



Rewarding Learning

ADVANCED
General Certificate of Education
2018

Centre Number

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Candidate Number

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Biology

Assessment Unit A2 3

assessing

Practical Skills in Biology

MV18

[ABY31]

FRIDAY 4 MAY, MORNING

Time

1 hour 15 minutes, plus your additional time allowance.

Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write on blank pages.

Complete in black ink only.

Answer **all eight** questions.

Information for Candidates

The total mark for this paper is 60.

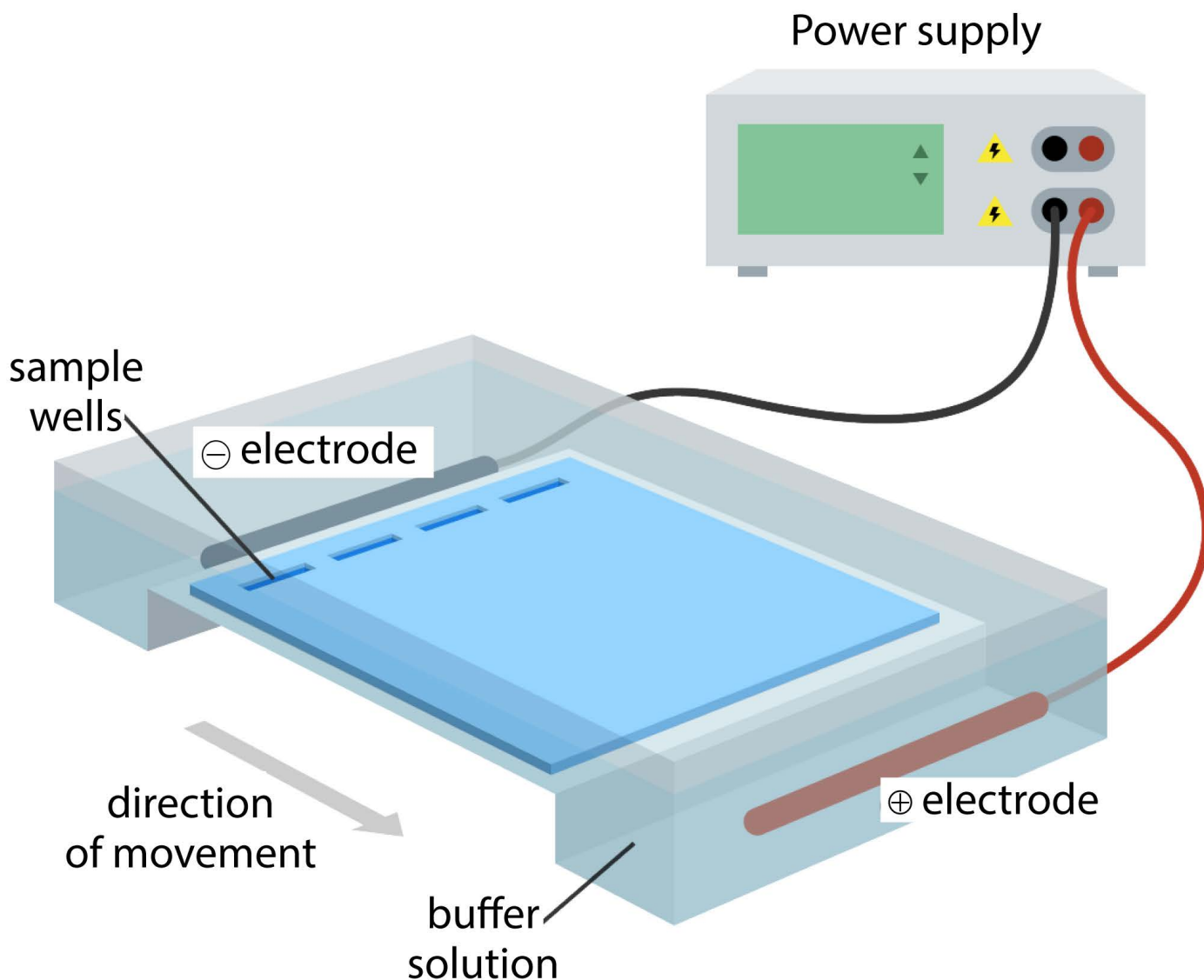
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

Statistics Sheets are provided for use with this paper.

