

السؤال الخامس

(6 درجات)

ا- اذكر مميزات وعيوب استخدامات الليزر في الطب

انتهت الأسئلة والله الموفق.

Constants: $k=1.38 \times 10^{-23} \text{ J/K}^0$ ثابت بولتزمان $h=6.625 \times 10^{-34} \text{ J.sec}$ ثابت بلانك
 $C=3 \times 10^8 \text{ m/sec}$ سرعة الضوء $e=1.6 \times 10^{-19} \text{ C}$ شحنة الالكترون $R=10,97 \times 10^6 \text{ m}^{-1}$ ثابت رابدرج

السؤال الرابع

ا- استنتج قيمة معامل كسب الإشارة الصغيرة لاشعة الليزر

(4 درجات)

ب- اذكر مميزات وعيوب استخدامات الليزر في الصناعة.

(3 درجات)

السؤال الثالث

(4 درجات)

ا- استنتج قيمة اتساع المنحني الطيفي لاشعة الليزر بطريقة دوبلر

(درجتان)

ب- اشرح ليزر المستويات الثلاثة

17 - وحدة قياس معامل اينشتين A_{21} هي

ب- الهرتز

ا- وحدات زمن

د- ليس له وحدات

ج- وحدات الطاقة وهي الجول

18 - سقطت حزمة ليزرية ذات طول موجي $\lambda=600\text{nm}$ على حاجز به فتحة نصف قطرها 0.01 mm فكم تكون زاوية حيود الشعاع ذو الترابط المكاني التام.

ا- $\theta=0.06^\circ$ ب- $\theta=0.03^\circ$ ج- $\theta=0.02^\circ$ د- $\theta=0.015^\circ$

19- كم يكون معامل التكبير لشعاع الليزر اذا كان طول التجويف $L=30\text{cm}$, $\gamma=70\text{m}^{-1}$

ا- $G=1.32 \times 10^9$ ب- $G=1.32 \times 10^9$ ج- $G=1.32 \times 10^{11}$ د- $G=20.132 \times 10^{11}$

20- في مقياس ميكلسون سقط شعاع ليزري طول له الموجي $\lambda=700\text{ nm}$ علي غشاء رقيق من الزجاج معامل انكساره 1.5 فسمح بمرور 200 هذبة واذا استبدل الغشاء الزجاجي بعشاء مائي معامل انكساره 1.333 وله نفس سمك الغشاء الزجاجي فكم عدد الهذبات التي يسمح بمرورها الغشاء المائي

ب- $n=267$

ا- $n=266$

د- $n=134$

ج- $n=133$

12- اي طريقة ضيخ تصلح للحصول علي اشباه الموصلات

ب - الضيخ الحراري
د-الضيخ الكيميائي

ا- الضيخ الضوئي
ج- الضيخ الكهربائي

13- كم تكون قوة سطوع شعاع ليزري قطره 0.3 mm اذا كانت قدرة الشعاع 0.8mw
وزاوية انفراجة $\theta=0.4^0$

ب- $B=1.435 \times 10^4 \text{ j/m}^2$
د- $B=3589 \text{ j/m}^2$

ا- $B=2.87 \times 10^4 \text{ j/m}^2$
ج- $B=7.177 \times 10^3 \text{ j/m}^2$

14- يحدث التداخل البناء في تجربة يونج ذو الشق المزدوج عندما يكون فرق المسار مساويا

ا- لعدد صحيح من انصاف الاطوال الموجية
ب- لعدد صحيح من الاطوال الموجية
ج- لعدد زوجي الاطوال الموجية
د- لاشئ مما ذكر

15- كم تكون النسبة بين تعداد المستوي الثاني الي تعداد المستوي الاول عند درجة حرارة 227^0 C

اذا كان طول موجة الانتقال بين المستويين $\lambda=950 \text{ nm}$

ب- $N_2/N_1=1.47 \times 10^{-13}$
د- $N_2/N_1=1.01 \times 10^{-29}$

ا- $N_2/N_1=1.47 \times 10^{13}$
ج- $N_2/N_1=1.01 \times 10^{29}$

16- غشاء رقيق من الزجاج سمكه 0.06mm استخدم لمقياس ميكلسون فسمح بمرور 150 هدبة .

معامل انكسار مادة الغشاء علماً بان طول موجة شعاع الليزر المستخدم $\lambda=480 \text{ nm}$

ب- $\mu=1.5$
د- $\mu=1.3$

ا- $\mu=1.6$
ج- $\mu=1.4$

6- احسب عدد الأنماط البصرية المتكونة في تجويف فابري-بيرو لشعاع ليزري طوله الموجي $\lambda=350 \text{ nm}$ إذا علمت أن المسافة الفاصلة بين المرآتين $L=0.35 \text{ cm}$

أ- 10^4 Modes ب- $2 \times 10^4 \text{ Modes}$ ج- 10^7 Modes د- $2 \times 10^7 \text{ Modes}$

7- في التجاويف الرنانة إذا كان قطر أي من المرآتين مساويا للمسافة الفاصلة بينهما يسمى التجويف في هذه الحالة

أ- تجويف فابيري بيرو ج- تجويف كروي متحد البؤرة
ب- تجويف كروي متحد المركز د- تجويف مستوي-كروي

8- إذا كان طول موجة شعاع ليزر الهيدروجين نتيجة لانحلال الذرات من مستوي الطاقة

الخامس الى مستويات طاقة اقل هو $\lambda=200 \text{ nm}$ احسب رتبة المدار النهائي

أ- المدار الاول ب- المدار الثاني ج- المدار الثالث د- المدار الرابع

9- إذا كانت زاوية حيود شعاع ليزري $\theta=1.2^\circ$ فكم تكون الزاوية المقابلة لهذه الزاوية

أ- $\Omega=3.77$ ب- $\Omega=4.5$ ج- $\Omega=11.83$ د- $\Omega=14.2$

10- أي من الكميات الفيزيائية الآتية لا تعتمد على شدة الموجة الكهرومغناطيسية الساقطة

أ- الامتصاص والانبعث التلقائي ج- الامتصاص والانبعث الاجباري
ب- الامتصاص وانقلاب التعداد د- لا شيء مما ذكر

11- تجويف ليزري يتكون من مرآتين انعكاسية المرآة الاولى $R_1=100\%$ ، انعكاسية المرآة الثانية .

$R_2=50\%$ احسب الشرط الحرج لإنبعاث أشعة الليزر إذا كان سمك المادة الفعالة 30 cm

و مساحة المقطع العرضي للإنتقال $\sigma=3.6 \times 10^{-19} \text{ cm}^2$

أ- $(N_2-N_1)_c = 6.42 \times 10^{17} \text{ atoms/cm}^3$ ب- $(N_2-N_1)_c = 3.21 \times 10^{18} \text{ atoms/cm}^3$

ج- $(N_2-N_1)_c = 6.42 \times 10^{20} \text{ atoms/cm}^3$ د- $(N_2-N_1)_c = 3.21 \times 10^{22} \text{ atoms/cm}^3$

السؤال الثاني اختار الإجابة الصحيحة من بين العبارات الآتية . (20 درجة -درجة لكل جزئية)

1- من عيوب الليزر الغازي المثار بواسطة المجال الكهربائي العمودي

- أ- عدم نقاء الخط الطيفي
- ب- الجهد المطبق صغير
- ج- طاقة أشعة الخرج تكون عالية
- د- ممانعة الدائرة تكون كبيرة

2- استخدم شعاعين ليزرين أحدهما طول الموجة معلوم $\lambda_1 = 800 \text{ nm}$ والآخر طول الموجة

مجهول λ_2 لأضواء فتحتين المسافة الفاصلة بينهما d فكان الوضع الزاوي للترتبة الثانية المضيئة للطول الموجي المعطى 0.2° والوضع الزاوي للترتبة الخامسة المظلمة للطول الموجي المجهول 0.5° فكم تكون قيمة الطول الموجي المجهول

- أ- $\lambda_2 = 273.6 \text{ nm}$
- ب- $\lambda_2 = 457.1 \text{ nm}$
- ج- $\lambda_2 = 727.4 \text{ nm}$
- د- $\lambda_2 = 1400 \text{ nm}$

3- يعتبر ليزر الأكسجين من ليزرات الغاز

- أ- ذو الذرة المتعادلة
- ب- ليزر الغاز الأيوني
- ج- ليزر الأكسامر
- د- ليزر الغاز الجزيئي

4- في حالة التوازن الحراري كانت النسبة بين تعداد المستوى الأول الى تعداد المستوى الأول $N_1/N_2 = e^8$

