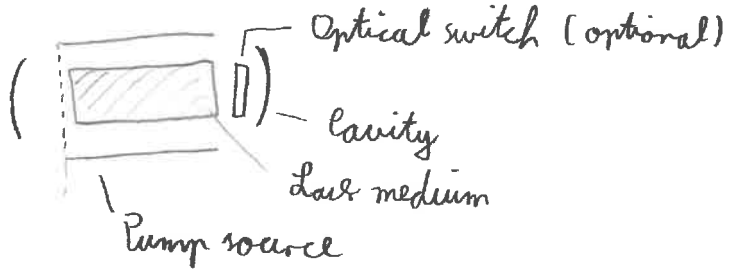
Upload your finished worksheet as a single pdf file on moodle before the next class session in order to get participation credit.
Try to keep your books closed. Discuss with your fellow students to come to an answer.
Show your work.

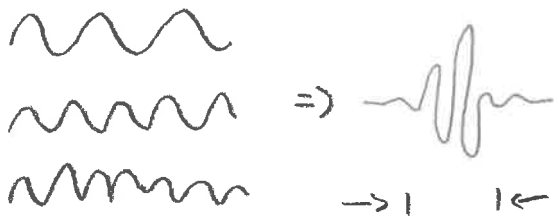
Name: _____

1. Sketch the basic components of a laser. Which components do you need?

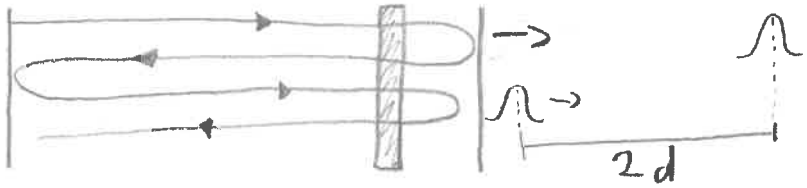


2. What is required to produce a short pulse? Explain with a sketch?

Source with a broad output and an optical switch to operate phase locked:



3. What is the key component of a (passively) mode locked laser? Sketch.



↳ Optical switch

4. The minimum pulse duration from a mode locked laser is related to the number of modes (bandwidth) it can support according to the following formula: $\Delta t = \frac{0.441}{N\Delta\nu}$. Calculate the minimum pulse duration for a laser with a spectral width from a) 600 - 800 nm and b) 680 - 720 nm

a) $\nu = \frac{c}{\lambda}$ $\quad \nu_1 = \frac{c}{600\,nm} = 5 \cdot 10^{14}\,Hz$ $\quad \nu_2 = \frac{c}{800\,nm} = 3{,}75 \cdot 10^{14}\,Hz$

$\Delta t = \frac{0.441}{1{,}25 \cdot 10^{14}\,Hz} = 3{,}5 \cdot 10^{-15}\,s = \underline{3{,}5\,fs}$

b) $\nu_1 = 4{,}41 \cdot 10^{14}\,Hz$ $\quad \nu_2 = 4{,}17 \cdot 10^{14}\,Hz$

$\Delta t = 18{,}1 \cdot 10^{-15}\,s = \underline{18{,}1\,fs}$

5. A commercial TiSa laser has a repetition rate of 100 Hz and delivers pulse energies of 10 mJ in 100 fsec pulses. Calculate the average power as well as the peak power.

$1\,W = \frac{1\,J}{s}$

$P_{Peak} = \frac{10\,mJ}{100 \cdot 10^{-15}\,s} = \underline{10^{11}\,W}$

$P_{Avg} = 10\,mJ \cdot 100\,Hz = \underline{1\,W}$

6. Now you focus your laser to a 30 micron spot size. What is the power density (W/cm^2)?

$D = 30\,\mu m \Rightarrow r = 1{,}5 \cdot 10^{-3}\,cm$

$A = \pi r^2 = 7{,}07 \cdot 10^{-6}\,cm^2$

$PD = \frac{10^{11}\,W}{7{,}07 \cdot 10^{-6}\,cm^2} = \underline{1{,}4 \cdot 10^{16}\,W/cm^2}$

The End.