You are reminded of the need for good English and clear presentation in your answers.

Use accurate scientific terminology in all answers.

- 1 The diagram below represents the main components of an electrophoresis system.

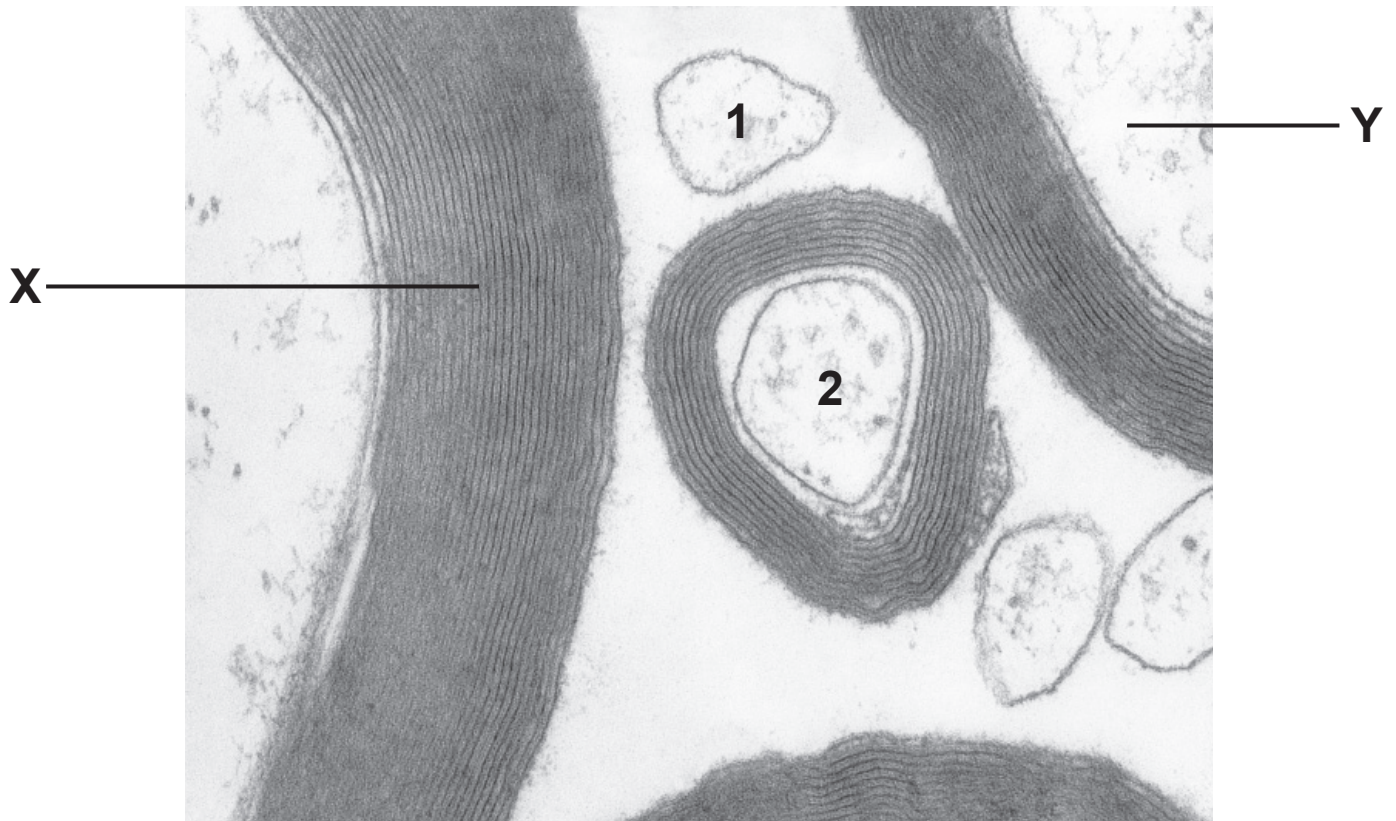


- (a) Apart from maintaining a constant pH, state **one** function of the buffer solution. [1 mark]

(b) Each of the four sample wells contains DNA from the same individual along with a blue dye. However, the DNA in each well had previously been incubated with a different restriction endonuclease.

