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$_2$

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$_x \quad _y \quad _z + \quad _2 \square \quad _2 + \quad _2$

$$3.959\ g \quad _2 \times \frac{1\ mol \quad _2}{44.01\ g \quad _2} \times \frac{1\ mol}{1\ mol \quad _2} \times \frac{12.01\ g}{1\ mol} \approx 1.080\ g$$

$2.161\ g$

2 3 (*s*) + 6 (*aq*) □ 2 3 (*aq*) + 3 2 (*l*)

2 3

2 3

(s) □ $^{+}(aq)$ + $^{-}(aq)$

$_2$ $_4(s)$ □

$_3$ $_2(s)$ □ $^{2+}(aq)$ + 2 $_3^{-}(aq)$

$_2$ $_3$ $_2(s)$ □ $^{+}(aq)$ + $_2$ $_3$ $_2^{-}(aq)$

$_4$ $_3(s)$ □ $_4^{+}(aq)$ + $_3^{-}(aq)$

$_3$ $_4(s)$ □ 3 $^{+}(aq)$ + $^{3-}$

$2\ \ ^{3+} + 6\ ^{-}\ \square\ \ 2$

$3\ \ \ \square\ \ 3\ \ ^{2+} + 6\ ^{-}$

$+\ 2\ \ \ \square\ \ \ _{2} + 2$

$\overset{0}{}\ \ \ \ \overset{+1}{}\ \overset{-1}{}\ \ \ \ \overset{+2}{}\ \overset{-1}{}\ \ \ \ \overset{0}{}$

$+\ 2\ \ \ \square\ \ \ _{2} + 2$

$2\ \ ^{+} + 2\ ^{-}\ \square\ \ 2$

$_3$

$= 39.10$

$= 14.01$

$_3 = 16.00 \times 3 = 48.00$

$_3 = 101.11\ g/mol$

$$M = \frac{mol}{L}$$

$$L \times M = mol$$

$$0.398\ L \times \frac{2.14\ mol\ _3}{L} = mol\ _3$$

$$\approx 0.8517\ mol\ _3$$

$$0.8517\ mol\ _3 \times \frac{101.11\ g\ _3}{1\ mol\ _3} \approx 86.1\ g\ _3$$

$_4$

$_3\ _4$

$_3\ _4$

$_2\ _4$

$$3\ _{4\,(aq)} + 2\ _3\ _{4\,(aq)} + \square\ _3\ _{4}\ _{2\,(s)} + 3\ _2\ _{4\,(aq)}$$

$_4$

$_3\ _4$

$_3\ _4!$

$_4!$

$_4$ $_3\ _4$

$$45.7\ mL \times \frac{0.265\ mol\ _3\ _4}{L} \times \frac{2\ mol\ _4}{3\ mol\ _3\ _4} \times \frac{L}{0.375\ mol\ _4} \approx 21.5\ mL$$

$$M = \frac{mol}{L}$$

$$\square \quad L \times M = mol$$

$$0.0457\ L \times 0.265\ M\ {}_{3}\ {}_{4} = mol\ {}_{3}\ {}_{4}$$

$$\approx \color{red}{0.01211\ mol\ {}_{3}\ {}_{4}}$$

$$0.01211\ mol\ {}_{3}\ {}_{4} \times \frac{2\ mol\ {}_{4}}{3\ mol\ {}_{3}\ {}_{4}} \approx \color{red}{0.008074\ mol\ {}_{4}}$$

$$M = \frac{mol}{L}$$

$$\square \quad L = \frac{mol}{M}$$

$$= \frac{0.008074\ mol\ {}_{4}}{0.375\ M\ {}_{4}}$$

$$\approx 0.0215\ L$$

$$\approx \color{red}{21.5\ mL}$$

${}_{3}\ {}_{4}\ {}_{2}$

${}_{3}\ {}_{4}$!

