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Medical Physics Class
Units and Physical Quantities

By

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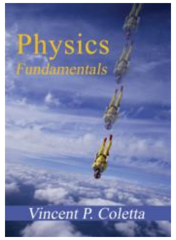

Reference: Physics Fundamentals
by Vincent P. Coletta
Loyola Marymount University, Los Angeles, CA

Google Classroom

ess3mwj

Medical Physics 1st year Pharmacy Students

Learning Goals

Looking forward at …

- Use of Units
- Fundamental Quantities
- Base and Derived Units
- Powers of Ten
- Conversion of Units
- Consistency of Units
- Significant Figures

Use of Units

- The unit is expressing the numerical value of any physical quantity.

- Distance or length may be expressed in units such as
  meters, feet, miles, or kilometers.
- Time may be expressed in units of
  seconds, hours, days, or years.
- Speed may be expressed in units of
  miles per hour, kilometers per hour, meters per second,

and so on.

Fundamental Quantities

- All physical quantities can be defined in terms of a very small number of **fundamental physical quantities.**
- Three fundamental quantities: **length**, **time**, **and mass.**
- **length** of an object is *defined* by comparing the object with multiples of some standard length, say, a meter.
- **time** of any event is *defined* by measurement of the event's time on a clock, using standard units of time hours, minutes, and seconds.
- **mass**, which is measured in units such as kilograms or grams.

Base and Derived Units

- base units are the units used to express fundamental quantities.
- meters, feet, seconds, and hours are all base units, since they are used to measure the two fundamental quantities length and time.
- derived units are the units used to express all other quantities are called.
- miles per hour and meters per second are examples of derived units.
- Base units are further characterized as being either primary or secondary.
- For each fundamental quantity, one base unit is designated the primary unit and all other units for that quantity are secondary.
- For measuring time, the second is the primary base unit, and minutes, hours, days, and so on are all secondary base units.

Powers of Ten

- Units that are powers-of-ten multiples of other units are often convenient to use, and so we use certain prefixes to denote those multiples. For example,

1. centi- means a factor of 10^{-2}, ➡ 1 centimeter (cm) 10^{-2} m
2. milli- means a factor of 10^{-3}, ➡ 1 millimeter (mm) 10^{-3} m
3. kilo- means a factor of 10^{3}, ➡ 1 kilometer (km) 10^{3}m.

Will see more common powers of ten units during this course.

Conversion of Units

- It is often necessary to convert units from one system to another.
- For example, you may need to convert a distance given in miles to units of meters.
- To do this, you can use the conversion factor

$$1\,mile\ = 1609\,meters.$$

- you may need to convert a time given in days to units of seconds.

$$1day = 1day\left(\frac{24\,hour}{1day}\right)\left(\frac{60\,mintue}{1\,hour}\right)\left(\frac{60\,second}{1\,minute}\right)$$
$$= 86400\,second$$

Consistency of Units

- The units are carried along in the calculation and treated as algebraic quantities.
- We then obtain from the calculation both the numerical answer and the correct units.
- Using units in this way will alert you when you make certain common errors.

Significant Figures

- When you measure any physical quantity, there is always some uncertainty in the measured value.
- For example, if you measure the dimensions of a desk with a meter stick marked with smallest divisions of millimeters, your measurements may be accurate to the nearest millimeter.
- The length of a desk to the nearest millimeter and express the desk's length as $98.6 \mp 0.1\, cm$. This means that you believe the length to be between $98.5\, cm$ and $98.7\, cm$.

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Significant Figures

- All non-zero digits are significant; 1, 2, 3, 4, 5, 6, 7, 8, and 9;
- Zeros between non-zero digits are significant, like 705 and 80008;
- Leading zeros are never significant, like in 0.03 or 0068;
- Trailing zeros are significant ONLY if a decimal place is present; examples where the zeros are not significant include 100, 380; those that are include 38.00, 590.0, and 280.190;

Significant Figures

- When two or more numbers are multiplied or divided, the final answer should be given to a number of significant figures equal to the smallest number of significant figures in any of the numbers used in the calculation.

- $15.025 \times 20.1 = 302$

- $\frac{1.35}{0.241} = 5.60$

Significant Figures

- when you add or subtract, the number of decimal places retained in the answer should equal the smallest number of decimal places in any of the quantities you add or subtract.

- $12.25 + \ 0.6 + \ \ 44 = 57$

The End

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