1D KINEMATICS

$v_{avg} = \Delta d / \Delta t$ $v_{avg} = v_f + v_i / 2$

$\Delta d = ½(v_f + v_i)\Delta t$ $v_f = v_i + a\Delta t$

$vf^2 = v_i^2 + 2a\Delta d$ $d_f = d_i + v_i\Delta t + ½a\Delta t^2$

VECTOR – DIRECTION & MAGNITUDE
SCALAR – MAGNITUDE ONLY

2D KINEMATICS

COMPONENTS

x = *cosine* θ

y = *sine* θ

RESULTANTS

ADD ALL X, ADD ALL Y THEN PYTHAGOREAN TM

$\theta = \tan^{-1} (\Delta y / \Delta x)$

+see also: RELATIVE VELOCITY
-boat and river type problems

PROJECTILES

+projectiles follow parabolas!
FROM REST, PROJECTILE:

$y = -½(g)(\Delta t^2)$

$x = vt$

LAUNCHING AT ANGLES:

$y = v_i(\sin\theta)\Delta t - ½g(\Delta t^2)$

$x = v_i(\cos\theta)\Delta t$

FORCES AND MOTION

FORCE IS A VECTOR
CONTACT FORCE // FIELD FORCE

NEWTON

NEWTON'S 1º LAW:

An object at rest REMAINS at rest and an object in motion CONTINUES in motion (unless there's a net external F)

INTERTIA

INERTIA – OBJS TEND TO NOT ACCELERATE

LAW OF INERTIA

$\Sigma F = 0$

EQUILIBRIUM – AN OBJECT AT REST OR MOVING AT A CONSTANT VELOCITY (TRANSLATIONAL)

$\Sigma F x = 0$ // $\Sigma F y = 0$

NEWTON'S 2º LAW:

the acceleration of an object is DIRECTLY proportional to the Σ external force and INVERSELY proportional to its mass

$\Sigma F = ma$

NEWTON'S 3º LAW:
FORCES ALWAYS EXIST IN PAIRS

for every action, there exists an EQUAL and OPPOSITE reaction

BASIC FORCES

WEIGHT – F_g; LOCATION DEPENDENT
NORMAL – F_N – THE EQUAL AND OPPOSITE RXN TO GRAVITY (OR ITS COMPONENT, AS PP TO THE SURFACE THE OBJECT IS RESTING ON)

FRICTION – F_F – OPPOSES THE APPLIED FORCE

COEFFICIENT OF FRICTION

$\mu_s = F_{smax} / F_n$; $\mu_k = F_f / F_n$

+Kinetic co. always smaller than static

$F_f = \mu F_n$

WORK AND ENERGY

WORK

a force that causes the displacement of an object does WORK on the object

$W = Fd$

(THIS ONLY OCCURS FOR FORCE / COMPONENT THAT IS PARALLEL; THEREFORE...)

WORK BY CONSTANT NET FORCES:

$W\Sigma = F_{net}\, d (\cos\theta)$

(distance moved by a force)(force) = work done!

$W\Sigma = (ma)d$ <!-- seeing as $F_{net} == ma$ -->

WORK ENERGY

KINETIC ENERGY

$KE = ½ mv^2$

WORK

$W_{net} = ½mv_f^2 - ½ mv_i^2$

$W_{net} = \Delta KE$

GRAVITATIONAL POTENTIAL ENERGY

mgh

ELASTIC

$½ kx^2$

WHERE K IS THE SPRING CONSTANT AND X IS STRETCH

CONSERVATION OF ENERGY

Mechanical energy (ME = KE + KEsp) is often conserved when there is no friction. Not conserved when there's friction; if friction -> work

MOMENTUM

BASICS

it's P for some reason
p=mv <!-- MASS * VELOCITY-->

NEWTON'S REAL 2º LAW
okay, we lied before

$F = \Delta p / \Delta t$

but: $F = (mv_f - mv_i) / \Delta t$

$F = m(v_f - v_i) / (t_f - t_i)$ <!-- $(v_f - v_i)/(t_f - t_i) == a$-->

IMPULSE-MOMENTUM THEOREM

$F \Delta t = \Delta p$

CONSERVATION OF MOMENTUM – N'S 3º

$P_{1i} + P_{2i} = P_{1f} + P_{2f}$

$M_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

COLLISIONS

PERFECTLY INELASTIC
THEY SMOOSH = THEY MOVE AS ONE

$M_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$

KE IS NOT constant!

PERFECTLY ELASTIC

KE and P are both constant
set the two equations, do some substitution (super happy funtimes)

$M_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

$½M_1v_{1i}^2 + ½m_2v_{2i}^2 = ½m_1v_{1f}^2 + ½m_2v_{2f}^2$

ROTATIONAL MOTION

CIRCULAR MTN

moves around a fixed axis of rotation, so it's relative
Θ= angle; r = radius; s = arc length

ANGULAR

ANGULAR DISPLACEMENT

$\theta = s/r = 2\pi r / r = 2\pi$ rad

θ (RAD) $= \pi / 180 * \theta$ (DEG)

ANGULAR VELOCITY

$\omega_{avg} = \Delta\theta / \Delta t$

ANGULAR ACCELERATION

$\alpha = \Delta\omega / \Delta t$

ANGULAR KINEMATICS

$\Delta\theta = ½(\omega_f + \omega_i)\Delta t$

$\omega f^2 = \omega_i^2 + 2\alpha\Delta\theta$

$\omega_f = \omega_i + \alpha\Delta t$

$\theta_f = \theta_i + \omega_i\Delta t + ½\alpha\Delta t^2$

TANGENTIAL

TANGENTIAL SPEED, ACCELERATION

$v_t = r\omega$

$a_t = r\alpha$

CENTRIPETAL

CENTRIPETAL – CENTER SEEKING
CONSTANTLY CHANGING DIRECTION

CENTRIPETAL ACCELERATION

$a_c = v_t^2 / r$

tangential and centripetal are perpendicular!

NEWTON'S 2º, WITH CIRCLES

$F_c = ma_c$

$F_c = mv_t^2 / r$ <!-- plugged in for a-->

$==mr\omega^2$

<!-- plugged in for v_t^2, then divided by r -->

INERTIA IS NOT A FORCE

NEWTON'S UNIVERSAL GRAVITATION

$Fg = G(m_1m_2) / r^2)$

ROTATIONAL

equilibrium and dynamics
EXTENDED OBJ- DEF. SIZE AND SHAPE
NET TORQUE – ROTATION
TORQUE = FORCE X LEVER ARM (DISTANCE WHERE PUSHED FROM CENTER)

$T = Fd(\sin\theta)$

sometimes Fr
To get Σ torque – add!
CCW – POSITIVE; CW – NEGATIVE

ROT AND TRANS

MOMENT OF INERTIA
resistance to rotation around an axis

$\Sigma f = 0$; Σ torque $= 0$

Σ torque $= I\alpha$

ROTATIONAL KINEMATICS

$½ I \omega^2$; work - $\Delta\tau$ $(I\alpha\theta)$