SI Physics - Full Discipline Demo

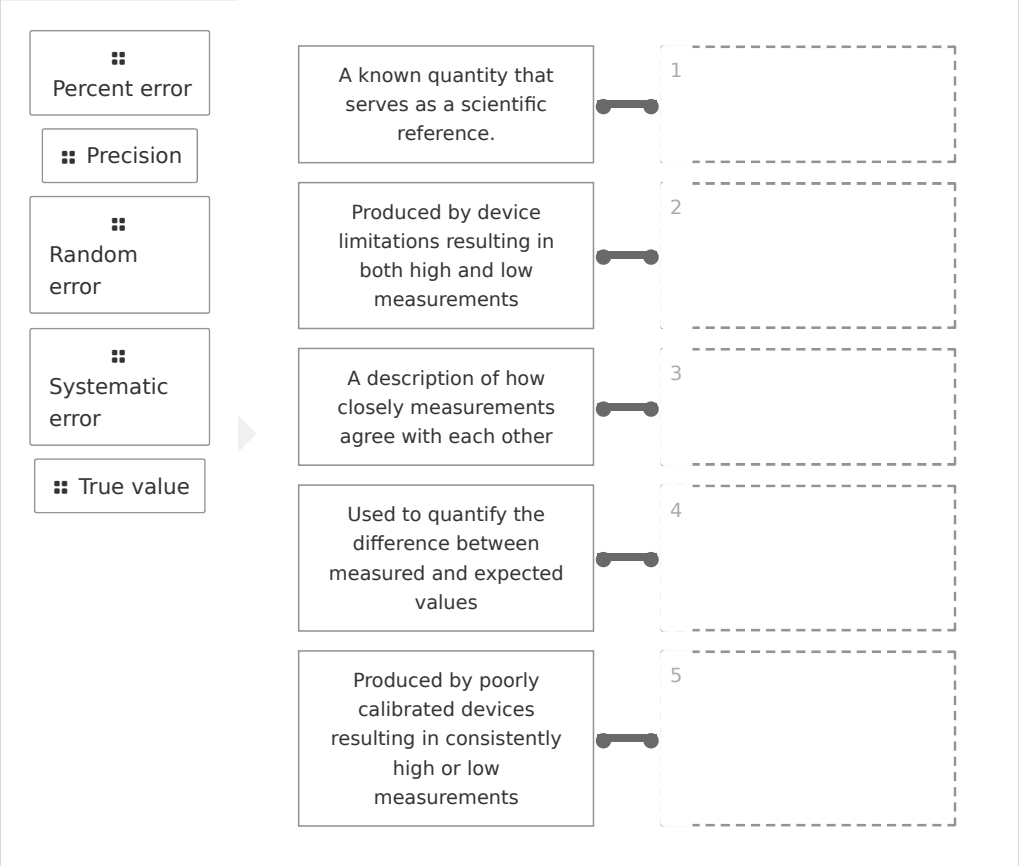
Introduction to Experimental Errors and Uncertainty

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Physics - Full Discipline Demo
Course	SI Physics - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

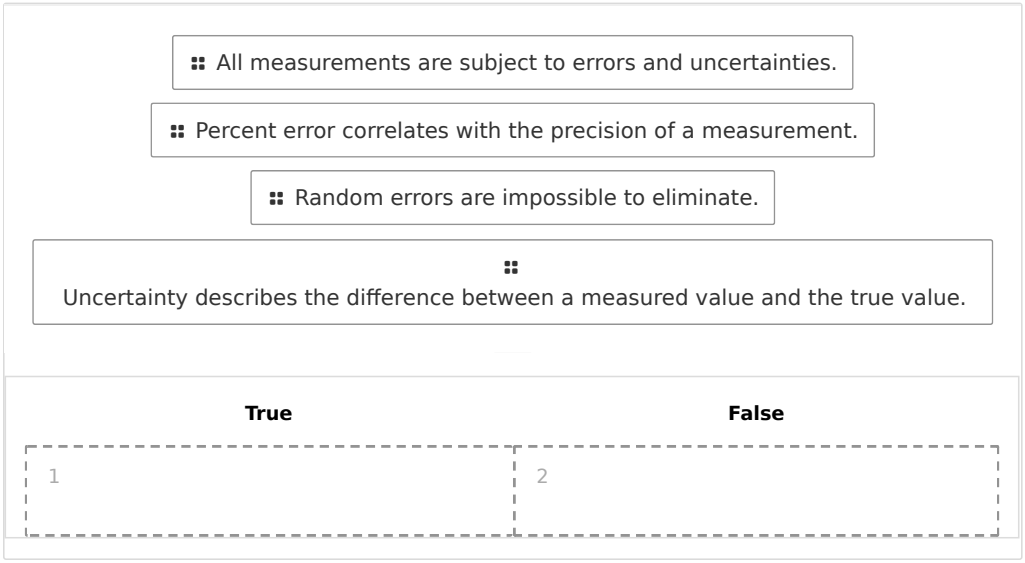


Correct answers:

1 True value 2 Random error 3 Precision 4 Percent error

5 Systematic error

Identify each statement as true or false.



