$\boxed{13.1}$ 100 g H_2O

$20°C \rightarrow 40°C \Rightarrow \Delta T = 20\,K$

How much heat transmitted?

1 cal = Q to raise 1 g H_2O by 1°C

$\Rightarrow$ here $Q = (1\ \text{cal}/1\,g \cdot 1°C)(100\,g)(20°C)$

$$\boxed{Q = 2\,000\ \text{cal} = 2\ \text{kcal}}$$

$\boxed{13.3}$ 10 g H_2O @ 20°C

How much Q_{out} to lower to 0°C?

$\Delta T = 20°C$

$$Q = \frac{1\ \text{cal}}{g\ °C} \times 10\,g \times -20°C = \boxed{200\ \text{cal removed} = Q}$$

$\boxed{13.5}$ 30 L H_2O

How much ΔT for 500 kcal?

30L = V need mass.

H_2O: 1 g = 1 mL (density)

$$\frac{30\,L}{} \left| \frac{1000\,mL}{1\,L} \right| \frac{1\,g}{1\,mL} = 30{,}000\,g = m$$

$$500 \times 10^3\ \text{cal} = \left(\frac{1\ \text{cal}}{1\,g\ °C}\right)(30{,}000\,g)\Delta T$$

$$\boxed{\Delta T = 16.7\ °C}$$

$\boxed{13.9}$ $100g$ H_2O @ $100°C$ ⟵ ①

added to

$100g$ @ $20°C$ ⟵ ②

What is T_{final}?

Conservation of Energy

$$\Delta Q_1 + \Delta Q_2 = 0$$

$$\Delta Q_1 = m_1 c\,(T_f - T_1)$$

$$\Delta Q_2 = m_2 c\,(T_f - T_2)$$

$$m_1 \cancel{c}\,(T_f - T_1) + m_2 \cancel{c}\,(T_f - T_2) = 0$$

$$m_1 (T_f - T_1) + m_2 (T_f - T_2) = 0$$

$$m_1 T_f - m_1 T_1 + m_2 T_f - m_2 T_2 = 0$$

$$T_f (m_1 + m_2) = m_1 T_1 + m_2 T_2$$

$$T_f = \frac{m_1 T_1 + m_2 T_2}{m_1 + m_2} = \frac{(100g)(100°C) + (100g)(20°C)}{200g}$$

$$\boxed{T_f = 60°C}$$

$\boxed{13.31}$

Al

$c_A = 910\ J/kg \cdot K$

$T_A = 473\ K$

$m_A = ?$

H_2O

$c = 4186\ J/kg \cdot K$ (Table 13.3)

$T_w = 20°C = 293\ K$

$m_w = 4.95\ kg$

— $T_f = 300K$ —

Conservation of Energy

$$\Delta Q_A + \Delta Q_w = 0$$

$$m_A c_A (T_f - T_A) = -m_w c_w (T_f - T_w)$$

$$m_A = \frac{m_w c_w (T_f - T_w)}{c_A (T_f - T_A)} = -\frac{(4.95\ kg)(4186\ J/kg \cdot K)(300K - 293K)}{(910\ J/kg \cdot K)(300K - 473K)}$$

$$\boxed{m_A = 0.92\ kg}$$

$\boxed{13.35}$

	Cu	Olive Oil	Glass
	$m = 200.5\,g$	$m = 118.1\,g$	$m = 84.0\,g$
$\boxed{\text{Table 13.3}}$	$c_c = 0.093\,kcal/kg\cdot K$	$c = 0.471\,kcal/kg\cdot K$	$c_G = 0.2\,kcal/kg\cdot K$
	$T_c = 20°C$	$T_o = 20°C$	$T_G = 300°C$

$$\longleftarrow \quad T_f = ? \quad \longrightarrow$$

$$\Delta Q_c + \Delta Q_o + \Delta Q_G = 0$$

$$\Delta Q_c = m_c c_c \Delta T_c \qquad \Delta Q_o = m_o c_o \Delta T_o \qquad \Delta Q_G = m_G c_G \Delta T_G$$

$$m_c c_c (T_f - T_c) + m_o c_o (T_f - T_o) + m_G c_G (T_f - T_G) = 0$$

$$T_f = \frac{m_c c_c T_c + m_o c_o T_o + m_G c_G T_G}{m_c c_c + m_o c_o + m_G c_G}$$

$$T_f = 72°C$$

$$= \frac{(200.5)(0.093)(20) + (118.1)(0.471)(20) + (84)(0.2)(300)}{(200.5)(0.093) + (118.1)(0.471) + (84)(0.2)}$$

$$\boxed{T_f = 71.7°C}$$

WEEK 2 HW

~~13.55~~, ~~13.57~~, ~~13.59~~, ~~13.65~~, ~~13.87~~
~~14.1~~, ~~14.3~~, ~~14.29~~, ~~14.43~~, ~~14.57~~
~~15.5~~, 15.9, ~~15.11~~
4.11

13.55 $1000\ cm^3$ block of ice @ $0°C$

Q to melt?

