PAG 5 Colorimeter and Potometer: OCR A Level Biology Exam Questions

16 questions · 38 marks · about 46 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · AS Paper 1 · June 2019 · Q22(b)(i) · 1 mark

(b) Before taking readings with a colorimeter it is important to calibrate the apparatus.

(i) Describe how a colorimeter is calibrated.

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

Question 2 · AS Paper 1 · June 2019 · Q22(b)(ii) · 1 mark

(ii) Why is it important to calibrate a colorimeter?

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

Question 3 · information from earlier in the question

(b) A group of students use beetroot to investigate the effects of the solvent ethanol on the permeability of the cell surface membrane.

This is the method they use:

1. Set up six test tubes of ethanol of different concentrations (0%, 20%, 40%, 60%, 80% and 100%).
2. Add a piece of beetroot to each test tube.
3. After 10 minutes, remove the beetroot from the test tube. If membrane damage has occurred the solution in the test tube is a purple colour.
4. Use a green filter in a colorimeter to measure the absorbance of the ethanol solution. The absorbance is proportional to the level of membrane damage.
5. Repeat the experiment.

(i) State **two** variables that were **not** controlled in this experiment.

1 .....

2 .....

[2]

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Question 3 · AS Paper 1 · June 2025 · Q24(b)(ii) · 1 mark

(ii) One of the students suggests using a red filter in the colorimeter because this is what they had used for a Benedict's test.

Suggest why the student is **incorrect** to suggest using a red filter.

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

Question 4 · A level Paper 2 · June 2022 · Q21(d)(i) · 4 marks

(d) Mycoprotein foods contain protein.

The presence of protein in a solution can be detected using biuret reagent.

In the presence of protein, biuret reagent turns from blue to violet.

(i) A colorimeter can be used, along with biuret reagent, to determine the concentration of protein in a solution.

Outline how to use a colorimeter to determine the concentration of protein in a solution.

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..... **[4]**

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Question 5 · A level Paper 1 · June 2018 · Q20(a)(i) · 3 marks

20 (a) A student carried out an investigation into the effect of ethanol on the permeability of cell membranes in beetroot.

The student's method comprised the following five steps:

1. Cut equal sized pieces of beetroot using a cork borer.
2. Wash the pieces in running water.
3. Place the pieces in 100 cm^3 of different concentrations of ethanol.
4. After 5 minutes, remove samples from each of the ethanol solutions.
5. Place each of the samples into a colorimeter to collect quantitative data.

(i) Each step in the student's method relies on certain assumptions.

For each assumption listed below, select the **numbered step** from the student's method that relies upon that assumption.

*Assumption **A***

Pigment will only leak into the solution if membranes are disrupted.

*Assumption **A** relates to step* .....

*Assumption **B***

Absorbance is proportional to concentration of pigment.

*Assumption **B** relates to step* .....

*Assumption **C***

Pigment will be released when the beetroot is sliced.

*Assumption **C** relates to step* .....

[3]

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Question 6 · A level Paper 1 · June 2018 · Q20(b)(i) · 3 marks

(b) Fig. 20.1 shows the graph plotted by the student.

