DEVIL PHYSICS
THE BADDEST CLASS ON CAMPUS

AP PHYSICS

Introductory Video

GIANCOLI LESSON 1-5 TO 1-6 UNITS, STANDARDS AND THE SI SYSTEM CONVERTING UNITS

Reading Activity Questions?

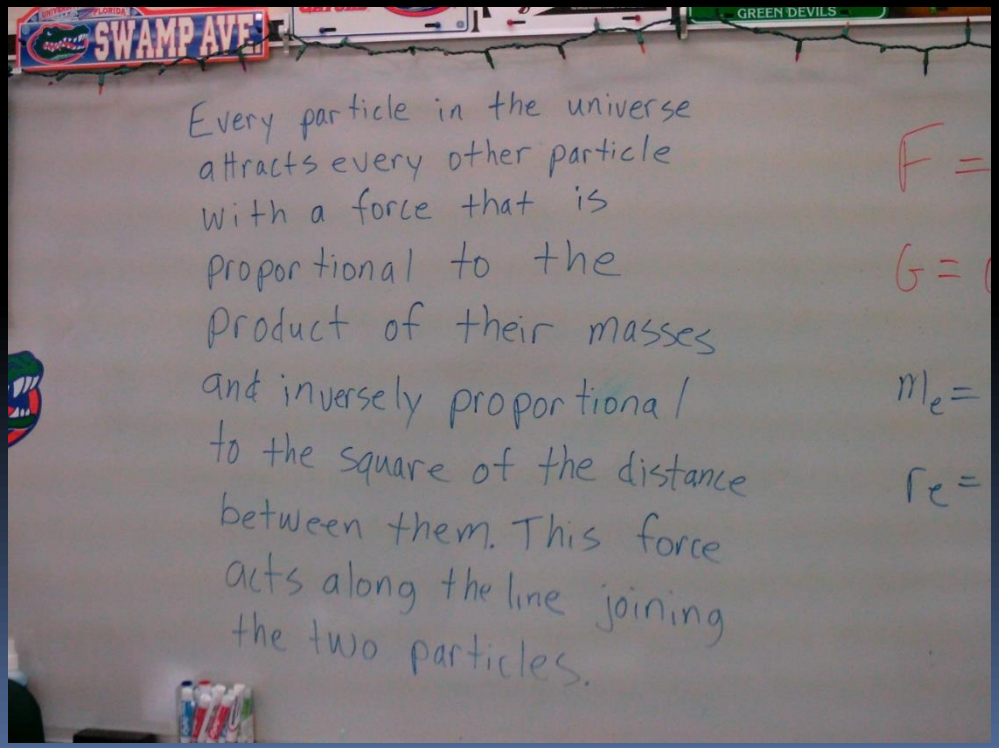
- Reading Activity 1-5 to 1-6
- Cornell Notes
  - unit
  - length/meter
  - time/second
  - mass/kilogram
  - Système International (SI)
  - cgs system
  - British engineering system
  - conversion factor

Objectives

- **MA.912.S.1.2: Determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment.**
- **State the meaning of "unit" and "standard" and the difference between the two.**

Objectives

- **State the primary SI units.**
- **Use conversion factors to convert units.**



Units and Standards

- **Units. Units are specifications for a measurement based on a standard.**
- **Standard. A standard is a defined value for a unit based upon some measurement.**