${}_{3}\ {}_{4}\ {}_{2}$

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${}_{3}\ {}_{4}$ ${}_{3}\ {}_{4}\ {}_{2}$

$$0.0457\ L \times \frac{0.265\ mol\ {}_{3}\ {}_{4}}{L} \times \frac{1\ mol\ {}_{3}\ {}_{4}\ {}_{2}}{2\ mol\ {}_{3}\ {}_{4}} \times \frac{366.0\ g\ {}_{3}\ {}_{4}\ {}_{2}}{1\ mol\ {}_{3}\ {}_{4}\ {}_{2}} \approx \color{red}{2.22\ g\ {}_{3}\ {}_{4}\ {}_{2}}$$

$${}_{2}\ {}_{3\,(s)} + 6\ {}_{(aq)}\ \square\ 2\ {}_{3\,(aq)} + 3\ {}_{2}$$

$$0.0674\ mol \qquad \times \frac{1\ mol \quad _2\ \ _3}{6\ mol} \times \frac{159.7\ g \quad _2\ \ _3}{1\ mol \quad _2\ \ _3} \approx 1.79\ g \quad _2\ \ _3$$

2 3 2 3 2 3

2 5

$2 \quad 5 \quad (l) + 3 \quad 2\,(g)$ □ $2 \quad 2\,(g) + 3 \quad 2 \quad (l)$

2 4

2 4

$2 \quad 2 \quad 4\,(l) + \quad 2 \quad 4\,(l)$ □ $3 \quad 2\,(g) + 4 \quad 2 \quad (g) \quad \Delta H = -1049\ kJ/mol$

$3.01 \times 10^{3}\,g$

$4 \quad 3\,(s)$ □ $\quad {}^{+}_{4}\,(aq) + \quad {}^{-}_{3}\,(aq) \quad \Delta H = 25.7\ kJ/mol$

$$q = 10.66\ \cancel{kJ} \times \frac{1000\ J}{\cancel{kJ}} = 10{,}660\ J,\ m = 242\ g,\ T_i = 19.5\ C,\ T_f = 117.6\ C$$

$$s = ?$$

$$q = m\,s\,\Delta T$$

$$\therefore\ s = \frac{q}{m\,\Delta T}$$

$$= \frac{q}{m\left(T_f - T_i\right)}$$

$$= \frac{10{,}660\ J}{242\ g\ (117.6\ \ C - 19.5\ \ C)}$$

$$s \approx \color{red}{0.449\ J/g\ \ C}$$

2 5

$$2\quad 5\quad (l) + 3\quad 2\,(g) \rightarrow 2\quad 2\,(g) + 3\quad 2\,(l)$$

$$m = 2.946\,g,\ T_i = 24.50\ C,\ T_f = 33.12\ C, C = 10.14\,kJ/\ C!$$

$$\Delta H = ?$$

$$\Delta H = \frac{q}{mol}$$

$$\Delta H = \frac{-87.41\ kJ}{0.06395\ mol\ \quad _2\ \quad _5}$$

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$$\Delta H_{rxn} = \sum n_p \, \Delta H_f \quad - \quad \sum n_r \, \Delta H_f$$

$$\Delta H_{rxn} = (2 \quad {}_{2\,(g)} + 3 \quad {}_{2} \ {}_{(l)}) - (\ {}_{2} \ {}_{5} \ {}_{(l)} + 3 \quad {}_{2\,(g)})$$

$$= \left(2\,(-393.5\ kJ/mol) + 3\,(-285.8\ kJ/mol)\right)$$

$$- \left(-277.6\ kJ/mol + \cancel{3\,(0\ kJ/mol)}\right)$$

$$\Delta H_{rxn} = -1366.8\ kJ/mol$$

$$2 \quad {}_{8} \quad {}_{18\,(l)} + 25 \quad {}_{2\,(g)} \ \square \ 16 \quad {}_{2\,(g)} + 18 \quad {}_{2} \ {}_{(l)} \qquad \Delta H_{rxn} = -10{,}921.8\ kJ$$

$\Delta H_{rxn} = -10{,}921.8\ kJ/mol$, $\Delta H_f\,[\quad {}_{2\,(g)}] = 0\ kJ/mol$

$\Delta H_f\,[\quad {}_{2}$

$$d = \frac{m}{V} = \frac{\square\, P}{R\,T}$$

$$\square \quad \square = \frac{m\,R\,T}{V\,P}$$

$$= \frac{0.564\ g\,(0.0821\ L \square atm/mol \square K)\,(363\ K)}{0.356\ L\,(0.9908\ atm)}$$

$$\square \approx 47.7\ g/mol$$

$2 \quad {}_{(s)} + \quad {}_{2\,(g)} \quad \square$

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3 8 (g) !

$$P = 2.50 \times 10^4\ mm\ Hg \times \frac{1\ atm}{760\ mm\ Hg} \approx 32.89\ atm$$!

