AEO «Nazarbayev Intellectual Schools»
Center for Pedagogical Measurements

NIS
Nazarbayev
Intellectual
Schools

EXTERNAL SUMMATIVE ASSESSMENT
TEST SPECIFICATION
«BIOLOGY»

Grade 12

Astana, 2024

Contents

1 Purpose

The purpose of assessment is to identify learners' knowledge and abilities acquired in the process of learning as well as their abilities to apply high-order thinking skills.

1.1 Relationship with International Standards

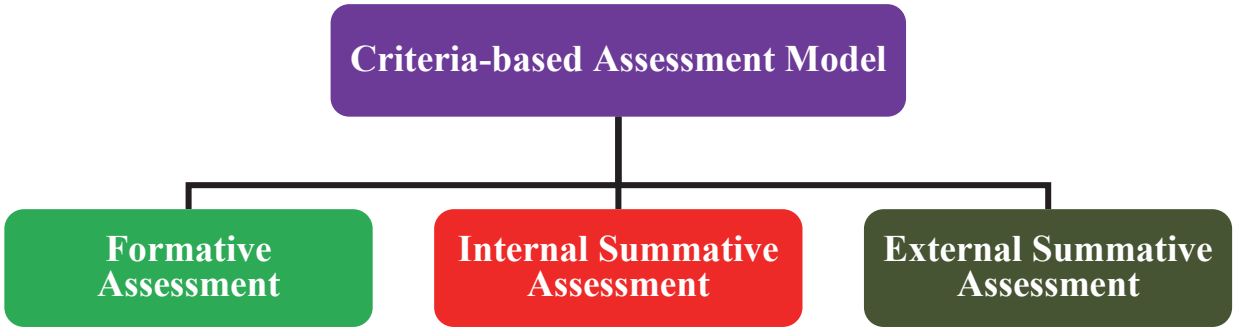
The Grade 12 Biology External Summative Assessment is designed to be comparable to the Cambridge International A-Level standard.

1.2 Relationship with Subject Programme

The Grade 12 External Summative Assessment will assess the content of the AEO «Nazarbayev Intellectual Schools» Educational Programme – NIS-Programme for Grade 11 and 12. The level of knowledge and abilities, as well as skills, will be defined by the expected outcomes within the Biology Subject Programme.

1.3 Relationship with the Criteria-based Assessment Model (CBAM)

The External Summative Assessment forms one part of the *Criteria-based Assessment Model* which also consists of Formative Assessment and Internal Summative Assessment.



2 External Summative Assessment Overview

Paper 1	**60 minutes**
All questions are compulsory. Learners answer 40 multiple-choice questions. Each question will have four options, from which learners will choose the correct one. The questions will assess the learners' knowledge, understanding, and ability to apply information. Calculators are allowed.	
40 marks are 23% of the total amount of marks	
Paper 2	**120 minutes**
All questions are compulsory. Learners answer between 8 and 12 questions, which may be broken into subparts. The questions will assess the learners' knowledge and ability to handle, apply, and evaluate information. Calculators are allowed.	
100 marks are 59% of the total amount of marks	

Paper 3	**90 minutes**
All questions are compulsory. This paper consists of two or three theoretical experiments. The experiments will assess the learners' knowledge, practical planning, analysis, and evaluation skills. Calculators are allowed.	
30 marks are 18% of the total amount of marks	

2.1 Assessment objectives

AO1	**Knowledge with Understanding** Learners should be able to demonstrate knowledge and understanding concerning: • scientific phenomena, facts, laws, definitions, concepts, and theories; • scientific vocabulary, terminology, and conventions (including symbols, quantities, and units); • operating principle of scientific instruments and apparatus, including techniques of operation and aspects of safety; • scientific quantities and their determination; • scientific and technological applications with their social, economic, and environmental implications; • presenting reasoned explanations for phenomena, patterns, and relationships.
AO2	**Handling, Applying, and Evaluating Information** Learners should be able to: • locate, select, organise and present information from a variety of sources; • translate information from one form to another; • manipulate numerical and other data; • analyse and evaluate information to identify patterns, report trends, and conclude; • make predictions and put forward hypotheses; • find arguments in support of hypotheses or to assess the course of action; • apply knowledge, including principles, to new situations; • evaluate information and hypotheses;
AO3	**Planning, Analysis, and Evaluation** Learners should be able to: • Identify a problem; design and plan investigations; • Identify independent, dependent, and controlled variables; • Analyse and process data. • Interpret and evaluate observations and experimental data; • Make conclusions based on evidence obtained from an investigation.

2.2 Use of calculators

Scientific or graphical calculators are allowed in all papers.

Calculators must be:
- of a size suitable for use on the desk;
- either battery or solar-powered;
- free of lids, cases, and covers which have printed instructions or formulas.

Calculators must not contain any of these facilities:
- symbolic algebra manipulation;
- symbolic differentiation or integration;
- communication with other machines or the internet.

