a)
$$\frac{d\sigma}{d\Omega} = \frac{\sigma}{4\pi}\left(1+\beta P_2(\cos\theta)\right)$$

Collecting at all angles amounts to integrating over all angles

$$\int d\Omega \frac{d\sigma}{d\Omega} = \sigma + \frac{\beta\sigma}{4\pi}\int_0^{2\pi} d\phi \int_0^{\pi} d\theta \sin\theta P_2(\cos\theta) \qquad (1)$$

$$P_2(\cos\theta) = \frac{1}{2}(3\cos^2\theta - 1)$$

Substituting $u = \cos\theta$, $du = -\sin\theta d\theta$

$$\int_0^{2\pi} d\phi \int_0^{\pi} \sin\theta d\theta = -2\pi \int_1^{-1} du \, \frac{1}{2}(3u^2-1)$$

$$= \pi \int_{-1}^{1} du\,(3u^2-1)$$

$$= \pi\left[u^3\Big|_{-1}^{1} - 2\right] = 0$$

So the second term of (1) vanishes and you have

$$\int \frac{d\sigma}{d\Omega} d\Omega = \sigma \quad \text{independant of } \beta$$

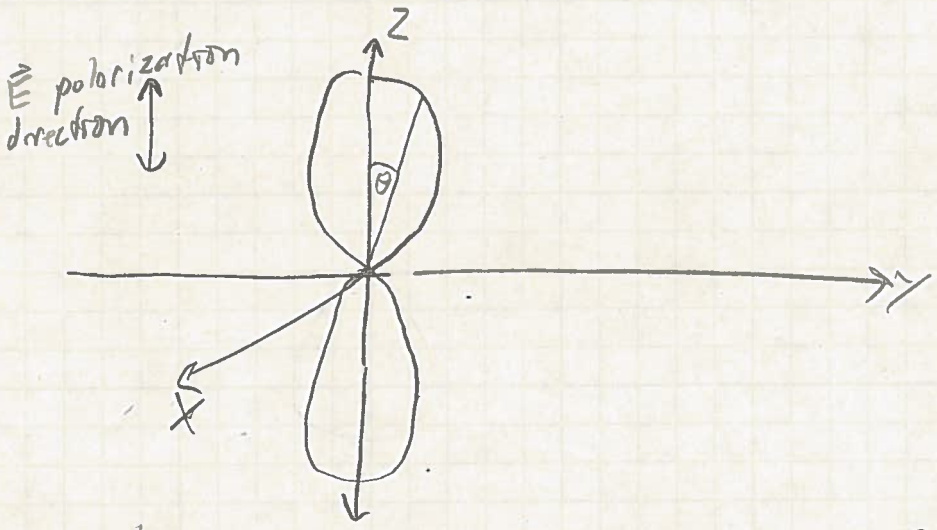
b) The second term vanishes when

$$P_2(\cos\theta) = 0 = \frac{1}{2}(3\cos^2\theta - 1)$$

or $\cos^2\theta = \frac{1}{3}$ $\quad \theta = \cos^{-1}\left(\frac{1}{\sqrt{3}}\right) = 54.736$

The magic angle

c) For $\beta = 2$, the intensity is maximal for $\theta = 0$ (along the light polarization) and zero for $\theta = 90°$. The distribution looks like this on a radial plot



Assuming the dissociation is much faster than molecular rotation (and judging from the potential curves in the graded paper, it definitely is), the molecular dipole must be ∥ to the molecular axis, so that the molecules that absorbed light and dissociated were the ones that were ∥ to $\vec{E}$.