Units and Standards

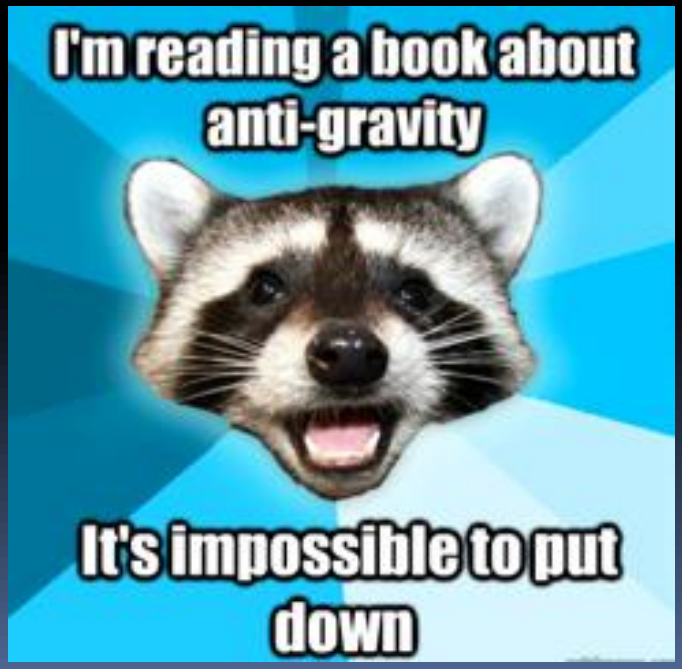
- **Examples: "Meter" is a unit of length. The standard for a meter has, at various times, been:**
  - **Distance from the tip of your nose to the tip of your longest finger when arm is extended horizontally. Problem?**
  - **One ten-millionth of the distance from the earth's equator to either pole. Problem?**
  - **Distance between two finely engraved marks on a particular bar of a platinum-iridium alloy. Problem?**

Units and Standards

- **Examples: "Meter" is a unit of length. The standard for a meter has, at various times, been:**
  - **For greater precision and reproducibility, changed in 1960 to 1,650,763.73 wavelengths of an orange light emitted by krypton 86 gas. Problem?**
  - **Current: length of path traveled by light in 1/299,792,458th's of a second. Problem?**
  - **How precise does it have to be?**

Units and Standards

- **Examples:**
  - **The standard for one inch is 2.54 cm.**
  - **For the standard for cm, see meter above and divide by 100**



Système International (SI)

- System of units and standards most commonly used in science
- Commonly known as the metric system
- Base units:
  - Length – meter (m)
  - Mass – kilogram (kg)
  - Time – second (s)
- Old name was MKS system (meter, kilogram, second)

Système International (SI)

- Secondary metric system: CGS System
- Base units:
  - Length – centimeter (cm)
  - Mass – gram (g)
  - Time – second (s)
- More useful for small stuff

British Engineering System

- Base units:
  - Length – foot (ft)
  - Force – pound (lb)
  - Time – second (s)
- Most engineering drawings are still in inches with tolerances measured in 1000ths of an inch

Units of Units

- Force $\Rightarrow$ Newton (N) $\Rightarrow$ $1 kg \cdot m/s^2$
- Energy and Work $\Rightarrow$ Joule (J) $\Rightarrow$ $1 kg \cdot m^2/s^2$
- Pressure $\Rightarrow$ Pascal (Pa) $\Rightarrow$ $1 kg/m \cdot s^2$

Using Units

- Units are mucho importante to problem solving¡!
  - FIRST – ensure the units for your inputs are compatible for any constants you are given
  - SECOND – ensure all units are the same for the same type of measurement
  - THIRD – make sure your units cancel into the correct units for your answer (see below)

Unit Conversions

- How do you add fractions?

$$\frac{1}{2} + \frac{1}{3} = ?$$

Unit Conversions

- How do you add fractions?

$$\left(\frac{1}{2}\right)+\left(\frac{1}{3}\right)=?$$

$$\left(\frac{1}{2}\right)\left(\frac{3}{3}\right)+\left(\frac{1}{3}\right)\left(\frac{2}{2}\right)=?$$

$$\left(\frac{3}{6}\right)+\left(\frac{2}{6}\right)=\left(\frac{5}{6}\right)$$

- Multiply by a conversion factor to get a common denominator
- Conversion factors always equal to 1
- Identity Property
- Unit conversion is the same – multiplying by 1 to change the *form* of a number

