ISP220 Symbols and Equations

Version 1.2

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A running list of topics included:

- Mechanics
- Electrodynamics
- Special Relativity
- General Relativity and Cosmology (not complete)

1 Mechanics

Symbols

x, y:	usually used as space coordinates
t:	usually used as time coordinate
Δ	used to indicate "the difference" between two quantities
$\overrightarrow{A}$	a representation of a generic vector "A"
$\mathbf{A}$	another representation of a generic vector "A"
h:	sometimes used as the height above some surface
R:	often reserved for the distance between two objects, like planets
s:	often used as speed
v:	often used as velocity
a:	used as acceleration
p:	used as momentum
m:	used as mass
M:	also used as mass, sometimes for a large object like a planet
F:	used as a generic symbol for force
E:	used as a generic symbol for energy
K:	used as a symbol for kinetic energy
U:	sometimes used as a symbol for potential energy
g:	reserved for the acceleration due to gravity close to the Earth
G:	used as the Universal Gravitational Constant

Equations

$v = x/t$	the average velocity equation
$\Delta x = x - x_0$	use of Δ to show the difference between an end point x and starting point x_0
$a = v/t$	the definition of an average acceleration
$p = mv$	the definition of momentum
$\overrightarrow{p} = m\overrightarrow{v}$	definition of momentum as a vector
$x = 1/2at^2$	the distance traveled when experiencing a constant acceleration
$F = ma$	Newton's second law for a system that doesn't change its mass
$K = 1/2mv^2$	the definition of kinetic energy
$U = mgh$	the definition of gravitational potential energy near the Earth
$F = G\frac{M_1 M_2}{R_{1,2}^2}$	Newton's Universal Gravitational Law

2 Electrodynamics

Symbols

Q:	a symbol for a generic electric charge
q:	another symbol for a generic electric charge, but maybe a small one
k:	Coulomb's constant (not used much by me)
$\mathbf{E}$:	symbol for the electric field
$\mathbf{B}$:	symbol for the magnetic field
U:	a symbol also used for the potential energy in an electric field
V:	a symbol representing the "potential difference" or voltage in an electric field

Equations

$F = k\frac{Q_1 Q_2}{R_{1,2}^2}$	Coulomb's Law of electrostatic force
$\overrightarrow{F} = \pm Q\overrightarrow{E}$	the force on a charge in an electric field (the sign of Q determines direction)
$\overrightarrow{F} = \pm Q\overrightarrow{v} \times \overrightarrow{B}$	the force on a charge Q moving with velocity v in a magnetic field $\mathbf{B}$[1]
$U = QV$	the energy gained by a charge Q moving (accelerating) through a voltage V

[1] I've not actually used this "cross product" equation, but I write it here to remind you of the RH rule. Think of the $\times$ as saying: "Take the fingers of your right hand and pass them first through the direction of the $\overrightarrow{v}$ and then through the direction of $\overrightarrow{B}$ and your thumb will point in the direction of $\overrightarrow{F}$. Here the sign of Q will turn the force in the other direction if Q is negative.

3 Tools

Symbols

$\mathcal{L}$:	a symbol for luminosity of a beam
σ:	the cross section for a collision to happen
R:	in context, the rate of the production of some particle physics reaction
N:	in context, the number of events produced in some period of time

Equations

$R = \mathcal{L}\sigma$	the rate of the production of a particle reaction characterized by its particular cross section
$N = \mathcal{L}\sigma\Delta t = R\Delta t$	the total number of events produced in a time period Δt

4 Special Relativity

Symbols

c:	symbol to represent the speed of light
u:	my symbol for the velocity of a frame of reference
"A":	"Away," my notation for a frame of reference moving at a constant velocity relative to an observer
"H":	"Home," my notation for the frame of reference of an observer
γ:	the "relativistic gamma"
β:	ratio of co-moving frame speed to that of light.
s:	the invariant interval in spacetime
m_R:	the relativistic mass
E_m:	the rest-mass energy, the rest energy
K:	still...the Kinetic Energy
E_T	the total energy

Equations

$\beta = u/c$	the fraction of the speed of light, typically for a frame's motion, "Away" in my notation
$\gamma = \frac{1}{\sqrt{1-\beta^2}}$	the relativistic gamma factor for $\beta = u/c$
$T_H = T_A\gamma$	a time interval of some clock, T_A in the Away frame as observed in Home. Time dilation.
$L_H = L_A/\gamma$	a length of some object, L_A in the Away frame as observed in Home. Length contraction.
$\Delta s^2 = c^2\Delta T^2 - \Delta x^2$	the invariant "interval" in spacetime—the same, independent of frame of reference

$v_H = \frac{v_A + u}{1 + \frac{u}{c^2} v_A}$	the relativistic velocity transformation for an object with v_A moving in u as seen by v_H
$\gamma \sim 1 + \frac{1}{2}\beta^2$	the approximation for γ when the speed is low
$\frac{1}{\gamma} \sim 1 - \frac{1}{2}\beta^2$	the approximation for $\frac{1}{\gamma}$ when the speed is low
$E_T = m\gamma c^2$	the total relativistic energy
$E_T^2 = m^2 c^4 + p^2 c^2$	another relation for total relativistic energy
$m_R = m\gamma$	the increase of mass of a co-moving object
$E_m = mc^2$	the rest energy of a mass
$p = m\gamma$	the relativistic momentum
$K = mc^2(\gamma - 1)$	the kinetic energy

5 General Relativity and Cosmology, not done

Symbols

G:	the parts of Einstein's Field Equation relating to geometry, space, and time
T:	the parts of Einstein's Field Equation relating to energy, momentum, mass, pressure, density, stress

Equations

$G = T$	a schematic representation of Einstein's Field Equation: geometrical pieces = energy pieces