CHAPTER 14

14-2

(a) $C_8H_9NO_2$

Molecular mass* $= 8(12.011\ g/mol) + 9(1.00794) + 14.0067$
$+ 2(15.999)$

$= 151\ g/mol$

So 325mg contains : $\dfrac{0.325g}{151\ g/mol} \times 6.02\times10^{23}$ atom/mol

$= 1.3\times10^{21}$ molecules

(b) $C_{13}H_{18}O_2$

Molecular mass* $= 13(12) + 18(1) + 2(16) = 206\ g/mol$

So 200 mg contains: $\dfrac{0.2}{206} \times 6.02\times10^{23}$

$= 5.8\times10^{20}$ molecules

* the atomic masses are listed on the periodic table on the back page of the textbook.

14-3 $C_{14}H_{18}N_2O_5$

(a) molecular mass in amu

$14(12) + 18(1) + 2(14) + 5(16) = 294\ u$

(b) $m = 294\ u \times 1.6605\times10^{-27}\ kg/u$

$= 4.88\times10^{-25}\ kg$

14-4

(a) $m = \frac{196.967\ g}{mole} \times \frac{1\ mol}{6.02\times10^{23}\ atoms}$

$= 3.27\times10^{-22}\ g = 3.27\times10^{-25}\ kg$

(b) in $285\ g \times \frac{1\ mol}{196.967\ g} = 1.45\ mol$

14-7

(a) $m_w = 0.71 \times \frac{580}{9.8} = 42\ kg$

1 mol of $H_2O = 2(1) + 16 = 18\ g/mol$.

$\#moles = 42000g \times \frac{1\ mol}{18} = 2333\ mol$

(b) $\#molecules = 2333 \times 6.02\times10^{23} = 1.4\times10^{27}$

14-9

$\rho = 1000\ kg/m^3$

$V = \pi R^2 h = \pi\ (0.045\ m)^2 \times 0.12\ m$
$= 7.6 \times 10^{-4}\ m^3$

$m = \rho V = 0.76\ kg$

H_2O : $2(1) + 16 = 18\ g/mole$

also # molecules $= \left(\dfrac{760 g}{18 g/mol}\right) \times 6.02 \times 10^{23} = 2.5 \times 10^{25}$

moles $= \dfrac{760}{18} = 42$ moles

14-11

$0.16\ g\ He = \dfrac{0.16\ g}{4\ g/mol} = 0.04$ mols

at same P, T, and V we need 25 moles of N_2 to fill the balloon

N_2 has $2(14) = 28\ g/mol$

so $m_{N_2} = 28\ g/mol \times 0.04\ mol$

$= 1.1\ g$

14-13

(a) $PV = nRT$

$T = 15.5 + 273 \cong 289\,K$

$$n = \frac{PV}{RT} = \frac{1.72\times10^{5} \times 2.81\,m^3}{8.31 \times 289}$$

$= 201$ mole

(b) $$P = \frac{nRT}{V} = \frac{201\,(8.31)(273+28.2)}{4.16}$$

$= 1.21\times10^{5}\,Pa$

14-15

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

1 → TANK

2 → ROOM

$$V_2 = \frac{P_1}{P_2}\frac{T_2}{T_1} = \frac{65}{1}\cdot\frac{297}{288} = 67\,m^3$$

14-19

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$T_2 = \frac{P_2}{P_1}\frac{V_2}{V_1}T_1 = 48.5 \cdot \frac{1}{16}\,(305K)$$

$T_2 = 925K$

14-23

(a) $Q_1 = Q_2$

let n_1 be # moles in 1 and n_2 # moles in 2

C_{Ne} is the Heat capacity per mole

$$n_1 C_{Ne} \Delta T_1 = n_2 C_{Ne} \Delta T_2$$

$$\Delta T_1 = T_f - T_1 \quad , \quad \Delta T_2 = (T_2 - T_f)$$

$$n_1 = \frac{P_1 V_1}{R T_1} = 542\,\text{mol} \qquad n_2 = \frac{P_2 V_2}{R T_2} = 241\,\text{mol}$$

$$\frac{P_1 V_1}{R T_1}(T_f - T_1) = \frac{P_2 V_2}{R T_2}(T_2 - T_f)$$

$$\frac{5 \cdot 10^5 \cdot 2m^3}{220}(T_f - T_1) = \frac{2 \cdot 10^5 \cdot 5.8}{580}(T_2 - T_f)$$

$$4.55 \cdot 10^{-2}(T_f - 220) = 2 \times 10^{-2}(580 - T_f)$$

$$T_f - 220 = 0.44(580 - T_f) = 255 - 0.44 T_f$$

$$1.44 T_f = 475 \Rightarrow \underline{T_f = 330\,K}$$

(b) $$P = \frac{n_f R T_f}{V_f} = \frac{(542 + 241)\, 8.31\, (330)}{2 + 5.8}$$

$$\underline{= 2.8 \times 10^5\ Pa}$$

14-35

$$U = \frac{3}{2} n R T$$

$$n = \frac{P_1 V_1}{R T_1}$$

$$U = \frac{3}{2} \frac{P_1 V_1}{\cancel{R} T_1} \cancel{R} T$$

$$\Delta U = \frac{3}{2} \frac{1.01 \times 10^5 \cdot 680 m^3}{293.2} (1.1^\circ K) = \underline{3.9 \times 10^5 J}$$

14-37

$PV = nRT$, if PV is constant and n is doubled

then $T' = T/2$

$$v_{rms}^2 \propto T$$

$$\text{so } \frac{v'_{rms}}{v_{rms}} = \sqrt{\frac{T'}{T}} = \sqrt{\frac{1}{2}}$$

$$v'_{rms} = 463 / \sqrt{2} = \underline{327 m/s}$$

14-39

$$v_{rms} = \sqrt{\frac{3kT}{m}}$$

$$v_{rms}^2 = \frac{3kT}{m} \Rightarrow m = \frac{3kT}{v_{rms}^2}$$

$$m = \frac{3 \times 1.38 \times 10^{-23} \times 301\,K}{(2.8 \times 10^{-3}\,m/s)^2} = 1.59 \times 10^{-15}\,kg$$

14-41

$$PV = nRT \Rightarrow T = \frac{PV}{nR}$$

$$T = \frac{2.12 \times 10^{4}\,Pa \times 50\,m^3}{421\,mol \times 8.31} = 303\,K$$

SO_2 : $32 + 32 = 64\,amu$

$$M_{SO_2} = 64 \times 1.66 \times 10^{-27}\,kg/amu = 1.06 \times 10^{-25}\,kg$$

$$v_{rms} = \sqrt{\frac{3kT}{M}} = \sqrt{\frac{3 \times 1.38 \times 10^{-23} \times 303}{1.06 \times 10^{-25}\,kg}}$$

$$= 344\,m/s$$