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3 8 (g)

$$PV = nRT$$

$$n = \frac{PV}{RT}$$

$$n_{C_3H_8} = \frac{32.89\ atm\,(5.0\ L)}{0.0821\ L \cdot atm/mol \cdot K\ (303\ K)}$$

$$n_{C_3H_8} \approx 6.61\ mol\ _3\ _8$$

$$6.61\ mol\ _3\ _8 \times \frac{-2219.0\ kJ}{1\ mol\ _3\ _8} \approx -1.5 \times 10^4\ kJ$$

$$\nu = 660\,kHz = 660 \times 10^3\,Hz,\ c \approx 2.998 \times 10^8\,m/s,\ h \approx 6.626 \times 10^{-34}\,J \cdot s$$

$$c = \lambda\,\nu$$

$$\therefore \quad \lambda = \frac{c}{\nu}$$

$$= \frac{2.998 \times 10^8\ m/s}{660 \times 10^3\ Hz}$$

$$\lambda \approx 454\ m$$

$$E = h\,\nu$$

$$= 6.626 \times 10^{-34}\ J \cdot s\,(660 \times 10^3\ Hz)$$

$$E \approx 4.37 \times 10^{-28}\ J/photon$$

$$\frac{50{,}000\ J}{s} \times \frac{photon}{4.37 \times 10^{-28}\ J} \approx 1.14 \times 10^{32}\ photons/s$$

$n_i = 5,\ n_f = 3!$

$\lambda = ?$

$$\Delta E = -R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$= -2.179 \times 10^{-18}\ J\,\left(\frac{1}{3^2} - \frac{1}{5^2}\right)$$

$$= -2.179 \times 10$$

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$^{2+}$, $^{2+}$, $^{2+}$, $^{2+}$

$^{2+} <$ $^{2+} <$ $^{2+} <$ $^{2+}$

$$\Delta H_{rxn} \approx \sum n_r \, BE \qquad - \sum n_p \, BE$$

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$\overline{2}$

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$\bar{2}$

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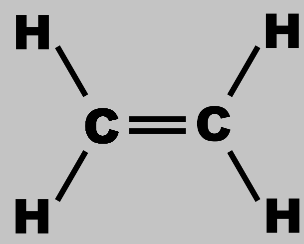
2 4



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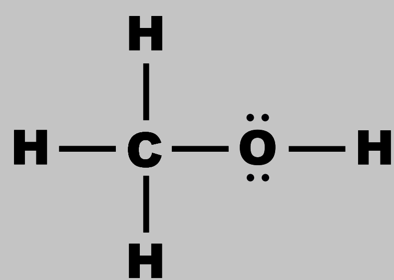

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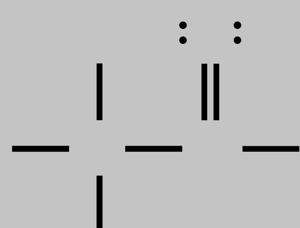

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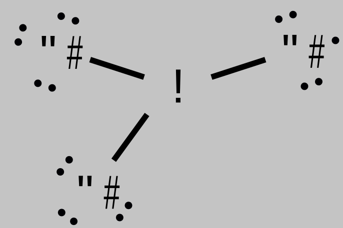