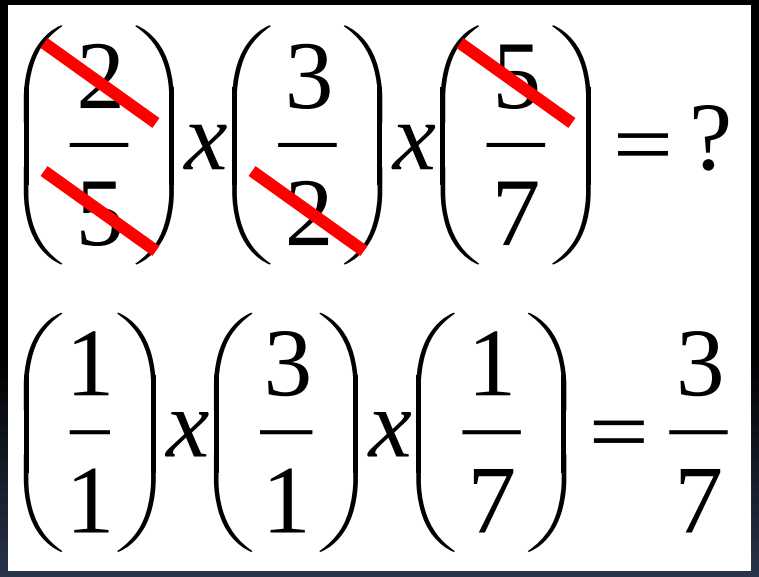
Unit Conversions

- How do you multiply fractions?

$$\left(\frac{2}{5}\right) x \left(\frac{3}{2}\right) x \left(\frac{5}{7}\right) = ?$$

Unit Conversions

- How do you multiply fractions?



- Common factors cancel out
- Then multiply

- Units cancel out in the same way fractions do

Unit Conversions

$$1\,\text{min} = 60\,\text{sec}$$

$$\frac{1\,\text{min}}{60\,\text{sec}} = \frac{60\,\text{sec}}{1\,\text{min}} = 1$$

Unit Conversions

- How do you convert 10 inches per second to meters per minute?

$$\left(\frac{10\cancel{in}}{1\cancel{s}}\right)x\left(\frac{1m}{39.37\cancel{in}}\right)x\left(\frac{60\cancel{s}}{1\min}\right)=\frac{10x60}{39.37}\frac{m}{\min}$$

$$15.24=15\,m/\min$$

- Multiply by conversion factors
- Conversion factors equal to 1 (Identity Property)
- Cancel out common units
- Then multiply

Unit Conversions

- Conversion factors do not count as significant figures if it is a defined conversion
  - 1 in = 2.54 cm (not significant figure)
  - 1 mi = 1.61 km (significant figure because 1.61 is not an exact or defined amount [1.609344 is exact)
- Look at the conversion factors on the inside front cover of your book

Unit Conversions

- **Sample problem: If I drive 60 mph, how fast is that in mm/sec?**

Unit Conversions

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  - **(60 mi/hr) x (1hr/60min) x (1min/60sec) x (5280ft/1mi) x (12in/1ft) x (2.54cm/1in) x (10mm/cm) = _____**

Unit Conversions

- **Sample problem: If I drive 60 mph, how fast is that in mm/sec?**
  - (60 ~~mi~~/~~hr~~) x (1~~hr~~/60~~min~~) x (1~~min~~/60sec) x (5280~~ft~~/1~~mi~~) x (12~~in~~/1~~ft~~) x (2.54~~cm~~/1~~in~~) x (10mm/~~cm~~) = _____

Unit Conversions

- **Sample problem: If I drive 60 mph, how fast is that in mm/sec?**
  - (~~60~~) x (1/~~60~~) x (1/~~60~~sec) x (88~~5280~~/1) x (12/1) x (2.54/1) x (10mm/1) = 26822.4 = 2.6×10^4 mm/sec

Sig Figs and Scientific Notation

Sig Figs and Scientific Notation

- In order to write really large numbers and really small numbers and still comply with the rules for significant figures , you have to use scientific notation
- As a general rule for ***my class***, you should never have an answer longer than three digits (but four isn't too bad)
- In problem solving, ***round your final answer only*** to significant figures

Review - Scientific Notation

- Move decimal so there is only one number to the left of the decimal
- Number of decimal place moves equals the power of ten

$6200000 = 6.2 \times 10^{6}$

$0.00725 = 7.25 \times 10^{-3}$

$9.85 \times 10^{5} = 985000$

$1.20 \times 10^{-3} = 0.00120$

Review - Scientific Notation

- Multiplying numbers in scientific notation
  - Multiply the base numbers
  - Add the powers of ten
  - Move the decimal as required (and increase the power of ten) so you only have one digit to the left of the decimal

