Cambridge International **A Level**

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8537370050

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2015**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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Write in dark blue or black pen.
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Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1 The information on the label of a bottle of one brand of cleaning solution for contact lenses states that it contains enzymes which remove protein from contact lenses.

The instructions for using the solution state that:

- The cleaning solution should be poured into the cleaning pot provided up to the marked level.
- The contact lenses should be left in the cleaning solution for a minimum of four hours.
- Before using the lenses, they should be washed in a sterile saline (sodium chloride) solution.

The contents of the solution are:

1. Subtilisin A, a protease with an optimum temperature of 60 °C and an optimum pH of 7.0–7.5.
2. Buffered saline, a physiological solution with the same 'balance of ions' as body fluids.
3. Disodium EDTA, a preservative.

A student was asked to find out the actual concentration of the protease present in the contact lens cleaning solution.

The student found a web site that gave the concentration of subtilisin A in different brands of contact lens cleaning solutions. These range between 20 $\mu g\,cm^{-3}$ and 100 $\mu g\,cm^{-3}$.

The student simulated a dirty contact lens using the protein gelatin and a thin transparent plastic sheet. One side of the plastic sheet was dipped into melted gelatin containing a dye. The gelatin was then allowed to set.

Fig. 1.1 shows a simulated contact lens.

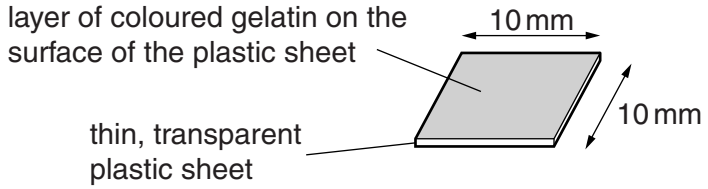


Fig. 1.1

The student tested the activity of subtilisin A by recording the time taken for the coloured gelatin to be removed, leaving the transparent plastic sheet.

Fig. 1.2 shows the apparatus the student used.

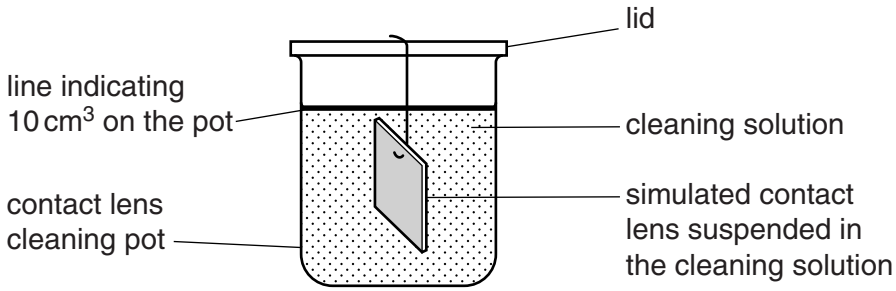


Fig. 1.2

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Table 1.1 shows the results of trials to find the time taken for the coloured gelatin to be removed by the cleaning solution at 35 °C.

Table 1.1

trial	1	2	3
time / minutes	35	50	40

(a) The student noticed that there was a large variation in the results. This may be because it was difficult to know when to stop the stopwatch.

Suggest two problems in deciding when to stop the stopwatch in this investigation.

1. .....

.....

2. .....

.....[2]

(b) The student made a stock cleaning solution containing 1 mg cm^{-3} of subtilisin A, disodium EDTA and a buffered saline solution. The disodium EDTA and the buffered saline solution were the same concentrations as used in the trials.

This solution was used to make a range of concentrations that could be used to find the concentration of subtilisin A in the contact lens cleaning solution.

(i) Describe how the student could dilute the stock solution to make a range of concentrations to use in their investigation. The student decided to make 50 cm^3 of each concentration.

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.....[3]

(ii) State a solution the student should use as a control. Give a reason for your answer.

control solution .....

reason .....

.....[2]

(c) The student used the apparatus shown in Fig. 1.2 to investigate the effect of different concentrations of subtilisin A on the rate of removal of coloured gelatin from the simulated lenses at 35 °C.

