Significant figures unit 1 worksheet 2

Name: ____________________________ Section: ___________________________ Student ID#:________________________ Work in groups on these problems. You should try to answer the questions without referring to your textbook. If you get stuck, try asking another group for help. All scientists the world over use metric units. Since 1960, the metric system in use has been the Système International d'Unités, commonly called the SI units. These units facilitate international communication by discouraging use of units peculiar to one culture or another (e.g., pounds, inches, degrees Fahrenheit). But regardless of the units used, we want to have some confidence that our measured and calculated results bear a close relationship to the “true” values. Therefore, we need to understand the limits on our measured and calculated values. One way we convey this is by writing numerical answers with no more and no fewer than the number of digits that are justified by the limits of our ability to measure and know the quantity. Learning Objective Know the units used to describe various physical quantities Become familiar with the prefixes used for larger and smaller quantities Master the use of unit conversion (dimensional analysis) in solving problems Appreciate the difference between precision and accuracy Understand the relationship between precision and the number of significant figures in a number Success Criteria Associate units with physical quantities Replace prefixes by multiplying by appropriate numerical factors Be able to use dimensional analysis for unit conversions Report computed values to the correct number of significant figures. The SI units consist of seven base units and two supplementary units. For now, we will only use the four base units listed below. Later we will talk about two others. We will never use the seventh unit (candela), a unit for luminous intensity. Table \(\PageIndex{1}\): Four of the Base units in the SI system Quantity Unit Abbrev. Length meter m Mass kilogram kg Time second s Temperature kelvin K Any other units can be constructed as a combination of fundamental units. For example, velocity could be measured in meters per second (written m/s or m×s–1), and area could be measured in units of meters squared (m2). When a named unit is defined as a combination of base units, it is called a derived unit. For example, the SI unit of energy is the joule (J), which is defined as a kg×m2×s–2. Note that when a unit is named for some scientist (e.g., Joule, Herz, Kelvin) the written name of the unit is not capitalized, but the abbreviation is capitalized. All metric units can be related to larger or smaller units for the same quantity by use of prefixes that imply multiplication of the stem unit by certain powers of 10. The following prefixes are important to know. Table \(\PageIndex{2}\): SI Prefixes Prefix Abbrev. 10±n Example Mega- M 106 Megaherz (MHz) Kilo- k 103 kilogram (kg) Deci- d 10–1 deciliter (dL) Centi- c 10–2 centimeter (cm) Milli- m 10–3 milliliter (mL) Micro- m 10–6 microgram (µg) Nano- n 10–9 nanometer (nm) Pico- p 10–12 picosecond (ps) Femto- f 10–15 femtosecond (fs) Give the names and their abbreviations for the SI units of length, mass, time, and temperature. The unit of volume is the liter (L). Why is this not a base SI unit? What kind of SI unit is it? A student is asked to calculate the mass of calcium oxide produced by heating a certain amount of calcium carbonate. The student’s answer of 90.32 is numerically correct, but the instructor marks it wrong. Why? Write the number of seconds in a day (86,400 s) in exponential notation, using a coefficient that is greater than 1 and less than 10. (This form is called scientific notation and is generally the preferred form of exponential notation, as explained below). The diameter of a helium atom is about 30 pm. Write this length in meters, using standard scientific notation. A cubic container is 2.00 cm on each edge. What is its volume in liters? What is its volume in milliliters (mL)? Are your answers reasonable? Units can actually help in setting up and solving many problems by using a method called dimensional analysis (also called the factor-label method). In dimensional analysis, a problem is typically viewed as a conversion of a given value in given units into a new value in certain desired units. Mathematically, such problems take on the general form \[(\text{given quantity in } \cancel{\text{given units}}) \underbrace{\left(\dfrac{\text{wanted units}}{\cancel{\text{given units}}}\right)}_{\text{conversion factor} \equiv 1} = \text{wanted quantity in wanted units}\] The factor "wanted units/given units" is a conversion factor, which is always a fractional expression of an equivalence relationship between two different units. In carrying out the multiplication and division, the given units cancel out, leaving the wanted units. To apply dimensional analysis, follow this general problem-solving strategy: Identify and record what is know, with its given units; identify what is to be calculated with its units; identify the concepts and/or relationships that connect the given information with what needs to be calculated; set up the solution using unit relationships as one or more conversion factors, such that all units except those desired for the answer cancel; do the mathematics; check or validate your answer by asking yourself if it is a reasonable result. How many inches is 2.00 cm, given that the inch is defined as exactly 2.54 cm? We know the length in centimeters. We want the length in inches. 1 inch (in.) is exactly 2.54 cm (no uncertainty) Possible conversion factors are 1 in/2.54 cm and 2.54 cm/1 in) We are starting with cm and want to end up with in, so the first conversion factor will do the job. \[(2.00 \,cm) \underbrace{\left(\dfrac{1\,in}{2.54 \,cm}\right)}_{\text{conversion factor} \equiv 1} = \,?\] Do the mathematics. \[(2.0 \cancel{\,cm}) \underbrace{\left(\dfrac{1\,in.}{2.54 \cancel{\,cm}}\right)}_{\text{conversion factor} \equiv 1} = 0.787\, in.\] Note that the centimeter units cancel, leaving the desired units of inches. If 2.54 cm is an inch, then 2.00 cm should be a fraction of an inch. So, 0.787 in looks like a reasonable answer. In general, how can you identify whether or not you have written the correct conversion factor for the problem? One liter is 1.06 quarts (qt). Write two possible conversion factors from this relationship. The posted speed limit is 60 mi/hr. You are doing 120 km/hr in your Porsche convertible that you just bought in Germany. Are you speeding? Explain. [1.0 mi = 1.6 km] In the gym, you slip on two 45-lb barbell plates to a bar that weighs 45 lb. What is the mass of the set-up in kilograms? [1.00 kg = 2.20 lbs] A table top is 36 in long and 24 in wide. What is the area of the table top in square meters? [1 in = 2.54 cm, exactly] Measured quantities always have some experimental error. Therefore, measured quantities are regarded as inexact. The accuracy of a measured quantity is its agreement with a standard or true value. In reality, we generally cannot know the true value of something we wish to measure. We gain confidence that our measured value is close to the truth by repeating the measurement many times. If our repeated measurements yield a set of data that differ very little from each other, we have some confidence that the average of these measured values is close to the true value. The repeatability of the measurements is called its precision. In general, we assume that greater precision in a set of numbers makes it more likely that the average value will be accurate. However, it is possible for a very precise set of values to be inaccurate. For example, a scientist could make the same error in each of a set of measurements, which could happen if a key measuring device were miscalibrated. Conversely, it is possible that a set of widely scattered values (poor precision) could have an average value that is very close to the true value, therefore resulting in high accuracy. We express the precision of a number by writing all the repeatable digits and the first uncertain digit from a measurement or calculation. The retained digits are called the significant figures (sig. figs.) of the number. The following rules should be used to determine the number of significant figures of a number and to establish the correct number of significant figures in the answer to a calculation. For decimal numbers with absolute value >1, all digits are significant. \(2.620\) has 4 sig. figs. \(50.003\) has 5 sig. figs. If there is no decimal point, zeroes that set magnitude only are not significant. \(103,000\) has 3 sig. figs. \(103,000.\) has 6 sig. figs. For decimal numbers with absolute value

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