



Faculty of science
Physics Department

Date: 25 May, 2017
Time: 3 hours

Final Examination in (Crystal Growth 354P)
Teaching Staff: Prof. Dr. Abdulaziz Abualfadi

Answer 5 questions from the following:

1- (a): Throughout its history the study of single crystals has been closely linked with device applications. Summarize some uses of single crystals.
(b) What are the basic requirements for the growth of crystals from solutions?
(c): Why the choice of crucible material is of fundamental importance in melt techniques.

2- (a): Describe one method used for growing single crystal films on single crystal substrates.

(b): List the advantages of gel growth technique. Discuss the methods of growing single crystals by gel growth with suitable examples?

3- (a): Discuss; i- Fluxed melt technique, ii- Crystallization by reactant diffusion
iii- Why crystals grow in space

(b): Explain the advantages and disadvantages of non-melt techniques and describe in details the Chemical Transport Method used in this technique.

4-(a): In Laser-Heated Pedestal Growth Technique (LHPG). Write in brief in three from the following: i-The importance of single crystal fibers ii- Source rods preparation iii- Advantages of LHPG method iv-Seeding process and formation of molten zone v- Line shaped laser beam

(b): Explain in detail the Bridgman method used for growing single crystals in a pure melt with necessary diagrams. List its merits and demerits?

5-(a): Discuss; i- Vernuel process for crystal growth from the melt without containing the melt in a crucible. ii- Zone refining method.

(b): Describe both Kyropoulos and Czochralski methods for growth from the melt. Differentiate between the two methods and give examples for materials grown by each method.

6- (a): From the factors which affect the size of the grown crystals during crystal growth are: The solvent, The number of nucleation sites, Mechanical agitation to the system and Impurities. Explain the effect of each factor?

(b): Compare using examples between the two methods: i- Slow crystallization from solution in water or organic solvent. ii- Hydrothermal crystallization for substance insoluble in water.

=====Good luck=====



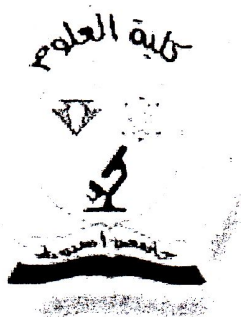
Final Exam. "Diffraction rays & its applications" (352 P)

Answer only Five Questions:

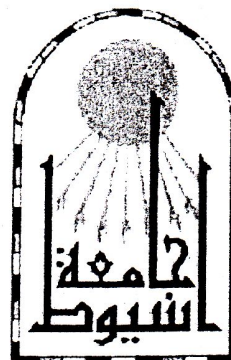
- 1-a) Explain the determination of the crystal structure of single crystal, give a schematic diagram of the experimental tools to describe the crystal symmetry.
- 1-b) Illustrate with the eqns. the dependence of atomic radius on the d-spacing and Miller indices of the FCC-crystalline planes.
- 1-c) Determine the energy of X-ray beam when Bragg's angle of 19.21° is observed during the 1st order reflection on (111) – plane of Aluminum of FCC- structure ($\rho = 2.7 \text{ gm/cm}^3$, atomic weight 27, and $N_A = 6.023 \times 10^{23}$)
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- 2-a) Prove that the packing factor's ratio of BCC to FCC crystal is less than unit.
- 2-b) Explain with the eqns. the conditions required for studying the crystal structure by neutron beam.
- 2-c) Cu has FCC structure, calculate its density, lattice constant and interplanar spacing for (321) planes. (given: atomic radius 0.128 nm, atomic weight 63.5, and $N_A = 6.023 \times 10^{23}$).
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- 3-a) Using XRD to deduce with the eqn. an identification of the crystallographic planes. If the Miller indices satisfy that: $h^2 + k^2 + \ell^2 = 5, 7, \text{ and } 12$, determine the different available crystalline planes.
- 3-b) Monochromatic X-ray beam incident on a simple cubic system, if the Bragg's angle of 22.4° is reflected from (111)-plane, identify the crystalline plane corresponding to 32.63° reflected angle.
- 3-c) Explain and drive Bragg's low of X-ray diffraction from a crystal, show the conditions required for applying the low.
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- 4-a) Compare between linear and continuous X-ray spectrum.
- 4-b) X-ray beam with wavelength λ incident on a certain cubic crystal, prove that the Miller indices of their crystalline planes depends on the resulting reflected angle, and energy beam.
- 4-c) Show that for cubic system, the ratio of atomic radius of different structures, 1 : 1.16 : 1.42
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- 5-a) If the crystalline plane ABC intercept the (x, y, z) –axis by the ratios: $2a : 3b : 2a$, respectively, determine the M. indices then draw the systemic diagram of the plane inside a cubic system.
- 5-b) X-ray beam with energy 2.7 KeV incident on (111) -planes of BCC structure. Determine the 2nd order Bragg's angle (given : atomic radius $r = 0.2 \text{ nm}$, and $h = 6.02 \cdot 10^{-27} \text{ erg. sec.}$)
- 5-c) Use the Bragg's low to find the dependence of the wavelength of the incident electron-beam in terms of the diffraction diameter and d-spacing, draw a schematic diagram of experimental set-up.
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- 6-a) Aluminum has FCC structure with the atomic radius $1.43 \text{ \AA}$, If energetic X-ray beam of 7.38 KeV incident on (100) plane, calculate the Bragg's angle considering the 1st order reflection ($h = 6.62 \times 10^{-34} \text{ J.sec.}$)
- 6-b) Find the wavelength dependence of the neutron and x-ray energies, respectively.
- 6-c) Describe the determination of the crystal structure using polycrystalline material, give a schematic diagram of the experimental tools to show the resulting XRD.

