9E. At what temperature do the following pairs of scales read the same: (a) Fahrenheit and Celsius (verify the listing in Table 19-1), (b) Fahrenheit and Kelvin, and (c) Celsius and Kelvin?

19-9- (a) Eq. 19.8 $\Rightarrow$ $T_F = \frac{9}{5} T_C + 32°$

at $T_C = T_F$, we have

$$T_F = \frac{9}{5} T_F + 32 \Rightarrow T_F = \underline{\underline{-40 °F}}$$

Same as in table 19.1

(b) Eqs 19.8 and 19.7 $\Rightarrow$ $T_F = \frac{9}{5} T_C + 32 = \frac{9}{5}(T - 273.15) + 32$

at $T = T_F$ $\Rightarrow$ $-\frac{4}{5} T_F = -\frac{9}{5}(273.15) + 32$

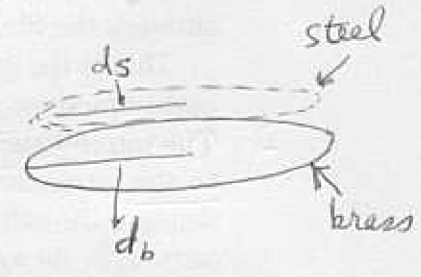
$$= -491.67 + 32 = -459.67$$

$$\therefore T_F = +574.59 \ °F$$

(c) Since $T_C = T - 273.15$, the Kelvin and Celsius temperatures can never have the same numerical value.

29P. A steel rod is 3.000 cm in diameter at 25°C. A brass ring has an interior diameter of 2.992 cm at 25°C. At what common temperature will the ring just slide onto the rod?

19-29



$d_s \equiv$ diameter of the steel rod

$d_b \equiv$ diameter of the brass ~~rod~~ ring

$d_s' = d_s(1+\alpha_s \Delta T)$ for steel

$d_b' = d_b(1+\alpha_b \Delta T)$ for brass $\quad \Delta T = T_f - 25°$

at $d_s' = d_b'$ solve for ΔT

$$\Delta T = \frac{d_s - d_b}{\alpha_b d_b - \alpha_s d_s} = \frac{3.000 - 2.992}{19\times10^{-6}(2.992) - 11\times10^{-6}(3.000)}$$

$$= 335.5$$

$$T_f = \Delta T + 25 = 360.5$$

$$\approx \underline{360\ °C}$$

54E. 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. (a) How much heat was transferred to the water? (b) How much to the bowl? (c) What was the original temperature of the cylinder?

19-54 $m_b = 150g$, $m_w = 220g$ } $T_i = 20.0\ ^\circ C$

for hot Copper → $m_{hc} = 300g$ $T_{hc} = ?$

at thermal equillibrium $T_f = 100^\circ C$

(a) Heat transfered to the water

$$= m_w c_w (100 - T_i) + m_s L_V$$

$$= 220 \times 1 (100 - 20) + 5 (539) = 2.03 \times 10^{4} \text{ cal}$$

(b) Heat transfered to the bowel

$$= m_b c_b (100 - 20) = 150 \times 0.0923 (100 - 20)$$

$$= 1.11 \times 10^{3} \text{ cal.}$$

(c) original temp comes from the heat lost by hot copper = heat gained by water and the bowl. So,

$$m_{hc} C_c (100 - T_{hc}) = 2.03 \times 10^{4} + 1.11 \times 10^{3}$$

$$300 (.0923)(T_{hc} - 100) = 2.14 \times 10^{4} \text{ cal}$$

$$\Rightarrow T_{hc} = 773 + 100 = 873\ ^\circ C$$

71E. A sample of gas expands from 1.0 m^3 to 4.0 m^3 while its pressure decreases from 40 Pa to 10 Pa. How much work is done by the gas if its pressure changes with volume via each of the three paths shown in the p-V diagram in Fig. 19-34?

