

Study Guide — BI Problem 8: Independent Project (Cumulative Capstone Test)

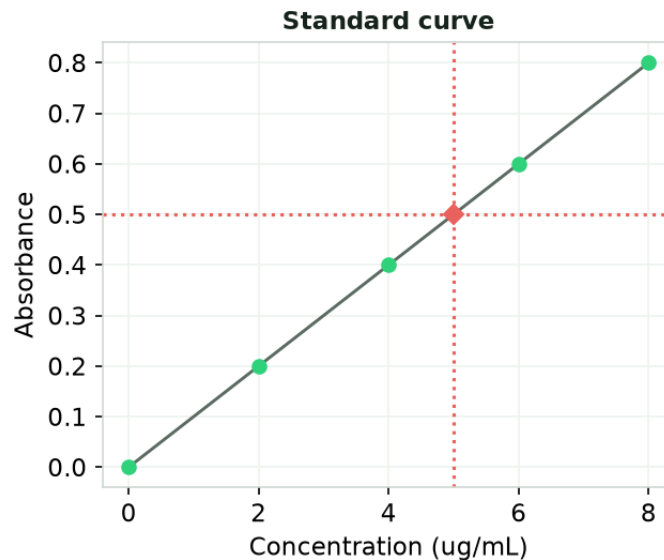
Biomedical Innovations · Problem 8 — Independent Project · Modeled on the PLTW Guided Review format

Vocabulary to know cold

Term	Definition
Experimental design	The plan for testing a hypothesis with an IV, DV, controls, and replication.
Validity	The degree to which a study actually measures what it intends to measure.
Reliability	The degree to which a method gives consistent, repeatable results.
Standard curve	A graph of signal versus known concentration used to find an unknown's concentration.
Specificity	A test's ability to correctly identify true negatives; low specificity yields false positives.
Chain of custody	A documented record of everyone who handled a specimen, preserving evidence integrity.
No-template control (NTC)	A PCR control with no DNA template, used to detect reagent contamination.
Dose-response relationship	How a measured effect changes as the dose of an agent increases.
Biohazard waste	Material contaminated with infectious or biological agents requiring special disposal.
Safety Data Sheet (SDS)	A document giving hazards, handling, and disposal information for a chemical.
Informed consent	A participant's voluntary, knowledgeable agreement to take part in research.
Confidentiality	Protecting participants' identifiable data from unauthorized disclosure.
Triage	Rapidly sorting patients by severity, often using vital signs, to prioritize care.

Worked examples (follow the reasoning)

Example 1. An ELISA-style standard curve is linear: absorbance = 0.10 per ug/mL of protein. An unknown reads 0.50 absorbance. Find its concentration and explain the method.



- Find the slope from the knowns: 0.20 absorbance at 2 ug/mL gives 0.10 absorbance per ug/mL.
- Set up the equation: absorbance = 0.10 x concentration.
- Solve for the unknown: $0.50 = 0.10 \times \text{concentration}$, so concentration = $0.50 / 0.10$.
- Concentration = 5 ug/mL.

Answer: 5 ug/mL, read off the standard curve where absorbance equals 0.50.

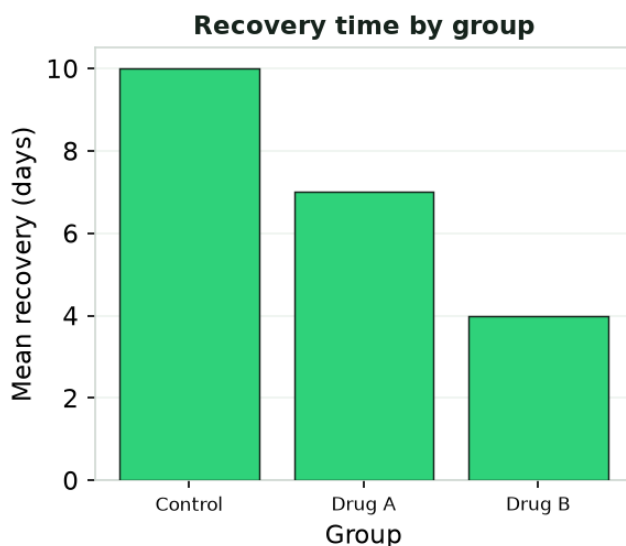
Example 2. Design a complete, ethical experiment to test whether a 10-minute warm-up lowers resting heart rate, naming each design element.