انتهت الأسئلة

تمنياتي بالتوفيق والتفوق ا.د. عبد المنعم سلطان.....



Physics Department
Faculty of Science
Assiut University



Physics 312F – Electromagnetic Theory & Electrodynamics

THIS TEST HAS ELEVEN PAGES

DURATION OF TEST: 3 HOURS

Date: 20th May 2017.

Examiner: Dr. Ahmed Mostafa Amry

Fundamental Physical Constants

Quantity	Symbol	Value	Unit	Relative std. uncert. u_r
UNIVERSAL				
speed of light in vacuum	c, c_0	299 792 458	m s^{-1}	(exact)
magnetic constant	μ_0	$4\pi \times 10^{-7}$ $= 12.566 370 614 \dots \times 10^{-7}$	N A^{-2} N A^{-2}	(exact)
electric constant $1/\mu_0 c^2$	ϵ_0	$8.854 187 817 \dots \times 10^{-12}$	F m^{-1}	(exact)
characteristic impedance of vacuum $\sqrt{\mu_0/\epsilon_0} = \mu_0 c$	Z_0	376.730 313 461...	Ω	(exact)
Newtonian constant of gravitation	G	$6.673(10) \times 10^{-11}$	$\text{m}^3 \text{kg}^{-1} \text{s}^{-2}$	1.5×10^{-3}
	$G/\hbar c$	$6.707(10) \times 10^{-39}$	$(\text{GeV}/c^2)^{-2}$	1.5×10^{-3}
Planck constant	h	$6.626 068 76(52) \times 10^{-34}$	J s	7.8×10^{-8}
in eV s		$4.135 667 27(16) \times 10^{-15}$	eV s	3.9×10^{-8}
$\hbar/2\pi$	$\hbar$	$1.054 571 596(82) \times 10^{-34}$	J s	7.8×10^{-8}
in eV s		$6.582 118 89(26) \times 10^{-16}$	eV s	3.9×10^{-8}
Planck mass $(\hbar c/G)^{1/2}$	m_p	$2.1767(16) \times 10^{-8}$	kg	7.5×10^{-4}
Planck length $\hbar/m_p c = (\hbar G/c^3)^{1/2}$	l_p	$1.6160(12) \times 10^{-35}$	m	7.5×10^{-4}
Planck time $l_p/c = (\hbar G/c^5)^{1/2}$	t_p	$5.3906(40) \times 10^{-44}$	s	7.5×10^{-4}

Answer ONLY 20 question from Part I(a).

Answer ALL questions in Part I(b)&Part II.

Part I(a): Multiple Choice (20 Points)

Circle the one best answer to each question.

