Power

- Power is the work done in unit time or energy converted in unit time

$$P = \frac{W}{t} \quad or \quad P = \frac{E}{t}$$

measures how fast work is done or how quickly energy is converted. Power is a scalar quantity.

- Units: $1\ W(Watt) = \frac{1J(joule)}{1s}$

A 100 W light bulb converts electrical energy to heat and light at the rate of 100 J every second.

Sometimes you'll see power given in kW or even MW.

Calculate the power of a worker in a supermarket who stacks shelves 1.5 m high with cartons of orange juice, each of mass 6.0 kg, at the rate of 30 cartons per minute.

$$P = \frac{W}{t} = \frac{Fd\cos 0^0}{t} = \frac{(30\times 60N)\times 1.5m}{60s} \qquad P = 45\ W$$

There is another way to calculate power

$$P = \frac{W}{t} = \frac{Fd\cos 0^0}{t} = F\frac{d}{t} \qquad P = Fv$$

Power is equal to force times velocity, providing that both force and velocity are constant and in the same direction.

Constant velocity with a force applied ??????

That's because we are interested in one force only. Net force is obviously zero. Like power of the engine of the car.

Efficiency

- Efficiency is the ratio of how much work, energy or power we get out of a system compared to how much is put in.

$$\text{efficiency} = \frac{\text{useful output}}{\text{total input}} \qquad \text{eff} = \frac{W_{out}}{W_{in}} = \frac{E_{out}}{E_{in}} = \frac{P_{out}}{P_{in}}$$

- No units
- Efficiency can be expressed as percentage by multiplying by 100%.
- No real machine or sysem can ever be 100% efficient, because there will always be some energy changed to heat due to friction, air resistance or other causes.

A car engine has an efficiency of 20 % and produces an average of 25 kJ of useful work per second.
How much energy is converted into heat per second.

$$\text{eff} = \frac{E_{out}}{E_{in}}$$

$$0.2 = \frac{25000\text{J}}{E_{in}} \qquad E_{in} = 125000\ \text{J}$$

heat = 125 kJ – 25 kJ = 100 kJ