Physics Andrew Lorimer

1 Motion

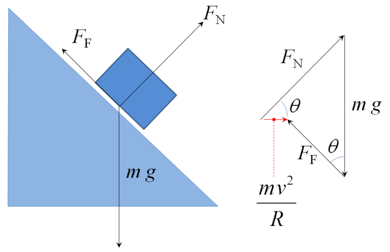
Unit conversion

m/s $\times 3.6 =$ km/h

Inclined planes

$F = mg\sin\theta - F_{frict} = ma$

Banked tracks



$\theta = \tan^{-1}\frac{v^2}{rg}$ (also for objects on string)

ΣF always acts towards centre, but not necessarily horizontally

$\Sigma F = \frac{mv^2}{r} = mg\tan\theta$

Design speed $v = \sqrt{gr\tan\theta}$

Work and energy

$W = Fx = \Delta\Sigma E$ (work)

$E_K = \frac{1}{2}mv^2$ (kinetic)

$E_G = mgh$ (potential)

$\Sigma E = \frac{1}{2}mv^2 + mgh$ (energy transfer)

Horizontal motion

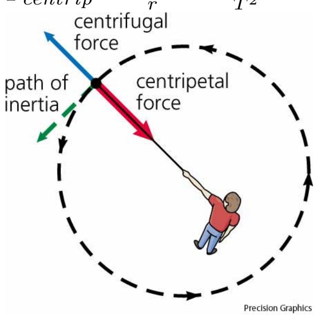
$v = \frac{2\pi r}{T}$

$f = \frac{1}{T}, \quad T = \frac{1}{f}$

$a_{centrip} = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$

ΣF towards centre, v tangential

$F_{centrip} = \frac{mv^2}{r} = \frac{4\pi^2 rm}{T^2}$



Vertical circular motion

$T =$ tension, e.g. circular pendulum

$T + mg = \frac{mv^2}{r}$ at highest point $T - mg = \frac{mv^2}{r}$ at lowest point

Projectile motion

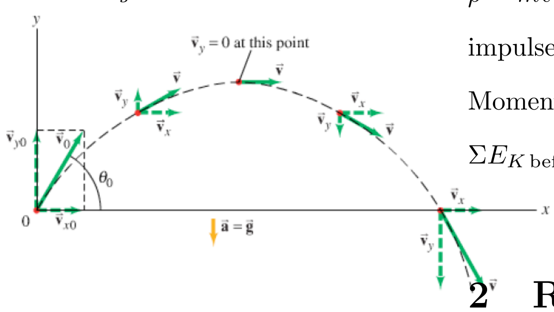
- horizontal component of velocity is constant if no air resistance
- vertical component affected by gravity: $a_y = -g$

$v = \sqrt{v_x^2 + v_y^2}$ (vector addition)

$h = \frac{u^2\sin\theta^2}{2g}$ (max height)

$y = ut\sin\theta - \frac{1}{2}gt^2$ (time of flight)

$d = \frac{v^2}{g}sin\theta$ (horizontal range)



Pulley-mass system

$a = \frac{m_2 g}{m_1 + m_2}$ where m_2 is suspended

Graphs

- Force-time: $A = \Delta\rho$
- Force-disp: $A = W$
- Force-ext: $m = k, \quad A = E_{spr}$

Hooke's law

$F = -kx$

$E_{elastic} = \frac{1}{2}kx^2$

Motion equations

$v = u + at$	x
$x = \frac{1}{2}(v+u)t$	a
$x = ut + \frac{1}{2}at^2$	v
$x = vt - \frac{1}{2}at^2$	u
$v^2 = u^2 + 2ax$	t

Momentum

$\rho = mv$

impulse $= \Delta\rho, \quad F\Delta t = m\Delta v$

Momentum is conserved.

$\Sigma E_{K\text{ before}} = \Sigma E_{K\text{ after}}$ if elastic

2 Relativity