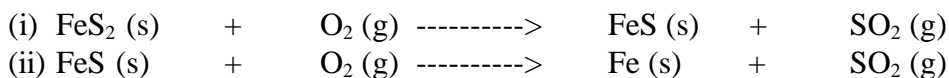


For full credit, please show all work clearly.

(1.) The following equations describe the formation of iron metal, in two steps.



- (a) Please add the two equations together, simplify the sum, and call it (iii). (5 points)  
(b) Please use the following data to calculate  $\Delta H^\circ$  for (iii). (5 points)

$$\begin{array}{l} \Delta H_f^\circ \text{SO}_2 (\text{g}) = -297.0 \text{ kJ/mole} \\ \Delta H_f^\circ \text{FeS}_2 (\text{s}) = -178.2 \text{ kJ/mole} \end{array}$$

- (c) For equation (i),  $\Delta H^\circ = -218.8 \text{ kJ}$ ; please calculate  $\Delta H_f^\circ \text{FeS} (\text{s})$ . (5 points)  
(d) Please calculate  $\Delta H^\circ$  for equation (ii). (5 points)  
(e) Please represent (i), (ii), and (iii) together on an energy level diagram. (5 points)  
(f) Given that sulfur occurs naturally as  $\text{S}_8 (\text{s})$ , please write the thermochemical equation for the formation of  $\text{FeS} (\text{s})$  from its elements. (5 points)

(2.) A researcher in the laboratory heated a lump of lead of mass 188.2 g from 25.0 °C to 99.8 °C, but dropped it accidentally into a styrofoam cup containing his coffee, which did not contain any milk, or sugar. The specific heat capacity of lead is 0.128 J/g/°C.

- (a) Please determine the energy supplied in heating the lead lump. (10 points)  
(b) Out of curiosity, the researcher measured the temperature of the coffee and found it to be 99.8 °C! How much heat energy was transferred from the lead to the coffee? (5pts)  
(c) He brewed himself another cup of coffee, but his sweet-heart called and he completely forgot about it. How much heat energy (in J) was lost to the surroundings as 251.1 g coffee cooled from 99.8 °C to 25.2 °C? Assume the specific heat capacity of coffee is 4.18 J/g/°C. (5 points)

(3.) (a) Please calculate the wavelength (in nm) of the photon emitted as the electron falls from the n=6 level to n=2 in the hydrogen atom? (5 points)  
(b) What is the energy of this photon, in J? (5 points)  
(c) What is the energy of this photon, in kJ/mole? (5 points)  
(d) What region of the electromagnetic spectrum is this radiation in? (5 points)

Please assume  $c=3.00 \times 10^8 \text{ m/s}$ ;  $R=109678 \text{ cm}^{-1}$ ;  $h=6.626 \times 10^{-34} \text{ Js}$

(4.) (a) Please draw the Aufbau diagram for the element arsenic. (2 points)  
(b) Please encircle and identify the core and valence electrons on the diagram above. (2 points)  
(c) Is the atomic radius of arsenic larger or smaller than that of bismuth? (2 points)  
(d) Which is the ion that arsenic will prefer to form? (2 points)  
(e) Please write the equation for the 1<sup>st</sup> Ionization Energy of arsenic, given that  $\Delta H^\circ = 947 \text{ kJ/mole}$ . (2 points)

- (5.) (a) Please write the shorthand electronic configurations of: Po, Ag, Sc, Sr, Se (5 pts)  
(b) Please identify five ions which are isoelectronic with Ar. (5 points)  
(c) Please draw orbital diagrams for the valence electrons of N, S, Mg, Ga, Fe (5 pts)  
(d) Please cite the effects of increasing the effective nuclear charge across a row, with respect to atomic radius, and ionization energy. (5 points)

Bonus Question: (5 points)

Please determine the wavelength (in nm) of photons with energy 2,000 kJ/mole.