ASSIUT UNIVERSITY

كلية العلوم
جامعة أسيوط

Final Exam - Second Term: 2023/2024 - Course Title: Physics of low temperature
Code P- 422- Time: 3 h - Teaching Staff: Prof. Dr. Ahmed Sedky

Q1 - Choose True (T) or False (F) (20 marks):

1- Superconductors can be used to increase the friction of the superconducting trains.

(a) F **(b) T**

2- Superconductors can be used in radar apparatus due to their ferromagnetic behaviors.

(a) F **(b) T**

3- The sign of the thermoelectric power of a superconductor is usually negative.

(a) F **(b) T**

4- The Cooper pairs move as a super-current with high power dissipation.

(a) F **(b) T**

5- The electron pairs require less energy than binding energy for breaking.

(a) F **(b) T**

6- The jump in specific heat at T_c is due to enhancing the order parameter.

(a) F **(b) T**

7- When $I > I_c$, the voltage appears to linearly increases with increasing I.

(a) F **(b) T**

8- The slope (dV/dI) defines the flux flow resistance R_f .

(a) F **(b)** T

9- The entropy of the electrons in the NS is higher than that in the SS.

(a) F **(b) T**

10- In the mixed state, $\psi(r)$ increases over a length equal to ξ.

(a) F **(b) T**

11- The T_c of La: 214 is about 68 K.

(a) F **(b) T**

12- The T_c of Y : 123 is about 38 K.

(a) F **(b) T**

13- The T_c of Bi: 2223 is about 89 K.

(a) F **(b) T**

14- Flux quantum in superconductor equals 4.14×10^{-14} (Web).

(a) F **(b) T**

15- In R:123 systems, R = Bi, Ti, and Hg.

(a) F **(b) T**

16- The temperature of liquid nitrogen is – 196 °C

(a) F **(b) T**

17- When $F_L > F_p$, the vortex lines will move (flux flow).

(a) F **(b) T**

18- When $F_L = F_p$, the vortex lines will be localized at the top of the well.

(a) F **(b) T**

19- Superconductivity is quenched when the flux flow occurs.

(a) F **(b) T**

20- The T_c of Ti: 2223 is about 127 K.

(a) F **(b) T**

Q2 (30 marks): Choose the correct answer (MCQ):

21- The T_c (288 K) of H_2S superconductors occurs at a pressure of:

(a) 300 GPa **(b) 180 GPa** **(c) 200 GPa**

22- The critical field Hc_2 of the Bi:2212 is about;

(a) 7 T **(b) 10 T** **(c) 9 T**

23- The highest Hc_2 obtained for high T_c superconductors is about;

(a) 100 T **(b) 92 T** **(c) 120 T**

24-The T_c of a superconductor is obtained when

(a) I = zero **(b) T = zero** **(c) V = zero**

25- The crystal structure of the FeSeTe system is;

(a) Orthorhombic **(b) Hexagonal** **(c) Tetragonal**

26- The specific heat of a superconductor at T_c equals;

(a) Zero **(b) ≈ 3Cen** **(c) << 3Cen**

27- The condensation energy at a critical field of 12 T equals;

(a) 5.762 J **(b) 5.732 J** **(c) 5.702 J**

28- If H_c (0) = 5 T and T_c = 150 K, then H_c (100 K) equals;

(a) 2.877 T **(b) 2.778 T** **(c) 2.718 T**

29- The field at London depth equals;

(a) B (a) **(b) (1/e)B(a)** **(c) Zero**

30- If $\lambda(0) = 5.1$ μm, then H_{c1} equals;

(a) 1.207×10^{-5} **T** **(b)** 1.267×10^{-5} **T** **(c)** 1.246×10^{-5} **T**

31- The energy gap at 0 K for a 40 K Tc of a superconductor equals;

(a) 1.943×10^{-21} **J** **(b)** 1.916×10^{-23} **J** **(c)** 1.966×10^{-20} **J**

32- The surface sheath of type (I) superconductors occurs when:

(a) $\kappa_{GL} \geq 0.419$ **(b)** $\kappa_{GL} < 0.419$ **(c)** $\kappa_{GL} > 0.319$

33- The G-L parameter of type (II) superconductors is

(a) $\kappa_{GL} \geq 0.707$ **(b)** $\kappa_{GL} < 0.707$ **(c)** $\kappa_{GL} = 0.607$

