Put the Answer in the Table

Question (3): Put [√] or [x]for each of the statement [30 Mark].			
1		16	
2		17	
3		18	
4		19	
5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11		26	
12		27	
13		28	
14		29	
15		30	

Question (4) (Midterm): (MCQ) [30 Mark]			
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	
8			

Question (5) [Oral]: Put [√] or [x] [10 Mark].			
1		4	
2		5	
3			

اختبار نهاية الفصل الدراسي الثاني

2021/2020

في

مقرر " فيزياء الليزر وتطبيقاته" 472 ف

ملاحظات هامة:(أ) أي شطب أوتغيير يلغي الدرجة

(ب) لكل فقرة درجتان

أجب عن **45 فقط** من الفقرات التالية – بوضع علامة صح (√) أو خطأ (X) بين القوسين أمام كل فقرة:

1) من أهم عمليات الحصول علي الليزرهي حدوث مايعرف "بقلب التعداد", والتي تعني زيادة تعداد المستوي السفلي للطاقة بالمقارنة مع تعداد المستوي العلوي. ( ) ( ).

2) التوازن الحراري لنظام ليزري يعني ان الطاقة الكلية له يجب ان تبقي ثابتة. ( ) ( ).

3) من أهم مراحل انتاج الليزر أن يكون الانبعاث التلقائي أفضل من المحفز. ( ) ( ).

4) في الأنبعاث التلقائي تبعث الذرة بفوتون واحد,بينما في المحفز بفوتونين.( ) ( ).

5) في الضخ الليزري يتم نقل طاقة الذرات من مستوي طاقةأعلي الي اخر أقل.( )( )

6) الليزرات المصنعة من الغاز يصلح لها الضخ الضوئي. ( ) ( ).

7) الليزرات المصنعة من مادة شبه موصلة أنسب لها الضخ الكهربائي. ( ) ( ).

8) الليزرات المصنعة من مادة صلبة أو سائلية أنسب لها الطيف الضوئي. ( ) ( ).

9) الليزرات المتعددة مستويات الطاقة افضلها ذلك ذو الثلاث مستويات. ( ) ( ).

10) الليزرات ذات الاربعة مستويات طاقة لها قلب تعداد بطيئ عن غيرها. ( ) ( ).

11) تبدأ فكرة عمل الليزر عندما تكون هناك حالة من الاتزان الحراري للنظام. ( ) ( ).

12) قلب التعداد يمكن تحقيقه تحت شروط انعدام الاتزان الحراري للنظام. ( ) ( ).

13) اذا كان تردد الانتقالات في المنطقة المايكروية فيسمي المضخم ميزر. ( ) ( ).

14) اذا كان تردد الانتقالات في المنطقة المرئية فيسمي المضخم ليزر. ( ) ( ).

15) ضمن شروط انعدام الاتزان ان لا ينطبق عليها قانون بولتزمان. ( ) ( ).

16) التوازن الحراري لنظام ليزري أي ان عدد الفوتونات الممتصة تساوي تلك المنبعثة.
( ) ( ).

17) التوازن الحراري عدد الفوتونات الممتصة تساوي تلك من الانبعاث التلقائي فقط.( )
( ).

18) لا يحدث شعاع الليزر بين مستويي الطاقة الاكثر استقرارا في الليزر الرباعي. ( )
( ).

19) مستوي الطاقة الاكثر استقرارا تمكث فيه الحالات المستثارة اطول وقت عن غيره.
( ) ( ).

20) ثابت استيفان – بولتزمان للاشعاع ثابت هام بالفيزياء ,وحدة قياسه(K^4.وات)/ $م^3$.
( ) ( ).

21) تعداد المستوي الثاني للطاقة اكبرمن غيره فان احتمالية المستحث اعلي من الامتصاص فلن نحصل علي ليزر.( ) ( ).

22) تعداد المستوي الاول للطاقة اكبرمن غيره فان احتمالية الامتصاص اعلي من المستحث فنحصل علي ليزر.( ) ( ).

23) تعداد المستوي الاول للطاقة مساويا لغيره فان احتمالية الامتصاص مساوية للمستحث فلن نحصل علي ليزر.( ) ( ).

24) للحصول علي شعاع الليزر, لابد من توافر رنان, يجب أن تكون مرآته محدبة .
( ) ( ).

25) في حالة الانبعاث التلقائي تبعث الذرة بفوتونين متشابهين تماما في خصائصهما الفيزيائية. ( ) ( ).

26) في حالة الانبعاث المحفز تبعث الذرة بفوتونين متشابهين تماما في خصائصهما الفيزيائية. ( ) ( ).

27) في حالة الامتصاص تتم استثارة ذرات المادة , ولشروط خاصة , تنتقل الالكترونات بداخلها لمستويات طاقة مختلفة. ( ) ( ).

28) ينبعث فوتونات ضوئية من الذرات المستثارة في صورة اطياف أما خطية أو شريطية طبقا للعمليات الانتقالية للالكترونات بداخلها. ( ) ( )

29) من أهم خصائص شعاع الليزر انبعاث حرارة عالية. ( ) ( ).

30) يعتبر ليزر الياقوت رباعي المستوي للطاقة. ( ) ( ).

31) نوع المادة الشائبة المستخدمة بالمادة الفعالة هي اكسيد النحاس. ( ) ( ).

32) الرمز الكيميائي لليزر الياقوت هو: Al_2O_3 . ( ) ( ).

33) مصدر الضخ في ليزر الياقوت هو" القوس الزئبقي" . ( ) ( ).

34) الطول الموجي لأشعة ليزر الياقوت هو 8850Å. ( ) ( ).

35) من أمثلة الليزرات الثنائية المستوي للطاقة هو : جاليوم – أرزنك أي (Ga As).
( ) ( ).

36) ينشأ عن أستخدام مصدر الضخ لليزر الياقوت نوعين من الأطوال الموجية, أي منهما له مواصفات شعاع ليزر, الأكبر شدة منهما ذات اللون البنفسجي. ( ) ( ).

37) ينشأ عن أستخدام غازات معينة مثل الارجون كمصدر ضخ لليزر الياقوت أفضل من غيرها. ( ) ( ).

38) الذي وضع النظرية الكمية للضوء (جسيم , موجة) هو العالم سير أسحق نيوتن.
( ) ( ).

39) كلمة ليزر لا تستخدم فقط ضمن ترددات الضوء المرئي, ولكن أيضا في أي الترددات القريبة أو البعيدة من تحت الحمراء. ( ) ( ).

40) بمفهوم الفوتونات, فأن طاقة المتذبذب الضوئي تأخذ كمات محددة مضاعفة للمقدار (hv), كان ذلك بفضل العالم جيمس هوك. ( ) ( ).

41) في عمليةالانبعاث التلقائي, فأن طور الموجة المنبعثة من ذرة يتوافق مع طور الموجة المنبعثة من ذرة اخري في اي اتجاه. ( ) ( ).

42) المقصود بعملية الضخ هو خفض المستوي الأعلي للطاقة للمادة الفعالة الي المستوي الاقل فيها. ( ) ( ).

43) تتم عملية الضخ الكيمائي للمواد الزجاجية والبلورية. ( ) ( ).

44) تستخدم عملية الضخ الضوئي للمواد ذات التركيب الكيمائي. ( ) ( ).

45) يتم الضخ بأستخدام أشعة أكس الناتجة من أنبوبة كولدج. ( ) ( ).

46) من خصائص مستوي الطاقة الأكثر أستقرارا (الشبه مستقر Metastable state), في الليزر الثلاثي , انه يتواجد في منتصف مستويات الطاقة الأخري. ( ) ( ).

