



كلية العلوم

جامعة أسيوط

التاريخ: الأربعاء 2016/8/24

قسم الفيزياء

شعبة : النظام الحديث

الفرقة : الرابعة

ملحوظة : لكل سؤال 12.5 درجة

أجب عن أربعة أسئلة فقط مما يأتي:

السؤال الأول:

أكتب مقالة علمية تاريخية عن خصائص الضوء - كمقدمة لفهم مبادئ الليزر؟

السؤال الثاني:

(أ) عرف المفاهيم العلمية التالية:

(كل فقرة 1.5 درجة)

قلب التعداد - الأتزان الحراري - الوسط الفعال لليزر.

(8 درجات)

(ب) تکلم عن خصائص معاملات اینشتین لفهم کیفیة الأنبعاث التلقائي والأنبعاث المرغم؟

السؤال الثالث:

(أ) اشرح المبادئ الأولية لتفاعل الموجات الكهرومغناطيسية مع المادة – مع التوضيح بالرسم؟ (4.5 درجة)

(ب) تكلم عن طرق الضخ الليزري - مع التوضيح بالرسم فقط - الليزرات المتعددة المستويات؟ (8 درجات)

السؤال الرابع:

(أ) صف ميكانيكية آلية للحصول علي شعاع ليزرالياقوت (Ruby Laser) - مع التوضيح بالرسم فقط -

(8 درجات)

مستويات الطاقة في هذه الحالة؟

(ب) إحصاء التعداد النسبي لمستويين الطاقة في ليزر الياقوت عندما يكون هناك انبعاث فوتوني بينهما ذو

(4.5 درجة)

طول موجي 6928 أنجستروم ، وبفرض أن درجة الحرارة للنظام 18 كيلفن؟

السؤال الخامس:

(أ) أكتب- باختصار :- مميزات- وخصائص شعاع الليزر- وأهم التطبيقات العملية له؟ (كل فقرة 1.5 درجة)

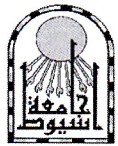
(ب) استنتج - باستخدام المعادلات الرياضية الفيزيائية - الشرط الحرج للحصول على مضخم شعاع الليزر؟

(8 درجات)

ملحوظة: استخدم الثوابت العلمية التالية – إذا لزم الأمر:

$$h = 6.6 \times 10^{-34} \text{ J sec.}, \quad k = 1.38 \times 10^{-23} \text{ J K}^{-1}, \quad c = 3 \times 10^8 \text{ m sec}^{-1}$$

انتهت الأسئلة – مع أطيب التمنيات بالتوفيق ،،،،،،،،،،،،

Assiut University Faculty of science Physics department	Summer course Semiconductor physics, thin films and its application (451p) Date: 04/09/2016 Time: 3hrs	
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Answer the following questions:

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

1. (b) The complex refractive index of ZnSe is given by the relation:

$$n^* = 4 + i 0.5$$

At $\lambda = 530$ nm. Deduce the complex dielectric constant (ϵ^*), the phase velocity (v), the absorption coefficient (α) and the reflectivity (R).

1. (c) For an intrinsic semiconductor with a gap, $E_g = 1.2$ eV, determine the position of Fermi level at 330°K if $m_p^* = 6 m_e^*$, Also, calculate the density of holes and electrons at 300°K .

(14 mark)

2. (a) Explain in details on the following:

1. Generation and recombination process of charge carriers in semiconductors.
2. Diffusion and drift currents.

2. (b) An electric field of 100 V/m is applied to a sample of n-type semiconductor whose Hall coefficient is -0.0125 m³/coulomb. Determine the current density in the sample assuming $\mu = 0.36$ m²V⁻¹S⁻¹.

2. (c) If the minority lifetime in p-type material is 10^{-7} s and the mobility of electrons in silicon is 0.15 m³ V⁻¹s⁻¹ at 300°K , and then determines the electron diffusion length (L_n).

(12mark)

3. (a) Explain in details **two** of the following:

1. Light emitting diode
2. Solar cells.
3. Photodiode and Photo-detector.

3. (b) Discuss Hall effect and its application in semiconductors.

