1, (10%) Give some experimental facts that support the wave -particle duality postulation.

2, (10%) (i) Discuss the origin of nuclear energy, thus we can say that mass is converted to energy. (ii) Give example that energy is realy converted into mass.

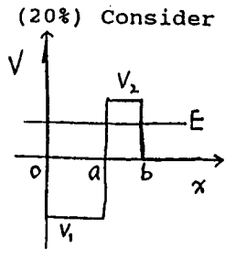
3, (10%) What are the forces that forms molecules, atoms, nucleus and protons.

4, (20%) L is the angular momentum operator.(i) Discuss the eigenvalues of L^2 and L_z . (ii) Why we only talk about L_z not L_x or L_y . (iii) What is the meaning of space quantization of angular momentum. Is there any experimental supports? (iv) If we have $\ell_1 = 1$ and $\ell_2 = 2$ what are the possible resultant ℓ ?

5, (15%) (i) Prove that for real potential the energy-eigen function of Schrodinger equation is stationary and the probability is a constant. (ii) Why usually the eigen values of a bound state are discrete? (Consider one dimension Schrodinger equation.)

6, (15) The helium atom has two electrons. Why for n=1 it can only be in S=0 state? For n≠1 , S=0 or 1. Which one has higher energy? Why? Can there be transitions between different S states? Why?

7, (20%) Consider the potential barrier as shown in the figure.



Calculate the transmission coefficient. Discuss the dependence of this coefficient. This is the so called tunnelling effect. Give a physical phenomenum that can be explained by this fact.

$V = \infty$ for $x < 0$

$V = -V_1$ for $0 < x < a$

$V = V_2$ for $a < x < b$

$V = 0$ for $x > b$

$0 < E < V_2$