Heat Capacity

Name: Answer Key

Discussion Study Sheet

Student ID:

Chem 192
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Date:

Important Formulas:

$$Q = M \bullet Cp \bullet \Delta T$$

$$\Delta T = T_{final} - T_{initial}$$

1. A 20.0 gram piece of metal at 203˚C is dropped into 100.0 g of water at 25˚ C. The water temperature rises to 29.0 ˚C. Calculate the specific heat of the specific heat of the metal.

WATER

$C_p = 4.184\ J/g°C$
$m = 100.0\ g$
$T_F = 29.0°C$
$T_I = 25$
$\Delta T = 4\ °C$

WATER

Heat Gained $= Q = m \cdot C_p \cdot \Delta T$
$= 100.0g \cdot 4.184\ J/g°C \cdot 4°C$
$= 1673.6\ J = 2\times10^3\ J$

METAL

$C_p = ?$
$m = 20.0g$
$T_F = 29.0°C$
$T_I = 203\ °C$
$-174\ °C$

METAL

Heat Lost $= -Q = m \cdot C_p \cdot \Delta T$
$-2\times10^3\ J = 20.0g \cdot C_p \cdot -174°C$
$C_p = \frac{-2\times10^3\ J}{20.0g \cdot -174°C} = 0.6\ J/g°C$

2. Heating 30.0 grams of water from 20.0˚C to 50.0˚C requires how many calories of heat?

$C_p = 4.184\ J/g°C$
$m = 30.0g$
$T_F = 50.0°C$
$T_I = 20.0°C$
$\Delta T = 30.0°C$

$Q = m \cdot C_p \cdot \Delta T$
$= 30.0g \cdot 4.184\ J/g°C \cdot 30.0°C$
$= 3765.6\ J$
$= 3.77\times10^3\ J$

3. What will the final temperature be when 50.0 grams of water at 10.0˚C are mixed with 10.0 grams of water at 50.0˚C? (assume no heat loss)

WATER #1

$m_1 = 50.0g$

$T_{F_1} = X$

$T_{I_1} = 10.0°C$

WATER #2

$m_2 = 10.0g$

$T_{F_2} = X$

$T_{I_2} = 50.0°C$

WATER #1 = WATER #2

Heat gained = Heat lost

$Q_1 = -Q_2$

$C_{pw} \cdot m_1 \cdot \Delta T_1 = -(C_{pw} \cdot m_2 \cdot \Delta T_2)$

$-\frac{m_1}{m_2} \cdot \Delta T_1 = \Delta T_2$

$-\frac{50.0g}{10.0g} \cdot (T_{F_1} - T_{I_1}) = T_{F_2} - T_{I_2}$

$-5.00 \cdot (X - 10.0°C) = X - 50.0°C$

$-5.00X + 50.0°C = X - 50.0°C$

$100.0°C = 6.00X$

$X = \frac{100.0°C}{6.00} = 16.7°C$

4. A 40.0 gram sample of unknown pure metal was heated to 62.0 ˚C and put into an insulated container with 85.0 grams of water at 19.2 ˚C. The water was heated by the hot metal to a ~~a~~ temperature of 21.0 ˚C.

(a) What is the specific heat of the metal?
(b) Could this metal be gold?

WATER

$C_{pw} = 4.184 J/g°C$

$m_w = 85.0g$

$T_{F_w} = 21.0°C$

$T_{I_w} = 19.2°C$

$\Delta T = 1.8°C$

METAL

$C_{pm} = ?$

$m_m = 40.0g$

$T_{F_m} = 21.0°C$

$T_{I_m} = 62.0°C$

$-41.0°C$

WATER

Heat Gained $= Q = C_{pw} \cdot m_w \cdot \Delta T_w$

$= 4.184 J/g°C \cdot 85.0g \cdot 1.8°C$

$= 640.152 J$

$= 6.4 \times 10^2 J$

METAL

Heat Lost $= -Q = C_{pm} \cdot m_m \cdot \Delta T_m$

$-6.4 \times 10^2 J = C_{pm} \cdot 40.0g \cdot (-41.0°C)$

$C_{pm} = \frac{-6.4 \times 10^2 J}{40.0g \cdot -41.0°C}$

(A) $C_p = 0.39 J/g°C$

(B) The Cp of gold is 0.13 J/g°C — this cannot be gold!