

Synchrotron Investigations

7.3 Mass

In this activity you will estimate the mass of a range of objects, and then accurately measure them to see how good your estimates were. Finally, you will calculate and analyse your percentage errors.

Materials

- Set 1; a set of five objects to allow weight estimation.
- One set of known weights (1 kg, 100 g, 10 g and 1 g) that can be used for comparison.
- Set 2; a set of three *different* objects to estimate.
- A variety of accurate measuring scales.

Stage 1: first estimates

1. For each of the objects in *Set 1*, estimate a weight and record your estimate in the first column of the table provided.
2. When estimating you may find it useful to compare your object's unknown weight to the known weights provided.
3. Don't forget to include units with each of your estimates.
4. Once you have recorded your estimates, use the scales provided to measure the true values of the objects.
5. Record these true values in the second column of the table.
6. Remember that different scales are accurate for different weights. For example, you would not use bathroom scales to measure the weight of the match head. If you are in any doubt as to how to use the Science Department milligram scales then consult your teacher.

Set 1 results

Object	My estimate	True value	Percentage error
half a brick			
one litre of milk			
TV remote control			
drawing pin			
match head			

Stage 2: feedback

7. Calculate the percentage error for each object in *Set 1*. Enter your calculations in the third column of the table.
 - a. Overall, were your estimates wildly inaccurate or reasonably close?

 - b. Which mass range were you most accurate at estimating? Why?

 - c. Which mass range were you least accurate at estimating? Why?

 - d. Science Department milligram scales are generally enclosed instead of being open to the air. Explain why this would be so.

Stage 3: improving your skills

One aim of this process was to increase the accuracy of your estimations. Using what you have just learnt about your estimation skills, perform the same process for the three objects in *Set 2*.

Set 2 results

Object	My estimate	True value	Percentage error
bottle of water			
A4 sheet of paper			
calculator			

Stage 4: first analysis

8. Calculate the percentage error for the *Set 2* objects and record the values in your table. Use the two tables you have completed to answer the following questions.
 - e. When making estimates, in what range are you most accurate? In what range are you least accurate? Do you think that there is any particular reason for this?
 - f. When recording your estimates, did you make a good choice of which units and prefixes to use? Show your choices to a partner and discuss whether you both agree on the choices made.
 - g. In general, do you tend to over-estimate weights, under-estimate weights or neither?
 - h. Was your accuracy in *Set 2* better after feedback from *Set 1* estimates and measurements? Why?
 - i. Do you think that another repetition would further improve your estimation skills?

Stage 5: Further Analysis

- j. Do you think that the statement below is correct?
The percentage errors in the second set of measurements will be smaller than those in the first set.
- k. Why is this likely to be correct/incorrect?

Collect the percentage error results for 20 students (or as many as are available). Calculate the mean and standard deviation for the percentage error of each object individually. Record this information in the tables.

Set 1 – Estimation												
Object	1	2	3	4	5	6	7	8	9	10		
half brick												
A litre of milk												
TV remote												
drawing pin												
match head												
Object	11	12	13	14	15	16	17	18	19	20	Mean	Std. Dev.
half brick												
A litre of milk												
TV remote												
drawing pin												
match head												

Set 2 - Estimation												
Object	1	2	3	4	5	6	7	8	9	10		
bottle of water												
A4 paper												
calculator												
Object	11	12	13	14	15	16	17	18	19	20	Mean	Std. Dev.
bottle of water												
A4 paper												
calculator												

- l) In calculating the mean and standard deviation for each estimation set as a whole, is it valid to simply average the means and average the standard deviations? Why? Why not? Check with your teacher that you have the correct answer.
- m) Calculate the overall mean and standard deviation for *Set 1* and then for *Set 2*. Record them below.
- n) Using the statistics you have just calculated, do you still agree with your answer to *Question j*? Give detailed reasons, referring to the information you collected in *Stage 5*.