Calculators may not contain any retrievable information including:
- databanks;
- dictionaries;
- mathematical formulas;
- text.

3 Description of papers

All learners complete all 3 papers. Papers 1 and 2 will require demonstrating knowledge and understanding of Biology, and the ability to handle and evaluate information (in accordance with AO1 and AO2). Paper 3 will assess learners' practical and experimental skills (in accordance with AO2 and AO3).

3.1 Paper 1

60 minutes

Calculators are allowed.
Paper 1 consists of 40 multiple-choice questions with one correct option.
All questions are compulsory.
Total 40 marks.

3.2 Paper 2

120 minutes

Calculators are allowed.
Paper 2 consists of 8-12 structured questions requiring short or detailed answers.
Learners may use a ruler, pencil, and eraser.
All questions are compulsory.
Total 100 marks.

3.3 Paper 3

90 minutes

Calculators are allowed.
Paper 3 consists of structured questions related to two or three theoretical experiments.
Learners may use a ruler, pencil, and eraser.
All questions are compulsory.
Total 30 marks.

3.4 Balance of marks

The balance of marks for the assessment objectives is shown in the table below:

Assessment Objectives	Paper 1	Paper 2	Paper 3	TOTAL
AO1	16	40	0	**56**
AO2	24	60	6	**90**
AO3	0	0	24	**24**
Total	**40**	**100**	**30**	**170**

3.5 Language of assessment

The language of the assessment is English.

4 Administration

All assessments must be conducted in compliance with all security measures in the Instructions on arranging and conducting External Summative Assessments of the academic achievements of Nazarbayev Intellectual Schools' learners. An instruction contains the following main points:

- examination materials and their safety;
- duties of teachers, invigilators, and examination administrators;
- preparation of classrooms and materials for the examination;
- preparation of appropriate classrooms for written examinations.

5 The Marking process

Marking is carried out by the Attestation committee, which includes the Principal examiner, Team Leaders, and Examiners. To mark each examination work, groups of Examiners are formed, led by Team Leaders.

All Examiners use the same version of the mark scheme during the marking. The Principal Examiner and the Team Leaders check selectively papers marked by Examiners to ensure the correct application of the Mark Scheme and the objectivity of the evaluation.

6 The grading process

The results of the assessment will be reported in the form of grades A*, A, B, C, D, and E, where A* is the highest grade and E is the lowest passing grade.

Grade U ('ungraded') will not represent a pass in a syllabus.

A learner's syllabus Grade will be calculated directly from the total of their marks on the components that they took (weighted in accordance with the set specifications), not from the component Grades.

The test specification contains A, C, and E Grade descriptors. The Attestation committee sets the thresholds for these grades based on professional judgment and the results of learners. The thresholds of the grades A *, B, and D are established by arithmetic means.

Grades A *, A, B, C, D, and E are transferred into the final grades.

6.1 Grade descriptions

Key Grade Descriptions are provided to give a general indication of the standards of achievement likely to have been shown by learners awarded particular grades. The grade awarded will depend in practice upon the extent to which the learner has met the assessment objectives overall.

Grade	Grade Description
A	Demonstrates a wide and detailed knowledge of the subject, and has a clear understanding of the principles and methods of the subject. The principles can be applied in both familiar and unfamiliar situations. Has a good ability to evaluate hypotheses. Answers given are well-expressed, direct, and relevant, and complex calculations are accurate and correctly set out. Solves problems in situations involving a wide range of variables. Can generate a hypothesis to explain theories and phenomena. Can design and plan investigations using suitable methods, interprets and evaluates observations and experimental data, and can evaluate and suggest improvements to ensure precision and accuracy.
C	Demonstrates a sound knowledge in many areas of the subject with some omissions, and has an understanding of many principles and methods of the subject. The principles can be applied most effectively in familiar and occasionally unfamiliar situations. Has a reasonable ability to evaluate information and hypotheses. Answers given are often well-expressed and relevant, and calculations frequently produce the correct answer. Solves problems involving a limited range of variables. Can generate a simple hypothesis to test a theory and make a prediction. Can generate a simple hypothesis to explain a given set of facts and data. Can plan a scientific task, test an idea, and present evidence.
E	Demonstrates a basic knowledge of the simple areas of the subject with some important omissions, and has a limited understanding of the principles and methods of the subject. The principles are generally only applied effectively in familiar situations. Has some ability to evaluate information and hypotheses. Answers given often include relevant points but can be confused with irrelevant additions. Can solve a problem involving one step where only a minor manipulation of data is needed. Will recognise a hypothesis that explains a set of facts or data. Can plan a scientific task, test a basic idea, answer a simple question, or solve a straightforward problem. Can draw simple conclusions consistent with the evidence collected and present evidence as charts, tables, or graphs.

7 Sample questions

Marks available for each question are shown at the end of each question, e.g. [1]. For all questions, mark schemes will be written alongside the questions to give clear guidance on how marks are awarded for each question.

