PHYSICS: LESSON 1-2 HEAT CAPACITY

Energy and Power
能量 功率

Power is the rate of energy transferred

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}} \Rightarrow P = \frac{E}{t} = \frac{Q}{t}$$ ← heat energy

energy unit : Joule (J)

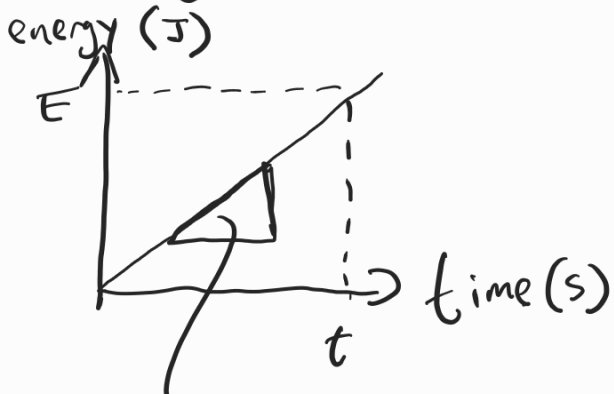
power unit : Joule per second (J/s) or Watt (W)

Example: Electric kettle is 1500W. Energy used after 3 min?

$1500\,W = 1500\,J/s$ $\quad 1500 \times 60 \times 3 = 27{,}000\,J$

$= 27\,kJ$

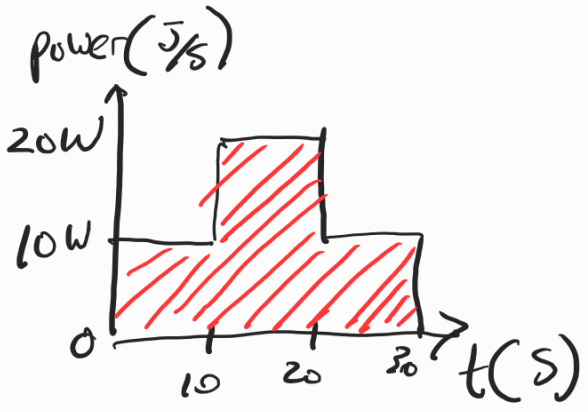
Graphs



gradient = $\frac{E}{t}$ = Power

↑

straight line
same gradient
power is constant



Total energy is the area under the graph

↑

First 10s : power 10W
Next 10s : power 20W
final 10s : power 10W

Heat Capacity

Heat Capacity (C) is the energy required to raise the temperature of a body by 1°C

$$E = C\Delta T \quad \text{or} \quad C = \frac{E}{\Delta T}$$

E: Energy, C: Heat Cap., ΔT: Change of temp

unit: J/°C

Specific Heat Capacity (c) is the energy required to raise the temperature of a 1 kg body by 1°C

$$E = mc\Delta T \quad \text{and} \quad C = mc$$

c: Specific Heat Capacity. Unit is $J\,kg^{-1}\,°C^{-1}$

Specific Heat Capacities of different material

water: $4200\ J\,kg^{-1}\,°C^{-1}$ copper: $390\ J\,kg^{-1}\,°C^{-1}$

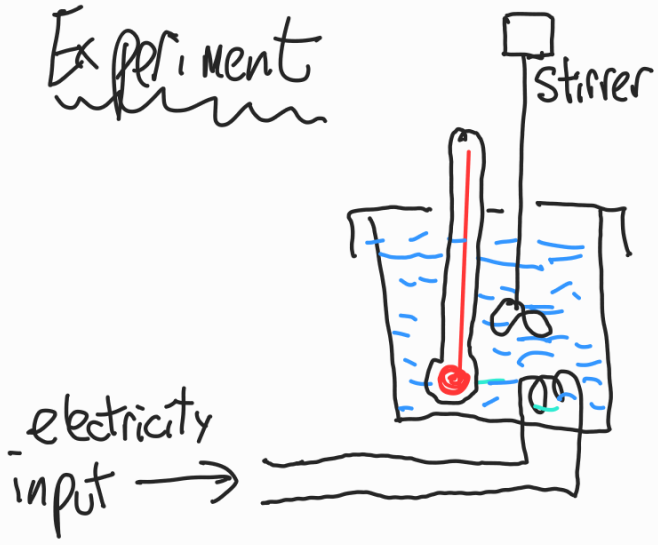
Example: Find the time required to boil 0.6 kg of water from 25°C to 100°C by a 1200 W kettle. Neglect heat loss. SHC of water is $4200\ \frac{J}{kg\,°C}$

