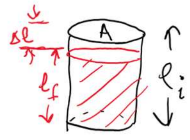
Q1 M1-122-11

Water at 90.0°C fills a Pyrex tube (radius=2.00 cm, height=12.0 cm) to the rim. If we ignore the expansion of the Pyrex tube, what will be the height of water if it is cooled to 10.0°C. (The coefficient of volume expansion of water is 207×10^{-6} C°)

A) 11.8 cm
B) 10. 4 cm
C) 10. 9 cm
D) 9.00 cm
E) 9.70 cm



$\Delta V = \beta V \Delta T$

$V = \text{length} \times \text{area} = l A$ ← does not change

$\Delta(l A) = \beta l A \Delta T$

$(\Delta l) A = \beta l A \Delta T$

$\Delta l = 207\times10^{-6}(12)(10-90) = -0.199$ cm

$\Delta l = l_f - l_i \Rightarrow l_f = \Delta l + l_i = -0.199 - 12.0 = 11.8$ cm.

Q2 M1-132-09

What is the change in area (in cm^2) of a 60.0 cm × 150 cm (width × height) glass plate when its temperature increases by 65.0 F°. The coefficient of volume expansion of glass is 2.70×10^{-5}/C°.

A) 5.85
B) 19.3
C) 3.24
D) 14.9
E) 8.62

$\Delta A = 2\alpha A \Delta T$

$\Delta A = 2\left(\frac{\beta}{3}\right) A \Delta T$

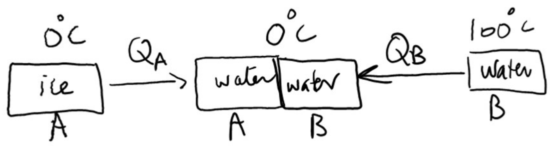
$\Delta A = 2\left(\frac{2.7\times10^{-5}}{3\ C°}\right)(60\ cm)(150\ cm)(65\ F°)\left(\frac{5C°}{19F°}\right)$

$\Delta A = 5.85\ cm^2$

Q3 M1-112-09

A block of ice, with a mass of 6.30 kg at 0.00 °C, is added to a certain amount of water. The water is cooled from 100 to 0.00 °C. What is the mass of water used? Assume that all the ice melted.

A) 5.01 kg
B) 2.04 kg
C) 3.42 kg
D) 1.50 kg
E) 6.05 kg



$Q_A + Q_B = 0$

$m_A L_f + m_B c_w (T_f - T_i) = 0$

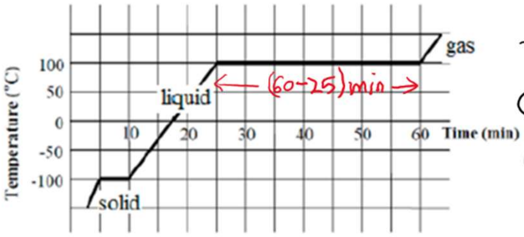
$m_B = \frac{-m_A L_f}{c_w(T_f - T_i)} = \frac{-(6.3\ kg)(333\times10^3\ J/kg)}{4.19\times10^3 \frac{J}{kg\,C°}(0°C - 100°C)}$

$m_B = 5.01$ kg

Q4 M1-142-11

When 200 W is supplied continuously to an isolated object of mass 0.400 kg, its phase changes from solid to liquid, and finally to gas as shown in the figure. What is the latent heat of vaporization, in J/kg, of the object?

A) 1.05×10^{6}
B) 2.00×10^{6}
C) 1.52×10^{7}
D) 2.35×10^{6}
E) 5.50×10^{6}



time = (60 - 25) min = 2100 s

Q = Energy = Power × time

$Q = 200 \times 2100\,J = 0.420\times10^{6}\,J$

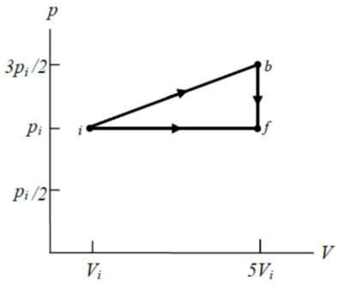
$L_v = \frac{Q}{m} = \frac{0.420\times10^{6}\,J}{0.400\,kg}$

$L_v = 1.05\ J/kg$

Q5 M1-122-09

A sample of a gas undergoes a transition from an initial state i to a final state f by two different paths, if and *ibf*, as shown in the figure. The energy transferred to the gas as heat along the path if is 10 p_iV_i. Find the change in internal energy of the gas for the path *ibf*.

A) 6 p_iV_i
B) p_iV_i
C) (3/2) p_iV_i
D) 10 p_iV_i
E) (5/2) p_iV_i



$\Delta E_{ibf} = \Delta E_{if}$ independent on path

$W_{if} = P_i(5V_i - V_i) = 4P_iV_i$

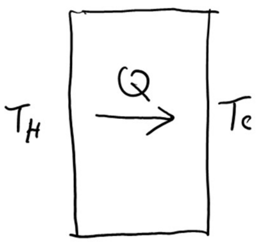
$\Delta E_{if} = Q_{if} - W_{if}$

$\Delta E_{ibf} = 10P_iV_i - 4P_iV_i = 6P_iV_i$

Q6 M1-112-10

Consider a copper slab of thickness 19 cm and cross sectional area 5.0 m². Heat is conducted from the left to the right of the slab at a rate of 1.2 MW. If the temperature on the left of the slab is 102 °C, what is the temperature on the right of the slab? (The thermal conductivity of copper is 400 W/m·K)

A) –12 °C
B) +12 °C
C) –20 °C
D) +20 °C
E) +42 °C



$P_{cond} = \frac{kA(T_H - T_c)}{L}$

$T_H - T_c = \frac{P_{cond}L}{kA}$

$\Rightarrow T_c = T_H - \frac{P_{cond}L}{kA}$

$T_c = 102 - \frac{(1.2\times10^{6})(0.19)}{(400)(5)} = -12\,°C$