1. Electric field intensity (E) at any point in an electric field is equal to
a. $\vec{E} = -\nabla V$ b. $\vec{E} = -\nabla V^2$ c. $\vec{E} = -\nabla V^{1/2}$ d. $\vec{E} = -\nabla V^{1/3}$
2. If magnetic field in region is given by $\vec{B} = 4\vec{i} + 8\vec{k}$, then flux passing through a 5 m^2 area loop will be
a. $20\vec{i} + 40\vec{k} \text{ Wb}$ b. 20 Wb c. 40 Wb d. 30 Wb
3. Value of magnetic field that will cause a max force of $7 \times 10^{-3} \text{ N}$ on a 20 cm wire carrying current of 10 A will be
a. $3.5 \times 10^{-3} \text{ T}$ b. $1.5 \times 10^{-3} \text{ T}$ c. $4.5 \times 10^{-3} \text{ T}$ d. $2.5 \times 10^{-3} \text{ T}$
4. The electric field a distance z above the midpoint of a straight line segment of length $2L$, ($z \gg L$) which carries a uniform line charge λ is
a. $E \cong \frac{1}{4\pi\epsilon_0} \frac{2\lambda L}{z^2}$ b. $E \cong \frac{1}{4\pi\epsilon_0} \frac{\lambda L}{z^2}$ c. $E \cong \frac{1}{4\pi\epsilon_0} \frac{2\lambda}{L z^2}$ d. $E \cong \frac{1}{4\pi\epsilon_0} \frac{2\lambda L^3}{z^2}$
5. Given the potential field, $V = 2x^2y - 5z$, and a point $P(-4, 3, 6)$. The value of $\vec{E}$ at point P is
a. 57.9 V/m b. 570.9 V/m c. 5.79 V/m d. 5790 V/m
6. The Energy of a Continuous Charge Distribution is
a. $W = \frac{1}{2} \int_{\text{all space}} \vec{D} \cdot \vec{E} dv$ b. $W = \frac{\epsilon_0}{2} \int_{\text{all space}} E dv$
c. $W = \frac{\epsilon_0}{2} \int_{\text{all space}} E^3 dv$ d. $W = \frac{\epsilon_0}{2} \int_{\text{all space}} E^4 dv$
7. The volume charge density associated with $\vec{D} = \frac{4xy}{z} \vec{i} + \frac{2x^2}{z} \vec{j} + \frac{2x^2y}{z^2} \vec{k}$
a. $\frac{4y}{z^2} (x + z^2)$ b. $\frac{4y}{z}$ c. $\frac{4y}{z^2} (x^2 + z^2)$ d. 0