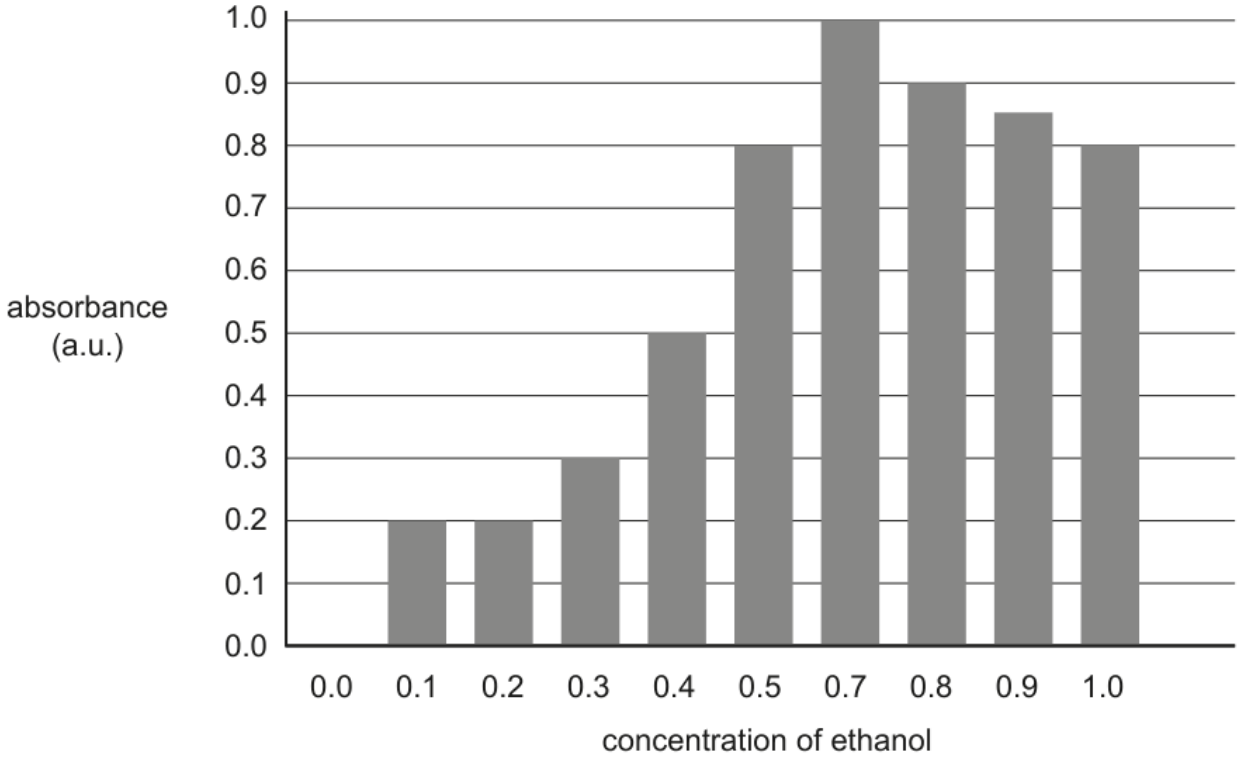


Fig. 20.1

(i) Make **three** criticisms of the way the student has displayed these results.

1 .....

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2 .....

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3 .....

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[3]

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Question 7 · information from earlier in the question

22 A student investigates the effect of ethanol on the membranes of beetroot cells at 25 °C.

They place equal masses of beetroot in tubes containing different concentrations of ethanol.

They then use a colorimeter to measure the concentration of purple pigment that leaked out of the cells.

The student replicates the experiment five times at each ethanol concentration and plots a graph of absorption in arbitrary units (A.U.) against concentration of ethanol.

(a) The student controls the mass of beetroot in this investigation.

Identify **two** other variables that the student should control in this investigation.

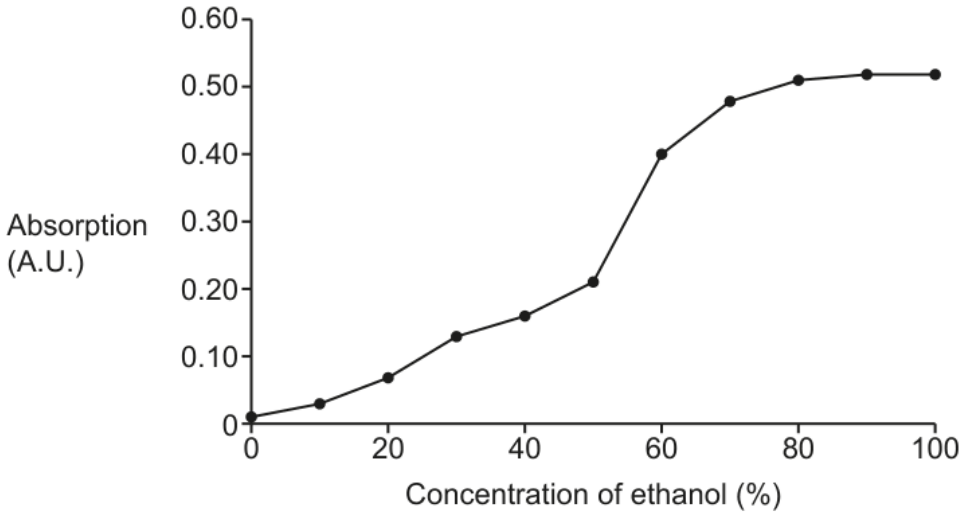
1 .....

2 .....

[2]

Question 7 · A level Paper 1 · June 2024 · Q22(b)(i) · 2 marks

(b) The student's graph is shown below.



(i) Explain the shape of the graph.

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

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Question 8 · A level Paper 1 · June 2024 · Q22(b)(ii) · 2 marks

(ii) The student repeats the experiment at a temperature of 30 °C.

Sketch the graph you expect the student to obtain.

