Osmosis in plant tissue

Answers, marking points and revision notes | AQA Combined Science 8464 and AQA GCSE Biology 8461

GCSE science required practicals

This practical online

Answers

1 Name the independent variable and the dependent variable in Mateusz's investigation. (2 marks)

The independent variable is the concentration of the sugar solution. The dependent variable is the percentage change in mass of the potato cylinder.

Marking points

- independent: concentration of sugar solution
- dependent: (percentage) change in mass of the potato

2 Mateusz used a cork borer and cut every cylinder to the same length. Explain why the cylinders needed to be the same size. (2 marks)

A bigger cylinder has a larger surface area, so water could move in or out faster and its mass would change by a different amount. Keeping the size the same means only the concentration of the solution affects the result.

Marking points

- a different size gives a different surface area (for water to cross)
- so the rate / amount of osmosis would change, making it an unfair test

3 Why did Mateusz blot each cylinder with a paper towel before measuring its mass at the end, and why must he blot every cylinder in the same way? (2 marks)

Blotting removes the solution left on the outside of the cylinder, so only the water taken into the cells is weighed. If some cylinders were blotted more than others, different amounts of surface liquid would be left on them and the masses could not be compared.

Marking points

- removes surface solution so it does not add to the mass
- blotting differently would leave different amounts of liquid, so results would not be comparable

4 Give **one** hazard in this practical and describe how to reduce the risk. (2 marks)

The scalpel is very sharp and could cut the fingers. Cut downwards onto a white tile, keeping fingers away from the blade.

Marking points

- a hazard, e.g. sharp scalpel / cork borer, broken glass, spilled solution
- a matching control, e.g. cut onto a tile away from the fingers, keep tubes in a rack, wipe spills

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5 Calculate the value of X in the table, the percentage change in mass in the 0.2 mol/dm^3 solution. Give your answer to 1 decimal place. Show your working. (3 marks)

Change in mass = 2.70 - 2.55 = +0.15 g. Percentage change = 0.15 ÷ 2.55 × 100 = 5.88... = +5.9%.

change in mass = end mass - start mass

change in mass = 2.70 g - 2.55 g = +0.15 g

percentage change = change in mass ÷ start mass × 100

percentage change = 0.15 ÷ 2.55 × 100

percentage change = 5.882...

X = +5.9% (1 decimal place)

Marking points

- change in mass = 2.70 - 2.55 = 0.15 g
- 0.15 ÷ 2.55 × 100
- +5.9%

6 Mateusz's friend said he should just compare the change in mass in grams. Explain why percentage change in mass is better. (2 marks)

The cylinders had different starting masses, from 2.44 g to 2.61 g. Percentage change takes the starting mass into account, so the results for different cylinders can be compared fairly.

Marking points

- the cylinders started with different masses
- percentage change allows a fair comparison between cylinders

7 Identify the anomalous result in the table and suggest what Mateusz should do about it. (2 marks)

The result for 0.6 mol/dm^3 (-2.8%) is anomalous, because it should be a bigger loss than at 0.4 mol/dm^3. He should repeat that concentration with a fresh cylinder and leave the anomaly out of his line of best fit.

Marking points

- 0.6 mol/dm^3 / -2.8% identified as anomalous
- repeat it / ignore it when drawing the line of best fit

8 The potato cylinder in distilled water (0.0 mol/dm^3) gained mass. Explain why, using ideas about osmosis. (3 marks)

Distilled water has a higher water concentration than the solution inside the potato cells. Water moved into the cells by osmosis, from the dilute solution to the more concentrated one, across the partially permeable cell membranes. The extra water inside the cells increased the mass of the cylinder.