$E = mc\Delta T$ or $Pt = mc\Delta T$

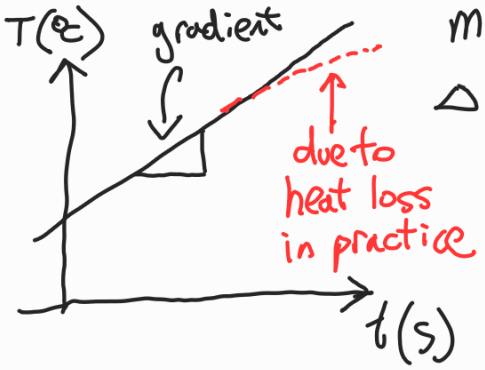
$1200 \times t = 0.6 \times 4200 \times (100 - 25)$

Answer: $t = 173\,s$

Experiment



Heat Up (apply electricity)

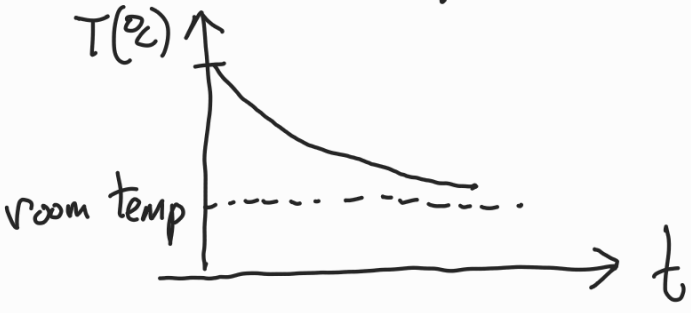


$E = Pt = mc\Delta T$

$\frac{Pt}{mc} = \Delta T$

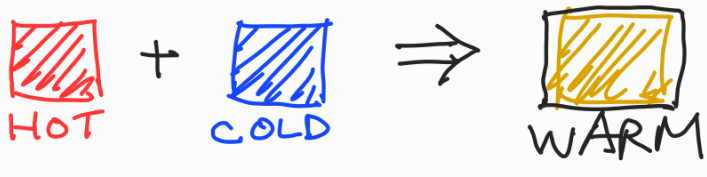
$\Delta T = \left[\frac{P}{mc}\right] \times t$ (gradient)

Cooling Down (disconnect electricity)



The decrease in temp slows down, because the rate of heat transfer depends on the difference of the two temperatures.

Temperature of a Mixture

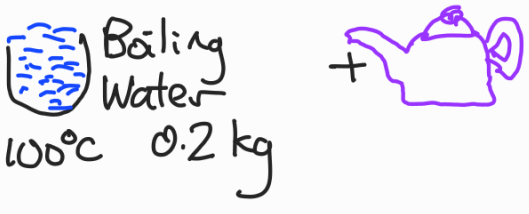


Energy: HOT → COLD

(energy loss) = (energy gain)

$c = 230\ J/°C$

EXAMPLE



Heat released by boiling water $E_1 = m_1 C_1 \Delta T = 0.2 \times 4200 \times (100 - T)$

Heat absorbed by teapot $E_2 = C_2 \Delta T = 230 \times (T - 25)$

Since $E_1 = E_2$, we get $0.2 \times 4200 \times (100 - T) = 230 \times (T - 25)$

result $T = \underline{83.9°C}$

END OF PART 2