Unit Three: Newton's Laws, Impulse and Momentum

Net Force on horizontal, vertical and inclined axis

Newton's 1st Law: Objects do not speed up, slowdown or change direction without an unbalanced (net force) – ie Law of Inertia

Inertia is mass; also stated objects in motion stay in motion . . .

Most mass = most kilograms

Newton's 2nd Law = $F_{net} = ma$ whatever happens to F_{net} happens to acceleration

(p) momentum is the product of mass & velocity

(J) Impulse is the product of net force & time it acts

An impulse is required to cause a change in momentum

[Net force is the rate of change in momentum]

Newton's 3rd Law

For every force there exists an equal and opposite force

(Note they operate on two separate objects)

If a person exerts a 10N force pulling a sled, the force of the sled on the person is also 10N

- Weight (F_g) is the downward force on an object caused by the gravitational field – measured in Newtons
- Normal Force (F_N) is the perpendicular force from the surface. Normal force is the apparent weight (scale reading)
- Net force – is the imbalance in force on an axis. It is the amount one force wins by. Find F_{Net} by add force vectors on any axis (remember direction)
  At equilibrium $F_{Net} = 0$ = Constant V
  With an imbalance $F_{Net} = ma$
- Components of weight – angle is equal to incline of ramp. If object is described in kg use $F_{g\parallel} = mg\sin\theta$ if in N use $F_{g\parallel} = F_g\sin\theta$

For horizontal axis

$F_{net} = F_{Ax} + F_f$

At equilibrium $0 = F_{Ax} + F_f$ $\quad F_{Ax} = F_f$

If F_{Net} is present $ma = F_{Ax} + F_f$

For vertical axis

$F_{Nety} = F_A + F_g$

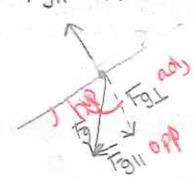
at equilibrium $0 = F_A + F_g$ $\quad F_A = -F_g$

For acceleration upward $F_A > F_g$ $\quad F_N > F_g$

For acceleration downward $F_A < F_g$ $\quad F_N < F_g$

For inclined axis

$F_{Net\parallel} = F_{g\parallel} + F_A + F_f$



Assign positive to up the ramp
negative to ramp

Variables, equations and units

m = mass = inertia (kg)

a = acceleration (m/s^2) $\quad$ [$1N = 1kg\,m/s^2$]

F_{Net} = Net force (N)

$p = mv$

$\Delta p = m\Delta v$ $\quad F_{Net} = ma$ $\quad$ [$F_{Net} = \frac{m\Delta v}{t}$]

$J = (F_{Net})(t)$ $\quad F_{Net} = \frac{\Delta p}{t}$

$J = \Delta p$

$F_g = mg$

$F_N = F_g\cos\theta = mg\cos\theta$ } θ = angle of incline from horizontal, for level surface $\theta = 0°$

$F_{g\perp} = F_N$

[$F_{g\parallel} = F_g\sin\theta = mg\sin\theta$] $\quad F_N = F_g$

$F_x = F\cos\theta$ $\quad F = \sqrt{F_x^2 + F_y^2}$ $\quad \theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$

$F_y = F\sin\theta$

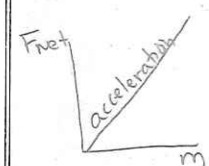
μ_k or μ_s = coefficient of friction, k = kinetic, s = static

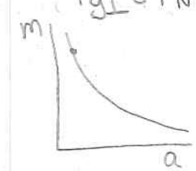
$F_f = \mu F_N$

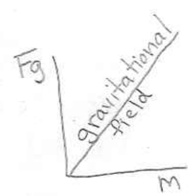
$F_f = \mu mg\cos\theta$

Graphical Relationship

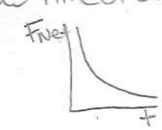
As θ increases $F_{g\parallel}$ increases, $F_{g\perp}$ & F_N decrease







as time of a collision increases the F_{Net} decreases



change in momentum is the same for a fast and slow stop... the net force is inverse to time

Unit Three: Friction, Springs, Centripetal and Gravitational Force, Conservation of momentum

- Friction - is a force from surface that opposes motion
  it is dependent on ① types of surfaces (μ) coefficient of friction
  ② whether or not objects are starting from rest (static) or the force to keep it moving
  ③ The Normal Force (dependent on incline & mass) $F_N = mg\cos\theta$

The force applied to keep an object moving is Force of Kinetic Friction

If object is at constant velocity (equilibrium) the
- horizontal (applied) force is equal to Frictional force
- $F_{g\parallel} = F_f$ for object at rest on inclined plane
- $F_f = F_{g\parallel} + F_A$ for object pulled up an inclined plane

- For a mass applied to a vertical spring $F_s = F_g = mg$
  so $mg = kx$
- For objects on a circular path or on a curved path acceleration is a result of changing direction of velocity not magnitude of velocity (ie...speed) known as centripetal acceleration

-Centripetal force & centripetal acceleration are both toward center of circle

-Velocity at any point is tangent to circle

- Gravitational Force cause all masses to attract
  as masses get farther apart, the force between them decreases by square
  If r doubles $F_g \div 4$
  1 Earth radii is on the surface of the Earth - a distance of 6.37×10^6 m away is doubling of r

Gravitational Field lines

Point inward

- Momentum is a conserved quantity (ie the total before & after) must remain the same

Variables, Equations and Units

All forces are measured in Newtons $= 1\,kg\,m/s^2$

$F_f = \mu F_N$

μ = coefficient of friction
μ_k = kinetic
μ_s = static
} No units

$F_N = F_g\cos\theta = mg\cos\theta$

$F_s = kx$ For a vertical spring $F_s = F_g = mg$

k = spring constant (N/m)

x = change in spring length (m)

For circular motion

$a_c = \frac{v^2}{r}$ $v = \frac{2\pi r}{T}$ $F_c = ma_c$

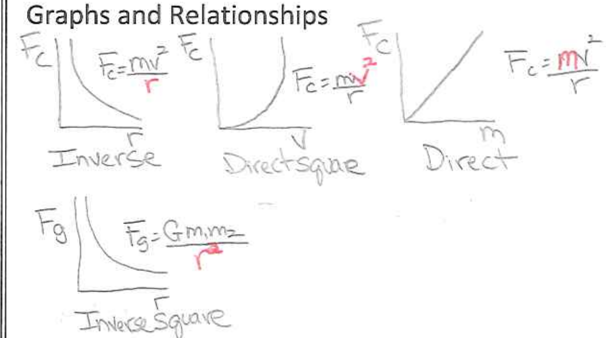
$F_c = \frac{mv^2}{r}$ not on PRT

$F_g = \frac{Gm_1m_2}{r^2}$ r = distance between masses (not radius don't cut in half)

G = Gravitational Constant $= 6.67\times10^{-11}\,N\,m^2/kg^2$

$p_{before} = p_{after}$

Graphs and Relationships



	before		after	
	1	2	1	2
m				
v				
p				
total				