Problems of Chapter 13

(1) $T_F = 84^\circ F$

a) $T_C = \dfrac{T_F - 32}{1.8} = \dfrac{84 - 32}{1.8} = 28.9\,^\circ C$

b) $T_K = T_C + 273.15 = 28.9 + 273.15 = 302.04\ K$

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(4) $\Delta T_C = -6\,^\circ C$

a) $\Delta T_K = ?$ $\quad \Delta T_K = \Delta T_C = -6\ K$

b) $\Delta T_F = ?$ $\quad \Delta T_F = \Delta T_C \times 1.8 = -6 \times 1.8 = -10.8$

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(8) $L_o = 18.3\ m \quad T_o = 10\,^\circ C \quad T = 50\,^\circ C$

$\Delta L = L_o \alpha \Delta T = (18.3)(12 \times 10^{-6})(50 - 10)$

$\Delta L = 0.0088\ m = 8.8\ mm$

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14) $A = \text{Area} = 75\ cm^2$, $h = 20\ cm$, $T_o = 25\,^\circ C$

$T = 95\,^\circ C$

$\Delta V_{brass} = V_o \beta_{brass} \Delta T = (75 \times 20)(57 \times 10^{-6})(95 - 25) = 5.985\ cm^3$

$\Delta V_{water} = V_o \beta_{water} \Delta T = (75 \times 20)(207 \times 10^{-6})(95 - 25) = 21.735\ cm^3$

$V_{overflow} = 21.735 - 5.985 = \boxed{15.75\ cm^3}$

(22)

$A_0 = 4.90874\ cm^2$

$T_0 = 20°C$

$T = ?$

$A = 4.91000$

$$A = A_0(1 + \underbrace{2\alpha}_{\text{Area expansion}} \Delta T) \Rightarrow \frac{A}{A_0} = 1 + 2\alpha \Delta T$$

Thus $$\Delta T = \frac{1}{2\alpha}\left(\frac{A}{A_0} - 1\right) = \frac{1}{2(19\times10^{-6})}\left(\frac{4.91000}{4.90874} - 1\right)$$

$$\Delta T = 6.8°C \Rightarrow T = 20 + 6.8 = 26.8°C$$

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(29) mass of ONE molecule of CO_2.

1 mole of $CO_2 = 12 + 2(16) = 44$ grams $= 0.044\ kg$

$$\text{mass of 1 molecule} = \frac{0.044\ kg}{6.02\times10^{23}} = 7.3\times10^{-26}\ kg$$

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(30) mass of one mole $= 13.003$ grams

a) By definition, mass of 1 atom $= 13.003\ u$

b) In kg, mass of 1 atom $= (13.003\ u)(1.67\times10^{-27}\ kg/u)$

$$= \boxed{2.1591\times10^{-26}\ kg}$$

(40) $T_1 = 18^\circ C \quad T_2 = 24^\circ C \quad N = \text{Constant}$

$$P_1V_1 = NkT_1$$
$$P_2V_2 = NkT_2 \Rightarrow \frac{P_1\cancel{V_1}}{P_2\cancel{V_2}} = \frac{\cancel{Nk}T_1}{\cancel{Nk}T_2} = \frac{T_1}{T_2}$$

$$\Rightarrow \frac{P_1}{P_2} = \frac{T_1}{T_2} = \frac{18+273}{24+273} = \frac{291}{297} = 0.98$$

or $P_1 = 0.98\,P_2$

$$\frac{\Delta P}{P_1} = \frac{P_2 - P_1}{P_1} = \frac{\cancel{P_2} - .98\cancel{P_2}}{0.98\cancel{P_2}} = 0.02$$

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(46) $T_1 = 16^\circ C \quad T_2 = 20^\circ C \quad P_1 = P_2$

$$\frac{\cancel{P_1}\cancel{V_1} = N_1 \cancel{k} T_1}{\cancel{P_2}\cancel{V_2} = N \cancel{k} T_2} \rightarrow 1 = \frac{N_1 T_1}{N_2 T_2} \Rightarrow$$

$$\frac{N_2}{N_1} = \frac{T_1}{T_2} = \frac{273+16}{273+20} = \frac{289}{293} = 0.986$$

$N_2 = 0.986\, N_1$

fraction pushed out $= \dfrac{N_1 - N_2}{N_1} = 1 - \dfrac{N_2}{N_1} = 1 - 0.986$

$= .014$

(52) $V_1 = 1.2\,m^3$ $P_1 = 1.0\times10^5$ Pa , $T_1 = 27^0C$

$V_2 = 0.6m^3$, $T_2 = 227^0C$, $P_2 = ?$

$$\frac{P_1V_1}{P_2V_2} = \frac{T_1}{T_2} \Rightarrow \frac{(1.0\times10^5)(1.2)}{P_2\ (0.6)} = \frac{27+273}{227+273}$$

$$\frac{1.2\times10^5}{0.6P_2} = \frac{3\cancel{00}}{5\cancel{00}} \Rightarrow 6\times10^5 = 1.8\,P_2$$

$$\boxed{P_2 = 3.3\times10^5\ Pa}$$

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(58) $m = 0.532$ kg of O_2

$p = 1.0\times10^5$ Pa

$T = 0^0C$

$V = ?$

$PV = nRT$ We need n = # of moles

$$n = \frac{0.532\ kg}{0.032\ kg/mol} = 16.625\ moles$$

$$V = \frac{nRT}{P} = \frac{(16.625)(8.31)(273+0)}{1.0\times10^5} = \boxed{0.38m^3}$$

61

$n = 0.42$ moles of air

$P = 1\text{ atm} = 1.013\times10^5$ Pa

$V = 1\text{ L} = 0.001\ m^3$

$KE = ?$

$$K_{total} = N\underbrace{\langle K_{tr}\rangle}_{\text{average kinetic energy of one molecule}} = N\left(\frac{3}{2}kT\right) = \frac{3}{2}\underbrace{NkT}_{=PV}$$

$$K_{TOTAL} = \left(\frac{3}{2}\right)(1.013\times10^5)(0.001) = 152\ J$$

67

$$\frac{(V_{rms})_{Ar}}{(V_{rms})_{Ne}} = \frac{\sqrt{\frac{\cancel{3kT}}{m_{Ar}}}}{\sqrt{\frac{\cancel{3kT}}{m_{Ne}}}} = \sqrt{\frac{m_{Ne}}{m_{Ar}}} = \sqrt{\frac{1}{2}} = \frac{1}{\sqrt{2}}$$