Marking points

- the water outside is more dilute (higher water concentration) than inside the cells
- water moves into the cells by osmosis
- through a partially permeable membrane, so the mass increases

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9 Calculate the change in mass in grams of the cylinder in the 1.0 mol/dm^3 solution, and say whether it gained or lost mass. (2 marks)

2.06 - 2.57 = -0.51 g, so the cylinder lost 0.51 g.

change in mass = end mass - start mass

change in mass = 2.06 g - 2.57 g

change in mass = -0.51 g (a loss of 0.51 g)

Marking points

- 2.06 - 2.57 = (-)0.51 g
- it lost mass

10 **Higher tier**

The percentage change in mass was +5.9% at 0.2 mol/dm^3 and -3.8% at 0.4 mol/dm^3.

Assume the percentage change falls at a steady rate between these two concentrations. Estimate the concentration of sugar solution that would give no change in mass. Give your answer to 2 significant figures. Show your working. (3 marks)

Between 0.2 and 0.4 mol/dm^3 the change falls by 5.9 + 3.8 = 9.7 percentage points. To reach 0% it has to fall 5.9, which is 5.9 ÷ 9.7 = 0.608 of the way. 0.608 × 0.2 = 0.122, so the concentration is 0.2 + 0.122 = 0.32 mol/dm^3.

total fall between the two points = 5.9 - (-3.8) = 9.7

fall needed to reach 0% = 5.9

fraction of the gap = 5.9 ÷ 9.7 = 0.6082...

extra concentration = 0.6082... × 0.2 = 0.1216... mol/dm^3

concentration = 0.2 + 0.1216...

concentration = 0.3216... = 0.32 mol/dm^3 (2 significant figures)

Marking points

- total fall = 9.7 (percentage points) over 0.2 mol/dm^3
- fraction of the way = 5.9 ÷ 9.7 (= 0.608) or equivalent
- 0.32 mol/dm^3

11 **Higher tier**

What does your answer to the last question tell you about the potato cells? Explain your answer. (2 marks)

The solution inside the potato cells has about the same concentration as a 0.32 mol/dm^3 sugar solution. At this concentration there is no overall movement of water into or out of the cells, so the mass does not change.

Marking points

- the concentration inside the potato cells is about 0.32 mol/dm^3 (the same as the solution)
- no net movement of water in or out, so no change in mass

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12 Mateusz's balance reads to 0.01 g.

a. State the resolution of the balance.

b. Another group used larger cylinders, about 10 g each. Explain why this would make the percentage changes more accurate.

(3 marks)

a. 0.01 g.

b. The changes in mass would be bigger, so the error of 0.01 g in each reading would be a much smaller fraction of the change. The percentage uncertainty is smaller, so the result is closer to the true value.

Marking points

- (a) 0.01 g
- (b) a bigger mass change is measured
- (b) so the reading error is a smaller proportion / smaller percentage uncertainty

13 Mateusz only used one cylinder at each concentration. Describe how he could check whether his results are repeatable, and how another group could check that they are reproducible.

(2 marks)

Repeatable: Mateusz repeats the whole experiment himself with fresh cylinders and the same method, and checks that he gets similar results. Reproducible: a different group, or the same experiment with different equipment, gets similar results.

Marking points

- repeatable: he repeats it himself with the same method and gets similar results
- reproducible: another person / group or a different method gives similar results

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14 Plan an investigation to find out whether sweet potato cells or ordinary potato cells have the more concentrated solution inside them.

(6 marks)

Cut cylinders from a sweet potato and from an ordinary potato using the same cork borer, and trim them all to the same length on a tile, removing the skin. Make up sugar solutions of 0.0, 0.2, 0.4, 0.6, 0.8 and 1.0 mol/dm^3 and pour the same volume of each into labelled boiling tubes, with two sets of tubes, one for each vegetable. Blot each cylinder, find its mass on a balance and place it in its tube. Leave all the tubes at the same temperature for the same time, for example 24 hours. Remove each cylinder, blot it in the same way and find its mass again. Calculate the percentage change in mass for every cylinder and repeat the whole thing three times so a mean can be worked out for each concentration, leaving out anomalies. Plot a graph of mean percentage change against concentration for each vegetable, on the same axes, and find where each line of best fit crosses 0%. The vegetable whose line crosses 0% at the higher concentration has the more concentrated solution in its cells.