Correct answers:

1 All measurements are subject to errors and uncertainties.

Random errors are impossible to eliminate.

2 Percent error correlates with the precision of a measurement.

Uncertainty describes the difference between a measured value and the true value.

Exploration

____ describes the range of values within which the true value lies.

- Accuracy
- Error
- Uncertainty ✔
- All of the above

Random error can be eliminated by performing multiple measurements on an object.

- True
- False ✔

Percent uncertainty is a measure of the _____ of a device.

- accuracy
- precision ✔
- systematic error
- All of the above

Exercise 1

Explain the difference between accuracy and precision.

Accuracy is a description of how close a measured value is to the true value, and is quantified by percent error. Accuracy is related to the systematic error in measurements, and is influenced by device calibration and reading techniques. Precision describes how close two or more independent measurements agree with each other, and is quantified by percent uncertainty. Precision is related to the random error in measurements, and is influenced by device limitations.

Was systematic and/or random error present in your measurements? Explain your answer by referencing Data Table 1.

Students should find evidence of both error types in Data Table 1. HOL testing suggests that systematic error was present as all measurements were greater than the true value. Random error was present in HOL data as measurements differed from each other.

Describe potential sources of systematic error and random error in your measurements. Explain your answer.

Student answers will vary but should include systematic sources of improperly calibrated stopwatch and measuring tape and the recording technique that caused lag between starting the watch and releasing the ball, and between hearing the contact and stopping the watch. Random error sources include limitations of the stopwatch, operator error, and differences between how each person performed their assigned tasks in the trials.

Did repeating trials improve the accuracy and precision of your measurements? Explain your answer.

Student answers will vary but should reference the percent error and percent uncertainty values calculated from each trial. Accuracy is unlikely to improve over repeated trials since it is related to systematic error. Students may, however, find increased precision in repeated trials.

Data Table 1: Time for Object to Fall 1.00 m
(SAMPLE ANSWER BELOW)

	Trial 1	Trial 2	Trial 3	Trial 4
Student Operator	Student answers will vary for data table. 0.48	0.47	0.46	0.49
Assistant Operator	0.51	0.52	0.49	0.53
Trial Average and Uncertainty	0.50 +/- 0.02 s	0.50 +/- 0.03 s	0.48 +/- 0.02 s	0.51 +/- 0.02 s
Percent Uncertainty	4.0%	6.0%	4.2%	3.9%
Percent Error	10.6%	10.6%	6.2%	12.8%

Competency Review

____ is the difference between a measured value and the true value.

- Error ✔
- Precision
- Uncertainty
- All of the above

Improperly calibrated devices cause _____ error.

- precision
- random
- systematic ✔
- All of the above

Random error results in measurements with unpredictable high and low values.

- True ✔
- False

Accuracy is quantified as _____.

- percent error ✔
- percent uncertainty
- random error
- All of the above

Low percent error implies that measurements are closely grouped.

- True
- False ✔

A measurement of 23.45 g was recorded and compared to the true value of 22.78. The percent error for the measurement is _____.

- 1.47%
- 2.02%
- 2.94% ✔
- 3.35%

The length of an object is measured two times and recorded as 4.51 m and 4.86 m. The percent uncertainty of the measurements is _____.

- 3.74% ✔
- 3.88%
- 7.20%
- 17.50%

The quality of measurement data with high percent uncertainty but low percent error can be improved with _____.

- a correction factor
- device calibration
- repeated measurement trails ✔
- All of the above

Extension Questions

Jason measures the mass of a sample and finds it to be 12.21 g. He states in his lab report that the measurement is both accurate and precise. Explain why his statement is incorrect and how it could be corrected. (SAMPLE ANSWER BELOW)

Jason cannot state that his measurement is accurate and precise without quantifying accuracy and precision by providing the percent error and percent uncertainty of his measurement. Jason should compare his sample to the known value to quantify accuracy and systematic error in his measurement. Furthermore, he should compare his measurement to other measurements of the sample to quantify precision and random error in his measurement. Lastly, Jason should state the level of uncertainty in his measurement as 12.21 +/- _____ g.