ESTIMATING GLOBAL ENERGY USE

(A)

pre-industrial

$m_{wood} \approx f \text{ kg / day} \times \text{person}$

$E_{wood} \approx 15\times10^{3} \text{ kJ / kg}$

$N_{people}^{(1800)} \approx 1\times10^{9} \text{ people}$

$$E_{1800} \approx m_{wood} \times E_{wood} \times N_{people}^{(1800)}$$

$$\approx \frac{f \text{ kg wood}}{\text{day} \times \text{person}} \times \frac{15\times10^{3} \text{ kJ}}{\text{kg wood}} \times 1\times10^{9} \text{ people}$$

$$\approx f\times10^{14} \text{ kJ /day} \approx 10^{16} \text{ kJ/year}$$

(B)

contemporary

$V_{gasoline} \approx 10 \text{ L / day} \times \text{person}$

$E_{gasoline} \approx 45\times10^{3} \text{ kJ / L}$

$N_{people}^{(2020)} \approx 8\times10^{9} \text{ people}$

$$E_{2020} \approx V_{gasoline} \times E_{gasoline} \times N_{people}^{(2020)}$$

$$\approx \frac{10 \text{ L gasoline}}{\text{day} \times \text{person}} \times \frac{45\times10^{3} \text{ kJ}}{\text{L gasoline}} \times 8\times10^{9} \text{ people}$$

$$\approx f\times10^{15} \text{ kJ /day} \approx 10^{18} \text{ kJ/year}$$

(C)

ESTIMATING EXPONENTIAL GROWTH RATE OF ENERGY USE

$$E_{total} \approx 10^{16} \text{ kJ} \times (50 + 70 + \ldots + 1670) \approx 6 \times 10^{19} \text{ kJ}$$