Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2021**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 30.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **12** pages. Any blank pages are indicated.

DC (CE/SG) 200349/3

1 When bananas ripen, they turn brown in colour. This is due to the formation of a brown product called melanin.

The enzyme catechol oxidase acts on its substrate, catechol, leading to the formation of a brown product, melanin, as shown in Fig. 1.1.

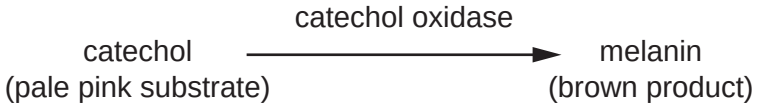

Fig. 1.1

As melanin is produced, the colour of the reaction mixture changes to brown. The intensity of the brown colour produced is proportional to the concentration of melanin. The more active the enzyme, the more intense the brown colour.

A colorimeter is used to measure the absorbance of the reaction mixture. Absorbance is a measure of the light absorbed by a coloured solution. With the reaction shown in Fig. 1.1, the more intense the brown colour, the higher the absorbance.

Catechol oxidase can be extracted from bananas.

(a) Some students were asked to extract catechol oxidase by grinding a slice of banana with sand and water, using a mortar and pestle. The resulting mixture was then filtered through a piece of cloth.

Suggest a reason for:

grinding with sand

.....

.....

.....

filtering through cloth.

.....

.....

..... [2]

(b) The students investigated the effect of the substrate concentration on the enzyme-catalysed reaction shown in Fig. 1.1.

The students were provided with:

- the extracted catechol oxidase enzyme solution prepared in step **(a)**, which was kept cold until needed
- a stock solution of 1.0% catechol solution made up in a buffered solution of pH 7.0
- a buffer solution of pH 7.0.

The procedure used by the students is outlined in steps 1 to 3.

1. The extracted catechol oxidase enzyme solution was mixed with the 1.0% catechol solution.
2. After 2 minutes a colorimeter was used to measure the absorbance of this mixture.
3. Step 1 and step 2 were repeated using different concentrations of catechol solution.

(i) Suggest why the students used a colorimeter to measure the absorbance rather than judging the intensity of the colour by eye.

.....

..... [1]

(ii) Identify the independent variable and the dependent variable in this investigation.

independent variable .....

dependent variable ..... [2]

The students used the absorbance values at 2 minutes as the initial rates of reaction.

Fig. 1.2 shows the results.

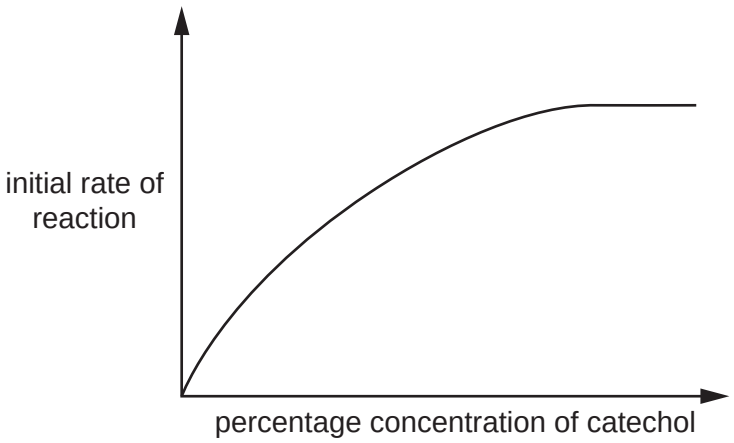

Fig. 1.2

(c) The students decided to investigate the effect of inhibitors on the reaction shown in Fig. 1.1. The students planned to add an inhibitor, inhibitor **Y**, to reaction mixtures containing different concentrations of catechol solution.

(i) Describe a method the students could use to collect the data needed to test the effect of inhibitor **Y** in reaction mixtures containing different concentrations of catechol solution.

The description of your method should be set out in a logical way and be detailed enough for another person to follow.

