Mansoura University
Faculty of Science
Physics Department

Course code: ph 312

Second semester 2015-2016
Date: 31-12-2015

3rd level Physics Students
Full Mark: 80
Allowed time: 2 hours
Course title: Neutrons and Reactor Physics

Answer the following questions:

1-a- Discuss that, how the relation between the numbers of protons and neutrons can be affecting on the stability of the nucleus, and what happened to the nucleus to be stable. (10 mark)

1-b- Define the following

i- Binding energy ii- Isomer iii- Potential scattering iv- Resonance scattering v- Curie vi- The mean free path vii- Critical energy for fission (10 mark)

2-a- Consider a parent atom *A* which decay to form a daughter *B* which is also unstable and forms an atom *C* which is stable. Show that, how the radioactive equilibrium can be occurred for *B*. (10 mark)

2-b- Show that, the dependence of the cross section of the neutron on its energy can be effect on the type of the reaction of the neutron with the target. (10 mark)

3-a- If the absorption cross section of Cd^{113} for certain neutrons is 208 barns, and the density of this material is 8.67 grams/cm^3 , calculate the macroscopic cross section, and the thickness of the Cd^{113} which required to reduce the intensity of neutrons beam to 1% of its original value. (10 mark)

3:-b- From the liquid drop model point of view, show the mechanism of the fission process of the nucleus, and drive an empirically formula for the binding energy. (10 mark)

4-a- Write short notes on a type of reactor, with showing its different components. (10 mark)

4-b- Calculate and compare the collision and absorption mean free paths for neutrons in graphite using these values $\sigma_s = 3.2*10^{-3}$ barns, $\sigma_a = 5$ barns, and the density $\rho = 2.25$ gm/cm^3. (10 mark)

With best wishes

Examiners: Pro. Dr. S. El-Wakiel &Dr. Abeer Awad

Mansoura University Faculty of Science Department of Physics Course Code: Phys. 311 Title: Solid State Physics		First Semester (Jan. 2016) Exam Type (Final): 3rd Year (Physics, Biophysics) Time: Two Hours Full Mark: 80 Mark

Answer **only three** questions from the following

1- a: Sketch the planes (112), (201) and (123) in a tetragonal lattice. [14 Mark]

b: Find the reciprocal lattice of FCC lattice and its volume. [13 Mark]

2- a: At what angle will a diffracted beam emerge from the (111) planes of a face centered cubic crystal of unit cell length 0.4 nm? Assume diffraction occurs in the first order and that the x-ray wavelength is 0.3 nm. Which wavelength would make diffraction from the (222) planes? [14 Mark]

b: Let the interaction energy between two atoms be given by:

$$U(r) = -\frac{A}{r^2} + \frac{B}{r^6}$$

If the atoms form a stable molecule with an inter-atomic distance of 0.4 nm and a dissociation energy of 3 eV, calculate A and B. [13 Mark]

3- a: Define Madelung constant and explain how to calculate it for NaCl crystal. [14 Mark]

b: Show that the condition of diffraction in the reciprocal lattice is similar to that in the real lattice. [13 Mark]

4- a: Show that the physical properties of bulk solids do not depend on the volume of solid. [14 Mark]

b: The unit cell of α-iron has a BCC structure with a lattice constant of 2.75 Å. Find

i) the density,

ii) the free volume per unit cell,

iii) number of atoms per mm^2 in the plane (101).

(Relative atomic mass of iron is 55.85 g/mole, $N_A = 6.022\times10^{23}$ $mole^{-1}$) [13 Mark]

أطيب التمنيات : أ.د. حمدى دويدار

لجنة التصحيح: أ.د. حمدى دويدار – أ.د. جمعة الدمراوى

Mansoura University Faculty of Science **PHYSICS DEPARTMENT** **Final Exam – 1st Term** (11 Jan. 2016)	**2015-2016**	**Third Level Students** **(Physics program)** **Course: Math. Physics 1 (Phy315)** **Time allowed: 2 hours**

Full Mark: 80 (Every question: 20 Mark)

Answer the following questions

Q1:

A) Using *Gamma* and *Beta* functions, estimate the following integrals:

i) $\int_0^\infty x^{-5/2}\left(1-e^{-x}\right)dx$ ii) $\int_0^1 \frac{dx}{\sqrt{1-x^4}}$ iii) $\int_0^\pi \tan^{3/4}\theta d\theta$

B) Express Beta function in terms of Gamma functions (prove it).

Q2:

A) Prove Rodrigues formula of the Legendre Polynomials as:

$$P_n(x)=\frac{1}{2^n n!}\frac{d^n}{dx^n}\left(x^2-1\right)^n$$ and use it to get $P_3(x)$.

B) Show that: $\int_{-1}^{1}\left(1-x^2\right)P_n'(x)P_m'(x)dx=\frac{2n(n+1)}{2n+1}\delta_{nm}$

Q3:

A) Prove the following integral representation of Bessel functions:

$$J_n(x)=\frac{1}{\pi}\int_0^\pi \cos(n\phi - x\sin\phi)d\phi$$

B) i) Show that: $\int_0^\infty e^{-x}J_0(x)dx=1$ ii) Evaluate $\int_{-\infty}^{\infty} xe^{-x^2}H_i(x)H_j(x)dx$

Q4:

A) In view of Hermite function $H_n(x)$, solve the following differential equation

$$\frac{d^2\Psi}{dx^2}+\left(\lambda-x^2\right)\Psi=0$$

and evaluate the corresponding orthogonality property $\int_{-\infty}^{\infty}\Psi_m(x)\Psi_n(x)dx$.

