**Laser physics test 2015**

1. What is the wavelength corresponding to the peak of the blackbody radiation at room temperature (300 K)? (1 point)
2. Why is the transition from 3s to 2s state in Hydrogen forbidden? What would be the energy change if this transition would be possible? (2 points)
3. Write down the time independent Schrödinger equation for a H2+ molecule (electron in the field of two protons at distances r1 and r2 from it, the distances between the protons being r)! (2 points)
4. In a 2D potential box there is a particle. For a particle in a two-dimensional box, if the particle is in the state ψ1,2(x,y) (nx=1 and ny =2) what is the probability that a measurement of the particle's position will yield 0<=x<=L/2 and 0<=y<=L/2 (3 points)?
5. What is the Fermi energy? How does doping change the Fermi level in semiconductors? (2 points)
6. If the average lifetime of an electron in the excited state of hydrogen is in the order of 10-8 s estimate how many orbits an electron makes during this time a.) when it is in state n=2 b:) when it is in state n=15 before it suffers a transition to state n = 1
7. How do the frequencies of the radiation absorbed or emitted by the H atom depend on the main quantum numbers? (1 point)
8. How many electrons are accepted by the p states in Xe and why? (2 points)
9. A monochromatic beam of electromagnetic radiation has an intensity of 1 mW/cm2. What is the average number of photons/m3 if the radiation is 300 THz (1012 Hz) frequency electromagnetic wave? What is the wavelength of that wave in vacuum? (2 points)
10. What are the boundary conditions set for an electron’s wave function, which is closed in a cubic box with the edge lengths 1, 2, and 5 nm along the x, y, and z axes respectively? What is the minimum energy of that electron? Is that energy kinetic or potential? (3 points)
11. Determine the saturation photon-flux density, and the corresponding saturation intensity, for the λ = 800-nm Ti:sapphire ion laser transition at ν = νo. Use the parameters provided in the table below. Assume that τs= 1.5\*tsp. (2 points)



1. A 100 cm long Er3+ doped silica fiber used as a laser amplifier has a total small signal gain of 15 at λ0=1.55 µm. Use the data in the table above to determine the population difference N required to achieve this gain. (2 points)
2. Ruby is a three level laser material with a ground state population N1 = 6\*1026 and negligible laser level population N2 at room temperature. Using the above table determine the amount of pumping rate (R=excited atoms/(m3\*s)) necessary to reach population inversion between levels 1 and 2. (2 points)