Light or gravity and seedling growth

Answers, marking points and revision notes | AQA GCSE Biology 8461 only (not Combined Science)

GCSE science required practicals

This practical online

Answers

1 Give the independent variable and the dependent variable for dishes A, B and C. (2 marks)

The independent variable is the direction of light (above, one side or none). The dependent variable is the growth of the seedlings, measured as their change in height in mm (or the number bending).

Marking points

- Independent: direction of light (or light versus dark)
- Dependent: growth, change in height, or number of seedlings bending

2 Aaliyah added 5 cm^3 of water to every dish each day. Give one other control variable and explain why it matters. (2 marks)

The temperature, because seedlings grow faster when warmer. If one dish was warmer, it would grow more for a reason that had nothing to do with light.

Marking points

- A sensible control, such as temperature, number of seeds, or type of seed
- A matching reason, such as it affects how fast the seedlings grow

3 Describe one hazard when growing seedlings on damp cotton wool for a week, and how to reduce the risk. (2 marks)

Mould can grow on the damp cotton wool and its spores may cause an allergic reaction. Keep the dishes covered if mould appears, throw them away sealed, and wash hands after handling them.

Marking points

- Mould or microorganisms growing (spores, allergic reaction)
- Precaution, such as do not open mouldy dishes, dispose of safely, wash hands

4 Compare the results for dishes A and B. What does this show about how shoots respond to light? (2 marks)

Only 1 seedling in dish A bent, but 18 in dish B bent towards the light from the side. This shows shoots grow towards light, which is called positive phototropism.

Marking points

- Uses data: 1 bent in A compared with 18 in B
- Shoots grow (bend) towards light / positive phototropism

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5 Calculate the percentage of seedlings in dish B that bent towards the light. (2 marks)

18 / 20 x 100 = 90%

Percentage = (number bending / total) x 100
= (18 / 20) x 100
= 90%

Marking points

- 18 / 20 x 100
- 90%

6 Calculate the mean growth per day for the seedlings in dish A over the 5 days.
Show your working. (3 marks)

Growth = 32 - 4 = 28 mm

Growth per day = 28 / 5 = 5.6 mm per day

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Growth per day = 28 / 5
= 5.6 mm per day

Marking points

- Change in height = 32 - 4 = 28 mm
- Divides by 5 days
- 5.6 mm per day

7 Rhys measured six seedlings from dish B on day 5. Their heights in mm were:
31 29 33 12 30 28

a. Which value is anomalous?

b. Calculate the mean height without the anomalous value.

Show your working. (3 marks)

a) 12 mm is anomalous, as it is much shorter than the others.

b) (31 + 29 + 33 + 30 + 28) / 5 = 151 / 5 = 30.2 mm

Leave out 12
31 + 29 + 33 + 30 + 28 = 151
151 / 5 = 30.2
Mean = 30.2 mm

Marking points

- 12 mm identified as anomalous
- Adds the other five values and divides by 5
- 30.2 mm

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8 Calculate how much taller, as a percentage, the dish C seedlings were than the dish A seedlings on day 5. Give your answer to the nearest whole number. (2 marks)

Difference = 47 - 32 = 15 mm. Percentage = 15 / 32 x 100 = 47%

Difference = 47 - 32 = 15 mm

Percentage = (15 / 32) x 100

= 46.875

= 47%

Marking points

- Finds the difference (15 mm) and divides by 32
- 47%

9 Suggest why the seedlings in darkness (dish C) grew the tallest. (2 marks)

With no light they cannot photosynthesise, so they use the food stored in the seed to grow upwards as fast as possible. This helps them reach light before the stored food runs out.

Marking points

- They grow quickly upwards using stored food (cannot photosynthesise in the dark)
- To reach light (so they can start photosynthesising)

10 Explain, in terms of auxin, why the seedlings in dish B bent towards the light but most in dish D did not. (3 marks)

In dish B, auxin made in the shoot tip moved to the shaded side. There it made the cells elongate more than on the lit side, so the shoot curved towards the light. In dish D the foil cap stopped light reaching the tip, so the tip could not detect the direction of light. Auxin stayed evenly spread, so both sides grew at the same rate and the shoots grew straight up.

Marking points

- Auxin collects on the shaded side of the shoot
- Causing cells on the shaded side to elongate more, so the shoot bends towards light
- In D the tip cannot detect light, so auxin stays even and the shoot does not bend

11 A bean seed is left on its side on damp paper. Its root bends downwards. Explain why, in terms of auxin. (2 marks)

Gravity makes auxin collect on the lower side of the root. In roots, auxin slows down cell elongation, so the upper side grows faster than the lower side and the root curves downwards.