(i) Identify the independent and dependent variables in this investigation.

independent variable .....

dependent variable .....[2]

(ii) Describe a method the student could use to find the effect of different concentrations of subtilisin A on the removal of protein from the simulated lenses.

Your method should be detailed enough for another person to follow and should not repeat any details from **(b) (i)** of how to dilute the stock cleaning solution.

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(d) The student plotted a graph of the results.

(i) Complete Fig. 1.3 by adding labels for the axes, including units, and by showing the expected shape of the curve. [3]



Fig. 1.3

(ii) Describe how the student would use this graph to find the actual concentration of subtilisin A in the contact lens cleaning solution.

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.....[1]

[Total: 19]

2 Alcohol is a small molecule that is able to pass from maternal blood into the blood of a fetus during pregnancy. Alcohol is thought to interfere with the development of the fetal nervous system. One possible effect of alcohol on the fetus is to change the speed of nerve conduction.

An investigation was carried out into the effect of pre-natal (before birth) alcohol exposure on the speed of nerve conduction in babies after birth. The babies were born to mothers aged 23 – 25 years old.

The speed of nerve conduction is measured by attaching surface electrodes to the skin. One electrode stimulates the skin and the other electrode records the presence of an action potential as it passes through a neurone. A meter records the time taken for the action potential to travel between the electrodes.

Fig. 2.1 shows a diagram of the apparatus.

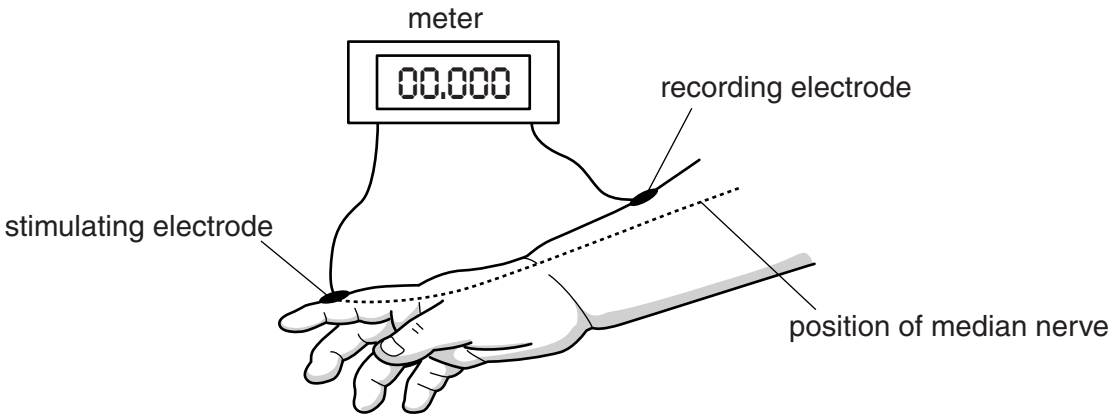


Fig. 2.1

The test shown in Fig. 2.1 was carried out on the median nerve. This nerve is found in the arm. Its sensory neurones supply the skin receptors in the hand and its motor neurones supply the muscles that move the arm and hand.

Two groups were tested.

- **Group 1** consisted of seventeen babies, seven male and ten female, who had been exposed to alcohol during pregnancy. The mothers of these babies all drank more than 32 mg of alcohol per day.

- **Group 2** consisted of thirteen babies, six male and seven female, who had not been exposed to alcohol during pregnancy. The mothers of these babies did not drink any alcohol.

Each group was tested:
- 20 days after birth
- 400 days after birth.

(a) Identify the **independent** variable in this investigation.

.....[1]

Table 2.1 shows the results of this investigation.

