PHYS211, Fact Sheet 1

Pythagorean Theorem

$a^2 + b^2 = c^2$, $c = \sqrt{a^2 + b^2}$

Trigonometry

$\sin\alpha$ = opposite/hypotenuse; $\cos\alpha$ = adjacent /hypotenuse; $\tan\alpha$ = opposite/adjacent
$\sin^2\alpha + \cos^2\alpha = 1$; $\alpha + \beta + \gamma = 180^o = \pi$; $c^2 = a^2 + b^2 - 2ab\cos\alpha$; $a/\sin\alpha = b/\sin\beta = c/\sin\gamma$

Kinematics (one-dimensional motion, constant acceleration)

Average speed: $v = \frac{d}{t}$, average velocity: $v = \frac{\Delta x}{t}$, acceleration: $a = \frac{\Delta v}{t}$
$v = v_0 + at$, $\Delta x = v_0 t + \frac{at^2}{2}$, $\Delta x = \frac{v^2 - v_0^2}{2a}$
d - distance traveled, Δx– displacement (change in coordinate)

Free fall

$\vec{\boldsymbol{a}} = \vec{\boldsymbol{g}}$, g = 9.81 m/s^2 ; a = -g, if axis y is directed upwards
speed acquired in free fall from rest: $v = gt$; distance traveled in free fall from rest: $h = \frac{gt^2}{2}$

Vectors

$\vec{a} = a_x\vec{x} + a_y\vec{y}$, $\vec{b} = b_x\vec{x} + b_y\vec{y}$, $\vec{a} \pm \vec{b} = (a_x \pm b_x)\vec{x} + (a_y \pm b_y)\vec{y}$, $\vec{c} = \vec{a} - \vec{b} = \vec{a} + (-\vec{b})$, $\vec{v} = \frac{\vec{d}}{t}$

Projectile motion

$\vec{a} = \vec{g}$ at any point of trajectory; horizontal component of the velocity: $v_x = v_0 cos\alpha$ = const;
vertical component of the velocity: at starting point $v_{y0} = v_0 sin\alpha$, $v_y = v_{y0} - gt$, $y = v_{y0}t - \frac{gt^2}{2}$
at the top of trajectory $v_y = 0$, time of traveling: $t = \frac{2v_0 sin\alpha}{g}$, maximum height: $h = \frac{v_0 sin^2\alpha}{2g}$,
range: $\frac{2v_0^2 sin\alpha cos\alpha}{g} = \frac{v_0^2 sin2\alpha}{g}$

Newton’s second law

$\vec{F}_{net} = m\vec{a}$, $\vec{F}_{net} = \Sigma\vec{F}_i$, $F_x = \Sigma F_{xi} = ma_x$, $F_y = \Sigma F_{yi} = ma_y$, translational equilibrium: $\vec{F}_{net} = 0$
Friction: $F_{static} \leq \mu_s N$, $F_{kinetic} = \mu_k N$

Work and Energy (constant force)

$W = Fdcos\theta, P = \frac{W}{t} = Fvcos\theta$

$K = \frac{mv^2}{2}, U = mgh, U = \frac{kx^2}{2}, E = K + U, W^{net} = K_2 - K_2, W^{cons.} = U_1 - U_2, W^{noncons.} = E_2 - E_1$
W - work done by constant force *F*; *d* – magnitude of displacement; θ - angle between displacement and force; *P* - power; *t* - time interval; *v* - speed of the object; *h* – change in height of the object
Energy conservation: if non conservative forces do not act on the object, $W^{noncons.} = 0$, and $E_2 = E_1$ (i.e. *E* = const); Efficiency = (useful energy output) / (total energy output)

Linear Momentum

$\vec{P} = m\vec{v}$, $\vec{P} = \Sigma m_i\vec{v}_i$, $\frac{\Delta P}{\Delta t} = F_{ext.net}$, impulse $\Delta\vec{P} = \vec{P}_2 - \vec{P}_1 = \vec{F}_{ext.net}\Delta t$
Conservation of momentum: if $\vec{F}_{ext.net} = 0$, then $\Delta\vec{P} = const.$ and $\vec{P}_{after} = \vec{P}_{before}$

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giga: 10^9, mega: 10^6, kilo: 10^3 (1 kg = 1000 g = 10^3 g, 1 km = 10^3 m), centi: 10^{-2}
(1 cm = 10^{-2} m = 1/100 m, 1 m = 100 cm), milli: 10^{-3} (1 mm = 10^{-3} m, 1 m = 1000 mm), micro: 10^{-6}, nano: 10^{-9}
1 in. = 2.54 cm = 0.0254 m, 1 ft = 0.305 m, 1 mi = 1609 m, 1 gal = 3.76 l = $3.76 \cdot 10^{-3}$ m^3, 1 lb = 4.45 N