Units

IB PHYSICS | MOTION

Two Types of Observations

Provide some examples of each

Quantitative	"How Many" / "How Much" Numerical
Qualitative	Description

Measurement

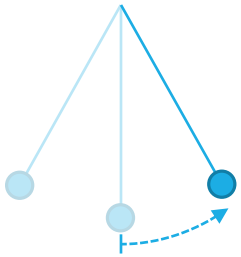
How can you **quantify** a measurement?

Systems and Units

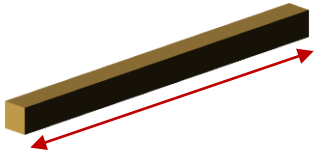
Fundamental S.I. Units:

Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electric Current	Ampere (amp)	A
Temperature	Kelvin	K
Amount of Substance	Mole	mol
Luminous Intensity	Candela	cd

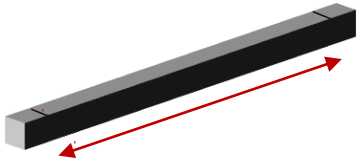
Units are Arbitrary



1790 - The length of a pendulum that swings half of its maximum distance in one second



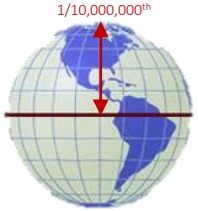
1795 - The length of an official bar of brass fabricated to be exactly one meter as determined in 1791



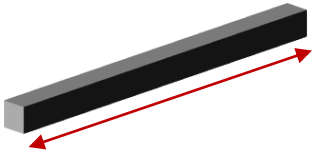
1889 – The distance between two lines on an official bar of platinum-iridium alloy, measured at 0°C

Take the history of the meter…

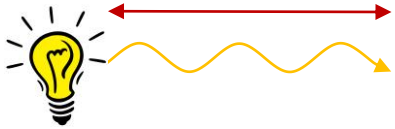
1791 - The length of one ten-millionth of the distance between the North Pole and the equator



1799 - The length of an official bar of platinum, measured from the brass bar and stored at the French National archives



1983 – The length traveled by light in a vacuum during 1/299,792,458 of a second



What's 'the standard'?

All of our base SI units are grounded in some "standard" that helps maintain consistency.

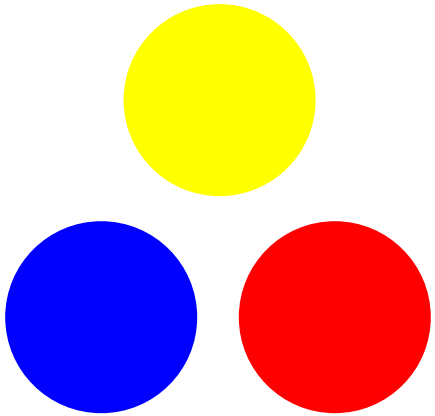
Some of these units even reference each other…

Definition of the Second

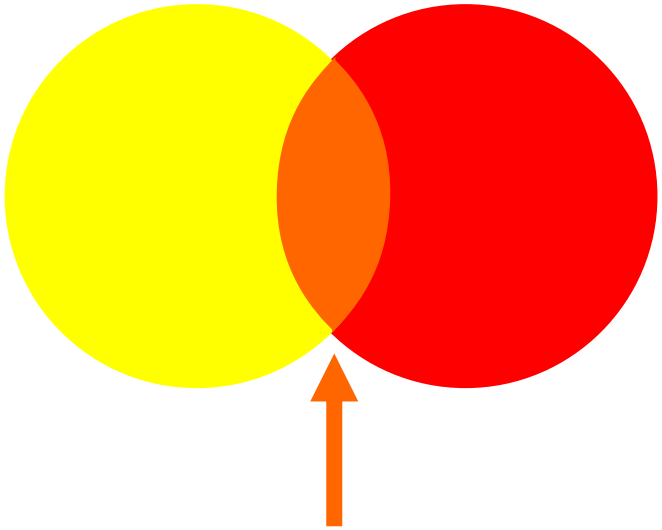
The "second" is defined as the interval required for 9,192,631,770 vibrations of the cesium-133 atom measured via an atomic beam clock

Primary and Secondary Colors

Primary Colors



Secondary Colors



Fundamental vs Derived

Fundamental S.I. Units

Length	m
Mass	kg
Time	s

Derived Units

Velocity: m/s

Acceleration: $m/s^2 = \frac{m/s}{s}$

Force:

$$N = kg \times m/s^2$$

Welcome to IB Land!

Since this course is *International* all of the units must be in the "European" format rather than the "American" format

This means that instead of writing units with a fraction slash, we must use negative exponents

7 m/s	m s^{-1}	6.67 $\frac{Nm^2}{kg^2}$	N m^2 kg^{-2}
9.81 m/s^2	m s^{-2}	2.2 $\frac{J}{K}$	J K^{-1}
87 g/cm^3	g cm^{-3}	8.31 $\frac{J}{K \times mol}$	J K^{-1} mol^{-1}

The Metric System

*Taken directly from the IB Physics Data Booklet

Prefix	Abbreviation	Value
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deca	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}

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The value given is the number of places the decimal moves

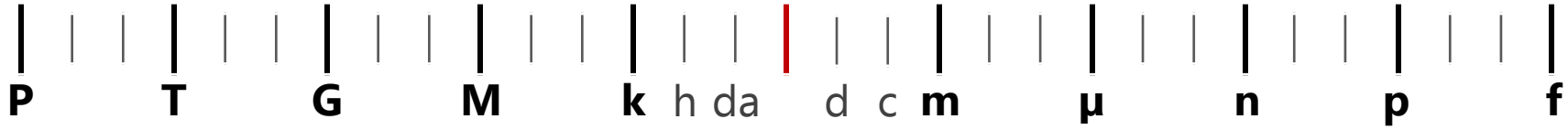
Please make sure that you go in the correct direction!

