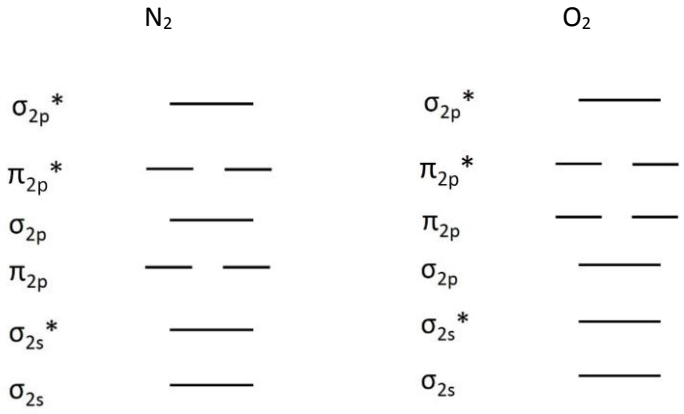
Matter and Motion Fall 2015

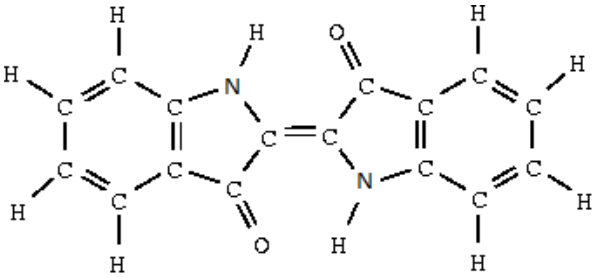
Chemistry Workshop 5

The workshop is intended to be a low-pressure setting where we get to practice problems, ask any questions, and discuss concepts and problem solving methods. Have fun! Work together on whiteboards or scratch paper and then neatly write your solutions in the notebook where you keep chemistry class notes. Your workshop solutions will be included in your portfolio.

1. Use molecular orbital theory to predict which molecule is more reactive.



2. The blue color in jeans often comes from the dye indigo blue. The structure of the indigo molecule is:



a) How many σ and how many π bonds exist in the molecule?

b) What hybrid orbitals are used by the carbon atoms in the indigo molecule?

3. The standard enthalpy of formation is the change in enthalpy that accompanies the formation of 1 mole of a compound from its elements, with all substances in their standard states (e.g., the standard state for nitrogen is $N_2(g)$). Write a reaction for the formation of each of the following compounds: NaCl, $C_6H_{12}O_6$, and $PbSO_4$.

4. Acid rain is produced from the reaction between sulfur trioxide and water to produce sulfuric acid. Write a balanced chemical equation for this reaction and calculate the standard enthalpy of reaction. You will want to use the table of standard enthalpy of formation found in Appendix 4. You can also find tables of standard enthalpies of formation online if nobody in your group has the book.

5. Use Hess's Law to determine ΔH for the reaction $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$, given that:

$C(graphite) + \frac{1}{2}O_2(g) \rightarrow CO(g)$ $\quad \Delta H = -110.54$ kJ

$C(graphite) + O_2(g) \rightarrow CO_2(g)$ $\quad \Delta H = -393.51$ kJ

6. Calculate the internal energy change for each of the following:

a) 200 J of work is required to compress a gas while the gas releases 43 J of heat.

b) A piston is compressed from a volume of 9.30 L to 1.80 L against a constant pressure of 1.90 atm while the gas absorbs 350 J.

7. Typical homes use about 40 kWh of electricity per day (1 kWh = 1 kilowatt hour where 1 watt = 1 J/s). Assuming 18% efficient solar panels, 8 hours of useful sunlight per day, and solar irradiance (the rate of light energy supplied by the sun) of 1 kW/m^2, calculate the minimum solar panel surface area necessary to provide all of the home's electricity. Do you think a typical roof is big enough to hold all of the necessary solar panels?

8. Calculate the bond energy for a N—N single bond using the following data: The standard enthalpy of formation for $N_2H_4(g)$ is 95.4 kJ/mol; the standard enthalpy of formation of N(g) is 472.7 kJ/mol; the standard enthalpy of formation of H(g) is 216.0 kJ/mol; the bond energy of N—H bond is 391 kJ/mol. Hint: write a reaction representing the breakdown of N_2H_4 into its constituent elements. Compare your calculated value to the literature value provided in Table 4.4 of your text.