Physics Principles

~~0 Uniform motion ($\vec{F}_{net} = 0$)~~
1 Accelerated motion ($\vec{F}_{net} \neq 0$)
2 Uniform circular motion ($\vec{F}_{net}$ is radially inward)
3 Work-energy theorem
4 Conservation of momentum
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7 Conservation of charge
8 Conservation of nucleons
9 Wave-particle duality

Kinematics

~~$\vec{v}_{ave} = \frac{\Delta \vec{d}}{\Delta t}$~~

$$\vec{d} = \vec{v}_f t - \frac{1}{2}\vec{a}t^2$$

$$\vec{a}_{ave} = \frac{\Delta \vec{v}}{\Delta t}$$

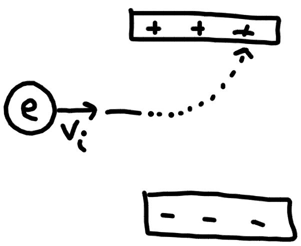
$$\vec{d} = \left(\frac{\vec{v}_f + \vec{v}_i}{2}\right)t$$

$$\vec{d} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2$$

$$v_f^2 = v_i^2 + 2ad$$

$$|\vec{v}_c| = \frac{2\pi r}{T}$$

$$|\vec{a}_c| = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$$



x-comp → Uniform Motion ($a = 0$)
y-comp → Accel Motion ($a \neq 0$)

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Kinematics

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~~$\vec{a} = \vec{v}_f t - \frac{1}{2}\vec{a}t^2$~~

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$|\vec{v}_c| = \frac{2\pi r}{T}$

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Dynamics

~~$\vec{a} = \frac{\vec{F}_{net}}{m}$~~

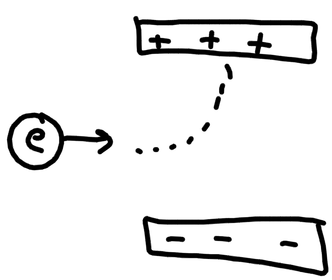
$|\vec{F}_g| = \frac{Gm_1m_2}{r^2}$

$|\vec{F}_f| = \mu|\vec{F}_N|$

$|\vec{g}| = \frac{Gm}{r^2}$

$\vec{F}_s = -k\vec{x}$

$\vec{g} = \frac{\vec{F}_g}{m}$



x-comp → Uniform motion ($a=0$)
y-comp → Accel motion ($a \neq 0$)

① $|\hat{E}| = \frac{\Delta V}{\Delta d}$
② $|\vec{F}| = q|\vec{E}|$
③ $a = \frac{F_{net}}{m}$

Parabolic Motion
(Like Projectile Motion)

y-comp

$d = v_i t + \frac{1}{2}at^2$ ($v_i t \to 0$)

$d = \frac{1}{2}at^2$

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Kinematics

$$\vec{v}_{ave} = \frac{\Delta \vec{d}}{\Delta t} \qquad \vec{d} = \vec{v}_f t - \frac{1}{2}\vec{a}t^2$$

$$\vec{a}_{ave} = \frac{\Delta \vec{v}}{\Delta t} \qquad \vec{d} = \left(\frac{\vec{v}_f + \vec{v}_i}{2}\right)t$$

$$\vec{d} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2 \qquad v_f^2 = v_i^2 + 2ad$$

~~$|\vec{v}_c| = \frac{2\pi r}{T}$~~ ~~$|\vec{a}_c| = \frac{v^2}{r}$~~ $= \frac{4\pi^2 r}{T^2}$

Cyclotron → Detection Chamber in Mass Spectrometer

$F_M = F_c$

$$q v |\vec{B}| = \frac{mv^2}{r}$$

$$F_c = \frac{mv^2}{r}$$

Memorize or Derive

a is inward → Constant magnitude
→ Changing direction

Speed is constant
Velocity (direction) changes.

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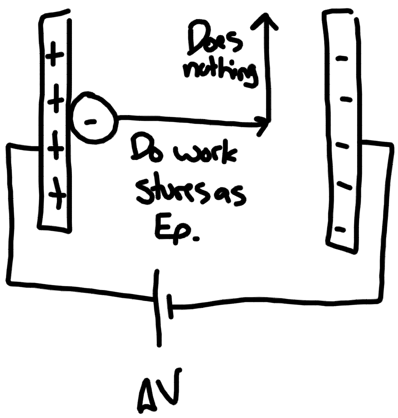
Momentum and Energy

$\vec{p} = m\vec{v}$	$E_k = \frac{1}{2}mv^2$
$\vec{F}\Delta t = m\Delta\vec{v}$	$E_p = mgh$
$W = \lvert\vec{F}\rvert \lvert\vec{d}\rvert \cos\theta$	$E_p = \frac{1}{2}kx^2$
~~$W = \Delta E$~~	
$P = \frac{W}{t}$	



$$\Delta V = \frac{\Delta E_p}{q}$$

Move 100% distance? Stored 100% of Ep.
75% 75%

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Momentum and Energy	
~~$p = mv$~~	$E_k = \frac{1}{2}mv^2$
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$W = \lvert\vec{F}\rvert\lvert\vec{d}\rvert\cos\theta$	$E_p = \frac{1}{2}kx^2$
$W = \Delta E$	
$P = \frac{W}{t}$	

$p_i = p_f$ $\quad \vec{p}_i = \vec{p}_f$ $\quad p_{ix} = p_{fx}$ $\quad p_{iy} = p_{fy}$

Iff no non-zero net external force ($F_{net} = 0$).