Answer on the graph. **[2]**

Question 9 · information from earlier in the question

(b) The permeability of plasma membranes can be investigated using beetroot.

Beetroot cells contain a red pigment. The red pigment leaks out of the cells only when the plasma membrane has become damaged.

Some students investigated the effect of pH on the permeability of plasma membranes in beetroot cells.

The students used a valid method for the investigation, which is outlined below:

- Equal-sized disks of beetroot were cut.
- The disks were each immersed in an equal volume of buffer solution.
- After a set time, the solution was stirred and the absorbance measured using a colorimeter.
- The procedure was replicated three times in each of six different pH buffers.

The students recorded their results in the format shown below.

pH2 – 80%, 78%, 78%: average = 78.67%
pH3 – 61%, 60%, 60%: average = 60.33%
pH4 – 19%, 23%, 22%: average = 21.33%
pH5 – 9%, 10%, 11%: average = 10 %
pH6 – 0%, 0%, 0%: average = 0
pH7 – 0%, 0%, 0%: average = 0

17

(i) Present the students' results in an appropriate table in the space below.

[4]

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Question 9 · A level Paper 2 · November 2021 · Q18(b)(iii) · 2 marks

(iii) Outline how the students could modify their investigation to get a more accurate value for the pH at which the red pigment begins to leak out of the beetroot cells.

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

Turn over

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(c) One student's results are shown in **Table 17.2**.

The results have been rounded to the nearest 5%.

Positive values represent increased growth and negative values represent decreased growth.

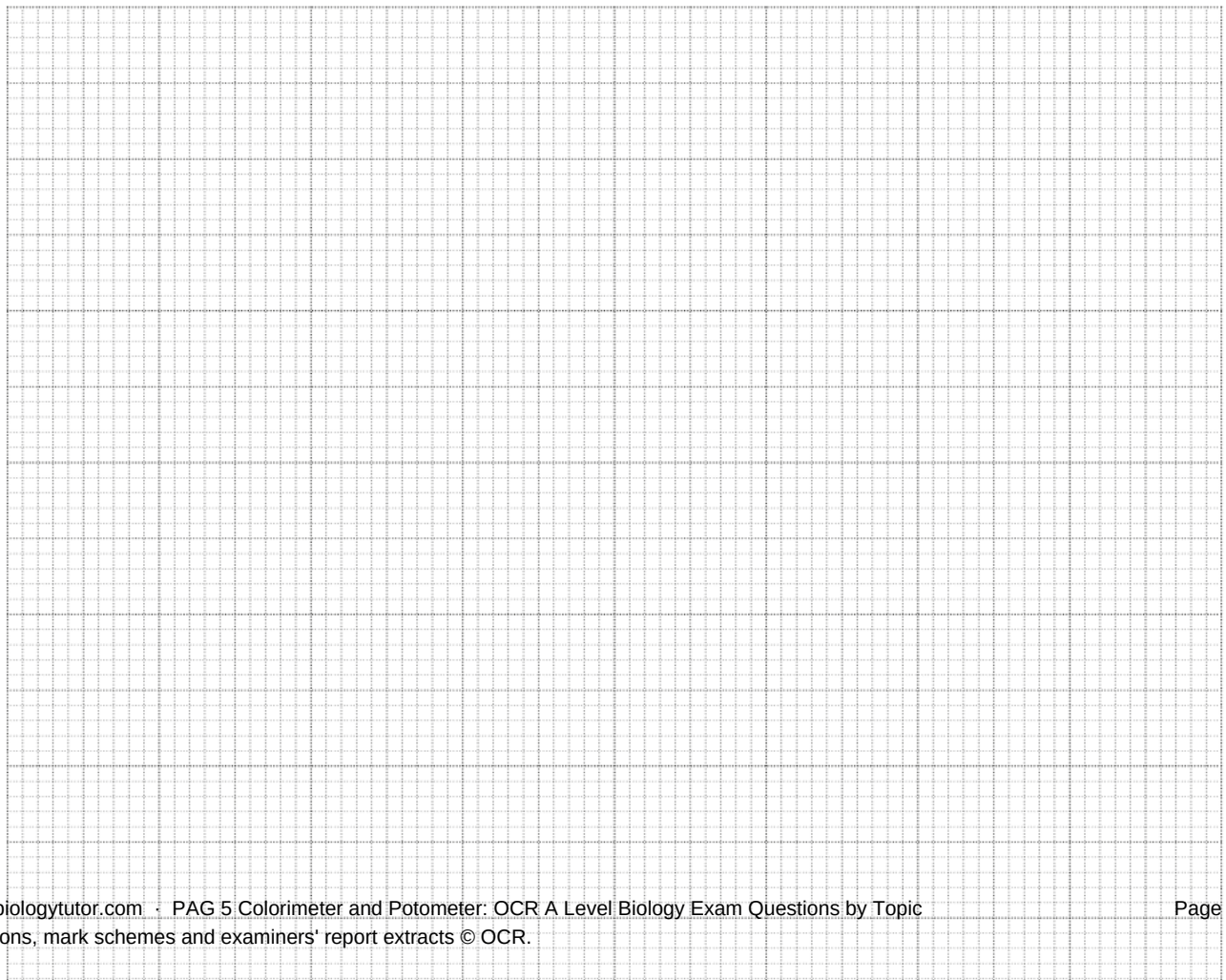
The concentration of IAA was measured in parts per million (ppm).

