Química Física I
Grado en Química

UNIVERSIDAD DE MURCIA

Lesson: ATOMIC SPECTROSCOPY

PROBLEM SHEET: QUESTIONS

1. (♦◇◇) Prove that the transition probability from the n state to the m state for a time independent perturbation is given by

$$P_{n\to m}(t) = \left|\frac{2H'_{mn}}{\hbar\omega_{mn}}\right|^2 \sin^2\left(\frac{\omega_{mn}t}{2}\right)$$

2. (♦♦♦) Prove that the electronic transition matrix element for a particle in a one-dimensional box along the x axis is biven by

$$\langle m|\mu|n\rangle = \frac{q\,l}{\pi^2}\left(\frac{\cos[(m-n)\pi]-1}{(m-n)^2} - \frac{\cos[(m+n)\pi]-1}{(m+n)^2}\right)$$

where q is the particle charge and l is the box length.

3. (♦◇◇) Prove that

$$\int_0^t \cos(\omega\,t')e^{i\omega_{mn}\,t'}dt' = \frac{1}{2i}\left(\frac{e^{i(\omega_{mn}+\omega)t}-1}{\omega_{mn}+\omega} + \frac{e^{i(\omega_{mn}-\omega)t}-1}{\omega_{mn}-\omega}\right)$$

4. (♦♦◇) Prove that

$$\left|e^{i(\omega_{mn}-\omega)t}-1\right|^2 = 4\,\sin^2\left(\frac{(\omega_{mn}-\omega)t}{2}\right)$$

5. (♦♦◇) The first line in the Lyman series of a hidrogenic atom is at 48.6 Å.

   a) Identify the chemical element.

   b) Calculate the minimum values of the wavelengths of the Balmer and Lyman series of that atom.

Dificulty level: (♦◇◇) Easy, (♦♦◇) Normal, (♦♦♦) To think a bit.

PROBLEM SHEET: SOLUTIONS

Question 5 $\Rightarrow$ $Z = 5$, $\lambda_{\mathrm{min,Lyman}} = 36.5\,\text{Å}$, $\lambda_{\mathrm{min,Balmer}} = 146\,\text{Å}$