Basic Book Builder

A Pandoc Template for building books and articles

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Contents

1 Introduction

This book builder template has been curated by John Haverlack.("John Haverlack | ACEP" n.d.)

> "*If I have seen further it is by standing on the shoulders of Giants.*"
>
> – Isaac Newton

1.1 Conventions

In this book we'll use a few conventions.

1.1.1 New Concepts

As many of the topics discussed in this book are a mix of **established** math and physics, **proposed** dualistic interpretations of established ideas, and also **speculative** ideas that I don't yet know how to address, I wanted a way to clearly distinguish these concepts. I've come up with the following convention to highlight these classes of concepts to indicate their level of mainstream acceptance.

In this book, established concept may be highlighted in green, and represent mainstream physics or math concepts.

Established Concept

Einsteins Relativistic Dynamics Equations

$$E^2 = (m_0 \cdot c^2)^2 + (p \cdot c)^2$$

New ideas proposed by the author which have not been peer reviewed, verified or tested, and should be looked at with scrutiny.

Proposed Concept

With the speed of light, $c = 1$:

$$E^2 = m_0^2 + p^2$$

Speculative Idea, that the author wonders about, but does not know how to demonstrate, or ideas that need further treatment to prove or disprove.

Speculative Concept

With the speed of light, $c = 1$:

$$E^2 = m_0^2 + p^2$$

Or Warnings...

Caution Note

Beware of this section.

Warning Note

Beware of this section.

Alerts

Extreme Highlight

2 Best Words Ever

Blah blah blah

3 Example Content

In $R\nu$ the Planck Length is the universal unit for measurement of distance, and is defined approximately to be:

$$\boxed{L_P = \sqrt{\hbar} = 5.72928 \times 10^{-35} m = 1L}$$

Where $1\ L$, is 1 Planck Length of distance.

3.0.1 SI Conversion Factors

The following conversion factors can be used to convert observable quantities of measure from the *SI* system of units to $R\nu$ to ~6 significant digits.

Conversion Factor	Symbol	Value
meters to Planck Length	χ_P	$1.74542 \times 10^{34} \frac{L}{m}$
seconds to Planck Length	τ_p	$5.23264 \times 10^{42} \frac{L}{s}$
mass to Planck Length	G_P	$1.62871 \times 10^{8} \frac{L}{kg}$
energy to Planck Length	E_P	$1.81219 \times 10^{9} \frac{L}{J}$
momentum to Planck Length	P_P	$5.43280 \times 10^{-1} \frac{L \cdot s}{kg \cdot m}$
temperature to Planck Length	k_P	$2.501998 \times 10^{-14} \frac{L}{K}$
charge to Planck Length	C_P	$1.89007 \times 10^{18} \frac{L}{C}$

3.0.2 Physical Constants

Applying conversion factors from the table above, we can convert SI values to Reduced Natural Units. For example, performing this analysis on the the speed of light yields a unit-less number with a value of 1:

$$c = 299792458 \frac{m}{s} = 299792458 \frac{m}{s} \cdot 1.74542 \times 10^{34} \frac{L}{m} \cdot \frac{1}{5.23264 \times 10^{42} \frac{L}{s}} = 1.00000$$

Quantity	Symbol	SI	ν
Speed of Light	c	$299792458 \frac{m}{s}$	1
Reduced Gravitational Constant	G_0	$8.38659 \times 10^{-10} \frac{m^3}{kg \cdot s^2}$	1
Boltzmann's Constant	k	$k = 1.380649 \times 10^{-}23 \frac{J}{K}$	1
Permittivity of Free Space	ϵ_o	$8.854187817620 \times 10^{-12} \frac{C^2 s^2}{kg \cdot m^3}$	1
Permeability of Free Space	μ_o	$\frac{1}{\epsilon_o \cdot c^2}$	1

Quantity	Symbol	SI	ν
Reduced Planck's Constant	$\hbar$	$1.054571726 \times 10^-34 \frac{kg \cdot m^2}{s}$	$1L^2$
Mass of the Electron	m_e	$9.10938 \times 10^{-31} kg$	$1.48366 \times 10^{-22} L$
Charge of the Electron	e^-	$-1.60218 \times 10^{-19} C$	$-3.02822 \times 10^{-1} L$
Unit Cycle	Θ	$2\pi = 6.28318... \ Radians$	$1\tau = 6.28318... \ Radians$

3.1 Fine Structure Constant

As a consistency check, we compute the *Fine Structure Constant* using Reduced Natural Units which is a unit less ratio that should be independent of our system of units.