B) For Laguerre polynomial functions $L_n(x)$, prove its generating function as

$$\exp\left(-\frac{xt}{1-t}\right)=(1-t)\sum_{n=0}^{\infty}L_n(x)t^n$$

With my best regards,

Prof. Dr. M. Sallah

Mansoura University Faculty of Science Physics Department		First Term Examination, Third Year : Physics , 313 ف Date : 18/1/ 2016 Time : 2 hours
Course (s) : Methods of Experimental Physics		Full Mark : 80 Mark

Answer the Following Questions

[1] Account on the following :

i- The quartz spectrograph. [10 Marks]

ii- Flame photometer as a tool in spectrum analysis. [10 Marks]

iii- Spark as a source of excitation. [10 Marks]

[2]a- Describe with a neat diagram the construction and working of any modern high vacuum pump. [12.5 Marks]

b- Describe the microphotometer and its uses. [12.5 Marks]

[3]a- Write short essay on the principle of scanning electron microscope and a comparison of the scanning electron microscope and the optical microscope. [12.5 Marks]

b- Calculate the root mean square (r.m.s) velocity of nitrogen molecules at 0 °C. The density of nitrogen at N.T.P. is 1.25 g/liter. Acceleration g=981 cm/s^2 (the density of mercury =13.59 g/cm^3). [12.5 Marks]

With best wishes

Examiners: Prof. Dr. Ibrahim Fouda & Dr. Mohamed Mansour

Mansoura University Faculty of Science Physics Department	January 2016	Third Year Physics & Biophysics Time allowed: 2 hrs Full Mark: 80

Course: Quantum Mechanics Phys(314)

Answer the following questions:

[1-a] Write the Schrödinger equation in spherical coordinates and separate it into radial and angular parts and solve the angular equation. [15]

[1-b] Write on the main postulates of quantum mechanics. [5]

[2-a] Solve the time-independent Schrödinger equation to determine the allowed energy levels of a particle moving in a symmetrical finite potential well of depth V_0 and width 2L. [15]

[2-b] Discuss the Degeneracy of the lowest three energy states of a spherical harmonic oscillator. [5]

[3-a] Find the bound state energy levels and their corresponding eigenfunctions of a particle moving In a one-dimensional harmonic oscillator potential. [10]

[3-b] Using the operator method to deduce the Hamiltonian operator $\hat{H}$ of a harmonic oscillator in terms of $\hat{a}$ and $\hat{a}^*$, where $\hat{a} = \left(\sqrt{\frac{m\omega}{2\hbar}} x + i \frac{p_x}{\sqrt{2\hbar m\omega}} \right)$ and use it to estimate the allowed energy levels. Discuss the effect of $\hat{a}$ and $\hat{a}^*$ operators on the eigenfunctions of the harmonic oscillator. [10]

[4-a] Show how to explain the tunneling of low energy alpha particles from the radioactive substances of high potential barrier. [15]

[4-b] Write the components of the angular momentum operators $\hat{L}$ and calculate $[x^n, \hat{P}_x]$ and $[\hat{E}, t]$. [5]

With Our Best Wishes

Prof. Dr. A.R. Degheidy & Dr. B.Elkenany

Mansoura University Faculty of Science Physics Department		Statistical Mechanics Time: Two hours Third Year – Special Physics

Final Exam First Semester (2016)

Answer the Following Questions: -

Question One: -

a) The three energy levels of a certain molecule are $E_1 = 0, E_2 = \epsilon, E_3 = 5\epsilon$

1- Show that at low temperature only levels E_1 and E_2 are populated.
2- Find the average energy E of the molecule at temperature T.
3- Find the contribution of these levels to the specific heat per mole.

b) Consider a system of N non-interacting quantum mechanical oscillations in equilibrium at temperature T. The energy levels of a single oscillator are $E_n = \left(n + \frac{1}{2}\right)\frac{\gamma}{V}$, n=0,1,2.... etc.

(γ is a constant and V is the volume)

1- Find U and C_V as a function of T.
2- Sketch $U(T)$ and $C_V(T)$.
3- Determine the equation of state for the system.
4- What is the function of particles in the n-the level?

Question Two: -

a) According to Maxwell-Boltzmann distribution determine the following:

1- The most probable energy.

2- The root mean square energy.

3- The average energy.

b) Derive the total energy density of a black-body radiation at a given temperature T. ($U = \sigma T^4$)

Question Three: -

a) Determine the relation of the specific heat of solid according to Debye's Theory.

b) Define the following:

1- The phase space.

2- The thermodynamic probability.

3- The macrostate and microstate.

4- The average energy of the oscillator according to plank.

5- The degree of freedom.

with my best wishes,

Prof. Mohamed Tawfik Attia