Problem 1.

Draw the energy level diagram for a 4-level laser and explain in words how it works.

Solution

Problem 2.

Calculate the (a) peak output and (b) average power for a laser that produces 12 ps pulses at a repetition rate of 1000 kHz with an energy of 100 µJ/pulse.

Solution

Part (a)

$$\begin{aligned} 100\,\mu\text{J} &= \frac{100 \times 10^{-6}\,\text{J/pulse}}{12 \times 10^{-12}\,\text{s/pulse}} \\ &= 8\,\text{MW} \end{aligned}$$

Part (b)

$$100 \times 10^{-6}\,\text{J/pulse} \times 1000 \times 10^{3}\,\text{s}^{-1} = 100\,\text{W}$$

Problem 3.

Briefly explain how a Q-switch works and the effect it has on the laser output.

Solution

Problem 4.

Explain how CW, pulsed, and Q-switched laser pulses differ from each other.

Solution

Problem 5.

Define the three χ terms which arise from the polarization in nonlinear optics and identify what frequency they oscillate at.

Solution

Problem 6.

A Nd:YVO4 laser has two output wavelengths in the IR wavelength region, 1064 nm and 1342 nm. We would like to use non-linear optics to create the harmonics of the 1342 nm line. Identify the following wavelengths:

(a) Fundamental,

(b) Second harmonic, and

(c) Third harmonic.

Solution

Problem 7.

Describe how a CCD works.

Solution

Problem 8.

What is the difference between random and non-random noise and is each one fundamental or non-fundamental?

Solution

Problem 9.

Identify the following types of noise as either fundamental (F) or non-fundamental (NF):

(a) Shot noise,

(b) Pink noise,

(c) Interference,

(d) Dark current noise,

(e) Readout noise, and

(f) Impulse noise.

Solution

Problem 10.

Identify and define the 3 types of atomic spectroscopy.

Solution

Part (a)

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Part (b)

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Part (c)

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