34- The G-L parameter of type (I) superconductors is **:**

(a) $\kappa_{GL} \leq 0.707$ **(b)** $\kappa_{GL} > 0.707$ **(c)** $\kappa_{GL} = 0.757$

35- If $H_{c2} = 4.1$ T, then Hc_3 equals;

(a) 6.949 T **(b) 6.937 T** **(c) 6.967 T**

36- Copper pairs occur as a result of interaction between;

(a) Electron-lattice **(b) Electron- phonon** **(c) Electron-electron**

37- A rapid change of C_{en} at T_c is ascribed to;

(a) Energy gap **(b) Electron pairs** **(c) Both of them**

38- The activation energy E_a of flux bundles can be obtained from;

(a) $\ln f$ **and** T_p **(b)** f **and** $1/T_p$ **(c)** $\ln f$ **and** $1/T_p$

39- If $T_c = 110$ K for a superconductor, $\gamma = 0.0125$, then $H_c(0)$ of BCS equals;

(a) 14.569 T **(b) 14.780 T** **(c) 14.699 T**

40- The temperature of liquid helium equals

(a) 4.2 K **(b) – 268.8 °C** **(c) both of them**

41- If $\xi(0) = 2.1$ μm, then H_{c2} equals;

(a) 7.407×10^{-5} **T** **(b)** 7.474×10^{-5} **T** **(c)** 7.496×10^{-5} **T**

42- If $\xi = 0.81$ μm and $\lambda = 0.6$ μm, then δ_{ns} equals;

(a) $\mathbf{8.06\times10^{-9}\ H_c}$ **(b)** $\mathbf{8.36\times10^{-9}\ H_c}$ **(c)** $\mathbf{8.96\times10^{-9}\ H_c}$

43- If G-L parameter $\kappa_{GL} = 0.511$ and $H_c = 0.21$ T, then Hc_2 equals;

(a) 0.149 T **(b) 0.152 T** **(c) 0.137 T**

44- If G-L parameter $\kappa_{GL} = 0.511$ and $H_c = 0.21$ T, then Hc_3 equals;

(a) 0.247 T **(b) 0.257 T** **(c) 0.237 T**

45- If r = 0.45 μm and $H_c = 0.125$ T, then I_c equal;

(a) $\mathbf{2.5\times10^{-8}}$ **(A)** **(b)** $\mathbf{2.81\times10^{-8}}$ **(A)** **(c)** $\mathbf{3.01\times10^{-8}}$ **(A)**

46-If $n(0) = 12.16 \times 10^{21}\ cm^{-3}$, $T_c = 150$ K , then n (100 K) equals**;**

(a) $\mathbf{9.758 \times 10^{21}/cm^{-3}}$ **(b)** $\mathbf{9.558 \times 10^{21}/cm^{-3}}$ **(c)** $\mathbf{9.798 \times 10^{21}/cm^{-3}}$

47-If $T_c = 150$ K, $\lambda(0) = 0.51$ μm, then λ (100 K) equals;

(a) 0.569 μm **(b) 0.549 μm** **(c) 0.579 μm**

48- If $E_c = 0.112$ J and $f_s(T) = 0.958$ J , then $f_n(T)$ equals;

(a) 1.07 J **(b) 1.061 J** **(c) 1.081 J**

49- If $Hc_2 = 20$ T , $\rho_n = 5\times10^{-5}$ (Ω.m), then γ for Hg:1223 under pressure equals;

(a) 0.079 (J/Kg.K) **(b) 0.088 (J/Kg.K)** **(c) 0.069 (J/Kg.K)**

50- Onset of diamagnetism occurs when;

(a) χ' **equals zero** **(b)** χ'' **is the maximum** **(c)** χ' **is the maximum**

Good Luck

Physics Department
Faculty of Science
Assiut University

P491 SELECTED TOPICS IN PHYSICS (I)

(Clinical Plasma Medicine)

THIS TEST HAS FIFTEEN PAGES

DURATION OF TEST: THREE HOURS

Answer All Questions from Part I,II & III.

