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# Unit 1: Foundations of Physics

## Directions:

Read Chapter 1 (pp. 1-36) of the textbook.

## Key Terms:

1. The following words can be found in **BOLD** throughout the chapters. Write their definitions below. (1 mark each)

**Accuracy:**

**Dependent Variable:**

**Experimental Error:**

**Independent Variable:**

**Linear Function:**

**Precision:**

**Scalar Quantities:**

**Scientific Method:**

**Scientific Notation:**

**Slope:**

**Uncertainty:**

**Vector Quantities:**

**Y-intercept:**

## **Chapter 1.1** (pp. 2-5) **What is Physics?**

(2 marks each)

1. What is the "Goldilocks principle" as it applies to Earth and its ability to support life?

2. List the four main steps of the scientific method as outlined in the text.

3. Explain the difference between a "quantitative observation" and a "qualitative observation," providing an example of each from the text's description.

4. What is a "hypothesis," and in what format is it often stated?

5. How does the text describe the purpose of an "experiment" in the scientific method?

6. What is the difference between a "law" and a "theory" in physics, according to the text?

7. Give an example from the text that illustrates how a measurement can be very precise but inaccurate.

8. Differentiate between "systematic errors" and "random errors," providing an example of each type of error from the text.

9. What is "scientific notation," and why is it considered a convenient way to express numbers?

10. When adding or subtracting measurements, what rule should be followed regarding the number of digits after the decimal point in the final answer?

11. When multiplying or dividing measurements, what rule determines the number of significant digits in the final product or quotient?

Chapter 1.2 (pp. 6-7) **Equipment Essentials**

**Part A: Fill in the Blanks** (1 mark each)

For objects that have a regularly repeated motion, each complete movement is called a _____.

1. The time it takes for one complete cycle to be finished is called the _____ of the cycle.

2. The number of cycles completed in one unit of time is called the _____ of the moving object.

3. A frequency of one cycle per second is officially called a _____.

4. If you know the frequency (f) of a vibrating object, you can find its period (T) using the relationship:
   T = _____.

5. The device that uses ticker tape to record both time and distance is called a _____ _____.

6. Another method for recording motion, often used with computers or graphing calculators, is a
   _____ _____.

**Part B: Short Answer Questions** (2 marks each)

1. Provide two examples of everyday objects mentioned in the text that have a measurable frequency.

2. Explain how a year, a day, and a month are examples of time measurements that involve events repeating at regular intervals.

3. Describe how a recording timer works to record both time and distance on ticker tape.

4. If you know both the distance an object has traveled and the time it took, what other physical quantity can you calculate, and why?

5. How are higher frequencies, such as those for radio signals, typically expressed in terms of units larger than Hertz? Give the conversion factors mentioned in the text.

6. What is the main purpose of using a motion probe in physics, as described in the text?

Chapter 1.3 (pp. 9-18) **Physics Essentials**

**Part A: Fill in the Blanks** (1 mark each)

1. The number of digits in a written value used to indicate the precision of a measurement is called _____ _____.

2. When a measurement is made to the nearest millimeter, it is considered more _____ than a measurement made to the nearest meter.

3. Errors that result from using an instrument that is inaccurate, like a worn meter stick or an improperly zeroed ammeter, are called _____ errors.

4. Errors that occur in almost any measurement and cause slight variations in repeated readings, like those from estimating the last digit, are called _____ errors.

5. A convenient way to express very large or very small numbers is by using _____ _____.

**Part B: Short Answer Questions** (2 marks each)

1. Explain the difference in precision between a wall measurement of "6 m by 3 m" for painting and "5.343 m by 2.634 m" for wallpapering. How many significant digits does each measurement have?

2. Using the example of purchasing a used car, explain how writing "$400" versus "$398.75" demonstrates the concept of significant digits.

3. When are zeros considered significant digits, and when are they just "decimal-placing zeros"? Provide an example from the text to illustrate this.

4. Describe a common personal error made by inexperienced experimenters when taking measurements with scales.

5. The text states that "there is no such thing as a perfectly accurate measurement." Explain why all measurements have some degree of uncertainty.

**Part C: Application & Calculation** (2 marks each)

**Rule for Addition/Subtraction:** When adding or subtracting measurements, the sum or difference will have as many digits after the decimal point as the single measurement with the **least number of digits after the decimal point**.

6. Perform the following operations and express your answer with the correct number of significant digits:

a) 2012.5 cm + 0.067 cm =

b) 3421.73 m - 3421.5 m =

c) 12.456 mm + 0.23 mm =

d) 12.3 mL - 0.12 mL =

**Rule for Multiplication/Division:** When multiplying or dividing measurements, the product or quotient must have no more significant digits than the single measurement with the **fewest significant digits**.

