<u>Exercises Group 1:</u>

A) Momentum and Force. Fields of Force.

A1 Braking a vehicle:

A vehicle with a mass of m = 800 kg drives on a straight road at a speed of v = 100 km/h. Calculate the momentum of the vehicle and the mean force that has to be applied to stop the vehicle within a time interval of Δt = 7 s.

A2 Acceleration of an electron:

Assume that a free electron (m_e=9,11*10^{-31} kg, Q = -e) currently has the velocity zero and is in an electric field of strength $\vec{E} =$ (100 N/C) $\vec{e} =$ accelerated. In which direction does the electron begin to move? What speed does it reach after traveling a distance of 1 cm and how long does it take?

A3 Coulomb force and gravitational force:

Two particles of the same kind interact with one another via the Coulomb force and the gravitational force. How large would the ratio of charge to mass have to be, if the amount of the Coulomb force were the same as that of the gravitational force? How big is this ratio for electrons?

B) Work and Power. Energy. Heat and Temperature

B1 normal projection:

Calculate the value of the orthographic projection Fs of the force

$\vec{F} = (1{,}28\ N)\vec{e}_x + (-4{,}13\ N)\vec{e}_y + (0{,}11\ N)\vec{e}_z$

on the direction of displacement $\vec{e}_s = 0{,}71\vec{e}_x + 0{,}63\vec{e}_y - 0{,}31\vec{e}_z$. You can do this using the formula

$F_s = F_x\cos(\alpha_x) + F_y\cos(\alpha_y) + F_z\cos(\alpha_z)$

How is this formula to be justified?

B2 hydropower plant:

(i) Calculate the energy flow that comes with a water throughput of 1 m^3/s at a head of 1 m in a water turbine.
(ii) Assume that around 70% of the primary energy flow is converted into an electrical output of 150 MW in a turbine generator unit. What is the required water throughput at a fall height of 43 m?

<u>Exercises Group 2:</u>

A) Momentum and Force. Fields of Force.

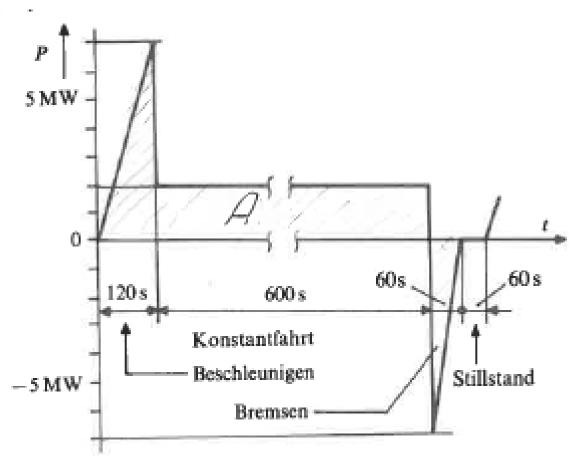
A1 Neutron stars:
The so-called neutron stars have about the mass of our sun (ca. $2*10^{30}$ kg) and a typical diameter of about 20 km. Their mean mass density is roughly that of an atomic nucleus.
(i) How big is the mean mass density?
(ii) According to Newton's law of gravitation, how heavy would a piece of weight with the mass of 1 kg be on the surface of a neutron star?
(iii) How heavy would 1 mm^3 of neutron star matter be on earth and what diameter would an iron ball of the same mass have?

A2 Coulomb interaction of two electrons:
Sketch correctly to scale the course of the magnitude of the force with which two electrons repel each other at distances of $0{,}5*10^{-10}$ m to $5{,}0*10^{-10}$ m according to Coulomb's law.

B) Work and Power. Energy. Heat and Temperature

B1 train set:
For example, the electric drive of a train set consumes the power shown in the figure below during a operational cycle (1 MW = 106 W).

(i) What is the total electrical energy consumed during this operational cycle?
(ii) What is the mean power consumed?



B2 crash test facility:
In a crash test facility, a vehicle including cuts m = 900 kg is accelerated uniformly via an electric linear motor through a distance s = 20 m with a constant force F = 5 kN.

(i) How big is the necessary electrical energy in kWh if all losses are neglected?
(ii) How big is the final speed achieved?

During the subsequent impact process, the vehicle is brought to a standstill within a distance of s = 80 cm.

(iii) What is the mean force that acts on a fictitious seated occupant, m1 = 80 kg?

B3 Connected load of a flow heater:
Suppose you want to design an electric water heater without a storage tank that heats a water flow of 0,1 l/s from 10 °C to 60 °C. What is the minimum required electrical connection power? (specific heat capacity of water c = 4,19 kJ/(kgK)).