1. The theoretical element Gruebelum (Gb) has a molecular weight of 253.46 g/mol. It has 3 known isotopes $^{250}\text{Gb}$, $^{252}\text{Gb}$, and $^{258}\text{Gb}$ of mass 250.347, 252.578, and 259.352 amu respectively. It is known that $^{252}\text{Gb}$ is the most common isotope at 65% of the world’s supply of Gb. What are the relative abundances of the other 2 isotopes? (2+2)

2. In a certain chemical reaction $\text{A} \rightarrow \text{B}$, it is known that mass is not conserved. If the amount of mass lost in this reaction is 0.067 amu, and the energy produced as a result goes into the kinetic energy of B, what is the value of this energy? (1amu = 1.66x10$^{-27}$ kg) (2)

3. Iron can be oxidized by air to form iron oxide.
   a) The following 2 reactions are possible reaction pathways for this oxidation process. Balance the two equations. (1+1)
   \[
   \text{Fe} + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3
   \]
   \[
   \text{Fe} + \text{O}_2 \rightarrow \text{FeO}
   \]
   b) An experiment was done to find which reaction was correct. In this experiment 0.558 g of Fe was reacted with excess amount of oxygen. After all Fe was reacted, 0.798 g of iron oxide was obtained. Use stoichiometry to find which reaction pathway is correct. Circle the right equation in part a. To get full points, you must show all work. (2)
1. A sample of liquid hexane (C₆H₁₄) weighing 21.5 g is reacted with 64 g of oxygen gas. The hexane is burned completely (hexane reacts with oxygen to form both carbon monoxide and water and carbon dioxide and water). After the reaction is complete the amount of gas present is 1.575 moles (assume all of the water formed is liquid). How much CO₂ is produced? How much CO is produced? How much O₂ remains? (hint: Make 2 balanced equations - one for the production of CO₂ and water, and one for the CO and Water)(1+1+1+1+1)

2. Following are the compounds having coordinate covalent bonds. Identify the donor and the acceptor atoms.(1/2 each =2)
   a. Cl⁻-BeCl₂-Cl⁻
   b. BF₃-NH₃
   c. H₂O-H⁺
   d. NH₄⁺

3. Consider the hypothetical formation of an atom of oxygen from 8 atoms of hydrogen and 8 neutrons. (Oxygen – 15.9994 amu neutron - 1.008665 amu, hydrogen - 1.00794 amu., 1 amu = 1.66x10⁻²⁷ kg)(1+2)
   a. Calculate the mass defect (mass lost in amu) in this chemical reaction.
   b. What is the binding energy (in J) corresponding to this loss in mass?
1. A common protein structure is the beta sheet. The beta sheets can be anti-parallel or parallel. The two structures are shown below. It is known that one of these structures is more stable than the other. Which one is more stable and why. (1+1)

2. It is known that the atomic mass of A is two times that of B. What is the percent composition (by mass) of B in A₄B? (2 points)

3. It is known that the mass of helium does not equal the sum of the masses of two deuterium (D) atoms, even though they are made up of the same elementary subatomic particles. If this mass is lost as the binding energy of the Helium nucleus, find the amount of energy (in J) you need to impart to the Helium nucleus to make two Deuterium atoms? (D - 2.01355321270 amu, He - 4.00260323 amu, 1 amu = 1.66x10⁻²⁷ kg) (2)

4. Consider the reaction where aluminum reacts with iodine (I₂) to give AlI₃. Write the balanced chemical equation for the above reaction. Determine the limiting reagent and the theoretical yield of the product if one starts with:
   a) 1.20 mol Al and 2.40 mol iodine.
   b) 1.20 g Al and 2.40 g iodine
   c) How many grams of the limiting reagent are left over in part b? (1+1+1+1)