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Exercises and Complements for the Introduction to Physics II

for Students

of Biology, Pharmacy and Geoscience

Sheet 11 / 13.05.2021 Zoom - Q&A on the Exercises: **25.05.2021/26.05.2021**

Exercise 41.

A laser with power $P = 5$ W emits coherent light of wavelength $\lambda = 690$ nm.

(a) What are the energy, mass and momentum of a single photon and what are the number of photons emitted per unit time $\dot{N}_{Ph}$ from the laser?

(b) What power does a photon flux of $\dot{N}_{Ph} = 5\ \mathrm{s}^{-1}$ correspond to? (This power can still be perceived by the human eye.)

Exercise 42.

The temperature of the solar surface is assumed to be $T_S = 5800$ K and the solar radiation is assumed to be black body radiation with an emissivity of $\epsilon = 1$.

(a) What is the energy radiated by the sun per second?

(b) What is the amount of radiant energy received per second by $1\,\mathrm{m}^2$ of the earth's surface with perpendicular incidence of the radiation (solar constant)? The solar radius is $R_S = 6.97 \cdot 10^8$ m and the mean radius of the earth's orbit around the sun is $r_E = 1.5 \cdot 10^{11}$ m.

Exercise 43.

What is the wavelength $\lambda_{\max}$, at which the maxima of the spectral energy distribution of the radiation lie. Consider the following radiation sources:
(a) the filament of a light bulb ($T = 3000$ K)

(b) the solar surface ($T = 5800$ K)

(c) the cosmic background radiation, which originated shortly after the big bang and has a temperature of $T = 2.72\,\mathrm{K}$ today.

Exercise 44.

What is the de Broglie wavelength of an electron traveling at 1 % of the speed of light?

Answers.

Exercise 41. (a) $E_{Ph} = 1.8$ eV, $m_{Ph} = 3.2 \cdot 10^{-36}$ kg, $p_{Ph} = 9.6 \cdot 10^{-28}$ kg m/s, $\dot{N}_{Ph} = 1.74 \cdot 10^{19}$ s^{-1} (b) $P = 1.44 \cdot 10^{-18}$ W

Exercise 42. (a) $3.92 \cdot 10^{26}$ W (b) $E_S = 1385$ J/(m$^2\cdot$ s)

Exercise 43. (a) 966 nm (b) 500 nm (c) 1.07 mm

Exercise 44. 2.43 Å