2- The photon energy required for ESR is calculated from the total angular momentum J and the magnetic field H by the equation

$\Delta E =$

3- The magnetic moment associated with the electron spin equals

$\mu =$

4- The Larmor frequency of the electron spin magnetic moment under an applied magnetic field of *1 T*

$\nu =$ Hz

5- The spin orbit coupling results in an additional energy

$\Delta E_{so} =$

6- The nuclear magnetic moment of the proton (H^1) (erg/Oe)

$\mu_{nuc} =$

7- The total energy of the s-electrons under a magnetic field H in the case of hyperfine coupling with the nucleus is calculated by the equation

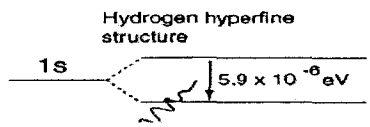
$E_{tot} =$

Section (C): (24 marks)
Answer only three of the following four questions: (8 degrees for each question)

1) For d-electrons $l=2$,
(a) draw a figure shows the orientations of the total orbital angular momentum L and the quantized values L_z under applied magnetic field and an energy level diagram.
(b) calculate the total orbital angular momentum L and its projections L_z, the total magnetic moment μ and its projections μ_z on the magnetic field.
(c) draw a vector diagram showing J and μ in the case of L-S coupling and deduce the relation between J and μ

2) ^1H nuclei in a human body under an applied magnetic field, deduce the spin dynamics using Block equations when excited by photons considering damping, then explain the types of spin relaxation times.

3) The following figure shows the energy levels of s-electrons in hydrogen atoms in the case of hyperfine coupling,



(٢)

Q:2 **(10 Marks)**

a) **Write a mathematical expression for the following**

1- The atomic packing factor (APF) for unit cell

.....

.....

.....

2- The free volume (V_f) of glassy material

.....

.....

.....

3- The molar refractivity (R_m) for the compound glass A_xB_y

.....

.....

.....

4- Extended state conductivity in amorphous semiconductor

σ_{ex}=.....

.....

....

5- The Abbe number (ν)as a measure of dispersion in glasses

ν= .....

.....

.....

b) **Explain briefly the steps taking place during plasma sputtering technique for amorphous thin film deposition process. What are the advantages and disadvantages of this technique?**

(4)

Q.3: **(10 Marks)**

a) **Compare between x-ray diffraction and differential scanning calorimetry (DSC) as tools generally used for characterization of solid materials.**

b) **Drive a mathematical expression for the ionic electrical conductivity (σ) in 3 dimensional amorphous solid in the presence of electric field ($E > 0$). How you can use (σ VS T) experimental data to calculate the barrier height (ΔE_a)**

(٤)

Part. II: (40 marks)

Answer four only from the following questions

Q:1 (10 Marks)

a) Define and write the units of the following:
Viscosity – Molar volume – Hopping frequency – Mean dispersion – Enthalpy

b) Compare between amorphous and crystalline solids from the view paints of their preparation techniques, structure and properties

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Assiut University faculty of Science Physics Department	The final Exam in Amorphous and Glassy Materials (457 Ph)	For the 4th level phys. Time:3 h Date:05-01-201

Answer the following questions: (1) "50 Marks"

Part. I: Answer this question (10 marks)

Choose the correct answer for these statements

1- The viscosity (η) of a material when transform from solid to liquid state undergoes
a) strong decrease b) strong increase c) slight increase
d) slight decrease

2- In the glass transition region, the enthalpy of the material changes with decreasing temperature to be:
a) Decreases b) Increases c) Remain the same
d) None of these

3- The coordination number for the tetrahedral structure of SiO_4 glass is
a) 4 b) between 2 – 3 c)> 4 d) 0.22 – 0.41

4- The most easy and popular technique used to prepare amorphous bulk glass is
a) Melt quench b) CVD c) thermal evaporation d) a and c.