47) من خصائص مستويي الطاقة الأكثر أستقرارا (الشبه مستقر Metastable stat), في الليزر الرباعي تواجدهما بالقرب من مستوي الطاقة الرابع.( ) ( ).

48) تردد الفوتون من عملية أنحلال ذرة بواسطة الأنبعاث التلقائي يتوافق مع ذلك الناتج من أنحلال ذرة أخري. ( ) ( ).

49) فوتونات الأنبعاث المحفز لها نفس طور وتردد واتجاه الفوتونات الساقطة علي المادة المادة الفعالة من عملية الضخ. ( ) ( ).

50) في عمليات تضخيم شعاع الليزر, تستخدم مرنانات, وهي عبارة عن بلورات زجاجية شفافة. ( ) ( ) ( ).

51) في عمليات الحصول علي شعاع الليزر, يكون الأنبعاث التلقائي هو المصدر الرئيسي لذلك. ( ) ( ) ( ).

52) في عمليات الحصول علي شعاع الليزر, يمكن حدوث أنبعاث تلقائي وأخر محفز في وقت واحد. ( ) ( ) ( ).

53) في عمليات الحصول علي شعاع الليزر, تسمي المادة الفعالة بالمادة الشفافة عندما يتساوي تعداد مستوين للطاقة بها. ( ) ( ) ( ).

54) في عمليات الحصول علي شعاع الليزر, أذا تساوت أحتمالية الأمتصاص مع تلك للأنبعاث المحفز, تكون المادة الفعالة شفافة. ( ) ( ) ( ).

55) في عمليات الحصول علي شعاع الليزر, أذا كانت أحتمالية الأنبعاث المحفز أكبر من أحتمالية الأمتصاص تسمي المادة الفعالة بالمادة النشطة. ( ) ( ) ( ).

56) تردد الفوتون من عملية أنحلال ذرة بواسطة الأنبعاث التلقائي يتوافق مع ذلك الناتج من أنحلال ذرة أخري. ( ) ( ) ( ).

57) فوتونات الأنبعاث المحفز لها نفس طور وتردد واتجاه الفوتونات الساقطة علي المادة المادة الفعالة من عملية الضخ. ( ) ( ) ( ).

58) من خصائص مستوي الطاقة الأكثر أستقرارا (الشبه مستقر Metastable state), في الليزر الثلاثي , انه يتواجد في منتصف مستويات الطاقة الأخري. ( ) ( ) ( ).

59) من خصائص مستويي الطاقة الأكثر أستقرارا (الشبه مستقر Metastable state), في الليزر الرباعي تواجدهما بالقرب من مستوي الطاقة الرابع. ( ) ( ) ( ).

60) في عمليات الضخ للحصول علي اشعة الليزر, يتم أستثارة ذرات المادة الفعالة ثم تأينها. ( ) ( ) ( ).

جامعة أسيوط - كلية العلوم – قسم الفيزياء

Final Exam - Second Term: (2021) – July 2nd, 2021

Nanomaterials Science and Applications (458 P)

Exam in 5 pages

Part I: Final Exam (45 marks)

Q1: Shade the correct answer ; A, B, C or D: (1 Mark each)

1. The … degree of perfection and less number of defects have been observed in gel growth
   (a) high (b) lessen (c) small (d)Lange
2. In ……., a liquid zone is created by melting a small amount of materials in a relatively large or long solid charge.
   (a) vernuil method (b) Skull method
   (c) Bridgmann method (d) Zone melting
3. In Zone melting technique, impurities tend to be …. in the melted portion of the sample
   (a) pure (b) un pure (c) concentrated (d) pure
4. VAPOUR GROWTH Techniques for growing crystals from vapour is divided into…
   (a) Chemical transport method. (b) Physical transport method.
   (c) A and B (d) none of above
5. When you imagine new nanowire-based structures with new properties and functionalities, you must consider:
   a) the degree of confinement including possible quantum confinement
   b) the large surface-to-volume ratio intrinsic to nanowires
   c) the length scale defined by nanowire diameter and the quality of the nanowire growth
   d) All mentioned
6. Nanowire dimensions determine the degree of confinement, and consequently affects
   a) The behavior of charge carriers in quantum electronic devices
   b) The number of charges in quantum electronic devices
   c) The behavior of charge carriers in classical electronic devices
   d) In changing the quantum characteristics in electronic devices
7. Phase purity is essential because it directly has effect on
   a) The electronic properties of the nanowires
   b) The band-structure and electronic properties of the nanowires
   c) The band-structure properties of the nanowires
   d) None of the above
8. During the annealing and growth processes, the Au nanoparticle alloys with specific ..... elements to form a liquid or solid alloy.
   a) group III and group IV b) group III
   c) group III and group V d) group IV
9. Binary and ternary phase diagrams indicate which alloy phases are stable at ....., during annealing, and at ..... .
   a) room temperature, the growth temperature
   b) growth temperature, the room temperature
   c) zero kelvin temperature, the growth temperature

d) 380 °C, 273°C

10. According to the conventional VLS and VSS mechanisms, reaction species dissolve into the nanoparticle and are transported to the growth interface via ..... through the nanoparticle

a) growth interface b) bulk diffusion c) high solubility d) nucleation

11. There are two major growth modes taking place during Au-assisted nanowire growth by MOCVD:

a) axial growth and radial growth
b) Non-uniform lateral growth and Uniform normal growth
c) Laser-heated pedestal growth and conformal growth
d) Low-temperature solution growth and Hydro-Thermal Growth

12. ..... morphologies, whereby nanowires exhibit wider bases and taper to narrower Au-capped tips, are a consequence of radial growth.

a) Condensed nanowire b) Electronic nanowire
c) Tapered nanowire d) None of the above

13. ..... is used to identify general nanowire morphology, including facet planes, diameter, and height.

a) Cathodoluminescence microscope
b) Transmission electron microscopy
c) Energy-dispersive X-ray spectroscopy
d) Field emission scanning electron microscopy

14. The X-ray radiation most commonly used is that emitted by .....

a) Iron b) Aluminum c) Copper d) Sulfur

15. .....is a non-destructive analytical technique which provides detailed information about the internal lattice of crystalline substances.

a) polycrystalline X-ray Diffraction
b) Single-crystal X-ray Diffraction
c) Single-crystal gamma-ray Diffraction
d) polycrystalline gamma-ray Diffraction

16. Specific applications of single-crystal diffraction:

a) Variations in crystal lattice with chemistry.
b) Characterization of cation-anion coordination.
c) New mineral identification, crystal solution and refinement.
d) All of them.

17. Filter fluorometers often employ.....

a) a high-pressure mercury vapor lamp
b) a low Viscosity mercury liquid lamp
c) a low-pressure mercury vapor lamp
d) a high Viscosity mercury liquid lamp

18. ..... the most popular vibrational spectroscopic technique used to identify the functional groups in organic and inorganic compounds.

a) Thermal analyses technique.
b) Power Compensation.
c) Infrared spectroscopic technique.
d) Micro hardness technique.

19. Thermo gravimetric analysis has widely been used in .....

a) testing of sample purity b) study of organic compounds
c) oxide mixtures and glass technology d) all of them.

20. Hardness tests are commonly carried out to determine the.....strength of materials.
a) Mechanical b) Electrical c) Optical d) Magnetic.

21. ..... method is the reliable and most common among the various methods of hardness measurement.
a) Micro hardness b) Vickers hardness.
b) Heat Flux DSC d) Power Compensation DSC.