8. The Fundamental Theorem for Gradients is

a. $\int_a^b (\nabla f) \cdot d\vec{l} = f(a) - f(b)$

b. $-\int_a^b (\nabla f) \cdot d\vec{l} = f(a) - f(b)$

c. $\int_a^b (\nabla f) \cdot d\vec{l} = f(b) / f(a)$

d. $\int_a^b (\nabla f) \cdot d\vec{l} = f(ab)$

9. The Fundamental Theorem for Divergences is

a. $\oint_S \vec{E} \cdot d\vec{a} = \int_S \nabla \cdot \vec{E} dv$

b. $\oint_S \vec{E} \cdot d\vec{a} = \int_{vol} \nabla \cdot \vec{E} dv$

c. $\oint_{vol} \vec{E} \cdot d\vec{a} = \int_{vol} \nabla \cdot \vec{E} dv$

d. $\oint_S \vec{D} \cdot d\vec{a} = \int_{vol} \nabla \cdot \vec{E} dv$

10. Poisson's equation is

a. $\nabla \cdot \vec{D} = \rho_v$

b. $\nabla^2 V = -\frac{\rho}{\epsilon_0}$

c. $\nabla \cdot \vec{E} = \epsilon_0 \rho_v$

d. $\nabla^2 V = 0$

11. Gauss's law in integral form is

a. $\oint_S \vec{E} \cdot d\vec{a} = \int_S \nabla \cdot \vec{E} dv$

b. $\oint_{surface} \vec{D} \cdot d\vec{a} = Q_{enc}$

c. $\oint_{vol} \vec{E} \cdot d\vec{a} = \int_{vol} \nabla \cdot \vec{D} dv$

d. $\oint_S \vec{D} \cdot d\vec{a} = \int_{vol} \nabla \cdot \vec{E} dv$

12. Laplace's equation is

a. $\nabla \cdot \vec{D} = \rho_v$

b. $\nabla^2 V = -\frac{\rho}{\epsilon_0}$

c. $\nabla \cdot \vec{E} = \epsilon_0 \rho_v$

d. $\nabla^2 V = 0$

13. Special Techniques for Calculating Potentials:

a. *Method of Images*

b. *Div. Theorem*

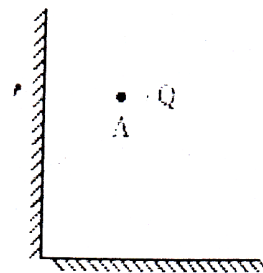
c. *Gauss's Law*

d. *Continuity Eqn.*

14. In a magnetic field of $2.50 \times 10^{-3} T$ such that magnetic force is equal to its weight then proton moves with speed of:

a. $3.09 \times 10^{-5} ms^{-1}$ b. $4.09 \times 10^{-5} ms^{-1}$ c. $2.09 \times 10^{-5} ms^{-1}$ d. $0.09 \times 10^{-5} ms^{-1}$

15. A point charge $+Q$ is brought near a corner of two right angle conducting planes which are at zero potential as shown in the given figure. Which one of the following configurations describes the total effect of the charges for calculating the actual field in the first quadrant ?

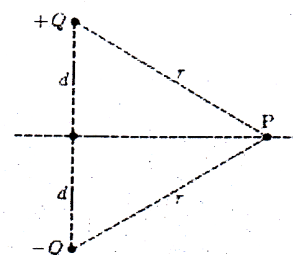


- a.
- b.
- c.
- d.

16. What is the value of total electric flux coming out of a closed surface ?

- a. Zero.
b. Equal to volume charge density.
c. Equal to the total charge enclosed by the surface.
d. Equal to the surface charge density.

17. Consider the right diagram. Which of the following statements is correct ? The electric field E at a point P due to the presence of dipole as shown in the above diagram (considering distance $r \gg$ distance d) is proportional to



- a. $1/r$ b. $1/r^2$ c. $1/r^3$ d. $1/r^4$

18. Gauss's law in differential form is

- a. $\nabla \cdot \vec{D} = \rho_v$ b. $\nabla \cdot \vec{E} = \rho_v$ c. $\nabla \cdot \vec{E} = \epsilon_0 \rho_v$ d. $\nabla \cdot \vec{E} = \rho_v / \epsilon_0$

19. For electrostatic fields in charge free atmosphere, which one of the following is correct ?

a. $\nabla \times \vec{E} = 0$ and $\nabla \cdot \vec{E} = 0$

b. $\nabla \times \vec{E} \neq 0$ and $\nabla \cdot \vec{E} = 0$

c. $\nabla \times \vec{E} = 0$ and $\nabla \cdot \vec{E} \neq 0$

d. $\nabla \times \vec{E} \neq 0$ and $\nabla \cdot \vec{E} \neq 0$

20. In free space, if $\rho = 0$, the Poisson's equation becomes

a. Maxwell's divergence equation $\nabla \cdot \vec{B} = 0$.

b. Laplace's equation $\nabla^2 V = 0$.

c. Kirchhoff's voltage equation $\sum V = 0$.

d. None of the above.

21. What is the force on a unit charge moving with velocity $\vec{v}$ in presence of electric field $\vec{E}$ and magnetic field $\vec{B}$?

a. $\vec{E} - \vec{v} \cdot \vec{B}$

b. $\vec{E} + \vec{v} \cdot \vec{B}$

c. $\vec{E} + \vec{v} \times \vec{B}$

d. $\vec{E} + \vec{B} \times \vec{v}$

22. Equation $\nabla \cdot \vec{B} = 0$ is based on

a. Gauss's Law

b. Lenz's Law

c. Ampere's Law

d. Continuity Equation.