$\alpha = \frac{e^2}{4\pi\epsilon_o\hbar c} = \frac{e^2}{2\tau} = 0.00729735 \approx \frac{1}{137}$

3.1.0.1 Dimensional Analysis The reader should be familiar with high school physics and chemistry dimensional analysis.

- $1 \ meter \ (m) = 100 \ centimeters \ (cm)$
- $1 \ kilometer \ (km) = 1000 \ meters \ (m)$
- $1 \ mile = 5280 \ feet \ (ft \ or \ ')$
- $1 \ foot \ (ft \ or \ ') = 12 \ inches \ (in \ or \ ")$
- $1 \ inch \ (") = 2.54 \ centimeters \ (cm)$

How many kilometers are in 1 mile? $1 \ mile = 1 \ mile \times \frac{5280 \ ft}{mile} \times \frac{12 \ in}{ft} \times \frac{2.54 \ cm}{in} \times \frac{1 \ m}{100cm} \times \frac{1 \ km}{1000m} = \frac{5280 \times 12 \times 2.54}{100 \times 1000} \ km = \frac{160934.40}{100000} \ km = 1.6 \ km$ Note that each unit in the denominator cancels with one if the numerator until we are left with only km.

3.2 Newton's Law of Gravity

The force of gravity (F_g) between 2 masses, $m1$ and $m2$ separated by distance r is given by Newton's Law of Gravity:

$F_g = G\frac{m_1 m_2}{r^2}$

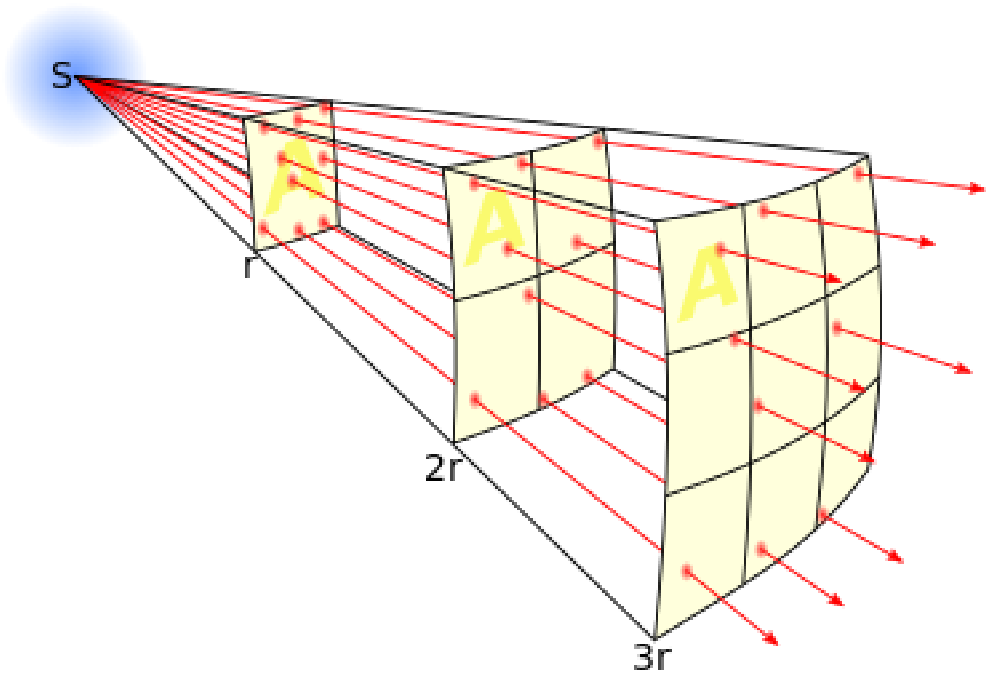
Where G, is the Gravitational Constant.

$G = 6.67430 \times 10^{-11} \ N\frac{m^2}{kg^2}$

The strength of gravitational force follow the inverse square law distributing gravitational flux over the surface area of a sphere ($4\pi r^2$).