فكم تكون كثافة الإشعاع الذي طول الموجة $\lambda = 50 \text{ A}^\circ$

- أ- $4.47 \times 10^{-9} \text{ J.Sec/m}^3$
- ب- $1.3 \times 10^{-4} \text{ J.Sec/m}^3$
- ج- $1.9 \times 10^{-8} \text{ J.Sec/m}^3$
- د- $9.1 \times 10^{-7} \text{ J.Sec/m}^3$

5- في الليزر الغازي المثار بواسطة المجال الكهربائي العمودي تكون

- أ- ممانعة الدائرة صغيرة وبالتالي يكون الجهد المطبق صغير
- ب- التيار المار وقدرة الخرج عالية
- ج- يلزم وجود الغاز تحت ضغط مرتفع
- د- كل ما ذكر

11	تكون طاقة اشعة خرج الليزر المثار بواسطة المجال الكهربائي الموازي كبيرة	()
12	في ذرة الهيدروجين لكي يحافظ الالكترونون علي مساره الدائري يجب ان تتساوي قوة الجذب الكهربائي بين الالكترونات والبروتون مع القوة الطاردة المركزية	()
13	قدرة خرج اشعة الليزر الغازي المثار بواسطة المجال الكهربائي العمودي كبيرة	()
14	في ليزر الهليوم-نيون يكون ضغط الهليوم مساويا 0.1 من ضغط النيون	()
15	يمكن الحصول على بلورة الياقوت بواسطة الانماء البلوري لخليط منصهر من اكسيد الكروم واكسيد الالومنيوم بحيث يكون اكسيد الكروم اكبر وزناً من اكسيد الالومنيوم	()
16	يحدث انقلاب التعهد بين مستويات الطاقة في حالة وجود او عدم وجود موجة كهرومغناطيسية ساقطة	()
17	يمتاز المجال الكهربائي الموازي بانخفاض قيمة الضغط المطبق علي الغاز	()
18	في خاصية الترابط المكاني تتناسب شدة الموجة مع سعة الموجة	()
19	في مقياس ميكلسون تكون كلا من الشريحتين الزجاجيتين شفافة وتميلان على الافقي بزاوية 45^0	()
20	التردد الرنيني لتجويف فايبري-بيرو يتناسب طردياً مع عدد الانعاط المتكونة بداخله وعكسياً مع المسافة الفاصلة بين المرااتين	()

اجب عن الأسئلة الآتية

السؤال الأول ضع علامة (✓) امام العبارات الصحيحة وعلامة (X) امام العبارات الخاطئة

(10 درجة - درجة نصف درجة لكل جزئية)

1	تقل قوة سطوع اشعة الليزر بزيادة الزاوية المجسمة	()
2	يجب تحديد طول موجة شعاع الليزر قبل استخدامه في الصناعة	()
3	يعتمد التغير في الطول الموجي المحسوب بطريقة دوبلر على اتساع المنحني الطيفي	()
4	في التجاويف الرنانة تكون النسبة بين F_2/F_1 تتناسب طردياً مع حاصل ضرب انعكاسية المرآتين	()
5	تعمل اشعة الليزر علي كي الانسجة بعد العمليات الجراحية مما يزيد من النزيف الدموي	()
6	تحتاج ليزرات المستويات الثلاثة لوقت اكبر لحدوث انقلاب التعداد بين مستويات الطاقة عن ماهو عليه في ليزر المستويات الاربعة	()
7	تزداد قيمة الشرط الحرج لانبعث اشعة الليزر بزيادة سمك المادة الفعالة	()
8	في ليزر اشباه الموصلات لا يمكن دراسة مستويات الطاقة لذرة او جزئ منفرد بل يجب دراسة مستويات الطاقة للبلورة ككل.	()
9	في ليزر المستويات الاربعة يحدث انقلاب التعداد بين المستوي الرابع والمستوى الثالث	()
1	عند الاتزان الحراري يكون معدل التغير في الفيض بالنسبة للمسافة مساويا للفرق بين عمليتي الامتصاص والانبعث المستحث	()

20- The no. of spectral lines for a radical of two different equivalent nuclei is expected by

- (a) $2n_1I_1+1$ (b) $(2nI-1)$ (c) $(2n_1I_1+1)(2n_2I_2+1)$

21- The ESR intensity of ^1H consists of two peaks of

- (a) Equal intensity centered at $g = 1$
(b) Equal intensity centered at $g = 2.0023$
(c) Different intensity centered at $g = 2.0023$

22- Number of expected lines of ESR for benzene and methoxymethyl radicals are

- (a) 12, 7 (b) 7, 12 (c) 9, 7

23- IS usually expressed by the difference in

- (a) The d-electron density at the nuclei between the source and absorber
(b) The s-electron density at the nuclei between the source and absorber
(c) None of them

24-- The oxidation state of an absorber nucleus can be determined from

- (a) QS value (b) IS value (c) None of them

25- Due to the greater d-electron, Fe^{2+} has fewer s-electrons than Fe^{3+} , which results

- (a) Greater negative IS for Fe^{2+} than Fe^{3+}
(b) Greater positive IS for Fe^{2+} than Fe^{3+}
(c) Both of them

26- Hyperfine interaction found in γ -rays of the Mössbauer spectrum can be expressed by

- (a) F- value (b) IS- value (c) QS- value

27- The recoil energy of γ -rays goes to zero in a solid material because

- (a) Effective mass of the nucleus is very large
(b) Momentum can be conserved with negligible movement of the nucleus.
(c) Both of them

28- Isomer shift occurs when

- (a) Two nuclides or more have the same number of protons
(b) Two nuclides or more have the same number of neutrons
(c) Both of them

8- Number of splitting energy states of NMR when $I = 3/2$ is

- (a) 3 (b) 4 (c) 2

9- During the NMR, the magnetization of the nucleus is rotated against RF from

- (a) x-y-plane into the z-axis (b) z-axis into the xy-plane (c) Both of them

10- During the NMR, the magnetization of the nucleus is allowed against RF from

- (a) z-axis into the xy-plane (b) x-y-plane into the z-axis (c) None of them

11- Two million protons placed in a 14.1 T field, the 180° wave pulse produces

- a) Inversion of populations of nuclear spins in the two energy states
(b) Equal populations of nuclear spins in the two energy states
(c) Both of them

12- The number of NMR peaks for CH_2 and CH_3 are

- a) 4,3 (b) 3,4 (c) 2,3

13- The J (H-H) between two peaks of 3.4275 and 3.7805 ppm shift is

- a) 21.18 Hz (b) 7.06 Hz (c) None of them

14- $T_{1/2}$ at 100 s^{-1} of ^1H NMR is

- a) 3.2 ms (b) 3.2 s (c) 3.2 Hz

15- The resonance frequency for the ESR spectrum in a field of 0.68 T is

- a) 19.06 GHz (b) 19.06 MHz (c) 19.06 Hz

16- The $T_{1\rho}$ time of ESR is usually

- a) Equal of NMR (b) Larger than NMR (c) Shorter than NMR

17- If g_{eff} does not equal g_e for the electron, then the electron

- (a) Gained angular momentum through SO-coupling
(b) Lost angular momentum through SO-coupling
(c) One of them

18- The ESR Hyperfine splitting or coupling is given by

- (a) $(2n+1)$ (b) $(2nI-1)$ (c) $(2nI+1)$

19- The number of ESR peaks of Na atom of spin $3/2$ is

- (a) 1 (b) 3 (c) 4

Q4 (28 marks) Chose the correct answer (MCQ: (دون اختياراتك في الجدول التالي)

1	2	3	4	5		6	7	8	9	10
11	12	13	14	15		16	17	18	19	20
21	22	23	24	25		26	27	28		

1- The ESR can be used to study the molecule of

- (a) Un-paired electron (b) Two unpaired electrons (c) All of the above

2- When an unpaired electron interacts with the B_0 , it produces

- (a) Two different energy states such that the higher is anti-parallel to the B_0 .
 (b) Two different energy states such that the lower is parallel to the B_0 .
 (c) All of the above

3- ESR spectra is working by

- (a) Varying ν and fixing B_0 (b) Varying B_0 and varying ν (c) Varying B_0 and fixing ν

4- NMR spectra is working by

- (a) Varying B_0 and varying ν (b) Varying B_0 and fixing ν (c) Varying ν and fixing B_0

5- The absorption of RF energy by the nuclear spins causes transitions from

- (a) Higher to lower energy (b) Lower to higher energy (c) Both of them

6- When a B_0 is applied to the electrons at RT,

- (a) All the electron spins will have the orientation of the B_0 .
 (b) Only a part of electron spins will have the orientation of the B_0 .
 (c) No electron spins will have the orientation of the B_0 .