Part I(b): Check the appropriate box ("Vector", "Scalar", or "Nonsense") for each quantity.(10 Points)

No.	Quantity	Vector	Scalar	Nonsense
23.	$\nabla \times (\nabla f)$			
24.	$\nabla \cdot (\nabla \times \mathbf{F})$			
25.	$\text{div}(\text{curl } \mathbf{F})$			
26.	$\text{curl}(\text{curl } \mathbf{F})$			
27.	$\nabla(\nabla \cdot \mathbf{F})$			
28.	$\text{curl}(\text{curl } f)$			
29.	$\text{grad}(\text{div } f)$			
30.	$\text{div}(\text{grad } \mathbf{F})$			
31.	$\nabla \cdot (\nabla f)$			
32.	$\text{div}(\text{div } \mathbf{F})$			

Part II: Work Problems (20 Points)

Show all your work and explain each major step to receive full credit.

- 1) Consider a one-dimensional world with two point conductors located at $x = 0 \text{ m}$ and at $x = 10 \text{ m}$. The conductor at $x = 0 \text{ m}$ is grounded ($V = 0 \text{ V}$) and the conductor at $x = 10 \text{ m}$ is kept at a constant potential of 200 V . Determine V .

2) Check that the fields:

$$\bar{E}(\bar{r}, t) = E_o \exp(-kz) \cos(kx - \omega t) \bar{j}$$

$$\bar{B}(\bar{r}, t) = \frac{E_o}{\omega} \exp(-kz) [k \sin(kx - \omega t) \bar{i} + k \cos(kx - \omega t) \bar{j}]$$

satisfy all of Maxwell's equations.

3) For an electric field $E = E_0 \sin(\omega t)$, what is the phase difference between the conduction current and the displacement current ?

- 4) Starting with Maxwell's equations in vacuum derive the wave equation for the E field [$\text{curl curl} = \text{grad div} - \nabla^2$].

- 5) Find an approximate value for the total charge enclosed in an incremental volume 10^{-9} m^3 located at the origin, if $\bar{D} = e^{-x} \sin y \bar{i} - e^{-x} \cos y \bar{j} + 6z \bar{k}$ C/m².

[END OF EXAM]



Answer all the following questions

Question (1): Put (✓) or (×) for all the following sentences: (10 Marks)

1. Crystal structure = base + lattice ().
2. The primitive unit cell contains the same kind of atoms, while the Bravais lattice contains only one lattice point ().
3. The cubic system has the greatest degree of symmetry, but the orthorhombic system has the least symmetry ().
4. The substance in which measured properties are independent of the direction of measurement is isotropic material ().
5. Precipitates are classified as volume defect while vacancies classified as linear defect ().
6. Schottky is equivalent to missing atom that leaves its original site and migrates to another position in the crystal ().
7. A screw dislocation being formed by a shear stress that is applied to produce the distortion ().
8. Both of dislocation and external surfaces can be classified as two-dimensional imperfection ().
9. Coordination number in body-centered cubic crystal structure is 12 ().
10. Point defects are thermodynamically stable defects ().

Question (II):**(10 Marks)**

In the following multiple choice questions, circle the correct answer(s). You must write down the steps to get the correct answer.

1. Iridium has an FCC crystal structure, a density of 22.4 g/cm^3 , and an atomic weight of 192.2 g/mol , then the radius of an iridium atom equal?

a) 0.553 nm b) 0.439 nm c) 0.363 nm d) 0.211 nm e) 0.136 nm

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2. Miller indices for the indicated plane, below figure, is:

a) (001) b) (110) c) (101) d) $(\bar{1}01)$ e) $(0\bar{1}1)$

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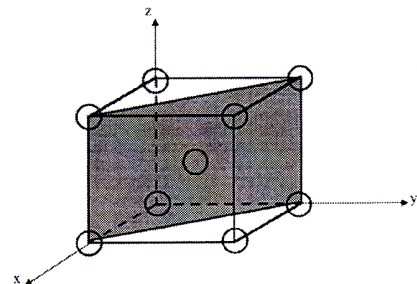
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3. Iron has a BCC crystal structure, an atomic radius of 0.124 nm and an atomic weight of 55.85 g/mol ; its theoretical density closest to [Hint: $N_A = 6.025 \times 10^{23} \text{ atoms/mol}$]:

a) 9.92 g/cm^3 b) 8.40 g/cm^3 c) 7.90 g/cm^3 d) 6.35 g/cm^3

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4. The linear density expression for FCC [100] direction in terms of the atomic radius R is:

A. $\frac{1}{2\sqrt{2}R}$

B. $\frac{1}{\sqrt{2}R}$

C. $\frac{1}{2\sqrt{6}R}$

D. $\frac{1}{6R}$

E. $\frac{1}{2\sqrt{3}R}$

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Question (III): Give reasons for the following

(10 Marks)

(a) X-ray can be used to detect the crystallinity of materials.