5- The molar refractivity of a glass (R_m) increases with decreasing
a) molar volume (V_m) b) refractive index (n)
c) glass density (ρ) d) all these

6- The density of a multicomponent glass is strong function of it's :
a) structure form b) chemical composition
c) cooling rate d) all these

7- Extended state conduction can takes place in:
a) crystalline semiconductor b) amorphous semiconductor
c) defect free amorphous semiconductor d) all these

8- Variable range hopping conduction takes place:
a) between nearest neighbor atoms b)between localized states near E_f
c) between dopant atoms at low temperature d) all these

9- For exothermic process in the DSC thermos-gram the chemical potential energy in the glassy sample changes to:
a)heat the sample b) decrease of the surrounding temperature
c) $\Delta H > 0$ d) $\Delta H < o$

10 The optical absorption in glasses for the IR region of the spectrum is due to:
a)electronic transition b) vibrational transition
c) a and b d) None of these

Assiut University faculty of Science Physics Department	The final Exam in Amorphous and Glassy Materials (457 Ph)	For the 4th level phys. Time:3 h Date:05-01-2017

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a) Compare between x-ray diffraction and differential scanning calorimetry (DSC) as tools generally used for characterization of solid materials.

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(2)

Q.5: (10 Marks)

a) Discuss how visible coloration results in glasses when transition metal ions (like Cr, Fe ....) are added to the glass during preparation process.

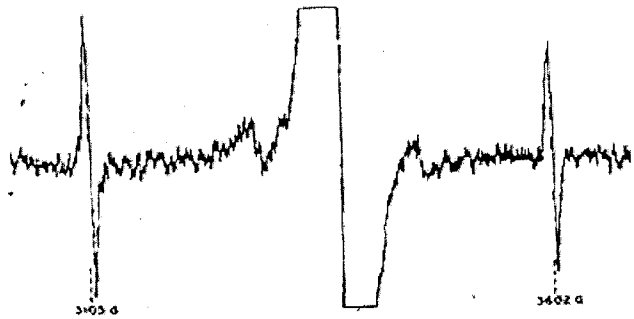
b) Plot the Lasocka and Kissinger relations using the following data. From these graphs find the constants A, B, and the activation energy for glass transition. "Consider the universal gas constant R = 8.31 kJ/mole"

Heating rate K/min	5	7.5	10	15	20
T_g(K)	374	376	379	381	384

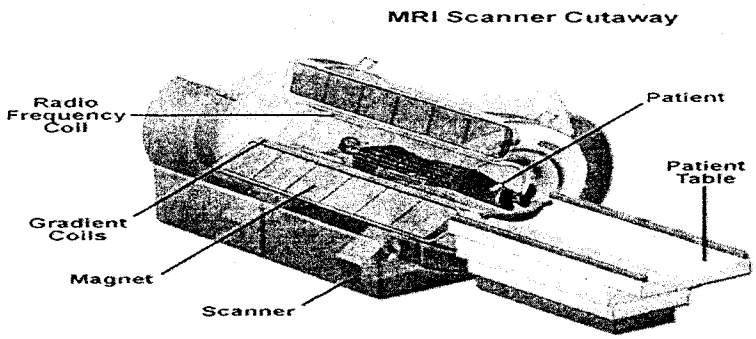
With my best wishes Prof. Dr. Atta Y. Abdel-latief

(i) calculate the hyperfine coupling constant a
(ii) draw the energy diagram and calculate the resonance frequencies under an applied magnetic field of $0.1T$

(b) The following figure shows ESR of the hydrogen atom as a function of the magnetic field, calculate the hyperfine coupling constant and the excitation photon frequency.



4) (a) In the following magnetic resonance imaging scanner, define the main parts and function of each part.



(b) Calculate the electromagnetic wave frequency which constructs the image under an applied magnetic field of 0.2T.