22. The permittivity or dielectric constant of the material is always.....
a) Greater than 1 b) Smaller than 1
c) Greater than 2 d) Smaller than 2

23. The dielectric loss is a measure of the ..... absorbed by a dielectric.
a) energy b) pressure c) power d) light

24. In the equation, $\delta = \frac{1}{\omega RC}$, $tan\delta$ is referred to as the .....
a) dielectric emission b) dielectric reflection.
c) dielectric absorption d) dielectric loss.

25. The polarization is a phenomenon that takes place in the dielectric materials in an external.....
a) Electric field b) Magnetic Field
c) Electric and Magnetic fields d) None of all.

26. ..... provides valuable information about physical properties of materials and offers applications in photo detection and radiation measurements.
a) X-ray Diffraction b) Photoconductivity
c) Nonlinear Optics d) IR spectrometer

27. Photo absorption and hence photo conduction takes place by which of the following mechanisms?
a) Band-to-band transitions b) Impurity levels to band edge transitions.
c) Both (a) and(b) d) None of all.

28. ..... is the amount of current that flows through the material or device when no radiation is incident on it.
a) Photo conduction b) Dark current
c) Both (a) and (b) d) Another

29. In the experiment of Photoconductivity, the crystal sample can be well-polished and surfaces are cleaned with.....
a) Acetone b) Ethanol c) Cyclohexane d) Water

30. ..... is an experiment that determines the amount or typically the weight percent of an element in a compound.
a) Elemental Analysis b) Powder X-ray diffraction
c) Thermal Analysis d) Differential Thermal Analysis.

31. The vario EL III Elementar Analyzer allows fully automatic individual or simultaneous quantitative determination of carbon, Hydrogen, and.....
a) Nitrogen b) Oxygen c) Sulfur d) All of them

32. Elemental Analysis always refers to CHNX analysis the determination of the mass fractions of carbon, hydrogen, nitrogen, and heteroatoms (X) ..... of a sample.
a) halogens, oxygen b) halogens, sulfur.
c) halogens, argon d) halogens, helium.

33. X-rays occur in that portion of the electromagnetic spectrum between gamma-rays and the .....

a) visible light
b) ultraviolet rays.
c) infrared rays
d) radio waves.

34. X-ray crystallography may be used to determine the material structure such as .....

a) how the atoms pack together.
b) what the interatomic distance.
c) what is the angle.
d) all of them.

35. In the equation, tan δ=1/ωRC , tanδ is referred to as the .....

(a) dielectric emission
b) dielectric reflection.
c) dielectric absorption
d) dielectric loss.

36. In equation, $D = \varepsilon_{\circ} E$, $\varepsilon_{\circ}$, is called .....

a) the absolute permittivity
b) The magnetic permeability.
c) relative permeability
d) Other

37. In equation, $D = \varepsilon_{\circ} E$, D is called the.....

a) Permittivity
b) Charge density
c) Electric field
d) Magnetic field

38. In the diffraction of X-rays, the Path difference between two waves is .....

a) $\lambda = dsin\theta$
b) $\lambda = 2dsin\theta$
c) $n\lambda = dsin\theta$
d) $n\lambda = 2dsin\theta$

39. In the diffraction of X-rays, the constructive interference between two waves is .....

a) $n\lambda = x$
b) $\lambda = 2x$
c) $n\lambda = 2x$
d) $\lambda = x$

40. The equation of Bragg's law is .....

a) $n\lambda = 2dsin\theta$
b) $n\lambda = 2d$
c) $n\lambda = 2xsin\theta$
d) $n\lambda = 2x$

41. When the incident beam strikes a powder sample, diffraction occurs in every possible orientation of an angle equals to.....

a) θ
b) 2θ
c) 3θ
d) 4θ

42. X-ray diffractometers consist of.....

a) X-ray tube
b) Sample holder
b) X-ray detector
d) All of them

43. UV-Visible spectroscopy is useful in characterizing the..... of variety of technologically important materials such as pigments.

a) absorption
b) transmission
c) reflectivity
d) all of them.

44. Spectrofluorometers need a ..... radiation source and are often equipped with a 75-450 W high-pressure Xenon arc lamp.

a) Continuous
b) Hesitating
c) Both (a) and (b).
d) None of all.

45. The basic principle of the vario III Elemetar Analyzer is ..... of organic and inorganic solid samples.

a) high temperature combustion
b) low temperature combustion
c) high density combustion
d) low density combustion

Part II (30 marks)

Q2: Shade (T) for True Statements or (F) for False Statements: (1 Mark for each)

46. Nanowire-based optical sensors use the evanescent molecules
47. Nanowire-based LEDs employing quantum-dot sections embedded within a nanowire
48. Coaxial nanowire structures can work as solar cells
49. Template-directed method relies on anisotropy of growth rates
50. III–V nanowires are compatible with existing semiconductor technologies can be readily integrated with Si-based microelectronics
51. Crystallographic defects such as stacking faults and twin planes
52. The VSS mechanism, so-called due to the vapor, liquid and solid phases involved
53. Deposition of III–V material occurs preferentially at the nanoparticle–substrate interface, so that nanowire nucleation takes place
54. Fluorescence spectrometers use double-beam optics to compensate for power fluctuations.
55. The most important applications of thermo gravimetric are found in weight loss of material.
56. Thermograms give information about decomposition mechanisms for material.
57. In Differential thermal analysis, vapor is applied to the system.
58. $Hv = \frac{1.8544\,P}{d^2}$ $Kg/mm\ (or) pascal$, d is the diagonal length of the indentation mark in mm.
59. Dielectric measurement is one of the useful characterizations of magnetic response of solids.
60. The dielectric loss is a measure of the energy absorbed by a dielectric
61. The complete combustion in Elemental Analyzer occurs with special or expensive catalysts.
62. Each crystalline solid has its unique characteristic X-ray powder pattern which may be used as a fingerprint for its identification.
63. X-ray powder diffraction is most widely used for the identification of unknown crystalline materials such as minerals and inorganic compounds.
64. The FTIR varies from the traditional dispersive spectrometer mainly due to the use of the interferometer instead of a monochromator.
65. Infrared spectroscopy is extensively applied to various samples such as liquid, gas and solid-sate matter to identify the unknown materials.
66. Fluorometers use filters to restrict excitation and emission beam wavelengths.
67. Elemental Analysis is the measurement of the difference in temperature (ΔT) between sample and a reference, as heat is applied to the system.
68. Fluorometers use either interference or absorption filters while Spectrofluorometers are usually fitted with grating monochromators.
69. Photomultiplier tubes are in common use as detectors.
70. DSC refers to the Differential Scanning calorimetry.
71. DSC is a commercially available instrument which has two types: Heat Flux Type and Power Compensation Type.
72. The action of an electric field brings the charges of the molecules of the dielectric into a certain ordered arrangement in space.
73. Dark current is not a constant background current but also has fluctuations or noise.
74. In a nonlinear process, the oscillation of electrons will eventually become a harmonic.
75. Nonlinear optical phenomena find wide applications in the area of laser technology, laser communication, and data storage technology

Best wishes, Prof. Mohamed Amokhtar

Faculty of Science
Department of Physics

Undergraduate
Final Exam
2nd semester 2020-2021
Course: Radiation Physics
Code:P444
Section: Phys. and Phys./Chem
Time:3 hours
Date:2-7-2021

Assiut University

Question (1): **(15 Mark)**

1. Discuss in details the decay of radioactive element ${}^{A}_{Z}X$ by the emission of β^--particles. (10 Mark)
2. The element ${}^{131}_{53}I$ decays by emitting β^-- particles with maximum kinetic energy 0.608 MeV. After the emission of β^-- particles, each residual nucleus of ${}^{131}_{54}Xe$ is left in an excited state and emits γ-rays with total energy 0.364 MeV. Draw the energy level diagram for this decay in both mass and energy scales. Consider that the atomic mass of stable ${}^{131}_{54}Xe$ is 130.905085 u. (5 Mark)

Question (2): **(15 Mark)**

1. Consider n successive radioactive disintegration of the two radioactive elements P and Q as $P \rightarrow Q \rightarrow R$, where R is a stable element. If λ_1 and λ_2 are the decay constants of P and Q, respectively. Determine the number of Q atoms that present at instant time t. (10 Mark)
2. Consider radioactive series whose first two members P and Q have half-lives of 6 *hrs* and 14 *hrs*, respectively, while the third member is stable. Assume that there are initially 10^6 atoms of the first member and none of the second and third members. Calculate the number of second member Q after 4*hrs*. (5 Mark)

Question (3): **(30 Mark)**

Put [√] or [x]for each of the statement.

