Exo1 :

1) Le quartz est un milieu NL d'ordre 2 (0,2pt)

Onde que $\lambda_1 \xrightarrow{(0,2pt)} \frac{\lambda_1}{2}$ ou $\omega_1 \to 2\omega_1$ (0,2pt)

$\Rightarrow$ génération de second Harmonique

2) Explication (0,1)

$$P_{NL}(\vec{r},t) = 2d\,E^2(\vec{r},t) = 2d\left(\frac{1}{2}\underline{\mathcal{E}}^{\omega}(\vec{r})e^{i\omega t} + \frac{1}{2}\underline{\mathcal{E}}^{\omega *}(\vec{r})e^{-i\omega t}\right)^2 \quad (0,2pt)$$

$$= P_{NL}^{0}(\vec{r}) + \mathrm{Re}\left\{P_{NL}^{2\omega}(\vec{r})e^{i2\omega t}\right\} \quad (0,1)$$

$$P_{NL}^{0}(\vec{r}) = d\left|\underline{\mathcal{E}}^{\omega}(\vec{r})\right|^2 \quad (0,2pt) \qquad P_{NL}^{2\omega}(\vec{r}) = d\left(\underline{\mathcal{E}}^{\omega}(\vec{r})\right)^2 \quad (0,2pt)$$

3) Relation d'accord de phase $\vec{k}_2 = 2\vec{k}_1$ (0,2pt)

(0,2pt)

Exo2 :

Conversion de fréquence (0,2pt) "Down conversion" (0,2pt) :

$$\left.\begin{aligned}\omega_- &= \omega_1 - \omega_2 \\ k_- &= k_{z1} - k_{z2}\end{aligned}\right\} 2\pi f_- = 2\pi f_1 - 2\pi f_2 \Rightarrow \frac{1}{T_-} = \frac{1}{T_1} - \frac{1}{T_2}$$

ou $\frac{c}{\lambda_-} = \frac{c}{\lambda_1} - \frac{c}{\lambda_2} \to \frac{1}{\lambda_-} = \frac{1}{\lambda_1} - \frac{1}{\lambda_2}$ (0,2pt)

$$\to \lambda_- = \frac{\lambda_1\lambda_2}{|\lambda_1 - \lambda_2|} \quad (0,2pt) = \frac{1{,}064 \cdot 10^{-6}}{|1{,}064 - 10^{-6}|} = 1{,}18\,\mu m$$

$$P = 2d\left(\vec{E}_1 + \vec{E}_2\right)^2 \quad (0,2pt) = 2d\left(E_1^2 + E_2^2 + 2E_1E_2\right) \quad (0,2pt)$$

$$= P_1 + P_2 + P_3 \quad (0,2pt)$$

$$P_1 = P_{NL}^{0}(\vec{r}) + \mathrm{Re}\left\{P_{NL}^{2\omega_1}(\vec{r})e^{2i\omega_1 t}\right\} \quad (0,2pt)$$

$$P_2 = P_{NL}^{0}(\vec{r}) + \mathrm{Re}\left\{P_{NL}^{2\omega_2}(\vec{r})e^{i2\omega_2 t}\right\} \quad (0,2pt)$$

$$P_3 = 4d\,E_1E_2 = 4d\left(\frac{1}{2}\underline{\mathcal{E}}^{\omega_1}(\vec{r})e^{i\omega_1 t} + \frac{1}{2}\underline{\mathcal{E}}^{\omega_1 *}(\vec{r})e^{-i\omega_1 t}\right) \times$$

$$\left(\frac{1}{2}\underline{\mathcal{E}}^{\omega_2}(\vec{r})e^{i\omega_2 t} + \frac{1}{2}\underline{\mathcal{E}}^{\omega_2 *}(\vec{r})e^{-i\omega_2 t}\right) \quad (0,2pt)$$

$$= 2d\,\mathrm{Re}\left\{\underline{\mathcal{E}}^{\omega_1}(\vec{r})\underline{\mathcal{E}}^{\omega_2}(\vec{r})e^{i(\omega_1+\omega_2)t} + \underline{\mathcal{E}}^{\omega_1}(\vec{r})\underline{\mathcal{E}}^{\omega_2 *}(\vec{r})e^{i(\omega_1-\omega_2)t}\right\}$$

(0,2pt) (0,2pt)