7.1 Paper 1: Sample questions

For each question, there are four possible answers**, A, B, C** and **D**. Choose the **one** you consider to be correct.

1 Which process is involved in ATP synthesis in chloroplasts?

A production of proton gradient across the thylakoid membrane

B diffusion of electrons through the thylakoid membrane

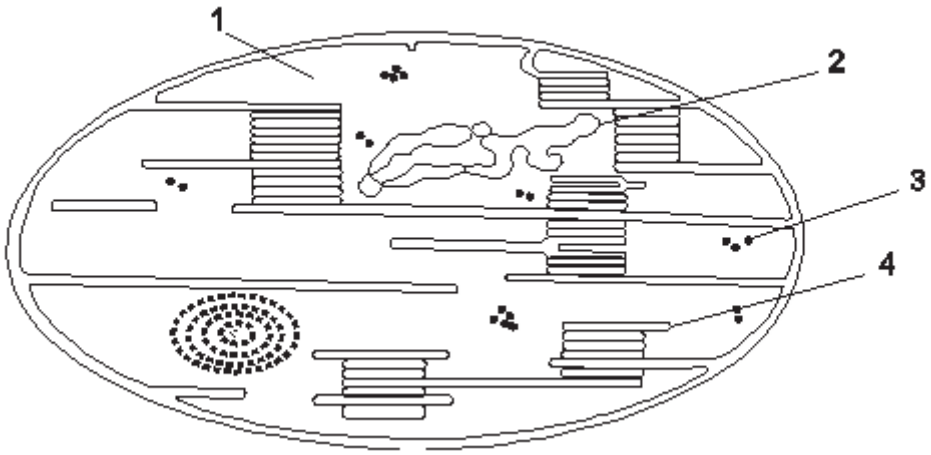
C break down of water by photolysis in the stroma

D movement of water into the thylakoid space from the stroma

A ☐ **B** ☐ **C** ☐ **D** ☐

[1]

2 The diagram represents the structure of a chloroplast.



Which row shows the correct functions of the parts of the chloroplast?

	the light-dependent stage	the light-independent stage	transcription	translation
A	1	2	3	4
B	2	3	4	1
C	4	1	2	3
D	3	4	1	2

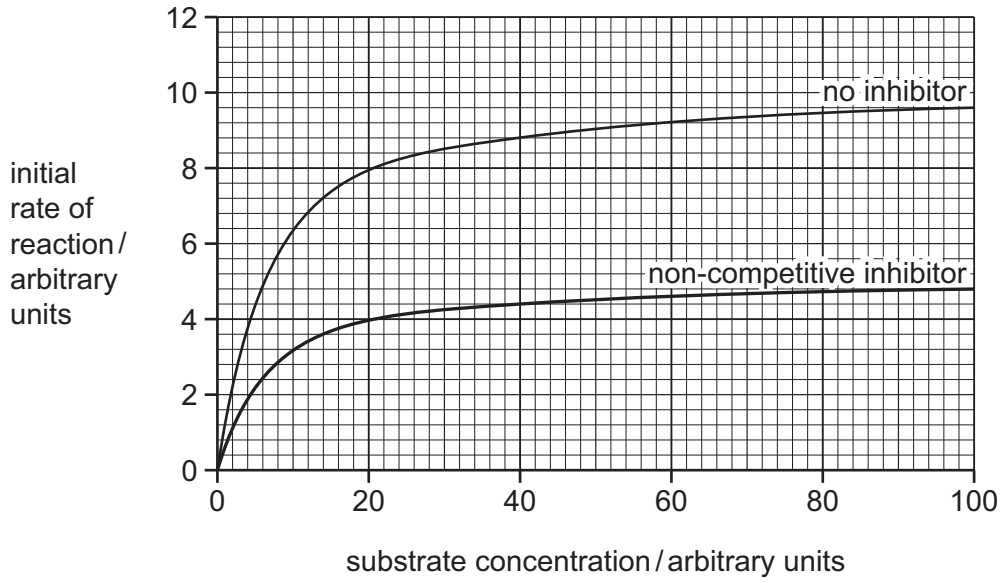
A ☐ **B** ☐ **C** ☐ **D** ☐

[1]

Question	Answer	Additional guidance
1	A	
2	C	

7.2 Paper 2: Sample questions

1 The graph below shows the effect of substrate concentration on the initial rate of an enzyme catalysed reaction with and without the addition of a non-competitive inhibitor.



(a) Describe the shape of the curve when no inhibitor is present.

.....

.....

.....

..... [2]

(b) **(i)** Draw the curve you would expect in the presence of a competitive inhibitor on the graph.

[2]

(ii) Explain, with reasons, the shape of the curve you have drawn.