1) The decay constant λ is defined as "the probability that a given nucleus will decay per unit time.	( )
2) The radioactive equilibrium occurs when the half-life of the parent nucleus is more short-lived than the daughter nucleus.	( )
3) Antineutrino is a neutral particle with zero rest mass.	( )
4) The annihilation process is a source of photons with energy 0.511Mev.(two photons)	( )
5) The electromagnetic waves (EM) include the whole electromagnetic spectrum such as γ-rays, X-rays,α particles, ultraviolet, visible, infrared, microwave, radar and radio wave.	( )
6) In transient equilibrium, both number of atoms of parent N_1 and daughter N_2 decrease exponentially with time with the half-life of parent and the ratio N_1/N_2 remains constant".	( )
7) Becquerel is defined as one disintegration per second.	( )
8) β^+ decay is radioactive parent nucleus transforms a neutron into a proton.	( )
9) Absorbed dose is measured in units of Sievert. (of J/kg or Gy)	( )
10) The atomic number identifies the chemical element	( )
11) Isotopes are nuclides that have same Z and different A and N.	( )
12) Bohr Theory works very well for one-electron structures.	( )
13) The condition for β^+ decay to be possible is $M(A,Z)-M(A,Z+1) > 0$, where $M(A,Z)$ and $M(A,Z+1)$ are the atomic masses of parent and product nuclei.	( )
14) In secular equilibrium, the number of parent nuclei remains unchanged.	( )
15) IC is a competing process of γ-rays.	( )
16) Radioactivity is the artificial disintegration of nuclei.	( )
17) Heavy nuclei are Z>83 and n:p ration is too low.	( )
18) Condition for α-decay to be possible is: M(A, Z) > M(A,Z+l) + M(4,2) .	( )
19) The mass numbers of the nuclides in the $^{237}_{93}Np$- series can be represented as 4n+1.	( )
20) The atom is neutral, thus the number of positive charges (protons) in the nucleus is equal the number of negative charges (electrons) revolve around the nucleus.	( )
21) Negatively charged electrons revolve around the nucleus as a result of the attractive electrostatic coulomb force between the positive and negative charges.	( )
22) The emitted photon has energy equals the difference in energy between the two atomic orbits.	( )
23) Electrons occupy allowed shells, the number of electrons per shell is limited to $2n^2$.	( )

24) Nuclei consist of neutrons and protons, which are known as nucleons.	( )
25) Mean life is defined as the time interval over which the number N_0 of radioactive atoms initially present in sample is reduced to N_0/e.	( )
26) α- particle consists of two neutrons and two protons.	( )
27) The mass numbers of the nuclides in the $^{235}_{92}U$- series can be represented as 4n+3.	( )
28) Isomers are nuclides that have same Z, N and A but nucleons existing at different energy levels.	( )
29) Nuclear force is mutual attractive force between nucleons.	( )
30) Radioactivity is a statistical event, in that we cannot predict if or when a certain atom will decay but can predict how many events can occur in period of time.	( )

Question (4) (Midterm): **(30 Mark)**

Multiple Choice Questions (MCQ)

1) The phenomenon which abound atomic electron may receive energy and move from a state of energy E_1 to another of higher energy E_2.

a) Excitation b) Ionization c) Binding energy

2) α-particle consists of.....

a) 2 neutrons and 2 protons b) 4 neutrons and 2 protons

c) 2 neutrons and 4 protons d) 4 neutrons and 4 protons

3) The energy required to completely break up the nucleus into well separated Z protons and N neutrons.

a) Binding energy b) Excitation c) Ionization

4) The average energy of the beta particles which is given practically in the form

a) $T_{\beta^-} = T_{max}/4$ b) $T_{\beta^-} = T_{max}/3$ c) $T_{\beta^-} = T_{max}/5$

5) Nuclear decay in which an unstable isotope nuclide (parent nucleus) spontaneously release excess energy with emission of particles and/or gamma-ray and that parent nucleus will transform into a new isotope nuclide (daughter nucleus) that may be stable or unstable.

a) Radioactivity b) Excitation c) Ionization

6) Nucleus capture orbital electron (usually K shell) and neutrino is emitted.

a) Electron Capture decay b) Internal conversion c) Proton Emission

7) The original positron and electron disappear and are replaced by two oppositely directed 0.511 MeV electromagnetic photons known as.

a) Annihilation b) Proton Emission c) Internal conversion

8) The energy that comes from a source and propagate through space or matter in the form of particles or electromagnetic waves.

a) Radiation b) Internal conversion c) Proton Emission

9) Neutrons are emitted during spontaneous fission or are artificially produced by bombarding nucleus with high energy radiation (particles or photons).

a) Neutron decay b) Radiation c) Internal conversion

10) The number of radioactive atoms is reduced to half in the time Known as …

a) Half-life time of decay b) Mean Life

11) When $\tau_1 > \tau_2$, both number of atoms of parent N_1 and daughter N_2 decrease exponentially with time with the half-life of parent and the ratio N_2 / N_1 remains constant.

a) Secular equilibrium b) Transient equilibrium c) No equilibrium

12) ……decay is radioactive parent nucleus transforms a neutron into a proton.

a) β^- b) β^+ c) α

13) 1Ci =……Bq.

a) 3.70×10^{10} b) 3.07×10^{10} c) 3.70×10^{9}

14) ……is a neutral particle with zero rest mass.

a) Antineutrino b) Proton c) Electron

15)……. are nuclides that have same N and different Z and A.

a) Isotones b) Isobars c) Isomers

Question (5) [Oral]:

Put [√] or [x]for each of the statement. (10 Mark)

1) Cosmic ray is highly energetic sub-atomic particles, mostly protons and helium nuclei, which travel across space at close to the speed of light comes from sun and supernova stars	( )
2) The number of radioactive atoms is reduced to half in the time Known as the half-life time of decay	( )
3) The mass numbers of the nuclides in the $^{238}_{92}U$- series can be represented as 4n+2.	( )
4) Isobars are nuclides that have same A and different Z and N.	( )
5) α-decay is the nuclear transformation in which an energetic α- particle (helium-4 nucleus) is emitted.	( )

Maximum Degree(100)	**Second Semester Exam 2021-2022 Semiconductor Physics and Thin Film Applications (451Phys.)**	**Assiut university Faculty of Science Physics Department**

Section (A): (Final Examine consists of the First and Second Questions). (50 degree)

