2. (10 points total) Some of the demonstrations we have seen since October 12 have involved (i) methanol mixed with a variety of chloride salts; (ii) sodium, potassium, and magnesium with water; and (iii) alkaline earth oxides with water. For two of these demonstrations,

(a) briefly describe what we observed in class, and  

(b) briefly discuss the physical or chemical concept that was illustrated.

(i) When the methanol was burned, the different salts emitted different colors of light. This demonstrated the "quantization" of e- energies in atoms.

(ii) Sodium reacted violently with H2O (making H2(g) and OH-aq), K reacted violently (we saw a flame), and Mg not at all. This demonstrated that the lower the IE, the more reactive a metal will be.

(iii) The reaction of MgO with H2O was very slightly exothermic while the reaction of CaO with H2O was highly exothermic (we turned H2O(2) into steam!). This was consistent with CaO's having a significantly smaller lattice energy.

3. Experiments indicate that in its ground state, an atom of W has four unpaired electrons.

(a) (4 points) Write down the abbreviated electron configuration consistent with this observation. You need not justify your answer here.

\[ \text{[Xe]} 6s^2 \text{.} 4f^{14} 5d^{4} -2 \text{ no } 4f^{14} -1 \text{ enas} \]

(b) (8 points) The other two (non-radioactive) elements in Group 6, Cr and Mo, each have six unpaired electrons in their ground state. Identify the two energetic factors that control the electron configuration of Group 6, and explain how they lead to two different electron configurations.

(i) The difference in E of the ns and (n-1)d subshells. Con: the driving force to have half-filled subshells.

(ii) The pairing penalty (the energetic cost of putting 2e- in the same orbital).

For Cr and Mo, the pairing penalty is worse.

\[ \text{ns}^1 (n-1)d^5 \text{ is most stable.} \]

For W, promoting an e- to the 5d (from the 4s) subshell is worse (i.e., requires more energy).

\[ \text{6s}^2 5d^4 \text{ is more stable.} \]