

#63276 Chemistry, General Chemistry

Chapter 10 (10.122)

The metabolism of glucose, $C_6H_{12}O_6$, yields carbon dioxide, $CO_{2(g)}$, and water, $H_2O_{(l)}$, as products. Energy released in this metabolic process is converted to useful work, w , with about 66.0 % efficiency. Use the data below to answer questions about the metabolism of glucose.

Substance ΔH°_f (kJ/mol)

$CO_{2(g)}$ -393.5

$C_6H_{12}O_{6(s)}$ -1273.3

$H_2O_{(l)}$ -285.8

$O_{2(g)}$ 0

1) Calculate the mass of glucose metabolized by a 46.2 kg person in climbing a mountain with an elevation gain of 1810 m. Assume that the work performed in the climb is four times that required to simply lift 46.2 kg by 1810 m.

Answer:

Work is equal to: $W = mgh$,

where m - mass of person in kg,

$g = 9.80 \text{ m/s}^2$

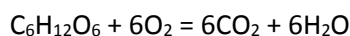
h - height, m.

$W = 46.2 \text{ kg} \cdot (9.80 \text{ m/s}^2) \cdot 1890 \text{ m} = 8.5 \times 10^5 \text{ kg} \cdot \text{m}^2/\text{s}^2 = 8.5 \times 10^6 \text{ J}$.

Actual work performed = $4W = 4 \cdot 8.5 \times 10^5 \text{ J} = 34.2 \times 10^5 \text{ J}$

Molar mass glucose is 180.16 g/mol

Standard enthalpy of combustion of glucose is:



$$\Delta H^\circ(C_6H_{12}O_6) = (6 \cdot \Delta H^\circ(CO_2) + 6 \cdot \Delta H^\circ(H_2O)) - 6 \cdot \Delta H^\circ(O_2) = (6 \cdot (-393.5) + 6 \cdot (-285.8)) - ((6 \cdot 0) + (-1273.3)) = -2801 \text{ kJ/mol}$$

Moles glucose required = $(34.2 \times 10^5 \text{ J}) / (2801000 \text{ J/mol}) = 1.22 \text{ mol}$ of glucose

Mass glucose = $1.22 \text{ mol} \cdot 180.16 \text{ g/mole} = 220 \text{ g}$ of glucose required to do the work.

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