Question (1): Choose and highlight the correct answer: ***(25degree)***

1- The general expression for the density holes in an intrinsic semiconductor with an energy gap E_g and $C = 4.83\times10^{21}$ is: (a) $P_i = CT^{2/3}\exp[-\frac{E_g}{2K_BT}]$ (b) $P_i = CT^{2/3}\exp[+\frac{2E_g}{K_BT}]$	
2- When the complex refractive index of a semiconductor is given by a relation $n^* = n + ik$ at a certain wavelength λ, hence the absorption coefficient α is: (a) $\alpha = \frac{2\pi k}{3\lambda}$ (b) $\alpha = \frac{4\pi k}{\lambda}$ (c) $\alpha = \frac{4\pi}{\lambda k}$	
3-The general expression for Fermi energy level in an intrinsic semiconductor is (a) $E_f = \frac{E_c-E_v}{2} + \frac{4}{3K_B T}\ln[\frac{m_p^*}{m_e^*}]$ (b) $E_f = \frac{E_c+E_v}{2} + \frac{3K_B T}{4}\ln[\frac{m_p^*}{m_e^*}]$	
4- If the direct band gap energy of ZnS semiconductor is 3.65eV, hence the wavelength (λ) of the emitted photons due to a direct recombination process of electrons from the conduction band with holes in the valence is: (a) $\lambda = 340$ nm (b) $\lambda = 430$ nm (c) $\lambda = 350$ nm	
5- The direct optical band gap of semiconductor compounds such as CdS and GaAs can be determined from the extrapolation of straight line portion of: (a) 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 $h\nu = E_g$. (b) The plot of $(\alpha h\nu)^{1/2}$ vs $h\nu$, and the intercept with $h\nu$-axis gives $h\nu = E_g$	
6- If the complex dielectric constant of nano-semiconductor compound of particle size 3 nm is given by $\varepsilon^* = \varepsilon_1 + i\varepsilon_2$, then real refractive index n is: (a) $n = \frac{1}{\sqrt{2}}[\{\varepsilon_1 + (\varepsilon_1^2 + \varepsilon_2^2)^{1/2}\}]^{1/2}$ (b) $n = \frac{1}{\sqrt{2}}[\{\varepsilon_1 + (\varepsilon_1^2 - \varepsilon_2^2)^{1/2}\}]^{1/2}$	
7- When the complex refractive index of a semiconductor is given by the relation $n^* = n + ik$ at a certain wavelength λ, hence the reflectivity (R) is given by: (a) $R = \frac{(n-1)^2+(k+1)^2}{(n+1)^2+(k+1)^2}$ (b) $\frac{(n+1)^2+(k+1)^2}{(n-1)^2+(k-1)^2}$ (c) $R = \frac{(n-1)^2+(k)^2}{(n+1)^2+(k)^2}$	
8- 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) $(\Delta n)_x = (\Delta n)_{x0} \exp[-\frac{x}{\sqrt{D_n n}}]$ (b) $(\Delta n)_x = (\Delta n)_{x0} \exp[+\frac{\sqrt{D_n \tau_N}}{x}]$ 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	
9- The light-emitting diode (LED), is a p–n junction diode, which 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 of the device:. *(a) Under the forward bias of an external electric field.* *(b) Under the reverse bias of an external electric field.*	
10- One of the most important properties of semiconducting material is: *(a) The positive temperature coefficient of its electrical conductivity (i.e., $\sigma \alpha T$).* *(b) The negative temperature coefficient of its electrical conductivity (i.e., $\sigma \alpha \frac{1}{T}$).*	
11- Presence of non radiative structural surface defect states in nano semiconductor materials results in:. *(a) Reduction in the PL emission intensity.* *(b) Improvement of the PL emission intensity.*	
12- Increasing the nanoparticle size via thermal annealing process of the polycrystalline nanosemiconductor results in: *(a) An increase in the optical band gap and enhancement in the PL intensity.* *(b) A decrease (i.e., red shift) in the optical band gap associated with a decrease in the PL intensity.*	
13- When the complex refractive index of a semiconductor is given by relation $n^* = n + ik$ at a certain wavelength λ, hence the real part of the complex dielectric constant ε_1 is given by: *(a) $n^2 + K^2$* *(b) $2nK$* *(c) $n^2 - K^2$*	
14- In perfect semiconductor crystals the mobility of charge carriers will be: *(a) Greater than that in the imperfect crystal.* *(b) Smaller than that in the imperfect crystal*	
15- Absorption process of incident photons with energy $h\nu > E_g$ by semiconductor leads to: *(a) Decrease in a sample resistivity due to increasing in the photo-generated charge carrier density.* *(b) Increase in a sample resistivity due to decrease in the photo-generated charge carrier density.*	
16- The efficiency of amorphous silicon solar cell is: *(a) Higher than that of single crystalline silicon cell.* *(b) Lower than that of single crystalline silicon cell.*	

17- If the conductivity of intrinsic Ge at 300 K is 2.12 $\Omega^{-1}m^{-1}$, electronic charge e = 1.6×10^{-19} C and electron and hole mobility $\mu_n = 0.36\ m^2V^{-1}S^{-1}$ and μ_p 0.17 $m^2V^{-1}S^{-1}$ respectively. Thus the intrinsic concentration (n_i) of charge carriers is:
(a) $n_i = 2.5 \times 10^{19}/m^3$ (b) $n_i = 5.2 \times 10^{19}/m^3$

18- Illumination of CdS nanosemiconductor with photons of energy $h\nu \geq E_g$ under the influence of external electric field results in:
(a) Generation of electron-hole pairs via optical excitation process.
(b) Recombination of electron-hole pairs via optical excitation process.

19- Doping process of semiconductor via incorporation of some impurities into the crystal lattice sites results in:
(a) A decrease in the electrical conductivity due to the decrease in the concentration of free charge carrier.
(b) An increase in the electrical conductivity due to the increase in the concentration of free charge carrier.
(c) No change in the electrical conductivity.

20- For an intrinsic semiconductor with energy gap, $E_g = 0.7$ eV, $m^*_p = 6\ m^*_e$, $C = 4.83 \times 10^{21}$ and $K_BT = 0.026$ eV at 300 °K, the density electrons is equal to:
(a) $n_i = 8.6 \times 10^{-34}/m^3$ (b) $n_i = 8.6 \times 10^{-24}/m^3$

21- Due to scattering process via electron-electron and electron -phonon interaction as a result of the increase in temperature leads to.
(a) Increasing of the optical band gap of pure semiconductor.
(b) Decreasing of the optical band gap of pure semiconductor.

22-, Reduction in nanoparticle size (D) accompanied by an increase in the surface to volume ratio (S/V) of atoms at the nanoparticle surface lead to:
(a) Blue shift of the optical bang gap and PL emission intensity enhancement.
(b) Red shift of the optical bang gap and PL emission intensity quenching.

23- Operation of photoconductors, photodiodes, and avalanche photodiodes devices is directly based on:
(a) The external photoelectric effect as the generation mechanism in which the light-induced increase in the emitted charge carriers.
(b) The internal photo effect in which the light-induced increase in the charge carriers and current flow through the external circuit.

24- UV irradiation induced PL intensity enhancement in $Zn_xCd_{1-x}S$ nano-semiconductor is ascribed to:
(a) Reduction in a nanoparticle size via photo-corrosion and oxidation processes
(b) Increase in a nanoparticle size via photo-corrosion and oxidation processes.