Best wishes

Examiner: Dr. Mohamed Almokhtar

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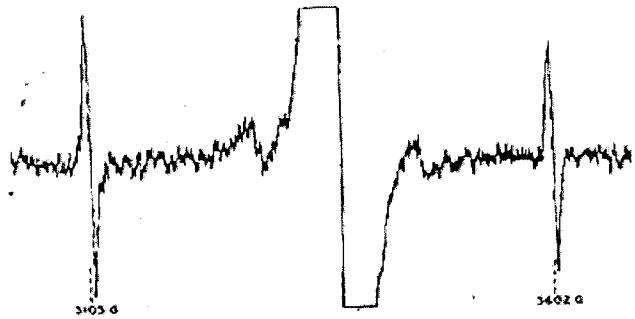

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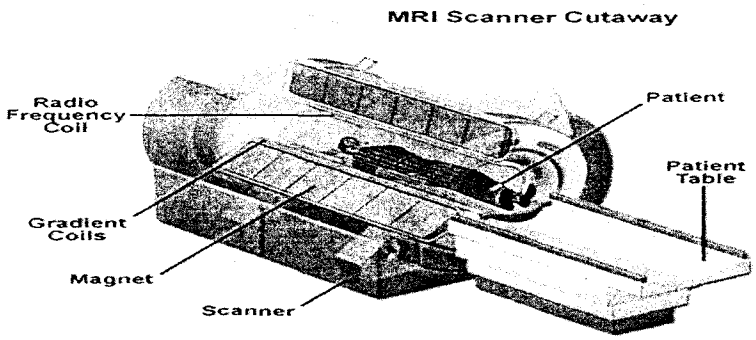

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Best wishes

Examiner: Dr. Mohamed Almokhtar

(c)

Part. II: **(40 marks)**

Answer four only from the following questions

Q:1 **(10 Marks)**

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Assiut University	Physics & Physics and Chemistry	Magnetic Resonance and Mosbauer spectroscopy
Faculty of Science	4th year	453 P
Physics Department	Exam date: 22 / 1 / 2017	Time allowed: 3 hours (50 marks)

Exam in 3 pages

Use the following physical constants when you need:

Electron charge $e = 1.6x10^{-19}$ *Coulomb*, Electron mass $m_e = 9.11x10^{-31}$ *kg*,
Proton mass $m_p = 1.673x10^{-27}$ *kg*, Planck's constant $h = 6.626\ x10^{-34}$ *J.s*
The gyromagnetic ratio of H^1, $g = 5.586$ *Dielectric permittivity* $K = 9\ x10^9\ Nm^2/Coul^2$
Boltzmann Constant $k = 1.38\ x\ 10^{-23}$ *J/K*

Section (A): (12 marks)
Choose the correct answer for the following sentences: (2 marks for each one)

1- For magnetic resonance imaging, an image contrast can be achieved by
(a) different relaxation times of the electrons
(b) different relaxation times of the protons
(c) precessions of the electrons

2- Transverse relaxation time (T2) indicates:
(a) the loss of coherence between spin precession
(b) the time required to the nuclei to align with the magnetic field.
(c) the time required for getting an NMR image.

3- With decreasing the temperature, the number of spins oriented with the magnetic field
(a) increases (b) decreases (c) doesn't change

4- In a magnetic resonance experiment, an applied static magnetic field is used for
(a) excitations between the energy levels
(b) splitting of the energy levels
(c) damping between the excited states

5- The electromagnetic wavelength required to spin flip the ^1H nuclei is
(a) larger than the electromagnetic wave length required to spin flip the electrons.
(b) smaller than the electromagnetic wave length required to spin flip the electrons.
(c) equal to the electromagnetic wave length required to spin flip the electrons.

6- Spin-lattice relaxation times is usually
(a) larger than the spin-spin relaxation times
(b) smaller than the spin-spin relaxation times
(c) equal to the spin-spin relaxation times

Section (B): (14 marks)
Complete the following sentences: (2 marks for each one)

1- The gyromagnetic ratio of an electron with total angular momentum J can be calculated using the relation:

$\gamma_J =$

Assiut University	**Semiconductor physics, thin films and its**	
Faculty of science	**application (451p)**	
Physics department	**Date: 03/01/2017**	**Time: 3hrs**

Answer the following questions:

Question .1

(a) Deduce mathematical expression for direct allowed and forbidden optical transitions in semiconductors.