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(b) The atomic packing factor always less than 1.

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(c) The physical properties of single crystals of some substances depend on the crystallographic direction in which measurements are taken.

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(d) For some elements, the degree of dissolvent of the solute (minor) and solvent (major) atoms is low.

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Question (IV): Answer the following questions: (20 Marks)

1. The metal rubidium has a BCC crystal structure. If the angle of diffraction for the (321) set of planes occurs at $2\theta=27^\circ$ (first-order reflection) when monochromatic X-radiation having a wavelength of $0.711 \text{ \AA}$ is used, compute: (5 Marks)

- (a) The inter-planar spacing for this set of planes.
- (b) The atomic radius for the rubidium atom.

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2. An alloy consists of 6 at% Pb and 94 at% Sn, if $A_{\text{Pb}} = 207.2 \text{ g/mol}$ and $A_{\text{Sn}} = 118.71 \text{ g/mol}$: (5 Marks)

(a) What is the composition, in weight percent, of this alloy?

(b) Calculate the amount of each element, if the mass of a given Sn-Pb alloy is 200 gm.

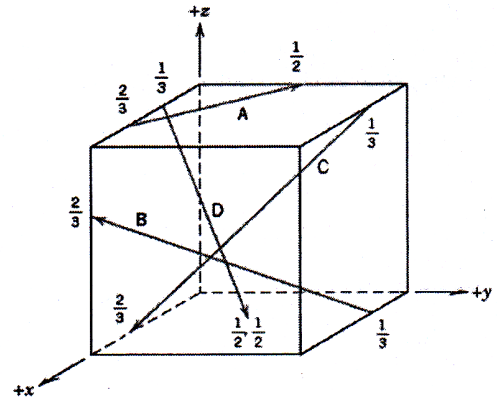
[illegible]

3. Calculate the number of vacancies per cubic meter in iron at 850°C. The energy for vacancy formation is 1.08 eV/atom. Furthermore, the density and atomic weight for Fe are 7.65 g/cm³ and 55.85 g/mol, respectively.

[Hint: $N_A = 6.022 \times 10^{23} \text{ atoms/mol}$; $k_B = 1.38 \times 10^{-23} \text{ m}^2 \text{ kg s}^{-2} \text{ K}^{-1}$] **(5 Marks)**

[illegible]

4. Within the following cubic unit cell, determine **two only** of the following directions A, B, C and D. Locate within a below cubic unit cell $11\frac{1}{2}$ point and Sketch (101) plane. (5 Marks)





Course Title: Nuclear Physics 1 – Code P342 – Final Exam. (50%)

Instructor Prof. Dr. A. A. Ebrahim

Constants: $R_0 = 1.3 \text{ fm}$, $e^2 / 4\pi\epsilon_0 = 1.44 \text{ MeV} \cdot \text{fm}$, $m_e = 0.511 \text{ MeV}$, $M_p = 938.28 \text{ MeV}$,
 $M_n = 939.52 \text{ MeV}$

Answer the following question:

Question #1(15 points)

- Calculate the kinetic energy of the alpha particle emitted in the process $^{235}\text{U} \rightarrow \alpha + ^{231}\text{Th}$. The binding energy of the alpha particle is 28.3 MeV and you may assume the following values (in MeV) for the binding energy per nucleon of ^{235}U is 7.538 and the binding energy per nucleon of ^{231}Th is 7.571.
- How much energy is required to remove a neutron ($m_n = 1.008665 \text{ amu}$) from ^{15}N that has an atomic mass of 15.000108 amu to make ^{14}N that has an atomic mass of 14.003074 amu?
- Write the various terms in the Semi-Empirical Mass Formula.
[NB: detailed mathematical expressions and values of constants are not required].
- Calculate the potential energy in MeV due to Coulomb repulsion of:
 - a) 2 protons separated by 1 fm
 - b) a gold nucleus ($Z=79$) and an α -particle with centers 10 fm apart
- Show that the electric quadrupole moment of a nucleus vanishes for spherically symmetric charge distribution.

