

---

## Table of contents

Energy:

$$E = \overline{W} = E_{kin} + E_{pot} = E_{Magn} + E_{Elec} \stackrel{continuum}{=} \frac{1}{2}kT + \frac{1}{2}kT = kT \stackrel{quantum}{=} \hbar\omega = h\nu \stackrel{distribution}{=} h\nu \frac{1}{e^{\frac{h\nu}{kT}} - 1} \stackrel{rela}{=} \quad (1)$$

= linear + rotational + vibration + spin + ...?

$$E_{kin}^{max} = eV_0 = h(\nu - \nu_0) \quad (2)$$

Average Energy Densitiy (Electromagnetic Intensity and Poynting-Vector):

$$\langle w_{EM} \rangle = \frac{1}{2}\varepsilon_0(\mathcal{E}^2 + c^2\mathcal{B}^2) = \varepsilon_0\mathcal{E}^2 + \frac{1}{\mu_0}\mathcal{B}^2 = \frac{1}{c}\frac{\mathcal{E} \cdot \mathcal{B}}{\mu_0} = \frac{1}{c}\mathcal{J} = \frac{1}{c}\langle |\vec{S}| \rangle \quad (3)$$

Quest: What is momentum  $p$  if there is no mass,  $m = 0$  ?

Quest: Is energy  $E$  also the cause for mass  $m$ , apart from being the ability to do work  $W$ ,  
 $\Delta E = W = F \cdot x = m \cdot a \cdot x = mx \cdot \frac{dv}{dt} = mx \cdot \frac{d^2x}{dt^2} = M \cdot \frac{d^2x}{dt^2}$  ?

Energy manifestation forms: Change (Transfer Movement), Potential (Rest Duration), Temperature, Light, Sound, Mass, Charge, Information, Communication, ...

Energy Total:

---


$$\begin{aligned}
E_{Tot} &= motion + rest = linear + rotational + vibration + spin + \dots = \\
Work + Heatchange &= (F \cdot \Delta r) \mp \Delta Q = E_{kin} + E_{pot} = E_{magn} + E_{elec} = pv \\
&\quad \underset{macro(continuum)}{=} \\
\frac{1}{2} \frac{p^2}{m} &= \frac{1}{2} m (\omega A)^2 \\
&\quad \underset{thermal}{=} \frac{1}{2} f b T \underset{micro(quantum)}{=} \\
\hbar \omega = h \nu &= \frac{1}{2} \frac{(\hbar k)^2}{m} \underset{relativistic}{=} \\
\sqrt{(pc)^2 + (mc^2)^2} &\underset{Entropy}{=} \\
\dots &\quad \underset{distribtionFermion}{=} \\
\dots &\quad \underset{distribtionBoson}{=} \\
\dots &\quad \underset{distribtionBoltzmann}{=} \\
\dots &
\end{aligned} \tag{4}$$