Oxford Cambridge and RSA

A Level Biology B (Advancing Biology)

H422/03 Practical skills in biology

Monday 18 June 2018 – Morning

Time allowed: 1 hour 30 minutes

You must have:
- the Insert (inserted)
- a ruler (cm/mm)

You may use:
- a scientific or graphical calculator

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- The Insert will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*****).
- This document consists of **20** pages.

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Answer **all** the questions.

1 Farmers rotate different crops on their land to produce higher yields. Crops like beans are used in the rotation to fix atmospheric nitrogen. This reduces the need for synthetic fertilisers.

(a) Name the type of crop, such as beans, that can fix nitrogen.

..... **[1]**

(b) The roots of bean plants form nodules due to infection by the nitrogen-fixing bacteria, *Rhizobium*.

Rhizobium can be cultured in a laboratory.

(i) The table shows information for the preparation of agar plates used to culture *Rhizobium*.

Complete the table by suggesting a role for mannitol.

Constituent added to agar	Role of constituent
Mannitol (a carbohydrate)	.....
Yeast extract	source of nitrogenous compounds
Magnesium sulfate	source of essential ions
Dipotassium phosphate and sodium chloride	pH and osmotic buffers

[1]

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(ii)* Write a method that could be used to prepare a culture of *Rhizobium* bacteria in the laboratory.

You are provided with:

- plates with agar containing the constituents listed in the table in part **(i)**
- a bean plant
- school or college resources.

In your answer you should describe how you would minimise potential hazards associated with the preparation.

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..... **[6]**

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(iii) After preparation in the laboratory, *Rhizobium* cultures are usually kept at 30 °C.

Explain why this is a suitable temperature.

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..... **[2]**

(c) **(i)** In response to infection by *Rhizobium*, bean plant nodule cells produce protein called leghaemoglobin.

Researchers wanted to find out more about three genes that code for leghaemoglobin. They used RNA interference (RNAi) to inhibit the production of leghaemoglobin using miRNA. They measured the relative transcript level of the leghaemoglobin genes of bean plants treated with miRNA (RNAi plants) and those of untreated bean plants.

The results are shown in Table 1.

Name of leghaemoglobin gene	**Relative transcript level of gene**	
	Untreated plants	**RNAi plants**
LjLb1	3.5	0.085
LjLb2	4.0	
LjLb3	2.0	0.045

Table 1

Transcript levels for gene LjLb2 in the RNAi plants were reduced by 97.4% compared with the untreated plants.

Calculate the relative transcript level for LjLb2 in the RNAi plant.

Show your working.

Answer = ... **[3]**

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(ii) Describe how miRNA inhibits the mRNA of the treated plants.

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..... **[3]**

(iii) Explain why the researchers chose miRNA rather than siRNA (small interfering RNA) to inhibit the transcription of the leghaemoglobin genes.

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..... **[1]**

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2 A student investigated the effect of temperature on the rate of diffusion of chloride ions from carrot cells.

This is the student's method for the preliminary experiment.

1. Cut thin sections of carrot.
2. Place the sections of carrot into a boiling tube of distilled water, maintained at a temperature of 100 °C.
3. Remove a sample of water from the boiling tube and add silver nitrate solution. The silver nitrate solution reacts with chloride ions to produce a white precipitate.
4. Measure the absorbance of the sample in a colorimeter. Higher chloride ion concentrations will produce more white precipitate which will increase absorbance.

(a) **(i)** All equipment and sections of carrot were washed with distilled water before use.

Explain why.

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..... **[1]**

(ii) The absorbance value obtained in step 4 was used as a reference value for further tests. This absorbance value was considered to represent the highest chloride ion concentration that could be measured in the boiling tube solution.

Explain why.

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..... **[1]**

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Using the sample produced from step 3 in the preliminary experiment, the student carried out a serial dilution that produced the results in Table 2.1.

Concentration of chloride ions (a.u.)	Absorbance
1000.0	0.080
100.0	0.040
10.0	0.020
1.0	0.018
0.1	0.005

Table 2.1

(b) Look at the trend in the results in Table 2.1.

Identify the anomalous result in this trend and give its expected absorbance value.

Anomalous result .....

Expected absorbance .....

[1]

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(c) The student used the method for the preliminary experiment to plan their investigation into the effect of temperature on the rate of chloride ion diffusion.

