Worked Example: Energy Content of Gasoline

Problem. Suppose a person could magically convert the chemical energy of gasoline directly into useful mechanical energy. This person drinks 0.5 liter of gasoline and bikes at a constant speed of 10 km/h which requires an average mechanical power of 100 W. How long could the cyclist ride using the energy from **0.5 liter** of gasoline? Does your answer surprise you? Why? Gasoline has an energy content of approximately

$$E = 3 \times 10^7 \text{ J/L}.$$

Solution.

1. **Energy in 0.5 liter of gasoline**

   The energy content is already given per liter:

$$E_{=} 0.5 \times 3 \times 10^7 \text{ J} = 1.5 \times 10^7 \text{ J}.$$

2. **How long can we bike?**

   Power is defined as energy per unit time:

$$P = \frac{E}{t}.$$

   Solving for time,

$$t = \frac{E}{P}.$$

   Substituting values,

$$t = \frac{1.5 \times 10^7 \text{ J}}{100 \text{ J/s}} = 1.5 \times 10^5 \text{ s}.$$

   Converting seconds to hours,

$$t = \frac{1.5 \times 10^5}{3600} \approx 42 \text{ h}.$$

Interpretation.

Using the energy in just **one liter of gasoline**, a cyclist traveling at 15 km/h could ride for nearly **4 days continuously**. This illustrates how energy-dense chemical fuels are compared to human metabolic power. The answer is surprising because we assumed an efficency of 100% for human body. In reality, the human body is only about 20-25% efficient at converting food energy into mechanical work, so the actual riding time would be significantly less.