

1.

(a) Heat required to increase the temperature of 1.00 g of Li metal

$$= \frac{1 \text{ g}}{6.94 \text{ g/mol}} \times 24.8 \text{ J/mol}^\circ\text{C} \times 1^\circ\text{C} = 3.57 \text{ J}$$

Heat required to increase the temperature of 1.00 g of Rb metal

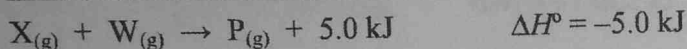
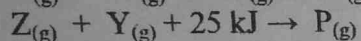
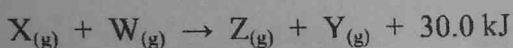
$$= \frac{1 \text{ g}}{85.47 \text{ g/mol}} \times 31.0 \text{ J/mol}^\circ\text{C} \times 1^\circ\text{C} = 0.363 \text{ J}$$

(b) To achieve a temperature change of 1°C ,

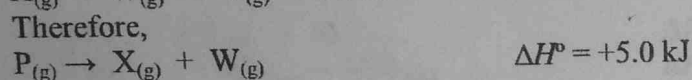
$$\frac{\text{Mass of Rb}}{1 \text{ g of Rb}} = \frac{3.57 \text{ J}}{0.363 \text{ J}}$$

$$\text{Mass of Rb} = 9.83 \text{ g of Rb}$$

2.



Therefore,



3.

$$n \text{ mol CO}_2 = \frac{\text{Mass of CO}_2}{44.01 \text{ g/mol}}$$

$$\frac{n \text{ mol CO}_2}{1 \text{ mol CO}_2} = \frac{186.0 \text{ kJ}}{16.20 \text{ kJ}}$$

$$n \text{ mol CO}_2 = 11.5 \text{ mol CO}_2$$

$$\frac{\text{Mass of CO}_2}{44.01 \text{ g/mol}} = 11.5 \text{ mol CO}_2$$

$$\text{Mass of CO}_2 = 506 \text{ g of CO}_2$$

4.

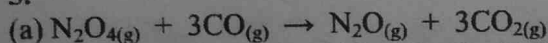
Heat lost by thallium = Heat gained by water

$$-m \cdot c \cdot \Delta T (\text{thallium}) = m \cdot c \cdot \Delta T (\text{water})$$

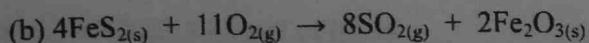
$$-(111.2 \text{ g})(c)(14.9^\circ\text{C} - 95.0^\circ\text{C}) = (125.00 \text{ g})(4.184 \text{ J/g}^\circ\text{C})(14.9^\circ\text{C} - 12.5^\circ\text{C})$$

$$c = 0.14 \text{ J/g}^\circ\text{C}$$

5.

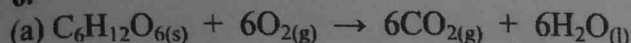


$$\begin{aligned} \Delta H^\circ_{\text{rxn}} &= [\Delta H^\circ_f \text{N}_2\text{O}_{(\text{g})} + 3\Delta H^\circ_f \text{CO}_{2(\text{g})}] - [\Delta H^\circ_f \text{N}_2\text{O}_{4(\text{g})} + 3\Delta H^\circ_f \text{CO}_{(\text{g})}] \\ &= [81.6 \text{ kJ/mol} + 3(-393.5 \text{ kJ/mol})] - [11.1 \text{ kJ/mol} + 3(-110.5 \text{ kJ/mol})] \\ &= -1441.5 \text{ kJ/mol of N}_2\text{O}_4 \end{aligned}$$



$$\begin{aligned} \Delta H^\circ_{\text{rxn}} &= [8\Delta H^\circ_f \text{SO}_{2(\text{g})} + 2\Delta H^\circ_f \text{Fe}_2\text{O}_{3(\text{s})}] - [4\Delta H^\circ_f \text{FeS}_{2(\text{s})} + 11\Delta H^\circ_f \text{O}_{2(\text{g})}] \\ &= [8(-296.8 \text{ kJ/mol}) + 2(-824.2 \text{ kJ/mol})] - [4(-178.2 \text{ kJ/mol}) - 11(0 \text{ kJ/mol})] \\ &= -3310 \text{ kJ/4 mol of FeS}_2 \\ &= -827.5 \text{ kJ/mol of FeS}_2 \end{aligned}$$

6.



(b) Heat gained by water = $m \cdot c \cdot \Delta T$ (water)

$$= (200.00 \text{ g})(4.184 \text{ J/g}^\circ\text{C})(37.3^\circ\text{C})$$

$$= 31\,200 \text{ J}$$

$$= 31.2 \text{ kJ}$$

$$n \text{ mol C}_6\text{H}_{12}\text{O}_6 = \frac{2.000 \text{ g}}{180.18 \text{ g/mol}} = 0.01110 \text{ mol}$$