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Momentum and Energy

$\vec{p} = m\vec{v}$

~~$E_k = \frac{1}{2}mv^2$~~

$\vec{F}\Delta t = m\Delta\vec{v}$

~~$E_p = mgh$~~ ✗

$W = |\vec{F}||\vec{d}|\cos\theta$

~~$E_p = \frac{1}{2}kx^2$~~ ✗

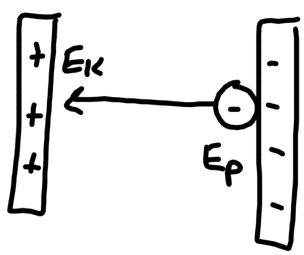
$W = \Delta E$

$P = \frac{W}{t}$

Atomic Physics

~~$W = hf_0$~~ ~~$E = hf = \frac{hc}{\lambda}$~~

~~$E_{k_{max}} = q_e V_{stop}$~~ $N = N_0\left(\frac{1}{2}\right)^n$



Accel plates in mass spectrometer!

or

Cyclotron

$E_{K_i} + E_p \rightarrow E_{K_f}$

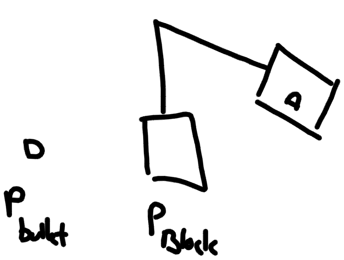
$\frac{1}{2}mv_i^2 + q\Delta V = \frac{1}{2}mv_f^2$

X-Ray Production

$E_p \rightarrow E_K \rightarrow E_{photon}$

$q\Delta V \rightarrow \frac{1}{2}mv^2 \rightarrow \frac{hc}{\lambda}$

Ballistic Pendulum



Collision → Cons. of $\vec{p}$

$E_K \rightarrow E_p$

$\frac{1}{2}mv^2 = mgh$ → Cons. of E

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Quantum Mechanics and Nuclear Physics

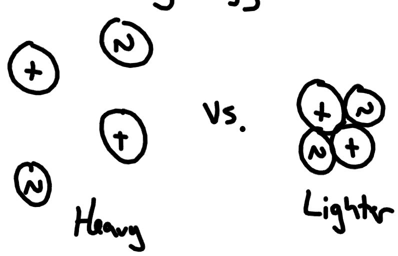
~~$\Delta E = \Delta mc^2$~~

$E = pc$

$p = \frac{h}{\lambda}$

$\Delta\lambda = \frac{h}{mc}(1 - \cos\theta)$

① Mass defect
+ Binding energy



$\Delta E = \Delta mc^2$

② Fission/Fusion reaction

$m_{Heavy} \rightarrow m_{Lighter} + E$

$\Delta E = \Delta mc^2$

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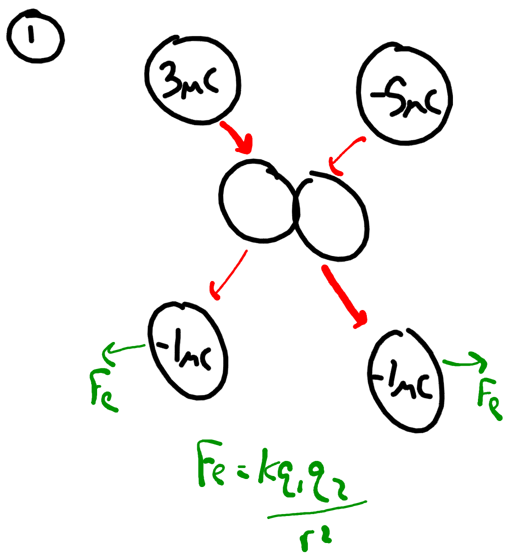
$$^{222}_{88}\text{Ra} \longrightarrow {}^{4}_{2}\text{He} + {}^{218}_{86}\text{Rn}$$

$$^{14}_{6}\text{C} \longrightarrow {}^{14}_{7}\text{N} + {}^{0}_{-1}\text{e} + {}^{0}_{0}\bar{\nu}$$



② Decays

$$^{214}_{+84}Po \rightarrow {}^{4}_{+2}\alpha + {}^{210}_{+82}Pb$$

$$+84e = +2e + 82e$$

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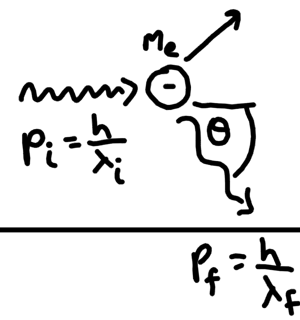
~~$p = \frac{h}{\lambda}$~~ $\quad$ ~~$\Delta\lambda = \frac{h}{mc}(1 - \cos\theta)$~~



① Light
- Wave: $\lambda = \frac{d\sin\theta}{n}$
- Photon: $E = hf = \frac{hc}{\lambda}$, $p = \frac{h}{\lambda}$

② Electron
- Particle: $p = mv$
- Wave: $p = \frac{h}{\lambda}$

$$mv = \frac{h}{\lambda}$$

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