7- Pascal's triangle and the number of elements for the fifth row are

- (a) 1:4:6:4:1, 8 (b) 1:5:10:10:5:1, 16 (c) None of them

Q3 (8 marks):

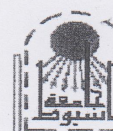
1- Explain with drawings and equations the different types of relaxations.

2- With drawings and equations, write a short account about the origin of the chemical shift.

3- Explain how the nucleus can possess an electric quadrupole moment and then determine the different values of I_z for $n = 5$.



جامعة أسيوط - كلية العلوم - قسم الفيزياء
Final First Term Exam (2024/2025)
Magnetic Resonance and Mössbauer Spectra
P-453 Time: 3 h - Prof. Dr. Ahmed Sedky



Answer the following questions:

Q1 (6 marks)- Complete the following:

- 1- The nuclear spin angular momentum is given by; -----
, and equals ----- when nuclear spin is $3/2$.
- 2- The effective magnetic moment of a molecule is given by -----,
and it is equals -----for a molecule of three unpaired electrons.

- 3- The F of hyperfine structure is given by; -----,
and it is equals -----, when $I = 7/2$ and $J = 5/2$.

Q2 (8 marks):

- 1- Calculate the splitting energies by eV of an electron due to their orbital and spinning motion when placed in a field of 3500 G.
- 2- Calculate the NMR chemical shifts by both ppm and Hz for ^1H operating at 200 MHz when the frequency difference between the reference and sample is 105 MHz.
- 3- Calculate the number of O-vacancies of ferrites when $R(A+B) = 2R(A)$.

(A) $E_g = 1.44 \text{ eV}$	(B) $E_g = 0.72 \text{ eV}$	(C) 0.56 eV
(13) For an intrinsic semiconductor with energy gap, $E_g = 0.7 \text{ eV}$, $m_p^* = 6 m_e^*$ at 300°K and $C = 4.83 \times 10^{21}$ the position of Fermi level is equal to:		
(A) $E_f = 0.853 \text{ eV}$	(B) $E_f = 0.385 \text{ eV}$	(C) $E_f = 0.583 \text{ eV}$
(14) When the energy band gap of ZnS photoconductor is 3.7 eV , and excitation wavelength (λ_{ex}) of the incident photons is 400 nm , hence PL emission can be attributed to:		
(A) Band to Band recombination process. (B) Defect states related-PL emission. (c) Near band edge emission (excitonic emission).		
(15) In direct band gap semiconductors, the allowed optical band gap is determined from:		
(A) Tauc's plot of $(\alpha h\nu)^{1/2}$ vs $h\nu$, and the intercept with $h\nu$ -axis at $(\alpha h\nu)^{1/2} = 0$ gives $h\nu = E_g$. (B) The extrapolation of straight line portion of Tauc's plot $[(\alpha h\nu)^2 \text{ vs } h\nu]$ to $(\alpha h\nu)^2 = 0$, and the intercept with $h\nu$ -axis gives $h\nu = E_g$. (C) The plot of $(\alpha h\nu)^{3/2}$ vs $h\nu$, and the intercept with $h\nu$ -axis gives $h\nu = E_g$		
(16) The presence of trapping centers in photoconductor device leads to:		
(A). Increase in a free carrier lifetime and its photosensitivity (i.e. efficiency). (B) Reduction in a free carrier lifetime and its photosensitivity. (C) No change occurs in the life time.		
17- Doping process of semiconductor via incorporation of some impurities into the crystal lattice sites results in:		
(A) No change in electrical conductivity. (B) Decrease in the electrical conductivity (C) Increase in the electrical conductivity		
18- The Free Exciton (Van-Mott Exciton) is characterized by:		
(A) Large radius and weak binding energy. (B) Small radius and strong binding energy. (C) It usually occurs at room temperature. (D) Both (A) and (C).		
(19) Increase in the degree of crystallization associated with nanoparticle size (D) increase via thermal annealing process of polycrystalline CdS results in:		
(A) Red shift of the optical band gap and (PL) emission spectrum. (B) Blue shift of the optical band gap and (PL) emission spectrum. (C) Blue shift of the optical band gap and reduction in the (PL) emission intensity.		
(20) The following data are given for intrinsic for GaAs at 300°K . $n_i = 2.4 \times 10^{19}/\text{m}^3$, $\mu_e = 0.39 \text{ m}^2\text{V}^{-1}\text{sec}^{-1}$, $\mu_p = 16 \text{ m}^2\text{V}^{-1}\text{sec}^{-1}$ and $e = 1.6 \times 10^{-19} \text{ C}$, the obtained value of electrical conductivity (σ) is:		
(A) $2.11 \Omega^{-1}\text{m}^{-1}$	(B) $1.11 \Omega^{-1}\text{m}^{-1}$	(C) $3.11 \Omega^{-1}\text{m}^{-1}$

With best regards
Prof. Dr. Mohamed A. Osman

(C) $k = \frac{1}{\sqrt{2}} [\{ \epsilon_2 + (\epsilon_1^2 + \epsilon_2^2)^{1/2} \}]^{1/2}$	
(4) When the intrinsic charge carrier concentration (n_i) is $2.5 \times 10^{19}/m^3$, at room temperature 300oC, where $K_B T = 0.026$ eV and $C = 4.83 \times 10^{21}$, hence the estimated forbidden energy gap is: (A) $E_g = 1.44$ eV (B) $E_g = 0.72$ e (C) 5.2 eV	
(5) When the energy band gap of ZnO photoconductor is 3.37 eV, and excitation wavelength (λ) of the incident photons is 400 nm, hence PL emission can be explained as: (A) Band to Band recombination process. (B) Defect states related PL emission. (c) Near band edge emission	
(6) Donor impurities in n-type semiconductor introduce localized defect states within the energy band gap: (A) Near the conduction band edge. (B) At the midpoint of the band gap (C) Near the valence band edge	
(7) If in intrinsic band gap semi-conductor (GaAs), $E_g = 1.4$ eV and $C = 4.83 \times 10^{21}$, then the electrons concentration at 300 K is: (A) 2.23×10^{12} (B) 3.43×10^{14} (C) 1.73×10^{10}	
(8) Enhancement of the optical and optoelectronic properties in nanosemiconductor materials can be attributed to: (A) Decrease in both the nanoparticle size (D) and surface area to volume ratio S/V of atoms on the nanoparticle surface. (B) Decrease in the nanoparticle size (D) and increase in surface area to volume ratio (S/V) of atoms on the nanoparticle surface. (C) Increase in both the nanoparticle size (D) and surface area to volume ratio (S/V) of atoms.	
(9) Presence of surface defect states and unsaturated dangling bonds which act as non-radiative recombination centers in nanosemiconductor results in: (A) Enhancement in the photoluminescence emission intensity. (B) Quenching in the photoluminescence emission intensity. (C) No change occurs.	
(10) Optical band gap and peak position of PL emission spectrum of $Zn_x Cd_{1-x} S$, alloyed nano-semiconductor reveal: (A) Blue shift with increasing the molar ratio (x) of zinc ions. (B) Red shift with increasing the molar ratio (x) of zinc ions. (C) No change occurs.	
(11) Light-emitting diode (LED) emits light, when electrons from the conduction band of n-region recombine with holes in the valence band of p-region within the energy gap and operate: (A) Under the forward bias of an external electric field. (B) Under the reverse bias of an external electric field.	
(12) When the intrinsic charge carrier concentration (n_i) is $2.5 \times 10^{19}/m^3$, at room temperature 300oC, where $K_B T = 0.026$ eV and $C = 4.83 \times 10^{21}$, hence the estimated forbidden energy gap is:	



Section (A) Answer the following questions:

Question 1:

(6 mark)

- (a) Deduce mathematical expression for direct allowed and forbidden optical transitions in semiconductors.
(b) The complex dielectric constant of CdS is given by the relation:

$$\varepsilon^* = 9.2 + i 3.4$$

At $\lambda = 500$ nm. Deduce the refractive index (n), the phase velocity (v), the extinction absorption coefficient (α) and the reflectivity (R).

Question 2:

(7 mark)

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

1. Generation and recombination process of charge carriers in semiconductors.
2. Diffusion and drift currents.
3. Hall effect and its application.

Question 3:

(7 mark)

Write shortly on the following:

- (a) Three different experimental techniques of semiconductor thin films preparation.
(b) Exciton absorption process in semiconductors.

