Question #70891

A 2.50-kg block of hot iron (cFe= 0.45 J/g K; Tin= 300 C) is dropped in cold water (Tin=20 C) to cool quickly. How much heat needs to be absorbed to cool the iron block to 25 C? How much cold water will be needed? What will happen if 10.0 L of cold water are used?

Solution

1) $Q = cm\Delta T$

Q – heat absorbed or emitted, J;
c – specific heat capacity, J/g K;
m – mass, g;
ΔT – change of temperature.

$Q = 0.45 \times 2500 \times (300-25) =$ **309 375 (J)** – heat needed to be absorbed to cool the iron block to 25 C.

2) $m = \frac{Q}{c\Delta T}$, $c(H_2O) = 4.2$ J/g K;

$m = \frac{309\,375}{4.2\times(25-20)} =$ **14 732 (g)** or **14.732 (kg)** – mass of cold water needed to cool the iron block to 25 C.

3) The heat emitted by iron is equal to the heat absorbed by water and the final temperature of iron cooled and water heated is the same.
$c_1m_1\Delta T = c_2m_2\Delta T$

$c_1m_1(300-T) = c_2m_2(T-20)$

$300c_1m_1 - c_1m_1T = c_2m_2T - 20c_2m_2$

$300c_1m_1 + 20c_2m_2 = c_2m_2T + c_1m_1T$

$300c_1m_1 + 20c_2m_2 = (c_2m_2 + c_1m_1)T$

$T = \frac{300c_1m_1 + 20c_2m_2}{c_2m_2 + c_1m_1}$

$T = \frac{300\times0.45\times2500+20\times4.2\times10000}{4.2\times10000+0.45\times2500} = \frac{337500+840000}{42000+1125} = \frac{1177500}{43125} =$ **27.3 (C)** – if 10.0 L of cold water are used, iron block will be cooled to 27,3 C.

Answer

309 375 (J) – heat needed to be absorbed to cool the iron block to 25 C.
14.732 (kg) – mass of cold water needed to cool the iron block to 25 C.
Iron block will be cooled to **27,3 C**, if 10.0 L of cold water are used.

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