(b) Explain the different types of Exciton absorption bands and temperature dependence of Exciton absorption spectra in semiconductors.

(c) The complex dielectric constant (ε^*) of ZnO is given by the relation:

$$\varepsilon^* = 9.5 + i\ 4.2$$

At $\lambda = 450$ nm. Deduce the real and imaginary parts of complex refractive index (n^*), the phase velocity (υ), the absorption coefficient (α) and the reflectivity (R).

Question .2

(a) Derive an expression for the position of Fermi level in p-type semiconductor at high temperature and explain how you can determine the ionization energy of acceptor atoms.

(b) Discuss Hall effect and its application in semiconductor material.

(c) Calculate the density of donor atoms which have to be added to intrinsic germanium to produce n-type material of resistivity 2×10^{-8} ohm.m, where the mobility of electron in the n-type semiconductor is 0.33 $m^2 V^{-1}S^{-1}$.

Question .3: Explain in details:

(a) Mechanism of DC photoconductivity and how you can determine the minority carrier life time from AC photoconductivity measurements.

(b) Diffusion length and life time of charge carriers in semiconductors.

(c) Determine the electron diffusion length (L_n), if the minority lifetime in p-type material is 10^{-8}s and the mobility of electrons in silicon is 0.18 $m^3 V^{-1}s^{-1}$ at 400°K.

Question .4: Discuss the following:

(a) Luminescence phenomena in semiconductors and its application in optoelectronic devices.

(b) Drift and Diffusion current in semiconductor materials.

(c) Calculate the position of Fermi level at 450 °C for n-type CdSe nanocrystals containing 5×10^{22} donor atoms/m^3, also calculate the conductivity if the mobility of the electron is 0.18 $m^3 V^{-1}s^{-1}$.

With my best wishes

Prof. Dr. Mohamed A. Osman

(4)

Q.3: **(10 Marks)**

a) **Compare between x-ray diffraction and differential scanning calorimetry (DSC) as tools generally used for characterization of solid materials.**

b) **Drive a mathematical expression for the ionic electrical conductivity (σ) in 3 dimensional amorphous solid in the presence of electric field ($E > 0$). How you can use (σ VS T) experimental data to calculate the barrier height (ΔE_a)**

(0)

Q.4: **(10 Marks)**

a) **Using Sketch diagram explain the steps used in the float process to produce windows and mirrors glass.**

b) **Calculate the average coordination number <N> for the following compounds:**

i) $Se_{85} In_{10} Pb_5$ **ii)** $Se_{50} In_{30} Pb_{20}$

consider: $N_{Se} = 2$, $N_{In} = 5$, $N_{Pb} = 4$

which one of these compounds can form glassy alloys.

Question (3): **(10**

a) If you know that the total current density in any matter that has elect magnetic properties can be written as: $\vec{J} = \vec{J}_f + \vec{J}_M + \vec{J}_P$, derive an expression f and $\vec{J}_P$ and then derive the Maxwell-Ampère's law in matter. (7 points)

b) Given $\vec{E} = E_m \sin(\omega t - \beta z)\,\hat{j}$, find $\vec{D}$, $\vec{B}$ and $\vec{H}$. (3 points)

Question (4): **(10 Mark)**

a) Derive Poynting vector in electrodynamics in its integral form and discuss the physical meaning of the Poynting theorem. (7 points)

b) In free space, $\vec{E} = 50\cos(\omega t - \beta z)\,\hat{\imath}$ (V/m). Find the Poynting vector crossing a circular area of radius 2.5 m. (3 points)

Question (5): **(10 Mark)**

a) Derive Poisson's equation under Lorentz gauge. (7 points)

b) If $\vec{B}$ is uniform, and $\vec{A} = -(\vec{r} \times \vec{B})/2$, where $\vec{r}$ is the vector from the origin to the point in question. Check that $\vec{\nabla} \cdot \vec{A} = 0$ and $\vec{\nabla} \times \vec{A} = \vec{B}$. (3 points)

