5. Ever solicitous for the financial well-being of the College, Macalester's Board of Trustees voted two weeks ago to invest a significant fraction of our endowment in the manufacturer of the drug Viagra, a solid with a molecular formula of $\text{C}_2\text{H}_3\text{N}_6\text{O}_4\text{S}$ and a molar mass of 474.6 g/mol. Viagra's standard enthalpy of formation ($\Delta H_f^\circ$) is $-518.5$ kJ/mol.

(a) (6 points) Write down the balanced chemical equation whose $\Delta H$ is the $\Delta H_f^\circ$ of Viagra. Be sure to indicate the phases of all substances.

$$22\text{ C}(g) + 15\text{ H}_2(g) + 3\text{ N}_2(g) + 2\text{ O}_2(g) + \text{ S}(s) \rightarrow 22\text{ C}_2\text{H}_3\text{N}_6\text{O}_4\text{S}(s)$$

- 1 pt per substance (max of -4 for errors)
- 4 if balanced or if 1 mol of Viagra not formed
- 5 something

(b) (15 points) When Viagra is combusted in a bomb calorimeter, it forms $\text{CO}_2(g)$, $\text{H}_2\text{O}(l)$, $\text{NO}_2(g)$, and $\text{SO}_3(g)$. Compute the thermal energy released (in kJ) when 1.00 g of Viagra undergoes complete combustion.

$$\text{C}_22\text{ H}_30\text{ N}_6\text{O}_4\text{S}(s) + 35\text{ O}_2(g) \rightarrow 22\text{ CO}_2(g) + 15\text{ H}_2\text{O}(l) + 6\text{ N}_2\text{O}_2(g) + \text{ SO}_3(g)$$

$$\Delta H_{\text{comb}} = 22\Delta H_f^\circ(\text{CO}_2, g) + 15\Delta H_f^\circ(\text{H}_2\text{O}, l) + 6\Delta H_f^\circ(\text{N}_2\text{O}_2, g)$$
$$+ \Delta H_f^\circ(\text{SO}_3, g) - \Delta H_f^\circ(\text{viagra}) - 35\Delta H_f^\circ(\text{O}_2)$$
$$= 22(-393.51\text{ kJ/mol}) + 15(-285.83\text{ kJ/mol}) + 6(33.2\text{ kJ/mol})$$
$$+ (-395.72\text{ kJ/mol}) - (-518.5\text{ kJ/mol})$$
$$= -12622.69\text{ kJ/mol}$$

So $\Delta H = 1.00\text{g viagra} \left(\frac{\text{mol viagra}}{474.6\text{ g viagra}}\right) \left(\frac{-12622.69\text{ kJ}}{1\text{ mol viagra}}\right)$

$$= -26.6\text{ kJ}$$

- 1 math, s.f. error
- 4 didn't use $\Delta H_f^\circ(\text{viagra})$
- 12 something

- 8 said $\Delta H_f^\circ = \Delta H_{\text{comb}}$
- 4 didn't multiply by # of mol of Viagra
- 2 error in balancing eqn
- 4 didn't use stoichiometric coefficients
- 4 in calculating $\Delta H_{\text{comb}}$