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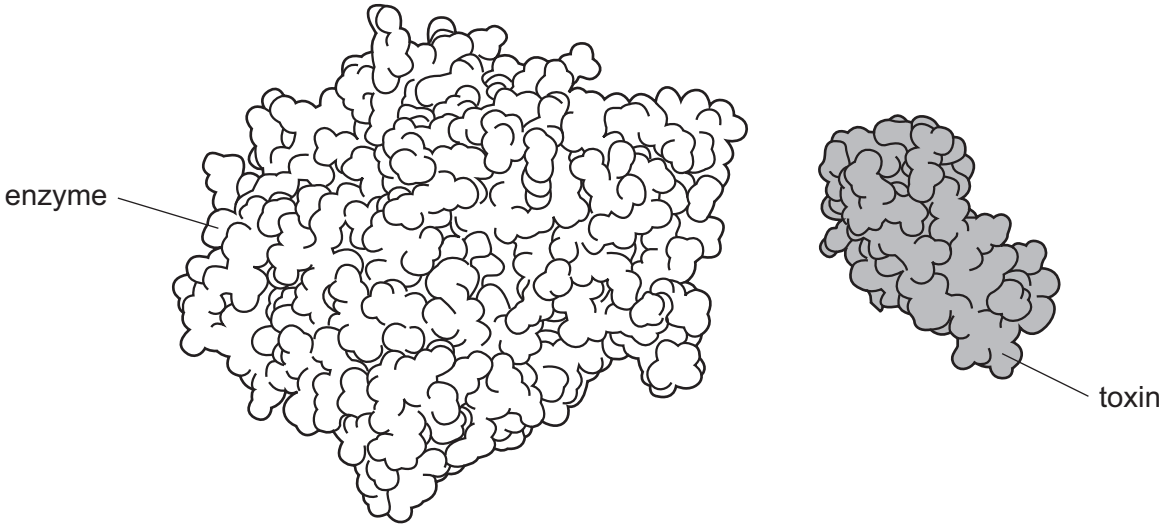
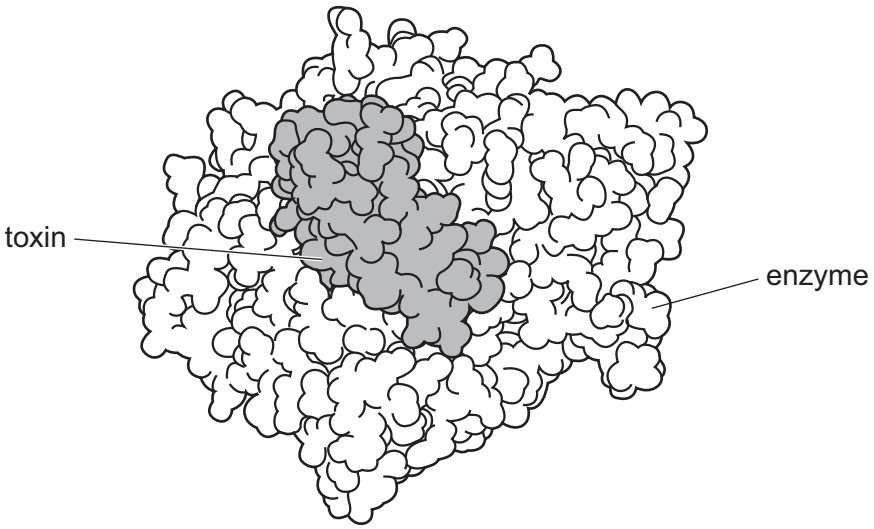
..... [3]

(c) The figure below shows the structure of the enzyme acetylcholinesterase and a lethal polypeptide toxin from a green mamba snake.



The following figure shows the toxin molecule irreversibly bound to the enzyme, blocking its active site.



A person is bitten by a green mamba snake.

Suggest what effect this toxin will have on their nervous system.

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.....

.....

.....

..... [3]

[Total: 10]

2 Maize plants produce fruits that show different traits (characteristics).

The fruits can be **purple** or **yellow** and **smooth** or **wrinkled**.

In a cross between two maize plants, 381 fruits were collected.

They showed the following traits:

216 purple and smooth

79 purple and wrinkled

65 yellow and smooth

21 yellow and wrinkled

(a) Draw a genetic diagram to explain the results. Use the symbols **A** for purple, **a** for yellow, **B** for smooth, and **b** for wrinkled.

Parental genotypes .....

Parental gametes .....

Genetic cross:

F1 genotypes .....