Section(B): Choose the correct answer from the following (30 mark)

(1) The injected excess carriers into a semiconductor, diffuse away from the metal-semiconductor point contact at $x = 0$ and their density decreases exponentially with a distance x by the equation:

(A) $(\Delta n)_x = (\Delta n)_{x0} \exp\left[-\frac{x}{\sqrt{D_n \tau_n}}\right]$ (B) $(\Delta n)_x = (\Delta n)_{x0} \exp\left[+\frac{\sqrt{D_n \tau_n}}{x}\right]$

Where, $L_n = \sqrt{D_n \tau_n}$ is the electron diffusion length. τ_n the lifetime and D_n is the electron diffusion coefficient

(2) The life time (τ) of minority carriers (holes) when a sample of n-type semiconductor is illuminated uniformly decay exponentially with time (t) as:

(A) $(\Delta p) = (\Delta p_0) \exp(-t^2/\tau)$ (B) $(\Delta p) = (\Delta p_0) \exp(-t)/\tau^2$
(C) $(\Delta p) = (\Delta p_0) \exp(-t/\tau)$

(3) If the complex dielectric constant of nano-semiconductor compound of particle size 3 nm is given by $\varepsilon^* = \varepsilon_1 + i\varepsilon_2$, then the distinction absorption coefficient (k) can be determined by the equation:

(A) $k = \frac{1}{\sqrt{2}} [\{-\varepsilon_1 + (\varepsilon_1^2 + \varepsilon_2^2)^{1/2} \}]^{1/2}$ (B) $k = \frac{1}{\sqrt{2}} [\{ \varepsilon_1 + (\varepsilon_1^2 - \varepsilon_2^2)^{1/2} \}]^{1/2}$

Q7)

(8 Marks)

Knowing that the saturation magnetization for Fe_3O_4 is 5.0×10^5 A/m. Assuming, that replacement of Fe^{2+} by Mn^{2+} , Co^{2+} and/or Cu^{2+} ions does not change the unit cell edge length of $8.40 \text{ \AA}$.

$$ZM^A = {}_{25}Mn^{54.938} {}_{26}Fe^{55.847} {}_{27}Co^{58.933} {}_{28}Ni^{58.71} {}_{29}Cu^{63.54} {}_{30}Zn^{65.37}$$

- a) Find the magnetic moment per Mn^{2+} ion, Fe^{2+} ion, Co^{2+} ion and Cu^{2+} ion in Bohr magnetons? (2 Marks)
- b) Design a cubic mixed-ferrite of compositions $[(Co_xFe_{1-x}Fe_2O_4)_8]$ and $[(Cu_xFe_{1-x}Fe_2O_4)_8]$ that has a saturation magnetization of 4.25×10^5 A/m, by expressing (x) in at.% for each case? (3 Marks)
- c) Estimate the number of Bohr magnetons exhibited per unit cell by the formula $[(Co_{0.20}Cu_{0.30}Mn_{0.50}Fe_2O_4)_8]$? (1 Marks)
- d) Calculate the saturation magnetization of $Co_{0.20}Cu_{0.30}Mn_{0.50}Fe_2O_4$ Compound? (1 Marks)
- e) By how much percent the saturation magnetization of $Co_{0.20}Cu_{0.30}Mn_{0.50}Fe_2O_4$ is less/larger than that of magnetite? (1 Marks)

Q6)

(6 Marks)

For the diffusion of carbon in γ -iron, the pre-exponential factor is $D_0 = 2.3 \times 10^{-5} \text{ m}^2/\text{s}$ and $H_{M,x} = 1.53 \text{ eV/atom}$. A γ -iron-carbon alloy initially containing $C_0 = 0.10 \text{ wt.}\%$ carbon is carburized at an elevated temperature and in an atmosphere in which the surface carbon concentration is maintained at $C_s = 1.10 \text{ wt.}\%$. If after 48 hour the concentration of carbon is measured to be $C_x = 0.30 \text{ wt.}\%$ at a position $x = 3.5 \times 10^{-3} \text{ m}$ below the surface, determine:

- The Diffusivity (D) of Carbon in fcc iron?
- The temperature (T) at which the treatment was carried out?

Table 5.1 Tabulation of Error Function Values

z	$\text{erf}(z)$	z	$\text{erf}(z)$	z	$\text{erf}(z)$
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

Marks of Q

Q5)

(4 Marks)

Show that: $C(x, t) = \frac{B}{\sqrt{\pi Dt}} \cdot \exp\left(-\frac{x^2}{4Dt}\right)$ is a solution to the 2nd Fick's laws of diffusion: $\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial x^2}$.
The parameters (B) and (D) are constants, being independent of both (x) and (t).

Marks of Q

Q4)

(4 Marks)

Below is data related to the formation of Schottky defects in Silver. Find the following:

a) The energy for defect formation e_v (in eV)?

b) The equilibrium number of Schottky defects n_v (m^{-3}) in Silver at 1000 K?

$T(K)$	$n_v(m^{-3})$
750	2.40×10^{21}
1000	?
1200	1.42×10^{24}

Q3)

(4 Marks)

The magnetization of a ferromagnetic materials can be expressed as: $M = Ng\mu_B \tanh\left(\frac{gB\mu_B}{k_B T}\right)$, and its Curie temperature as: $T_C = N\lambda\mu_o(g\mu_B)^2/k_B$, where (λ) is Weiss constant.

- Show that in view of the molecular field theory and above (T_C) the material obeys Curie-Weiss law.
- Sketch the relation between (χ^{-1}) versus (T) for such materials. What do the slope, y-intercept and x-intercept stand for.

Q2)**(4 Marks)**

Given the average component of the dipole moment of a molecule in the direction of the applied field ε as $\bar{p}_x = p \left(\coth u - \frac{1}{u} \right)$, $u = \frac{p\varepsilon}{k_B T}$. Hint: $\coth x = \frac{1}{x} + \frac{x}{3} - \frac{x^3}{45} + \frac{2x^5}{945} - \dots$

a) Use an appropriate approximation to obtain expressions of the dipolar polarizability (α_d) and total polarizability (α) of the molecule.

b) Justify your approximation for $p = 10^{-29} \text{Coul} \cdot \text{m}$, $\varepsilon = 10^5 \text{V/m}$ and $T = 300\text{K}$.

11. If (C) is the concentration of the diffusing species at distance (x) from the source and time (t) , then according to Fick's second law (assuming diffusion coefficient, (D) is constant):

- a) $\partial C/\partial x = D (\partial C/\partial t)$ b) $\partial C/\partial t = D (\partial^2 C/\partial x^2)$
 c) $\partial C/\partial x = D (\partial^2 C/\partial t^2)$ d) $\partial C/\partial t = D (\partial C/\partial x)$

12. Which of the following is not a part of Fick's first law?

- a) Diffusion flux b) Diffusion coefficient
 c) Change in concentration with respect to the position in space
 d) Change in concentration with respect to time

13. If (P) is the polarization of a dielectric material of dielectric constant (ϵ_0) and (E) is the macroscopic electric field, then internal field is:

- a) $E + \frac{P}{\epsilon_0}$ b) $E + \frac{P}{3\epsilon_0}$ c) $E + \frac{3P}{\epsilon_0}$ d) $3E + \frac{P}{\epsilon_0}$

14. If (r) is the radius of an atom and (ϵ_0) is the permittivity of free space, then electronic polarizability is:

- a) $4\pi\epsilon_0 r^2$ b) $4\pi\epsilon_0 r^3$ c) $4\pi^2 \epsilon_0 r^3$ d) $4\pi\epsilon_0^2 r^3$

15. Under the effect of an alternating voltages, ferroelectrics show:

- a) polarization b) polarizability
 c) hysteresis d) none

16. If (k_B) is Boltzmann constant and (p) is dipole moment, the dipolar polarizability for low applied electric fields, at temperature (T) on a dipolar substance is:

- a) $\frac{p^2}{3k_B T}$ b) $\frac{3p^2}{k_B T}$ c) $\frac{p}{3k_B T}$ d) $\frac{3p}{k_B T}$

17. If M stands for a divalent ion, a general formula for ferrites is:

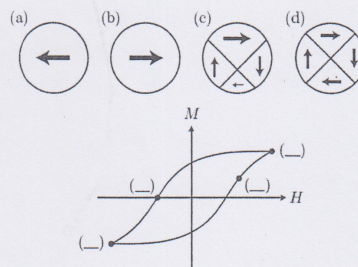
- a) $MOFe_2O_3$ b) $MOFeO_3$ c) $MOFe_2O_2$ d) MFe_3O_4

18. If (C) and (θ) are the Curie constant and paramagnetic Neel temperature of an antiferromagnetic material, the magnetic susceptibility at a temperature (T) above its Neel temperature is given as:

- a) $\frac{C}{T-\theta}$ b) $\frac{C}{T+\theta}$ c) $\frac{C}{T}$ d) $\frac{T-\theta}{C}$

19. and 20.

The arrows represent the magnetic moments of the ferromagnetic domains of an iron disc. The graph below shows the total magnetization (M) as a function of the applied field (H) . Positive (M) and (H) are directed to the right. Match the domain configurations with the points on the graph.