Table 17.2

Concentration of IAA (ppm)	% change in length	
	Root	Shoot
1×10^{2}	–100	0
1×10^{1}	–100	+200
1×10^{0}	–75	+140
1×10^{-1}	–45	+70
1×10^{-2}	+25	+30
1×10^{-3}	+65	+10
1×10^{-4}	+70	0
1×10^{-5}	+55	0

21

(i) Plot a graph of the data in **Table 17.2**. **[4]**



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Question 10 · A level Paper 1 · June 2023 · Q17(c)(ii) · 2 marks

(ii) The students were given an IAA solution of concentration 100 ppm.

Outline a procedure the students could use to prepare the 8 test solutions required for the experiment.

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

Question 11 · A level Paper 1 · June 2023 · Q17(c)(iii) · 2 marks

(iii) Describe **two** precautions the students should take to make sure the concentrations of the solutions they prepare are accurate.

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2 .....

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[2]

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4 An investigation was carried out into the loss of water from a leafy shoot. The apparatus used is shown in Fig. 4.1.

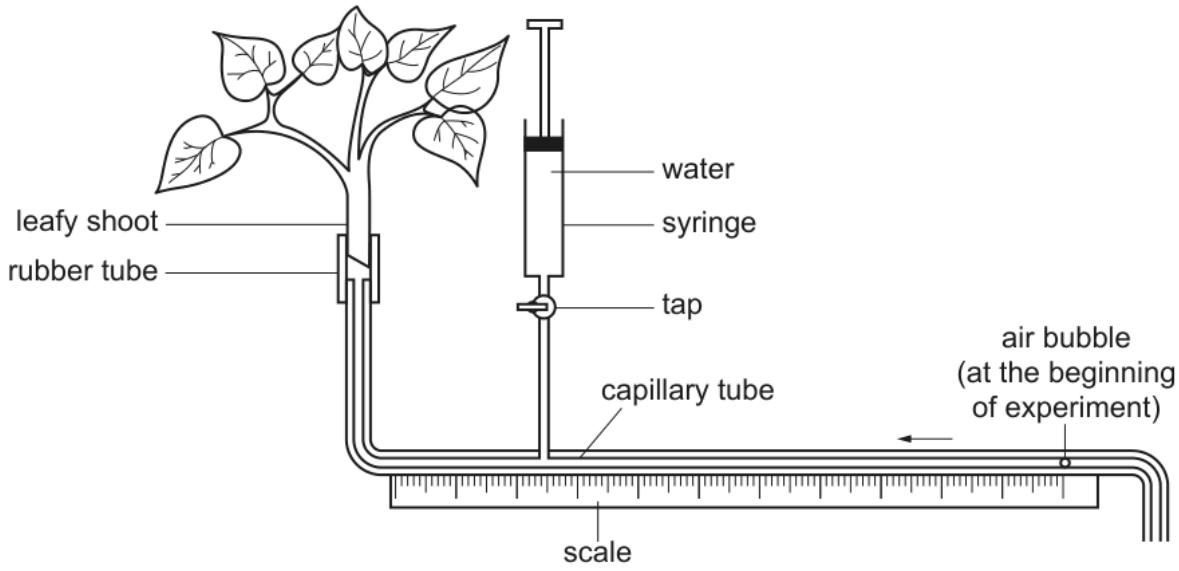


Fig. 4.1

(a) (i) State what assumption is made when using this apparatus to measure the rate of transpiration.

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

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Question 13 · AS Paper 2 · June 2019 · Q4(a)(ii) · 6 marks

(ii)* There must be no air in the apparatus in Fig. 4.1 for it to work correctly.

