Answer on Question #79848, Chemistry/ General Chemistry

Find the enthalpy change per mole of sodium when sodium reacts with water. 13 grams of sodium reacts with 247 cm3 of water, producing a temperature change from 298 K to 339.7 K. The specific heat capacity of water is 4.18 J/K g.

Answer

$2Na + 2H_2O \rightarrow 2NaOH + H_2$

$\Delta H_{rxn} = -q$

$q = cm\Delta T$

where

q is amount of heat absorbed/released

c is specific heat of solution (in such calculation an assumption is made that $c_{solution} = c_{water}$)

m is mass of solution

ΔT is temperature change

Find mass of solution:

$m_{solution} = m(H_2O) + m(Na) - m(H_2)$

$m(H_2O) = V(H_2O) \times \rho(H_2O) = 247\ cm^3 \times 1\ g/cm^3 = 247\ g$

$m(Na) = 13\ g$

Find $m(H_2)$:

$n(Na) = m/M = 13g/23\ g/mol = 0.57\ mol.$

According to equation mole ratio $n(Na):n(H_2) = 2:1$, then $n(H_2) = n(Na)/2 = 0.57/2 = 0.29\ mol.$

$m(H_2) = n \times M = 0.29\ mol \times 2g/mol = 0.58\ g$

$m_{solution} = 247\ g + 13\ g - 0.58\ g = 259.42\ g$

$q = 4.18\ J/K\ g \times 259.42\ g \times (339.7\ K - 298\ K) = 45218\ J$

The temperature of solution increased because heat was absorbed by the solution ($q>0$).

Then $\Delta H_{rxn} = -q = -45218\ J$ per 0.57 mol of Na

Find ΔH_{rxn} per 1 mole of Na

$\Delta H_{rxn} = -45218J/0.57\ mol = -79331\ J/mol \cong -79\ kJ/mol$

Answer: -79 kJ/mol