Describe what you would expect to see in the gel following electrophoresis. [2 marks]

2 The image below shows a section through several neurones.



(a) Identify the parts of a neurone labelled **X** and **Y**.
[2 marks]

X _____

Y _____

(b) Give **two** pieces of evidence which suggest that neurone **2** would conduct impulses at a faster rate than neurone **1**. [2 marks]

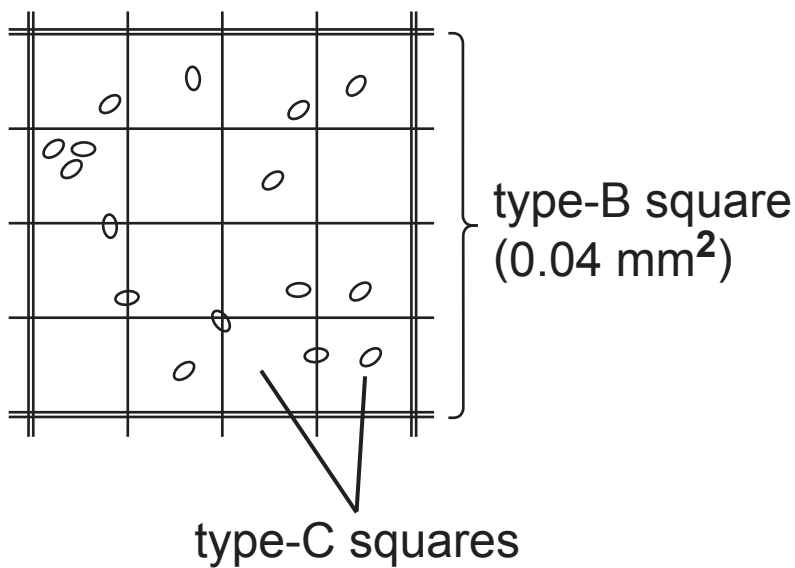
1. _____

2. _____

(c) Name precisely the type of microscope which would have been used to produce this image. [1 mark]

3 In an investigation of population growth, a yeast culture in a conical flask was sampled at regular intervals and the number of cells estimated using a haemocytometer.

(a) The diagram below represents a type-B square from one of the samples. The depth between the surface of the haemocytometer grid and the overlying coverslip was 0.1 mm.



(i) Suggest why it was **not** appropriate to use type-A or type-C squares in estimating the number of yeast cells in this sample. [2 marks]

- (ii) Using the information provided and the diagram, calculate the number of yeast cells in one mm^3 .
[2 marks]
(Show your working.)

Answer _____ cells mm^{-3}

- (b) To ensure validity, it is necessary to control relevant variables, as well as taking additional precautions.

- (i) Suggest a variable that should be controlled when sampling the yeast from the flask. [1 mark]

- (ii) Suggest a precaution that should be taken when adding the yeast to the haemocytometer. [1 mark]

(c) Changes in yeast population numbers over time can be represented by a line graph, using a log scale on the y-axis.

Explain why a log scale is appropriate in this situation.
[2 marks]

(d) An alternative method of estimating microbe populations involves using a colorimeter. For bacterial populations, this is often the preferred method.

(i) Suggest **one** reason why the colorimeter method may be more appropriate for measuring bacterial populations than a haemocytometer. [1 mark]

(ii) In this case, the colorimeter is not used to measure changes in colour. Instead, differences in the 'turbidity' of samples are measured. Suggest the meaning of the term 'turbidity'. [1 mark]

- 5** Pigments which are important in photosynthesis can be separated and identified using paper chromatography.

When preparing a chromatogram, it is important to produce a small, concentrated spot of pigment extract on the pencil line (origin).

- (a)** Describe how a small, concentrated spot of pigment extract can be produced on the origin of the chromatogram. [2 marks]

- (b)** The different pigments can be identified on the basis of their R_f values.

Describe how R_f values are calculated. [2 marks]

(c) The table below shows the R_f values of different photosynthetic pigments calculated by four students.