Q1) Choose the correct option for the following questions (1 Marks each) (20 Marks)

1. Density of a crystal remains unchanged as a result of:
 - a) Vacancy defect
 - b) Interstitial defect
 - c) Frankel defect
 - d) Schottky defect
2. A Frenkel defect is:
 - a) a vacancy-like point defect in an ionic crystal
 - b) a defect that maintains the electrical charge neutrality in an ionic solid
 - c) both of the above
 - d) none of the above
3. The equilibrium vacancy concentration in a crystalline solid depends on temperature (T) as:
 - a) $\exp(T)$
 - b) $\exp(+\frac{1}{T})$
 - c) $(\frac{1}{T})$
 - d) $-\exp(\frac{1}{T})$
4. Which thermodynamic property increases in a crystalline solid due to the presence of vacancies?
 - a) Enthalpy
 - b) Entropy
 - c) Internal energy
 - d) Work done
5. When carbon atoms are trapped in the crystal of iron, the defect is known as:
 - a) Frenkel defect
 - b) Schottky defects
 - c) Interstitial defect
 - d) Stoichiometric defect
6. When NaCl crystal is doped with MgCl_2 , the nature of defect produced is:
 - a) Frenkel defect
 - b) Schottky defects
 - c) Interstitial defect
 - d) None of these
7. Concentration gradient refers to:
 - a) Change of concentration with respect to time
 - b) Change of concentration with respect to space
 - c) Change of concentration with respect to temperature
 - d) None of the mentioned
8. Interstitial diffusion is generally faster than diffusion by vacancy mode. This is because:
 - a) Number of interstitial sites is greater than vacancies
 - b) Vacancy diffusion requires more energy than interstitial diffusion
 - c) Interstitial species are smaller than substitution species
 - d) All of the mentioned
9. As the temperature decreases, the rate of vacancy diffusion in metals:
 - a) Increases
 - b) Decreases
 - c) Remains the same
 - d) May increase or decrease
10. The relation between temperature and diffusion coefficient is:
 - a) Linear
 - b) Exponential
 - c) Sinusoidal
 - d) Diffusion coefficient is not related to temperature

	Assiut University Faculty of Science Department of Physics First Semester (2024-2025) Final Exam (50%)	Physics Program Level: (4) Date: January 12 th , 2025 Time: 3 hours	
Course Title: Selected Topics in Physics (1) Teaching Staff: Prof. Dr. Salah A. Makhoulouf			Code: P 491

Constants & Conversion of Units:

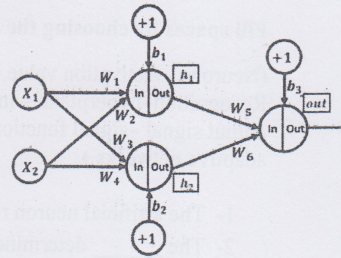
Electron mass: $m = 9.11 \times 10^{-31} \text{ kg}$	
Electron charge: $e = 1.602 \times 10^{-19} \text{ C}$	$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$
Planck's constant: $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$ or $h = 4.14 \times 10^{-15} \text{ eV}\cdot\text{s}$	$1 \text{ \AA} = 10^{-10} \text{ m}$
Avogadro's number: $N_A = 6.02 \times 10^{23} \text{ atom/mole}$	$\hbar = 1.054 \times 10^{-34} \text{ J}\cdot\text{s}$
Speed of light: $c = 3 \times 10^8 \text{ m/s}$	$\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$
Boltzmann's constant: $k_B = 1.38 \times 10^{-23} \text{ J/K}$	$1 \mu_B = 9.27 \times 10^{-24} \text{ J/T}$
$\epsilon_0 = 8.854 \times 10^{-12} \text{ Fm}^{-1}$	Electric Field Units: $\text{V/m} = \text{N/C}$
Units of electric dipole moment is called Debye (D) $1 \text{ D} = 10^{-18} \text{ statC} \cdot \text{cm} (\text{cgs units})$ $1 \text{ D} \approx 3.33564 \times 10^{-30} \text{ C} \cdot \text{m} (\text{SI units})$	Units of Capacitance: $F = \text{C/V}$

Question Three: (10 points)

Train the following Neural Network (NN) using the data provided in the tables. Perform a **single weight update for only (W_5 and W_6)** using the sigmoidal activation function for both the **forward** and **backward** passes.

W_1	W_2	W_3	W_4	W_5	W_6	b_1	b_2	b_3
0.5	0.1	0.5	0.2	-0.2	0.5	0.2	-0.3	1.3

Training data		
X_1	X_2	Output
0.1	0.3	0.05



Question Four: (15 points)

A. Given the following flowcharts, write a MATLAB or Python program for the following algorithm: (7 points)

Given An adjusted linearly contained training set $\mathcal{X}' = \mathcal{X}_1 \cup \mathcal{X}_0$ comprising augmented vectors $X_k \in \mathbb{R}^{n+1}$.
(Note that the corresponding desired classes d_k have been used in the augmentation process. Their use is implicit.)

Initialize $\rightarrow W \in \mathbb{R}^{n+1}$ to $W_1 = 0$ or some small random vector.

Iterate $\rightarrow$ Repeat (on an epoch by epoch basis)

- $\{$
- $\sim$ Select an $X_k \in \mathcal{X}'$ (in any sequence)
- $\sim$ Compute $X_k^T W_k$
- $\sim$ If $X_k^T W_k \leq 0$
- $W_{k+1} = W_k + \eta X_k$
- $\}$ until $(X_k^T W_k > 0 \text{ for all } X_k \in \mathcal{X}')$

B. Write the mathematical form and draw a sample curve for each of the following signal functions:

- 1- Binary threshold signal function. (2 points)
- 2- Linear threshold signal function. (3 points)
- 3- Sigmoid signal function. (3 points)

Best wishes

Dr. Amal Abdelazim

Answer the following questions:

Question One: (15 points)

Fill spaces by choosing the appropriate terminologies form the following list:

(Neurons - Activation value - Learning rule -Unsupervised learning - hidden - Recognition-hyperplane - input signals -linearly separable - Autoassociator - output signal -signal function - Gradient rules - feedforward- supervised learning- adaptive networks.)

- 1- The artificial neuron receives _____ from possibly n different sources.
- 2- The _____ determines the output of a neuron based on its internal activation value.
- 3- In the context of artificial neural networks, the term _____ " refers to the weighted sum of the inputs received by a neuron.
- 4- In the sample data set of _____, each pattern X_k has its corresponding output vector D_k .
- 5- A neural network where information flows only in one direction, from input to output, is called a _____ network.
- 6- _____ is an example of feedback neural network, when neurons in a single field connect back onto themselves.
- 7- _____ is the ability to classify data into (known) categories
- 8- Artificial neural networks are massively parallel _____ of simple nonlinear computing elements called _____.
- 9- Neurons can be of three types: input, _____, and output.

Question Two: (10 points)

- A. Write briefly the **training steps** of Neural Network (Backpropagation for updating weight) **(5 points)**
- B. Suppose that we have a 3-dimensional artificial neuron with $X = (-1, 0.6, 2)$, $w_1 = 0.3$, $w_2 = 0.5$ and $w_3 = 0.1$. Compute the value of the bias weight w_0 such that the neuron outputs 0.7 in **ONLY ONE** of the following cases: **(5 points)**
 1. Using the Linear threshold signal function with $\alpha = 2$.
 2. Using the Sigmoid signal function with $\lambda = 3$.

السؤال الخامس: (10 درجات = 4+3+3)

(1) برهن المتطابقة الآتية: $\sin^3 \theta = \frac{3}{4} \sin \theta - \frac{1}{4} \sin(3\theta)$

(2) أحسب قيم المقادير الآتية (ii) $i^{10} + i^9 + i^{16}$ (i) $\left(\frac{1+i}{1-i}\right)^{10}$

(3) اعط مثال مع البرهان يوضح أن العلاقة التالية $\ln z^n = n \ln z$ ليست صحيحة دائماً، متي تصح التساوي.