3.2.0.1 Inverse Square Law Any source of a signal strength (S_0) that radiates isotropically in 3-dimensional space will distribute that signal strength (S_0) over the surface area of a sphere ($SA = 4\pi r$) of radius (r). Such that the intensity (I) at distance (r) is:

$$I(r) = \frac{S_0}{4\pi r^2} = \frac{S_0}{2\tau r^2}$$



$R\nu$

Reduced Gravitational Constant In this version of Newton's Law of Gravity we introduce a new constant G_0, the reduced gravitational constant to accommodate for the factor of $4\pi = 2\tau$ which is has been integrated in the SI version of the gravitational constant.

$F_g = G\frac{m_1 m_2}{r^2} = G_0\frac{m_1 m_2}{4\pi r^2} = G_0\frac{m_1 m_2}{2\tau r^2}$

Where:

$G = \frac{G_0}{2\tau} = 6.67384 \times 10^{-11}\frac{N \cdot m^2}{kg^2}$

Analyzing the units:

$$\frac{N \cdot m^2}{kg^2} = \left(\frac{(kg \cdot \frac{m}{s^2}) \cdot m^2}{kg^2}\right) = \frac{m^3}{s^2 kg}$$

Converting seconds to meters with the SI speed of light as a conversion factor:

$$\frac{m^3}{s^2 kg} \cdot \frac{1}{c^2} = \frac{m^3}{s^2 kg} \cdot \frac{s^2}{m^2} = \frac{m}{kg}$$

Thus where space and time are measured in units of meters, the reduced gravitational constant, is:

$$\boxed{G_0 = \frac{2\tau G}{c^2} = \frac{2\tau \cdot 6.67384 \times 10^{-11}}{299792458^2}\frac{m}{kg} = 9.33135 \times 10^-27\frac{m}{kg}}$$

Observation This implies that not only can space an time be measure in units of meters, but so can mass.

3.2.1 Relativistic Energy Momentum Relation

Einsteins Relativistic Energy Momentum relationship shows a Pythagorean relation between the total energy (E), rest mass (m_0) and momentum (p) of a system.

$$E^2 = (m_0 \cdot c^2)^2 + (p \cdot c)^2$$

Where space and time are both measure in units of meters, c=1.

$$E^2 = (m_0)^2 + (p)^2$$

From this we can see that Energy, Momentum and Mass have equivalent units.

> *While we do not really know what energy, mass and momentum are we know that they are fundamentally "made" out of the same stuff because they have the same units.*

3.2.1.0.1 Objects of mass at rest For an object at rest with no momentum ($p = 0$) we see Einstein's famous equations:

$$E = m_0 \cdot c^2$$

Or, with $c = 1$, this is much simpler to understand. Energy = Mass

$$E = m_0$$

3.2.1.0.2 Zero mass objects moving at the speed of light And for objects with no mass, like photos, ($m_0 = 0$):

$$E = pc$$

Or, with $c = 1$, this is much simpler to understand. Energy = Momentum

$$E = p$$

3.3 Planck's Constant

The Reduced Planck constant , ħ, represents a conversion factor for relating the frequency, ω (in 2π radians per second), of a photon to the energy of that photon. This can easily be seen from the simple but profound relationship:

$$E = \hbar\omega$$

Where:

$$\hbar = 1.054571726 \times 10^{-34} J \cdot s$$

and

$$J \cdot s = kg \cdot \frac{m^2}{s}$$

Reduced Planck's Constant $\hbar = \frac{h}{2\pi} = \frac{h}{\tau}$

Simplifying our units by converting time and mass to units of meters:

$$\boxed{\hbar = 1.054571726 \times 10^{-34} kg \cdot \frac{m^2}{s} \cdot \frac{G_0}{c} = 3.282462 \times 10^{-69} m^2}$$

Which suggest that the Plank constant can be interpreted as an areas for which the square root of is suspiciously close to the Plank length:

$$\boxed{\sqrt{\hbar} = \sqrt{3.282462 \times 10^{-69} m^2} = 5.72928 \times 10^{-35} m}$$

3.3.0.1 Planck Area The Planck Area is the square of the Planck Length.

$l_P = \sqrt{\frac{\hbar G}{c^3}}$

and $l_P^2 = \frac{\hbar G}{c^3}$

In $R\nu$ units both c and G_o are 1.