Pigment	Student			
	A	B	C	D
Carotene	0.96	0.93	0.97	0.85
Xanthophyll	0.70	0.68	0.69	0.56
Chlorophyll a	0.66	0.65	0.66	0.49
Chlorophyll b	0.42	0.46	0.44	0.33

The results produced by the students show variability.

(i) Suggest **one** reason to account for the variability shown in the results for students **A**, **B** and **C**.

[1 mark]

(ii) Compare and contrast student **D**'s results with those of the other students. [2 marks]

(iii) Suggest **one** reason to account for the results recorded by student **D**. [1 mark]

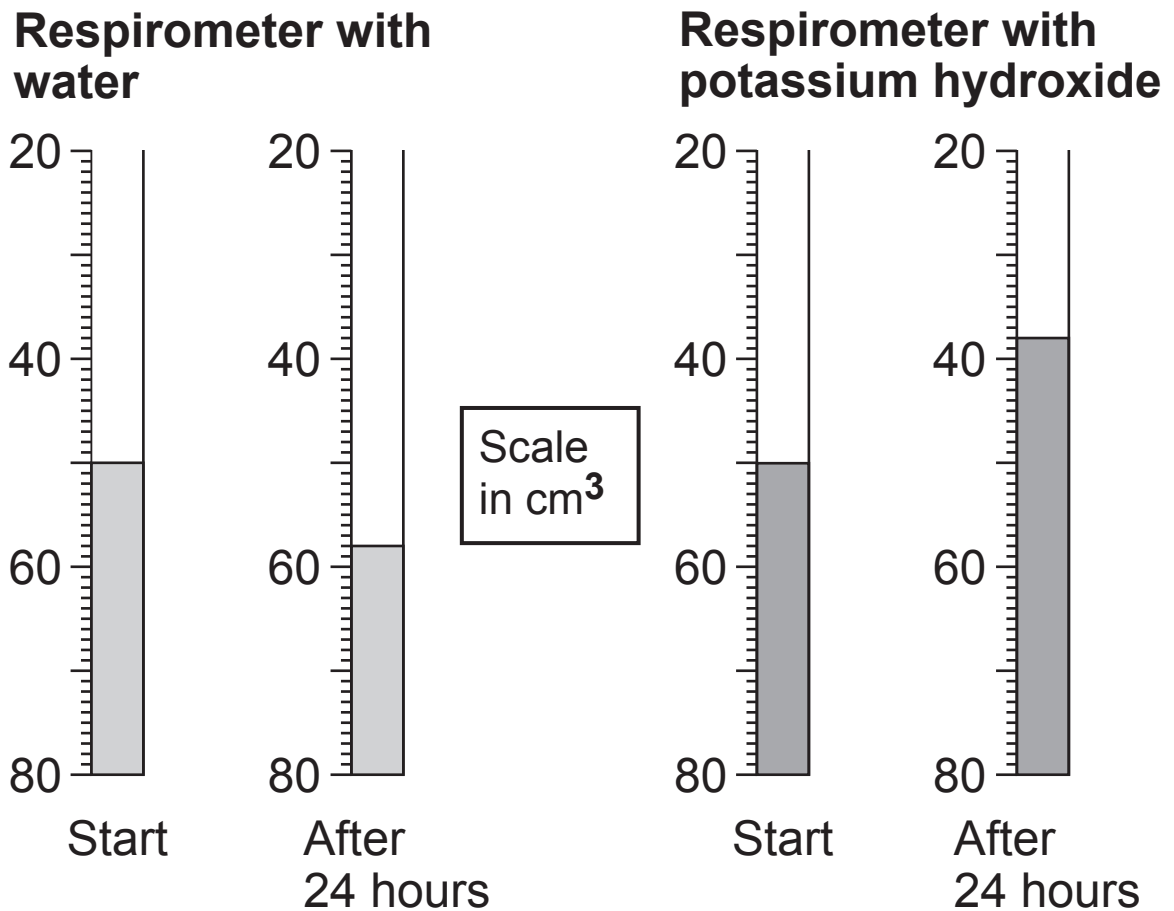
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- 6** Respirometers can be used to calculate oxygen uptake, carbon dioxide production and RQ values for living material.

