Answer on Question #63401 - Chemistry - General Chemistry

Question:

A block of copper weighing 14.9 g is heated to 64.7 °C in boiling methanol. It is then dropped into 33.2 g of methanol initially at 21.7 °C. Find the final temperature of copper + methanol in °C.

Solution:

Let's describe the process in words. A copper block at 64.7 °C gives certain amount of heat to cold methanol and cools down to some temperature T_1. The cold methanol at 21.7 °C absorbs exactly that amount of heat from copper and heats up to the same temperature T_1. And now come to formulas.

The substance temperature change $T_1 - T_0 = \pm H/C*m$, where T_0 and T_1 - initial and final temperature of substance (K), H absolute value of amount of heat transferred to/from substance (J), C- specific heat of substance (J/gK), m – mass of substance (g). We use "plus" sign in case of heating, and "minus" in case of cooling.

Than for copper: $T_1 = T_{0Cu} - H / (C_{Cu} * m_{Cu})$;   (1)

For methanol: $T_1 = T_{0Me} + H / (C_{Me} * m_{Me})$;   (2)

Let's express H from the first equation:

$H = (T_{0Cu} - T_1) * (C_{Cu} * m_{Cu})$;   (3)

and put it to the second:

$T_1 = T_{0Me} + ((T_{0Cu} - T_1) * (C_{Cu} * m_{Cu}) / (C_{Me} * m_{Me}))$ (4)

The specific heat of copper (C_{Cu}) is 0.385 J/gK, of methanol (C_{Me})– 2.14 J/gK (https://en.wikipedia.org/wiki/Heat_capacity).

So $(C_{Cu} * m_{Cu}) / (C_{Me} * m_{Me}) = (0.385 * 14.9) / (2.14 * 33.2) = 0.081$.

Than equation (4) will look like this:

$T_1 = T_{0Me} + 0.081(T_{0Cu} - T_1)$ (5)

Now find T_1:

$T_1 = T_{0Me} + 0.081T_{0Cu} - 0.081T_1$ (6)

$T_1 + 0.081T_1 = T_{0Me} + 0.081T_{0Cu}$ (7)

$1.081\ T_1 = T_{0Me} + 0.081T_{0Cu}$ (8)

And finally

$T_1 = (T_{0Me} + 0.081T_{0Cu}) / 1.081$ (9)

Do the calculation:

(to convert °C to K we have to add 273.15)

$T_1 = ((21.7+273.15) + 0.081(64.7+273.15)) / 1.081 = (294.85 + 0.081 * 337.85) / 1.081 = 298.07$ K or $(298.07-273.15) = 24.9$ °C.

Answer:

The final temperature of copper + methanol is 24.9 °C.