Question (6): **(10 Mark)**

a) Write the Lorentz transformation in terms of components that are parallel and perpendicular to the motion and then show how to draw the Minkowski diagram for S and S' inertial frames. (5 points)

b) Derive the four vector components of momentum $\vec{p}$. (5 points)

Useful relations:

For any two vectors $\vec{A}_1$ and $\vec{A}_2$:

- $\vec{\nabla} \times (\vec{A}_1 \times \vec{A}_2) = (\vec{A}_2 \cdot \vec{\nabla})\vec{A}_1 - (\vec{A}_1 \cdot \vec{\nabla})\vec{A}_2 + \vec{A}_1(\vec{\nabla} \cdot \vec{A}_2) - \vec{A}_2(\vec{\nabla} \cdot \vec{A}_1)$
- $\vec{\nabla} \cdot (\vec{A}_1 \times \vec{A}_2) = \vec{A}_2 \cdot (\vec{\nabla} \times \vec{A}_1) - \vec{A}_1 \cdot (\vec{\nabla} \times \vec{A}_2)$
- Divergence theorem for vector $\vec{A}$ is: $\int_S \vec{A} \cdot d\vec{a} = \int_V \vec{\nabla} \cdot \vec{A}\, d\tau$
- Stokes's theorem for vector $\vec{A}$ is: $\int_l \vec{A} \cdot d\vec{l} = \int_S (\vec{\nabla} \times \vec{A}) \cdot d\vec{a}$

Q.5: (10 Marks)

a) **Discuss how visible coloration results in glasses when transition metal ions (like Cr, Fe, ...) are added to the glass during preparation process.**

b) **Plot the Lasocka and Kissinger relations using the following data. From these graphs find the constants A, B, and the activation energy for glass transition. "Consider: the universal gas constant R = 8.31 kJ/mole"**

Heating rate K/min	5	7.5	10	15	20
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With my best wishes Prof. Dr. Atta . Y. Abdel-latief

Assiut University
Faculty of Science
Department of Physics

Undergraduate
Final Exam (50%)

First semester 2016-2017

Course : Selected Topics in Physics (1)
Code : P491
Section : Physics
Time : 3 Hours
Date : 15/1/2017

Answer the following question:

Question (1): (10 Mark)

Write number of each statement and put [√] or [×], then discuss your answer (if √ or ×):

1- The units of both electric displacement $\vec{D}$ and polarization $\vec{P}$ are not the same.

2- Magnetic properties of matter comes from magnetic moments of circulating electrons.

3- Like electric polarization $\vec{P}$, magnetization $\vec{M}$ is parallel to magnetic field $\vec{B}$.

4- The total current density in any matter that has electric and magnetic properties can be written as: $\vec{J} = \vec{J}_M + \vec{J}_P$.

5- Since the magnetic field $\vec{B}$ is irrotational, we can write $\vec{B} = \vec{\nabla} \times \vec{A}$, where $\vec{A}$ is the vector potential.

6- The electric field $\vec{E}$ can be described by $\vec{E} = -\vec{\nabla}V - \frac{\partial \vec{A}}{\partial t}$.

7- If we know that the Bio-Savart Law is given by $\vec{B} = \frac{\mu_0}{4\pi} I \oint \frac{(d\vec{l} \times \hat{r})}{|\vec{r}|^2}$, then the vector potential is given by $\vec{A} = \frac{\mu_0}{4\pi} \oint \frac{\vec{J}}{r} d\tau$.

8- Gauge transformation can be defined as a systematic transformation of the potentials that leaves the fields invariant under transformation.

9- Lorentz gauge takes the time derivative is zero.

10- Coulomb gauge occurs when the time derivative is zero and div $\vec{A} = 0$.

Answer four (4) only of the following questions:

Question (2): (10 Mark)

a) Define the electric polarization and magnetization. (2 points)

b) Derive an expression of the bound volume charge density is given by ρ_b , then derive Gauss Law in differential form for electric displacement. (6 points)

c) Find polarization $\vec{P}$ in a dielectric material with $\varepsilon_r = 2.8$ if $D = 3.0 \times 10^{-7}$ C/m^2. (2 points)