Two similar respirometers, each with 10 germinating peas, were set up and left for 24 hours. One of the respirometers contained water and the other contained potassium hydroxide.

- (a)** The part of each respirometer containing the living material was covered with foil. Explain the reason for this. [2 marks]

For each respirometer, the level of fluid was measured at the start and at the end of the 24-hour period. The results are represented in the diagram below.



(b) (i) Give the volume of oxygen consumed by the peas over the 24 hours. [1 mark]

_____ cm³

- (ii) Calculate the RQ value for the peas. [2 marks]
(Show your working.)

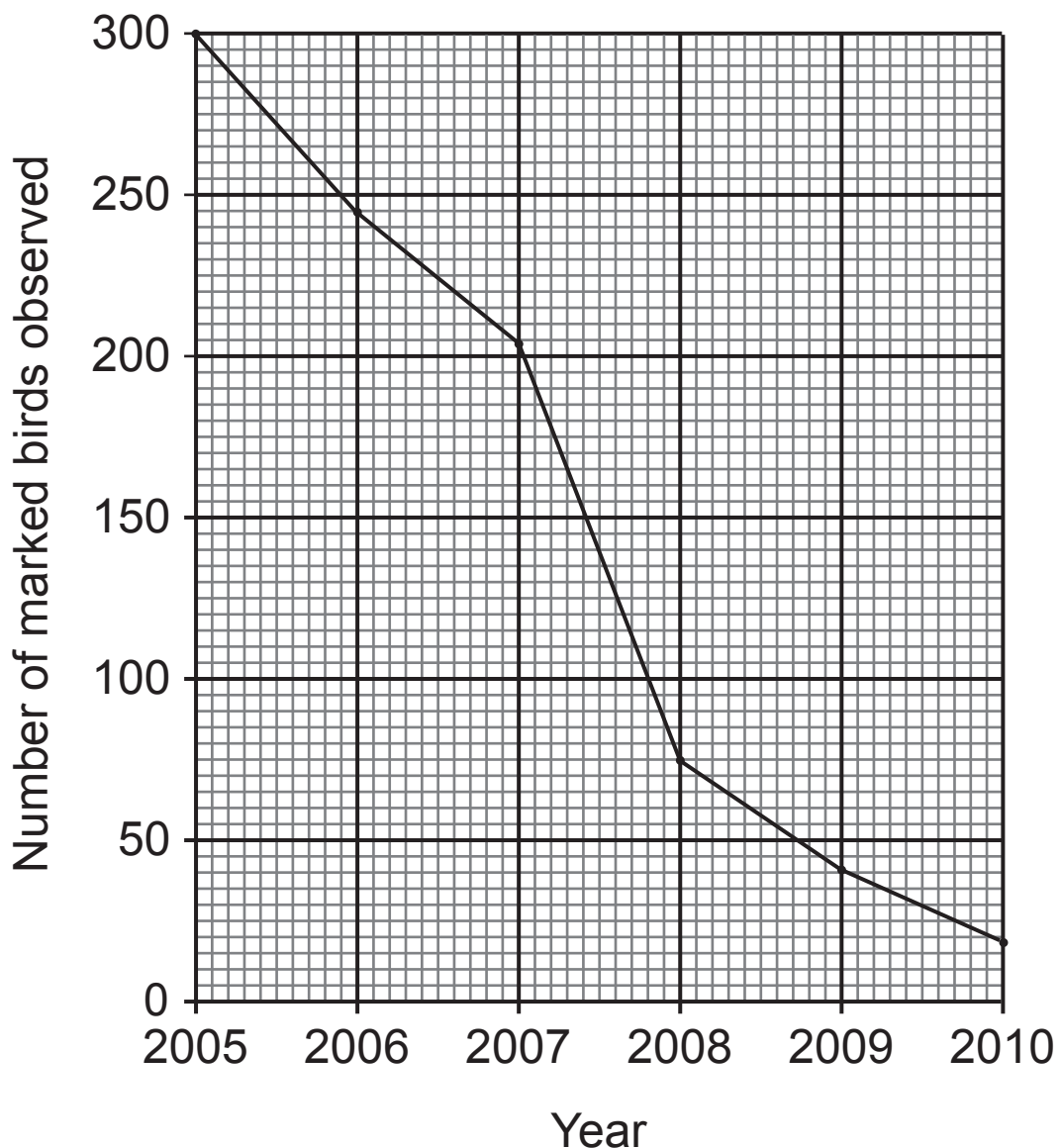
- (c) (i) The two respirometers were kept at the same temperature over the 24-hour period.
Give **one** reason for this. [1 mark]

