P 141

1)

Lead

$m_1 = 50_g$

$C_1 = 0.16$

$T_{i_1} = 200$

$T_{f_1} = 15$

$\Delta T_1 = -185°C$

Loses heat

Antifreeze

$m_2 = ?$

$c_2 = 2.20$

$T_{i_2} = 5$

$T_{f_2} = 15$

$\Delta T = 10°C$

Absorbs heat

$$-Q = Q$$

$$-m_1 c_1 \Delta T_1 = m_2 c_2 \Delta T_2$$

$$-(50)(0.16)(-185) = m_2 (220)(10)$$

$$\frac{-(50)(0.16)(-185)}{(2.20)(10)} = m_2$$

$$67.27_g = m_2$$

#2)

Concrete → Looses Heat Energy

$m_1 = 1\,ton = 1000kg = 1000000g$

$T_{f_1} = 20°C$
$T_{i_1} = 35°C$ } $\Delta T_1 = -15°C$

$c_2 = 2.10$

Water → Gains Heat energy

$m_2 = ?$

$T_{f_2} = 20°C$
$T_{i_2} = 12°C$ } $\Delta T_2 = 8°C$

$c_1 = 4.18$

$-Q = Q$

$-m_1 c_1 \Delta T_1 = m_2 c_2 \Delta T_2$

$-(1000000)(2.10)(-15) = m_2(4.18)(8)$

$31500000 = 33.44 m_2$

$\frac{31500000}{33.44} = m_2$

$941986g = m_2$

↓

941986mL water

↓

V = ~942L water

3)

Water 1

$m_1 = 100\,kg \rightarrow 100000\,g$

$C_1 = 4.18$

$T_{i_1} = ??$

$T_{f_1} = 40°C$ } ΔT_1

Gains heat

Water 2

$m_2 = 25\,kg \rightarrow 25000\,g$

$C_2 = 4.18$

$T_{i_2} = 60°C$

$T_{f_2} = 40°C$ } $\Delta T_2 = -20°C$

loses heat

$$-Q = Q$$

$$-m_2 C_2 \Delta T_2 = m_1 C_1 \Delta T_1$$

$$-(25000)(4.18)(-20) = (100000)(4.18)\Delta T_1$$

$$\frac{-(25000)(4.18)(-20)}{(100000)(4.18)} = \Delta T_1$$

$$5°C = \Delta T_1$$

$$\Delta T_1 = T_{f_1} - T_{i_1}$$

$$5 = 40 - T_{i_1}$$

$$T_{i_1} = 35°C$$

4)

Metal Cup

$m_2 = 230g$

$c_2 = ???$

$T_{i_2} = 20°C$

$T_{f_2} = 75°C$

$\Delta T_2 = 55°C$

Gains heat

Water

$m_1 = 100g$

$c_1 = 4.18$

$T_{i_1} = 80°C$

$T_{f_1} = 75°C$

$\Delta T_1 = -5°C$

loses heat

$$-Q = Q$$

$$-m_1 c_1 \Delta T_1 = m_2 c_2 \Delta T_2$$

$$-(100)(4.18)(-5) = 230(c_2)(55)$$

$$\frac{-100(4.18)(-5)}{230(55)} = c_2$$

$$0.165 \frac{J}{g°C} = c_2$$

6)

Oil

$m_2 = 150$

$c_2 = 2.00$

$T_{i_2} = 21.5°C$

$T_f = ?$

Gains Heat (+Q)

Cast Iron

$m_1 = 2500g$

$c_1 = 0.46$

$T_{i_1} = 140°C$

$T_f = ?$

loses Heat (−Q)