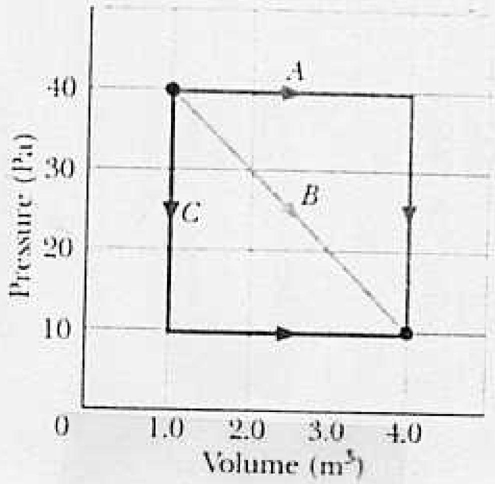
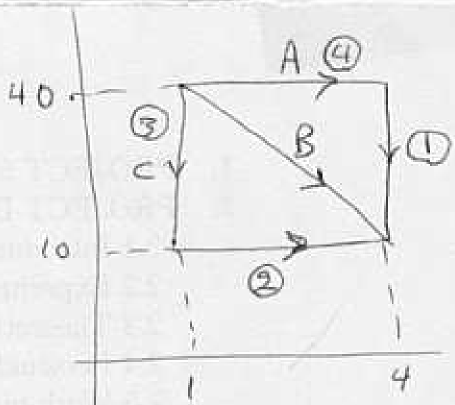


FIGURE 19-34
Exercise 71.



19-71 $W_A = W_{④} + W_{①}$

$= 40(4-1) + 0$

$= 120$ J

$W_C = W_3 + W_2 = 0 + 10(4-1) = 30$ J

W_B = area under the curve = area of trapezoid = (sum of the base / 2) * height

$= \frac{10+40}{2}(4-1) = 25 \times 3 = 75$ J

75E. Gas within a chamber passes through the cycle shown in Fig. 19-37. Determine the net heat added to the system during process CA if the heat Q_{AB} added during process AB is 20.0 J, no heat is transferred during process BC, and the net work done during the cycle is 15.0 J.

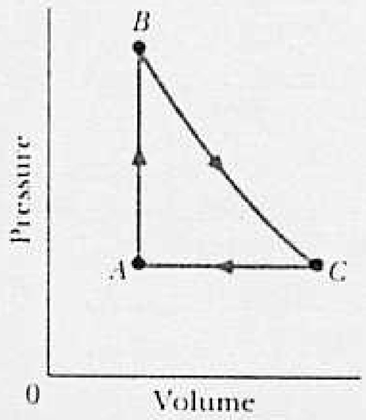


FIGURE 19-37 Exercise 75.

19-75 this is a cylic process $\Rightarrow \Delta E_{in} = 0 \Rightarrow Q = W$

$Q_{AB} = 20\,J$, $Q_{BC} = 0$, $W = 15$

$Q = Q_{AB} + Q_{BC} + Q_{CA} = W$

$\therefore Q_{CA} = W - Q_{AB} - Q_{BC}$

$= 15 - 20 - 0 = -5\,J$

This means 5J of energy leaves the system in the form of a heat.

83E. Consider the slab shown in Fig. 19-17. Suppose that $L =$ 25.0 cm, $A = 90.0\ cm^2$, and the material is copper. If $T_H =$ 125°C, $T_C = 10.0$°C, and a steady state is reached, find the rate of heat transfer through the slab.

19-83E $A = 90\ cm^2 = 90 \times 10^{-4}\ m^2$, $K_{Copper} = 401\ W/m.K$

$L = 25\ cm = 0.25\ m$

$T_H = 125\ °C$, $T_C = 10.0\ °C$

using Eq. (19-30)

$$H = kA\ \frac{(T_H - T_C)}{L} = 401 \times 90 \times 10^{-4}\ \frac{(125 - 10)}{0.25}$$

$$= 1.66 \times 10^{3}\ J/s.$$