



S11-30min Experimental Design: 30-minute Pack

EDEXCEL 1ST0 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / ____

Answer ALL questions. Show all your working.

- 1** In the painkiller trial, volunteers are not told whether they have been given the new painkiller or the placebo. This is called a blind trial.
- (a) State what is meant by a double-blind trial. (1)
- (b) Explain why it is useful for volunteers not to know which tablet they have received. (2)
- (c) Explain why it is also useful for the researcher recording results not to know which volunteer received which tablet. (1)

(Total for Question 1 is 4 marks)

2 A garden centre wants to test whether a new plant feed increases the average height that tomato plants grow to after 8 weeks. They have 60 tomato plants of the same variety and age available.

(a) Write a suitable hypothesis for this investigation. (1)

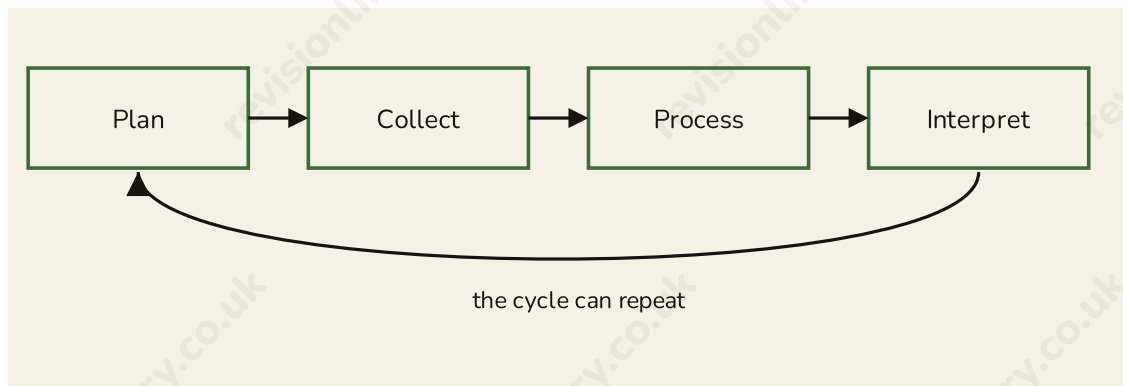
(b) Identify the explanatory (independent) variable and the response (dependent) variable for this investigation. (2)

(c) State which group of plants should act as the control group. (1)

(d) Give two variables, other than the feed, that should be kept constant between the two groups of plants, and explain why this matters. (2)

(Total for Question 2 is 6 marks)

- 3** A student's investigation into whether energy drinks affect reaction time follows the statistical enquiry cycle shown below.



- (a) As well as writing a hypothesis and deciding the control group, constants and random allocation, state one other decision that should be made about the design at the plan stage. (1)
- (b) State the stage of the cycle at which the student would calculate a mean of repeated reaction time measurements, to help remove the effect of random error. (1)
- (c) At the interpret stage, the student concludes that energy drinks improve reaction time. Explain why a control group was essential for her to reach this conclusion. (2)

(Total for Question 3 is 4 marks)

4 Two students each investigate the same hypothesis: that a stretched elastic band travels further when pulled back further. Student A tests 1 elastic band, with 3 repeats at each pull-back distance. Student B tests 10 different elastic bands, with 3 repeats at each pull-back distance for each band.

(a) Explain why Student B's investigation is likely to give more reliable conclusions about elastic bands in general than Student A's. (2)

(b) Both students take 3 repeat readings at each distance rather than 1. State what they should do with the 3 repeat readings before using them to draw a conclusion. (1)

(c) At one pull-back distance, Student A records these three repeat distances travelled: 42 cm, 45 cm, 41 cm. Work out the range of these three readings. (1)

(Total for Question 4 is 4 marks)

5 In an investigation into whether a new teaching app improves test scores, students who use the app also happen to spend more time revising overall than students who do not use the app.

(a) Explain why 'time spent revising' is a confounding variable in this investigation. (2)

(b) State one change to the experimental design that would prevent this variable from confounding the results. (1)

(Total for Question 5 is 3 marks)

6 A researcher wants to test whether a new toothpaste tastes better than a leading competitor's toothpaste, using a blind taste test with 40 volunteers.

(a) Explain how the researcher could make this a blind trial for the volunteers. **(1)**

(b) Explain why it would be very difficult to make this trial double-blind. **(2)**

(c) Suggest one practical way the researcher could reduce this problem, without needing the person running the test to know the brands. **(1)**

(Total for Question 6 is 4 marks)

7 A company claims its new energy bar improves marathon runners' finishing times. To test this, they ask 12 runners from the same running club to eat the energy bar before their next race, then compare their times to their personal best times from previous races (without the energy bar). All 12 runners know they are testing the new energy bar.

Evaluate the design of this investigation, referring to at least three different weaknesses and the effect each has on the validity of the conclusions.