(12 mark)

4. Write only on three different experimental techniques of semiconductor thin films preparation:

(12 mark)

With my best wishes
Prof. Dr. Mohamed A. Osman

Question No.1: (15 deg.)

Choose the correct answer-(Or answers):

1. When light is reflected or scattered by bodies, we see:
(A) Spectrum (B) bodies (C) light
2. Spectra emitted from some materials gives us an idea about:
(A) Light components (B) Nature of light (C) material structure
3. light *can be considered as.....and is treated using* quantum theory
(A) energy (B) waves (C) particles
4. Certain crystals polarizes light which forces us to treat it as :
(A) energy (B) waves (C) particles
5. when we use the words “ colors, refractive index “ we are talking in
..... Language.
(A) quantum (B) Wavelike (C) particulate
6. When we use the words “ photons – frequencies – energies “ we
are talking in Language.
(A) quantum (B) Wavelike (C) particulate
7. Both reflection and refraction of light –together- can't be treated
unless considering light as :
(A) Particles (B) Waves (C) Photons
8. When shadows appear , this means that the light may be :
(A) Particles (B) Waves (C) Photons
9. Far away light sources emits light treated as Waves:
(A) Plane (B) Spherical (C) Paralleled-rays
10. in Stimulated emission all obtained photos have the same :
(A) Phase (B) Energy (C) Direction
11. Microwave Amplification by Stimulated Emission of Radiation
(A) Laser (B) Maser (C) leather
12. Laser is ultra-pure because it is :
(A) Mono Wavelength (B) Monochromatic (C) High frequency
13. One of the conditions of Laser emission is: the number of exited
atoms Than the number of stable ones
(A) Larger (B) Less (C) equals “to”

١٤. أقرب طبقات الغلاف الجوي الأرضي:

(أ) تعكس (ب) منص (ج) تدد... ما ينصاعد إليها

١٥. طبقة الأوزون هي السقف الأخير لحماية الأرض من الأشعة الكونية والشهب حيث أنها:

(أ) سمكة جدا (ب) حقل كهربائي (ج) حقل مغناطيسي

Question No. 2: (30 deg.)

Choose and discuss the correct answer-(Or answers):

1. Vision requires the presence of:

(A) medium (B) Vision instrument (C) Light Source

.....
.....
.....
.....

2. When objects absorb light and then emit, we see

(A) Spectrum (B) bodies (C) light

.....
.....
.....
.....

3. Different colors are:

(A) Waves (B) particles (C) Vibrations

.....
.....
.....
.....

4. We can use the light in life applications as a result of our knowledge of its:

(A) laws of motion (B) behaviors (C) nature

.....
.....
.....
.....

5. Light refracts when it passes through two different mediums which forces us to treat it as :

- (A) energy (B) waves (C) particles
-
-
-
-

6- Light interferes and gives bright or dark spot , which forces us to treat it as :

- (A) energy (B) waves (C) particles
-
-
-
-

7- Light interaction with sensitive material can't be explained unless considering the light as :

- (A) energy (B) waves (C) particles
-
-
-
-

8- The greater the refractive index of the heavy medium , the the refractive angle.

- (A) Greater (B) Smaller
-
-
-
-

9- Spontaneous emission is characterized in :

- (A) Phase difference (B) Destructive Interference (C) Optical resonance
-
-
-
-

10- Stimulated emission is characterized in :

(A)Phase difference (B)Constructive Interference (C)Coherence

11- Gas type of Laser requires the presence of :

(A)One Gas (B)Two gases (C)Several gases

12- Phase difference between laser waves equals :

(A)0 (B) $(n + \frac{1}{2} n) \lambda$ (C) λ

١٣. أثناء النهار يقوم الغلاف الغازي الأرضي ٥٣% من اشعة الشمس:

(أ) بإفاد (ب) بعكس وارجاع (ج) بامتناس

١٤. طبقة الاستراتوسفير (الافزوسفير) الاشعة فوق بنفسجية الزائدة عن الحاجة:

(أ) منص (ب) تعكس للخارج (ج) تنفذ

١٥. من فضل الله علينا أن الغلاف الغازي الارضي:

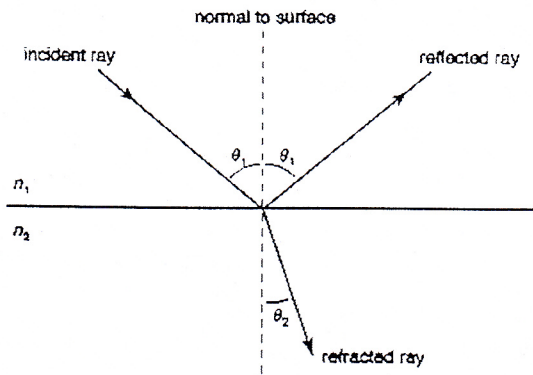
(ج) ملئهم.... بالأرض

(ب) متصل

(أ) منفصل

Question No.3 (5 deg.)

(A). Comment shortly on the following shape :



(B) Complete the following statement:

*** Gravity – according to – Newton**

*** Gravity – according to – Einstein:**

.....انتهت الاسئلة مع التمنيات بالتوفيق.....

Answer the following questions:

1. Correct the following statements and explain their meanings:

- i. Expand $[(x-3)^3(x+14)^2]$
- ii. PLOT $\{-(1-x^2)^{1/2}, x\}$.
- iii. solve $[x^2+2=0, x]$
- iv. Plot $[y=0.5x+0.5]$
- v. draw $[(1+x^2)^{1/2}, -(1-x^2)^{1/2}]$
- vi. Plot $\{u \cdot \text{Cos}[u], \text{Sin}[u]/u\}, \{u, -5, 5\}$
- vii. Factor $\{x^3-2x+1\}$

2. Prove that the equation of a straight line that touches a circle with of radius equal to (r), and a center at (x', y') is equal to:

$$y' = mx' + r\sqrt{1 + m^2}$$

Where (m) is its slope. How many lines can we draw?

3. Write down the Computer's Mathematica order for the following:

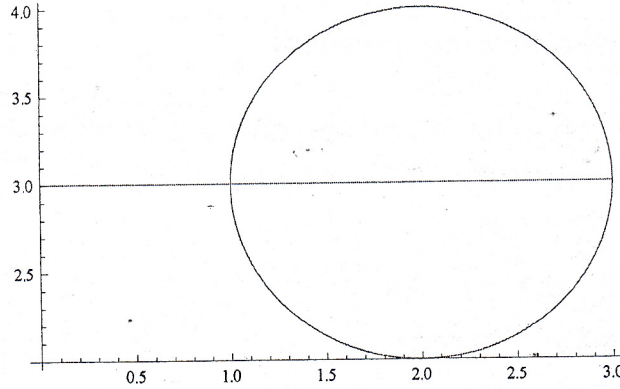
- i. Draw a circle of radius equal to 2.7.
- ii. Draw a straight line with a slope equal to 1.2.
- iii. Get the value of "x" in the equation: $x^3 - 4 = 0$.
- iv. Draw the two functions $\{x^2, x^3\}$ on the same graph.
- v. Draw a straight line parallel to the x-axis.
- vi. Draw a circle with center at (1,2) and radius equal to 1.5.
- vii. The numerical value of $(x \cos x)^{1/2}$ for $x=45^\circ$.
- viii. Draw a straight line tangential to the circle in (i).
- ix. Get the value of x in the equation: $\text{Ln}[x] = \text{Cos}[x]$
- x. Draw two circles inside each other with their center at (1, 2)

