

3.1 Variables, controls and planning

Name: _____ Class: _____ Date: _____

Total: 26 marks

KEY WORDS independent variable • dependent variable
• control variable • control treatment

Objective

Design fair tests and write defensible plans: independent, dependent and control variables, control treatments, and the planning checklist the WBI13 scheme credits. Original practice for the Unit 3 assessed skills (specification PDF pages 25–26) and the Summer 2025 planning demands.

1 Key knowledge and worked examples

■ Name the variable, then give its reason

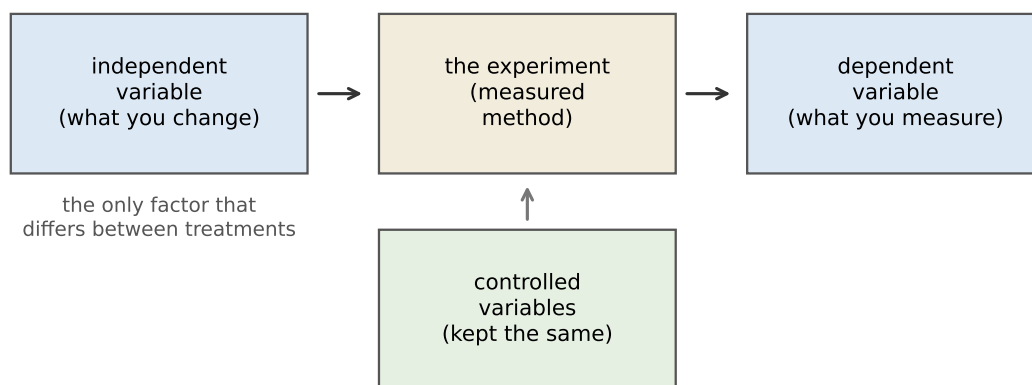
The **independent variable** is what you change; the **dependent variable** is what you measure; every other quantity that could affect the dependent variable is a **control variable** and must be held constant *with a reason*: temperature is controlled because it changes membrane fluidity and enzyme action; solution volume because it dilutes the measured pigment differently. A mark needs both halves – the variable and the effect it would have.

■ A control treatment is not a control variable

A **control treatment** leaves the independent variable out (solvent without trifluralin; water instead of methanol) so any measured difference can be attributed to the independent variable alone. It allows a valid comparison; it is not “the control variable”.

■ The planning checklist

Apparatus named; variables identified; measuring technique justified (graticule for cell lengths, colorimeter for colour, stopwatch and intervals for time courses); controls with reasons; repeats for reliability and a mean; safety issue plus its control (methanol flammable – keep from flames; cultures incubated below 30 °C); how the data will be used (table headings, graph type); sources of uncertainty and how each is reduced.



Beetroot example: alcohol concentration changed, pigment loss measured; temperature, size, volume, time fixed; a water-only treatment is the control.

2 Practice

2.1 In a seedling investigation, state the independent variable when some seedlings sit in solvent containing trifluralin and others sit in solvent alone. [1]

2.2 Explain why the solvent-only seedlings are needed, in terms of what can be concluded. [2]

2.3 A student measures pigment loss from beetroot at 20 °C and at 60 °C. Give two control variables with the reason each must be fixed. [4]

2.4 Explain why the seedlings were germinated on moist paper before treatment began, rather than placed onto treated discs as dry grains. [2]

3 Exam-style questions

3.1 Brine shrimp hatch rates are measured at 15 °C, 20 °C, 25 °C and 30 °C. Plan this investigation: identify the variables, describe how the dependent variable is measured, state two controls with reasons, and give one ethical consideration in the specification's terms. [6]

3.2 Yeast is grown in glucose solution and its respiration rate followed with a redox indicator. Write a plan that states: the independent and dependent variables; two control variables with reasons; how the data will be presented and used; and one safety point with its control. [6]

3.3 An investigation germinates 40 wheat grains on filter paper soaked in 7 mg cm^{-3} trifluralin solution, incubated at 25°C , with root tips sampled after 12 hours. Justify the 25°C incubation temperature, and explain what the data would show if trifluralin arrested mitosis at metaphase. [5]

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 The presence (or concentration) of trifluralin.

2.2 It is a control treatment, so any difference in results is due to trifluralin and not the solvent; it allows a valid comparison between like and like.

2.3 Any two, each with reason: beetroot piece size/surface area – larger pieces leak more pigment; volume of liquid – dilutes the pigment differently; time of immersion – leakage continues with time; same beetroot/age – pigment content varies; light – could affect membrane state.

2.4 To ensure all grains used were viable and had begun growth, so every treatment starts from seedlings at the same stage of development.

3.1 Independent: temperature. Dependent: hatching rate – number hatched per number of eggs per time interval, counted under a hand lens. Two controls with reasons, e.g. salinity of water – affects survival; oxygen/aeration – needed for respiration; number of eggs per dish; volume of water. Measurement detail: replicate dishes per temperature, water baths to hold temperature. Ethical: the specification requires the ethical use of organisms – minimal numbers, no deliberate harm beyond the treatment, appropriate disposal.

3.2 Independent: substrate (glucose) concentration or temperature as planned. Dependent: rate of colour change of the redox indicator, timed to a fixed endpoint, 1/time as rate proxy. Controls with reasons: temperature – affects enzyme-controlled respiration rate; pH – affects the indicator colour; volume of yeast suspension – more cells respire faster; indicator volume. Data: table of concentration against mean time with units; line graph of rate against the independent variable; compare the initial gradient or rate proxy. Safety: none of the standard human pathogens cultured; wash hands, disinfect benches; keep the water bath electrical parts dry.

3.3 25 °C is near the optimum for the enzymes of germination/mitosis, so rates are measurable and enzymes do not denature or slow excessively. If mitosis arrested at metaphase, cells in the treated roots would accumulate in metaphase – a raised percentage of cells at that stage, with prophase still seen but anaphase and telophase absent, because the spindle does not form or cannot separate the chromatids.