Part I: True or False questions: (10 Points)

Tick the correct answer:

Statement	True	False
1. Physical plasma is a special excited gas state, sometimes named "the fourth state of matter" following solid, liquid, and gaseous states.		
2. It can not be generated by a continuous supply of energy to the atoms or molecules of a neutral gas until an excited state is achieved.		
3. The most important basic plasma effect is relevant for medical applications is inactivation of a broad spectrum of microorganisms, including multidrug resistant pathogens		
4. The electron impact ionization is not the most robust procedure generating a plasma for biomedical purposes.		
5. Plasma medicine can be considered a field of applied redox biology.		
6. One of the most important results of basic research in plasma medicine is the insight that biological plasma effects are mainly mediated via reactive oxygen and nitrogen species influencing cellular redox regulated processes.		
7. Plasma medicine is a new field of research combining plasma physics, life science and clinical medicine.		

Statement	True	False
8. Thermal plasmas have long been used in various medical fields (for instance for cauterization and sterilization of medical instruments).		
9. Experiments show that cold atmospheric plasmas (CAPs) allow efficient, contact-free and painless disinfection, even in microscopic openings, without damaging healthy tissue.		
10. Plasma is matter (gas) heated beyond its gaseous state, heated to a temperature so high that atoms are stripped of at least one electron in their outer shells, so that what remains are positive ions in a sea of free electrons.		
11. The energy is not transferred by inelastic and elastic collisions of high-energy electrons generated by a strong electric field with the atoms or molecules in the gas resulting in its partial ionization.		
12. The temperature of such partially ionized gas is always substantially lower than the characteristic ionization temperature.		
13. In a plasma, the different species-ions, electrons, and neutrals- may have different temperatures: Ti, Te, and Tn. These three (or more, if there are different kinds of ions or atoms) interpenetrating fluids can move through one another, but they may not collide often enough to equalize the temperatures, because the densities are usually much lower than for a gas at atmospheric pressure.		
14. During an elastic collision the particles only exchange kinetic energy.		
15. One of the most important basic plasma effects is relevant for medical applications is stimulation of cell proliferation and angiogenesis with lower plasma treatment intensity.		
16. Physical plasma can not be generated by a continuous supply of energy to the atoms or molecules of a neutral gas until an excited state is achieved.		

Statement	True	False
17. The energy required to generate physical plasma may be provided separately by thermal, chemical, electrical and radiative resources or a combination of all.		
18. The electron impact ionization is not the most robust procedure generating a plasma for biomedical purposes.		
19. In physical plasma, the energy is transferred by inelastic and elastic collisions of high-energy electrons generated by a strong electric field with the atoms or molecules in the gas resulting in its partial ionization.		
20. Medical treatment techniques using such plasmas have been firmly established for a long time in the field of electro surgery, even if they were not explicitly referred to as plasma medicine at the time. Such techniques, like argon plasma coagulation (APC), rely on precisely targeted thermal necrotization of tissue to achieve hemostasis (cauterization), or to cut or remove tissue		
21. Electrons moving in a gas under the action of a magnetic field are bound to make numerous collisions with the gas molecules.		
22. When an electron travels a distance equal to its free path λe in the direction of the field E, it gains an energy of $eE\lambda e$.		
23. Electrical breakdown occurs in Townsend regime with the addition of secondary electrons emitted from the cathode due to ion or photon impact.		
24. Glow discharge means that the plasma is in contact with only a small part of the cathode surface at low currents.		
25. During an elastic collision the particles only does not exchange kinetic energy.		
26. Low-temperature plasma (LTP) applications in biomedical systems are the main element of plasma medicine .		
27. Plasmas produce electromagnetic radiation, including ultra-violet (UV) radiation and light in the visible spectrum, and involves excited gas particles, charged ions, free electrons, free radicals, neutral reactive oxygen and nitrogen species, and molecule fragments.		

Part II: Multiple Choice: (20 Points)

Circle the one best answer to each question:

1. What is a plasma?
   a) Mixture of atoms and molecules in gaseous state.
   b) Soup of electrons and ions.
   c) Ionized gaseous state.
   d) A gas with equal number of electrons and ions with no uncharged particles.

2. What is the frequency usually used for plasma applications and why?
   a) 2.54 GHz , Cheap source.
   b) 13.56 GHz , We get good property plasmas at this frequency.
   c) 13.56 MHz , Federal government mandated frequency.
   d) 13.56 GHz , Federal government mandated frequency.