4. Write down the 'Mathematica' orders for the following 2D-crystallographic figures:

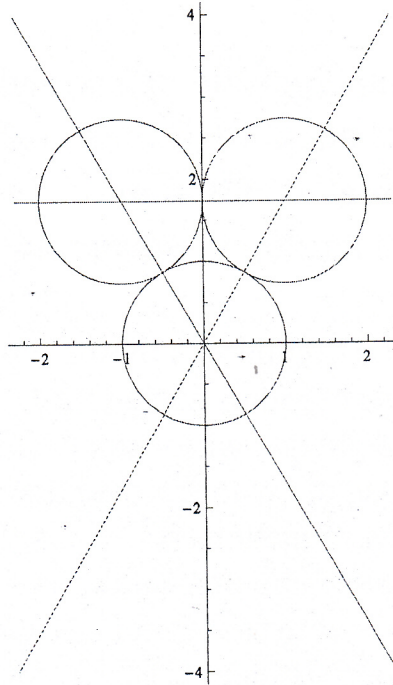
To be continued

Continue

i. Just the one circle and one straight line:



ii. A part of what is called '2D-Hexagonal' system:

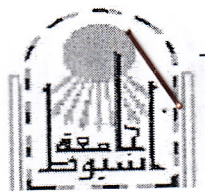
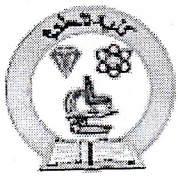


iii. How many circles would be in touch with the central one?

What the area not covered with circles in above triangle?

What is the percentage of this area to that of the triangle?

.....
تنبيه مهم: عند كتابة أي امر يدويا يجب وضع خط تحت الحروف ال Capital .
.....

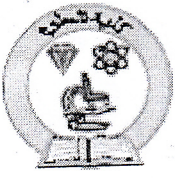


Final Exam – Second Term: 2015/2016 - Course Title: Physics of Low Temperature P- 422- Time: 3h - Prof. Dr. Ahmed Sedky

Answer the following questions:

Q1 Write the reason for the following (10 marks):

1. The surface energy can be obtained in terms of thermodynamic critical field.
2. The Specific heat has a jump near T_c for superconductors.
3. The Energy gap can be obtained in superconductors by using ultrasonic waves.
4. The Type (I) superconductor can carry a surface sheath.
5. The normal electrons could not carry any current in superconductors.
6. The grain size can be obtained from XRD patterns.
7. The Orthorhombic distortion is zero for $Ti:2223$ superconductors.

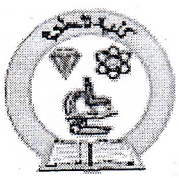


Q2(10 marks):

(a) Explain with the required diagram the mechanism of BCS theory for electron pairs.

(b) Calculate H_{c1} , H_{c2} and H_{c3} for a superconductor when $\xi = 0.4 \text{ nm}$ and $\lambda_L = 0.8 \text{ nm}$

(c) Prove that χ must be negative for superconductors, and then and write the reason.

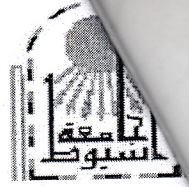
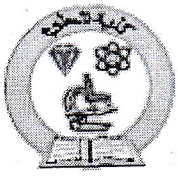


Q3(10 marks):

(a) Derive an expression for the energy of triangular vortex lattice in mixed state.

(b) Prove that $E_g(0) = 3.52K_B T_c$ is applicable only for weakly coupled superconductor.

(c) Clarify in details how the flux creep occurs in a superconductor, and then explain how you can determine the activation energy of flux bundles.

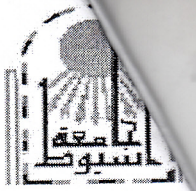
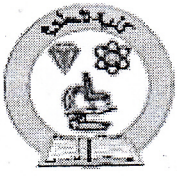


Q4(10 marks):

(a) Calculate size of BCS electron pairs in both conventional and high T_c superconductors, and then compare them with similar values of the normal state.

(b) Clarify in details how you can use a superconductor in only one of its applications.

(c) Calculate by nm the spacing of vortex lines for a superconductor if $K_{GI} = 0.955$, pinning radius = 1.2 nm and $\rho_f = 2\rho_n$.



Q5(10 marks):

(a) Determine the flux flow resistance along a flat strip of type (II) in mixed state.

(b) Write the type of crystal structure, T_c , $J_c(0)$ and H_{c2} values for Bi: 2223 and MgB_2 high T_c systems.

