

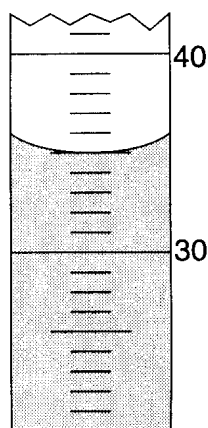
1. During a laboratory activity to investigate reaction rate, a student reacts 1.0-gram samples of solid zinc with 10.0-milliliter samples of HCl(aq). The table below shows information about the variables in five experiments the student performed.

Reaction of Zn(s) with HCl(aq)

| Experiment | Description of Zinc Sample | HCl(aq) Concentration (M) | Temperature (K) |
|------------|----------------------------|---------------------------|-----------------|
| 1          | lumps                      | 0.10                      | 270.            |
| 2          | powder                     | 0.10                      | 270.            |
| 3          | lumps                      | 0.10                      | 290.            |
| 4          | lumps                      | 1.0                       | 290.            |
| 5          | powder                     | 1.0                       | 280.            |

Which two experiments can be used to investigate the effect of the concentration of HCl(aq) on the reaction rate?

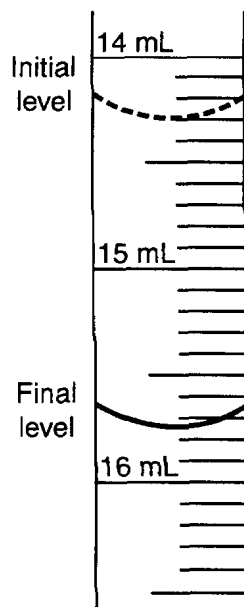
- A) 1 and 3                      B) 1 and 5  
 C) 4 and 2                      D) 4 and 3
2. During a laboratory activity, a student combined two solutions. In the laboratory report, the student wrote "A yellow color appeared." The statement represents the student's recorded
- A) conclusion                  B) observation  
 C) hypothesis                  D) inference
3. The diagram below represents a portion of a 100-milliliter graduated cylinder.



What is the reading of the meniscus?

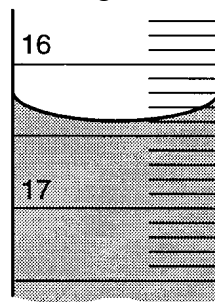
- A) 35.0 mL                      B) 36.0 mL  
 C) 44.0 mL                      D) 45.0 mL

4. The diagram below represents a section of a buret containing acid used in an acid-base titration.



What is the total volume of acid that was used?

- A) 1.10 mL                      B) 1.30 mL  
 C) 1.40 mL                      D) 1.45 mL
5. The diagram below shows a portion of a buret.



What is the meniscus reading in milliliters?

- A) 16.00    B) 16.40    C) 17.00    D) 17.60
6. An aluminum sample has a mass of 80.01 g and a density of 2.70 g/cm<sup>3</sup>. According to the data, to what number of significant figures should the calculated volume of the aluminum sample be expressed?
- A) 1            B) 2            C) 3            D) 4
7. A sample of an element has a mass of 34.261 grams and a volume of 3.8 cubic centimeters. To which number of significant figures should the calculated density of the sample be expressed?
- A) 5            B) 2            C) 3            D) 4

8. Which quantity of heat is equal to 200. joules?

- A) 20.0 kJ                      B) 2.00 kJ  
C) 0.200 kJ                     D) 0.0200 kJ

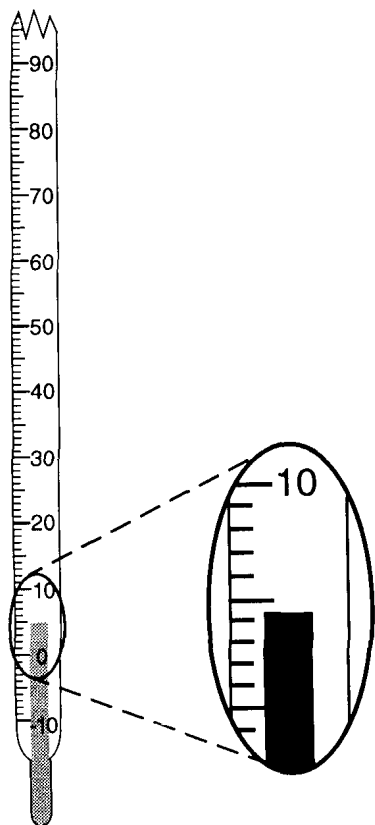
9. Which mass measurement contains four significant figures?

- A) 0.086 g                      B) 0.431 g  
C) 1003 g                        D) 3870 g

10. Expressed to the correct number of significant figures, the sum of two masses is 445.2 grams. Which two masses produce this answer?