25- According to Franck-Condon principle, PL emission spectrum is usually:
(a) Red-shifted with respect to the optical absorption spectrum.
(b) Blue shifted with respect to the optical absorption spectrum

Question (2): Highlight (T) if the answer is correct and (F) if the answer is wrong **(25 degree)**

26- PL emission due to band-to-band radiative transitions in direct band gap semiconductors occurs when an excited electron in the conduction band recombine with hole in the valence band.	
27- Trapping levels near the center of the energy band gap have a high probability of capturing both the electrons and hole and act as non-radiative recombination centers.	
28- Under the reverse biased of light-emitting diode (LED), the light emission takes place when electrons from the conduction band of n-region recombine with holes in the valence band of p-region accompanied by releasing energy in the form of photons depends on the energy band gap.	
29- Photoconductivity in p-type semiconductor is due to photo generated free hole in the conduction band and an electron bounded at the neighborhood of the acceptors for each absorbed photon.	
30- The excess kinetic energy of trapped charge carriers can be released either by emission of photons via radiative recombination process or released this energy to another free carrier and host lattice as phonons via non radiative recombination process (i.e., relaxation process).	
31-The mobility of charge carriers is defined as the drift velocity acquired by a charge carrier per unit electric field.	
32- Photovoltaic energy conversion independent on the number of photons striking earth surface with energy larger than the band gap of the semiconductor.	
33- The optical properties of nanomaterials depend on some parameters such as size, shape, surface characteristics, doping process and interaction with the surrounding environment or other nanostructures.	
34- Metal resistivity decreases with increasing temperature due to different types of scattering process of charge carriers, whereas semiconductor resistivity decreases due to increase in the concentration of free charge carriers.	
35- One of the most fascinating and useful aspects of nanomaterials is their applications include optical detector, laser, sensor, imaging, phosphor, display, solar cell, photocatalysis, photo-electrochemistry and biomedicine.	
36- If energy gap $E_g = 0.7$ eV, $m^*_p = 6\ m^*_e$ in an intrinsic semiconductor at 300 ^oK where $KT = 0.025$ eV, hence the Fermi level is equal to $E_f = 0.385$ eV.	
37- Capturing centers which localized near the conduction band edge will be more likely to act as electron trapping centers than as a recombination centers.	
38- When a sample of n- type semiconductor is illuminated uniformly the excess of created minority carriers (holes) which has life time (τ) decay exponentially with time (t) according to the relation: $(\Delta p) = (\Delta P_0)exp^{(-t/\tau)}$	

39- Electrical conductivity in a homogeneous semiconductor material can be expressed as: $\sigma = e\,E(n\mu_n + p\mu_p)$, Where, n and p are the densities of free electrons and holes, and μ_n and μ_p their mobility respectively.	
40- In fabrication of photo detectors and photodiodes, it is preferable to use high photosensitive materials, high photoelectric gain and high speed of photo response.	
41- Photoconductors are used in street light control, optically activated switches and Information storage.	
42- Presence of structural defects such as vacant and interstitial lattice sites and other complexes introduce electronic energy states within the energy band gap of a semiconductor.	
43- In n-type semiconductor donor impurities introduce localized electronic states within the forbidden energy gap near the valence band edge.	
44- LEDs can emit light of an intended color by changing the optical energy gap of the semiconductor used in in the manufacture of the device without using any color filters as traditional lighting methods need.	
45- The direct inter-band optical transition from the conduction band to the valence band occurs, when minimum of the conduction band and maximum of the valence band exist at the same points in k-space (i.e., $k_i = k_f$).	
46- Einstein relation between diffusion coefficient (D_e) and mobility (μ_e) of electron can be expressed as: $\frac{D_e}{\mu_e} = \frac{(2K_B^2\,T)}{e}$, where K is Poltzmzan constant, T is the absolute temperature, e is the electronic charge.	
47- When electromagnetic wave (light) enters and travels through the semiconductor thin films, its intensity decay according to the equation $\boldsymbol{I = I_o\ exp\ -\alpha x}$, where α is the absorption coefficient typically in cm^{-1}, x is the thickness of the sample, and I_0 is the initial light intensity incident on the surface of the film.	
48- When an electron is captured by an excited center in the band gap containing a hole, or a hole being captured by an excited center containing electron. Then PL emission can be assigned as defect related- PL emission.	
49- The advantages of thin films coated by chemical vapour deposition (CVD are high coating hardness, good adhesion and uniformity of thin films.	
50- The physical properties of a thin film such as mechanical, electrical, magnetic and optical properties are highly dependent on their thickness and surface roughness.	

SECTION B:(Mid-term examine, oral and activity) **(5o degree)**

Question 3: Highlight (T) if the answer is correct and (F) if the answer is wrong.

51- In thermal evaporation and sputtering techniques a reactive gas can be used in the deposition chamber to deposit thin films from elemental and compound sources, which used in microelectronics.	
52- Passivation process and modification of nanoparticle surface by using wide band gap inorganic shell and/or organic molecules as capping agent. results in reduction of the undesired pathways/non radiative surface traps and unsaturated dangling bonds (broaken surface bonds).	
53- Fermi level in semiconductors depends strongly on the temperature and dopin levels (dopant concentration).	
54- Thin films prepared by physical vapor deposition (PVD) exhibit some disadvantages such as excellent process control, low deposition temperature, dense and adherent coatings, elemental, alloy and compound coatings are possible.	
55- Tuning of the nanoparticle size in semiconductors via chemical means such as temperature and time of reaction, pH concentration, results in achievement different emission colors along wide spectral wavelengths region.	
56- Thin film solar cells which used in several technologies are made by depositing one or more thin layers on a substrate, such as glass, plastic or metal.	
57- Luminescent colloidal semiconductor nanocrystals have attracted prominent attention due to their size-dependent optical properties and optoelectronic properties due to quantum confinement effects which result in size-dependent physical and chemical properties.	
58- In photodiodes, photons absorbed in the depletion layer generate electrons and holes which drift in opposite directions under the influence of internal local field. Such a transport process induces an electric current in the external circuit.	
59- Devices in which the internal amplification process occurs by applying a sufficiently large reverse bias across the junction are known as avalanche photodiodes (APDs).	
60- Semiconductor colloidal nanocrystals (NCs) can be used as building blocks in large area and low-cost electronic and optoelectronic devices via simple solution processing such as spin-coating, spraying, dipping etc.	
61- The quantum efficiency (η) of a photodetector is defined as the ratio of the flux of generated electron-hole pairs that contribute to the detector current to the flux of incident photons.	
62- In quantum dots (QDs) electron and hole energy states are discrete and can be precisely adjusted by size. As a result, PL can cover a very broad spectral region as a function of QD size.	

63- Photoconductor detectors operate by registering either the photocurrent i_p, which is proportional to the photon flux ϕ, or the voltage drop across a load resistor R placed in series with the circuit.

64- Photodiodes are faster than photodetectors because strong field in the depletion region supplies a large velocity to the photogenerated carriers. Furthermore, photodiodes are not affected by many of the trapping effects.

65- Optical properties of nanomaterials are the most exploited and useful properties for technological applications, ranging from sensing and detection, optical imaging, light energy conversion, environmental protection, biomedicine, food safety, and optoelectronics.

66- According to Franck-Condon principle, PL emission spectrum is usually blue-shifted with respect to the optical absorption spectrum, i.e. appearing at longer wavelength.

67- Optical and electrical properties of $Zn_xCd_{1-x}S$, alloyed semiconductor nanoparticles are significantly independent on the molar ratio (x) of zinc content.

68- A localize center is assigned as a recombination center, if the captured carriers has a great probability of recombination with a carrier of opposite sine at the imperfection than its thermal re-excitation to the frees state.

69- The diffusion current in semiconductor at constant temperature is directly proportional to Square of the applied electric field (E^2).

70- In the manufacture of photo-detectors and photodiodes, it is preferable to use semiconductors with high photosensitive and have a high photoelectric gain and photo response speed.

71- An intrinsic semiconductor behave as an insulator material at room temperature.

