

Exercise 2: Accuracy and precision, systematic and random errors

1. The following five mass measurements are made on an electronic balance:

2.331 g, 2.334 g, 2.333 g, 2.337 g, 2.335 g

a. The true mass is 2.390 g. Is this an example of **systematic** or **random** error?

b. For the true mass given in part a, write a five measurement sequence (like the one above) that demonstrates the *other* type of error.

c. Calculate the **average** (mean) and the **standard deviation** of the numbers given in part a. Don't forget units or the number of digits that should appear in the standard deviation.

d. Calculate the average (mean) and the standard deviation of the numbers given in part b.

e. Suppose the partnership of Alice and Bob measured the sequence of mass numbers in part a, and the partnership of Carol and Ted measured the sequence of masses in part b. Given their respective averages and standard deviations, and assuming you had no knowledge of what they were measuring, would you **conclude** that the two groups were measuring the same item? Why or why not?

f. Suggest a way in which Alice and Bob could relatively easily **fix** their error (or at least get better results). Why does this fix not apply to Carol and Ted?

2. Classify the following "experimental" errors as causing **systematic** or **random** errors.

a. Reactant powder left in the weighing boat after reactant transfer to the reaction vessel

b. An electronic balance that is miscalibrated

c. A digital thermometer giving fluctuating readings

d. Calculation error when applying a formula, such as Hess's Law or the First Law of Thermodynamics

3. Though words such as "accuracy" and "precision" have precise definitions, in everyday conversation, they are used as synonyms, which is inaccurate. Classify the following phrases found in abstracts as either statements concerning **precision** or statements concerning **accuracy**:

a. The heat of reaction was found to be 120.3 ± 2.4 kJ/mol of reactant

b. The measured value was found to be 14% off of the calculated value

c. The wavelength was measured to be 370 ± 10 nm, which was 10% below the generally accepted result.