Marking points (any 6, with the method in a logical order)

- cylinders of both vegetables cut with the same cork borer and trimmed to the same length
- a range of sugar concentrations (at least five), same volume in each tube
- blot and measure the mass before
- leave for the same time at the same temperature
- blot in the same way and measure the mass after
- calculate percentage change in mass
- repeat and calculate means
- plot percentage change against concentration for each vegetable
- compare where each line crosses 0%: the higher concentration means the more concentrated cell contents

How it is marked

- 5-6 marks: a full, logical plan with both vegetables, a range of concentrations, mass measured before and after with blotting, percentage change worked out, repeats, controls, and a clear way of comparing the two (where each line crosses 0%).
- 3-4 marks: a plan that would mostly work, with both vegetables in sugar solutions and masses measured, but some detail missing, such as percentage change, repeats, controls or how the comparison is made.
- 1-2 marks: some relevant ideas, such as putting potato in sugar solution and weighing it, without a clear order or without comparing the two vegetables.

Revision notes: the method

Aim: To find out how the concentration of a sugar solution affects the change in mass of potato pieces, caused by osmosis.

Equipment

- potato
- cork borer and white tile
- scalpel
- ruler marked in mm
- sugar solutions of different concentrations and distilled water
- boiling tubes and a test tube rack
- measuring cylinder
- top-pan balance reading to 0.01 g

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- paper towels
- forceps
- marker pen and timer

Method

1. Use a cork borer to cut six potato cylinders of the same diameter, then trim them on a tile with a scalpel so they are all the same length, for example 3 cm, removing any skin.
2. Label six boiling tubes with the concentrations 0.0, 0.2, 0.4, 0.6, 0.8 and 1.0 mol/dm^3.
3. Use a measuring cylinder to add the same volume, for example 10 cm^3, of the matching solution to each tube.
4. Gently blot each cylinder dry, measure its mass on the balance and record it next to its tube.
5. Put one cylinder into each tube, making sure it is fully covered, and start the timer.
6. Leave the tubes at room temperature for the same time, for example overnight or at least 30 minutes.
7. Remove each cylinder with forceps, blot it gently in the same way as before and measure its mass again.
8. Calculate the percentage change in mass for each cylinder.
9. Repeat the experiment with fresh cylinders and calculate a mean percentage change for each concentration.
10. Plot percentage change in mass against concentration and draw a line of best fit.

Variables

- **Independent:** The concentration of the sugar solution
- **Dependent:** The percentage change in mass of the potato cylinder (masses measured on a balance before and after)
- **Control:** the same size of potato cylinder (same diameter and length, so the same surface area); the same volume of solution in each tube; the same time left in the solution; the same temperature; potato from the same potato, blotted in the same way each time

Hazards

Hazard	What could happen	How to reduce the risk
Sharp scalpel and cork borer	cuts to the hands	cut downwards onto a white tile, away from the fingers, and carry the scalpel pointing down
Glass boiling tubes	cuts from broken glass if a tube is knocked over	keep tubes in a rack, and tell the teacher about breakages rather than picking up glass by hand
Spilled sugar solution	slipping on a wet floor	wipe up spills straight away

Key points

- Use percentage change in mass, not change in mass, because the cylinders did not all start at the same mass
- Osmosis is the movement of water, not sugar, from a dilute solution to a more concentrated solution through a partially permeable membrane
- A gain in mass means water moved into the cells; a loss means water moved out
- Where the line of best fit crosses 0% change, the solution has the same concentration as the potato cells

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- Blot every cylinder in exactly the same way: left-over surface liquid adds mass that is not water inside the cells
- Percentage change = (end mass - start mass) ÷ start mass × 100, and keep the sign (+ or -)

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