Question #2(10 points)

The following are atomic masses in units of amu ($1 \text{ amu} = 931.5 \text{ MeV}/c^2$).

Electron	0.000549	$^{152}_{62}\text{Sm}$	151.919756
Neutron	1.008665	$^{152}_{63}\text{Eu}$	151.921749
^1H	1.007825	$^{152}_{64}\text{Gd}$	151.919794

- What is the Q-value of the reaction $^{152}\text{Eu}(n,p)$?
- What types of weak-interaction decay can occur for ^{152}Eu ?
- What is the maximum energy of the particles emitted in each of the processes given in (b)?

Question #3(10 points)

The binding energy of a nucleus with atomic number Z and mass number A can be expressed by Weisacker's semi – empirical formula

$$B = a_v A - a_s A^{2/3} - \frac{a_c Z^2}{A^{1/3}} - a_a \frac{(N - Z)^2}{A} - \frac{a_p}{A^{1/2}}$$

where

$a_v = 15.56 \text{ MeV}$, $a_s = 17.23 \text{ MeV}$, $a_c = 0.697 \text{ MeV}$, $a_a = 23.285 \text{ MeV}$, $a_p = -12, 0, 12 \text{ MeV}$

for even-even, odd-even (or even-odd) or odd-odd nucleus respectively.

Estimate the energy needed to remove four neutrons from nucleus ${}^{48}_{20}\text{Ca}$.

Question #4(10 points)

The masses of ${}^{14}_7\text{N}$, ${}^{14}_8\text{O}$ and ${}^{14}_9\text{F}$ are as tabulated below. It follows that ${}^{14}_8\text{O}$ is radioactive. **Detail** the various possible decay modes to the ground state of the daughter nucleus and **give** the maximum energy of each component.

Nucleus	${}^{14}_7\text{N}$	${}^{14}_8\text{O}$	${}^{14}_9\text{F}$
Atomic mass	14. 927959	14. 929759	14. 929145

- **Draw** a diagram for this decay? **What** are the features of this decay?

Question #5 (5 points)

If the binding energies of the mirror nuclei ${}^{41}_{21}\text{Sc}$ and ${}^{41}_{20}\text{Ca}$ are 343.143 MeV and 350.420 MeV respectively, **estimate** the radii of the two nuclei by using the semi empirical mass formula.

****Good Luck****

Answer the following questions:

“50 Marks”

Q:1(a) Deduce an expression for the ambipolar diffusion net current under the action of an electric field. Comparing it with that of the free diffusion net current of the charged particles in plasma

b- Write an expression for the following:

- i- Diffusion coefficient of the charged particles in the absence and presence of magnetic field in plasma
- ii- Ambipolar diffusion coefficient under the action of an electric field
- iii- The mobility of charged particles in the presence of magnetic field in plasma

Q:2(a) Discuss the motion of charged particles in :

- i- A non uniform magnetic field
- ii- A constant- crossed electric and magnetic fields

b- Assume in the magnetic mirror configuration that the minimum magnetic field is 0.2 Tesla and the maximum magnetic field 0.76 Tesla, calculate the angle θ which the particle orbit makes with the Z-axis at the central plane of this mirror. Explain what happen for the charged particles in the magnetic

mirror when i- $\sin \theta > \sqrt{\frac{B_{\text{minimum}}}{B_{\text{maximum}}}}$ ii- $\sin \theta < \sqrt{\frac{B_{\text{minimum}}}{B_{\text{maximum}}}}$

Q:3(a) Deduce an expression for:

- i- The plasma dielectric constant
- ii- The total stored energy in plasma medium.

b- Put (✓) for the correct statements and (x) for the wrong statements in the following:

- i- Plasma magnetic moment is given by $\mu = \frac{\text{parallel kinetic energy } W_{//}}{\text{Electric Field}}$
- ii- Plasma is a paramagnetic material
- iii- The magnetic moment of plasma is constant
- iv- There is current produced in quasi neutral plasma due to the drift velocity of charged particles in crossed-constant electric and magnetic fields.
- v- The intensity of plasma spectral lines depends on ion temperature