- (ii) Apart from temperature and time, suggest **one** other variable that should have been controlled.
[1 mark]

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(b) In a survey investigating lifespan/death rate in a lakeshore bird species, 300 birds were marked in 2005 at a specific lakeshore site. On the same date each year for the next five years, the number of marked birds was counted and recorded.

The graph below shows the numbers of marked birds observed throughout the survey.



- (i) Describe fully the trend shown by the graph.
[2 marks]

- (ii) This survey, while providing data on bird lifespan, could not be used to estimate population size using the capture-mark-recapture technique.

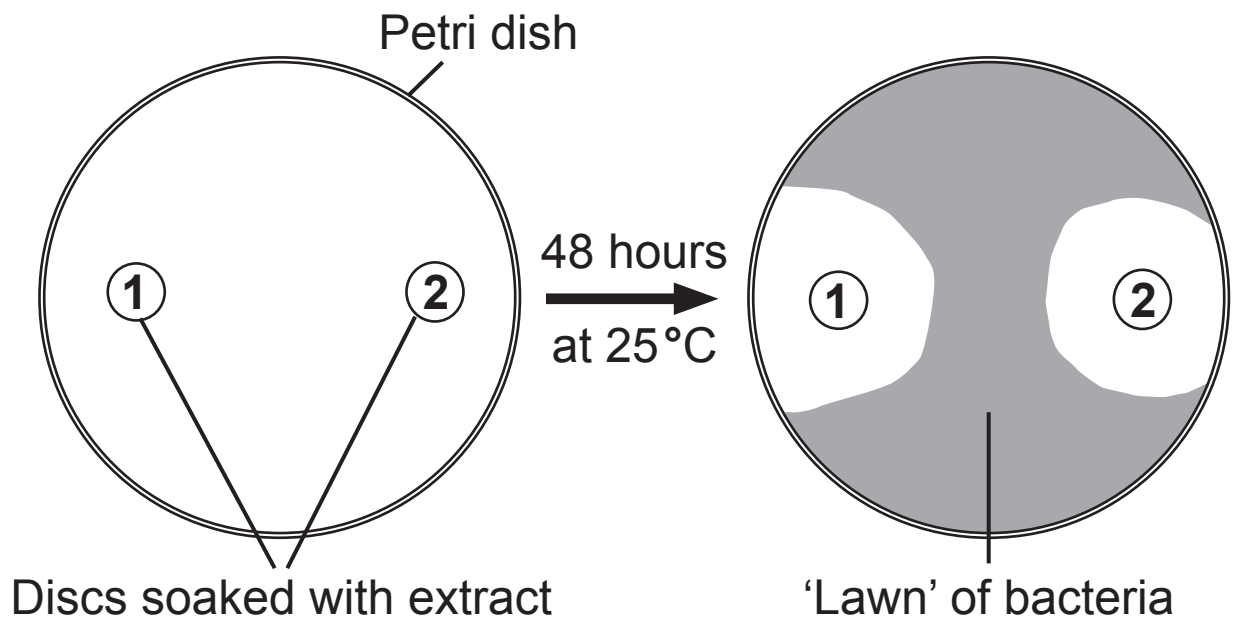
Suggest **two** reasons for this. [2 marks]

1. _____

2. _____

The antimicrobial properties of the herb thyme were investigated using bacterial plates as described in **8(a)(i)**. Thyme leaves were ground up in a mortar with a little ethanol and then sterile filter paper discs were soaked in the extract. Two of these discs (**1** and **2**) were then added to a freshly prepared bacterial plate.

The plate was incubated upside down for 48 hours at 25°C. The results are shown in the diagram below.



(ii) State why the dish was incubated upside down.
[1 mark]

(iii) The diameter (or radius) or area of the clear zone can be used to compare the antimicrobial effectiveness of the extracts in the discs.

