Pre-Lab: Measurements and Uncertainty

A student made the following six measurements of the mass of an object: 

1. You are using a mass balance to measure the mass of an object. Assume that you can measure reasonably to the nearest one-half of the smallest division and the smallest division on your mass balance is 0.1 g. This means your instrumental precision (instrumental uncertainty) of the mass measurements is $\frac{1}{2}(0.1 \text{ g}) = 0.05 \text{ g}$. If your object is exactly twenty-seven grams, how would you record the mass measurement to reflect the precision of the instrument (and your ability to use it)?
   a. 27 g  
   b. 27.0 g  
   c. 27.00 g  
   d. 27.000 g

Questions 2 & 3: A student made the following six measurements of the mass of an object: $m = 31.4 \text{ g}, 31.4 \text{ g}, 31.4 \text{ g}, 31.4 \text{ g}, 31.4 \text{ g}, 31.4 \text{ g}$. Assume the instrumental uncertainty is $\delta_{\text{inst}} = 0.1 \text{ g}$

2. What is a reasonable estimate of the sample uncertainty, $\delta_{\text{samp}}$? Hint: Consider the variation between each measurement and the average of all the measurements.
   a. 31.4 g  
   b. 0.4 g  
   c. 0.1 g  
   d. 0.0 g

3. What is a reasonable estimate of the uncertainty of the measurement, $\delta m$? Hint: Look at both the instrumental and sample uncertainties and choose the larger value.
   a. 31.4 g  
   b. 0.4 g  
   c. 0.1 g  
   d. 0.0 g

4. A student measures a density of $(8.90 \pm 0.06) \text{ g/cm}^3$ for a copper cylinder and the accepted value for the density of copper is $8.94 \text{ g/cm}^3$. How should you describe the two values?
   a. They do not agree. (There is a significant discrepancy.)
   b. They are close but do not quite agree. (There is a slightly significant discrepancy.)
   c. They agree within uncertainty. (There is no significant discrepancy.)

5. What is the smallest division on the dial of a dial caliper?
   a. 10 mm  
   b. 1 mm  
   c. 0.1 mm  
   d. 0.01 mm

6. What is the smallest division on the barrel of a micrometer and the thimble of a micrometer?
   a. 0.5 mm, 0.01 mm  
   b. 0.5 mm, 0.05 mm  
   c. 0.1 mm, 0.01 mm

7. Which instrument should you not attempt to “zero” yourself (according to the lab manual)?
   a. micrometer  
   b. dial caliper  
   c. ruler  
   d. triple beam balance

8. What part of the dial caliper do you use to measure inside diameters?
   a. the thick wire that extends out of the end of the instrument
   b. the larger pair of jaws
   c. the smaller pair of jaws
   d. You can’t measure an inside diameter with the dial caliper.

9. Calculate the following volume with its uncertainty and choose the best answer (including the units and the correct number of significant digits – see Rules for reporting experimental values, A-8, Appendix C).
   [2 pts]
   $V = L \times W \times H$; $L = (25.0 \pm 0.5) \text{ mm}$  
   $W = (10.0 \pm 0.5) \text{ mm}$  
   $H = (12.5 \pm 0.5) \text{ mm}$
   a. $V = (3.12 \pm 1.5) \times 10^3 \text{ mm}^3$  
   b. $V = (3.1 \pm 0.3) \times 10^3 \text{ mm}^3$
   c. $V = (3.125 \pm 0.343) \times 10^3 \text{ mm}^3$  
   d. $V = (3.125 \pm 0.011) \times 10^3 \text{ mm}^3$