(b) Consider a cylindrical superconducting wire of $V = 3.14 \text{ cm}^3$, $\ell = 2 \text{ cm}$, $R = 10 \text{ m}\Omega$, $T_c = 30 \text{ K}$ and $H_{c2}(0) = 6 \text{ T}$. Calculate the thermodynamic critical field and the number density of electron pairs at 0 K.



Course Title: Radiation Physics - Code: P444 - Final Exam (50 Marks)

Answer the following questions:

- Q1: (a) For 140 keV gamma rays, the mass attenuation coefficients for hydrogen and oxygen are 0.26 and 0.14 cm²/g, respectively. What is the mean free path in water at this energy? [4 Marks]
- (b) Indicate which of the three major interaction processes (photoelectric absorption, Compton scattering, pair production) is dominant in the following situations: [2.5 Marks]
- (1) 1 MeV gamma rays in aluminium (2) 100 keV gamma rays in hydrogen
(3) 100 keV gamma rays in iron (4) 10 MeV gamma rays in carbon
(5) 10 MeV gamma rays in lead
- (c) What is the main parameters that specific energy loss (Bethe formula) dependence on? [2.5 Marks]
- (d) Estimate the exposure rate at 5 m from a 1.0 Ci source of ⁶⁰Co. Where The exposure rate constant for ⁶⁰Co is 13.2 R.cm²/hr.mCi. [4 Marks]
- Q2: (a) Which class of solid-state detector is suitable for measuring a person's accumulated radiation dose? How does the detector function? [4 Marks]
- (b) Discuss the relationship between voltage applied to the counter and charge collected (I – V Curve). [Short Discussion] [5 Marks]
- (c) As an application of RANGE, any detector that is to measure the full incident energy of a charged particle must have an active thickness that is greater than the range of that particle in the detector material. Discuss in short? [3 Marks]
- Q3: (a) If 10 kBq of ¹³²Te (T_{1/2} = 3.2 d = 76.8 h) is used as a generator of ¹³²I (T_{1/2} = 2.28 h), what will be the maximum activity of ¹³²I that will grow into the source and when will it occur? [4 Marks]
- (b) Determine by Q-value analysis whether ⁶⁵Zn can undergo radioactive transformation by β⁺, EC, or β⁻ transition. [4 Marks]
- (c) A reference person weighs 70 kg and contains, among other elements, 18% carbon (65 billion atoms of ¹⁴C per gram of C) and 0.2% potassium. How many microcuries of ¹⁴C and of ⁴⁰K will be present in such a person? [4 Marks]
- Q4: (a) Discuss in details the radiation damage mechanisms to DNA. [5 Marks]
- (b) What Follows Chromosome Damage by ionizing radiation? [4 Marks]
- (c) A radioactive source with an activity of 0.2 μCi is used to determine the counting efficiency of a radiation detector. (a) If the response of the detector is 66,600 counts per minute (c/m), what is the detector efficiency? (b) What is the efficiency if the source activity is 20 kBq? [4 Marks]

$N_a = 6.022 \times 10^{23} \text{ atoms/mol.}, \rho_w = 1 \text{ g/cm}^3.$



في
علوم الليزر وتطبيقاته
(472 ف)

كلية العلوم

جامعة أسيوط

التاريخ: الثلاثاء 2016/ 6/14
الزمن: ثلاث ساعات

قسم الفيزياء

الفرقة : الرابعة

ملحوظة : لكل سؤال 12.5 درجة

أجب عن أربعة أسئلة فقط مما يأتي:

السؤال الأول:

أكتب مقالة علمية تاريخية عن خصائص الضوء – كمقدمة لفهم مبادئ الليزر؟

السؤال الثاني:

(أ) عرف المفاهيم العلمية التالية:

(كل فقرة 1.5 درجة)

قلب التعداد - الأتزان الحراري - الوسط الفعال لليزر.

