# ***Making Laboratory Measurements***
# ***Significant Figures***

**Name:**_____

***By the end of this activity, students will know and be able to:***

1) **Record appropriate number of digits in a table when making laboratory measurements**
2) **Define significant figures (significant digits)**

**In discussing measurements and significant figures, ACCURACY tells us how close a measurement is to the true value of the quantity that is being measured. PRECISION refers to the closeness of a set of measurements to each other.**

**Some of the measuring instruments you will use in the lab are thermometers, graduated cylinders, rulers, burettes, and electronic balances. All of these instruments, except electronic balances, are graduated. This means they are marked with lines and numbers. When recording a reading from a graduated measuring instrument, you should write down all the numbers indicated by the graduations (lines and numbers) plus an estimated (guessed or approximated) final digit. This final written digit is called an UNCERTAIN digit. The digits preceding the final digit are called CERTAIN digits. Data taken in the lab may only contain one uncertain digit.**

***(All of the figures referred to in this exercise are on the next page.)***

**Figure 1: The correct volume reading for the liquid in the graduated cylinder is 1.5 milliliters *(Remember that liquid volumes are read from the bottom of the meniscus).* The "1" is a certain digit and the "5" is an uncertain digit (estimated).**

**All the certain digits plus the one uncertain digit collectively are called SIGNIFICANT FIGURES. For instance, if a chemistry student or scientist records the number 37.624 on a data sheet, the digits 3, 7, 6, and 2 are certain digits and 4 is an estimated digit. Thus the number 37.624 contains FIVE significant figures.**

**The exactness of a measurement is determined by the number of significant figures it contains. The number 37.624 contains FIVE significant figures and the number 37.6 contains THREE significant figures. The number 37.624 is more exact or precise than the number 37.6 because 37.624 contains more significant figures. The relative precision of measuring instruments can be determined by noting which instrument can give readings with more significant figures.**

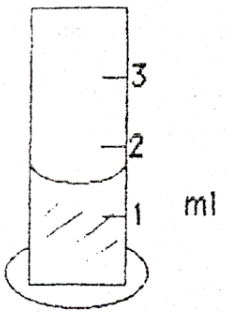


Figure 1

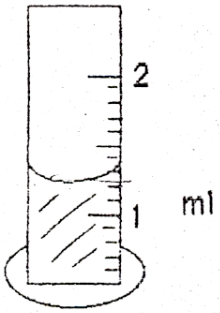


Figure 2

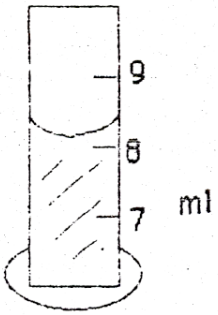


Figure 3

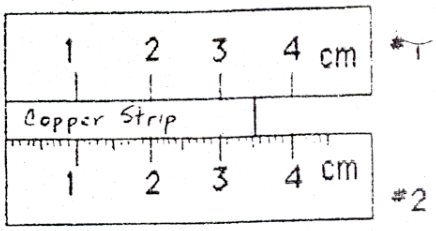


Figure 4

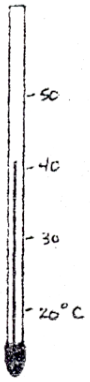


Figure 5

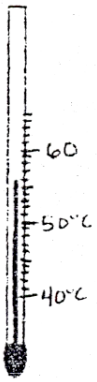


Figure 6

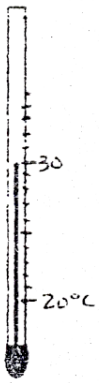


Figure 7

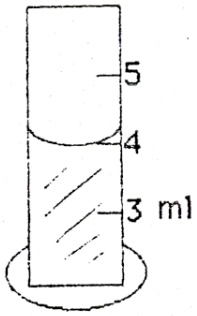


Figure 8

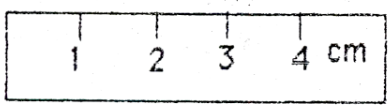


Figure 9

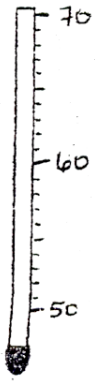


Figure 10

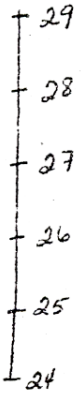


Figure 11


Figure 12

Figure 13

***FOLLOW-UP QUESTIONS & ANALYSIS:*** **Name:**_____

**DIRECTIONS: For each lab measurement below, express your answer in correct number of significant figures (all certain digits + one estimated) and include all units.**