- Question/hypothesis: If students warm up for 10 minutes, then their post-rest heart rate will be lower than with no warm-up.
- Independent variable: warm-up (10 min vs none); Dependent variable: heart rate in beats per minute.
- Controlled variables: same time of day, same measurement device, same rest period before measuring.
- Control group: students who do NOT warm up; use random assignment and an adequate sample size with replication.
- Ethics: obtain guardian permission and student assent, keep data confidential, and have the plan reviewed (IRB concept).
- Analyze with group means and an appropriate graph (bar graph of mean heart rate), and note correlation does not prove causation unless the design is controlled.

Answer: A controlled, randomized, replicated, consented experiment with warm-up as IV, heart rate as DV, constant controls, a no-warm-up control group, and confidential data analyzed by comparing group means.

Practice questions (with reasoning)

1. A bar graph compares mean recovery days: Control 10, Drug A 7, Drug B 4. Which treatment had the best outcome?



- A. Control
- B. Drug A
- C. Drug B
- D. They are equal

Answer: C. Drug B has the shortest mean recovery time, the most favorable result.

2. A method gives consistent results but measures the wrong thing. It is:

- A. valid but not reliable
- B. reliable but not valid
- C. both valid and reliable
- D. neither

Answer: B. Consistency is reliability; measuring the wrong construct means it lacks validity (spirals to P3).

3. A PCR run shows a band in the no-template control. The best interpretation is:

- A. the experiment worked perfectly
- B. reagents are contaminated and results are invalid
- C. the sample is very pure
- D. the storage temperature was correct

Answer: B. A band in the NTC indicates contamination, invalidating the run (spirals to P6).

4. Hazardous chemical gel-stain waste should be disposed of by:

- A. pouring down the sink
- B. following SDS instructions as hazardous chemical waste
- C. placing in regular trash
- D. mixing with biohazard sharps

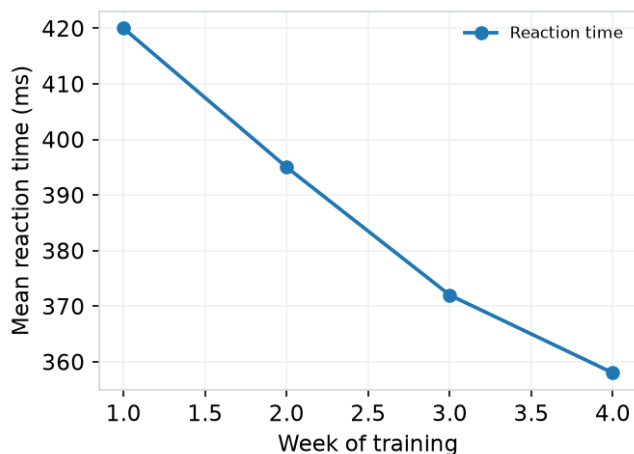
Answer: B. The SDS dictates proper hazardous chemical waste disposal for stains.

5. Which step best protects survey participants in an independent project?

- A. Publishing names with answers
- B. Keeping responses confidential and obtaining informed consent
- C. Surveying only friends
- D. Skipping documentation

Answer: B. Confidentiality plus informed consent are essential ethical safeguards.

6. A student's independent project tracks the mean reaction time (ms) of volunteers across four weeks of a training program. What does the data trend support?



- A. Reaction time increased over the program
- B. Reaction time decreased steadily over the four weeks, supporting that training improved performance
- C. No change occurred across the weeks
- D. The data are random with no trend

Answer: B. The mean reaction time falls each week from 420 to 358 ms, a downward trend consistent with improved performance over the training program.