$2 \times 10^{3} \times 4 \times 10^{4} = 8 \times 10^{7}$

$4 \times 10^{5} \times 3 \times 10^{-3} = 12 \times 10^{2} = 1.2 \times 10^{3}$

$6 \times 10^{-7} \times 3 \times 10^{-2} = 18 \times 10^{-9} = 1.8 \times 10^{-8}$

Review - Scientific Notation

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Check Using Scientific Notation on Calculators

$2 \times 10^3 \times 4 \times 10^4 = 8 \times 10^7$

$4 \times 10^5 \times 3 \times 10^{-3} = 12 \times 10^2 = 1.2 \times 10^3$

$6 \times 10^{-7} \times 3 \times 10^{-2} = 18 \times 10^{-9} = 1.8 \times 10^{-8}$

Review - Scientific Notation

- Dividing numbers in scientific notation
  - Divide the base numbers
  - Subtract the powers of ten
  - Move the decimal (and decrease the power of ten) so you only have one digit to the left of the decimal

$8 \times 10^{6} \div 2 \times 10^{4} = 4 \times 10^{2}$

$1 \times 10^{-8} \div 9 \times 10^{4} = 0.111 \times 10^{-12} = 1.11 \times 10^{-13}$

$4 \times 10^{5} \div 3 \times 10^{-3} = 0.75 \times 10^{8} = 7.5 \times 10^{7}$

$6 \times 10^{-7} \div 5 \times 10^{-2} = 1.2 \times 10^{-5}$

Review - Scientific Notation

- Adding and subtracting numbers in scientific notation
  - Convert numbers to decimal numbers
  - Add or subtract
  - Convert back to scientific notation
  - ***Or just use a calculator***

$8x10^{6} + 2x10^{4} = 8000000 + 20000 = 8020000$

$= 8.02x10^{6}$

$6x10^{-3} - 5x10^{-2} = 0.006 - 0.05 = -0.044$

$= -4.4x10^{-2}$

Review - Scientific Notation

- Speaking of calculators . . .
  - Everyone take out their calculators
  - Make sure you can switch your display from decimal to scientific notation and back again
  - Perform the following operation using the scientific notation functions of your calculator:

$6.39 \times 10^{7} \div 8.72 \times 10^{-5} = 7.33 \times 10^{11}$

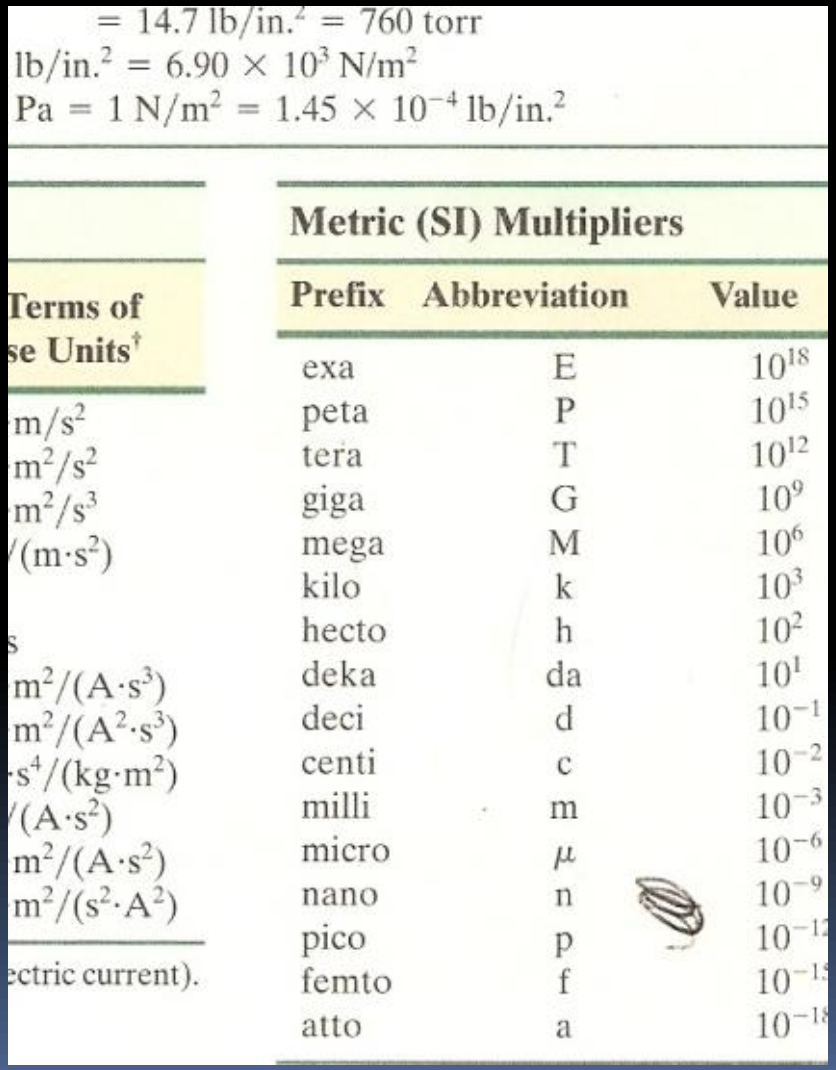
GET YOUR CALCULATOR ENGRAVED!!!

