

Total Marks: /30

1. What are the full electron configurations of the following atoms (3 points)
 - a. Cu^{2+}
 - b. Ni
 - c. O^{2-}
 - d. Ar
 - e. Au
 - f. Na^{1+}
2. A 100 lumen laser is directed at a 2L of water at 20°C. Let us say that it takes 4200 J to heat 1L of water 1 degree. If it takes 6 days for the water to heat up to 30°C, assuming perfect delivery and absorption of energy and no energy loss over this time, what is the wavelength of the laser that was used? Assume that 1 lumen = 4.09×10^{15} photons/s. (4 points)
3. The conductivity of an unknown intrinsic semiconductor was measured to increase by a factor of 10 between the two temperatures 25°C and 100°C. Recall that the relationship between conductivity and temperature should follow an Arrhenius-type relationship of the form $\sigma = \sigma_0 e^{\frac{-E_g}{2k_b T}}$, assuming that electron and hole mobilities do not change over this temperature range. Determine the band gap of this unknown semiconductor. (6 points)
4. What is the conductivity of pure germanium at 26°C if n_i at 300K is 4×10^{13} /Ohm-cm while the electron and hole mobilities are 3600 and 1700 cm^2/Vs , respectively? (2 points)
5. Assume that Gd atoms in Gd metal act as isolated Gd atoms in terms of their magnetic moment. Calculate the saturation magnetization of Gd metal. Note: Gd has a density of 7.9 g/cm^3 and a molar mass of 157.25 g/mol . (5 points)
6. Calculate the theoretical density of diamond. The molar mass of carbon is 12 g/mol and the atomic radius is 70pm. (7 points)
7. If we want to make an LED that is formed from $\text{Ga}_x\text{Al}_{(1-x)}\text{As}$ that emits at a wavelength of 450 nm, what is x? (3 pts)