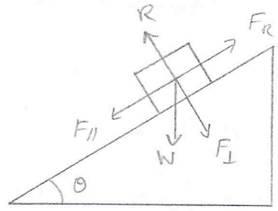
$V = u + at \quad s = ut + \frac{1}{2}at^2 \quad v^2 = u^2 + 2as \quad s = \frac{(v+u)}{2}t$

$F = ma = \frac{\Delta p}{\Delta t} \quad \Delta P = F_{avg}\Delta t \quad p = mv$

$F_{\parallel} = W\sin\theta$

$F_{\perp} = W\cos\theta$



$M = F_{\perp}s \quad M_c = Fd \quad W = F_{\parallel}s \quad P = Fv$

$\Delta GPE = mg\Delta h \quad \Delta kE = \frac{1}{2}m(v^2 - u^2) \quad W = P\Delta V \quad \rho = \frac{m}{V}$

$\underbrace{\vec{V}_B - \vec{V}_A}_{\text{sep}} = e(\underbrace{\vec{u}_A - \vec{u}_B}_{\text{approach}})$

$P = \frac{F}{A} \quad p = \rho gh \quad \sigma = \frac{F}{A} \quad \varepsilon = \frac{x}{L_0} \quad E = \frac{FL_0}{Ax} \quad F = kx$

$\Delta EPE = \frac{1}{2}k(x_2^2 - x_1^2) \quad I = \frac{Q}{t} \quad I = nAv_d q \quad V = \frac{W}{Q} \quad P = IV \quad R = \frac{V}{I} \quad R = \frac{\rho L}{A}$

$E = \frac{V}{d} \quad F = qE \quad R_{series} = \sum_{r=1}^{n} R_i \quad R_{parallel} = \frac{1}{\sum_{r=1}^{n}\frac{1}{R_i}} \quad \mathcal{E} = I(R + r)$

$V_{terminal} = \mathcal{E} - Ir$

$V_{out} = \frac{V_{in}R_2}{R_1 + R_2} \quad \frac{\mathcal{E}_x}{\mathcal{E}_y} = \frac{AX}{AY} \quad \mathcal{E}_x = \frac{AX}{AB}\mathcal{E}_0$

$v = f\lambda \quad f = \frac{1}{T} \quad I \propto A^2 \quad I = \frac{P}{A} \quad f' = f\left(\frac{v + v_0}{v - v_s}\right) \quad \eta = \frac{W_{useful}}{W_{total}}$

$W = \lambda\frac{d}{s} \quad n\lambda = d\sin\theta \quad d = \frac{1}{m} \quad A = Z + N$

Radio	Microwave	Infra red	Visible	Ultra violet	X rays	γ rays
10^6	10^{-1}	10^{-3}	7×10^{-7}	4×10^{-7}	10^{-8}	10^{-10}
10^{-1}	10^{-3}	7×10^{-7}	4×10^{-7}	10^{-8}	10^{-13}	10^{-16}

	u	d	s	$\bar{u}$	$\bar{d}$	$\bar{s}$
charge	$+\frac{2}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{2}{3}$	$+\frac{1}{3}$	$+\frac{1}{3}$
strangeness	0	0	-1	0	0	+1

Subatomic particles
- leptons (weak force): $e^-, e^+, \nu_e, \bar{\nu}_{e,\mu}$
- hadrons (weak + strong)
  - baryons (3 quarks): p^+, n^0
  - mesons (2 quarks): π

β^- decay $\quad {}^1_0n^0 \rightarrow {}^1_1p^+ + {}^0_{-1}e^- + \bar{\nu}_e$

$d \rightarrow u + e^- + \bar{\nu}_e$

β^+ decay $\quad {}^1_1p^+ \rightarrow {}^1_0n^0 + {}^0_{+1}e^+ + \nu_e$

$u \rightarrow d + e^+ + \nu_e$

α decay $\quad {}^A_ZX \rightarrow {}^{A-4}_{Z-2}Y + {}^4_2\alpha$

γ decay $\quad {}^A_ZX \rightarrow {}^A_ZX + {}^0_0\gamma$ (photon of E)

Strong nuclear – gluon – 10^{-15}m – quarks – repel + attract

Weak nuclear – Z^0, W^+, W^- bosons – 10^{-17}m – quarks + leptons – neither

Electromagnetic – γ (photon) – ∞ – charged particles – repell + attract

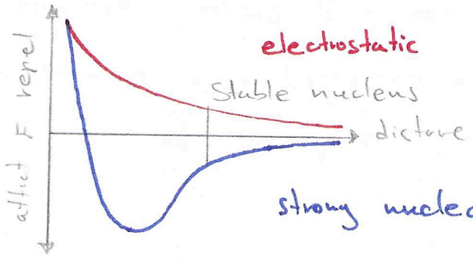
Gravity – graviton – ∞ – massive particles – attract

$\alpha \sim \frac{1}{10}c \quad$ 4MeV

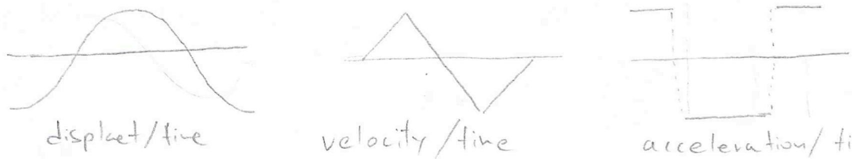
$\beta \sim \frac{99}{100}c \quad$ 0.5MeV

