

Study Guide — BI Problem 3: Medical Innovation (Pretest)

Biomedical Innovations · Problem 3 — Medical Innovation · Modeled on the PLTW Guided Review format

Vocabulary to know cold

Term	Definition
Design problem	A clearly stated need a product or device must meet, defined for a specific user before prototyping.
Prototype	An early working model of a device built to be tested and improved.
Accuracy	How close a measurement is to the true (accepted) value.
Precision (reliability)	How consistent repeated measurements of the same sample are with one another.
Calibration	Adjusting an instrument using samples of known value so its readings are trustworthy.
Independent variable	The single factor the experimenter deliberately changes.
Dependent variable	The outcome that is measured and may respond to the independent variable.
Control group	A baseline group or standard used for comparison so results can be attributed to the variable tested.
Replication	Repeating trials to check consistency and reduce the effect of random error.
PPE	Personal protective equipment such as gloves and eye protection that guards against exposure.
Sharps container	A rigid, puncture-resistant container for needles and other sharp waste.
Specimen labeling	Marking each sample immediately with identifying information to prevent mix-ups.

Worked examples (follow the reasoning)

Example 1. A team measures the true value of a reference solution at 100 units. Device A reads 100, 100, 100. Device B reads 88, 112, 95. Classify each device for accuracy and precision.

- Precision = how close the repeated readings are to EACH OTHER.
- Device A readings (100,100,100) are identical, so Device A is highly precise.
- Device B readings (88,112,95) are spread out, so Device B is imprecise.
- Accuracy = how close readings are to the true value of 100.
- Device A averages 100, so it is accurate; Device B averages ~98 but is too scattered to be reliable.

Answer: Device A is both accurate and precise; Device B is neither precise nor reliable.

Example 2. List, in order, the first three steps of attacking a medical-device design problem.

- Step 1: Define the need — who is the user and what problem must the device solve?
- Step 2: Research and set design requirements (criteria and constraints).
- Step 3: Brainstorm and build a prototype to test against those requirements.

Answer: Define the need, set requirements, then prototype and test.

Practice questions (with reasoning)

1. A new thermometer reads 37.0, 37.1, 36.9 degrees C on a sample whose true value is 37.0 degrees C. The device is best described as:

- A. precise but inaccurate
- B. accurate and precise
- C. inaccurate and imprecise
- D. uncalibrated

Answer: B. Readings are close to each other (precise) and close to the true value (accurate).

2. Which item belongs in a sharps container?

- A. a used paper towel
- B. an empty cardboard box
- C. a used hypodermic needle
- D. a clean glass slide

Answer: C. Needles are sharps and must be placed in a puncture-resistant container.

3. In a study testing a new sensor, the variable the team changes on purpose is the:

- A. dependent variable
- B. independent variable
- C. control
- D. constant

Answer: B. The factor deliberately changed is the independent variable.