Describe and explain the precautions that need to be taken when setting up and using the apparatus in Fig. 4.1 to ensure that no air is present.

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

Additional answer space if required.

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Turn over

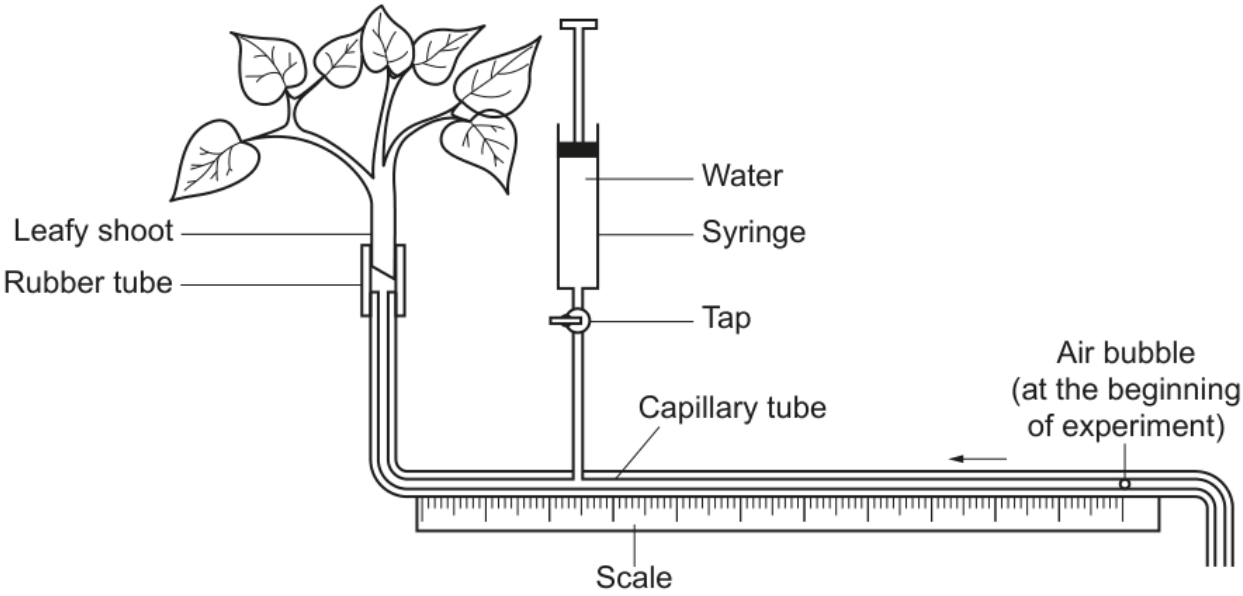
(b) A class of students investigated the effect of humidity on the rate of transpiration from a leafy shoot.

They made the assumption that the volume of water uptake by a leafy shoot is equivalent to the volume of water lost through transpiration.

This is the method the class followed:

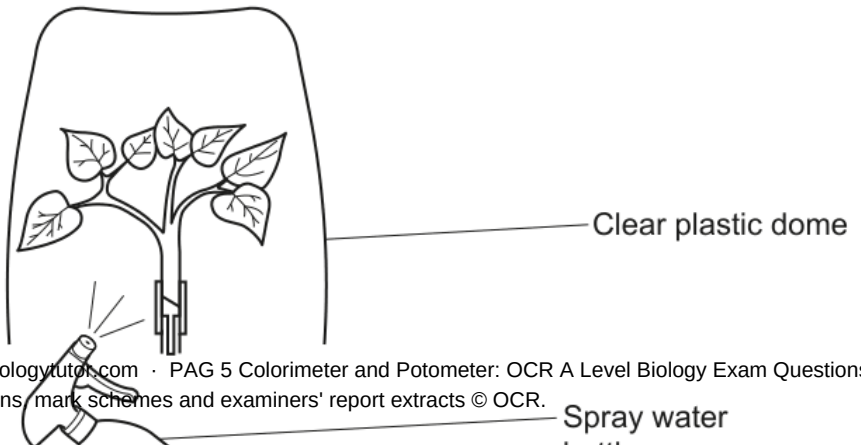
- The class was divided into three groups.
- Each group had a potometer and a leafy shoot, shown in **Fig. 2.1**.
- Each group investigated one humidity level and completed three trials.
- They measured the distance moved by the air bubble in a fixed time.
- Group A used only the apparatus shown in **Fig. 2.1**.
- Groups B and C added to the apparatus. They put a clear plastic dome over the leafy shoot and used a water spray to vary the humidity around the leafy shoot. This is shown in **Fig. 2.2**.