7. Perform the following operations and express your answer with the correct number of significant digits:

   a) Multiply 5.34 m by 2.52 m. What is the area?

   b) Divide 84.6 $m^2$ by 2.3 m. What is the length?

   c) 1.23 m x 0.23 m =

   d) 4.765432 cm x 1.4 cm =

**Scientific Notation Conversion:** (1 mark each)

8. Convert the following measurements into scientific notation:

   a) 0.00352 kg

   b) 620,000,000 km

   c) 300,000,000 m/s (speed of light)

   d) 0.00000000000000016 C (charge of an electron)

Chapter 1.4 (pp. 19-32) **Analysis of Units and Conversions.**

**Part A: Short Answer Questions** (2 marks each).

1. What was the original basis for units of measurement like the "grain" and the "fathom"?

2. Why was there a need to standardize early units of measurement, and what was the main problem with units like "Viking's embrace"?

3. Which historical document first standardized English units of measurement?

4. Why did the United States not adopt the Imperial system of measurement in 1824?

5. What was the primary recognized advantage of a "simpler system" of measurement, as proposed by Simon Stevin?

6. What does "SI" stand for, and from what language is it derived?

7. According to the text, what are the only three countries in the world that have not adopted the SI system?

8. Explain the concept of a "conversion factor" in dimensional analysis.

9. What is the unique property of the conversion factor between inches and centimeters (1 inch = 2.54 cm) regarding significant digits?

10. What is the fundamental rule you must always follow when performing a two-step metric conversion?

11. Provide two examples of "derived units" mentioned in the text.

12. In a straight-line graph, what do the symbols 'm' and 'b' represent in the general equation $y=mx+b$ ?

13. What are the names of the three most common types of graphical relationships described in the notes?

**Part B: Fill in the Blanks** (1 mark each).

1. The method that allows you to easily solve problems by converting from one unit to another through the use of conversion factors is called _____ _____.

2. The metric system is based on powers of _____.

3. A _____ unit is composed of more than one unit.

4. In graphing, the variable plotted on the y-axis is usually the _____ variable, while the variable on the x-axis is the _____ variable.

5. For a direct graphical relationship, as the independent variable increases, the dependent variable _____ in direct proportion.

6. For an inverse graphical relationship, as the independent variable increases, the dependent variable _____.

**Part C: Calculation Problems** (2 marks each)

Show all your work, including units and conversion factors, and express your final answer with the correct number of significant digits.

1. **One-Step and Two-Step Metric Conversions:**

   a) Convert 7.2 nm into m.

   b) Convert 4.30 µm into km.

   c) Convert 12 s into ks.

   d) Convert 83,000 mL into L.

   e) Convert 235 ks into ms.

   f) Convert $6.4 \times 10^{-2}$ Mm into dm.

2. **Derived Unit Conversions:** (2 marks each)

a) Convert 2.45 g/mL into kg/L. Why has the numerical value remained unchanged?

b) Convert the density of neon gas from $0.7772 \times 10^{-3}$ mg/mL into kg/L.

c) Convert 43 mi/h (just over the speed limit in a U.S. city) into m/s. (Given: 5280 feet = 1 mile)

d) Convert 33.0 km/h into m/s.

3. **Use of Rate and Density as Conversion Factors:** (3 marks each)

a) The density of mercury metal is 13.6 g/mL. What is the mass of 2.3 L of mercury?

b) The density of lead is 11.3 g/cm$^3$. The volumes 1 cm$^3$ and 1 mL are exactly equivalent. What is the volume in liters of a 14.3 kg piece of lead?

c) The speed of light is $3.0 \times 10^{10}$ cm/s. Sunlight takes 8.37 min to travel from the photosphere (light-producing region) of the Sun to Earth. How many kilometers is Earth from the Sun?

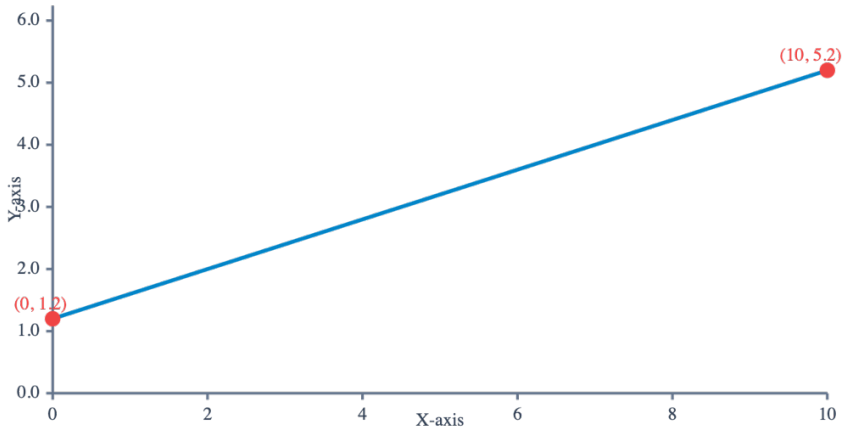
d) What is the volume in L of a 13.0 kg piece of zinc metal? (Density of Zn = 7.14 g/mL)