Describe **three** variables that the student would need to control when planning this investigation. Include reasons why each of your chosen variables must be controlled.

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(d) Fig. 2.1 shows the results of the student's experiment carried out at different temperatures.

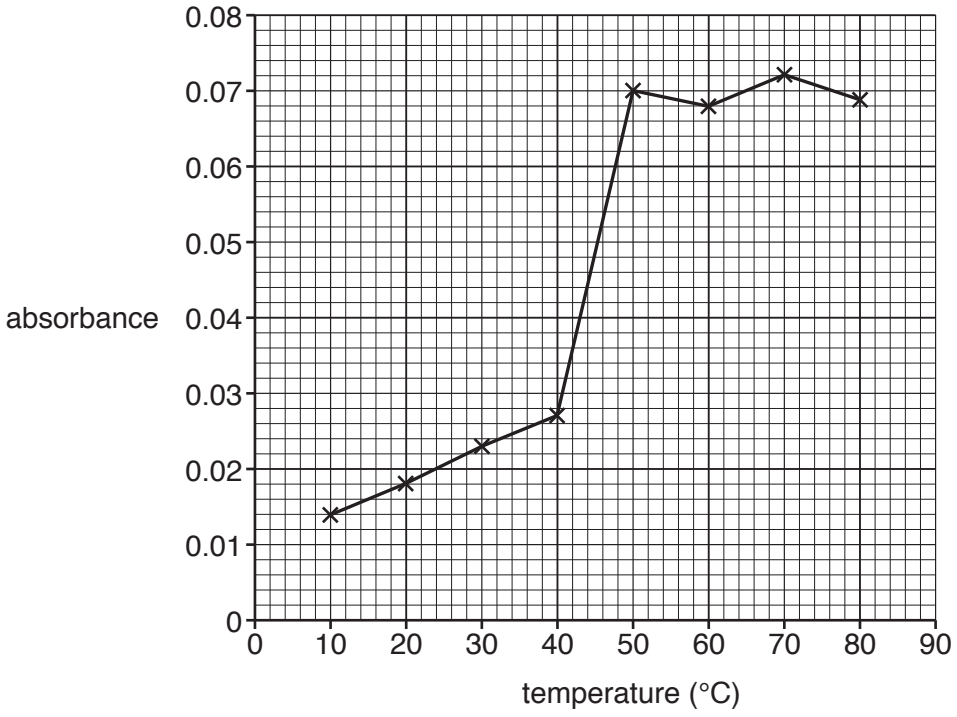

Fig. 2.1

(i) Use Fig. 2.1 to calculate the increase in absorbance between 10 °C and 40 °C.

Answer = ... **[1]**

(ii) Suggest why the absorbance changed between 10 °C and 40 °C.

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..... **[2]**

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Fig. 2.2 shows absorbance measured at different concentrations of chloride ions.

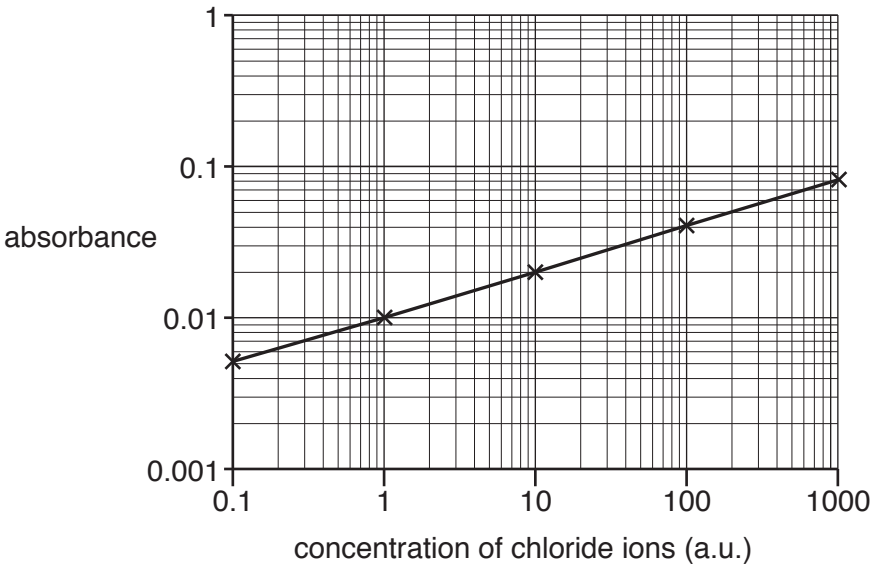

Fig. 2.2

(iii) Using the graph in Fig. 2.1 and the graph in Fig. 2.2, estimate the chloride ion concentration at a temperature of 45 °C.