General Operating Procedure

- Perform all operations on your calculator without rounding if possible
- Round your final answer to the correct number of significant figures using scientific notation if needed
- If using intermittent rounding, never round to less than the correct number of sig figs
- On tests, I use ±5% tolerance for intermittent rounding differences

Metrics With Prefixes

- Prefixes are added to units to stand for a power of ten
- 1cm is a centimeter and centi is a prefix for 10^{-2} thus 1cm = $1x10^{-2}$ m or 0.01m
- Note the chart on the inside front cover of your books



= 14.7 lb/in.^{2} = 760 torr
lb/in.^{2} = 6.90×10^3 N/m^2
Pa = 1 N/m^2 = 1.45×10^{-4} lb/in.^{2}

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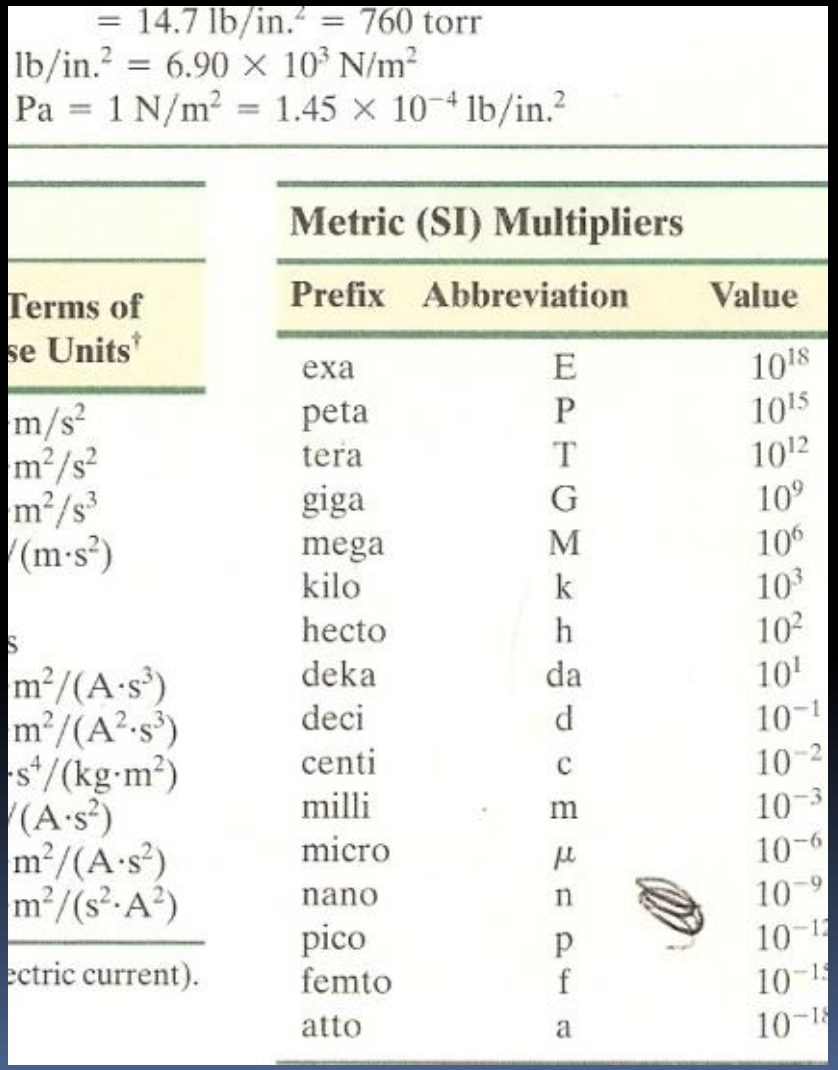
Metric (SI) Multipliers