3. Is plasma frequency a good parameter for measurement (Yes/No), Why?
   a) Yes, We can measure it easily.
   b) No, It's hard to measure the plasma frequency.
   c) Yes, Plasma frequency is same as the electron frequency in plasma.
   d) No, Other waves too can exist in the same frequency.

4. What is a Debye length?
   a) It is the 1/e distance for reducing the momentum.
   b) An effective length over which a plasma will shield a magnetic field.
   c) It is the length an electron can travel without collision.
   d) Length over which sheath exist in a plasma.

5. What happens to sheath potential as we go into the sheath (from plasma) ?
   a) Potential decreases.
   b) Potential increases.
   c) Potential remains a constant.
   d) Potential changes as a sinusoidal function.

6. Plasma with small Debye length shields out
   a) A.C field b) D.C field c) Nothing d) Both a) and b)

7. In the phenomenon of electric discharge through gases at low pressure, the coloured glow in the tube appears as a result of:

a) Excitation of electrons in the atoms.

b) The collision between the atoms of the gas.

c) The collisions between the charged particles emitted from the cathode and the atoms of the gas.

d) The collision between different electrons of the atoms of the gas.

8. The transition of non-sustaining discharge into self-sustaining discharge is called

a) ionization b) collision

c) spark breakdown d) vacuum breakdown

9. Electrical conduction in gases was first studied in 1905 by:

a) Loeb b) Maxwell c) Townsend d) Hertz

10. According to Townsend current growth process the current (I) in a uniform electric field gap is:

a) $I_o exp(-\alpha d)$ b) $I_o\, exp(\alpha d)$

c) $I_o\, exp(\gamma d)$ d) $I_o\, exp(-\gamma d)$

11. In a self-sustained discharge the anode current I_a is given in the form:

a) $I_a = I_o exp(-\alpha d)$ b) $I_o = I_o\, exp(-\gamma d)$

c) $I_a = \gamma I_o exp(-\alpha d)$ d) $I_b = \dfrac{I_e\, exp(\alpha d)}{1+\gamma - \gamma\, exp(\alpha d)}$

12. A plasma is a:

a) Gas heated beyond its gaseous state, to a temperature so high that atoms are stripped of at least one electron in their outer shells, so that what remains are positive ions in a sea of free electrons.

b) Quasineutral gas of charged and neutral particles which exhibits collective behavior.

c) Fourth state of matter.

d) All of the above.

13. The breakdown voltage of gas or air with increase in pressure under uniform field has_____relation with pressure

a) Linear b) Square c) non-linear d) reciprocal

14. The collisional cross section is defined as

a) An "effective area" that quantifies the likelihood of a scattering event when an incident species strikes a target species.

b) The area around a particle in which the center of another particle must be in order for a collision to occur.

c) Quantify the probability of a collision taking place between two or more particles.

d) All of the above.

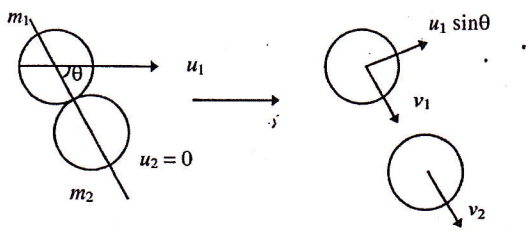
15. The maximum energy δ transferred to the internal energy of the target particle is given by.

a) $\delta = (m_2/(m_1 + m_2))\, cos^2\, \theta$

b) $\delta = (m_2/(m_1 + m_2))\, cos\, 2\theta$

c) $\delta = (m_1/(m_1 + m_2))\, cos\, 2\theta$

d) $\delta = (m_2/(m_1 + m_2))\, sin\, 2\theta$



16. Ionization coefficients α, γ are functions of

a) applied voltage
b) pressure and temperature
c) electric field
d) ratio of electric field to pressure

17. Time lag for breakdown is

a) Time difference between instant of applied voltage and occurrence of breakdown.

b) Time taken for the voltage to rise before breakdown occurs.

c) Time required for gas to breakdown under pulse application.

d) None of the above.

18. Streamer mechanism of breakdown explains the phenomena of electrical breakdown of

a) Very short spark gaps.

b) When *pd* is less than 1000 torr.cm.

c) Very long gaps where field is non-uniform.

d) Spark gaps subjected to impulse voltages.