Marking points

- Auxin builds up on the lower side due to gravity
- In roots, auxin inhibits elongation, so the upper side grows more and the root bends down

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12 Cress seedlings are thin and curved, so measuring their height with a ruler is difficult. Suggest one improvement to the measuring method and explain why it helps. (2 marks)

Gently straighten each seedling along the ruler, or photograph the dish next to a scale and measure on the image. This gives the full length of the curved shoot rather than just how high it reaches, so the growth measurement is more accurate.

Marking points

- A specific improvement, such as measuring along the curved shoot with thread, or photographing against a scale
- Reason: measures the real length so the growth is more accurate

13 Another class did the same investigation and got similar results. What does this tell you about the results? Explain your answer. (2 marks)

The results are reproducible. A different group with different equipment got similar results, so we can be more confident the conclusion is correct.

Marking points

- The results are reproducible
- Because someone else repeating it got similar results (gives more confidence)

14 Plan an investigation to show how gravity affects the direction in which young roots grow. (6 marks)

Soak broad bean seeds overnight, then let them germinate on damp paper until each has a straight root about 1 cm long. Pin six seedlings to damp cotton wool in a petri dish, each with its root pointing in a different direction (up, down, sideways). Put the lid on and tape the dish standing on its edge so it is vertical. Keep the dish in a dark cupboard so light cannot affect the growth, at the same temperature, and keep the cotton wool damp. Set up a second dish in the same way but fix it to a slowly turning clinostat, so gravity acts on all sides of the roots equally. Mark the position of each root tip on the lid with a pen every day for 3 days. Measure the angle the root has turned through with a protractor, or describe the direction it now grows. Compare the two dishes: in the still dish the roots should all bend downwards, but on the clinostat they should keep growing in their starting direction.

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

- Uses germinated seedlings with short straight roots
- Roots pointing in different directions to start
- Dish held vertically (or seedlings placed on their side)
- Kept in the dark so light does not affect growth
- Control dish on a clinostat (rotating) so gravity is cancelled out
- Keeps temperature and moisture the same
- Records the direction or angle of root growth over several days
- Uses several seedlings and compares results

How it is marked

- 5-6 marks: a clear, logical plan with roots in different directions, a vertical dish in the dark, a clinostat or other control, controlled conditions, and a clear way of recording direction of growth over time.
- 3-4 marks: a sensible plan showing roots placed in different directions and observed, but missing the control or key details such as keeping it dark.
- 1-2 marks: a few relevant ideas, such as putting a seed on its side and watching the root, with little detail.

Revision notes: the method

Aim: To find out how the direction of light affects the growth and bending of cress seedlings.

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Equipment

- Cress seeds
- Four petri dishes
- Cotton wool and water
- Four cardboard boxes, two with a slot cut in one side
- Two lamps (one above dish A, one shining into the slots for dishes B and D)
- Aluminium foil (to cover shoot tips)
- Ruler marked in mm
- Labels and pen

Method

1. Place a layer of damp cotton wool in each of four petri dishes and label them A to D.
2. Sprinkle 20 cress seeds evenly over each dish and leave them to germinate in a warm place for 2 days.
3. Measure the height of every seedling in mm with a ruler and work out a mean for each dish.
4. Put dish A in an open box with the lamp shining from directly above.
5. Put dish B in a box with a slot cut in one side so light only comes from that side.
6. Put dish C in a closed box so it is in complete darkness.
7. For dish D, cover the top 2 mm of each shoot with a small cap of foil and place it in a box with a side slot like dish B.
8. Keep all dishes at the same temperature and add the same volume of water to each every day.
9. After 5 days measure the height of each seedling again, count how many are bending towards the light, and work out the mean height for each dish.

Variables

- **Independent:** Direction of light (from above, from one side, none), and whether the shoot tip is covered.
- **Dependent:** Growth of the seedlings, measured as the change in mean height in mm, and the number bending towards the light.
- **Control:** Type of seed (all cress); Number of seeds in each dish; Temperature; Volume of water added each day; Time left to grow; Brightness of the lamp

Hazards

Hazard	What could happen	How to reduce the risk
Mould growing on damp cotton wool	Spores could cause an allergic reaction if breathed in	Do not open mouldy dishes; dispose of them sealed and wash hands after handling
Hot lamp	Burns, or the cardboard box could scorch	Use an LED lamp kept a safe distance from the box and switch it off at the end of the day
Water near electrical equipment	Electric shock	Water the dishes away from the lamp and plug

Key points

- Shoots grow towards light (positive phototropism) and roots grow down with gravity (positive gravitropism, also called geotropism).

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- Auxin made in the shoot tip moves to the shaded side, where it makes cells elongate more, so the shoot bends towards the light.
- In roots, extra auxin on the lower side slows elongation, so the root bends downwards.
- Seedlings in the dark grow tall, thin and pale as they use their stored food to grow upwards searching for light.
- Compare growth (change in height), not just final height, and use a mean of many seedlings because they vary.
- Covering the tip stops it detecting light, which shows that the tip is where the light is sensed.

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