§6-4 Power + Efficiency

Power is the rate at which work is done:

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

Where P is the power (J/s or $W \rightarrow$ watt)

W is the work done (J)

Δt is the time to do the work (s)

MP 263

$W = 1.50 \times 10^5 J$

$\Delta t = 10.0 s$

$P = ?$

$P = \frac{W}{\Delta t}$ ← symbol for work

$P = \frac{1.50 \times 10^5 J}{10.0 s}$

$P = 1.50 \times 10^4 W$ ← unit → watt

MP 264

$m = 60.0 kg$

$h = 4.00 \times 10^2 m$

$\Delta t = 1.00 min$ $(60.0 s)$

a) $W = ?$

b) $P = ?$

a) $W = \Delta E_g$ or $W = F_{||} \Delta d$ ($F_{||} = mg$)

$W = E_{g_2} - E_{g_1}$ ($E_{g_1} = 0$)

$W = E_{g_2}$

$W = mgh$

$W = (60.0 kg)(9.81 m/s^2)(4.00 \times 10^2 m)$

$W = 2.35 \times 10^5 J$

b) $P = \frac{W}{\Delta t}$

$P = \frac{2.35 \times 10^5 J}{60.0 s}$

$P = 3.92 \times 10^3 W$

or $3.92 kW$

A note about units:

$1000 W \cdot 3600 s = 3600000 J = 3.6 \times 10^6 J$

$kW \cdot h \Rightarrow P\Delta t = W$ or ΔE

↑ unit on your NS "Power" bill

What you are really paying for is the energy not the power

Efficiency

$$\text{Efficiency} = \frac{E_{output}}{E_{input}} \times 100\%$$

MP|269

$E_{input} = 3.50 \times 10^3\ J$

$m = 0.500\ kg$

$h = 1.00 \times 10^2\ m$

$E_{output} = E_g$

Efficiency = ?

$E_g = mgh$

$E_g = (0.500\ kg)(9.81\ m/s^2)(100\ m)$

$E_g = 490.5\ J$

E_{output}

$$\text{Efficiency} = \frac{E_{output}}{E_{input}} \times 100\%$$

$$\text{Efficiency} = \frac{490.5\ J}{3.50 \times 10^3\ J} \times 100\%$$

Efficiency = 14.0%

The process of converting the chemical potential energy into gravitational potential energy is 14.0% efficient.

TO DO

1. PP|266
2. PP|270-271