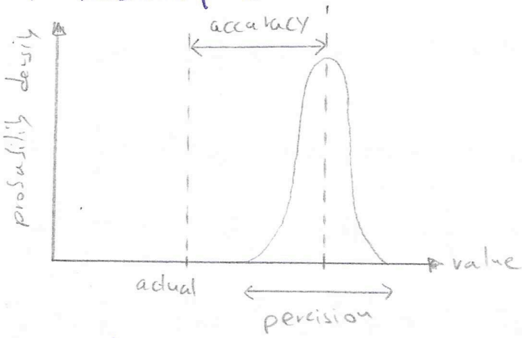
$\gamma = c \quad$ 10keV – 10MeV

β decay – Weak nuclear force

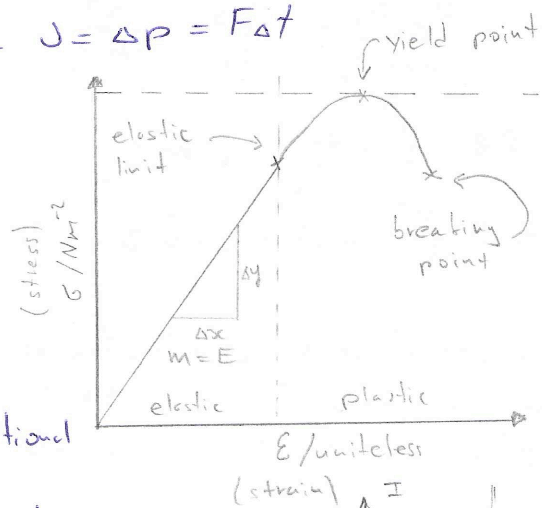


- base quantities: length(m), time(s), mass(kg), temp(k), current (A)
  7 amount of a substance(mol), luminous intensity (cd)
- uncertainty - limits of measuring equipement + technique
- accurate - close to true value
- percise - close to mean value

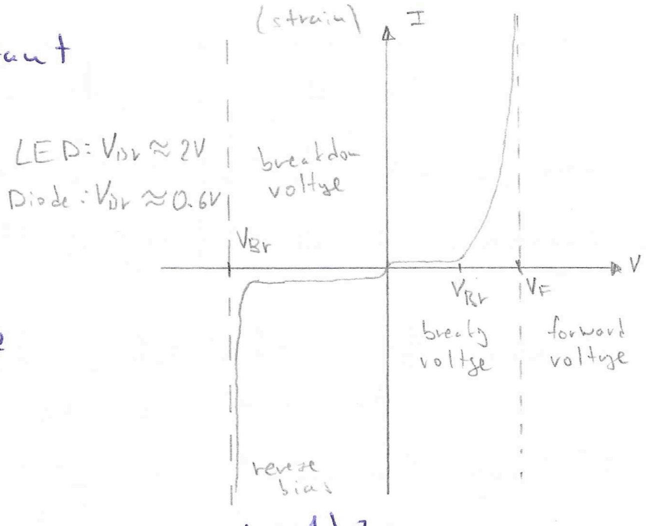




- ellastic collision - KE conserved $e=1$ Vapproach = Vseparation
- inellastic collision - KE not conserved but p consered
  - Vapproach ≠ Vseparation
- explosions $p_i = 0$ so $p_f = 0$ impulse $J = \Delta p = F\Delta t$
- compressive force F tensile force F



- young modulus - ratio of tensile stress to tensile strain $E = \frac{Fl_0}{A x}$
- ohms law - current in ohmic conductor is propotional to voltge across it provided temp + physical conditions are constant
- LDR light ↑ R↓ — thermistor T↑ R↓
  dark ≈ 5MΩ NTC
  light ≈ 500Ω PTC T↑ R↑

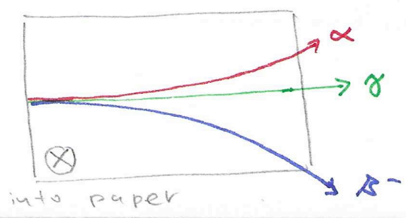


- kirchoffs law - 1st $\Sigma I_{in} = \Sigma I_{out}$ - q consered
  - 2nd $\Sigma emf = \Sigma pd$ - E conserved
- monochromatic - only one f or λ
- coherent - constant phase difference ϕ
- laser - monochromatic + coherent
- coherent sources constructive $= n\lambda$ destructive $= (n+\frac{1}{2})\lambda$
- fringe - place of constructive interference
- polarised - only transverse - single plane ⊥ to propagation

$m_e = 9.11 \times 10^{-31}$ kg $m_p = 1.67 \times 10^{-27}$ kg $r_{p^+} \approx 10^{-15}$ m $r_{nucleus} \approx 10^{-15} - 10^{-14}$ m

A - nucleon Z - proton N - neutron $r_{atom} \approx 10^{-10}$ m

- charge + energy/mass - conserved
- specific charge $= \frac{Q}{m}$



(left hand rule)