(ب) تكلم عن خصائص معاملات أينشتين لفهم كيفية الأنبعث التلقائي والأنبعث المرغم؟ (8 درجات)

السؤال الثالث:

أ) تكلّم عن طرق الضخ الليزري – مع التوضيح بالرسم فقط – الليزرات المتعددة المستويات؟ (8 درجات)

(ب) إذا كانت نسبة تعداد مستويين الاعلى للطاقة والآخر الأكثر استقرارا في ليزر الهليوم - نيون هي:

فأحسب الطول الموجي للضوء المنبعث عند درجة حرارة 330K ؟ (4.5 درجة)

السؤال الرابع:

أ) صف ميكانيكية آلية للحصول على شعاع ليزر الهليوم - نيون - مع التوضيح بالرسم فقط - مستويات

الطاقة في هذه الحالة؟ (8 درجات)

(ب) إحسب التعداد النسبي لمستويين الطاقة في ليزر الياقوت عندما يكون هناك إنبعاث فوتوني بينهما ذو

طول موجي 6928 أنجستروم ، وبفرض أن درجة الحرارة للنظام 18 كيلفن؟ (4.5 درجة)

السؤال الخامس:

أ) أكتب- باختصار - مميزات وخصائص شعاع الليزر- وأهم التطبيقات العملية له؟ (كل فقرة 1.5 درجة)

(ب) استنتج - باستخدام المعادلات الرياضية الفيزيائية - الشرط الحرج للحصول علي مضخم شعاع الليزر؟

(8 درجات)

ملحوظة: استخدم الثوابت العلمية التالية – إذا لزم الأمر:

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انتهت الأسئلة – مع أطيب التمنيات بالتوفيق ،،،،،،،،،،

Answer the following questions:

Qu.1 Choose the correct answer from the following **(10 marks)**

- 1) Nanoscale materials may differ from microscale materials in the following aspects
Gravitational forces become (Negligible, large, intermediate) and electromagnetic forces dominate.
- 2) The (classical, quantum mechanical, or both) models; can be used to describe motion and energy.
- 3) (Greater, smaller, intermediate) surface to volume ratios.
- 4) Random molecular motion becomes (more, less) important.
- 5) Gravitational force is (negligible, weak, strong).
- 6) Electromagnetic force is (strong, weak, moderate) at nano scale.
- 7) Surface atoms requires (less ,high ,average) energy to move because they are in contact with fewer atoms of the substance.
- 8) Melting point (decreases, increases, still constant) with size reduction.
- 9) The mechanical strength of the materials becomes (larger, smaller)than for the micro sized or bulk.
- 10) For quantum dots dimensionality equals (0, 1, 2, 3)

Qu.2 (a) **(5 marks)**

Given the following data for CdSe, $m_e = 0.13 m_0$, $m_h = 0.45 m_0$, $\epsilon = 9.4$,
Calculate the following:

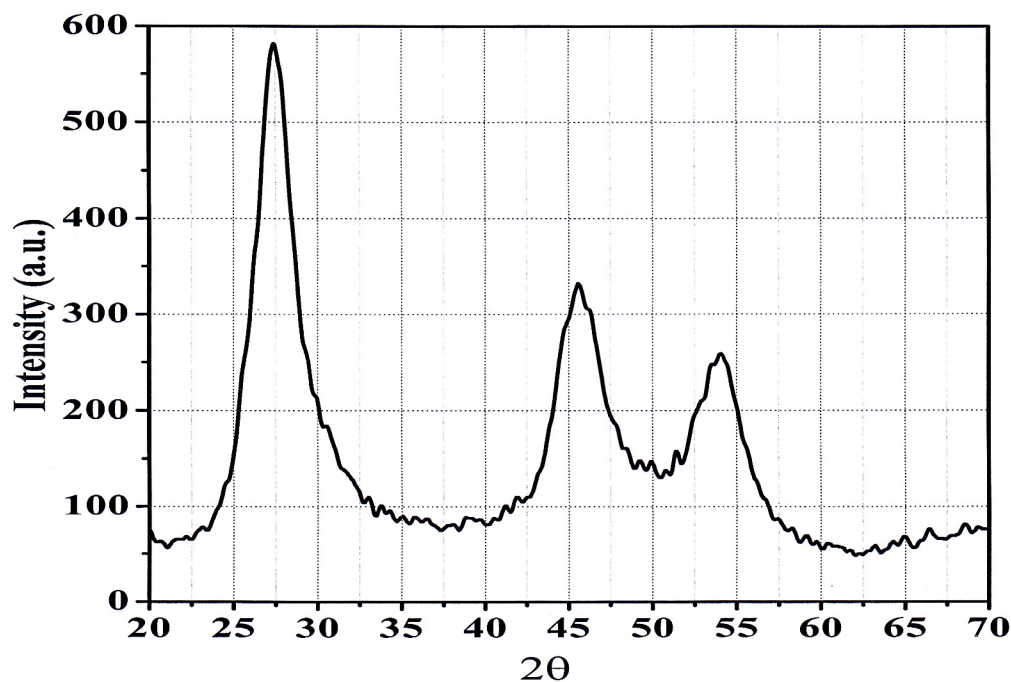
- a. The effective mass.
- b. Exciton Bohr radius for each.

