

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS  
DEPARTMENT OF PHYSICS

PHYSICS 212 Modern Physics  
TERM 022  
EXAM #2

Date: Monday 21 April 2003  
Instructor: Dr. A. Mekki

Grade = **/30**

Name: Key Id#: \_\_\_\_\_

SHOW THE DETAILS OF YOUR WORK

**Problem#1 (5 points)**

The width of a spectral line of wavelength 400 nm is measured to be  $10^{-5}$  nm. What is the average time that the atomic system remains in the corresponding energy state (lifetime)?  
(Hint: Use the Heisenberg uncertainty principle)

$$\lambda = 400 \text{ nm} = 4 \times 10^{-7} \text{ m}$$

$$\Delta\lambda = 10^{-5} \text{ nm} = 10^{-14} \text{ m}$$

$$E = \frac{hc}{\lambda} \Rightarrow dE = -\frac{hc}{\lambda^2} d\lambda$$

$$\Delta E = \frac{hc}{\lambda^2} \Delta\lambda$$

$$\Delta E \cdot \tau \geq \frac{\hbar}{2}$$

$$\tau = \frac{\hbar}{2\Delta E} = \frac{\hbar \lambda^2}{2hc \Delta\lambda} = \frac{\lambda^2}{4\pi c \Delta\lambda}$$

$$\tau = \frac{4 \times 10^{-7}}{4\pi \times 3 \times 10^8 \times 10^{-14}} = 4.2 \times 10^{-9} \text{ s} = \boxed{4.2 \text{ ns}}$$