**3322 Fall 2021 – Quick Problems Meeting 1**

For all homework in the 3322 class, answers must be type and presented digitally using MS Word (AND NOT provided as pdf files). Answers must be presented in the correct order using adequate spacing between answers and parts of an answer. Please do not use highlights. Use a space between a number and the units. Where relevant, correct grammar and punctuation (such as capitalization for a person’s name) must be used. When referring to the spreadsheet software Excel, please capitalize the initial E. In general, you should get into the habit of using all significant figures for the physical constants. I also suggest you use Excel software for doing the calculations. **Provide only the Answers for Questions that require that.**

1. The spectral distribution of light emitted from a radiating blackbody, ρ(λ,T) (i.e., light intensity at a wavelength, λ vs. that wavelength) is a sensitive function of that body’s temperature, T. This dependence can be used to measure the temperature of hot objects, without making physical contact with them in a technique called *optical pyrometry*. [This method now is being used to check the temperature of people for the Coronavirus]. In the limit where (hc/λkBT) >>1, the maximum in a plot of spectral density ρ(λ,T) versus λ is given by λmax = hc/(5kBT). Use this relationship, to determine at what wavelength, λ in meters the maximum in ρ(λ,T) occurs for (a) T = 3422 ºC (the melting point of tungsten, the metal with the highest M. Pt.) and (b) T = 98.6 oF, which is taken to be the normal skin temperature for human beings (i.e., since the emission spectrum of human skin conforms closely to a blackbody radiator, determine λmax for human skin. Provide answers to (a) and (b) to 4 & 3-significant figures respectively. [Background provided in Notes #1]. **Provide Answers only.**

[5 + 5 points]

1. Pulsed lasers are powerful sources of nearly monochromatic radiation and can be used to etch and cut very hard materials. Nd:YAG Lasers that emit 1064 nm photons at a 25.0 MHz repetition rate in pulses of 10.0-ns duration with a total energy in the pulse of 0.0200 J are commercially available. [The laser medium for Nd:YAG lasers actually consists of synthetic cubic garnet crystal, Nd:Y3Al5O12].

(a) What is the average power (energy output per unit time) in units of watts (W) of this laser?

Note: 1 W = 1 Joule/second. **Provide Answer only.**

(b) What is the average power in units of watts associated with each pulse from this laser? {Answer will be different from the one for 2(a)}. **Provide Answer only.**

(c) How many 1064-nm photons are emitted in each Nd:YAG laser pulse? **Provide Answer only.**

(d) How many 532.0 nm photons are delivered per second from a Coherent Inc. Verdi Green DPSS Laser operating cw (continuous-wave) at 5.00 Watts. **Provide Answer only.**

[A Verdi V-10 laser system as made by Coherent Inc. is a compact solid-state, diode-laser pumped, frequency-doubled laser based on a Nd:Vanadate crystal laser medium. It produces a single-frequency, green-colored (532.0 nm) laser beam, at an output power of up to 10 W. Such a laser is used in our research laboratory (located in M103) to pump dye lasers and Ti:sapphire lasers for very High-Resolution (up to 0.0035 cm-1) and ultra-high sensitivity Intracavity Laser Spectroscopy experiments].

Provide all answers to Question 2 using at least 3-significant figures.

Hint: In solving Question 2, you need to use the following concepts:

1. a laser pulse corresponds to a rapid output of energy expended over a short amount of time – it is assumed that the same total output energy is provided throughout the laser’s pulse duration;
2. Power = Energy/Time.

[4 + 4 + 6 + 6 points]

[Total number of points = 30]