F1 phenotypes ..... [4]

Question	Answer	Mark	Additional Guidance
1 (a)	increases rapidly until the substrate concentration reaches 8 arbitrary units (*accept range between 5 – 8)*, then increases at a slower rate until it reaches 82 *(accept range between 82 – 84)* then levels off / plateaus/no further increase in rate	**1** **1** **[2]**	Description of general trend = 1 mark Quoting 2 concentrations with inclusion of units = 1mark
(b)(i)	line between the non-competitive inhibitor and no inhibitor eventually meet line without an inhibitor	**1** **1** **[2]**	
(ii)	binds with/blocks active site; competes with the substrate (for the active site); (idea of) at high concentrations of the substrate, the effect of the inhibitor is negligible / more enzyme-substrate complexes formed or not permanent/temporary	**1** **1** **1** **[3]**	
(c)	any three from: acetylcholine is not broken down/less is broken down/cannot bind; acetylcholine remains bound to the receptors on the postsynaptic membrane; ref to sodium ion channels stay open; overall consequence e.g. repeated contraction / muscle spasm / repeated action potentials / repeated stimulation / paralysis of muscle	 **1** **1** **1** **1** **[3]**	
	Total	**10**	

2 (a)	correct parental genotypes – AaBb and AaBb	**1**	
	correct gametes – AB, Ab, aB, ab;	**1**	
	correct genotypes of offspring – (see table below)	**1**	
	correct phenotypes linked to genotypes -(see table below)	**1**	
		[4]	

F1 genotype	AABB	AABb	AaBB	AaBb	AAbb	Aabb	aaBB	aaBb	aabb
F1 phenotype	purple smooth	purple smooth	purple smooth	purple smooth	purple wrinkled	purple wrinkled	yellow smooth	yellow smooth	yellow wrinkled

7.3 Paper 3: Sample questions

1 The effects of surface area to volume ratio on the rate of diffusion were investigated.

The main procedure used is listed below:

- Five beakers were labelled with the value 8 mm^3, 64 mm^3, 216 mm^3, 512 mm^3,1000 mm^3
- Purple agar was made with very dilute sodium hydroxide solution and Universal Indicator
- Cubes from the block of agar were cut to match the labels on the beaker. Dimensions are provided in Table 1.1.
- Each cube was placed into the beaker with a label that matches its volume.
- Hydrochloric acid was added to all five beakers so that the cube of agar in each beaker was covered.
- The time in seconds it takes for each cube of agar to change completely to red was recorded.

Rate of diffusion was calculated using formula below:

$$rate\ of\ diffusion = \frac{half\ the\ width\ of\ the\ cube}{time\ taken\ for\ whole\ cube\ to\ change\ colour}$$

Table 1.1

dimensions of agar cube/mm	volume / mm^3	surface area / mm^2	surface area to volume ratio	time taken for the whole cube to change colour / s	rate of diffusion / mm s^{-1}
2 x 2 x 2	8	24	3.0	48	0.021
4 x 4 x 4	64	96	1.5	132	0.015
6 x 6 x 6	216	216	1.0	339	0.009
8 x 8 x 8	512	384	0.8	499	0.008
10 x 10 x 10	1000	600	0.6	720	0.007

(a) Identify different variables in this experiment and describe them.

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..... [2]

(b) (i) Suggest what effect could have different concentrations of hydrochloric acid on the rate of diffusion.

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..... [1]

(ii) Suggest what effect could have the reduction of agar cube size on the rate of diffusion.

.....

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..... [1]

(c) Teacher collected data recorded by 10 students during practical about the rate of diffusion of agar cubes with 2x2x2 and 8x8x8 dimensions.

Table 1.2

student	rate of diffusion of 2x2x2 agar cube	rate of diffusion of 8x8x8 agar cube
1	0.021	0.007
2	0.029	0.014
3	0.031	0.015
4	0.023	0.012
5	0.030	0.014
6	0.025	0.009
7	0.028	0.011
8	0.022	0.008

9	0.027	0.010
10	0.029	0.012
mean	0.027	0.011
standard deviation	0.004	0.003

Students decide to use a t-test to find out if the difference between the rate of diffusion of a 2x2x2 agar cube and an 8x8x8 agar cube is significant.

(i) State a null hypothesis for this test.

.....

..... [1]

(ii) Calculate *t* - test and degree of freedom.

The formula of *t* value:

$$t = \frac{|\underline{x}_1 - \underline{x}_2|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

Where
s = standard deviation
n = sample size
$\underline{x}$ = mean

Show your work.

t - test .....

degree of freedom ..... [2]

Table 1.3 shows the probability values of t.

Table 1.3

degrees of freedom	10	11	12	13	14	15	16	17	18	19	20
probability 0.05	2.228	2.201	2.179	2.160	2.145	2.131	2.120	2.110	2.101	2.093	2.086

(iii) State conclusions based on the calculated *t* value.

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..... [3]

(d) Suggest one improvement to the procedure and explain how it would reduce experimental error.

.....

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.....

..... [1]

Total [11]

2. Student conducted an experiment to investigate the effect of different concentrations of sucrose solutions on potatoes.

The student cut potato strips, so they were 40 mm long and 5 mm wide. Each potato strip was placed into large test tubes containing 1.2 mol dm^{-3}, 1.0 mol dm^{-3}, 0.8 mol dm^{-3}, 0.6 mol dm^{-3}, 0.4 mol dm^{-3}, 0.2 mol dm^{-3} of sucrose solution. After 20 minutes, strips were removed from the test tubes and dried out using a paper towel. The length of each strip was measured and recorded in Table 2.1.