Table 2.1

type of neurones in the median nerve	mean speed of nerve conduction / $m\,s^{-1} \pm s$			
	20 days		400 days	
	group 1 pre-natal alcohol exposure	**group 2** no pre-natal alcohol exposure	**group 1** pre-natal alcohol exposure	**group 2** no pre-natal alcohol exposure
sensory neurones	31.14 ± 1.67	26.06 ± 2.10	44.51 ± 2.37	51.66 ± 1.77
motor neurones	27.54 ± 1.02	31.14 ± 3.12	46.51 ± 3.73	49.80 ± 0.38

s = standard deviation

(b) (i) What conclusions can be made about the effects of pre-natal alcohol exposure compared to no pre-natal alcohol exposure on the conduction velocity in the median nerve in the sensory neurones and in the motor neurones.

sensory neurones .....

.....

.....

motor neurones .....

.....

.....[2]

(ii) State **one** other conclusion about conduction velocity in the median nerve that can be made from these results.

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.....[1]

(c) Identify which of the results in Table 2.1 is the most reliable. Give a reason for your answer.

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.....[2]

(d) (i) State why the results for the sensory conduction velocity of the median nerve of **group 1** and **group 2** at 20 days and 400 days may be significant.

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.....[1]

(ii) There is a difference between the mean conduction speed in sensory neurones in the two groups of babies.

State **one** reason why the *t*-test is suitable to determine if this difference is significant.

.....

.....[1]

(iii) State a null hypothesis for this test.

.....

.....[1]

(e) Suggest two reasons why the results of this investigation may not be valid for **all babies** born to mothers who drank alcohol while they were pregnant.

1. .....

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2. .....

.....[2]

[Total: 11]

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Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3255944211

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2015**

1 hour 15 minutes

Candidates answer on the Question Paper.

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[Turn over

1 Many fungi are decomposer organisms which carry out extracellular digestion. To do this they secrete a number of enzymes.

A group of students made a solution of enzyme extract from a fungus. The extract contained the enzyme amylase. They wanted to find out the concentration of amylase in the extract.

They were provided with:

- $0.5\,g\,dm^{-3}$ stock solution of amylase
- starch agar plates with wells into which enzyme solutions can be placed. Starch agar plates are Petri dishes containing agar mixed with starch.

Fig. 1.1 shows how the students used the plates to find the concentration of amylase.