Fig. 2.1



7

Fig. 2.2



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Question 15 · information from earlier in the question

(b) A student obtained replicate readings for the movement of the air bubble during five minutes in three different conditions. The results are shown in Table 4.1.

Condition	Distance moved by bubble in 5 minutes (mm)						
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Mean
In still air	89	84	86	87	85	86	86.2
With an electric fan	142	139	144	138	139	141	140.5
In still air and lower leaf surface covered with petroleum jelly	32	28	31	57	27	29	34.0

Table 4.1

(i) Identify an anomalous reading in the data **and** evaluate the extent to which it has affected the mean that has been calculated.

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

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(iii) The internal diameter of the capillary tubing was 0.7 mm.

Table 4.2 shows the mean rate of transpiration in each of the experimental conditions.

Condition	Mean rate of transpiration ($mm^3 min^{-1}$)
In still air	
With an electric fan	10.81
In still air and lower leaf surface covered with petroleum jelly	2.62

Table 4.2

Calculate the mean rate of transpiration for the leafy shoot in still air.

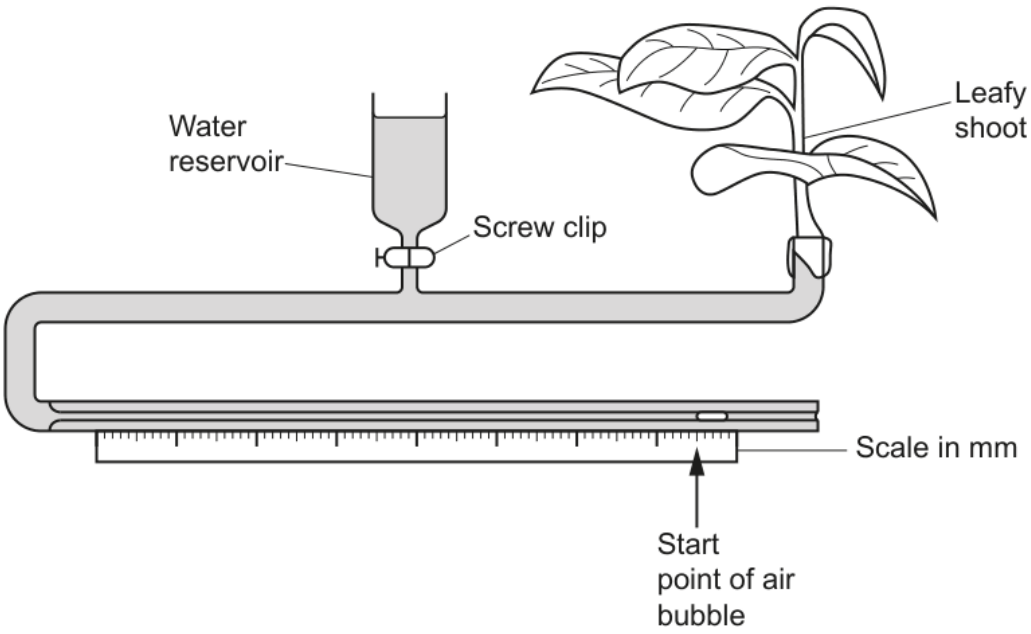
Use the formula: Volume of a cylinder = $\pi r^2 l$

rate of transpiration = ... $mm^3 min^{-1}$ **[3]**

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(c) A scientist plans to investigate the effect of temperature on the rate of transpiration in *P. vulgaris*.

The scientist uses a potometer in their investigation, as shown in the diagram below.



(i) The scientist plans to calculate the rate of transpiration by measuring the distance moved by the air bubble.

The scientist carries out a preliminary trial by measuring the distance moved by the air bubble in 30 minutes at 20 °C.

The bubble moves 18 mm in 30 minutes. The diameter of the capillary tubing in the potometer is 1 mm.

Calculate the rate of transpiration, in $mm^3 h^{-1}$, during this preliminary trial.

