Thermochemistry Whiteboard Challenge

No notes or booklets allowed!

Glucose ($C_6H_{12}O_6$) can be formed in the cells of green plants through an endothermic reaction of carbon dioxide and water. This process, known as photosynthesis, occurs using energy provided by the sun.

$$2{,}800\ kJ + 6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$$

a) In the process of photosynthesis, which requires a greater magnitude of energy: breaking bonds or forming bonds? ~~How can you tell?~~ Explain.

endothermic

Bond breaking, because $+\Delta H_{rxn}$, so energy input to break bonds must be greater than energy released making bonds.

b) What is the enthalpy value for photosynthesis, ΔH_{rxn}, in kJ/mol?

$$\Delta H_{rxn} = +2{,}800\ kJ/mol_{rxn}$$

c) How much heat would be absorbed or released if 1.72 g of carbon dioxide reacted with excess water? Assume 100% of the carbon dioxide reacts.

2 s.f.

$$1.72\ g\ CO_2 \times \frac{1\ mol\ CO_2}{44.01\ g\ CO_2} \times \frac{2{,}800\ kJ}{6\ mol\ CO_2} = \boxed{18\ kJ\ absorbed}$$

d) If this reaction occurs in a calorimeter, determine the temperature change of the solution. (Assume the total mass of the calorimeter, including the reacting chemicals, is 245 g and the specific heat of solution is 4.18 J/g°C).

$$q_{rxn} = -q_{calor.} = -mC\Delta T$$

$$18{,}000\ J = -(245\ g)\left(4.18\ \frac{J}{g\,^\circ C}\right)\Delta T$$

$$\Delta T = \frac{-18{,}000}{(245)(4.18)} = \boxed{-18\,^\circ C}$$

e) The initial temperature of the solution in the calorimeter is 28.3°C. What would the final temperature be after the reaction?

$$\Delta T = T_f - T_i$$

$$-18 = T_f - 28.3$$

$$T_f = 28.3 - 18 = \boxed{10.\,^\circ C}$$