$Q = mL_f$ $\qquad m = ?$ $\qquad V = 1000\ cm^3$

$m = \rho V$ $\qquad \rho_{ICE} = 920\ kg/m^3$ (pg. 358)

$L_f = 333.7\ kJ/kg$ (pg. 546)

$$m = \left(920 \frac{kg}{m^3}\right)\left(1000\ cm^3 \times \left(\frac{1\ m}{100\ cm}\right)^3\right)$$

$m = 0.92\ kg$

$Q = (0.92\ kg)(333.7\ kJ/kg) = 307\ kJ$

$$\boxed{Q = 3.07 \times 10^5\ J}$$

13.57 Q needed to melt Cu @ 1356K?

· First heat to melting temp, then melt.

$Q = mc\Delta T$ $\qquad\qquad Q = mL_f$

$T_{melt} = 1083°C = 1356\ K$ (Table 13.6) $\Rightarrow \Delta T = 0$

$Q = mL_f$ $\qquad m = 0.2\ kg$, $L_f = 205\ kJ/kg$

$= (0.2\ kg)(205\ kJ/kg) = \boxed{41\ kJ = Q}$

$\boxed{13.59}$ Initially

ICE

$m_I = ?$

$T = 0°C$

$L_f = 333.7\ kJ/kg$

WATER

$m_W = 0.50\ kg$

$T_W = 20°C$

$c_W = 4.186\ kJ/kg\ K$

Finally

WATER @ 0°C

Ice gains heat: $Q = mL_f$

H_2O loses heat: $Q = mc\Delta T$ $\qquad \Delta T = 0 - 20 = -20\ K$

$$\Delta Q_{ICE} + \Delta Q_{H_2O} = 0$$

$$m_I L_f + m_W c_W \Delta T_W = 0$$

$$m_I = \frac{-m_W c_W \Delta T_W}{L_f} = \frac{-(0.50\ kg)(4.186\ kJ/kg \cdot K)(-20\ K)}{333.7\ kJ/kg}$$

$$\boxed{m_I = 0.125\ kg}$$

$\boxed{13.65}$ Hg: $m = 0.50\ kg$

$c = 138\ J/kg\ K$

$T_i = 240\ K$

Heat to vaporize?

$$Q_{tot} = \underbrace{mc\Delta T}_{\text{raise temp}} + \underbrace{mL_v}_{\text{vaporize}}$$

$T_{boil} = 357°C = 630\ K$ (Table 13.6)

$L_v = 296\ kJ/kg = 296 \times 10^3\ J/kg$

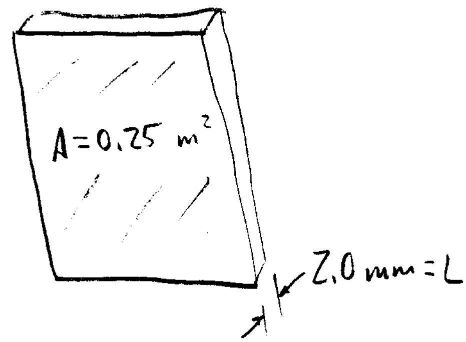
$$Q_{tot} = (0.50\ kg)(138\ J/kg \cdot K)(630 - 240\ K) + (0.50\ kg)(296 \times 10^3\ J/kg)$$

$$= 174910\ J$$

$$\boxed{Q = 175\ kJ}$$

$\boxed{13.87}$

$k_T = 0.80 \ W/m \cdot K$



$T_{OUT} = -18°C$

$T_{IN} = 21°C$

What is Q/sec ?

H = heat transferred per time:

$$= -k_T A \frac{\Delta T}{L} = \frac{-(0.80 \ W/m \cdot K)(0.25 \ m^2)(-18 - 21 \ K)}{0.002 \ m}$$

$$\boxed{H = 3900 \ W = 3.9 \ kW}$$

So 3.9 kJ per second heat is transferred