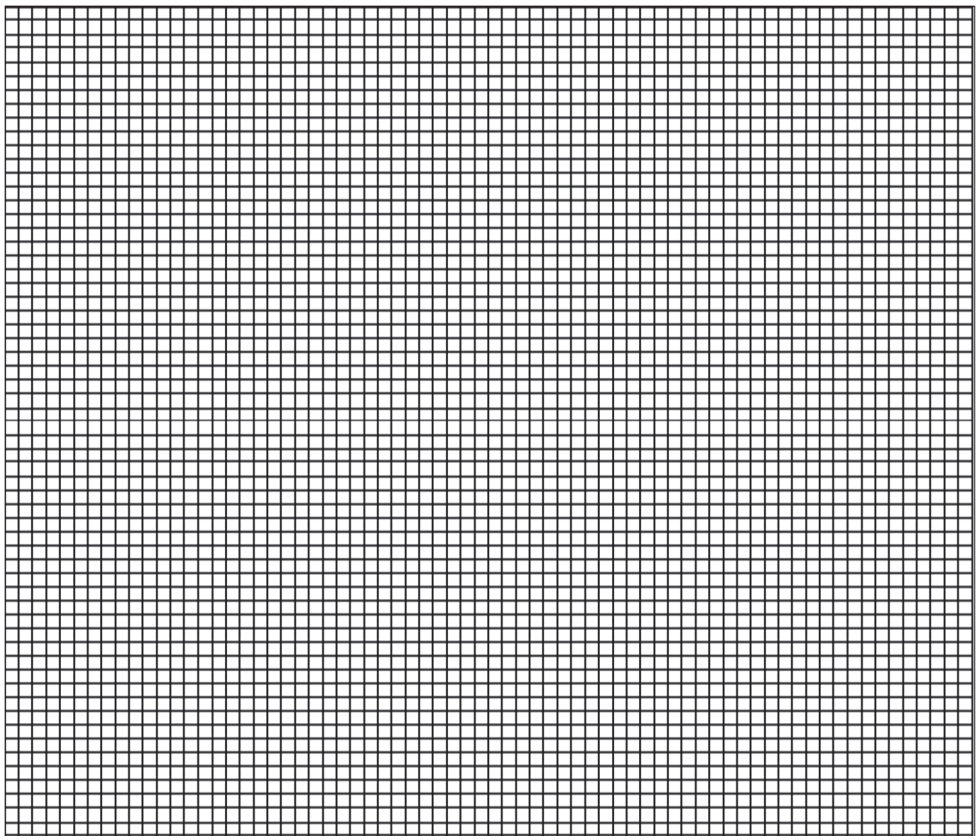
Table 2.1

Concentration of sucrose solution/ mol dm^{-3}	**The initial length of potato strip/mm**	**The final length of potato strip/mm**	**Change in length of potato strip/ %**
1.2	40.0	37.5	
1.0	40.0	38.0	
0.8	40.0	39.0	
0.6	40.0	40.5	
0.4	40.0	41.0	
0.2	40.0	42.0	

(a) Calculate the percentage of change in length of the potato strip and fill Table 2.1.

[1]

(b) Plot a graph of your processed results from (a) on the grid below.



[5]

(c) Use your graph to find the concentration of sucrose solution which would give no change in length.

..... [1]

Total [7]

3 Student wants to investigate the relationship between the colour of light and the rate of photosynthesis of the water plant *Elodea canadensis.*

(a) Outline a procedure to find out how the rate of photosynthesis is affected by the colour of light.

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.....

.....

.....

..... [4]

(b) Two different strains of the species of algae were tested using a range of different wavelengths of light.

- Light of known wavelength was passed through the tube containing algae for two hours.
- The light transmission through the suspension and the oxygen concentration was then measured.

The results were used to plot the absorption spectrum and the action spectrum for each strain of alga.

Fig.3.1 shows these spectra.