السؤال السادس: (10 درجات = لكل فقرة 2 درجة)

اختر الإجابة الصحيحة من بين الإجابات الآتية ثم انقلها إلى كراسة الإجابة:

(1) قيمة التكامل التالي $\int_{|z|=2} \frac{1}{z-i} dz$ تساوي هو

- (i) 0 (ii) 2π (iii) $2\pi i$ (iv) ليس مما سبق

(2) قيمة التكامل التالي $\int_{|z|=\frac{1}{2}} \frac{2z+1}{z^2+z} dz$ تساوي هو

- (i) 0 (ii) 2π (iii) $2\pi i$ (iv) ليس مما سبق

(3) قيمة التكامل التالي $\oint_{|z|=1} e^z dz$ تساوي هو

- (i) 0 (ii) 2π (iii) $2\pi i$ (iv) ليس مما سبق

(4) قيمة التكامل التالي $\int_{|z|=1} \frac{e^z}{z} dz$ تساوي هو

- (i) 0 (ii) 2π (iii) $2\pi i$ (iv) ليس مما سبق

(5) قيمة التكامل التالي $\int_0^{2\pi} \sin^2\left(\frac{\pi}{6} + 2e^{i\theta}\right) d\theta$ تساوي هو

- (i) $-\frac{\pi}{2}$ (ii) πi (iii) $2\pi i$ (iv) ليس مما سبق

انتهت الأسئلة مع أطيب التمنيات بالتوفيق والنجاح د. أيمن شحاته محمد

الاختبار النهائي للفصل الدراسي الأول العام الجامعي: 2024 / 2025 م الفرقة: الرابعة - قسم الفيزياء - كلية العلوم درجة الاختبار: 50 درجة الزمن: 120 دقيقة (ساعتين)		جمهورية مصر العربية وزارة التعليم العالي - جامعة اسيوط كلية العلوم - قسم الرياضيات اسم المقرر: تحليل رياضي
أستاذ المقرر: د. أيمن شحاته محمد	التاريخ 2025/1/18م	يوم: السبت رقم المقرر: MATH 419

مستعيناً بالله أجب عن خمسة أسئلة فقط من الأسئلة الآتية:

السؤال الأول: (10 درجات = 4+3+3)

(1) باستخدام التعريف الأولي لنهاية المتتابعة ، برهن أن $\lim_{n \rightarrow \infty} \frac{1-2n}{n+1} = -2$

(2) أدرس المتتابعة الآتية من حيث كونها مضطربة الزيادة أم مضطربة النقصان أم غير ذلك: $(x_n) = \left(\left(\frac{1}{3}\right)^n\right); n \in \mathbb{N}$

(3) إذا كانت $A = \left\{ \frac{(-1)^n}{n}, n \in \mathbb{N} \right\}$ ، أوجد كلا من $Sup(A)$, $Inf(A)$, $Max(A)$, $Min(A)$

السؤال الثاني: (10 درجات = 4+3+3)

(1) ادرس اتصال الدالة المعرفة $f(x) = \begin{cases} \frac{x^2-1}{x-1}, & x \neq 1 \\ 1, & x = 1 \end{cases}$ عند النقطة $a=1$

(2) ادرس قابلية الدالة للتفاضل $f(x) = |x|$ عند نقطة الاصل .

(3) أدرس فترات تزايد وتناقص الدالة الآتية : $f(x) = \sqrt{1-x^2}$

السؤال الثالث: (10 درجات = 4+3+3)

(1) عين نقاط الانقلاب للمنحنى التالي : $f(x) = \frac{1}{x^2+1}$

(2) عين قيمة c التي تحقق نظرية القيمة المتوسطة للدالة :

$f(x) = \ln x, x \in [1, e]$

(i) $\lim_{x \rightarrow 0} \frac{\sin(x) - x}{x - \tan(x)}$

(ii) $\lim_{x \rightarrow 0^+} x^{\sin x}$: أحسب النهايات التالية :

السؤال الرابع: (10 درجات = 4+3+3)

(1) ادرس وجود النهاية التالية $\lim_{z \rightarrow 0} \frac{z}{\bar{z}}$

(2) برهن أن الدالة $u = \cosh x \sin y$ توافقية .

(3) اثبت أن $f(z) = z^2$ تكون منتظمة الاتصال في المنطقة $|z| < 1$.

1. Materials in crystalline form are more stable than the amorphous form ().
2. The electron and hole mobility in a crystal becomes higher than that in the corresponding non-crystal ().
3. The crystallization of a melt consists of two processes (i) nucleation of the crystalline phase from the melt and (ii) growth of these nuclei ().
4. Toughness is a measure of the amount of force required to plastically deform material ().
5. Fragility measures the sensitivity of structure to temperature change ().
6. The specific volume of a glass of the same composition is independent of the adopted cooling rate ().
7. Increases in either electron density or polarizability of the ions increase the refractive index ().
8. Decreases in fictive temperature, which increase the density of most glasses, and increase the refractive index ().
9. The refractive index is not constant as it varies with the wavelength of the incident light ().
10. The density of glass is equal to the molecular weight of the glass divided by its molar volume ().
11. The glass transition is the transition from a liquid state to a supercooled liquid state without crystallization ().
12. The glass obtained by a fast cooling rate has a higher specific volume than that obtained using a slow cooling rate ().
13. Soda-lime glasses are non-silicate and oxide-classified glasses ().
14. The crystal-liquid transition is an irreversible process ().
15. The variation in index with wavelength is known as optical dispersion or simply as dispersion ().
16. The glass transition temperature depends on the heating or cooling rate and the experimental method used for the measurement ().
17. Glass is physically solid but structurally is not liquid ().
18. Chalcogenide glasses are semiconductors composed of one or more of Te, Ce, or S ().
19. Instable solid with no long-range atomic order and atoms can rearrange to form a more stable state given enough time and thermal energy ().
20. A broad crystallization peak indicates bulk, or three-dimensional crystal growth, while a narrow peak thus implies surface, or one-dimensional crystal growth ().

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6. Compare briefly between the DSC, DTA, and TGA techniques.

(3 Marks)

7. Illustrates the methods could be used for glass thin films preparation and discuss one of them in more details. (3 Marks)

(3 Marks)

3. How the specific heat of glass varies with temperature.

4. Goldschmidt offered a theory

5. Discuss the molar refractivity of glasses.

2. A material having a modulus of 1011 N/m^2 and a fracture surface energy of 2 J/m^2 has a pristine strength of 40 GN/m^2 . What is the interatomic distance in this material? (3 marks)

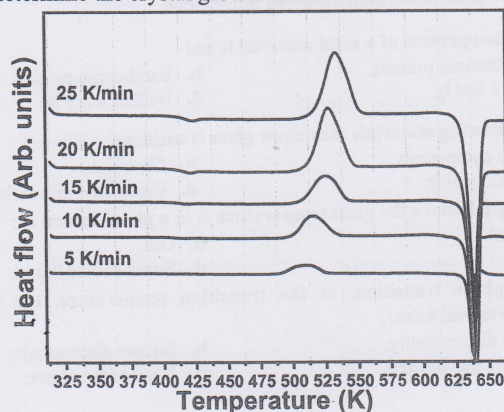
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11. Bulk chalcogenide glasses can be prepared by:
- Sol-gel method.
 - Melt quenching method.
 - Chemical precipitation method.
 - Vapor condensation technique.
12. The process refers to a technique where a material is subjected to a constant temperature over time while monitoring its properties or reactions.
- Iso-thermal.
 - Non-isothermal.
 - Iso-conversional.
 - Isobaric.
13. The semiconducting property of the chalcogenide glasses is a direct consequence of their bonding:
- Covalent.
 - Metallic.
 - Ionic.
 - Both b and c.
14. The absorption coefficient (α) has the following frequency dependence: $(\alpha h\nu) = B(h\nu - E_g)^r$ where B is constant which depends on the transition probability and E_g is the optical band gap of the specimen and r is an index equals for the direct forbidden transition.
- $\frac{1}{2}$.
 - $\frac{3}{2}$.
 - $\frac{2}{3}$.
 - 2.
15. The describes the exponential behavior of the absorption edge in the optical absorption spectra of disordered or crystalline materials and provides information about the degree of disorder in a material.
- Tauc equation.
 - Urbach equation.
 - Drude-Lorentz equation.
 - Wimple-Di Dominico equation.

