**Force:** — ($SI$ units = Newtons = $kg\text{-}m/s^2$)

**Newton's 2nd Law of motion:** Instantaneous Force = (mass, $m$) $*$ (instantaneous acceleration, $a$)

$$\boxed{\vec{F}(\vec{r},t) = m\vec{a}(\vec{r},t)}$$

Force is a 3-D vector quantity.

$kg$ $\quad$ $m/sec^2$

1 Newton of force = 1 $kg\text{-}m/(sec)^2$

Weight, $W$ = (mass, $m$) × (gravitational acceleration, $g$). *n.b.* Weight, $W$ is a <u>force</u>!

Earth's gravitational acceleration: $g = 9.81\ m/sec^2$ (at sea level) $\quad g = \dfrac{G_N * M_{earth}}{(R_{earth})^2}$

$$\boxed{W = mg}$$

**Pressure:** — Pressure = force $F$ per unit area, $A$. *n.b.* Pressure, $p$ is a <u>*scalar*</u> (not vector) quantity!

$$\boxed{p = F/A} \quad (Newtons/(meter)^2$$

$SI$ / metric units of pressure ≡ Pascal, $Pa$ $\quad 1\ Pa = 1N/m^2$.
1 Atmosphere (14.7 $psi$) = 101,325 Pascals = $1.01325 \times 10^5$ Pascals.

**Work & Energy:** — Work $\boxed{W = \int_C \vec{F}(\vec{r}) \cdot d\vec{\ell}(\vec{r})}$. If force is <u>*constant*</u>: Work $W$ = Force, $F$ × Distance, $d$

For <u>*constant*</u> force: $\boxed{\boldsymbol{W = Fd}}$ = energy required to *e.g.* move an object of weight $W = mg$ upwards a distance $d$ on earth's surface ( = uniform gravitational field).

energy

$SI$ / metric units of work & energy = <u>*Joules*</u>

Energy is (*always*) <u>conserved</u>

Energy required to move an object can be electrical, gravitational, wind, chemical, *etc*.

**Power:** = instantaneous time rate of change of energy ($SI$ units = *Watts*)

$$\text{Power} \ \boxed{P(t) = \frac{\partial E(t)}{\partial t}} \quad Watts = Joules \text{ per } second = Joules/sec$$

1 *kilo-Watt* = 1000 *Watts* = $10^3$ *Watts*

1 *mega-Watt* = 1 million *Watts* = $10^6$ *Watts*