72- When the intrinsic charge carrier concentration (n_i) is $2.5 \times 10^{19}/m^3$, at room temperature, where $2K_BT = 0.052eV$ and $C = 4.83 \times 10^{21}$, hence the forbidden energy gap equals to 1.44 eV

73- Doping process of wide band gap semiconductor via incorporation of some impurities into the crystal lattice sites results in decrease in the electrical conductivity due to low concentration of free charge carriers.

74- When the complex refractive index of a semiconductor is given by relation $n^* = n + ik$ at a certain wavelength λ, hence phase velocity (υ) is: $\upsilon = \frac{c}{n}$.

75- Measurement of PL emission spectrum is a useful tool for studying and identification of localized trap states in the energy band gap and the intrinsic electronic band structure,

With my best regards

Prof. Dr .M. A. Osmand

Assiut University
Faculty of Science
Department of Physics
Second semester 2020-2021

Course: *Atomic and Molecular Spectroscopy*
Code: P432
Time: 3 Hours
Final Exam (100%)

Student name:

Academic No.:

The exam is written in eleven (11) pages.

Direction:

1- Make sure you fill in the bubbles for your name and student number on the bubble sheet.
2- Make sure you write your name and your academic number in this test booklet.
3- There are *fifty* multiple choice questions on this test booklet. Answer all questions.
4- You may write scratch work in this test booklet itself, but only the answers on the bubble sheet.
5- Multiple choice questions have one correct answer. Mark your answer on the bubble sheet. Each correct answer will score *two* marks.
6- The exam consists of two parts, the first is the final exam "50 marks" and the second is the oral, midterm, and Quarterly Acts Exams "50 marks".

First Part: *(50 Marks)*

Choose the correct answer:

1-	The principal quantum number n can have any integer value ranging from:		
	a- $-\infty \rightarrow +\infty$	b- $0 \rightarrow \infty$	
	c- $1 \rightarrow \infty$	d- $1 \rightarrow 7$	
	e- $0 \rightarrow 7$		
2-	The orbital quantum number ℓ can have any integer value ranging from:		
	a- $0 \rightarrow n$	b- $0 \rightarrow n-1$	
	c- $1 \rightarrow n$	d- $0 \rightarrow n+1$	
	e- $0 \rightarrow 2\ell+1$		
3-	The magnetic quantum number m_ℓ can have any integer value ranging from		
	a- $0 \rightarrow n$	b- $-n \rightarrow +n$	
	c- $-\ell \rightarrow +\ell$	d- $0 \rightarrow \ell$	
	e- $0 \rightarrow 2\ell+1$		

4-	In the Bohr model of the hydrogen atom, by increasing the quantum number, the energy difference between any two successive levels in the atom …..		
	a- increasing	b- be equal	
	c- decreasing	d- all of the above	
	e- none of the above		
5-	In the Bohr model of the hydrogen atom, by increasing the quantum number, the distances between successive energy levels "the difference between the radius of the successive orbitals" in the atom …..		
	a- increasing	b- be equal	
	c- decreasing	d- all of the above	
	e- none of the above		
6-	In the Bohr model of the hydrogen atom, by increasing the quantum number, the angular momentum of the electron …..		
	a- increasing	b- be equal	
	c- decreasing	d- all of the above	
	e- none of the above		
7-	In the Bohr model of the hydrogen atom, by increasing the quantum number, the total energy of the electron …..		
	a- increasing	b- be equal	
	c- decreasing	d- all of the above	
	e- none of the above		
8-	In the Bohr model of the hydrogen atom, by increasing the quantum number, the kinetic energy of the electron …..		
	a- increasing	b- be equal	
	c- decreasing	d- all of the above	
	e- none of the above		

9-	In the Bohr model of the hydrogen atom, by increasing the quantum number, the potential energy of the electron …..		
	a- increasing	b- be equal	
	c- decreasing	d- all of the above	
	e- none of the above		
10-	In the Bohr model of the hydrogen atom, by increasing the quantum number, the velocity of the electron …..		
	a- increasing	b- be equal	
	c- decreasing	d- all of the above	
	e- none of the above		
11-	In the ground state, the quantum numbers (n, ℓ, m_ℓ, m_s) for hydrogen are, respectively,		
	a- 1, 1, 1, 1.	b- 1, 0, 0, 0.	
	c- 1, 0, 0, ±1/2.	d- 1, 1, 1, ±1/2.	
	e- 1, 1, 0, ±1/2.		
12-	According to the selection rule, when a photon is emitted or absorbed, transitions can only occur between state with values of ℓ that differ by		
	a- four units.	b- three units.	
	c- two units.	d- one unit.	
	e- zero unit.		
13-	The Pauli exclusion principle:		
	a- Any two electrons in an atom can occupy the same quantum state.		
	b- All electrons in an atom can occupy the same quantum state.		
	c- No two electrons in an atom can occupy the same quantum state.		
	d- The position and momentum of a particle can both be measured precisely at the same time.		
	e- The position and momentum of a particle cannot both be measured precisely at the same time.		

14-	In terms of an atom's electron configuration, the letters K, L, M, and N refer to:		
	a- different shells with n equal to 1, 2, 3, or 4 respectively.		
	b- different sub shells with ℓ equal to 1, 2, 3, or 4 respectively.		
	c- different sub shells with m_ℓ equal to 1, 2, 3, or 4 respectively.		
	d- the four possible levels for the magnetic quantum number.		
	e- the four possible quantum numbers.		
15-	How many possible sets of quantum numbers or electron states are there in the $5f$ sub shell?		
	a- 6	b- 10	
	c- 14	d- 18	
	e- 22		
16-	A hydrogen atom is in the $6h$ sub shell. Which of the following could be an orbital quantum number ℓ ?		
	a- 22	b- 5	
	c- 6	d- 8	
	e- 10		
17-	A hydrogen atom is in the $6h$ sub shell. Which one of the following is not a magnetic quantum number m_ℓ ?		
	a- 0	b- 1	
	c- 2	d- 4	
	e- 6		
18-	In a hydrogen atom, a given electron has $n = 7$. How many values can ℓ have?		
	a- 6	b- 7	
	c- 15	d- 30	
	e- 98		

19- Consider ground-state helium holding two electrons in orbit. If one of the electrons has quantum numbers (n, ℓ, m_ℓ, m_s) of $(1, 0, 0, -1/2)$ respectively, the quantum numbers for the other electron will be:

a- $(1, 1, 0, -1/2)$	b- $(1, 0, 0, +1/2)$
c- $(1, 1, 1, +1/2)$	d- $(1, 0, 1, +1/2)$
e- none of the given answers	

20- The values of n and ℓ for a $4f$ sub shell are:

a- $n = 4, \ell = 4$	b- $n = 4, \ell = 3$
c- $n = 4, \ell = 2$	d- $n = 4, \ell = 1$
e- $n = 3, \ell = 3$	

21- A neutral atom has an electron configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$. What is its atomic number?

a- 5	b- 11
c- 14	d- 18
e- 25	

22- A neutral atom has an electron configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$. If a neutral atom holds one additional electron, what is the ground state configuration?

a- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	b- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
c- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$	d- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2\ 4s^1$
e- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$	

23- A neutral atom has an electron configuration of $1s^2\ 2s^2\ 2p^6$. If a neutral atom holds one additional electron, what is the ground state configuration?

a- $1s^2\ 2s^2\ 2p^6\ 3s^1$	b- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
c- $1s^2\ 2s^2\ 2p^7$	d- $1s^2\ 2s^3\ 2p^6$
e- $1s^2\ 2s^2\ 2p^6\ 3s^2$	