Q:4(a) Discuss with draw the plasma pinch effect

b- Assume a plasma with density $N=2 \times 10^{15} \text{ cm}^{-3}$ and temperature of 100 eV. If the current in the very narrow filament formed along the axis of the discharged tube is 80 amp. Calculate the radius of this filament . using $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ & kT in J

Q:5(a) Drive the relation between the phase velocity of Alfven waves and both of the magnetic flux and the plasma mass density

b- Assume that the approximate phase velocity of Alfven waves is 30 m/sec and the magnetic flux is 10 Tesla. Calculate the plasma mass density in this case

With my best wishes

Prof. Dr. Abd El-Haleem Turkey



Faculty of science
Physics Department

Date: 23 May, 2017
Time: 3 hours

Final Examination in (X-ray Diffraction & Applications 352P)

Teaching Staff: Prof. Dr. Abdulaziz Abualfadl

Constants: $h = 6.626 \times 10^{-34} \text{ J.s}$, $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$, $k_B = 1.38 \times 10^{-23} \text{ J/K}$, $e = 1.6 \times 10^{-19} \text{ C}$, $C = 3 \times 10^8 \text{ m/s}$,
 $N_A = 6.02 \times 10^{23} \text{ atom/mole}$, $m_e = 9.1 \times 10^{-31} \text{ kg}$, $m_n = 1.67 \times 10^{-27} \text{ kg}$

Answer 5 questions from the following:

1- (a): Why X-rays are used for diffraction studies in crystals. Write a note on neutron diffraction. How neutron diffraction differs from X-ray diffraction? State the advantages and disadvantages of using neutron diffraction in comparison with X-rays for determining the crystal structure.
(b): Define: i)- Bravais lattice, ii)- Basis, iii)- Primitive Unit Cell, iv)- Primitive Lattice Vectors, v)- Point group, vi)- Packing factor.

2- (a): What are the Miller indices? Write the procedure for finding the Miller indices of a given plane.

(b): Determine the Miller indices of a plane that makes intercepts of 2 Å, 3 Å, 4 Å on the coordinate axes of an orthorhombic crystal, and draw the cubic crystal planes whose Miller indices are (110), (011), (111) and (200).

(c): Determine the Lattice parameter of nickel (f.c.c) if the Bragg's angle for its (2 2 0) reflection is $38^\circ 12'$ and the wavelength of the X-ray used is 1.54 Å.

3- (a): Calculate the atomic packing factor of a body centered cubic structure.

(b): Explain the following techniques used for practical X-ray diffraction:

i- A rotating single crystal can be irradiated by a single X-ray wavelength.

ii- A monochromatic X-ray beam is allowed to irradiate a small specimen of the substance grounded to a fine powder.

4- (a) Explain the determination of crystal structure using Laue method. State two significant uses of Laue's diffraction technique?

(b) A beam of thermal neutrons emitted from the opening in a reactor is diffracted by the (110) planes of a nickel crystal at an angle 18.5° . Calculate the effective temperature of the neutrons given that nickel is f.c.c. with a lattice parameter of 3.5 Å.

5- (a)- What is the meaning of the crystallographic symbols: m , 2 , $\bar{3}$, $4/m$, 4_2 , X_3 .

(b): A beam of X-rays is incident on a NaCl crystal with lattice spacing 0.282 nm. Calculate the wavelength of X-ray if the first order Bragg's reflection takes place at a glancing angle of $8^\circ 35'$.

(c): The lattice constant of the simple cubic lattice is 5.63 Å. Calculate the distance between the nearest (111) planes in simple cubic lattice.

6- (a): A sample of chromium (Cr) is analyzed by X-ray diffraction using copper K_α radiation for which $\lambda_{K_\alpha} = 1.54 \text{ Å}$. Determine the Miller indices of the plane from which the angle of reflection, θ , is 31.4° . The lattice constant of Cr, a , is 3.02 Å. Report your answer in the form (hkl) .

(b) Evaluate the geometrical structure factor F_{hkl} for reflections from the (hkl) planes in fcc lattice, and show the factor vanishes unless h, k, l are all even or all odd.

=====Good luck=====