$l_P = \sqrt{\hbar}$

and $l_P^2 = \hbar$ ## Bekenstein's Bound After having recently read *Three Roads to Quantum Gravity* by Lee Smolin, I now suspect the meaning of this areas is related to the Bekensteins Law as applied to a surface areas surrounding a mass. Where the thermodynamic entropy, *S*, is proportional to the the enclosed surface area, A.

$S = \frac{1}{4} \cdot \frac{A}{G\hbar}$

$S = \frac{kc^3 A}{4G\hbar}$

$S \leq \frac{2\pi kRE}{\hbar c} = \frac{\tau RkE}{\hbar c}$

From our new values for $G_0$and $\hbar$ we can likely rewrite this:

$S = \frac{\pi \cdot A}{\hbar G_0}$

With the limiting case being at the Plank scale.

$S = \frac{\pi \cdot \sqrt{\hbar}}{\hbar G_0}$

3.4 Planck Length

https://en.wikipedia.org/wiki/Planck_length

The concept of the Planck Length comes from exploring the limits of Quantum Mechanics and General Relativity. The limits of General Relativity can be seen a the event horizon of a black hole, described by the Schwarzschild Radius. And the limits of Quantum Mechanics can be found in the Compton Wavelength for a given quanta.

The Schwarzschild Radius is defined as the distance at which light cannot escape from the gravitational field of a mass (m):

Classic Derivation.

$r_S = \frac{2Gm}{c^2}$

The reduced Compton Wavelength represents a lower limit on the wavelength for quanta that can interact with a quantum particle with mass (m):

$\lambda_C = \frac{h}{mc}$

$\bar{\lambda}_C = \frac{2\pi\hbar}{mc} = \frac{\tau\hbar}{mc}$

And set the Schwarzschild Radius equal to the Compton Wavelength: $r_S = \lambda_C$

$\frac{2Gm}{c^2} = \frac{h}{mc}$

$m^2 = \frac{hc}{2G}$

$m = \sqrt{\frac{hc}{2G}}$

$l_P = \frac{2G\sqrt{\frac{hc}{2G}}}{c^2}$ $l_P = \frac{2G\sqrt{\frac{hc}{2G}}}{c^2} = \sqrt{\frac{2Gh}{c^2}}$

With reduced Compton Wavelength $r_S = \bar{\lambda}_C$

$\frac{2Gm}{c^2} = \frac{\tau\hbar}{mc}$

$m^2 = \frac{\tau\ \hbar\ c}{2G}$

$m = \sqrt{\frac{\tau\ \hbar\ c}{2G}}$

$l_P = \frac{2G\sqrt{\frac{\tau\ \hbar\ c}{2G}}}{c^2}$

$l_P = \frac{2G\sqrt{\frac{\tau\ \hbar\ c}{2G}}}{c^2} = \sqrt{\frac{4\ \tau\ G\ \hbar}{c^3}}$

If we reduce the units in these equation to those of mass and time measured in meters.

$l_P = \sqrt{4\tau\hbar G_o}$

and

$\lambda_C = \frac{\hbar}{m}$

$m = R_s = \lambda_C = \frac{\hbar}{m}$

This is known as the Planck Mass, M_P. $M_P = m = \sqrt{\hbar}$

Solving the Compton Wavelength for distance we find the classic Plank Length:

$\lambda_C = \frac{\hbar}{\sqrt{\hbar}} = \frac{\sqrt{\hbar}}{\sqrt{\hbar}} \cdot \frac{\hbar}{\sqrt{\hbar}} = \sqrt{\hbar} = L_P$

Which is in precise agreement with the value we found in above. Thus the Plank Length is:

$L_P = \sqrt{\hbar} = 5.72928 \times 10^{-35} m$

When we measure distance, time, and mass in units of distance, c=1, and the Plank Time, T_P, is equal to Plank Length, L_P, which is equal to the Plank Mass, M_P:

$$\boxed{L_P = T_P = M_P}$$

Conversion Factor	Symbol	Value
meters to Planck Length	χ_P	$1.74542 \times 10^{34} \frac{L}{m}$
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momentum to Planck Length	P_P	$5.43280 \times 10^{-1} \frac{L \cdot s}{kg \cdot m}$
temperature to Planck Length	k_P	$2.501998 \times 10^{-14} \frac{L}{K}$
charge to Planck Length	C_P	$1.89007 \times 10^{18} \frac{L}{C}$

