

Experimental Design

Simulation: edtechsims.com/experimental-design

Name: _____ Class: _____ Date: _____



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By the end of this activity, you should be able to:

- define and identify the independent, dependent and controlled variables in an investigation
- explain why controlled variables must be kept constant for a fair test
- identify and correct flaws in the design of an experiment
- process and present experimental results, including identifying anomalous readings

Part A: Key Terms

On the sim: Read the green information box at the top of the sim.**A1** Complete the sentences.

[3]

The _____ variable is what the experimenter deliberately changes.

The _____ variable is what is measured as a result.

The _____ variables are all other factors kept constant to ensure a fair test.

A2 Explain why only ONE variable should be changed at a time in an investigation.

[2]

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Part B: Sorting the Variables

On the sim: For each scenario, sort every variable card into the correct group. Record your answers in the table BEFORE you click Submit, then record your score.**B1** Temperature and Mould Growth

Scenario 1	Temperature & Mould Growth
Independent variable	
Dependent variable	
Controlled variables	
My score	_____ / _____

B2 Exercise and Heart Rate

Scenario 2	Exercise & Heart Rate
Independent variable	
Dependent variable	
Controlled variables	
My score	_____ / _____

B3 Caffeine and Reaction Time

Scenario 3	Caffeine & Reaction Time
Independent variable	
Dependent variable	
Controlled variables	
My score	_____ / _____

B4 Which variable card did you find hardest to sort? Explain why it belongs in its group. [2]

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B5 In the Caffeine scenario, explain why the hours of sleep the night before must be kept the same. [2]

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Part C: Applying Your Knowledge

C1 A student investigates how the length of a pendulum affects the time taken for 10 complete swings.

- (a) State the independent and dependent variables. [2]

Independent variable:

Dependent variable:

- (b) State two controlled variables. [2]

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- (c) Write a hypothesis for this investigation. [1]

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C2 A student wants to find out whether fertiliser affects plant growth. She puts Plant A (with fertiliser) on a sunny windowsill and Plant B (without fertiliser) in a dark cupboard. After two weeks, Plant A is taller.

- (a) Explain why this is not a fair test. [2]

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- (b) Suggest two improvements to the investigation. [2]

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Part D: Practice Questions

D1 A student investigates how the temperature of water affects the time taken for 5 g of sugar to dissolve. Table 1 shows the results.

Temperature / °C	Trial 1 / s	Trial 2 / s	Trial 3 / s	Mean / s
20	124	120	122	
30	95	97	96	96
40	74	90	72	
50	55	57	56	56
60	41	43	42	42

Table 1

(a) Identify the anomalous result in Table 1. [1]

(b) Complete Table 1 by calculating the mean times at 20 °C and 40 °C. Do not include the anomalous result. [2]

(c) On Fig. 1, plot the mean times against temperature and draw a smooth curve of best fit. [3]

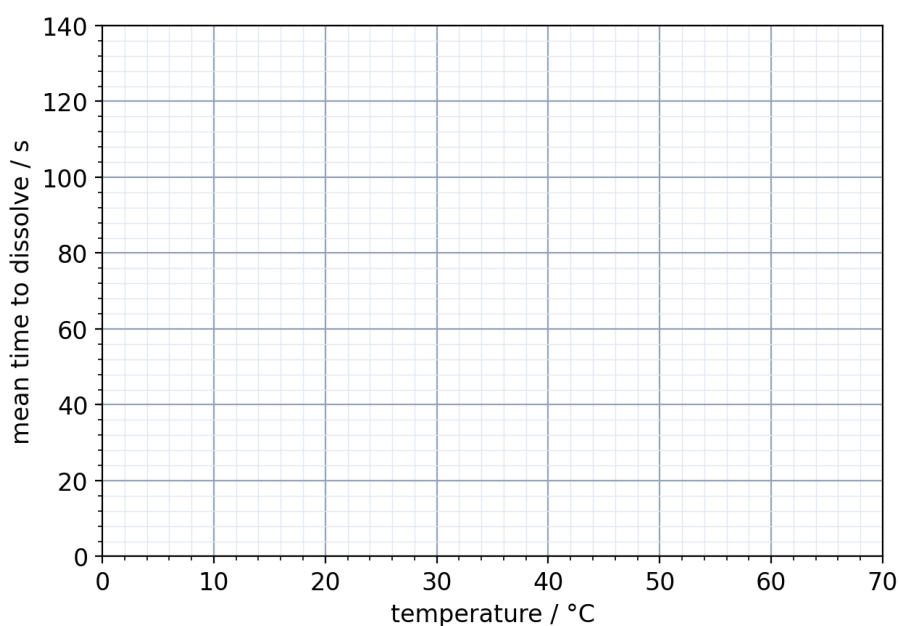


Fig. 1

(d) Describe the relationship shown by your graph. [1]

(e) State two variables the student should keep constant. [2]

(f) Explain why the student repeated each temperature three times.

[1]

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Answer Key: Experimental Design

Part A

A1 independent; dependent; controlled

A2 If more than one variable is changed, it is impossible to tell which variable caused the change in the dependent variable, so the test would not be fair.

Part B

Scenario	Temperature & Mould Growth
Independent variable	Temperature (°C)
Dependent variable	Number of mould spots after 5 days
Controlled variables	Type of bread; size of bread piece; amount of moisture; exposure to light; duration of experiment

Scenario	Exercise & Heart Rate
Independent variable	Type of exercise
Dependent variable	Heart rate (bpm)
Controlled variables	Duration of exercise; age of participant; time of day; fitness level

Scenario	Caffeine & Reaction Time
Independent variable	Amount of caffeine consumed (mg)
Dependent variable	Reaction time (ms)
Controlled variables	Age of participant; hours of sleep prior night; time since last meal; stress level; type of stimulus

B4 Open response; the explanation must match the definition of that variable type.

B5 Lack of sleep can also slow reaction time. If sleep varied, any change in reaction time could be due to tiredness rather than caffeine.

Part C

C1(a) IV: length of the pendulum. DV: time taken for 10 complete swings.

C1(b) Any two: mass of the bob; angle of release (amplitude); type of string; location/gravity; method of timing.

C1(c) e.g. As the length of the pendulum increases, the time taken for 10 swings increases.

C2(a) Two variables were changed at once (fertiliser and light), so the difference in height cannot be linked to the fertiliser alone. Only one plant per group was used.

C2(b) Any two: place both plants in the same light conditions; keep water, soil, temperature and pot size the same; use several plants in each group; measure height at the start and end.

Part D

D1(a) 90 s (Trial 2 at 40 °C).

D1(b) 20 °C: $(124 + 120 + 122) / 3 = 122$ s. 40 °C: $(74 + 72) / 2 = 73$ s.

D1(c) Points plotted at (20, 122), (30, 96), (40, 73), (50, 56), (60, 42), joined by a smooth curve; 1 mark for axes use, 1 for points, 1 for curve.

D1(d) As the temperature increases, the time taken for the sugar to dissolve decreases (at a decreasing rate).

D1(e) Any two: mass of sugar; volume of water; type/particle size of sugar; rate of stirring; type of container.

D1(f) To identify anomalous results and calculate a mean, making the results more reliable.