- A) 210.10 g + 235.100 g  
B) 210.100 g + 235.10 g  
C) 210.1 g + 235.1 g  
D) 210.10 g + 235.10 g

11. The diagram below represents a Celsius thermometer recording a certain temperature.



What is the correct reading of the thermometer?

- A) 5°C    B) 4.3°C    C) 0.3°C    D) 4°C

12. During a laboratory experiment, a sample of aluminum is found to have a mass of 12.50 grams and a volume of 4.6 milliliters.

What is the density of this sample, expressed to the correct number of significant figures?

- A) 2.717 g/mL                      B) 2.72 g/mL  
C) 3 g/mL                            D) 2.7 g/mL

13. How many kiloJoules are equivalent to 10 Joules?

- A) 0.001 kJ                        B) 0.01 kJ  
C) 1000 kJ                         D) 10,000 kJ

14. Which measurement contains a total of three significant figures?

- A) 0.12    B) 012    C) 120    D) 120.

15. What is the product of  $(2.324 \text{ cm} \times 1.11 \text{ cm})$  expressed to the correct number of significant figures?

- A) 2.58 cm<sup>2</sup>                        B) 2.5780 cm<sup>2</sup>  
C) 2.5796 cm<sup>2</sup>                     D) 2.57964 cm<sup>2</sup>

16. A student measures the mass and volume of a piece of aluminum. The measurements are 25.6 grams and 9.1 cubic centimeters. The student calculates the density of the aluminum. What is the percent error of the student's calculated density of aluminum?

- A) 1%    B) 2%    C) 3%    D) 4%

17. The accepted value for the percent by mass of water in a hydrate is 36.0%. In a laboratory activity, a student determined the percent by mass of water in the hydrate to be 37.8%. What is the percent error for the student's measured value?

- A) 5.0%                              B) 4.8%  
C) 1.8%                              D) 0.05%

18. A student intended to make a salt solution with a concentration of 10.0 grams of solute per liter of solution. When the student's solution was analyzed, it was found to contain 8.90 grams of solute per liter of solution. What was the percent error in the concentration of the solution?

- A) 1.10%                              B) 8.90%  
C) 11.0%                              D) 18.9%

19. Base your answer to the following question on the following information.

Carbon and oxygen are examples of elements that exist in more than one form in the same phase.

Graphite and diamond are two crystalline arrangements for carbon. The crystal structure of graphite is organized in layers. The bonds between carbon atoms within each layer of graphite are strong. The bonds between carbon atoms that connect different layers of graphite are weak because the shared electrons in these bonds are loosely held by carbon atoms. The crystal structure of diamond is a strong network of atoms in which the shared electrons are strongly held by the carbon atoms. Graphite is an electrical conductor, but diamond is not. At 25°C, graphite has a density of 2.2 g/cm<sup>3</sup> and diamond a density of 3.51 g/cm<sup>3</sup>.

The element oxygen can exist as diatomic molecules, O<sub>2</sub>, and as ozone, O<sub>3</sub>. At standard pressure the boiling point of ozone is 161 K.

Calculate the volume, in cm<sup>3</sup>, of a diamond at 25°C that has a mass of 0.200 gram. Your response must include both a correct numerical setup and the calculated result.

Base your answers to questions 20 and 21 on the information below.

In preparing to titrate an acid with a base, a student puts on goggles and an apron. The student uses burets to dispense and measure the acid and the base in the titration. In each of two trials, a 0.500 M NaOH(aq) solution is added to a flask containing a volume of HCl(aq) solution of unknown concentration. Phenolphthalein is the indicator used in the titration. The calculated volumes used for the two trials are recorded in the table below.

**Volumes of Base and Acid Used in Titration Trials**

|                      |                     | <b>Trial 1</b>          | <b>Trial 2</b>          |
|----------------------|---------------------|-------------------------|-------------------------|
| <b>Solution (aq)</b> | <b>Molarity (M)</b> | <b>Volume Used (mL)</b> | <b>Volume Used (mL)</b> |
| NaOH                 | 0.500               | 17.03                   | 16.87                   |
| HCl                  | ?                   | 10.22                   | 10.12                   |

20. Identify *one* additional safety precaution the student should have taken before performing the titration.

21. Based on the information given in the table, how many significant figures should be shown in the calculated molarity of the HCl(aq) solution used in trial 2?

22. Base your answer to the following question on the information below.

Archimedes (287–212 BC), a Greek inventor and mathematician, made several discoveries important to science today. According to legend, Hiero, the king of Syracuse, commanded Archimedes to find out if the royal crown was made of gold, only. The king suspected that the crown consisted of a mixture of gold, tin and copper.

Archimedes measured the mass of the crown and the total amount of water displaced by the crown when it was completely submerged. He repeated the procedure using individual samples, one of gold, one of tin, and one of copper. Archimedes was able to determine that the crown was not made entirely of gold without damaging it.

Determine the volume of a 75-gram sample of gold at STP.