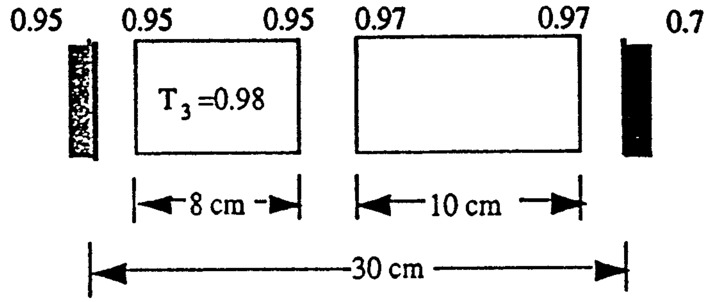
9.18

The difference here from 9.17 is that $g_2 \neq g_1$ and hence all of the equations for Q–switching must be re–examined (see Problem 9.16). Furthermore, the absorption cross–section is given, not the stimulated one. $N_2 + N_1 = N_0 = 1.58^{+19}\ \mathrm{cm}^{-3}$

$\therefore N_1 = 0.58\times10^{+19}\ \mathrm{cm}^{-3}$; (a) $P_{spont} = \dfrac{h\nu N_2 \cdot Vol}{\tau_{sp}} = 9.53\ \mathrm{kW}$

(b) $P_{pump} = \dfrac{1}{0.9}\dfrac{6943}{4500}P_{spont} = 16.4\ \mathrm{kw}$;

(c) $\tau_{RT}' = 2\left[\dfrac{12}{c} + \dfrac{2.35\mathrm{x}8}{c} + \dfrac{1.78\mathrm{x}10}{c}\right] = 3.24\ \mathrm{ns}$



$\sigma_{STIM} = \dfrac{g_1}{g_2}\sigma_{abs} = 2.65\times10^{-20}\ \mathrm{cm}^2$;

$\gamma_{th} = \dfrac{1}{2l_g}\ln\dfrac{1}{R_1T_a^2T_b^2T_c^2T_d^2T_s^2} + \ln(1/R_2) = 2.09\times10^{-2}\ \mathrm{cm}^{-1} + 1.78\times10^{-2} = 3.87\times10^{-2}\ \mathrm{cm}^{-1}$

$1/\tau_p = (1 - R_1T_a^2T_b^2T_c^2T_d^2T_s^2)/\tau_{RT} = 1.67\times10^{+8}\ \mathrm{sec}^{-1}$;

$(N_2-N_1)_{th} = 1.52\times10^{+18}\ \mathrm{cm}^{-3}$

$n_{th} = 1.52^{+19}$ atoms; $n_i = (N_2 - \dfrac{g_1}{g_2}N_1)Al_g = \left(10^{19} - \dfrac{1}{2}\times 0.58\times10^{+19}\right)10 = 7.1\times10^{+19}$

atoms $\therefore \dfrac{n_i}{n_{th}} = 4.66 \quad \therefore\ n_{xtr} = 0.99$;

$$P_{out} = \frac{\alpha_{exT}}{\alpha_T}\frac{h\nu}{\tau_p}\left\{\frac{n_i-n_{th}}{(1+g_2/g_1)} - \frac{n_{th}}{(1+g_2/g_1)}\ln\frac{n_i}{n_{th}}\right\}$$

$$= \frac{1.78}{3.87}\cdot\frac{2.86\times10^{-19}}{6\times10^{-9}}\left\{\frac{1.69\times10^{+19}}{1.5}\right\} = 474\ \mathrm{MW}$$

$W = \eta_{cpl}\dfrac{n_i h\nu}{(1+g_2/g_1)}n_{xtn} = 6.16$ Joules; $\Delta t = \dfrac{W}{P} = 13.0$ nsec