Final Exam Countdown ....

Today: Office hours 4.30-6pm

Thurs: Problem Section

Friday: Quiz - waves and sound

Monday: Office hours 10-11.30am, 2-4pm } by appointment (email)

Wednesday: Final Exam 8-11am

Probably: 6 questions, 20 points each (max. 100)

Ace the Final!

- Lecture Notes - define material (not textbook)
- Quizzes + solutions - understand your mistakes
- Lab Homeworks - " " "
- In-class examples, textbook examples
- "Quickie" review: discussion questions at ends of chapters.

Make sure you know definitions and units of concepts.

Review: Kinematics

- Position, Velocity, Acceleration (vectors)

For constant acceleration ($\therefore$ constant net force)

$$\begin{cases} v = v_0 + at \\ x = x_0 + v_0 t + \tfrac{1}{2}at^2 \end{cases} \qquad (\underline{mv = mv_0 + Ft})$$

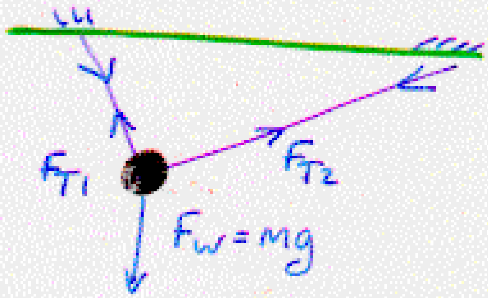
Newtonian version

$$\Rightarrow \quad v^2 = v_0^2 + 2ax \qquad (\underline{\tfrac{1}{2}mv^2 = \tfrac{1}{2}mv_0^2 + F.x})$$

Newton's Laws - make sure you know them!

(1) $\Rightarrow$ No net force $\Rightarrow$ no acceleration (object has $v=0$ or $v=$ constant)

e.g. Statics : $\frac{dv}{dt} = 0$ means $\sum \vec{F} = 0$

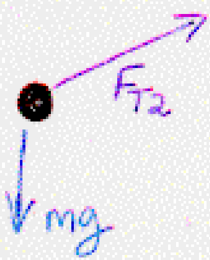


i.e. $\sum F_x = 0$

$\sum F_y = 0$

(2) Dynamics: Net force $F = \frac{d(mv)}{dt} = ma$

(e.g. if string breaks on left :



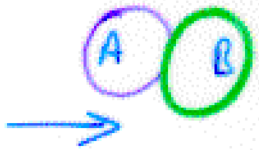
Net $\vec{F} = m\vec{a} = \vec{F}_{T2} + m\vec{g}$

Force, Momentum + Impulse, Kinetic Energy

Newton II ⇒ $\Delta(mv) = \int F.dt$ = **impulse**

'A force acting over time changes momentum'

In collisions, Newton III ⇒ $F_{AB} = -F_{BA}$, also $t_A = t_B$ in contact



So $(\Delta mv)_A = -(\Delta mv)_B$

⇒ Conservation of Momentum if no external forces acting

Work and Kinetic Energy

Work $\equiv \int F.dx$: "A force acting over distance does work"

For a mass m,

Work $= \Delta KE = \Delta\left(\frac{1}{2}mv^2\right)$

Elastic collisions: Total KE conserved, Momentum Conserved

$m_A v_A + m_B v_{Bi} = \ldots$ ⇒ 2 equations for v_A, v_B

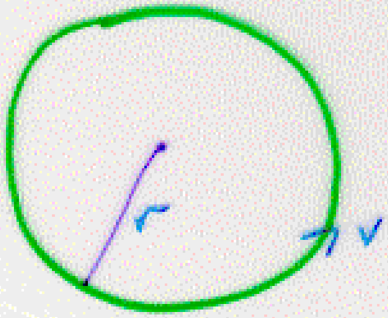
$\frac{1}{2} m_A v_A^2 + \frac{1}{2} m_B v_B^2 = \ldots$

Inelastic collisions: Momentum Conserved, but not K.E

⇒ 1 equation for v_A, v_B and v_f

$P_i = P_f$ $\quad m_A v_A + m_B v_B = (m_A + m_B) v_f$.

Circular Motion

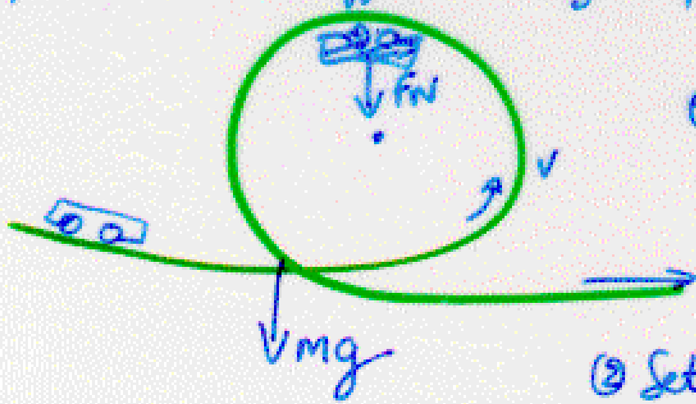


Even if speed constant, velocity changes

$\Rightarrow$ Centripetal Force $F_c = \dfrac{mv^2}{r}$

- review problems with "effective weight" provided by F_N

e.g.



① Add up all forces pointing towards center.

② Set this sum $= \dfrac{mv^2}{r}$

e.g. At bottom of circle

$$F_N - mg = \frac{mv^2}{r}$$

$$\Rightarrow \underline{F_N} = mg + \frac{mv^2}{r} > \text{static weight } mg$$

At top:

$$F_N + mg = \frac{mv^2}{r}$$

$$\Rightarrow F_N = \frac{mv^2}{r} - mg < \text{static weight } mg$$

Note: F_N must be ≥ 0 for objects to stay in contact

Rotation and Torque

Solid body: all parts have same angular velocity ω [rad/s] with $v = r\omega$

Torque $\tau = F r \sin\theta$ about rotation center $r=0$

Center of gravity: defined such that grav. torque

$\sum mg\, x = (mg)\, x_c$: point at which weight can be thought to act.

Fw.

Equations of Rotational Motion

- use Moment of Inertia $I = \sum m r^2$

Then: $\tau = I \dfrac{d\omega}{dt} = I\alpha$ $\left(F = m\dfrac{dv}{dt}\right)$

(so for ω = constant or 0, $\Rightarrow$ no net torque)

Also no external torque

$\Rightarrow$ Ang. Momentum $I\omega$ = constant. (mv)

Rotational K.E. $= \frac{1}{2}\sum m v^2 = \sum \frac{1}{2} \underbrace{m r^2}_{I} \omega^2 = \frac{1}{2} I \omega^2$