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..... **[2]**

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3 Fig. 3.1, **on the insert**, shows a light photomicrograph of a cross-section of a healthy artery.

(a) **(i)** Identify layer **Y**.

..... **[1]**

(ii) Describe the importance of layer **Y** in the normal functioning of an artery.

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..... **[1]**

(b) **(i)** The artery in Fig. 3.1 has a diameter of 0.40 mm measured between **A** and **B**.

Calculate the magnification of this image.

Show your working.

Answer = ... **[2]**

(ii) Fig. 3.2, **on the insert**, shows a light photomicrograph of a cross-section of a diseased artery. The diseased artery has a diameter 14.3% greater than the healthy artery in Fig. 3.1. The diameter of the healthy artery is 0.40 mm.

Calculate the actual diameter of the diseased artery. Give your answer to 2 significant figures.

Show your working.

Diameter = ... mm **[2]**

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(c) Suggest why layer **Y** is much thicker in this diseased artery than in the healthy artery shown in Fig. 3.1.

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..... **[2]**

(d) **(i)** Capillaries do not have a layer **Y**.

Explain why the absence of layer **Y** is important in the formation of tissue fluid.

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..... **[1]**

(ii) Complete this passage about the formation of tissue fluid using the most appropriate words.

Tissue fluid is formed at the ..... end of capillaries

due to the high ..... pressure. The high

..... concentration in capillaries produces a high

..... pressure. This enables fluid to diffuse back into the

capillaries.

[4]

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4 The Mantoux test is used to check if a person is immune to tuberculosis (TB) to decide whether they need a BCG vaccination.

A red inflamed lump (induration) may appear three days after the injection of tuberculin.

A person is considered to be immune to TB if they develop an induration that has a diameter of at least 10 mm.

(a) For an induration of 10 mm the percentage error is 10%.

(i) Explain how this percentage error could lead to incorrect decisions about whether a BCG vaccination is needed.

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..... **[2]**

(ii) A health professional measures the diameter of the induration using a ruler marked in millimetres.

Suggest one way this method for measuring indurations could be improved. Explain your answer.

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The Mantoux test requires:
- a solution of tuberculin kept away from the light between 2 °C and 8 °C
- a sterile needle and a sterile syringe.

An alternative to the Mantoux test is a more accurate antibody test called ELISA which requires:
- a fresh blood sample
- full laboratory facilities.

The Mantoux test was used on a sample of 89 people and was followed up with an ELISA. The results are shown in Table 4.1

	Number of people		
	ELISA positive	**ELISA negative**	**Total**
Mantoux positive	22	6	28
Mantoux negative	18	43	61
Total	40	49	89

Table 4.1

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(b)* Evaluate the use of the Mantoux test and ELISA for testing whether people are immune to TB.

In your answer you should refer to the data in Table 4.1.

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(c) Ten patients were studied to determine whether the age at BCG vaccination affected the length of time that immunity against TB was effective.

Any correlation was tested using Spearman's rank correlation coefficient:

$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

The data collected are shown in Table 4.2.

Patient	Age at vaccination	Rank	Time immune (years)	Rank	d	d^2
A	13		16			
B	12		17			
C	14		18			
D	1		22			
E	30		4			
F	35		1			
G	15		18			
H	14		17			
I	0		23			
J	13		16			
					Total	

Table 4.2

(i) Calculate the Spearman's rank correlation coefficient for these data.

You may complete Table 4.2 to help you with your working.

Give your answer to **four decimal places**.

Spearman's rank correlation coefficient ..... **[3]**

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The null hypothesis used in the study was:

"There is no negative correlation between age at vaccination and length of time immunity was effective."

Table 4.3 shows the critical values for Spearman's rank correlation coefficient.

	Critical values for r_s	
Degrees of freedom	**p = 0.05**	**p = 0.01**
8	0.6429	0.8333
10	0.5636	0.7455
18	0.4014	0.5501
20	0.3805	0.5218

Table 4.3

(ii) Use Table 4.3 to decide if the null hypothesis was correct.

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..... **[3]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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