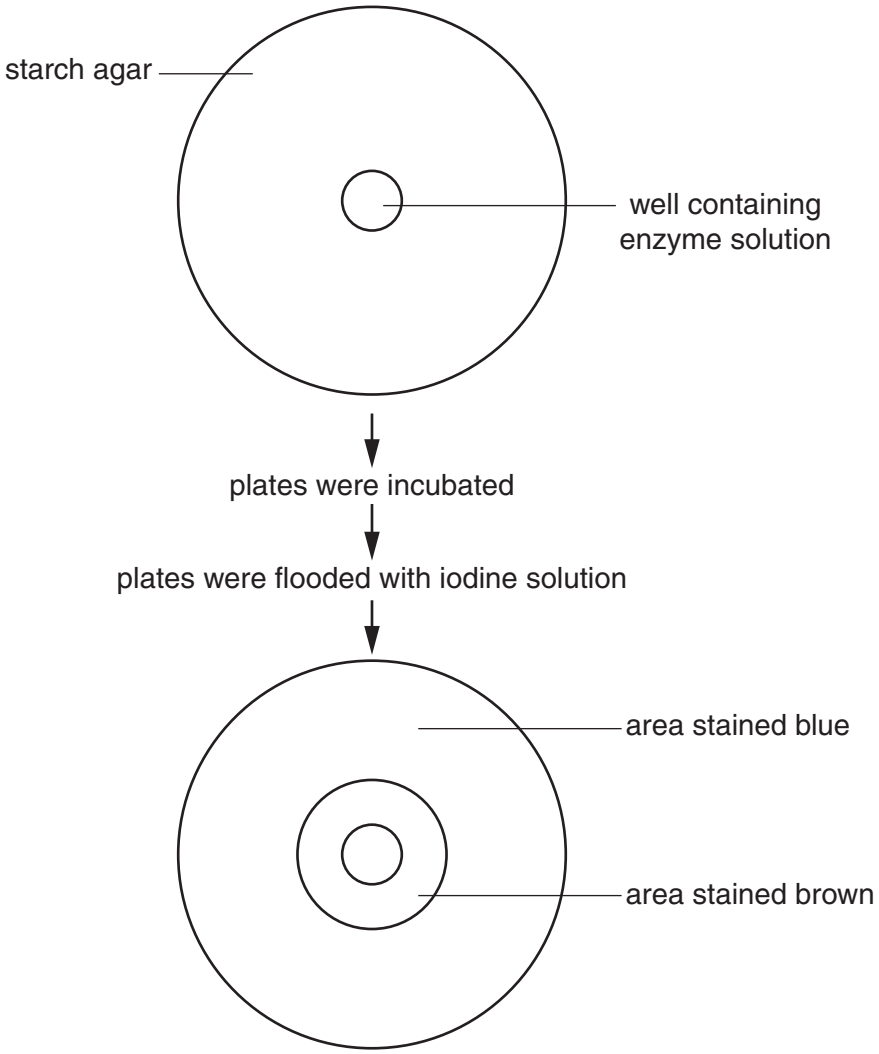


Fig. 1.1

The students thought that the area stained brown was proportional to the amylase concentration.

(a) Identify the independent and dependent variables in this investigation.

independent variable .....

dependent variable ..... [2]

(b) Describe how the students could use the method outlined in Fig. 1.1 to find out the concentration of the enzyme amylase in their extract.
Your method should be detailed enough for another person to follow.

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(c) There are different types of amylase enzyme. They hydrolyse starch in different ways. Two of these enzymes are:

- β-amylase hydrolyses every second α-1,4 glycosidic bond in starch molecules
- γ-amylase hydrolyses all α-1,6 glycosidic bonds and all α-1,4 glycosidic bonds in starch molecules.

In a second investigation, the students were provided with two beakers, **A** and **B**. One contained β-amylase and the other contained γ-amylase. They used these solutions to hydrolyse 25 cm^3 samples of 0.5 g dm^{-3} starch solution.

Suggest **and** explain how the students could identify which beaker contained β-amylase and which contained γ-amylase.

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(d) Humans produce the enzyme α-amylase in their salivary glands. There may be many copies of the gene coding for α-amylase on chromosome 1. The concentration of the α-amylase in the saliva is positively correlated with the number of copies of this gene.

In a third investigation, the students obtained saliva from six people, **A** to **F**. Equal volumes of saliva were added to wells in agar plates similar to those shown in Fig. 1.1.
The plates were incubated for the same length of time and the area of the brown zone for each sample of saliva was calculated.

Table 1.1 shows results of this investigation.

Table 1.1

enzyme extract	area of brown zone / mm^2					
	plate 1	plate 2	plate 3	plate 4	plate 5	plate 6
A	3632	3848	3632	3632	3632	3848
B	2827	2827	2642	2463	1963	2827
C	2124	1963	1963	2124	1963	2124
D	1385	1257	1809	1257	1257	1385
E	656	707	707	656	707	656
F	298	298	314	314	298	298

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(i) Identify **two** results in Table 1.1 that may be anomalous. Show your answers by circling the two values. [2]

(ii) State how the students should deal with these anomalies.

.....[1]

(iii) The students decided to calculate the standard deviations of their results using the formula:

$$s = \sqrt{\frac{\Sigma(x - \overline{x})^2}{n - 1}}$$

Key to Symbols

s = standard deviation x = a result $\overline{x}$ = mean Σ = sum of n = sample size

Use Table 1.2 and the formula above to calculate the standard deviation for the results for person **F**.

Table 1.2

plate	x	$x - \overline{x}$	$(x - \overline{x})^2$
1	298		
2	298		
3	314		
4	314		
5	298		
6	298		
Σ			
$\overline{x}$			

answer ..... [2]

(iv) Suggest an explanation for the results shown in Table 1.1.