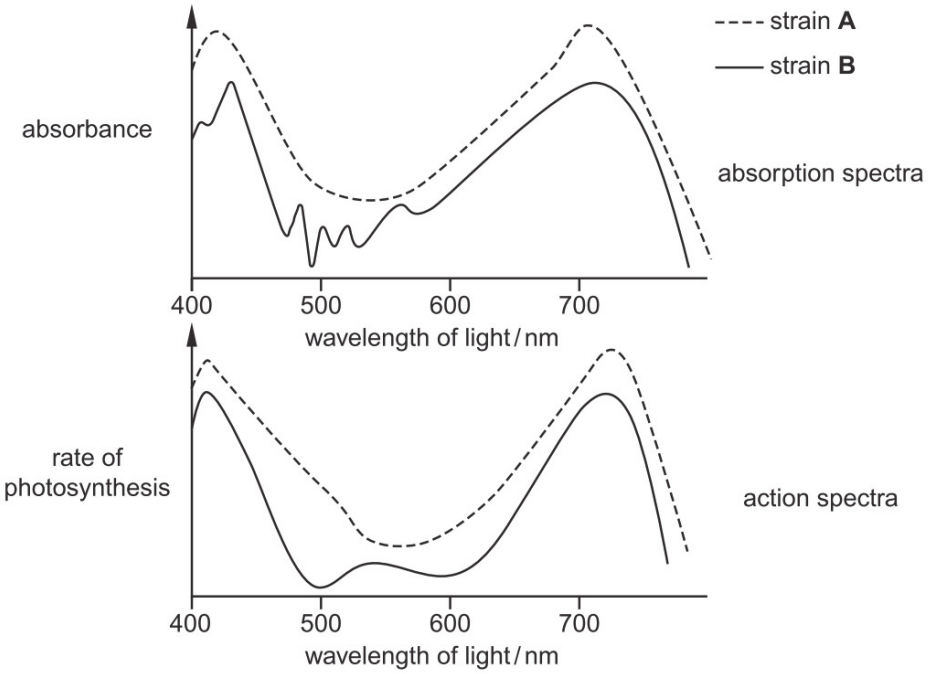

Fig.3.1

(i) Water is not suspended, algae transmits 100% of the light.

State how the data to plot the absorption spectrum was obtained.

.....

..... [1]

(ii) State the data which would be used to plot the action spectrum

..... [1]

The photosynthetic pigments of the algae were extracted and separated by two-way chromatography.
The pigments were first separated by one solvent and then separated again by a second solvent at right angles to the first solvent.

Fig. 3.2. shows the results for the two different strains.

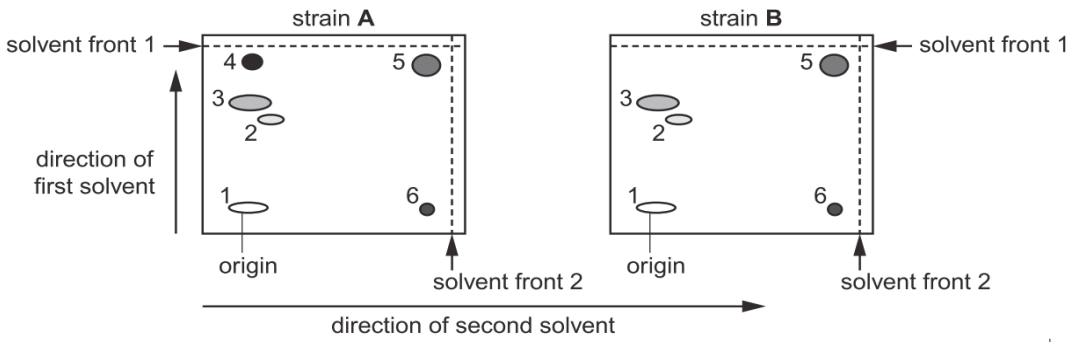

Fig. 3.2.

(c) Using the information in **Fig.3.2**, suggest why using two different solvents gives a better separation of these pigments than just using one solvent.

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.....

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..... [3]

(d) Different photosynthetic pigments absorb different wavelengths of light.

Table 3.1 shows some information about the pigments, **P, Q, R, S** and **T**, found in these unicellular algae, including the wavelength of light at which maximum light absorption occurs.

Table 3.1

pigment	wavelength of light / nm	Rf value	
		solvent 1	solvent 2
P	620	0.20	0.89
Q	545 and 547	0.60	0.29
R	420 and 660	0.65	0.11
S	490	0.91	0.19
T	430 and 645	0.82	0.92

$$Rf = \frac{\text{distance moved by pigment}}{\text{distance moved by solvent front}}$$

One of the strains of algae lacks one of the pigments.
Using the information in **Table 3.1, Fig. 3.1 and Fig. 3.2:**

(i) Identify the strain of alga that lacks one of these pigments and state the letter of the missing pigment

Strain.....

Pigment ……

[2]

(ii) State the evidence that supports your answer to **(i).**

.....

.....

.....

..... [3]

Total [12]