Applying conversion factors from the table above, we can convert SI values to Reduced Natural Units. $c = \frac{1}{\sqrt{\epsilon_o \mu_o}}$

Quantity	Symbol	SI	ν
Speed of Light	c	$299792458 \frac{m}{s}$	1
Gravitational Constant	G_0	$8.38659 \times 10^{-10} \frac{m^3}{kg \cdot s^2}$	1
Boltzmann's Constant	k	$k = 1.380649 \times 10^{-}23 \frac{J}{K}$	1
Permittivity of Free Space	ϵ_o	$8.854187817620 \times 10^{-12} \frac{C^2 s^2}{kg \cdot m^3}$	1
Permeability of Free Space	μ_o	$\frac{1}{\epsilon_o \cdot c^2}$	1
Planck's Constant	$\hbar$	$1.054571726 \times 10^{-}34 \frac{kg \cdot m^2}{s}$	$1L^2$
Mass of the Electron	m_e	$9.10938 \times 10^{-31} kg$	$1.48366 \times 10^{-22} L$
Charge of the Electron	e^-	$-1.60218 \times 10^{-19} C$	$-3.02822 \times 10^{-1} L$

3.5 Fine Structure Constant

https://en.wikipedia.org/wiki/Fine-structure_constant As a consistency check, we compute the *Fine Structure Constant* using Reduced Natural Units which is a unit less ratio that should be independent of our system of units.

$\alpha = \frac{e^2}{4\pi\epsilon_o\hbar c} = \frac{e^2}{4\pi} = 0.00729735 \approx \frac{1}{137}$

This check confirms that our system of Reduced Natural Units has internally consistent values for c, ϵ_o, $\hbar$ and $e-$. And also G_o which was used to computer prior values is also consistent.

3.6 Sage Code

Unit Analysis computations have been performed with Sage Math.

```
# Define constance
one = 1.n(digits=6)
pi = pi.n(digits=6)
tau = 2 * pi
t = tau

# Define the units
meters = var('m')
m = one*meters

seconds = var('s')
s = seconds

kilograms = var('kg')
kg = kilograms

newtons = kg * m / s^2
N = newtons

joules = N * m
J = joules

print("pi    =", pi)
print("tau   =", t)

# Speed of light in meters/second
speed_of_light = 299792458 * meters/seconds
sol = speed_of_light
c = sol
print("si c  =", c)

rnu_c = c / c
print("R\u03BD c  =", rnu_c)

# Gravitational Constant
gravitational_constant = 6.67384e-11 * N*(m^2/kg^2)
G = gravitational_constant
```

```
print("si G  =", G)

rnu_G = 4*pi*G/c^2
Go = rnu_G
print("R\u03BD Go =", Go)


# Planck's Constant
reduced_plancks_constant = 1.054571726e-34 * J*s
h_bar = reduced_plancks_constant
print("si \u210F  =", h_bar)

rnu_h_bar = h_bar * Go / c
print("R\u03BD "u"\u210F  =", rnu_h_bar)

# Planck Length
rnu_h_bar_str = str(rnu_h_bar)
numerical_part_str = rnu_h_bar_str.split('*')[0]
numerical_part_str = numerical_part_str.strip('()')
numerical_part = float(numerical_part_str)
rnu_sqrt_h_bar = numerical_part^(1/2)
# ^ Sage cannot process sqrt on units... Lame.
lP = rnu_sqrt_h_bar * m
print("R\u03BD \u221A\u210F =", lP)
```

3.6.0.1 Output

```
pi    = 3.14159
tau   = 6.28319
si c  = 299792458*m/s
Rν c  = 1
si G  = (6.67384e-11)*m^3/(kg*s^2)
Rν Go = (9.33135e-27)*m/kg
si ℏ  = (1.05457e-34)*kg*m^2/s
Rν ℏ  = (3.28246e-69)*m^2
Rν √ℏ = (5.72928e-35)*m
si lP = (1.61620e-35)*sqrt(m^2)
Rν lP = (2.77455e-47)*sqrt(m^3/kg)
```

4 Terminology

Citations

"John Haverlack | ACEP." n.d. https://www.uaf.edu/acep/about/our-team/john-haverlack.php. Accessed September 30, 2025.