CHAPTER 18 | Absorption of Heat

1 | How much water remains unfrozen after $77.2\ kJ$ is transferred as heat from $260\ g$ of liquid water initially at $25°C$?
$(Ans: 0.11\ kg)$

2 | A small electric immersion heater is used to heat $100\ g$ of water for a cup of instant coffee. The heater is labeled "$200\ watts$" (it converts electrical energy to thermal energy at this rate). Calculate the time required to bring all this water from $23.0°C$ to $100°C$, ignoring any heat losses. $(Ans: 160\ s)$

3 | What mass of steam at $100°C$ must be mixed with $150\ g$ of ice at its melting point, in a thermally insulated container, to produce liquid water at $60°C$?
$(Ans: 0.036\ kg)$

4 | Ethyl alcohol has a boiling point of $78.0°C$, a freezing point of $-114°C$, a heat of vaporization of $879\ kJ/kg$, a heat of fusion of $109\ kJ/kg$, and a specific heat of $2.43\ kJ/kg \cdot K$. How much energy must be removed from $0.510\ kg$ of ethyl alcohol that is initially a gas at $78.0°C$ so that it becomes a solid at $-114°C$? $(Ans: 742\ kJ)$

5 | An insulated Thermos contains $130\ cm^3$ of hot coffee at $80.0°C$. You put in a $12.0\ g$ ice cube at its melting point to cool the coffee. By how many degrees has your coffee cooled once the ice has melted and equilibrium is reached? Treat the coffee as though it were pure water and neglect energy exchanges with the environment. $(Ans: 13.5°C)$

The specific heat of water: $c_w = 4186\ J/(kg.K)$
The specific heat of ice: $c_i = 2060\ J/(kg.K)$
The specific heat of copper: $c_c = 386\ J/(kg.K)$
The heat of fusion for water: $L_f = 333\ kJ/kg$
The heat of vaporization for water: $L_v = 2256\ kJ/kg$

6 | A $150\ g$ copper bowl contains $220\ g$ of water, both at $20.0°C$. A very hot $300\ g$ copper cylinder is dropped into the water, causing the water to boil, with $5.00\ g$ being converted to steam. The final temperature of the system is $100°C$. Neglect energy transfers with the environment.

(a) How much energy is transferred to the water as heat? $(Ans: 84935.2\ J)$

(b) How much to the bowl? $(Ans: 4644.2\ J)$

(c) What is the original temperature of the cylinder? $(Ans: 873°C)$

7 | A person makes a quantity of iced tea by mixing $500\ g$ of hot tea (essentially water) with an equal mass of ice at its melting point. Assume the mixture has negligible energy exchanges with its environment. If the tea's initial temperature is $T_i = 90°C$, when thermal equilibrium is reached what are

(a) the mixture's temperature T_f $(Ans: 5.3°C)$, and

(b) the remaining mass m_f of ice? $(Ans: 0.0\ g)$

If $T_i = 70°C$, when thermal equilibrium is reached what are

(c) T_f $(Ans: 0.0°C)$, and

(d) m_f? $(Ans: 60.0\ g)$

8 | (a) Two $50\ g$ ice cubes are dropped into $200\ g$ of water in a thermally insulated container. If the water is initially at $25°C$, and the ice comes directly from a freezer at $-15°C$, what is the final temperature at thermal equilibrium? $(Ans: 0°C)$

(b) What is the final temperature if only one ice cube is used? $(Ans: 2.5°C)$

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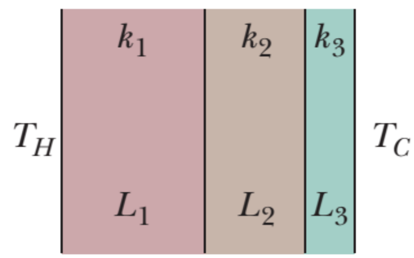
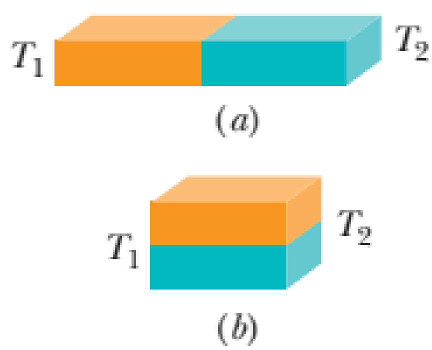
CHAPTER 18 | Heat Transfer Mechanism

