Biomicroscopy I - Solutions Exercise Sheet 10

November 18, 2025

1 Energy and wavelength of a photon

A.
$$E = \frac{1.24\text{eV} \cdot 1\mu\text{m}}{1\mu\text{m}} = 1.24\text{eV}$$

B.
$$E_{red} = \frac{1.24\text{eV} \cdot 1\mu\text{m}}{0.65\mu\text{m}} = 1.9\text{eV}$$

C.
$$E_{2.48\mu\text{m}} = \frac{1.24\text{eV} \cdot 1\mu\text{m}}{2.48\mu\text{m}} = 0.5\text{eV}$$

D.
$$\lambda_{2\text{eV}} = \frac{1.24\text{eV} \cdot 1\mu\text{m}}{2\text{eV}} = 620\text{nm}$$

E.
$$\lambda_{3.1\text{eV}} = \frac{1.24\text{eV} \cdot 1\mu\text{m}}{3.1\text{eV}} = 400\text{nm} \rightarrow \text{Violet}$$

2 Fluorescence as a three-stage process

A. **(i)**

B. **(iii)**

C. **(ii)**

D. No, the molecule cannot be excited with orange light:
$$E_{orange} = \frac{1.24\text{eV} \cdot 1\mu\text{m}}{0.59\mu\text{m}} = 2.1016\text{eV} < 2.17 < 2.61$$

E. Yes, the molecule can be excited with violet light:
$$E_{violet} = \frac{1.24\text{eV} \cdot 1\mu\text{m}}{0.4\mu\text{m}} = 3.1\text{eV} > 2.61$$

F. Emission occurs at the transition $E_1 \rightarrow E_0$. Therefore, the energy $E_{emitted}$ of the emitted light will be
$$E_{emitted} = E_1 - E_0 = 2.17\text{eV}$$

The corresponding wavelength $\lambda_{emitted}$ is then

$$\lambda_{emitted} = \frac{1.24\text{eV} \cdot 1\mu\text{m}}{2.17\text{eV}} = 571\text{nm}$$

and thus, the corresponding colour is yellow.

G. $E_{lost} = E_2 - E_1 = 2.61 - 2.17 = 0.44\text{eV}$.

3 Fluorescence lifetime and decay rates

A. $\tau_r = \frac{1}{k_r} = 1.43\text{ns}$

B. $\tau_{nr} = \frac{1}{k_{nr}} = 3.3\text{ns}$

C. $k = k_r + k_{nr} = 10^9\text{s}^{-1}$

D. $\tau = \frac{1}{k} = 1\text{ns}$

E. $Q = \frac{k_r}{k_r + k_{nr}} = 0.7\ (70\%)$