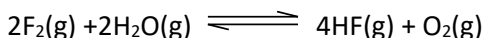


THERMOCHEMISTRY (no calculator)

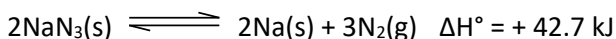
(All questions may be completed without the use of a calculator. Answers given were generated without a calculator.)

1) For the reaction:



- a) Use enthalpies of formation to calculate the value of ΔH° for the reaction.
Enthalpies of formation: $\text{H}_2\text{O}(\text{g}) = -242 \text{ kJ/mol}$, $\text{HF}(\text{g}) = -271 \text{ kJ/mol}$ **[-600 kJ]**
- b) Use bond energies to calculate ΔH° for the reaction.
F-F (158 kJ/mol); H-F (568 kJ/mol); O=O (494 kJ/mol); O-H (463 kJ/mol) **[-598 kJ]**

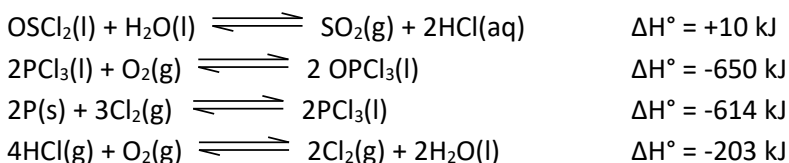
2) Given the thermochemical equation



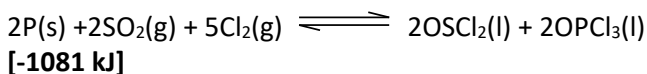
- a) Calculate $\Delta H^\circ_{\text{f},298}$ for $\text{NaN}_3(\text{s})$. **[-21.35 kJ/mol]**
- b) Calculate ΔE°_{298} for the above reaction. **[about +35 kJ]**

3) A 20.0 millimole sample of an organic compound was burned in excess oxygen in a bomb calorimeter. The calorimeter contained 1000 g of water and the calorimeter itself had a heat capacity of 3.816 kJ/°C. The temperature of the calorimeter and its contents increased from 19.00°C to 27.00°C. What quantity of heat would be liberated by the combustion of one mole of this organic compound under these conditions? **[\Delta E^\circ = q_v = -3.20 x 10³ kJ]**

4) Given:



Calculate the value of ΔH° for the reaction



- 5) The combustion of 10.0 millimoles of cyclohexane, $\text{C}_6\text{H}_{12}(\text{l})$, in a bomb calorimeter evolves 39.12 kJ of heat. The products of the combustion are carbon dioxide gas and water liquid.
- a) Calculate ΔE° for the combustion of one mole of cyclohexane. **[-3912 kJ]**
- b) Write the chemical equation for the reaction above and calculate ΔH° for the combustion of cyclohexane. **[-3920 kJ/mol]**
- c) Calculate the enthalpy of formation of cyclohexane from your calculated value of ΔH° for the combustion of cyclohexane and the molar enthalpies of formation of CO_2 gas (-394 kJ/mol) and H_2O liquid (-286 kJ/mol). **[-160 kJ/mol]**

- 6) One mole of He gas initially at 0°C and 1.0 atm is warmed up to 27°C at a constant pressure of 1.0 atm, calculate:
- The ΔV for this process [**2.24 L**]
 - The change in internal energy, ΔE , for this process [*Hint: He behaves like an ideal gas, so $E = 1.5nRT$*] [**3.4×10^2 J**]
 - The work (w) done by the He [**about -225 J**]
 - The heat (q) transferred [**about 5.65×10^2 J**]
 - ΔH for the process [**$\Delta H = q_p \cong 5.65 \times 10^2$ J**]
- 7) Benzene (C_6H_6) and acetylene (C_2H_2) have the same empirical formula, CH. Which compound releases more energy per mole of CH? ΔH°_f of gaseous $C_6H_6 = +83$ kJ/mol and ΔH°_f of $C_2H_2(g) = +227$ kJ/mol
[$C_2H_2(g)$ produces about 100 kJ/mol CH more than $C_6H_6(g)$]
- 8) A typical candy bar has a mass of about 60 g.
- Assuming that a candy bar is 100% sugar and that 1.0 g of sugar is equivalent to about 17 kJ of energy, calculate the energy in kJ contained in this typical candy bar. [**1.0×10^3 kJ**]
 - If cycling at 23 kph requires 2.0×10^3 kJ/hr, approximately how many minutes of cycling would be needed to burn the energy produced from this candy bar? [**30**]