You should **not** repeat the details from **(a)** describing how the extract of catechol oxidase is prepared.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [8]

Fig. 1.3 shows the results when **no** inhibitor **Y** was added.

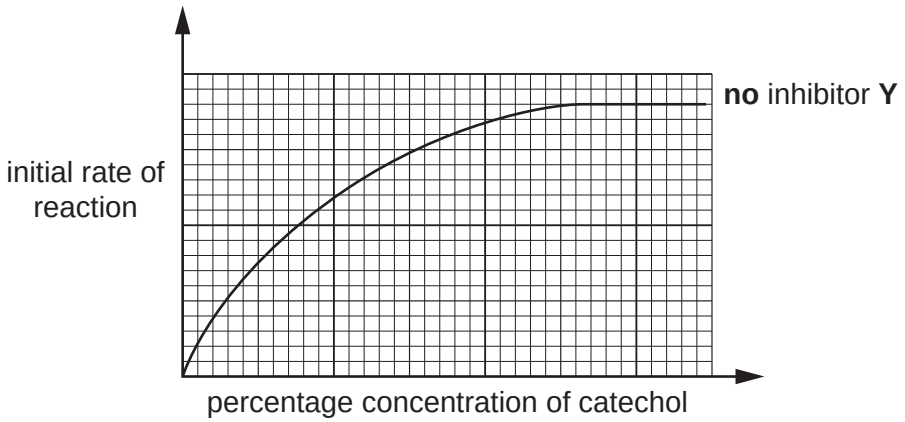

Fig. 1.3

The students suggested that inhibitor **Y** was acting as a **non-competitive** inhibitor.

(ii) On Fig. 1.3, sketch the curve expected if inhibitor **Y** was acting as a non-competitive inhibitor. [2]

V_{max} is the maximum initial rate of reaction of the enzyme.

The Michaelis-Menten constant, K_m, is the substrate concentration at which the initial rate of reaction is half its maximum value.

(iii) Draw on Fig. 1.3 the positions of V_{max} and K_m of the enzyme when **no** inhibitor **Y** is present. [2]

(iv) Use your graph to describe the effect of the addition of inhibitor **Y** on the K_m of this enzyme.

.....

.....

..... [1]

(d) Hypertension is a condition where people have long-term high blood pressure.

Two main types of drug are used to lower blood pressure in people with hypertension:

- ACE inhibitors
- diuretics.

Scientists investigated the effectiveness of the drugs when used separately **and** in combination.

505 people with hypertension were split into four groups as shown in Table 1.1.

Table 1.1

group	treatment
1	placebo (no active drug given)
2	ACE inhibitor only
3	diuretic only
4	ACE inhibitor **and** diuretic

The results are shown in Fig. 1.4.

