# Answers to Lesson 1: Mastering Accuracy and Precision Questions

## Essential Question

1. How can you distinguish between accuracy and precision in scientific measurements?  
 - Accuracy refers to how close a measurement is to the true value, while precision refers to the consistency of repeated measurements.

## Pathfinder: Lab Experiment: Measuring Density

2. While conducting your investigations, did you experience any experimental errors? If so, how did it affect your findings?  
 - Experimental errors, such as human error or instrument limitations, introduce uncertainty and can cause deviations from the true value or inconsistencies in repeated measurements.

3. What patterns do you see in your repeated measurements? Are they consistent, or do they vary significantly?  
 - Consistent patterns in repeated measurements indicate precision. Significant variation suggests issues with measurement techniques or instruments.

4. If you could not identify your solid, explain why not.  
 - Failure to identify the solid could result from measurement errors, insufficient precision, or reference data discrepancies.

5. In reference data values, densities are reported along with temperature. Why could that be?  
 - Density depends on temperature as it affects the material's volume. Reporting temperature ensures accurate comparisons.

6. How would you measure the density of a liquid? And the density of a gas?  
 - For liquids: Measure mass using a balance and volume using a graduated cylinder, then use the formula Density = Mass/Volume.  
 - For gases: Use a sealed container to measure the mass of the gas and calculate the volume based on the container's dimensions.

## Progress Check 2

7. Why must the measurements be repeated multiple times?  
 - Repeating measurements ensures precision by identifying and reducing random errors.

8. If the density values you calculated are inconsistent, how would you troubleshoot or refine the procedure to improve your results?  
 - Troubleshooting may involve calibrating instruments, controlling environmental factors, or reducing human errors.

9. Which measurement implies greater precision: 8.60 g or 9 g?  
 - 8.60 g implies greater precision because it includes more significant figures.

10. With how many significant figures should your findings from the lab be reported?  
 - Findings should be reported based on the least precise measurement used in the calculations.

## Lesson Check

11. Often, the true value of the property being measured is not known. Evaluate whether these measurements demonstrate accuracy, precision, both, or neither: 4.5 g, 4.7 g, 4.6 g, and 4.8 g.  
 - The measurements demonstrate precision because they are consistent but may lack accuracy if the true value differs.

12. A chemist measures the volume of a bracelet and finds it is 5 cm³. Can the chemist report 5.0 cm³?  
 - Yes, 5.0 cm³ indicates greater precision, reflecting the uncertainty of the measurement.

13. Why is it important to repeat the measurements and report findings with the correct number of significant figures?  
 - Repeating measurements ensures precision and reliability, while significant figures communicate the uncertainty and accuracy of the data.

14. What happens if a measurement is not precise in scientific experiments, and how can imprecise measurements affect the results?  
 - Imprecise measurements reduce reliability, introduce errors, and make it harder to draw accurate conclusions.

## Lesson Check: Scenario-Based Questions

15. A laboratory student is tasked with determining the density of an unknown liquid. The true density of the liquid is 1.25 g/cm³:  
 - i. What can be said about the student’s measurements of 1.18 g/cm³, 1.20 g/cm³, and 1.19 g/cm³?  
 - B. The measurements are precise but not accurate.  
 - ii. If the student obtains measurements of 1.25 g/cm³, 1.26 g/cm³, and 1.24 g/cm³, how would you describe the data?  
 - C. The measurements are both accurate and precise.  
 - iii. Which scenario best represents a set of measurements that are accurate but not precise?  
 - B. 1.18 g/cm³, 1.25 g/cm³, and 1.32 g/cm³ when the true density is 1.25 g/cm³.

## Power Up

16. Reflect on the following prompts to think critically about accuracy and precision:  
 - Measurements can vary based on instrument accuracy and user handling.  
 - Significant figures indicate precision and limit overinterpretation.  
 - Calibration ensures instruments yield accurate data.  
 - Systematic errors can be minimized with robust experimental design.

## Beyond the Lesson

17. How are accuracy and precision crucial in healthcare, particularly in medication administration?  
 - Accuracy ensures the correct dosage is delivered, while precision ensures consistent dosing, both of which are essential for patient safety and treatment effectiveness.

18. Why is it important that repeated doses of medication remain consistent in precision?  
 - Consistent dosing prevents under- or overdosing, ensuring safe and reliable treatment outcomes.