Question	Answer	Mark	AOs	Additional Guidance
1(a)	Independent variable: surface-to-volume ratio of agar cubes Dependent variable: rate of diffusion Controlled variable: concentration/volume of hydrochloric acid/ temperature	1 1 1 **[2]**	**AO3**	**AW**
1(b)(i)	The higher the concentration of the hydrochloric acid, the higher the rate of diffusion. The lower the concentration, the lower the rate of diffusion of hydrochloric acid into the agar. *ORA*	**[1]**	**AO3**	**AW**
1(b)(ii)	The smaller the agar cube size is, the higher the rate of diffusion.	**[1]**	**AO3**	
1 (c) (i)	There is no significant difference between the rate of diffusion of 2x2x2 agar cube and 8x8x8 agar cube	**[1]**	**AO3**	
1(c)(ii)	T value ≈10.119 Degree of freedom = 18	1 1 **[2]**	**AO2**	
1(c)(iii)	the null hypothesis should be rejected because the calculated value / 10.119, is greater than, the critical value of t / table value of t / 2.101 (at df=18) there is a significant difference between rates of diffusion of 2x2x2 and 8x8x8 agar cubes	1 1 1 **[3]**	**AO2**	
1(d)	*Any one of the improvements:* Ensure consistent distance/to make, results/cutting/sizes of cubes, more precise Use larger blocks to determine end point/final colour change easier Keep the temperature constant by using a water bath because it is a factor that affects diffusion	 1 1 1	**AO3**	**do not** accept putting on a white background the improvement method without an explanation

<table>
<tr><td></td><td>Repeat several times under the same conditions to determine the variance of results</td><td>1

[1]</td><td></td><td>is awarded 1 mark
do not accept an explanation without the statement of the improvement method</td></tr>
<tr><td></td><td>Total</td><td>11</td><td></td><td></td></tr>
<tr><td>2(a)</td><td><table><tr><th>Concentration of sucrose solution/ mol dm^{-3}</th><th>The initial length of potato strip/mm</th><th>The final length of potato strip/mm</th><th>Change in length of potato strip/mm</th></tr><tr><td>1.2</td><td>40.0</td><td>37.5</td><td>-6.25</td></tr><tr><td>1.0</td><td>40.0</td><td>38.0</td><td>-5.0</td></tr><tr><td>0.8</td><td>40.0</td><td>39.0</td><td>-2.5</td></tr><tr><td>0.6</td><td>40.0</td><td>40.5</td><td>+1.25</td></tr><tr><td>0.4</td><td>40.0</td><td>41.0</td><td>+1.25</td></tr><tr><td>0.2</td><td>40.0</td><td>42.0</td><td>+5.0</td></tr></table></td><td>[1]</td><td>AO2</td><td>1 mark for all correct answers</td></tr>
<tr><td>2(b)</td><td>x-axis labelled sucrose concentration and units AND
y-axis labelled <u>change</u> in length and units

all plots correct

plotted points to cover at least half the width and height of the printed grid

use of both + and – values on the y-axis

sensible and linear scale</td><td>
1

1

1

1

1
[5]</td><td>AO3</td><td>final length can be accepted in a graph grid

accept +/– ½ square</td></tr>
<tr><td>2(c)</td><td>x-axis intercept (from their graph)</td><td>[1]</td><td>AO3</td><td>accept +/– ½ square</td></tr>
<tr><td></td><td>Total</td><td>7</td><td></td><td></td></tr>
<tr><td>3 (a)</td><td>Any four from:

(ref. to) control variables identified e.g. time,</td><td>
1</td><td>AO3</td><td></td></tr>
</table>

	temperature, the distance between light source and plant use coloured filters / method of producing different colours of light / different coloured light bulbs / LEDs / use different wavelengths of light suggestion of number of colours e.g. red orange, yellow, green, blue / range of wavelengths count number of bubbles calculate the mean rate of photosynthesis	1 1 1 1 **[max 4]**		**accept** a minimum of 4 colours / range 400 – 700 nm wavelength
3 (b)(i)	subtract the transmission (for each wavelength) from 100	**[1]**	**AO2**	**A** as formula 100-transmission (for each wave length) **A** subtracting the transmission from the transmission without any algae/just water **R** subtracting the wave length
3(b)(ii)	oxygen concentration	**[1]**	**AO2**	**A** **p**roduction/volume/amount/quantity
3 (c)	*Any three from:* *1. ref. to idea of different movement /spread in different solvents* *2. ref. to idea that some pigments are not soluble in some pigments* *3. ref. to idea that some pigments have the same solubility in solvent 1* *4. ref. to second solvent separates pigments that are not separated by solvent 1*	**1** **1** **1** **1** **[max 3]**	**AO3**	
3 (d)(i)	Strain **B** Pigment **S**	**1** **1** **[2]**	**AO3**	**A** spot/dot/ number 4
3 (d)(ii)	*Any one from:* 1. chromatogram for **B** has a pigment/ spot/ number 4 missing	**1**	**AO2**	**ecf** for incorrect

	2. at about Rf 0.9 (1) (in solvent 1) 3. the absorption spectrum for **B** has low(est) absorbance at 490 nm 4. the action spectrum for **B** has low(est) activity at 490 nm	**1** **1** **1** **[max 1]**		pigment in (i), mp. 1, 3 or 4 2. **A** Rf 0,19/ 0.2 (at solvent 2) A it has the highest Rf in solvent 1/ a low Rf at solvent 2 3. **A** if a range 470-530 nm given 4. A rate of photosynthesis is low(est) at 490 nm
	Total	**12**		
	Total for three practice	**30**		