Chemistry 1901
Assignment 10: Nitrogen chemistry (Explosives and Atmospheric)

Short answer questions:
1) Give the name and formula of the nitrogen compound that fits each of the following descriptions:
   a) hydride produced at multimillion-tonne level;
   b) hydride used in the manufacture of rocket propellants and drugs;
   c) strong acid
   d) strong fluorinating agent
2) N can exist in a wide range of oxidation states from –3 to +5. Provide a molecule example of each (name and formula please).
3) Most high explosives contain nitrogen. Why?
4) The following reaction was studied in two different lecture demonstrations:
   \[ \text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g}) \]
   In the “Star Wars” experiment the H2 gas burned brightly (with a soft “woooof” sound). In the H2 balloon experiment, on the other hand, a loud explosion was heard. Why the difference?
5) Why doesn’t NO form from N2 and O2 under normal atmospheric conditions? How does NO form in a car engine?
6) Which of the following oxides of nitrogen are paramagnetic?
   a) NO   b) NO2   c) N2O4   d) N2O5

Calculation questions:
7) RDX (C3H6N6O6) is a powerful explosive.
   a) Write a balanced chemical equation to describe the complete combustion of RDX to give water vapour, carbon dioxide and dinitrogen.
   b) How might the equation for the explosive decomposition of RDX differ from the above equation? Suggest a reasonable chemical equation to describe the overall chemistry.
   c) What properties of RDX make it a good explosive?
   d) How much heat is generated from the complete combustion of 100 g of RDX?
   [Data: \( \Delta H^\circ_{\text{f}}(\text{H}_2\text{O}, \text{g}) = -242 \text{ kJ/mol}; \Delta H^\circ_{\text{f}}(\text{CO}_2, \text{g}) = -394 \text{ kJ/mol}; \Delta H^\circ_{\text{f}}(\text{RDX}, \text{s}) = +65 \text{ kJ/mol} \)]
8) When ammonium nitrite (NH4NO2) is heated, it decomposes to nitrogen gas and water vapour. Calculate the volume of N2 gas produced from 1.00 g of solid NH4NO2 at 250°C and 1.00 atm. Is this reaction likely to be explosive? Why?
9) During exercise, fat molecules react with water (hydrolyse) to form a group of compounds called fatty acids. These fatty acids are then converted to carbon dioxide and water releasing energy to power the muscles. A typical human fatty acid is palmitic acid: \( \text{CH}_n(\text{CH}_2)_n\text{COOH} \).
   a) Write a balanced equation for the complete oxidation of palmitic acid producing CO2(g) and H2O(l)
   b) The direct combustion of palmitic acid in a calorimeter yields the same products as in the body together with the production of 9980 kJ of heat per mole of palmitic acid. What is the standard enthalpy of formation of palmitic acid?
   Data: \( \Delta H^\circ_{\text{f}}(\text{H}_2\text{O}(l)) = -285.8 \text{ kJ mol}^{-1}; \Delta H^\circ_{\text{f}}(\text{CO}_2(\text{g})) = -393.5 \text{ kJ mol}^{-1} \)
   c) Carbohydrates yield about 17 kJ g\(^{-1}\) of energy in the body. Calculate the equivalent energy value of fat using palmitic acid as the example.
10) Mars is both smaller than Earth and further from the sun. It receives 609 J/m\(^2\)/s of solar energy, of which 29% is reflected back into space. Its radius is 3,400 km. Calculate the expected surface temperature of Mars. The measured surface temperature is 213 K (−60°C). Comment on the size of the Greenhouse effect on Mars.