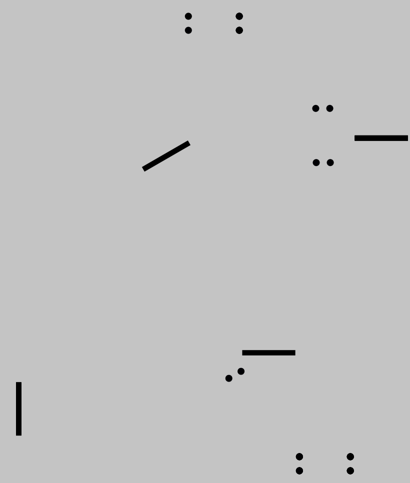

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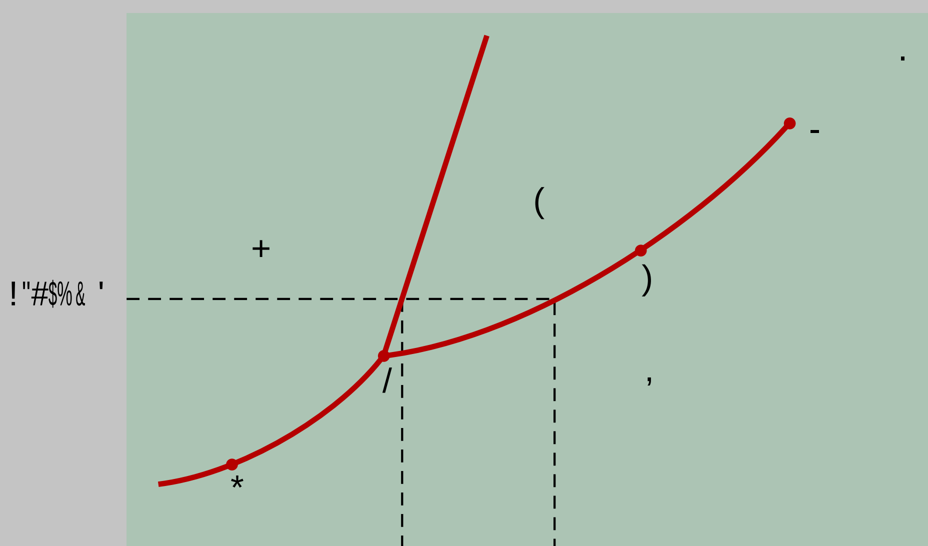

8 18 (l)

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$V_{gas} = 3785\ mL$, $d_{gas} = 0.740\ g/mL$, $\Delta H_{gas} = -5461\ kJ/mol$, $\square = 114.2\ g/mol$

$s_{ice} = 2.10\ J/g\ \square\ C$, $T_{i\ ice} = -20.\ C$,

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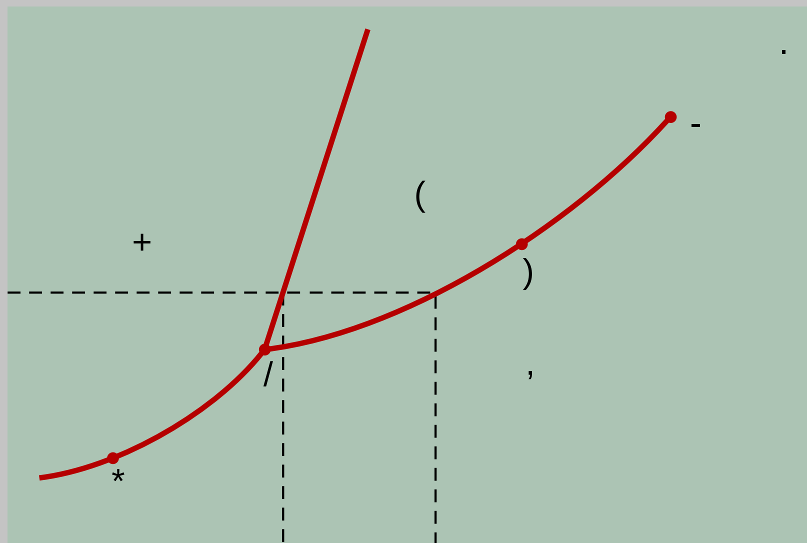

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$$Molarity = \frac{moles\ solute}{Liters\ solution}$$

$$M = \frac{mol}{L}$$

$$molality = \frac{moles\ solute}{kilograms\ solvent}$$

$$m = \frac{mol}{kg}$$

$$solute = 12.4\ mol \qquad , \quad ! \quad = 36.46\ g/mol$$

$$\underline{+\ solvent = \ water}$$

$$= solution = 1\ L,\ d = 1.18\ g/mL$$

$$d = \frac{mass}{V}$$

$$mass = d\ V$$

$$= \left(\frac{1.18\ g}{mL} \times \frac{1000\ mL}{L}\right) 1\ L$$

$$mass = {\color{red}1180\ g} \times \frac{kg}{1000\ g}$$

$$mass = {\color{red}1.18\ kg\ solution}$$

$$12.4\ mol \qquad \times \frac{35.46\ g}{1\ mol}$$

$$solute = 125\ g\ \_{2},\ ! = 110.98\ g/mol$$

$$+\ solvent = 500.\ mL\ water\ (= 500.\ g = 0.500\ kg, since\ d = 1\ g/mL)$$

$$K_f = 1.86\ C\ kg/mol,\ T_f = 0\ C$$

$$\overline{= solution}$$

$$125\ g\ \_{2} \times \frac{1\ mol\ \_{2}}{110.98\ g\ \_{2}} = 1.126\ mol\ \_{2}$$

$$m = \frac{mol}{kg}$$

$$m = \frac{1.126\ mol\ \_{2}}{0.500\ kg}$$

$$m \approx 2.252\ mol\ \_{2}/kg$$

$$_{2\,(s)} \quad {}^{2+}_{(aq)} + 2\ {}^{-}_{(aq)}$$

$$i = 3$$