Energy Estimate: Biking on One Gallon of Gasoline

Problem

If the human body could use gasoline as an energy source, how far could a person bicycle at a constant speed of $15\,\text{km/h}$ using $1\,\text{gallon}$ of gasoline?

Given Information

- 1 gallon of gasoline ≈ 3 kg $= 3000$ g

- Energy content of gasoline:
$$1 \text{ g gasoline} \approx 40 \text{ kJ} = 4.0 \times 10^4 \text{ J}$$

- Cycling power at $15\,\text{km/h}$:
$$P \approx 500 \text{ W}$$

Total Available Energy

$$E_{\text{in}} = 3000 \text{ g} \times 4.0 \times 10^4 \ \frac{\text{J}}{\text{g}}$$
$$= 1.2 \times 10^8 \text{ J}$$

Time of Cycling

Power is energy per unit time:
$$P = \frac{E}{t} \quad \Rightarrow \quad t = \frac{E}{P}$$

$$t = \frac{1.2 \times 10^8 \text{ J}}{500 \text{ J/s}}$$
$$= 2.4 \times 10^5 \text{ s}$$

Convert seconds to hours:
$$t = \frac{2.4 \times 10^5}{3600}$$
$$\approx 6.7 \times 10^1 \text{ h} \approx 65 \text{ h}$$

Distance Traveled

$$d = vt$$
$$= (15 \text{ km/h})(65 \text{ h})$$
$$\approx 9.8 \times 10^2 \text{ km} \approx 1000 \text{ km}$$

Efficiency Correction

Human mechanical efficiency is approximately

$$e \approx 25\%$$

Thus, the realistic distance is

$$d_{\text{actual}} = e\,d$$
$$= 0.25 \times 1000 \text{ km}$$
$$\approx 250 \text{ km}$$

Final Answer

$$\boxed{d \approx 250 \text{ km}}$$