01-01

Linear Motion Intro

Prefixes, factor labeling, dimensional analysis & 4-step

Prefixes for units

- SI is a French acronym for international units
- These kinds of units have two parts: a prefix and a base
- Example: kilometer
  - Kilo is the prefix, Kilo means thousand
  - Meter is the base
  - So a kilometer means 1000 meters
- Important: when doing calculations you can substitute a number for the prefix

Sig figs

(sorry, bad news for sig fig fans!)

- Sig figs is something traditionally taught in chemistry, I won't teach it here
- But, Keep **three good digits** so you know your final answer is within 1% of KEY answer
  - Example: say final answer is exactly 1 m/s and you say 1.1 m/s: you're 10% too high!
  - You put down 1.01 and your 1% high, no problem!

Prefixes for units

- Important: when doing calculations you can substitute a number for the prefix
- Example:
  - Earth is 150 gigameters from the sun. If it takes 500 seconds for light to reach us, how many meters per second is the speed of light? (hint: giga means billion or 10^9) so 150 gigameters = 150 x 10^9 m)

Prefixes for units – Clicker Question!

- The International Space station goes a distance of 41 Mm per orbit at a speed 7.8 km/sec. How many seconds does it take for a single orbit? (2 min)
  - hints: M means mega, which means million
  - k means kilo, which means thousand
  - The proper equation is: $X = v\ t$
  - X is distance, v is speed, and t is time

Pick one of these choices with your clicker:

a) 25,000 sec
b) 320 sec
c) 3.2×10^{9} sec
d) 5,250 sec
e) 1.9×10^{-4} sec

Prefixes you need to MEMORIZE

Prefix	Symbol	Amount as #	Amount as exponent
Tera	T	Trillion	10^{12}
Giga	G	Billion	10^{9}
Mega	M	Million	10^{6}
Kilo	K	Thousand	10^{3}
Centi	C	Hundredth	10^{-2}
Milli	m	Thousandth	10^{-3}
Micro	μ	Millionth	10^{-6}
Nano	n	Billionth	10^{-9}

Memorized prefixes – Clicker Question!

- Which of the following is NOT mathematically the same as 3 Gigahertz?

a) 3×10^9 hertz

b) 3 billion hertz

c) 3,000 megahertz

d) 3,000,000,000 hertz

e) Trick question, they all are!

Factor label method
"T-charts" or "Conversion factors"

- Converts to different units by stating equalities between those units
- Example: I have 42 donuts, how many dozen donuts do I have?
  - 1 dozen donuts = 12 donuts, use this to convert between donuts and dozens of donuts
  - Take your "given" (the thing with the number) and divide it by 1 so everything is a fraction
  - Arrange your equivalency as a fraction equal to the number one such that when you multiply this version of 1, it converts to the units you want
  - Let's try this together on the board:

Dimensional analysis

- Dimensions can be treated like algebraic variables, but you know this already…
- Which makes sense, a 2000 foot per second house or a 2000 square foot house?
- You know you multiply length in feet by width in feet and you get square feet, that's all dimensional analysis means – the units make sense!

Dimensional Analysis – Clicker Question!

- Momentum is mass x velocity. The SI unit for mass is the kg (only SI unit with a prefix!). The SI units for distance and time are meters and seconds. Using dimensional analysis, find the proper units for momentum. (1 min.)
- Pick one of these choices with your clicker:

a) kg m sec
b) m sec/kg
c) 1/ (kg m sec)
d) kg m/sec
e) Kg/m/sec

Using the 4-step method

- A systematic method of physics problem solving
- Know who's buried in Grant's tomb? Bet you know how many steps in the 4-step method too…you smarty pants!
- Step 1: Picture the description (literally!)
- Step 2(*): List (WRITE) the knowns and unknowns in the form of variables
- Step 3: From your list, pick the equation to use and write it by itself
- Step 4: Plug in and solve with units

* Most important step and worth most partial credit on test

Using the 4-step method

- We just say in shorthand:

1. Picture
2. List knowns and unknowns
3. Write the equation
4. Solve with units

Using the 4-step method - Example

- A car accelerates from an initial speed of 5 m/s to 20 m/s over a quarter mile (400 m). What was his rate of acceleration? Pick from among these equations: *(Background info:* v_0 *means initial velocity,* v_f *means final velocity,* Δx *means distance,* Δt *means time,* a *means accleration)*
- *Hint: one equation can only solve one unknown*

$\Delta x = v_0 \Delta t + \frac{1}{2} a \Delta t^2$

$v_f = v_0 + a \Delta t$

$v_f^2 = v_0^2 + 2a \Delta x$

- Use dimensional analysis to come up with the proper units for acceleration *(Hint: you cannot add apples and oranges, because addition requires identical units)*