Prefix	Abbreviation	Value
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deka	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

Metrics With Prefixes

- *I want to sell you a memory stick with a 3,000 hB capacity for $3. Is that a good deal?*



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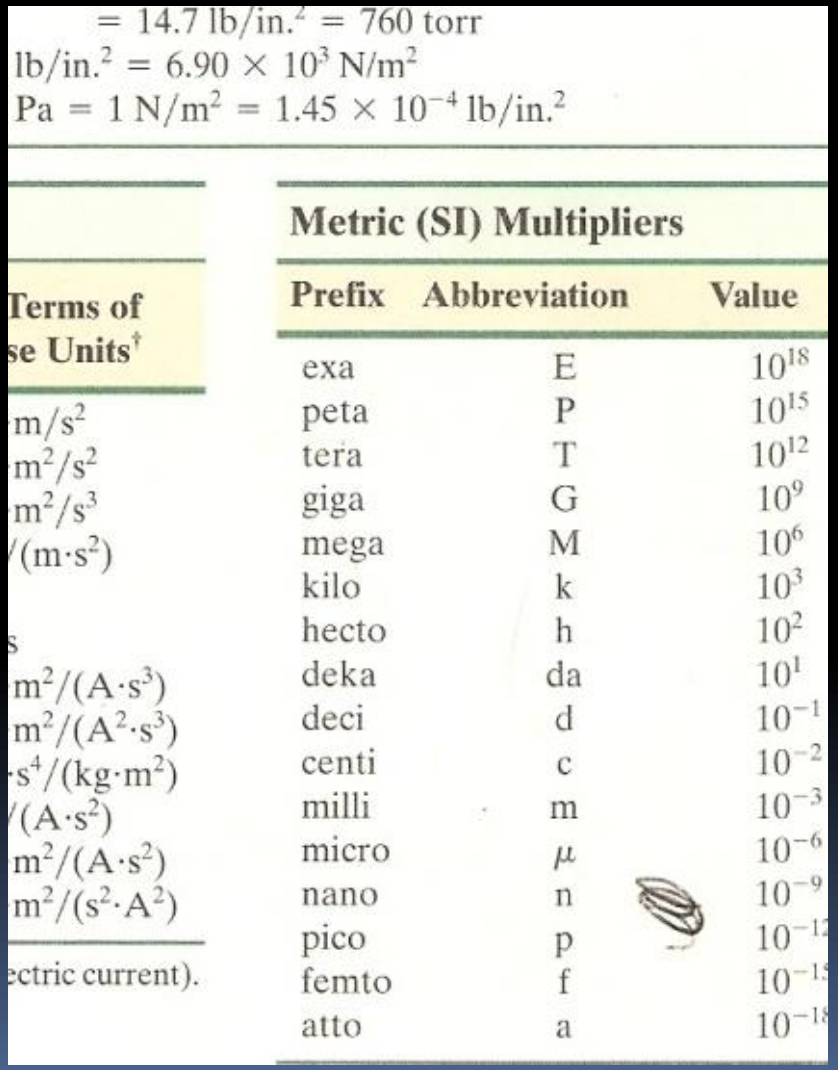
Metrics With Prefixes

- *I want to sell you a memory stick with a 3,000 hB capacity for $3. Is that a good deal?*
- *Not hardly. 3,000 hB is equal to 300,000 B which is 300 kB.*



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Summary Review

- **MA.912.S.1.2: Can you determine appropriate and consistent standards of measurement for the data to be collected in a survey or experiment?**
- **Can you state the meaning of "unit" and "standard" and the difference between the two?**

Summary Review

- Can you state the primary SI units?
- Can you use conversion factors to convert units?

QUESTIONS?

Homework

#12-22

STOPPED HERE ON 9/4