1 | Figure below shows the cross-section of a wall made of three layers. The layer thicknesses are L_1, $L_2 = 0.700L_1$, and $L_3 = 0.350L_1$. the thermal conductivities are k_1, $k_2 = 0.900k_1$, and $k_3 = 0.800k_1$. the temperatures at the left side and right side of the wall are $T_H = 30.0°\text{C}$ and $T_C = -15.0°\text{C}$, respectively. Thermal conduction is steady.

a) What is the temperature difference ΔT_2 across layer 2 (between the left and right sides of the layer)? $(Ans: 15.8°\text{C})$
b) If k_2 were, instead, equal to $1.1k_1$, would the rate at which energy is conducted through the wall be greater than, less than, or the same as previously? $(Ans: greater)$
c) What would be the value of ΔT_2? $(Ans: 13.8°\text{C})$



2 | in figure (a) two identical rectangular rods of metal are welded end to end, with a temperature of $T_1 = 0°\text{C}$ on the left side and a temperature of $T_2 = 100°\text{C}$ on the right side. In $2.0\ min$, $10\ J$ is conducted at a constant rate from the right side to the left side. How much time would be required to conduct $10\ J$ if the rods were welded side to side as in figure (b)? $(Ans: 30\ s)$

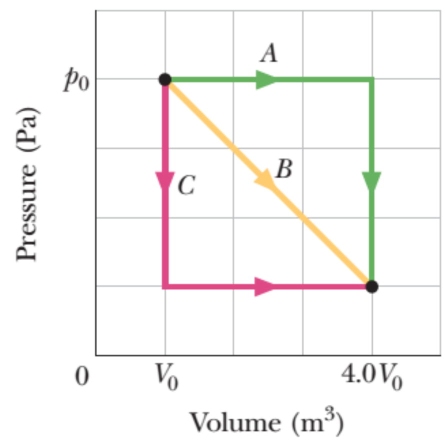


3 | (a) What is the rate of energy loss in watts per square meter through a glass window $3.0\ mm$ thick if the outside temperature is $-27°\text{C}$ and the inside temperature is $24°\text{C}$? $(k_{Glass} = 1.0\ W/m.K)$ $(Ans: 17\ kW/m^2)$
(b) A storm window having the same thickness of glass is installed parallel to the first window, with an air gap of $7.5\ cm$ between the two windows. What now is the rate of energy loss if conduction is the only important energy-loss mechanism? $(k_{Air} = 0.026\ W/m.K)$ $(Ans: 18\ W/m^2)$

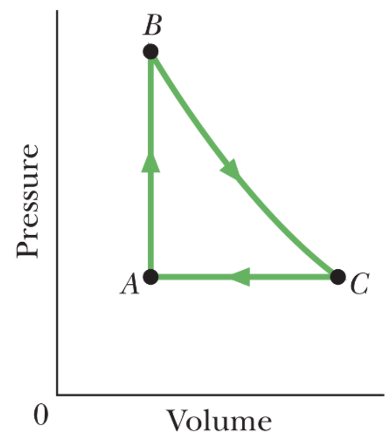
CHAPTER 18 | The First Law of Thermodynamics

1 | In figure head-on, a gas sample expands from V_0 to $4.0V_0$ while its pressure decreases from p_0 to $p_0/4.0$. If $V_0 = 1.0$ m^3 and $p_0 = 40$ Pa, how much work is done by the gas if its pressure changes with volume via

a) path A, $(Ans\text{: } 120\ J)$
b) path B, (Ans: 75 J) and
c) path C? $(Ans\text{: } 30\ J)$



4 | As a gas is held within a closed chamber, it passes through the cycle shown in the figure. Determine the energy transferred by the system as heat during constant-pressure process CA if the energy added as heat Q_{AB} during constant-volume process AB is $20.0\ J$, no energy is transferred as heat during adiabatic process BC, and the net work done during the cycle is $15.0\ J$. $(Ans\text{: } 18\ cal)$



2 | When a system is taken from state i to state f along path iaf in figure in front, $Q = 50\ cal$ and $W = 20\ cal$. Along path ibf, $Q = 36\ cal$.

a) What is W along path ibf? $(Ans\text{: } 6\ cal)$
b) If $W = -13\ cal$ for the return path fi, what is Q for this path? $(Ans\text{: } -43\ cal)$
c) If $E_{int,i} = 10\ cal$, what is $E_{int,f}$? $(Ans\text{: } 40\ cal)$
d) If $E_{int,b} = 22\ cal$, what is Q for path ib, $(Ans\text{: } 18\ cal)$ and
e) path bf? $(Ans\text{: } 18\ cal)$