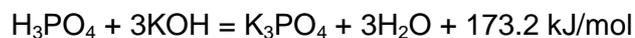200 mL of a 2.5 mol/L solution of phosphoric acid reacts with 300 mL of a 3.0 mol/L solution of a potassium hydroxide. The reaction occurs in a glass calorimeter of mass 1000 g. Calculate the energy released and the temperature change which the calorimeter will undergo.

Answer:

$H_3PO_4 + 3KOH = K_3PO_4 + 3H_2O + 173.2$ kJ/mol

$C_M = v/V$ $v = C_M \cdot V$

v $(H_3PO_4) = 2.5 \cdot 0.2 = 0.5$ mol

v $(KOH) = 3.0 \cdot 0.3 = 0.9$ mol

However, according to the equation, the required amount of KOH is: v (KOH) $_{need} = 0.5 \cdot 3 = 1.5$ mol

The real amount of KOH is less. That is why, KOH is a limiting reagent for the reaction. The amount of K_3PO_4 formed must be calculated from this value.

v $(K_3PO_4) = 0.9/3 = 0.3$ mol

$Q_{reaction} = 173.2 \cdot 0.3 = 51.96$ kJ = 51 960 J

$Q = c \cdot m \cdot \Delta T$

$\Delta T = Q/ (c \cdot m)$

c (glass) = 0.840 J/g·ºC

$\Delta T = 51\ 960/ (0.840 \cdot 1000) = 61.857$ ºC