(b) Explain what the electron beam lithography process . **(10 marks)**

Qu.3 (a) Write True (T) or False (F) in the following: **(5 marks)**

1. Tuning the size of semiconductor nanocrystal is a means to tune the optical band gap and therefore the wavelength absorbed or emitted by the nanocrystal. []
2. Quantum confinement effect causes the energy gap to increase; therefore more energy is needed in order to be absorbed by the band gap of the material. []
3. High surface area to volume ratio provides strong driving force to speed up thermodynamic processes that minimize free energy. []
4. Fullerene is a carbon molecule with carbon atoms arranged in a spherical shape.[]
5. Nanosized particles are chemically very active because of their large surface to volume ratio [].

(b) Using the attached XRD pattern calculate the particle size (D) from; Scherrer equation (5 marks)



Qu.4 Write about the following:

(15 marks)

1. Ball milling (mechanical attrition) method.
2. Sol-Gel technique as a chemical bottom-up method.
3. Physical vapor deposition (sputtering).

With my best wishes| Prof.dr. Aly Othman

Notes:

Electronic charge = 1.602×10^{-19} Coul, $\epsilon_0 = 8.85 \times 10^{-12}$, $h/2\pi = 1.054 \times 10^{-34}$

ANSWER ONLY FOUR QUESTIONS.

1- a- The physical system Formed by a e^+ and an electron is called positronium. Determine the ionization energy and Bohr radius.

(Hint: $a_0(H) = \hbar^2/me^2$, $E_n(H) = -me^4/2\hbar^2n^2$)

b- Calculate the number of components in the anomalous Zeeman effect of the sodium lines at $5890/96 \text{ \AA} [3^2P_{3/2,1/2} - 3^2S_{1/2}]$

2)-a- A spectral cadmium line at $6438 \text{ \AA}$ is the result of $[6^1D_2 - 5^1P_1]$ transition. Draw an energy levels diagram representing the normal Zeeman Effect in an magnetic field.

b- Construct a diagram of the Stark effect of H_α line of the hydrogen spectrum

3- a- Prove that the allowed rotational energies of a linear molecule can be written as: $\bar{E}_J = \bar{B}J(J+1) \text{ cm}^{-1}$, $\bar{B} = h/8\pi^2IC \text{ cm}^{-1}$

b- Draw the energy – levels pattern for a non-rigid rotating linear molecule

4- Show that for a rotation – vibration coupling term, the allowed transition frequencies for the $v = 0 \rightarrow v = 1$ transitions are:

$$\bar{\nu} = \bar{\omega} + 2B(J+1), J = 0, 1, 2, \dots \dots \dots \text{ for } \Delta J = +1$$

$$\bar{\nu} = \bar{\omega} - 2BJ, J = 0, 1, 2, \dots \dots \dots \text{ for } \Delta J = -1$$

5-a- Calculate the possible values of $\vec{L} \cdot \vec{S}$ for $L=1$ and $S=1$

b- Illustrates the relative orientation of the three vectors.

Good - Luck