

Specification for Assessment #5

Conducting Scientific Measurements

Competency

Student can carry out a plan for scientific investigations of various types.

Focus of this assessment:

- ☐ Declarative knowledge
- ☒ Procedural knowledge
- ☐ Problem solving

Evidence

Students are presented with a plan for conducting scientific measurements. Students provide evidence of a component of the competency by making accurate measurements to the proper precision and generating a data table. Directions will not require students to analyze or interpret the collected data, or to perform calculations, conversions, or arithmetic related to the collected data.

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Example Task

Today, you will measure the mass of three balls used in sports. The safety procedures for this activity are:

- Stay at your own laboratory station for the entire activity.
- Do not do anything that might hurt you, another student, or the laboratory equipment.

Materials

- triple-beam balance
- tennis ball, softball, and baseball
- blank paper
- pen or pencil

You will use a triple-beam balance to make your mass measurements. Then, you will record your measurements in a data table. Follow the instructions below:

- Step 1. Create a data table on a blank sheet of paper. Your data table should include two columns, one labeled “type of ball” and the other labeled “mass.”
- Step 2. Place one of the balls on your triple-beam balance. Use the balance to measure the mass of the ball. Record the mass in your data table in the units indicated on the scale to the proper precision. **Do not convert units.**
- Step 3. Repeat *Step 2* for each of the other two balls.

When you are finished, sit quietly until your teacher collects your materials.

Scoring Plan for the Example Task

Presentation of Data

Data are recorded in a table (with or without gridlines).	1 pt.
Response includes label for type of ball (e.g., as a column heading in a data table).	1 pt.
All three balls are identified in the response.	1 pt.
Response includes label for mass (e.g., as a column heading in a data table).	1 pt.
Three measured values are included in the response.	1 pt.
Each of the three measured values is labeled with “grams” or “g” or response specifically indicates that all values are reported in these units (e.g., within a column heading).	1 pt.

Precision of Measurements

All three measurements are reported to the same precision (i.e., same decimal place).	1 pt.
Each measured value is reported to the 1/100th place.	1 pt.

Accuracy of Measurements

For each of the three measurements, one point is awarded if reported value is within 0.40 g of accepted value.	3 pts. max.
For each of the three measurements, one point is awarded if reported value is within 0.20 g of accepted value. <ul style="list-style-type: none">A student is awarded an additional point for each measurement to this higher degree of accuracy.	3 pts. max.

Procedure for Creating Parallel Tasks

Parallel tasks require the student to perform measurements of one physical property (mass, length, or fluid volume) of three different objects, such as a tennis ball, softball, and baseball, for which the values of those measurements are assumed not to be the same.

The administrator must determine or verify the accepted values of each object to be used in scoring.

Directions

- The directions specifically state:
 - Create a data table.
 - Include column labels.
 - Make measurements to the proper precision.
- Provide sufficiently detailed directions to the student that will enable the student to complete the task without having prior experience conducting the same investigation. The instructions, however, must not include procedural details related to specific elements represented in the scoring plan (e.g., how to use measuring equipment or how to record a measurement to the appropriate precision).
- Provide blank paper to the student on which the student can record the measurements in a data table.

Measurement Equipment

Measurements are to be made using the metric system exclusively, though not limited to standard SI units (e.g., a length measurement in centimeters is acceptable and does not need to be converted to meters). Measurement equipment required to complete the task is limited to one of the following:

- mass: triple-beam balance
- length: ruler or meterstick
- fluid volume: graduated cylinder

Only measurement devices with scales having smallest divisions equal to 1×10^n (e.g., 1 mL, 10 mm, or 0.01 g) are to be used. Scales not meeting this requirement (e.g., a graduated cylinder having a scale with marks every 2 mL) cause the proper estimation and recording of the measurement to be beyond the scope of this competency. Due to the nature of the uncertainty related to reading a digital scale, only analog measuring devices are used in assessments based on this specification.

Equipment must be capable of producing repeated measurements to within $\pm 2 \times$ the smallest scale division.

Scoring Plan for Parallel Tasks

Scoring plan used for the example task	Generic scoring criteria for all parallel tasks
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Presentation of Data

Same as generic.	Data are recorded in a table (with or without gridlines).	1 pt.
Response includes label for type of ball (e.g., as a column heading in a data table).	Response includes label for category (e.g., a column heading in the data table).	1 pt.
All three balls are identified in the response.	The names of each of the three categorical values are included in the response.	1 pt.
Response includes label for mass (e.g., as a column heading in a data table).	Response includes label for measured quantity.	1 pt.
Same as generic.	Three measured values are included in the response.	1 pt.
Each of the three measured values is labeled with “grams” or “g” or response specifically indicates that all values are reported in these units (e.g., within a column heading).	Appropriate units are given for each measurement, or student specifies an appropriate unit and that it applies to all the measured values (e.g., in a column heading).	1 pt.

Precision of Measurements

Same as generic.	All three measurements are reported to the same precision (i.e., same decimal place).	1 pt.
Each measured value is reported to the 1/100th place.	All three measurements are reported to the proper precision for the measurement instrument (i.e., exactly one decimal place beyond the scale’s smallest division).	1 pt.

Accuracy of Measurements

For each of the three measurements, one point is awarded if reported value is within 0.40 g of accepted value.	For each of the three measurements, one point is awarded if reported value is within 4 x smallest scale division of accepted value.	3 pts. max.
For each of the three measurements, one point is awarded if reported value is within 0.20 g of accepted value. <ul style="list-style-type: none"> A student is awarded an additional point for each measurement to this higher degree of accuracy. 	For each of the three measurements, one point is awarded if reported value is within 2 x smallest scale division of accepted value. <ul style="list-style-type: none"> A student is awarded an additional point for each measurement to this higher degree of accuracy. 	3 pts. max.