Question (II): Answer the following questions:

(25 Marks)

- The following figure shows the DSC traces of $\text{As}_{30}\text{Te}_{60}\text{Ga}_{10}$ at different heating rates. Determine the possible phase transitions in the DSC curves. Which one of these transitions is exothermic and which one is endothermic? Find T_g , T_p , and T_m for the different heating rates. Determine the activation energy for the crystallization process, and determine the crystal growth mechanism. **(7 marks)**





Answer the following questions

Question (I): Select the correct answer(s) for the following statements:

(15 Marks)

1. Glass transition for a higher cooling rate will occur at:
 - a. Lower temperatures.
 - b. Higher temperatures.
 - c. Does not depend on the cooling rate.
 - d. More information is needed to make a statement.
2. The best glass-forming alloys have:
 - a. Higher viscosity.
 - b. Smallest volume change upon crystallization.
 - c. Small free volume at T_m .
 - d. All of the above.
3. is the ability of a material to resist various kinds of rapidly changing stresses is expressed by the magnitude of alternating stress for a specified number of cycles.
 - a. Plasticity.
 - b. Toughness.
 - c. Fatigue strength.
 - d. Ductility.
4. Chalcogenide glasses are amorphous semiconductors that contain at least one of the elements of the group in the periodic table:
 - a. IIIb.
 - b. IVb.
 - c. Vb.
 - d. VIb.
5. The glass transition is a:
 - a. First-order phase transition.
 - b. Second-order phase transition.
 - c. Third-order phase transition.
 - d. None of the above.
6. A glassy and crystalline material, both formed from the same initial liquid and currently are at the same temperature, which one has a higher specific volume:
 - a. The crystalline material has a higher specific volume.
 - b. The glassy material has a higher specific volume.
 - c. Both have the same volume.
 - d. Cannot be determined from the given information.
7. The crystallization process of a solid material is an:
 - a. Endothermic process.
 - b. Exothermic process.
 - c. Both a and b.
 - d. Neither a nor b.
8. Which of the following materials may show glass transition:
 - a. Ionic compounds.
 - b. Ceramics.
 - c. Chalcogenide.
 - d. Crystalline materials.
9. A fast-cooled liquid above the glass temperature is in a phase known as:
 - a. Crystal.
 - b. Gas.
 - c. Glass.
 - d. Super-cooled liquid.
10. In first-order phase transition, at the transition temperature, the enthalpy versus temperature curve will have:
 - a. Finite discontinuity.
 - b. Infinite discontinuity.
 - c. Only slope changed.
 - d. None of the above.

5. A piece of metal has a cutoff wavelength of $\lambda_{\text{cutoff}} = 450 \text{ nm}$. Consider illuminating this piece of metal with two different wavelengths of light: a $\lambda_1 = 500 \text{ nm}$ beam and a $\lambda_2 = 400 \text{ nm}$ beam. For each of the two beams, find:
- a) The maximum kinetic energy of ejected electrons.
 - b) What is their speed?
 - c) What is their de Broglie wavelength?

Solution:

END OF QUESTIONS....GOOD LUCK

4. The Bohr model of the hydrogen atom proposed that the electron orbits around the proton in a circle of radius 5.3×10^{-11} m. The electric force is responsible for the radial acceleration of the electron. What is the speed of the electron in this model?

Solution:

3. Given that the force constant for the $^1\text{H}^{35}\text{Cl}$ molecule is 515.7 N m^{-1} , and that $m(^1\text{H}) = 1.0078 \text{ u}$ and $m(^{35}\text{Cl}) = 34.969 \text{ u}$, calculate, in the harmonic oscillator approximation, the vibration wavenumber of this molecule.

Solution.

2. What is the de Broglie wavelength of an electron that has 2.0 keV of kinetic energy? What about an electron with 200 keV of kinetic energy? The second one requires relativity—why?

Solution:

C. Problems. Answer the following questions.

[30 marks]

1. An electron, a proton, and a photon each have a wavelength of 0.24 nm. For each one, find the momentum, the energy, and, where relevant, the accelerating voltage needed to achieve that wavelength.

Solution:

B. True or false questions (Answer only Ten question).

[5 marks]

No.	Statement	T or F
1.	The Zeeman effect refers to the splitting of atomic energy levels in the presence of a static magnetic field.	
2.	When an atom is placed in a magnetic field, the magnetic dipole moment associated with the angular momentum of electrons interacts with the magnetic field.	
3.	The Stark effect describes the splitting or shifting of atomic energy levels in the presence of an electric field.	
4.	The work function is the minimum amount of energy required to remove an electron from a metal's surface to infinity.	
5.	Bohr proposed that the angular momentum of an electron revolving in energy shells is given by: $m_e v r = n h / 2 \pi$	
6.	Bohr Atomic Model Theory fails to explain the effect of magnetic field on the spectra of atoms. It also failed to explain the Stark effect and Heisenberg Uncertainty Principle.	
7.	Bohr Atomic Model Theory fails to explain the effect of magnetic field on the spectra of atoms. It also failed to explain the Stark effect and Heisenberg Uncertainty Principle.	
8.	According to Bohr, electrons move around the central nucleus in a fixed circular orbit. These orbits of specific energies and are also referred to as energy shells or energy levels.	
9.	The electromagnetic spectrum is the range of frequencies of EM radiations along with their associated wavelengths and photon energies.	
10.	The Pauli exclusion principle basically helps us to understand the electron arrangements in atoms and molecules, and it also gives an explanation for the classification of elements in the periodic table.	
11.	There are two salient rules that the Pauli exclusion principle follows: - Only two electrons can occupy the same orbital. - The two electrons that are present in the same orbital must have opposite spins, or they should be antiparallel.	
12.	The movement of particles or molecules from one point to another within the same axis is known as translation motion.	
13.	Rotational Motion is the movement of particles around the axis.	
14.	The motion of electrons from higher energy state to lower energy state or lower energy state to higher energy state is called electronic motion in other words movement of electrons from orbital to orbital.	

45. As per Bohr model, the minimum energy (in eV) required to remove an electron from the ground state of doubly ionized Li atom ($Z = 3$) is:

- a) 122.4 eV b) 40.8 eV c) 1.52 eV d) 13.6 eV

46. Raman effect is scattering of _____

- a) Atoms b) Molecules c) Protons d) Photons

47. The elastic scattering of photons is called as _____

- a) Atmospheric scattering b) Rayleigh Scattering
c) Conserved Scattering d) Raman Scattering

48. In Raman spectroscopy, the radiation lies in the _____

- a) Microwave Region b) Visible Region
c) UV Region d) X-ray Region

49. The ratio of wavelengths of the last line of Balmer series and the last line of Lyman series is

- a) 0.5 b) 2 c) 3 d) 4

50. According to Bohr model, the orbital angular momentum of electron in the orbit $n=2$ is

- a) h b) $h/2\pi$ c) h/π d) $h/4\pi$

51. If J be the angular momentum of an electron in an Bohr orbit then orbit radius is equal to :

- a) Jmv b) $J/2mv$ c) $J/2\pi m$ d) $mJ/2\pi v$

52. The angular momentum of electron in n^{th} orbit is given by

- a) nh b) $h/2\pi n$ c) $nh/2\pi$ d) $n^2 h/2\pi$

53. Bohr's atom model assumes _____

- a) The nucleus is of infinite mass and is at rest.
b) Electrons in a quantised orbit will not radiate energy.
c) mass of the electron remains constant.
d) All the above conditions

54. The electron in a hydrogen atom first jumps from the third excited state to the second excited state and subsequently to the first excited state. The ratio of the respective wavelengths, λ_1/λ_2 , of the photons emitted in this process is:

- a) 20/7 b) 27/5 c) 7/5 d) 9/7

34. The different types of energies associated with a molecule are _____
- Electronic energy
 - Vibrational energy
 - Rotational energy
 - All of the mentioned
35. Spectrum applies specifically to a
- range of energy.
 - range of speed
 - range of
 - range of wavelengths or frequencies.
36. The correct order of different types of energies is _____
- $E_{el} \gg E_{vib} \gg E_{rot} \gg E_{tr}$
 - $E_{el} \gg E_{rot} \gg E_{vib} \gg E_{tr}$
 - $E_{el} \gg E_{vib} \gg E_{tr} \gg E_{rot}$
 - $E_{tr} \gg E_{vib} \gg E_{rot} \gg E_{el}$
37. Light of wavelength $4000 \text{ \AA}$ is incident on a sodium surface for which the threshold wavelength of photo-electrons is $5420 \text{ \AA}$. The work function of sodium is
- 5 eV
 - 5.29 eV
 - 2.29 eV
 - 2 eV
38. Photoelectrons stopping potential depends on Photoelectrons stopping potential depends on
- Frequency of incident light and nature of the cathode material.
 - The intensity of the incident light.
 - The frequency of the incident light.
 - Nature of cathode material.
39. A proton has four times the momentum of an electron. If the electron has a de Broglie wavelength λ_e , what is the de Broglie wavelength of the proton?
- λ_e
 - $\lambda_e/4$
 - $4\lambda_e$
 - $16\lambda_e$
40. What is the wave number of an radiation moving with the speed of light, with a frequency of $6 \times 10^{14} \text{ Hz}$?
- $1.2 \times 10^6 \text{ m}^{-1}$
 - $2.0 \times 10^6 \text{ m}^{-1}$
 - $0.5 \times 10^6 \text{ m}^{-1}$
 - $4.6 \times 10^6 \text{ m}^{-1}$
41. The region of electromagnetic spectrum for nuclear magnetic resonance is
- Microwave
 - UV-rays
 - Infrared
 - RF
42. The minimum energy required to remove an electron is called
- Stopping potential
 - Kinetic energy
 - Work function
 - None of these
43. Zeeman effect is the splitting of spectral line in the presence of
- Electric Field
 - Magnetic Field
 - Inert Environment
 - Vacuum
44. The splitting of spectral lines because of electric effect is known as
- Zeeman effect
 - electromagnetic effect
 - Stark effect
 - None of these