4. **Conversions Involving Units with Exponents:** (3 marks each)

a) Convert 5.4 $dm^3$ into $cm^3$.

b) Convert 0.43 $m^3$ (cubic meters) into mL. (Given: 1 mL = 1 $cm^3$)

5. **Graphing Analysis:**




a) For the linear graph shown above calculate the slope (m) and determine the y-intercept (b) by inspection. (3 marks)

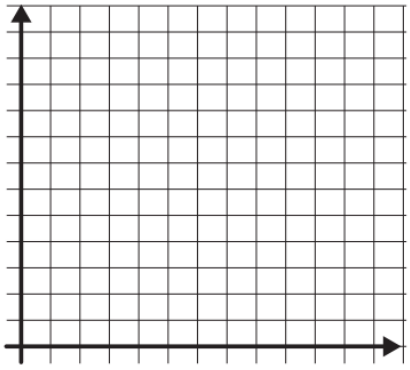
b) Write the general equation for the straight line from part (a) using the calculated slope and y-intercept. (2 marks)

c) Describe how the dependent variable changes with respect to the independent variable for each of the three common types of graphical relationships (Direct, Inverse, Exponential) shown in Figure 1.5.6.
(6 marks)

6. **Graphing:**

a) A student is investigating how the temperature of a cup of hot water changes over time as it cools in a room. They record the temperature every 5 minutes for 30 minutes. Use the following grid to plot a graph of temperature vs time (x-axis). (2 marks)

| Temperature ($^{o}$C) | Time (min) |
|---|---|
| 85 | 0 |
| 72 | 5 |
| 63 | 10 |
| 56 | 15 |
| 51 | 20 |
| 47 | 25 |
| 44 | 30 |



b) Based on your graph, describe the relationship between time and temperature. Is it linear, exponential, or another type of relationship? Explain your reasoning. (2 marks)

c) Estimate the temperature of the water after 12 minutes using your graph. (1 mark)

d) Predict what the temperature of the water might be after 40 minutes if the trend continues. (1 mark)

Chapter 1.5 (pp. 33-36) **Vectors**

**Part A: Short Answer Questions** (2 marks each)

1. What is a "vector," and how is it different from a scalar quantity? Provide an example of a vector quantity mentioned in the text.

2. Describe the two common conventions used to identify the direction of vectors.

3. Explain the difference between "distance traveled" and "displacement." Use Buddy the dog's trip around the yard as an example to illustrate this difference.

4. What is a "free-body diagram," and what is its purpose in physics?

5. When drawing a free-body diagram, where are the tails of the vectors typically placed?

**Part B: Fill in the Blanks** (1 mark each)

1. Arrows showing both magnitude and direction of displacements are called _____.

2. Physical quantities that have magnitude but no direction are called _____ quantities.

3. Physical quantities that have both magnitude and direction are called _____ quantities.

4. The sum of two or more vectors is called the _____(or vector sum).

5. To symbolize a vector quantity when typing, you can use a small _____above the symbol (e.g., $\vec{d}$ ) or type it in _____ _____(e.g., ***d***).

**Part C: Application & Problem Solving**

1. **Vector Representation:** (1 mark each)

   a) A car travels 15 km East. Write this displacement using numerical direction convention.

   b) A bird flies 25 km/h south. Write this velocity using cardinal direction convention.

2. **Distance vs. Displacement Calculation:** (1 mark)
   Refer to Buddy the dog's trip in Figure 1.5.1. Calculate the total distance Buddy traveled.

3. **Vector Addition (Conceptual):** (1 mark each)
   Imagine you walk 3 meters North, and then 2 meters East.

   a) If you were to add these two displacements as scalar quantities, what would be the sum?

   b) If you were to add these two displacements as vector quantities, would the resultant displacement be the same as your answer in (a)? Explain why or why not, referring to the text's explanation of adding displacements.

4. **Free-Body Diagram Analysis:**
   Refer to Figure 1.5.5 (the basketball tug-of-war, where Player A pulls with 120.0 N left and Player B pulls with 120.0 N right).

   a) What is the resultant force on the basketball? (1 mark)

b) Explain why the resultant force is what you calculated in part (a), based on the players' actions and the ball's motion. (2 marks)

c) If player A pulled with 150 N to the left and player B pulled with 120 N to the right, what would be the resultant force on the ball (magnitude and direction)? (2 marks)