Method: A

$$-Q = Q$$

$$-m_1 c_1 (T_f - T_{i_1}) = m_2 c_2 (T_f - T_{i_2})$$

$$-(2500)(0.46)(T_f - 140) = 150(2.00)(T_f - 21.5)$$

$$-1150(T_f - 140) = 300(T_f - 21.5)$$

$$-1150T_f + 161000 = 300T_f - 6450$$

$$6450 + 161000 = 300T_f + 1150T_f$$

$$\frac{167450}{1450} = \frac{1450T_f}{1450}$$

$$115.5°C = T_f$$

6) Method B:

$$T_f = \frac{m_2 c_2 T_{i2} + m_1 c_1 T_{i1}}{m_1 c_1 + m_2 c_2}$$

$$T_f = \frac{(150)(2.00)(21.5) + (2500)(0.46)(140)}{(2500)(0.46) + (150)(2.00)}$$

$$T_f = \frac{6450 + 161000}{1150 + 300}$$

$$T_f = 115.5\,^\circ C$$

7)

Mercury

$m_1 = 2.3g$

$C_1 = 0.1395$

$T_{i1} = 80°C$

$T_f = ?$

Hotter → Loses Heat

Antifreeze

$m_2 = 10g$

$C_2 = 2.20$

$T_{i2} = -5°C$

$T_f = ?$

Colder → Absorbs Heat

METHOD A:

$$-Q = Q$$

$$-m_1C_1(T_f - T_{i1}) = m_2C_2(T_f - T_{i2})$$

$$-(2.3)(0.1395)(T_f - 80) = (10)(2.20)(T_f - (-5))$$

$$-0.3208(T_f - 80) = 22(T_f + 5)$$

$$-0.3208T_f + 25.66 = 22T_f + 110$$

$$-0.3208T_f - 22T_f = 110 - 25.66$$

$$\frac{-22.3208T_f}{-22.3208} = \frac{84.34}{-22.3208}$$

$$T_f = -3.78°C$$

7) METHOD B:

$$T_f = \frac{m_2 c_2 T_{i2} + m_1 c_1 T_{i1}}{m_1 c_1 + m_2 c_2}$$

$$T_f = \frac{10(2.2)(-5) + (2.3)(0.1395)(80)}{(2.3)(0.1395) + (10)(2.2)}$$

$$T_f = \frac{(-110) + (25.67)}{(0.3208) + (22)}$$

$$T_f = -3.78\ ^\circ C$$

#8)

m_{H_2O}: $n = \frac{m}{M}$ $\quad 2.5 = \frac{m}{18\,g/mole}$ $\quad m_{H_2O} = 45g$

m_{CO_2}: $n = \frac{m}{M}$ $\quad 1.8 = \frac{m}{44\,g/mole}$ $\quad m_{CO_2} = 79g$

$m_1 = 45\,g$

$m_2 = 79\,g$

$T_{1i} = 125\,^\circ C$

$T_{2i} = 30^\circ C$

$T_f = ?$

$C_1 = 1.41$ (water vapour)

$C_2 = 0.839$ (carbondioxide)

$$T_f = \frac{m_2 C_2 T_{i2} + m_1 C_1 T_{i1}}{m_1 C_1 + m_2 C_2}$$

$$T_f = \frac{79(0.839)(30) + (45)(1.41)(125)}{(45)(1.41) + 79(0.839)}$$

$$T_f = \frac{1988.43 + 7931.25}{63.45 + 66.281}$$

$$T_f = 76.5\,^\circ C$$

METHOD A:

METHOD B: (H_2O hotter releases) (CO_2 → colder absorbs)

$$-m_1 c_1 \Delta T_1 = m_2 c_2 \Delta T_2$$

$$-m_1 c_1 (T_f - T_{i_1}) = m_2 c_2 (T_f - T_{i_2})$$

$$-(45)(1.41)(T_f - 125) = 79(0.839)(T_f - 30)$$

$$-63.45(T_f - 125) = 66.28(T_f - 30)$$

$$-63.45 T_f + 7931.25 = 66.28 T_f - 1988.4$$

$$1988.4 + 7931.25 = 66.28 T_f + 63.45 T_f$$

$$\frac{9919.65}{129.73} = \frac{129.73 T_f}{129.73}$$

$$76.5°C = T_f$$