#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 m/s^2
h – heigh, m.
W = 46.2 kg ·(9.80 m/s^2)·1890 m = 8.5 x 10^5 kg·m^2/s^2 = 8.5 x 10^6 J.
Actual work performed = 4W = 4· 8.5 x 10^5 J = 34.2 x 10^5 J

Molar mass glucose is 180.16 g/mol
Standard enthalpy of combustion of glucose is:

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

Moles glucose required = (34.2 x 10^5 J)/(2801000 J/mol) = 1.22 mol of glucose
Mass glucose = 1.22 mol · 180.16 g/mole = 220 g of glucose required to do the work.