Practice Problems

11. $C_5H_{12}(l) + 8\,O_2(g) \rightarrow 5\,CO_2(g) + 6\,H_2O(l) + 3509.0\ kJ$

$$\Delta H_{comb}\,O_2^\circ = \frac{-3509.0\ kJ}{1\ mol\ C_5H_{12}} \times \frac{1\ mol\ C_5H_{12}}{8\ mol\ O_2}$$

$$= -438.62\ kJ/mol\ O_2.$$ (−438.63 is ok for this course)

$$\Delta H_{comb}\,CO_2^\circ = \frac{-3509.0\ kJ}{1\ mol\ C_5H_{12}} \times \frac{1\ mol\ C_5H_{12}}{5\ mol\ CO_2}$$

$$= -701.80\ kJ/mol\ CO_2.$$

$$\Delta H_{comb}\,H_2O^\circ = \frac{-3509.0\ kJ}{1\ mol\ C_5H_{12}} \times \frac{1\ mol\ C_5H_{12}}{6\ mol\ H_2O}$$

$$= -584.83\ kJ/mol\ H_2O$$

12. $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) + 1366.8\ kJ$.

m 4.608 g

M 46.069 g/mol

$$\Delta H_f\,C_2H_5OH = 4.608\,g \times \frac{1\ mol}{46.069\ g} \times \frac{-1366.8\ kJ}{1\ mol}$$

$$= -1367\ kJ$$

13. $2\,C_6H_{14}(l) + 19O_2(g) \rightarrow 12\,CO_2(g) + 14H_2O + 8326.4\ kJ$

m 56.78 g

M 86.178 g/mol

$\Delta H_{comb}^\circ = -4163.2\ kJ/mol$ (× 2)

$$\Delta H_{comb} = 56.78\,g \times \frac{1\ mol}{86.178\,g} \times \frac{-8326.4\ kJ}{2\ mol}$$

$$= -2743\ kJ.$$

b) $2\,C_8H_{18}(\ell) + 25\,O_2(g) \rightarrow 16\,CO_2(g) + 18\,H_2O(\ell)$

$C_8H_{18}(\ell) + \frac{25}{2}\,O_2(g) \rightarrow 8\,CO_2(g) + 9\,H_2O(\ell) + 5470.3\ kJ$

m 1360 g

M 114.232 $\frac{g}{mol}$

$$\Delta H_{comb}\ C_8H_{18} = \frac{1360\,g}{} \times \frac{1\,mol}{114.232\,g} \times \frac{-5470.3\ kJ}{1\,mol}$$

$$= -65127\ kJ$$

$$= -65100\ kJ \text{ or } -6.51 \times 10^{-4}\ kJ$$

c) $C_7H_{16}(\ell) + 11O_2(g) \rightarrow 7CO_2(g) + 8H_2O(g) + 4817.0\ kJ$

m 2.344×10^4 g

M 100.667 $\frac{g}{mol}$

$$\Delta H_{comb}\ C_7H_{16}(\ell) = 2.344 \times 10^4\,g \times \frac{1\,mol}{100.667\,g} \times \frac{-4817.0\ kJ}{1\,mol}$$

$$= 1.122 \times 10^6\ kJ.$$

14. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g) + 890.8\ kJ$

m 1.00g

M 16.043 $\frac{g}{mol}$

$$\Delta H_{comb}\ CH_4 = 1.00\,g \times \frac{1\,mol}{16.043\,g} \times \frac{-890.8\ kJ}{1\,mol}$$

$$= -55.5\ kJ$$

15. $C_{10}H_8(s) + 12O_2(g) \rightarrow 10CO_2(g) + 4H_2O(g) + 5156\ kJ$

m = ?

M = 128.174 $\frac{g}{mol}$

$\Delta H_r = n\,\Delta H^\circ_{comb}$.

$-500.0\ kJ = n\,(5156\ kJ/mol)$

$n = 0.09697\ mol$

$m_{C_{10}H_8} = 0.09697\,mol \times \frac{128.174\,g}{mol}$

$= 12.43\ g$

16. $2\,CH_3OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$

$CH_3OH(\ell) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(g) + 726.1\ kJ$

$m = ?\ (kg)$

$M = 32.042\ \frac{g}{mol}$

$\Delta H_r = n\,\Delta H_{comb}^{\circ}$

$-5.39 \times 10^5\ kJ = n\ (-726.1\ kJ/mol)$

$n = 742.32\ mol$

$m_{CH_3OH} = 742.32\ mol \times \frac{32.042\ g}{mol}$

$= 23.8\ kg$

17. $2\,C_3H_6(g) + 9O_2(g) \rightarrow 6\,CO_2(g) + 6H_2O(g) + 4116.0\ kJ$

a) $\Delta H_{comb}^{\circ} = \frac{-4116.0\ kJ}{2\ mol} = -2058.0\ kJ/mol$

b) $2\,C_3H_6(g) + 9O_2(g) \rightarrow 6\,CO_2(g) + 6H_2O(g) + 4116.0\ kJ$

$m = 5.00\ g$

$M = 42.081\ \frac{g}{mol}$

$\Delta H_r = 5.00\ g \times \frac{1\ mol}{42.081\ g} \times \frac{-4116.0\ kJ}{2\ mol}$

$= -245\ kJ$ (released)

$\therefore$ $+245\ kJ$ is available

18. a) $\Delta H_r = n\,\Delta H_{comb}^{\circ}$

$-110.95\ kJ = 0.050\ mol\ \Delta H_{comb}^{\circ}$

$\Delta H_{comb}^{\circ} = -2219\ kJ/mol$

$= -2.2 \times 10^3\ kJ/mol$

OR $-2200\ kJ/mol$

b) propane

19. $C_4H_{10(g)} + \frac{13}{2} O_{2(g)} \rightarrow 4CO_{2(g)} + 5H_2O_{(\ell)} + 2877.6\ kJ$

$m = ?$

$M = 58.124\ \frac{g}{mol}$

$1.00\ MJ = 1.00 \times 10^6\ J$

$= 1.00 \times 10^3\ kJ$

$\Delta H_r = n \Delta H°_{comb}$

$1.00 \times 10^3\ kJ = n\ (2877.6\ kJ/mol)$

$n = \frac{1.00 \times 10^3\ kJ}{2877.6\ kJ/mol}$

$= 0.3475\ mol$

$m_{C_4H_{10}} = 0.3475\ mol \times \frac{58.124\ g}{mol}$

$= 20.2\ g$

20. $2C_3H_8O_{(\ell)} + 9O_{2(g)} \rightarrow 6CO_{2(g)} + 8H_2O_{(\ell)}$

a) $C_3H_8O_{(\ell)} + \frac{9}{2} O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(\ell)} + 2006\ kJ$

$m = 25.00\ g$

$M = 18.015\ \frac{g}{mol}$

$\Delta H_r = 25.00\ g \times \frac{1\ mol}{18.015\ g} \times \frac{-2006\ kJ}{4\ mol}$

$= -695.9\ kJ$