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..... [3]

[Total: 20]

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[Turn over

2 The speed at which an electrical impulse travels along a nerve can be determined by carrying out a nerve conduction velocity (NCV) test.

Surface electrodes are placed on the skin over nerves at various locations. They produce a very mild electrical charge, which stimulates the nerve.

The resulting electrical activity in the nerve is measured by a recording electrode. The distance between the electrodes and the time it takes for electrical impulses to travel between them are used to determine the nerve conduction velocity.

Fig. 2.1 shows how the NCV is measured in the ulnar nerve of the human forearm.

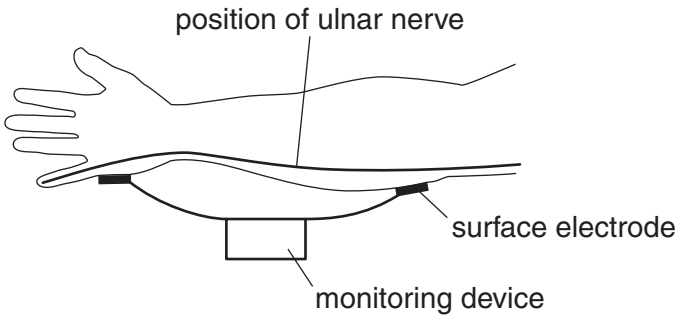


Fig. 2.1

An investigation to measure the NCV in the ulnar nerve in females of different ages was carried out on 394 individuals.

(a) Suggest **three** variables which the investigators should have standardised.

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Table 2.1 shows the results of this investigation.

Table 2.1

age category/years	mean conduction velocity ± S_M	confidence limits	
		lower limit	upper limit
30–39	54.3 ± 1.200	51.90	56.70
40–49	54.7 ± 0.645	53.41	55.99
50–59	52.4 ± 0.600	51.20	53.60
60–69	52.2 ± 0.675		
70–79	49.0 ± 1.075	46.85	51.15

S_M = standard error

(b) The confidence limit = mean ± 2 S_M.

Use this formula to calculate the missing confidence limits. Use the space below for any working and enter your answers in Table 2.1.

[1]

One conclusion from these data is that mean conduction velocity in the ulnar nerve varies significantly with age.

(c) (i) Identify **two** age categories which appear to support this conclusion and give a reason for your choice.

age categories ..... *and* .....

reason .....

.....

..... [2]

(ii) State which statistical test could have been used to confirm this conclusion and give a reason for your choice.

test .....

reason .....

..... [2]

(iii) State a null hypothesis for this test.

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..... [1]

(d) State **one** reason why the results of the investigation were considered to be reliable.

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..... [1]

[Total: 10]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4457745297

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2015**

1 hour 15 minutes

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1 The information on the label of a bottle of one brand of cleaning solution for contact lenses states that it contains enzymes which remove protein from contact lenses.

The instructions for using the solution state that:

- The cleaning solution should be poured into the cleaning pot provided up to the marked level.
- The contact lenses should be left in the cleaning solution for a minimum of four hours.
- Before using the lenses, they should be washed in a sterile saline (sodium chloride) solution.

The contents of the solution are:

1. Subtilisin A, a protease with an optimum temperature of 60 °C and an optimum pH of 7.0–7.5.
2. Buffered saline, a physiological solution with the same 'balance of ions' as body fluids.
3. Disodium EDTA, a preservative.

A student was asked to find out the actual concentration of the protease present in the contact lens cleaning solution.

The student found a web site that gave the concentration of subtilisin A in different brands of contact lens cleaning solutions. These range between 20 $\mu g\,cm^{-3}$ and 100 $\mu g\,cm^{-3}$.

The student simulated a dirty contact lens using the protein gelatin and a thin transparent plastic sheet. One side of the plastic sheet was dipped into melted gelatin containing a dye. The gelatin was then allowed to set.

Fig. 1.1 shows a simulated contact lens.