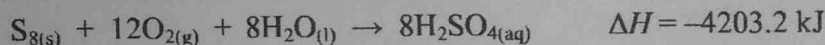
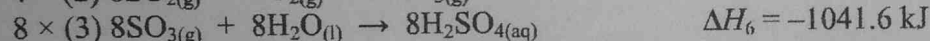
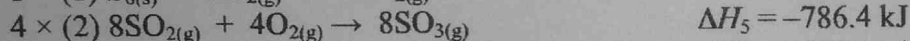
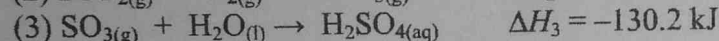
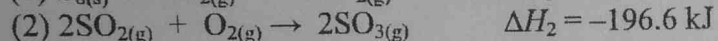
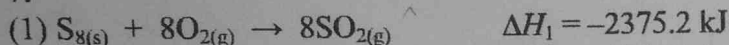
$$\Delta H^\circ_{\text{comb}} = \frac{-31.2 \text{ kJ}}{0.01110 \text{ mol}} = -2.81 \times 10^3 \text{ kJ/mol}$$

$$(c) \Delta H^\circ_{\text{comb}} = [6\Delta H^\circ_f \text{CO}_{2(g)} + 6\Delta H^\circ_f \text{H}_2\text{O}_{(l)}] - [\Delta H^\circ_f \text{C}_6\text{H}_{12}\text{O}_{6(s)} - 6\Delta H^\circ_f \text{O}_{2(g)}]$$

$$-2.81 \times 10^3 \text{ kJ/mol} = [6(-393.5 \text{ kJ/mol}) + 6(-285.8 \text{ kJ/mol})] - [\Delta H^\circ_f \text{C}_6\text{H}_{12}\text{O}_{6(s)} - 6(0 \text{ kJ/mol})]$$

$$\Delta H^\circ_f \text{C}_6\text{H}_{12}\text{O}_{6(s)} = -1270 \text{ kJ/mol}$$

7.



$$\Delta H_{\text{rxn}} = -525.4 \text{ kJ/mol of H}_2\text{SO}_4$$

8.



$$\Delta H^\circ_{\text{rxn}} = [4\Delta H^\circ_f \text{Fe}_3\text{O}_4(s) + \Delta H^\circ_f \text{O}_{2(g)}] - [6\Delta H^\circ_f \text{Fe}_2\text{O}_3(s)]$$

$$= [4(-1118.4 \text{ kJ/mol}) + (0 \text{ kJ/mol})] - [6(-824.2 \text{ kJ/mol})]$$

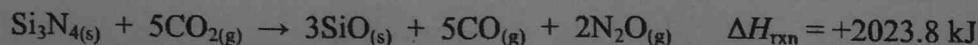
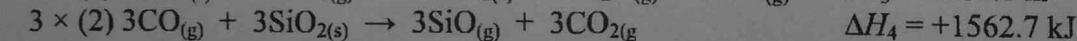
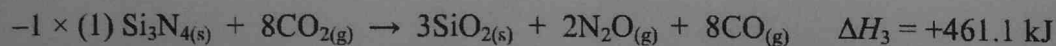
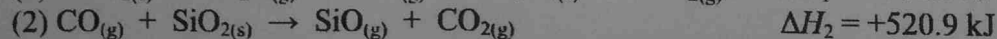
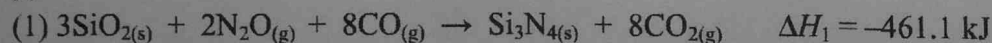
$$= 471.6 \text{ kJ/6 mol of Fe}_2\text{O}_3$$

$$= 78.6 \text{ kJ/mol of Fe}_2\text{O}_3$$

$$n \text{ mol Fe}_2\text{O}_3 = \frac{5.00 \text{ g}}{159.7 \text{ g/mol}} = 0.0313 \text{ mol}$$

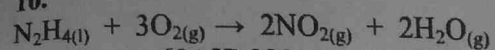
$$\text{Heat absorbed by 5.00 g sample} = 0.0313 \text{ mol} \times 78.6 \text{ kJ/mol} = 2.46 \text{ kJ}$$

9.



$$\Delta H_{\text{rxn}} = +2023.8 \text{ kJ/mol of Si}_3\text{N}_4$$

10.



$$\begin{aligned} \text{(a) } \Delta H_{\text{comb}} &= [2\Delta H_f^\circ \text{NO}_{2(g)} + 2\Delta H_f^\circ \text{H}_2\text{O}_{(g)}] - [\Delta H_f^\circ \text{N}_2\text{H}_{4(l)} - 3\Delta H_f^\circ \text{O}_{2(g)}] \\ &= [2(+33.2) \text{ kJ} + 2(-241.8) \text{ kJ}] - [(+50.6 \text{ kJ/mol}) - 3(0 \text{ kJ/mol})] \\ &= -467.8 \text{ kJ/mol of N}_2\text{H}_4 \end{aligned}$$

$$\text{(b) Mass of N}_2\text{H}_{4(l)} = 10.0 \text{ kg} \times 87.8 \% = 8.78 \text{ kg}$$

$$n \text{ mol N}_2\text{H}_4 = \frac{8.78 \text{ kg}}{32.06 \text{ g/mol}} = 274 \text{ mol of N}_2\text{H}_4$$

$$\text{Heat given off by the 10.0 kg sample} = 274 \text{ mol} \times 467.8 \text{ kJ/mol} = 1.28 \times 10^5 \text{ kJ}$$