Use the formula: Volume of cylinder = $\pi r^2 l$

Rate of transpiration = ... $mm^3 h^{-1}$ **[2]**

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Mark schemes

Question 1 · AS Paper 1 · June 2019 · Q22(b)(i) · 1 mark

(b)	**(i)**	set to zero absorbance using blank / (distilled) water ✓	**1**

ALLOW set to 100% transmission using water

Question 2 · AS Paper 1 · June 2019 · Q22(b)(ii) · 1 mark

		(ii)	idea that values are, all measured to the same standard / comparable / accurate / valid ✓
			Total

Question	**Answer**
1	**ALLOW** reduce systematic error / AW
5	

Marks	**Guidance**

Question 3 · AS Paper 1 · June 2025 · Q24(b)(ii) · 1 mark

(ii)	*idea that* choice of filter depends on colour of solution measured ✓ Benedict's test is a blue solution , this is , purple / red (solution) ✓

1 max	3.4	**ALLOW** *idea that* red pigment/solution will reflect red light (making absorption low) ORA for transmission **ALLOW** like will reflect like / colour of filter should be different to colour of , pigment / solution

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Question 4 · A level Paper 2 · June 2022 · Q21(d)(i) · 4 marks

(d)	**(i)**	**1**	zero the colorimeter ✓
		2	use known (concentration of protein) solutions ✓
		3	plot calibration curve / absorbance vs concentration ✓
		4	measure absorbance of (unknown) sample ✓
		5	compare (absorbance of) sample with (calibration) graph ✓
		6	use appropriate filter for , (shade of) purple / biuret ✓

4 max	1.2 2.5 3.3	**1 IGNORE** calibrate / blank / tare **1 ALLOW** reference to 100% only if explicitly measuring transmission **3, 4** and **5 ALLOW** 'transmission' as AW for 'absorbance' **6 ALLOW** use , green / yellow , filter

Question 5 · A level Paper 1 · June 2018 · Q20(a)(i) · 3 marks

20	**(a)**	**(i)**	3 **OR** 2 ✓ 5 ✓ 2 ✓	**3**

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Question 6 · A level Paper 1 · June 2018 · Q20(b)(i) · 3 marks

(b)	(i)	*x* axis / concentration of ethanol , has no units ✓ should be a line graph (as continuous data) ✓ *x* axis / concentration (of ethanol) , has incorrect scale / 0.6 not included ✓ no title ✓	3 max

List Rule

If all **three** prompt lines used and more than one criticism is on the line mark the **first** one on each line.
If only **one** or **two** lines used but there is more than one criticism listed mark as continuous prose.

ALLOW bar graph not appropriate for continuous data

Question 7 · A level Paper 1 · June 2024 · Q22(b)(i) · 2 marks

22	(b)	(i)	(increased) ethanol (concentration) increases permeability of membranes / AW ✓ (curve) levels off as , no more / all , pigment is released ✓	2

ALLOW e.g. ethanol disrupts phospholipid bilayer so more pigment leaks out
IGNORE positive correlation

ALLOW until concentration of pigment inside and outside cell is the same

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Question 8 · A level Paper 1 · June 2024 · Q22(b)(ii) · 2 marks

22	(b)	(ii)	curve to the left of the student's curve ✓ reaches same max value ✓
			Total

2	**IGNORE** start point (increased temperature may cause release of pigment at 0% ethanol) **Max 1** if curve drops below student curve at any point (allow if touches points) or if goes above maximum shown by last two points
6	

Question 9 · A level Paper 2 · November 2021 · Q18(b)(iii) · 2 marks

		(iii)	use pH buffer range with narrower intervals ✓ pH (buffers) , close to pH6 / between pH5 and pH6 / between pH5 and pH7 ✓

Question		Answer
2	3.3	**ALLOW** stated values (must be more than one) at interval of less than 1 **ALLOW** stated value of buffer within the range pH5 to pH7 'test more values between pH5 and pH6' = 2 marks. 'test at pH 6.5' = 1 mark (mp2)

Marks	AO element	Guidance

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Question 10 · A level Paper 1 · June 2023 · Q17(c)(ii) · 2 marks

17	(c)	(ii)	keep , (some) stock / undiluted , solution to use for , 100 / 10^2 , ppm ✓ use serial dilution ✓ 1cm^3 of , stock / 100ppm / 10^2, solution and add 9cm^3 of (distilled) water (to get 10ppm) ✓ repeat this procedure with each previously diluted solution ✓	

max 2	3.3	**MUST** be clear statement not implied **ALLOW** other stated volumes to give 1 in 10 **ALLOW** annotated drawing for MPs 3 and 4

Question 11 · A level Paper 1 · June 2023 · Q17(c)(iii) · 2 marks

17	(c)	(iii)	use , new / clean , syringe / pipette for , measuring volumes / each transfer ✓ ensure (adequate) mixing at each step / AW ✓	**2**	3.3

Mark as continuous prose
ALLOW other suitable apparatus for measuring volume
ALLOW separate / different for clean / new
IGNORE rinsing