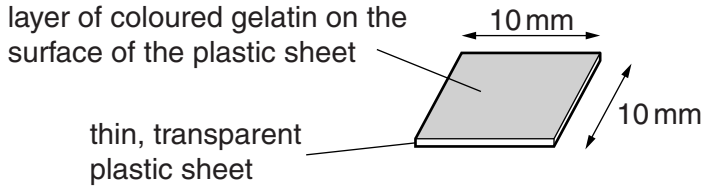


Fig. 1.1

The student tested the activity of subtilisin A by recording the time taken for the coloured gelatin to be removed, leaving the transparent plastic sheet.

Fig. 1.2 shows the apparatus the student used.

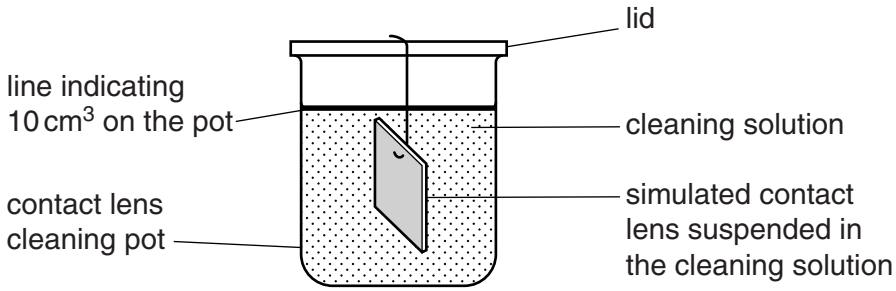


Fig. 1.2

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Table 1.1 shows the results of trials to find the time taken for the coloured gelatin to be removed by the cleaning solution at 35 °C.

Table 1.1

trial	1	2	3
time / minutes	35	50	40

(a) The student noticed that there was a large variation in the results. This may be because it was difficult to know when to stop the stopwatch.

Suggest two problems in deciding when to stop the stopwatch in this investigation.

1. .....

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2. .....

.....[2]

(b) The student made a stock cleaning solution containing 1 mg cm^{-3} of subtilisin A, disodium EDTA and a buffered saline solution. The disodium EDTA and the buffered saline solution were the same concentrations as used in the trials.

This solution was used to make a range of concentrations that could be used to find the concentration of subtilisin A in the contact lens cleaning solution.

(i) Describe how the student could dilute the stock solution to make a range of concentrations to use in their investigation. The student decided to make 50 cm^3 of each concentration.

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.....[3]

(ii) State a solution the student should use as a control. Give a reason for your answer.

control solution .....

reason .....

.....[2]

(c) The student used the apparatus shown in Fig. 1.2 to investigate the effect of different concentrations of subtilisin A on the rate of removal of coloured gelatin from the simulated lenses at 35 °C.

(i) Identify the independent and dependent variables in this investigation.

independent variable .....

dependent variable .....[2]

(ii) Describe a method the student could use to find the effect of different concentrations of subtilisin A on the removal of protein from the simulated lenses.

Your method should be detailed enough for another person to follow and should not repeat any details from **(b) (i)** of how to dilute the stock cleaning solution.

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.....[6]

(d) The student plotted a graph of the results.

(i) Complete Fig. 1.3 by adding labels for the axes, including units, and by showing the expected shape of the curve. [3]



Fig. 1.3

(ii) Describe how the student would use this graph to find the actual concentration of subtilisin A in the contact lens cleaning solution.

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.....[1]

[Total: 19]

2 Alcohol is a small molecule that is able to pass from maternal blood into the blood of a fetus during pregnancy. Alcohol is thought to interfere with the development of the fetal nervous system. One possible effect of alcohol on the fetus is to change the speed of nerve conduction.

An investigation was carried out into the effect of pre-natal (before birth) alcohol exposure on the speed of nerve conduction in babies after birth. The babies were born to mothers aged 23 – 25 years old.

The speed of nerve conduction is measured by attaching surface electrodes to the skin. One electrode stimulates the skin and the other electrode records the presence of an action potential as it passes through a neurone. A meter records the time taken for the action potential to travel between the electrodes.

Fig. 2.1 shows a diagram of the apparatus.

