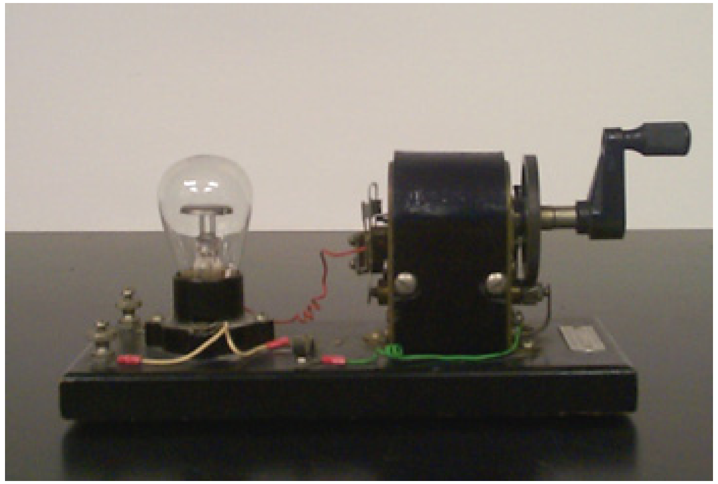
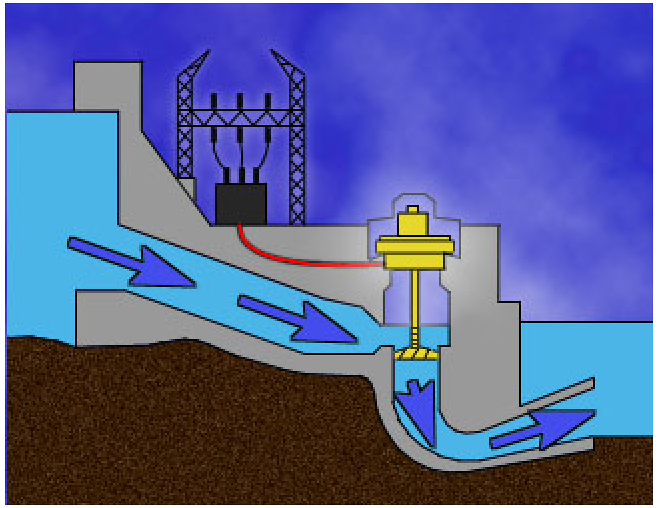
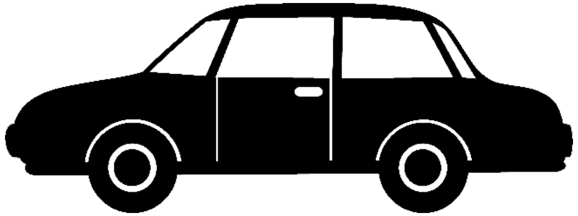
Introduction to Physics I

For Biologists, Geoscientists, & Pharmaceutical Scientists







Tab. 3.2 Beispiele zur Leistung

Kraftwerke	ca. 1000 Megawatt (MW)
Motoren (Flugzeug)	ca. 10 MW
(PKW)	ca. 100 kW
mittlerer Leistungsbedarf eines Bundesbürgers	ca. 6 kW
Glühlampen (ab dem 1. September 2012 Herstellungs- und Vertriebsverbot für $>$10 W)	ca. 100 W
LED (entspricht der Helligkeit einer 17 W Energiesparlampe oder der einer 75 W Glühlampe)	ca. 10 W
Mensch (Höchstleistung für einige s)	ca. 1 kW
(Dauerleistung: Gehen mit 5 km h^{-1})	ca. 70 W
Akustik (Sprechen)	ca. 10 μW
Grenze der Empfindlichkeit für Wärmestrahlungsdetektoren	ca. 1 pW
Hörschwelle des Ohres bei 1000 Hz	ca. 0,1 fW

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Energy

When work W is performed on an object, its energy is increased by:

$$\Delta E = W$$

Energy is "saved" or "stored" work

The two main forms of energy are Kinetic Energy & Potential Energy.

Kinetic Energy

Energy of motion

→ Translation : $E_{kin} = \frac{1}{2} m v^2$

→ Rotation : $E_{kin} = \frac{1}{2} J \omega^2$

Potential Energy

Energy of position or state

→ Gravitational : $E_{pot} = mgh$

→ Elastic : $E_{pot} = \frac{1}{2} D x^2$

→ Chemical : electromagnetic energy from ~~position~~ state of atoms and molecules.

E.g. : burning, batteries

→ Nuclear : energy from state of sub-atomic particles

E.g. : solar energy, nuclear power

→ Electromagnetic : energy due to charge & magnetic dipoles & energy of electromagnetic fields.

E.g. : capacitor, electromagnetic waves

→ Thermal energy : motion of atoms and molecules

↳ Work on friction is transformed into thermal energy

$W = \mu_G m g s$

$\Delta E_{th} = W$

[Exps]

- Infrared camera $ thermal energy
- Balloon : work → elastic pot. energy → kin. energy
- Diode & batteries : chem. pot. energy → electrical pot. → light energy

[Slides]

Power

Power is the derivative of work with respect to time :

$$P = \frac{dW}{dt} \quad \left[\frac{J}{s}\right]$$

$$[W]$$

20 km walking at 5 km/h with 70 W of power ⤳

$$\frac{20\,km}{5\,km/h} \cdot \frac{3600\,s}{1\,h} \cdot 70\,W = 1008\,kJ$$

$$\approx 1\,MJ$$

Same as used by airplane (10 MW) in 0.1 s. –

4 Airplane speed is $900 \frac{km}{h}$.

$$\therefore \quad 0.1s \cdot \frac{1h}{3600s} \cdot 900 \frac{km}{h} = 0.025\,km$$
$$= 25\,m$$

Conservation Laws

Total momentum:

$$\vec{p}_{tot} = \vec{p}_1 + \vec{p}_2 + \dots \vec{p}_n = \text{const.}$$

Total energy:

$$E_{tot} = E_{kin} + E_{pot} + E_{chem} + \dots = \text{const.}$$

Total Angular momentum:

$$\vec{L}_{tot} = \vec{L}_1 + \vec{L}_2 + \dots \vec{L}_n = \text{const.}$$

Total mass:

$$m_{tot} = m_1 + m_2 + \dots m_n = \text{const.}$$