900 nm = 900,000,000,000 m

or

900 nm = 0.0000009 m

The Metric System



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milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

base

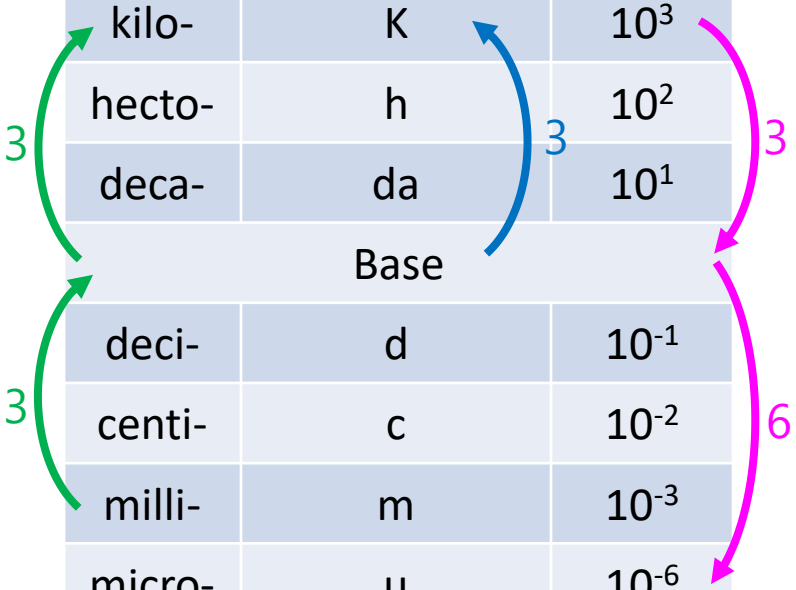
9

900 nm → 0.0000009 m

900×10^{-9} m

The Metric System

Prefix	Abbreviation	Power
giga-	G	10^{9}
mega-	M	10^{6}
kilo-	K	10^{3}
hecto-	h	10^{2}
deca-	da	10^{1}
Base		
deci-	d	10^{-1}
centi-	c	10^{-2}
milli-	m	10^{-3}
micro-	µ	10^{-6}
nano-	n	10^{-9}



Conversions:

250 g = 0.25 kg

0.00325 kg = 3,250,000 µg

54 mm = 0.000054 km

The Metric System | Try These

Prefix	Abbreviation	Power
giga-	G	10^{9}
mega-	M	10^{6}
kilo-	K	10^{3}
hecto-	h	10^{2}
deca-	da	10^{1}
Base		
deci-	d	10^{-1}
centi-	c	10^{-2}
milli-	m	10^{-3}
micro-	µ	10^{-6}
nano-	n	10^{-9}

65 µC = 0.000065 C

12 MW = 12,000,000 W

The Metric System

SI prefixes

1000^n	10^n	Prefix	Symbol	Short scale	Long scale	Decimal equivalent in SI writing style
1000^8	10^{24}	yotta-	Y	Septillion	Quadrillion	1 000 000 000 000 000 000 000 000
1000^7	10^{21}	zetta-	Z	Sextillion	Trilliard (thousand trillion)	1 000 000 000 000 000 000 000
1000^6	10^{18}	exa-	E	Quintillion	Trillion	1 000 000 000 000 000 000
1000^5	10^{15}	**peta-**	P	Quadrillion	Billiard (thousand billion)	1 000 000 000 000 000
1000^4	10^{12}	tera-	T	Trillion	Billion	1 000 000 000 000
1000^3	10^9	giga-	G	Billion	Milliard (thousand million)	1 000 000 000
1000^2	10^6	mega-	M	Million		1 000 000
1000^1	10^3	kilo-	k	Thousand		1 000
$1000^{2/3}$	10^2	hecto-	h	Hundred		100
$1000^{1/3}$	10^1	deca-	da	Ten		10
1000^0	10^0	*(none)*	*(none)*	One		1
$1000^{-1/3}$	10^{-1}	deci-	d	Tenth		0.1
$1000^{-2/3}$	10^{-2}	centi-	c	Hundredth		0.01
1000^{-1}	10^{-3}	milli-	m	Thousandth		0.001
1000^{-2}	10^{-6}	micro-	μ	Millionth		0.000 001
1000^{-3}	10^{-9}	nano-	n	Billionth	Milliardth	0.000 000 001
1000^{-4}	10^{-12}	pico-	p	Trillionth	Billionth	0.000 000 000 001
1000^{-5}	10^{-15}	femto-	f	Quadrillionth	Billiardth	0.000 000 000 000 001
1000^{-6}	10^{-18}	atto-	a	Quintillionth	Trillionth	0.000 000 000 000 000 001
1000^{-7}	10^{-21}	zepto-	z	Sextillionth	Trilliardth	0.000 000 000 000 000 000 001
1000^{-8}	10^{-24}	yocto-	y	Septillionth	Quadrillionth	0.000 000 000 000 000 000 000 001

There's more…

"What about Instagram?"

Lesson Takeaways

- ❑ I can describe the difference between quantitative and qualitative observations
- ❑ I can identify the 7 Fundamental SI units
- ❑ I can define and give an example of a derived unit
- ❑ I can represent fractional units with negative exponents
- ❑ I can convert metric units between prefixes