24-	What is the electron configuration for *Li* which has three electrons?		
	a- $1s^3$	b- $1s^2\ 1p^1$	
	c- $1s^2\ 2s^1$	d- $1s^1\ 2s^2$	
	e- $1s^1\ 2s^1\ 2p^1$		
25-	The magnitude of the orbital angular momentum of an electron in an atom is what multiple of $\hbar$? (ℓ is a positive integer.)		
	a- ℓ	b- $\ell/2$	
	c- $\sqrt{\ell(\ell+1)}$	d- $2\ell+1$	
	e- ℓ^2		

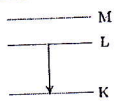
Second Part: ***(50 Marks)***

26-	The magnetic quantum number m_ℓ is most closely associated with what property of an electron in an atom?		
	a- Magnitude of the orbital angular momentum	b- Energy	
	c- z component of the spin angular momentum	d- Radius of the orbit	
	e- z component of the orbital angular momentum		
27-	The quantum number m_s is most closely associated with what property of the electron in an atom?		
	a- Magnitude of the orbital angular momentum	b- Energy	
	c- z component of the spin angular momentum	d- Radius of the orbit	
	e- z component of the orbital angular momentum		
28-	The number of possible values of the magnetic quantum number m_ℓ associated with a given value of the orbital quantum number ℓ is:		
	a- ℓ	b- $\ell/2$	
	c- $\ell(\ell+1)$	d- $2\ell+1$	
	e- $\ell+1$		

29-	An electron is in a quantum state for which the magnitude of the orbital angular momentum is $6\sqrt{2}\,\hbar$. The value of the orbital quantum number ℓ is:	
	a- 4	b- 5
	c- 17	d- 8
	e- 9	
30-	An electron is in a quantum state for which there are seven allowed values of the z component of the angular momentum. The magnitude of the angular momentum is:	
	a- $\sqrt{3}\,\hbar$	b- $2\sqrt{3}\,\hbar$
	c- $\sqrt{7}\,\hbar$	d- $\sqrt{56}\,\hbar$
	e- $\sqrt{14}\,\hbar$	
31-	Space quantization means that:	
	a- space is quantized	b- L_z can have only certain discrete values
	c- $\vec{L}$ and $\vec{\mu}$ are in the same direction	d- $\vec{L}$ and $\vec{\mu}$ are in opposite directions
	e- an electron has a magnetic dipole moment	
32-	An electron in an atom is in a state with $\ell = 5$. The minimum angle between $\vec{L}$ and the z axis is:	
	a- 0°	b- 155.9°
	c- 24.1°	d- 36.7°
	e- 90.0°	
33-	In the relation $\mu_z = -m_\ell\,\mu_B$, the quantity μ_B is:	
	a- the component of the dipole moment along the magnetic field	b- the Bohr magneton
	c- the permeability of the material	d- a friction coefficient
	e- none of the above	

34-	The electron states that constitute a single subshell for an atom all have:		
	a- the same value of n and the same value of ℓ	b- the same value of n	
	c- the same value of ℓ and the same value of m_ℓ	d- the same value of ℓ	
	e- the same set of all four quantum numbers		
35-	The Stern-Gerlach experiment makes use of:		
	a- a strong uniform magnetic field	b- a strong non-uniform magnetic field	
	c- a strong uniform electric field	d- a strong non-uniform electric field	
	e- strong perpendicular electric and magnetic fields		
36-	The magnetic field $\vec{B}$ is along the z axis in a Stern-Gerlach experiment. The force it exerts on a magnetic dipole with dipole moment $\vec{\mu}$ is proportional to:		
	a- μ_z^2	b- B^2	
	c- dB/dz	d- d^2B/dz^2	
	e- $\int B\, dz$		
37-	A magnetic dipole $\vec{\mu}$ is placed in a strong uniform magnetic field $\vec{B}$. The associated force exerted on the dipole is:		
	a- along $\vec{\mu}$	b- along $-\vec{\mu}$	
	c- along $\vec{B}$	d- along $\vec{\mu} \times \vec{B}$	
	e- Zero		
38-	The force exerted on a magnetic dipole as it moves with velocity $\vec{v}$ through a Stern-Gerlach apparatus is:		
	a- proportional to v	b- proportional to $1/v$	
	c- zero	d- proportional to v^2	
	e- independent of v		

39-	How many electrons can be put in a shell with principal quantum number n:	
	a- $2n^2$	b- $2n$
	c- $2(2\ell+1)$	d- $2n+1$
	e- $2\ell+1$	
40-	How many electrons can be put in a subshell with quantum number n and ℓ :	
	a- $2n^2$	b- $2n$
	c- $2(2\ell+1)$	d- $2n+1$
	e- $2\ell+1$	
41-	Give the possible values of the total-angular-momentum quantum number J that result from the addition of angular momenta "orbital angular momentum and spin angular momentum" with quantum numbers 3/2 and 4 :	
	a- $11/2$	b- $11/2, 9/2, 7/2, 5/2$
	c- $5/2$	d- $5, 4, 3, 2, 1$
	e- $3/2, 1/2, 0, -1/2, -3/2$	
42-	Suppose a hydrogen atom in a $3d_{5/2}$ state is placed in an external magnetic field. Into how many sub states will it split?	
	a- 3	b- 4
	c- 5	d- 6
	e- None of the above	
43-	Why is it easier to analyze a mixture of gaseous atomic species by absorption spectroscopy than it is to analyze a mixture of molecular species?	
	a- atomic species do not have side reactions.	
	b- molecular species do not absorb light.	
	c- atomic spectra have simpler narrower lines that are easier to resolve than molecular spectra.	
	d- atomic species have a continuous spectrum.	
	e- atomic species have a discrete spectrum.	

44-	The probability of finding an electron in a hydrogen atom is directly proportional to its:	
	a- energy.	b- momentum.
	c- potential energy.	d- wave function.
	e- square of the wave function.	
45-	The most energetic photon in a continuous x-ray spectrum has an energy approximately equal to:	
	a- the energy of all the electrons in a target atom	
	b- the kinetic energy of an incident-beam electron	
	c- the kinetic energy of a K-electron in the target atom	
	d- the total energy of a K-electron in the target atom	
	e- the rest energy, mc^2 , of an electron	
46-	In connection with x-ray emission the symbol K_α refers to:	
	a- an alpha particle radiation	
	b- x-ray radiation from potassium	
	c- x-ray radiation associated with an electron going from $n = \infty$ to $n = 1$	
	d- an effect of the dielectric constant on energy levels	
	e- x-ray radiation associated with an electron going from $n = 2$ to $n = 1$	
47-	The transition shown gives rise to an x-ray. The correct label for this is: 	
	a- K_α	b- K_β
	c- L_α	d- L_β
	e- K_L	

48-	The Pauli exclusion principle is obeyed by:		
	a- all particles	b- all charged particles	
	c- all particles with spin quantum numbers of 1/2	d- all particles with mass	
	e- all particles with spin quantum numbers of 1		
49-	The minimum energy principle tells us that:		
	a- the energy of an atom with a high atomic number is less than the energy of an atom with a low atomic number		
	b- the energy of an atom with a low atomic number is less than the energy of an atom with a high atomic number		
	c- when an atom makes an upward transition the energy of the absorbed photon is the least possible		
	d- the ground state configuration of any atom is the one with the least energy		
	e- the ground state configuration of any atom is the one with the least ionization energy		
50-	The ionization energy of an atom in its ground state is:		
	a- the energy required to remove the least energetic electron		
	b- the energy required to remove the most energetic electron		
	c- the energy difference between the most energetic electron and the least energetic electron		
	d- the same as the energy of a K_α photon		
	e- the same as the excitation energy of the most energetic electron		
	e- transitions from a state that decays rapidly		