Using the information provided, give **one** argument **against** using each of these measurements in this experiment. [2 marks]

Measuring diameter (or radius) of the clear zone

Measuring area of clear zone

(iv) Based on your answer in **(iii)**, suggest **one** way in which the accuracy of results could be improved in this investigation. [1 mark]

(b) To compare the antimicrobial properties of different parts of the thyme plant, 20 discs were prepared as described earlier for a leaf extract and a further 20 for root extract. The investigation was then carried out as before.

The results from this investigation are summarised in the table below.

	Part of plant	
	Leaf	Root
Mean diameter of clear area/mm (\bar{x})	13	22
Standard deviation (error) of the mean ($\hat{\sigma}_{\bar{x}}$)	2.6	3.4

(i) Suggest how the results for the leaf and the root could represent an adaptation for the thyme plant.
[1 mark]

A **t**-test can be used to determine if the difference in the results for the root and leaf extracts is significant.

(ii) Calculate the value of **t** using data from the table opposite. [2 marks]
(Show your working.)

(iii) Using your calculated value of **t** and the Statistics Sheets provided, summarise the outcome of the **t**-test. [2 marks]

THIS IS THE END OF THE QUESTION PAPER

SOURCES

- Q1 Source: <https://www.yourgenome.org/facts/what-is-gel-electrophoresis>, modified.
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- Q2 © Dennis Kunkel Microscopy / Science Photo Library
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For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
Total Marks	

Examiner Number

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Biology

Statistical Formulae and Tables

Statistics Sheets

Statistical Formulae and Tables

1 Definition of Symbols

n = sample size

\bar{x} = sample mean

$\hat{\sigma}$ = estimate of the standard deviation

These parameters are obtained using a calculator with statistical functions, remembering to use the function for $\hat{\sigma}$ – which may be designated a different symbol on the calculator – with $(n - 1)$ denominator.

2 Practical Formulae

2.1 Estimation of the standard deviation (error) of the mean ($\hat{\sigma}_{\bar{x}}$)

$$\hat{\sigma}_{\bar{x}} = \sqrt{\frac{\hat{\sigma}^2}{n}}$$

2.2 Confidence limits for population mean

$$\bar{x} \pm t \sqrt{\frac{\hat{\sigma}^2}{n}}$$

which can be rewritten, in terms of $\hat{\sigma}_{\bar{x}}$, as

$$\bar{x} \pm t(\hat{\sigma}_{\bar{x}})$$

where t is taken from t tables for the appropriate probability and $n - 1$ degrees of freedom.

3 Tests of significance

3.1 Student's *t* test

Different samples are denoted by subscripts; thus, for example, \bar{x}_1 and \bar{x}_2 are the sample means of sample 1 and sample 2 respectively.

The following formula for *t* is that to be used:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\hat{\sigma}_1^2}{n_1} + \frac{\hat{\sigma}_2^2}{n_2}}}$$

which can be rewritten, in terms of $\hat{\sigma}_{\bar{x}}$, as

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\hat{\sigma}_{\bar{x}_1}^2 + \hat{\sigma}_{\bar{x}_2}^2}}$$

with $n_1 + n_2 - 2$ degrees of freedom.

3.2 Chi squared test

Using the symbols *O* = observed frequency, *E* = expected frequency and Σ = the sum of

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

with $n - 1$ degrees of freedom (where *n* is the number of categories).

