

CHEM 103

R&R 11

14 June 2024

Adapted from a 21 June 2021 document

1. Exposure to high doses of microwaves can cause tissue damage. Estimate how many photons, with $\lambda = 12$ cm, must be absorbed to raise the temperature of your eye by 3.5°C . Assume the mass of an eye is 11 g, with a specific heat capacity of $4.0\text{ J/(g}\cdot^\circ\text{C)}$.

2. Molybdenum metal must absorb radiation with a minimum frequency of $1.09\times 10^{15}\text{ s}^{-1}$ before it can eject an electron from its surface via the photoelectric effect.

a. What is the minimum energy needed to eject an electron?

b. What wavelength of radiation will provide a photon of this energy?

3. A diode laser emits light at a wavelength of 987 nm. All of its output energy is absorbed in a detector that measures a total energy of 0.52 J over a period of 32 seconds. How many photons per second are being emitted by the laser?

4. Suppose a microwave emits electromagnetic radiation with a wavelength of 11.2 cm. How many photons of radiation are required to heat 200. mL of coffee from 23 °C to 60 °C? If the power of the microwave is 900. W (one watt is one joule per second), how long would it take to heat the coffee? Assume that the specific heat and density of coffee are the same as water's.

5. What is the maximum number of orbitals (m_l) with:

- a. $n = 4$ and $l = 1$
- b. $n = 2$ and $l = 2$
- c. $n = 3$ and $l = 2$
- d. $n = 5$, $l = 2$, and $m_l = -1$

6. What are the quantum numbers (n , l , and m_l) that can describe a 3p orbital?

7. What are the quantum numbers that can describe a 5d orbital?

8. What is the maximum number of electrons that can occupy each of the following subshells? (Hint: the Pauli Exclusion Principle states that each electron must have a unique set of quantum numbers.)

- a. 3p
- b. 2s
- c. 5d
- d. 4f
- e. 3d