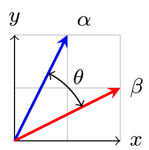
General Physics 1

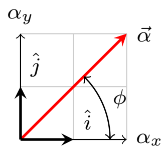
Class: Phys 1110

Definitions

Speed	$v = \left\lvert \frac{dx}{dt} \right\rvert$
Velocity	$\vec{v} = \frac{d\vec{s}}{dt}$
Acceleration	$\vec{a} = \frac{d\vec{v}}{dt}$
Force	$\vec{F} = m\vec{a}$

Vectors





Norm 2	$\lvert\lvert\vec{\alpha}\rvert\rvert_2 = \sqrt{\alpha_1^2 + \cdots + \alpha_n^2}$
addition	$\vec{\alpha} + \vec{\beta} = \binom{\alpha_x + \beta_x}{\alpha_y + \beta_y}$
Dot Product	$\vec{\alpha} \cdot \vec{\beta} = \lvert\lvert\vec{\alpha}\rvert\rvert\, \lvert\lvert\vec{\beta}\rvert\rvert \cos\theta$
	$= \alpha_x\beta_x + \alpha_y\beta_y$
Cross Product	$\lvert\lvert\vec{\alpha} \times \vec{\beta}\rvert\rvert = \lvert\lvert\alpha\rvert\rvert\, \lvert\lvert\beta\rvert\rvert \sin\theta$
Unit Vector	$\vec{\alpha} = x\hat{i} + y\hat{j}$
X component	$\alpha_x = \vec{\alpha} \cdot \hat{i} = \lvert\lvert\vec{\alpha}\rvert\rvert \cos\phi$
Y component	$\alpha_y = \vec{\alpha} \cdot \hat{j} = \lvert\lvert\vec{\alpha}\rvert\rvert \sin\phi$

Newton laws

N I

$\sum \vec{F} = \vec{F_{net}}$

N II

$\vec{F} = m\vec{a}$

N III

let $\vec{F_{ab}}$ be the force **on a from b** and $\vec{F_{ba}}$ be the force **on b from a**.
$\vec{F_{ab}} = -\vec{F}_{ba}$

Kinematics

$v_1 = v_0 + at$
$v_1^2 = v_0^2 + 2a\Delta x$
$x_1 = x_0 + vt + \frac{1}{2}at^2$

Circular Motion

Period(T)	time for 1 revolution.
Circle radius	r
Speed	$\lvert\lvert\vec{v}\rvert\rvert = \frac{2\pi r}{T}$

Work(W) & Energy(E)

Work	$W_{1\to2} = \int_{x_1}^{x_2} \vec{F}_{Net} \cdot d\vec{x}$
W-K Thm	$W_{Net} = \Delta K$
Kinetic E	$K = \frac{1}{2}m\Delta v^2$
Potential E	$\Delta U_{Gravity} = mg\Delta h$
Mechanical E	$E_{Mechanical} = K + U$
Conservative E_{mec}	$\Delta K + \Delta U = 0$
	$\Delta E_{Mec} = \sum W_{NC}$
	$\Delta U = -W_{A\to B}$
	$F(x) = -\frac{du}{dx}$

Conservative forces are gravity and springs.

Gravity

G	The gravitational constant
M_E	The mass of the Planet
m	The mass of the body
r_1	the initial distance between the body and the planet.
r_2	the final distance between the body and the planet.

Force	$F_{Grav} = G\frac{m_1 m_2}{r^2}$
Work	$W_{1\to2} = GM_E m \left(\frac{1}{r_2} - \frac{1}{r_1}\right)$
Close to Earth	$W = -gm\Delta y$
potencial energy	$U = -\frac{GMm}{r}$
Escape speed	$v_{esc} = \sqrt{\frac{2GM}{R}}$

Kepler Laws

K I

A planet's orbit is an ellipse with the sun at one focus.

K II

K III

For a planet around the sun, the period T and the mean distance r from the sun are related by $\frac{T_A^2}{r_A^3} = \frac{T_B^2}{r_B^3}$. This means that planets further from the sun (larger r)have longer orbit (longer T).

Momentum

Momentum Def 1	$\vec{p} = m\vec{v}$
Momentum Def 2	$\vec{F} = \frac{d\vec{p}}{dt}$
center of mass	$\vec{R}_{CM} = \frac{\sum_{i=1}^{N} m_i \vec{r}_i}{M_{total}}$
Total Momentum	$\vec{P}_{total} = M_{total} V_{CM}$

Rotational Kinematic

Arc Length(R=radius)	$s = R\theta$
(in degrees)	$s = 2\pi R\frac{\theta}{360}$
Angular Velocity	$\omega = \frac{d\theta}{dt}$
Angular Acceleration	$\alpha = \frac{d\omega}{dt}$
Tangential(Tan.) speed	$v_{tan} = R\omega$
Tan. Acceleration	$a_{tan} = R\alpha$
Moment Of Inertia	$I = \sum m_i r_i^2$
	$I = \int r^2\, dm$
Rot. Kinetic Energy	$K_{system} = \frac{1}{2}I\omega^2$
Torque (τ)	$\lvert\tau\rvert = r \cdot F_\perp$
	$\lvert\tau\rvert = rF\sin\theta$
	$\vec{\tau} = \vec{r} \times \vec{F}$
	$\tau_{net} = \sum \tau$
($F = ma$ rot. equivalent)	$\tau = I\,\alpha$
Angular momentum	$\vec{L} = \vec{r} \times \vec{p}$
If $\tau_{ext} = 0$ then	$L_{tot} = I\omega$

Static Equilibrium

$\sum F_x = 0$, $\sum F_y = 0$, $\sum \tau = 0$

Simple Harmonic Motion

Pendulum	$x(t) = x_0 \cos\omega t$
Mass-spring	$\omega = \sqrt{\frac{k}{m}}$
	$T = 2\pi\sqrt{\frac{m}{k}}$

Wave Speed

Transversal W. Ex: Water.
Longitudinal W. Ex: Sound.

Period	$T = f^{-1}$
Speed	$v = \frac{\lambda}{T} = \lambda f$
Displacement	$y(x, t=0) = A\sin(2\pi\frac{x}{\lambda})$
	$= Asin(kx)$
	$y(x,t) = A\sin(2\pi(\frac{x}{\lambda} + \frac{t}{T}))$
Ang. Freq.	$\omega = \frac{2\pi}{T}$
Interference	$y_{tot}(x,t) = y_1(x,t) + y_2(x,t)$

Standing Waves

Integer	n
Total length	$L = n\frac{\lambda}{2}$

Fluid

Area	A
Volume	V
Density	$\rho = \frac{m}{V}$
Pressure	$p = \frac{F_\perp}{A}$
	$\Delta p = \rho g \Delta h$
Archimedes P.	$F_{buoy} = m_{fluid}g = \rho V g$

Constants

$c_{light} = 299\,792\,458\ ms^{-1}$
$c_{sound} = 343\ ms^{-1}$

$g = 9.807\ \ ms^{-2}$
$G = 6.6743 \cdot 10^{-11}\ \ m^3kg^{-1}s^{-2}$

Other

Change	$\Delta v^2 = (v_f^2 - v_i^2)$
Spring Force	$\vec{F} = -k\vec{x}$
Spring work	$W_{1\to 2} = -\frac{1}{2}k(x_2^2 - x_1^2)$