Question 12 · AS Paper 2 · June 2019 · Q4(a)(i) · 1 mark

4	(a)	(i)	water loss / transpiration / evaporation, equals uptake ✓	**1**

ALLOW all the water taken up is, lost / transpired / evaporated
ALLOW none of the water (taken up) is used

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(ii)* ***Please refer to the marking instructions on page 4 of this ma***

In summary:
Read through the whole answer. (Be prepared to recognise and
Using a 'best-fit' approach based on the science content of the a
***Level 3**, best describes the overall quality of the answer.*
Then, award the higher or lower mark within the level, according

- *award the higher mark where the Communication Stateme*
- *award the lower mark where aspects of the Communicatio*

- ***The science content determines the level.***
- ***The Communication Statement determines the mark withir***

Level 3 (5–6 marks)
A detailed description **and** explanation of the precautions needed when setting up **and** using the apparatus.
There is a well-developed line of reasoning which is clear and logically structured. All the information presented is relevant and substantiated.

Level 2 (3–4 marks)
A basic description **and** explanation of the precautions needed when setting up **and** using the apparatus.
OR
A detailed description and explanation of the precautions needed when setting up **or** using the apparatus.
There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)
A description of some of the precautions needed when setting up **and** using the apparatus.
There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

0 marks
No response or no response worthy of credit.

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ark scheme for guidance on how to mark this question.

credit unexpected approaches where they show relevance.)
*nswer, first decide which of the level descriptors, **Level 1**, **Level 2** or*

*to the **Communication Statement** (shown in italics).*
nt has been met.

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Question 14 · AS Paper 2 · June 2023 · Q2(b)(i) · 3 marks

(b)	**(i)**	*Any three from:* **1** close dome off at bottom/ seal a clear plastic bag which can be tied (to stem of shoot) ✓ **2** testing, more/ lots of, humidities **OR** repeat more than x3 ✓ **3** group A cover leafy shoot (with a clear dome) ✓ **4** control, (room) temperature / light intensity ✓ **5** limit air movement ✓ **6** same area sprayed/even spray, each time ✓ **7** same/measure, volume (of water) in each spray ✓ **8** same, type of plant/size of leaves, used each time ✓ **9** check humidity level with, relative humidity meter / hygrometer **OR** use a humidifier ✓

Max 3	**3.3**	**IGNORE** ref to (all use same) apparatus as this is stated in the question. **1 ALLOW** ensure the, dome/bag is airtight **2 IGNORE** do more trials unqualified/ Group A use apparatus in Fig 2.2 **2 ALLOW** all groups should do all humidities. **3 ALLOW** Group A use a clear dome **6 ALLOW** distance the spray is used stays same **7 IGNORE** amount for 'volume' **8 ALLOW** same, stomatal density/ number of leaves/ surface area for 'same size leaves'

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Question 15 · AS Paper 2 · June 2019 · Q4(b)(iii) · 3 marks

(iii)	6.63 ✓ ✓ ✓	**3**

Correct answer = 3 marks even if no working shown.
ALLOW answer in table 4.2

ALLOW close figure showing, rounding error / error due to rounding during calculation, but deduct 1 mark

If final answer incorrect award 2 marks for:

answer not to 2 d.p: 7 / 6.6 / 6.631 / 6.632 or more d.p.

answer for 5 mins: 33.16

diameter used: 26.53

radius not squared: 18.95

Award 1 mark if two errors occur:

wrong answer not to 2 d.p: 33 / 33.2 / 27 / 26.5 / or more d.p.

diameter used & 5 mins: 132.63

If no calculated answer then **award 1 mark** for working:

$(3.14 \times 0.35^2) \times (86.2 \div 5)$
or
$(3.14 \times 0.35^2) \times 17.24$

ALLOW π for 3.14

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Question 16 · A level Paper 3 · June 2024 · Q3(c)(i) · 2 marks

3	(c)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 28 / 28.3 award two marks** 1mm / 2 = 0.5 $0.5^2 = 0.25$ x π = 0.78539 x 18 = 14.137 ✓ x 2 = 28.274 = 28 mm^3 h^{-1} ✓	**2**

ALLOW 1 mark for correct answer not rounded to two or three significant figures (e.g. 28.27433, 28.2857, 28.26, 28.278) (depending on value of π used)

ALLOW 1 mark for correctly working out volume of water lost in 30 minutes (to any number of sig figs (e.g.14.137165, 14.142855,14.13,14.139) (depending on value of π used)

ECF if diameter rather than radius used to calculate volume (110 or 113) for 1 mark

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