Table 1 Student's *t* values

d.f.	<i>p</i> = 0.1	0.05	0.02	0.01	0.002	0.001
1	6.314	12.706	31.821	63.657	318.31	636.62
2	2.920	4.303	6.965	9.925	22.327	31.598
3	2.353	3.182	4.541	5.841	10.214	12.924
4	2.132	2.776	3.747	4.604	7.173	8.610
5	2.015	2.571	3.365	4.032	5.893	6.869
6	1.943	2.447	3.143	3.707	5.208	5.959
7	1.895	2.365	2.998	3.499	4.785	5.408
8	1.860	2.306	2.896	3.355	4.501	5.041
9	1.833	2.262	2.821	3.250	4.297	4.781
10	1.812	2.228	2.764	3.169	4.144	4.587
11	1.796	2.201	2.718	3.106	4.025	4.437
12	1.782	2.179	2.681	3.055	3.930	4.318
13	1.771	2.160	2.650	3.012	3.852	4.221
14	1.761	2.145	2.624	2.977	3.787	4.140
15	1.753	2.131	2.602	2.947	3.733	4.073
16	1.746	2.120	2.583	2.921	3.686	4.015
17	1.740	2.110	2.567	2.898	3.646	3.965
18	1.734	2.101	2.552	2.878	3.610	3.922
19	1.729	2.093	2.539	2.861	3.579	3.883
20	1.725	2.086	2.528	2.845	3.552	3.850
21	1.721	2.080	2.518	2.831	3.527	3.819
22	1.717	2.074	2.508	2.819	3.505	3.792
23	1.714	2.069	2.500	2.807	3.485	3.767
24	1.711	2.064	2.492	2.797	3.467	3.745
25	1.708	2.060	2.485	2.787	3.450	3.725
26	1.706	2.056	2.479	2.779	3.435	3.707
27	1.703	2.052	2.473	2.771	3.421	3.690
28	1.701	2.048	2.467	2.763	3.408	3.674
29	1.699	2.045	2.462	2.756	3.396	3.659
30	1.697	2.042	2.457	2.750	3.385	3.646
40	1.684	2.021	2.423	2.704	3.307	3.551
60	1.671	2.000	2.390	2.660	3.232	3.460
120	1.658	1.980	2.358	2.617	3.160	3.373
∞	1.645	1.960	2.326	2.576	3.090	3.291

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Table 2 χ^2 values

d.f.	$p = 0.900$	0.500	0.100	0.050	0.010	0.001
1	0.016	0.455	2.71	3.84	6.63	10.83
2	0.211	1.39	4.61	5.99	9.21	13.82
3	0.584	2.37	6.25	7.81	11.34	16.27
4	1.06	3.36	7.78	9.49	13.28	18.47
5	1.61	4.35	9.24	11.07	15.09	20.52
6	2.20	5.35	10.64	12.59	16.81	22.46
7	2.83	6.35	12.02	14.07	18.48	24.32
8	3.49	7.34	13.36	15.51	20.09	26.13
9	4.17	8.34	14.68	16.92	21.67	27.88
10	4.87	9.34	15.99	18.31	23.21	29.59
11	5.58	10.34	17.28	19.68	24.73	31.26
12	6.30	11.34	18.55	21.03	26.22	32.91
13	7.04	12.34	19.81	22.36	27.69	34.53
14	7.79	13.34	21.06	23.68	29.14	36.12
15	8.55	14.34	22.31	25.00	30.58	37.70
16	9.31	15.34	23.54	26.30	32.00	39.25
17	10.09	16.34	24.77	27.59	33.41	40.79
18	10.86	17.34	25.99	28.87	34.81	42.31
19	11.65	18.34	27.20	30.14	36.19	43.82
20	12.44	19.34	28.41	31.41	37.57	45.32
21	13.24	20.34	29.62	32.67	38.93	46.80
22	14.04	21.34	30.81	33.92	40.29	48.27
23	14.85	22.34	32.01	35.17	41.64	49.73
24	15.66	23.34	33.20	36.42	42.98	51.18
25	16.47	24.34	34.38	37.65	44.31	52.62
26	17.29	25.34	33.56	38.89	45.64	54.05
27	18.11	26.34	36.74	40.11	46.96	55.48
28	18.94	27.34	37.92	41.34	48.28	56.89
29	19.77	28.34	39.09	42.56	49.59	58.30
30	20.60	29.34	40.26	43.77	50.89	59.70
40	29.05	39.34	51.81	55.76	63.69	73.40
50	37.69	49.33	63.17	67.50	76.15	86.66
60	46.46	59.33	74.40	79.08	88.38	99.61
70	55.33	69.33	85.53	90.53	100.43	112.32
80	64.28	79.33	96.58	101.88	112.33	124.84
90	73.29	89.33	107.57	113.15	124.12	137.21
100	82.36	99.33	118.50	123.34	135.81	149.45

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