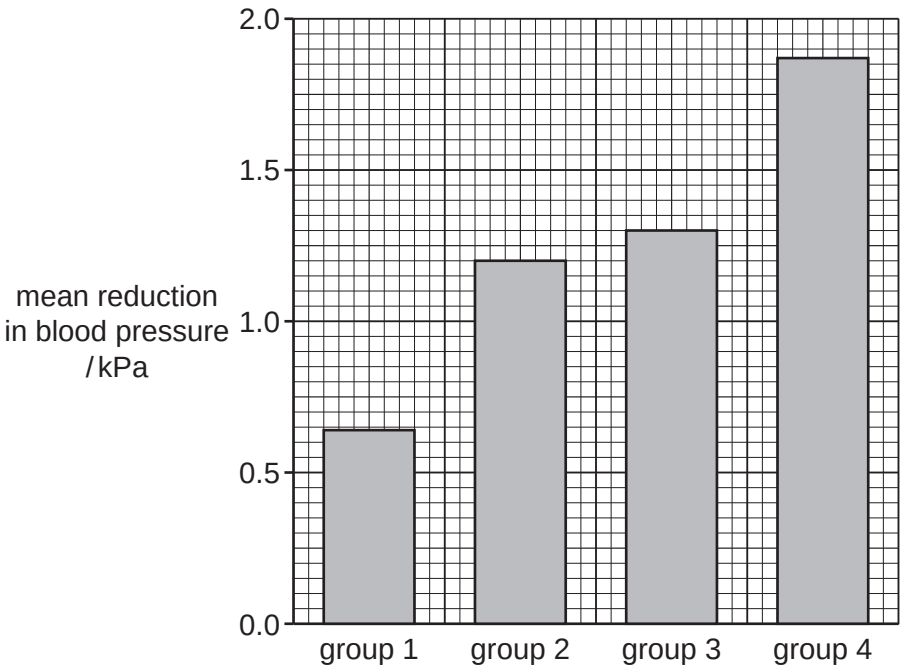

Fig. 1.4

The scientists analysed the data and concluded that a combination of an ACE inhibitor **and** a diuretic should be used to lower blood pressure in the treatment of hypertension.

With reference to the data in Table 1.1 and Fig. 1.4, discuss the conclusion that a combination of an ACE inhibitor and a diuretic should be used to lower blood pressure in the treatment of hypertension.

.....

.....

.....

.....

.....

..... [3]

[Total: 21]

2 Inheritance of wing shape and eye colour in the fruit fly, *Drosophila melanogaster*, is controlled by two genes.

- Gene **N**/**n** controls wing shape. Allele **N** for wrinkled wings is dominant to allele **n** for normal wings.
- Gene **E**/**e** controls eye colour. Allele **E** for rosy eyes is dominant to allele **e** for red eyes.

A biologist predicted that, if the genes are on **different** chromosomes, the ratio of the phenotypes of the F2 generation would be 9:3:3:1.

The biologist carried out a breeding experiment.

- Homozygous dominant fruit flies with wrinkled wings and rosy eyes were crossed with homozygous recessive fruit flies with normal wings and red eyes.
- All the F1 fruit flies had wrinkled wings and rosy eyes.
- The F1 fruit flies were crossed with each other.

Table 2.1 shows the results for the F2 generation.

Table 2.1

F2 phenotype	frequency
wrinkled wings rosy eyes	44
wrinkled wings red eyes	2
normal wings rosy eyes	2
normal wings red eyes	16
total	64

(a) The chi-squared test (χ^2 test) was used to analyse the data in Table 2.1.

(i) State **one** reason why the chi-squared test (χ^2 test) was used.

.....

..... [1]

(ii) State the null hypothesis that the biologist would use for this test.

.....

.....

..... [1]

(iii) Complete Table 2.2 **and** calculate the value of χ^2 for the results of the F2 generation.

The equation for the calculation of χ^2 is:

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

O = observed result

E = expected result

$\sum$ = sum of

Table 2.2

offspring phenotype	***O***	***E***	$\frac{(O-E)^2}{E}$
wrinkled wings rosy eyes	44		
wrinkled wings red eyes	2		
normal wings rosy eyes	2		
normal wings red eyes	16		
		χ^2 =	

[3]

Table 2.3 shows some critical values of χ^2 at different probability levels.

Table 2.3

degrees of freedom	**probability (p)**			
	0.10	**0.05**	**0.01**	**0.001**
1	2.71	3.84	6.64	10.83
2	4.61	5.99	9.21	13.82
3	6.25	7.82	11.34	16.27
4	7.78	9.49	13.28	18.46

(iv) State why the student used the critical value of **7.82** in this investigation.

.....

.....

..... [1]

(v) Use your calculated value of χ^2 to:

- explain whether the null hypothesis should be accepted or rejected

  .....

  .....

  .....

  .....

- suggest a conclusion the biologist could make about the inheritance of the genes controlling wing shape and eye colour in fruit flies.

  .....

  .....

  .....

  ..... [3]

[Total: 9]

BLANK PAGE

BLANK PAGE