1. **"The volume of the liquid is 40.63 milliliters." The following statement is a lab measurement. Rewrite the measurement and mark an "X" above the digit which is UNCERTAIN.** ***(Include unit)***

2. **What is the name of the lab instrument pictured in figure #2?**

3. **What is the two-layered curved upper surface of a column of liquid called?**

4. **When a meniscus forms at the upper surface of a liquid in a graduated cylinder, do you read the graduated cylinder at the TOP, BOTTOM, or MIDDLE of the meniscus?**

5. **What is the volume of the liquid in the graduated cylinder in Figure #2?** ***(Include unit)***

6. **Rewrite your answer to #5 and mark an "X" over the estimated (uncertain) digit.** ***(Include unit)***

7. **How many significant figures are in the lab measurement that you recorded for #5?**

8. **What is the volume of the liquid in the graduated cylinder in Figure #3?** ***(Include unit)***

9. **Rewrite your answer to #8 and mark an "X" over the estimated (uncertain) digit.** ***(Include unit)***

10. **How many significant figures are in the lab measurement that you recorded for #8?**

11. **Which lab instrument is more precise, the graduated cylinder in figure #2 or figure #3?**

12. **Which lab measurement is more precise, 35 cm or 35.7 cm?** ***(Include unit)***

13. **What is the length of the copper strip as measured by ruler #1 in figure #4?** ***(Include unit)***

14. **What is the length of the copper strip as measured by ruler #2 in figure #4?** ***(Include unit)***

15. **Which ruler measurement has the greater number of significant figures, the measurement from ruler #1 or ruler #2?**

16. **Which lab instrument is more precise, ruler #1 or ruler #2?**

17. **What is the temperature reading of the thermometer in figure #5?** ***(Include unit)***

18. **Rewrite your answer to #17 and mark an "X" over the estimated (uncertain) digit.** ***(Include unit)***

19. **How many significant figures are in the lab measurement that you recorded for #17?**

20. **What is the temperature reading of the thermometer in Figure #6?** ***(Include unit)***

21. **Rewrite your answer to #20 and mark an "X" over the estimated (uncertain) digit.** ***(Include unit)***

22. **How many significant figures are in the lab measurement that you recorded for #20?**

23. **Which lab instrument is more precise, the thermometer in figure #5 or figure #6?**

***When a lab measurement is exactly on an instrument graduation line/mark, add a zero, or zeros to the measurement reading. For instance, look at figure #7. The mercury in the thermometer is exactly on 30 degrees Celsius. Because the thermometer can be read to the tenths place, the temperature should be recorded as 30.0 degrees Celsius (3 significant figures).***

24. **What is the volume reading of the graduated cylinder in Figure #8? *(Include unit)***

25. **What is the maximum number of significant figures that can be read from the ruler in figure #9?**

26. **What is the maximum number of significant figures that can be read from the thermometer in figure #10?**

27. **Re-draw Figure #11 on your paper and use arrows to mark the readings 27.2 AND 25.0 .**

28. **Re-draw Figure #12 on your paper and use arrows to mark the readings 3.35 AND 4.00 .**

***** Use the lab instruments provided at each lab station to finish this exercise *****

29. **Put any amount of water in a 100 mL graduated cylinder. Properly read the measurement. What is the volume measurement of the water in the graduated cylinder? *(Include unit)***

30. **Put any amount of water in a 10 mL graduated cylinder. Properly read the measurement. What is the volume measurement of the water in the graduated cylinder? *(Include unit)***

31. **Get a laboratory thermometer. What is the temperature reading of the room? *(Include unit)***

32. **Use a ruler to measure the line in figure #13. What is the length of this line *(in millimeters)* ?**

33. **Examine a 100 mL graduated cylinder and a 150 mL beaker. Which lab instrument would give a more precise measurement of volume?**

34. **Refer to question #33: Assuming both lab instruments had the same amount of water in them, which lab instrument would be more accurate?**

***Electronic balances do all the work for you. Record ALL the digits shown on the balance display. The last digit written is the estimated (uncertain) digit.***

35. **What is the mass of your pen or pencil according to balance #1? *(Include unit)***

36. **What is the mass of your pen or pencil according to balance #2? *(Include unit)***

37. **Which electronic balance is more precise, balance #1 or #2?**

38. **All the certain digits plus one uncertain digit written down in a lab measurement are called**

_____.