(Total for Question 7 is 5 marks)

Mark scheme · S11-30min Experimental Design: 30-minute Pack

Question 1

- (a) **B1** a trial in which neither the volunteer/participant nor the researcher recording the results knows which group (treatment or placebo) each volunteer is in, oe
- (a) **Answer: A double-blind trial is one in which neither the volunteer nor the researcher recording results knows which group (treatment or placebo) each volunteer is in.**
- (b) **B1** if volunteers knew, those given the real drug might expect to feel better and report more improvement (or vice versa)
- (b) **B1** blinding removes this bias (the placebo effect), so the comparison between groups is fairer/more valid, oe
- (b) **Answer: If volunteers knew which tablet they had, those given the real drug might expect it to work and report feeling better regardless (the placebo effect). Keeping them blind removes this bias, so the comparison between the groups is fairer.**
- (c) **B1** prevents the researcher from (consciously or unconsciously) treating, recording or interpreting the two groups differently, oe
- (c) **Answer: It stops the researcher from treating, recording or interpreting results differently for the two groups, even unintentionally.**

Question 2

- (a) **B1** a testable statement linking plant feed and height, e.g. 'plants given the new feed grow taller than plants not given it', oe
- (a) **Answer: Tomato plants given the new plant feed grow taller after 8 weeks than tomato plants not given the feed.**
- (b) **B1** explanatory (independent) variable: whether the plant is given the new feed cao
- (b) **B1** response (dependent) variable: height of the plant after 8 weeks cao
- (b) **Answer: Explanatory: whether the plant is given the new feed. Response: the plant's height after 8 weeks.**
- (c) **B1** the group of plants not given the new feed (grown under otherwise identical conditions), oe
- (c) **Answer: The group of plants that is not given the new feed, but is grown under otherwise identical conditions.**
- (d) **B1** gives two valid constants, e.g. amount of water/sunlight given, pot size, soil type
- (d) **B1** explains that keeping them the same means any difference in height can be attributed to the feed rather than to another factor, oe
- (d) **Answer: e.g. the amount of water and sunlight each plant receives should be kept the same. This matters because, if they were different, any difference in height could be caused by these factors rather than by the plant feed.**

Question 3

- (a) **B1** any valid design decision, e.g. sample size/number of repeats, or how the response variable will be measured, oe
- (a) **Answer: e.g. how large a sample to use, or how many repeats to take.**
- (b) **B1** process cao
- (b) **Answer: Process**
- (c) **B1** without a control group there would be nothing to compare the energy drink group's reaction times against
- (c) **B1** so only by comparing the processed data from both groups at the interpret stage can any change in reaction time be attributed to the energy drink itself, oe
- (c) **Answer: Without a control group, there would be no comparison to show what reaction times would be without an energy drink. Comparing the processed results from both groups is the only way to attribute any improvement to the drink itself, rather than to another cause.**

Question 4

- (a) **B1** testing more elastic bands means the results are less affected by one unusual/faulty band
- (a) **B1** so the conclusion is more likely to generalise to elastic bands in general, rather than just to the one band Student A tested, oe
- (a) **Answer: Testing 10 different bands means the result is not dominated by one unusually stretchy or weak band. This means Student B's conclusion is more likely to apply to elastic bands in general, whereas Student A's only tells her about the one band she used.**
- (b) **B1** calculate the mean of the 3 repeats, oe
- (b) **Answer: Calculate the mean of the 3 repeat readings.**
- (c) **B1** 4 (cm) cao
- (c) **Answer: 4 cm**

Question 5

- (a) **B1** it is linked to using the app (app users happen to revise more)
- (a) **B1** and it could itself affect test scores, so it is impossible to tell whether any improvement is due to the app or to the extra revision time, oe
- (a) **Answer: Time spent revising is linked to using the app (app users revise more overall), and extra revision could itself improve test scores. This makes it impossible to tell whether any improvement is due to the app or simply to the extra time spent revising.**
- (b) **B1** e.g. randomly allocate students to app/no-app groups and keep total revision time the same/monitored for both groups, oe
- (b) **Answer: Randomly allocate students to the app and no-app groups, and make sure total revision time is kept about the same for both groups.**

Question 6

- (a) **B1** use plain, unlabelled/coded containers so volunteers cannot see which toothpaste is which brand, oe
- (a) **Answer: Put each toothpaste sample in a plain, unlabelled container marked only with a code, so volunteers cannot see which brand they are tasting.**
- (b) **B1** whoever sets up/hands out the samples usually needs to know which brand is which, in order to give out the right sample and record which was tasted
- (b) **B1** so that person (even unintentionally) could influence volunteers' responses, or record/interpret results differently for each brand, oe
- (b) **Answer: The person running the test usually needs to know which coded sample is which brand, in order to hand out the correct sample and record results accurately. This means that person could, even unintentionally, influence a volunteer's response or interpret results differently depending on the brand.**
- (c) **B1** a third party, not involved in running the test, codes the samples, and the code is only revealed after all results have been recorded, oe
- (c) **Answer: Have someone not involved in running the test label the samples with a code, and only reveal which code matches which brand after all the results have been recorded.**

Question 7

- **B1** no control group: all 12 runners receive the energy bar, so there is nothing to compare against to isolate its effect, oe
- **B1** no blinding: knowing they have the 'new' bar could create a placebo effect (expecting to run faster), biasing times regardless of the bar's real effect
- **B1** comparing to personal bests does not hold other variables constant, e.g. weather, course or the runner's current fitness could differ from the earlier race and confound the comparison, oe
- **B1** the sample is small (12) and drawn entirely from one running club, so it may not be representative of marathon runners generally, limiting how far conclusions can be generalised
- **B1** an overall judgement is given, e.g. the conclusion that the bar improves times is not well supported without a randomised, controlled, blind design comparing to a genuine control group under matched race conditions
- **Answer: The design is weak. There is no control group, so there is nothing to isolate the bar's effect from other causes. Runners are not blinded, so knowing they have the new bar could create a placebo effect. Comparing to personal bests does not control for other variables such as weather, course or current fitness. The sample is also small and drawn from a single club, limiting how far results can be generalised. Overall, the claim is not well supported without a randomised, controlled, blind trial comparing matched groups under the same conditions.**