

- LED light bulbs have been around for over 15 years. They last much longer and are much more energy efficient than the incandescent light bulbs that were used before.

The electric power input into an LED lamp is 10.0 W while the output is 3.0 W radiant power (giving light) plus 7.0 W heat power (warming the lamp and its surroundings).

In the old times, an incandescent light bulb consumed 60.0 W to yield the same brightness as the LED lamp mentioned above.

- What types of energy are transformed from one form to another in a lamp? (*Hint: there are three types.*)
- Which form of energy is the total energy input and which form of energy is useful energy? Which form of energy is considered as «waste»?
- How much power output is extracted from the lamp?
- What is the efficiency of the LED lamp?
- What was the efficiency of an old incandescent light bulb?



- The efficiency of an electric motor is 70.0 %.

- What is the total energy input, if the useful energy output is 460.0 kJ?
- What is the extracted power output, if the power supplied is 50.0 kW?

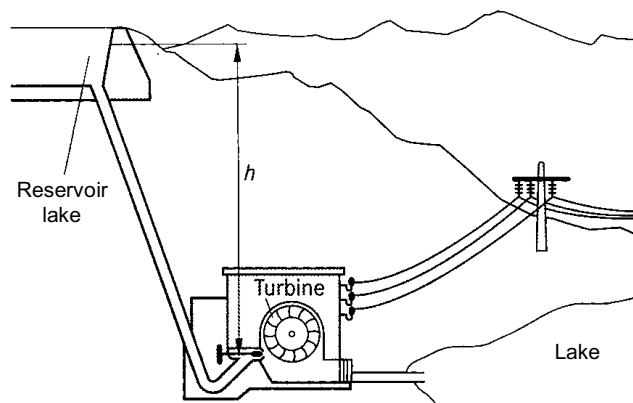
- A crane's electric motor ($\eta = 75\%$) lifts up a load of 400.0 kg ($h = 15.0$ m).

- What types of energy are described here? (*Hint: there are three types.*)
- Which form of energy is the total energy input and which form of energy is useful energy? Which form of energy is considered as «waste»?
- Calculate the amount of work required for lifting the load.
- What is the amount of useful energy?
- What amount of energy input into the motor is required for lifting the load?

- The water collected in a reservoir lake drives a turbine which lies 200.0 m below. The turbine drives a generator which produces an electric current and voltage.

The total extracted power output is 13.00 MW with an efficiency of 90.00 %.

- What types of energy are described here? (*Hint: there are four types.*)
- Which form of energy is the total energy input and which form of energy is useful energy? Which form of energy is considered as «waste»?
- What is the supplied power input?
- How many kg's of water per second flow through the turbine?



- Winston ($m = 60.0$ kg) is walking uphill ($h = 400.0$ m). This takes him an hour ($t = 1.00$ h) ... if only there was an elevator, letting him ride up within 5.00 min ... !!! The elevator of his dreams would have a mass of $m = 100.0$ kg and operate with an efficiency of 72 %.

- What is Winston's power, if he goes uphill walking by foot?
- What would be the work done on the elevator (incl. Winston), for one ride up?
- What would be the useful energy output of the elevator for one ride up?
- What would be the extracted power output of the elevator for one ride up?
- How much energy input is needed for one ride up on the elevator?
- How much chocolate does Winston need to eat to walk up on foot? (100 g of chocolate contain 2'180 kJ of energy, $\eta_{\text{Winston}} = 35\%$)

6. A solar panel converts light (radiant energy) into electrical energy. The efficiency is about 15 %. The gained electrical energy is used for powering an LED light bulb ($\eta = 30.0 \%$). Assume the energy input into the solar panel is 4.90 MJ.
- What is the electrical energy gained by the solar panel?
 - What is the radiant energy (light) emitted by the LED light bulb?
 - Calculate the total efficiency of the combined devices.
7. A car of mass $m = 1.200 \text{ t}$ is travelling horizontally at a constant velocity of $120 \frac{\text{km}}{\text{h}}$ on a highway, covering a distance of 21.0 km. The coefficient of rolling resistance is $C_{rr} = 0.022$, and the air resistance exerts a force of 516 N. Doing this, the engine consumes 1.52 ℓ of gasoline (one liter of gasoline contains 35.0 MJ of energy.)
- What types of energy are described here? (*Hint*: there are three types.)
 - Which form of energy is the total energy input and which form of energy is useful energy? Which form of energy is considered as «waste»?
 - What is the force applied by the motor?
 - What is the work done by the motor?
 - What is the useful energy output?
 - What is the useful energy output per liter of gasoline?
 - What is the energy input per liter of gasoline?
 - Determine the efficiency.

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| 1. c) 3.0 W | d) 30 % | e) 5.0 % | | | |
| 2. a) 657 kJ | b) 35.0 kW | | | | |
| 3. c) 58.9 kJ | d) 58.9 kJ | e) 78 kJ | | | |
| 4. c) 14.44 MW | d) 7362 kg | | | | |
| 5. a) 65.4 W | b) 628 kJ | c) 628 kJ | d) 2.09 kW | e) 872 kJ | f) 30.9 g |
| 6. a) $7.4 \cdot 10^5 \text{ J}$ | b) $2.2 \cdot 10^5 \text{ J}$ | c) 4.5 % | | | |
| 7. c) 0.78 kN | d) 16 MJ | e) 16 MJ | f) 11 MJ | g) 35 MJ | h) 31 % |