Work and Energy

Work done by the force F along distance d is

$$W = F \cdot d \quad \longrightarrow \quad [W] = [E_{kin}] = J$$

Change in kinetic energy and work:

$$\Delta E_{kin} = \frac{m\,v_2^2}{2} - \frac{m\,v_1^2}{2} \quad \longrightarrow \quad \Delta E_{kin} = W_{all\ forces}$$

Change in mechanical energy and work:

$$\Delta E_{pot} = -W_{gravity} \quad \longrightarrow \quad \Delta E_{mech} = W_{except\ gravity}$$

Homework 17

Problem 1.

Using that the change in mechanical energy is equal to the change in kinetic energy plus the change in potential energy and the fact that $\Delta E_{kin} = W_{all\ forces}$, show that the change in mechanical energy equals the work done by all forces except gravity (you may use the notes from our last class).

Problem 2.

A water pump lifts $10\ kg$ of water per second to the water supply tank $10\ m$ over the ground level. What work is performed by the pump per 1 hour?

Problem 3.

Compare the work done by a car's engine to accelerate it from $0\ km/h$ to $20\ km/h$ with the work necessary to accelerate it from $20\ km/h$ to $40\ km/h$.

Problem 4.

Find the work done by the friction force when it stops a $1000\ kg$ car moving at a speed of $72\ km/h$. Having found the work, use it to find braking distance. The friction coefficient is $\mu = 0.4$. *Hint: look up the formula for the friction force.*

Homework 17

Problem 5* (bonus problem).
A beam of charged particles with different masses moves towards a region with constant electric field. It is not important to us here what an electric field is; we only need to know that in that region, a constant force F acts on every particle (in the direction opposite to the initial motion). The width of this region is l. The speed of particles in the beam is the same and equal to v. What minimal mass m_0 should a particle have to get to the other side of the region with the electric field? What will the particle's speed be after it moves out of this region if its mass is m? Consider both the case $m > m_0$ and case $m < m_0$. Gravity could be neglected in this problem.