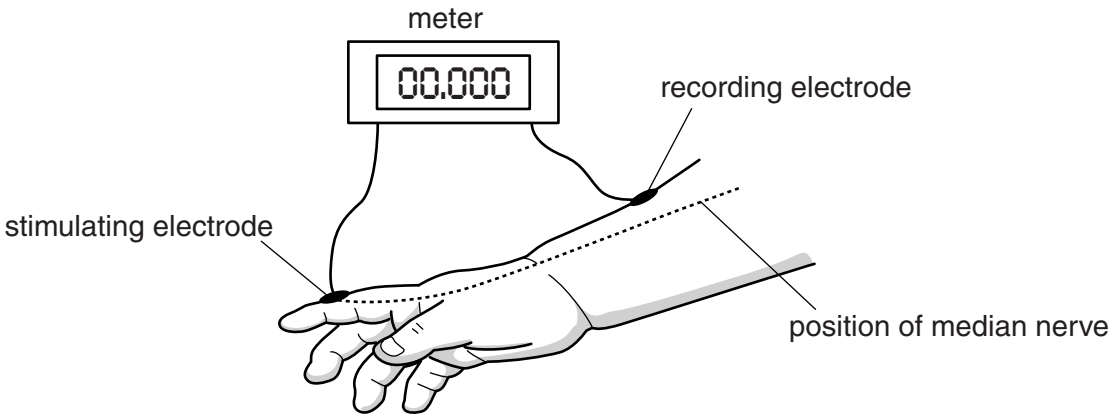


Fig. 2.1

The test shown in Fig. 2.1 was carried out on the median nerve. This nerve is found in the arm. Its sensory neurones supply the skin receptors in the hand and its motor neurones supply the muscles that move the arm and hand.

Two groups were tested.

- **Group 1** consisted of seventeen babies, seven male and ten female, who had been exposed to alcohol during pregnancy. The mothers of these babies all drank more than 32 mg of alcohol per day.

- **Group 2** consisted of thirteen babies, six male and seven female, who had not been exposed to alcohol during pregnancy. The mothers of these babies did not drink any alcohol.

Each group was tested:
- 20 days after birth
- 400 days after birth.

(a) Identify the **independent** variable in this investigation.

.....[1]

Table 2.1 shows the results of this investigation.

Table 2.1

type of neurones in the median nerve	mean speed of nerve conduction / $m\,s^{-1} \pm s$			
	20 days		400 days	
	group 1 pre-natal alcohol exposure	**group 2** no pre-natal alcohol exposure	**group 1** pre-natal alcohol exposure	**group 2** no pre-natal alcohol exposure
sensory neurones	31.14 ± 1.67	26.06 ± 2.10	44.51 ± 2.37	51.66 ± 1.77
motor neurones	27.54 ± 1.02	31.14 ± 3.12	46.51 ± 3.73	49.80 ± 0.38

s = standard deviation

(b) (i) What conclusions can be made about the effects of pre-natal alcohol exposure compared to no pre-natal alcohol exposure on the conduction velocity in the median nerve in the sensory neurones and in the motor neurones.

sensory neurones .....

.....

.....

motor neurones .....

.....

.....[2]

(ii) State **one** other conclusion about conduction velocity in the median nerve that can be made from these results.

.....

.....[1]

(c) Identify which of the results in Table 2.1 is the most reliable. Give a reason for your answer.

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.....[2]

(d) (i) State why the results for the sensory conduction velocity of the median nerve of **group 1** and **group 2** at 20 days and 400 days may be significant.

.....

.....[1]

(ii) There is a difference between the mean conduction speed in sensory neurones in the two groups of babies.

State **one** reason why the *t*-test is suitable to determine if this difference is significant.

.....

.....[1]

(iii) State a null hypothesis for this test.

.....

.....[1]

(e) Suggest two reasons why the results of this investigation may not be valid for **all babies** born to mothers who drank alcohol while they were pregnant.

1. .....

.....

2. .....

.....[2]

[Total: 11]

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