23. The principle quantum number is related to:
- The shape of the orbital.
 - The spatial orientation of the orbital.
 - The average distance of the most electron-dense regions from the nucleus.
 - The number of electrons.
24. The spin quantum number (m_s) can have a value of:
- 1/2, +1/2
 - 1/2, -3/2
 - +1, -1
 - 0, +1
25. According to Heisenberg's uncertainty principle, the more accurately we know about a subatomic particle's momentum, the less we know about its precise:
- mass
 - speed
 - location
 - energy
26. A sodium surface is illuminated with light of wavelength 300 nm. The work function for sodium metal is 2.46 eV. Find the maximum kinetic energy of the ejected photoelectrons.
- 4.13 eV.
 - 2.46 eV.
 - 1.67 eV.
 - 6.59 eV.
27. What is the Pauli Exclusion Principle?
- An atomic orbital can only hold a maximum of 2 electrons, each with opposite spins.
 - An atomic orbital can hold a minimum of 6 electrons, each with opposite spins.
 - An atomic orbital can hold a maximum of 6 electrons, each with the same spin.
 - An atomic orbital can hold a minimum of 2 electrons, each with opposite spins.
28. Which of the following set of quantum numbers is not valid?
- $n = 5, l = 2, m = 0, s = 1/2$
 - $n = 1, l = 2, m = 0, s = 1/2$
 - $n = 5, l = 3, m = 2, s = 1/2$
 - $n = 5, l = 2, m = 0, s = -1/2$
29. What is the ratio of minimum to maximum wavelength in the Balmer series?
- 5:9
 - 5:36
 - 1:4
 - 3:47
30. Find out the minimum energy required to take out the only one electron from the ground state of Li^+ ?
- 13.6 eV
 - 122.4 eV
 - 25.3 eV
 - 67.9 eV
31. What is the energy required to ionize an H-atom from the third excited state, if ground state ionization energy of H-atom is 13.6 eV?
- 1.5 eV
 - 3.4 eV
 - 13.6 eV
 - 12.1 eV
32. The work function of lithium is 2.5 eV. The maximum wavelength of light that can cause the photoelectric effect in lithium is
- 3980 Å
 - 4980 Å
 - 5980 Å
 - 6980 Å
33. The Kinetic energy of a photoelectron emitted on shining a light of wavelength 6.2×10^6 m on a metal surface of work function 0.1 eV is:
- 0.01 eV
 - 0.02 eV
 - 0.1 eV
 - 1 eV

14. Which atomic orbital is spherical in shape?
- a) 2s b) 3p c) 3d d) 4f
15. A neutral atom of an element has 2 electrons in the first energy level, 8 in the second energy level and 8 in the 3rd energy level. This information does not necessarily tell us:
- a) The atomic number of the element.
b) The total number of electrons in s orbitals.
c) The total number of electrons in p orbitals.
d) The number of neutrons in the nucleus of an atom of the element.
16. Which statement about the four quantum numbers which describe electrons in atoms is incorrect?
- a) n = principal quantum number, $n = 1, 2, 3, \dots$
b) l = subsidiary (or azimuthal) quantum number, $l = 1, 2, 3, \dots, (n-1)$
c) m_l = magnetic quantum number, $m_l = (-l), \dots, 0, \dots, (+l)$
d) m_s = spin quantum number, $m_s = +1/2$ or $-1/2$.
17. The maximum number of electrons with $l = 3$ is
- a) 14 b) 2 c) 10 d) 6
18. If 5eV of energy is supplied to an electron with a binding energy of 2.3eV, with what kinetic energy will the electron be launched?
- a) 4.2.3eV b) 4.7.3eV c) 4.11.5eV d) 2.7eV
19. A 500 nm photon of light strikes a semi-conductive surface with a binding energy of 2eV. With what velocity will an electron be emitted from the semi-conductive surface?
- a) 8.38×10^5 m/s b) 9.33×10^5 m/s c) 3×10^8 m/s d) 4.11×10^5 m/s
20. The quantum mechanical model describes electrons as:
- a) Particles b) Waves
c) Particles with wave-like properties d) Small, hard spheres
21. Heisenberg's Uncertainty Principle states that the ___ and ___ of an electron cannot be known simultaneously.
- a) Position, mass b) Position, charge
c) Momentum, speed d) Position, momentum
22. There are ___ types of quantum numbers.
- a) 2 b) 7 c) 4 d) 5

5. What will be the longest wavelength in the Balmer series of hydrogen spectrum?
 a) $6557 \times 10^{-10} \text{ m}$ b) $5557 \times 10^{-10} \text{ m}$ c) $9557 \times 10^{-10} \text{ m}$ d) $1557 \times 10^{-10} \text{ m}$
6. A hydrogen atom in its ground state absorbs 10.2 eV of energy. What is the orbital angular momentum is increased by?
 a) $4.22 \times 10^{-3} \text{ Js}$ b) $2.11 \times 10^{-34} \text{ Js}$ c) $3.16 \times 10^{-34} \text{ Js}$ d) $1.05 \times 10^{-34} \text{ Js}$
7. Which of the following is true regarding the Bohr model of atoms?
 a) Assumes that the angular momentum of electrons is quantized.
 b) Uses Faraday's laws.
 c) Predicts continuous emission spectra for atoms.
 d) Predicts the same emission spectra for all types of atoms.
8. Hydrogen atoms are excited from ground state to the state of principal quantum number 4. Then, what will be the number of spectral lines observed?
 a) 3 b) 6 c) 5 d) 2
9. When a hydrogen atom is in its first excited level, what is the relation of radius and Bohr radius?
 a) Twice b) 4 times c) Same d) Half
10. What is the wavelength of electromagnetic radiation which has a frequency of $4.464 \times 10^{14} \text{ s}^{-1}$?
 a) $1.338 \times 10^{23} \text{ m}$ b) 1.489 nm c) $1.489 \times 10^{-6} \text{ m}$ d) $6.716 \times 10^{-7} \text{ m}$
11. What is the wavelength of electromagnetic radiation which has a frequency of $5.732 \times 10^{14} \text{ s}^{-1}$?
 a) $1.718 \times 10^{23} \text{ m}$ b) $1.912 \times 10^6 \text{ m}$ c) $5.230 \times 10^{-7} \text{ m}$ d) 523.0 m
12. What is the electronic spectra in the visible range span?
 a) $12500\text{-}25000 \text{ cm}^{-1}$ b) $25000\text{-}50000 \text{ cm}^{-1}$
 c) $25000\text{-}72000 \text{ cm}^{-1}$ d) $15000\text{-}30000 \text{ cm}^{-1}$
13. According to the uncertainty principle for an electron, time measurement will become uncertain if which of the following is measured with high certainty?
 a) Energy b) Momentum c) Location d) Velocity



ASSIUT UNIVERSITY
FACULTY OF SCIENCE
PHYSICS DEPARTMENT



Physics 432P – Atomic and Molecular Spectroscopy

FINAL EXAM

DURATION OF TEST: THREE HOURS

Date, 23rd January 2025

Examiner: Dr. Ahmed Mostafa Amry

Physical Constants

$$R_H = 1.0973731568508 \times 10^7 \text{ m}^{-1}$$

$$= 2.1798741 \times 10^{-18} \text{ J}$$

$$e = 1.602 176 6208 \times 10^{-19} \text{ C}$$

$$a_0 = 5.29177 \times 10^{-11} \text{ m}$$

$$h = 6.626069 \times 10^{-34} \text{ J s}$$

$$\hbar = 1.05457266 \times 10^{-34} \text{ J s}$$

$$c = 299,792,458 \text{ m/s}$$

Answer the required questions in section A, B and C.

A. MC Questions. Answer 30 Question Only. (Select the best answer)

(15 Marks)

1. A subshell of an atom contains a maximum of _____ electrons.
a) $4l - 2$ b) $4l + 2$ c) $2l + 1$ d) $2n^2$
2. The radius of the Bohr orbit depends on which of the following?
a) $1/n$ b) n c) $1/n^2$ d) n^2
3. Photoelectric emission occurs only when the incident light has more than a certain minimum
a) power b) wavelength c) intensity d) frequency
4. The work-function of a metal is
a) The minimum current required to take out electron from the metal surface.
b) The maximum frequency required to take out electron from the metal surface.
c) The minimum amount of energy required to take out the electron from the metal surface.
d) None of these.