciate that the essential purpose of the bungs was to minimise evaporation, it was uncommon for them to refer to the evaporation of water evaporating resulting in a change in the concentration of the sucrose solution.

(c)     Candidates who read this question with sufficient care should have noted that it referred to the results provided in the table. Accounts, therefore based on repeating the investigation with other sucrose solutions were inappropriate and did not gain credit. The investigations carried out for assessment of practical skills at AS all require candidates to plot their data as appropriate graphs, and it was hoped that candidates would have applied a similar approach here. Relatively few did, and of these, even fewer appreciated that they should identify the concentration of sucrose in which the ratio of final length to initial length was 1. Few candidates displayed an understanding of the concept of a ratio in part (ii).

**E17.**          **Unit 2**

          (a)     (i)      Many identified the root tip as the region or area where mitosis was taking place.

(ii)     Too many did not know the reason for using a stain and often thought it was to stain the organelles, the nucleus or the cell. Only the better candidates identified its role as staining the chromosomes.

(iii)     Many had the correct idea of producing a single layer of cells so that light could pass through.

(b)     (i)      Only the best candidates gave the correct answer here, as few recognised that only during prophase and metaphase would chromosomes be visible as chromatids.

(ii)     Most candidates found this question very difficult and often just repeated the stem, stating that a different root tip had been used. Only the better candidates gave some idea that the garlic may have been growing in different conditions or that it might be genetically different.

          **Unit 3**

(a)     Most candidates were able to explain that the tip was the site of root growth and cell division but fewer knew that a stain was required to distinguish the DNA or chromosomes rather than cells, nuclei or organelles. In part (iii), while many correctly described the cells being separated or formed into a single layer to allow light through, some thought it necessary to remove air bubbles or to break open cells to release the contents.

(b)     Credit was given for correct recognition of the two stages involved; many candidates were unsure of these or were unable to complete the calculation. In the second part, only the very best candidates could supply suitable ideas about genetic variation, differing environmental factors or the role of chance. Many others suggested the differences would be due to the size of the tip, the area of the slide or the stage in mitosis at which the slide was made. Some blamed the observer for miscounting or the poor quality of the microscope.

**E18.**          Many candidates knew why the tissue was chopped in a cold tissue, although some gave general statements that it slowed cell activity, without qualification. Many candidates also knew that an isotonic solution was needed to reduce the osmotic effects, although this was sometimes worded in a rather vague way. Fewer candidates gained the mark for explaining the use of a buffer, with some answers just referring to ‘maintaining pH’, which was given in the question.

Many candidates correctly referred to centrifuging at a higher speed, but did not mention that it was the supernatant that was centrifuged.

**E19.**          (a)     Most candidates gained the idea of C12, but not the condensation of the two sugars involving the loss of the water molecule, C12H24O12 was therefore a common answer.

(b)     The Benedict’s test was well rehearsed, although heating was sometimes either omitted or just implied by use of a waterbath. Weaker candidates included the use of a hydrolysing agent as an initial stage in the test. The results of A and B were described by the better candidates in terms of amount of visible precipitate, but very few then attempted to explain the result.

**E20.**          (a)     In part (i) there were many imprecise answers referring to the prevention of contamination without explaining that there might be bacteria present in the agar. A few candidates thought that sterilisation would get rid of unwanted substances rather than microorganisms. Part (ii) also produced many vague answers. It was common to read “so that you can compare them” and the inevitable references to “fair tests”. However, the better candidates were well aware of the need to show that the bacteria grew well without the antibiotic present.

(b)     There were many references to the bacteria becoming immune, rather than resistant. Some thought that the bacteria had grown before the antibiotic was applied, or that the antibiotic was “not strong enough”.

**E21.**          (a)     Most candidates performed creditably on this question and many gained full or almost full marks. In general, candidates did appear to have absorbed the information provided before embarking on answering and the better candidates showed very good appreciation of experimental procedures, often giving more detailed explanations than was required by the mark scheme.

A majority gained full marks on this part. Most realised that the urea had diffused into the tubing, although a significant number suggested the urea entered by osmosis. The blue colour of the indicator inside the tubing was then usually correctly linked to the formation of an alkaline solution as a result of the production of ammonia. A number suggested that the carbon dioxide also contributed to the alkalinity. Some weaker candidates apparently thought that the solutions would be acid above pH 8.0, and therefore suggested that the urease had diffused out. Some attributed the yellow colour outside the tubing to carbon dioxide passing out, but it was pleasing to note that some of the better candidates added the explanation that the indicator stayed yellow outside because the timescale was too short for enough ammonia to pass out and raise the pH above 8.

(b)     (i)      Although a majority was familiar with the test for proteins, it was surprising that so many candidates suggested using Benedict’s or iodine solutions. Some of those who did opt for the biuret test wrongly suggested boiling the mixture.

(ii)     Most recognised that enzymes are proteins and that therefore the urease solution inside tubing would give a positive result with the protein test. Better candidates explained that there would be no protein outside the tubing as the urease would not diffuse through the membrane, but weaker candidates often merely said that water is not or does not contain protein.

(c)     There were many good answers to this question, but there were also many candidates who demonstrated very limited ability to plan a simple investigation. The examiners awarded one mark for a method of maintaining a suitable range of temperatures, such as using water baths, and one for a method of measuring the activity of the urease in order to determine the optimum temperature. Based on the information provided, the most obvious way of comparing activity at different temperatures seemed to be to measure the time taken for the indicator to turn blue, but relatively few chose this method. Many elected to use a colorimeter or standard solutions with some other indicator, or to collect the carbon dioxide. Any appropriate method was accepted. One mark was awarded for the basic principle of comparing the activity over a range of temperatures where a candidate failed to give any detail. The third mark was awarded for the idea of keeping other variables constant, or for refining the accuracy by narrowing the range of temperatures around the apparent optimum, although the latter point was rarely seen. Although not penalised, surprisingly large numbers used the same arrangement of tubing as in the original experiment, rather than just mixing urea and urease solutions. Weaker candidates often tried to use the biuret test as a method of measuring activity.

Resource currently unavailable.