

**PHYSICS 505/551**  
**1<sup>st</sup> HOMEWORK**  
**Dr. V. Lempesis**

**Hand in: Thursday 3<sup>rd</sup> October 2013**

1. The operators for the square angular momentum and the projection of the angular momentum along z direction are given by:

$$\mathbf{L}^2 = -\hbar^2 \left[ \frac{1}{\sin \theta} \frac{\partial}{\partial \theta} \left( \sin \theta \frac{\partial}{\partial \theta} \right) + \frac{1}{\sin^2 \theta} \frac{\partial^2}{\partial \phi^2} \right]$$

$$L_z = -i\hbar \frac{\partial}{\partial \phi}$$

Show that the spherical harmonic  $Y_2^2(\theta, \phi)$  is an eigenfunction of both operators.

2. The action of the raising operator  $l_+$  on the minimum projection state  $Y_l^{-l}$  gives zero, i.e.  $l_+ Y_l^{-l} = 0$ . Use this property to find the analytical form of  $Y_l^{-l}$ .

3. We know that  $Y_1^0 = \left( \frac{3}{4\pi} \right)^{1/2} \cos \theta$ . Apply the lowering operator to find  $Y_1^{-1}(\theta, \phi)$ .

**Please send your answers in pdf form (typed or in clearly handwritten form) in my email address (vlempesis@ksu.edu.sa). Do not forget to put your name and your ID number on it. Also define if you are in phys 505 or phys 551 course.**