19. The mechanism of breakdown in vacuum is due to

a) Particle exchange
b) Field emission
c) Clump formation
d) All of the above.

20. SF_6 has the following property which is not favorable for use in electrical apparatus.

a) High dielectric strength.

b) High are quenching ability.

c) It is not environmental friendly and causes global warming.

d) None of the above.

21. The most common method to invert population is?

a) Quantum effects b) Gas discharge

c) Temperature effect d) All of these

22. Which is application of Plasma in industry?

a) Magnetrons b) Arcs

c) Eye glasses d) All of these

23. Low pressure glow discharge is applicable for?

a) Pulsed laser b) DC laser

c) Light laser d) Ultraviolet laser

24. High pressure glow discharge is applicable for?

a) Pulsed laser b) DC laser

c) Light laser d) Ultraviolet laser

25. In the non-transferred plasma arc welding process, an arc is struck between the tungsten electrode and _____between the tungsten electrode and _____

a) Workpiece b) Earth clamp

c) Insulated copper nozzle d) Gas cylinder

26. The breakdown criterion in a uniform field electrode gap is

a) $\gamma exp(\alpha d) = -1$ b) $\alpha\, exp(\gamma d) = 1$

c) $\gamma exp(\alpha d) = 1$ d) $\gamma exp(\alpha d) = -\alpha$

27. Ionization coefficients α, γ are functions of

a) applied voltage b) pressure and temperature

c) electric field d) ratio of electric field to pressure

28. According to Townsend current growth process the current (I) in a uniform electric field gap is

a) $I_o exp(-\alpha d)$ b) $I_o\, exp(\alpha d)$

c) $I_o exp(-\gamma d)$ d) $I_o\, exp(\gamma d)$

29. Townsend's first ionization coefficients A depends upon (T-gas temperature , p-gas pressure, E- voltage across gas medium)

a) T b) P c) E/P d) P and E/P

30. The secondary ionization coefficient Γ is define as the net number of secondary electrons produced per incident of

a) Positive ion b) Excited particles

c) Photon d) All off above

31. The total current as per Townsend's theory is (if I_0- initial current due to cathode, α - First ionization coefficient, γ - Secondary ionization coefficient)

a) $I_0\, exp(\alpha d)/[1-\gamma(exp(\alpha d)-1)]$ b) $I_0 exp(\alpha d)/[1-\gamma(exp(\alpha d)]$

c) $(I_0 exp(\alpha d)\ /\ [exp(\alpha d)-\gamma-1]$ d) $I_0\, exp(\alpha d)/[1-\gamma]$

32. .....are collisions which when occur, no change takes place in the internal energy of the particles but only their kinetic energy gets redistributed.

a) Inelastic collision b) Electric collision

c) Air collision d) Elastic collisions

33. Which of the following parameters is used to describe the average speed of particles in a plasma?

a) Pressure b) Temperature c) Density d) Volume

34. What are some common examples of plasmas in nature?

a) The sun and stars b) Lightning

c) Earth's auroras d) All of the above

35. What type of reaction occurs when a plasma is created?

a) Nuclear fusion b) Nuclear fission

c) Chemical reactions d) None of the above

36. What is the primary use of plasmas in industry?

a) Power generation b) Welding and cutting

c) Medical treatments d) All of the above

37. What is the name of the process in which a gas is heated to the point that its electrons are separated from its atoms?

a) Ionization b) Fusion

c) Fission d) None of the above

38. Plasma have _____ collisions

a) Continous
b) Frequent
c) In frequent
d) Both a and b

39. Larmour radius is equal to

a) $v_\perp/\omega$ b) $v_\perp.\omega$ c) $v_\perp/2\omega$ d) $\omega/v_\perp$

40. Charged particle shows ... motion with larmour radius

a) Linear b) Orbitrary c)) vibratory d) circular

41. λ_D is defining by using the

a) Electron spin
b) Electron flux
c) Electron temperature
d) Magnetic flux

42. The cyclotron frequency ω_c is:

a) $|q|/mB$ b) $(|q|B)/m$ c) $mB/|q|E$ d) $|q|B^2/m$

43. We define the Larmor radius r_L to be

a) $|q|/mB$
b) $mB/|q|E$
c) $mv_\perp/|q|B$
d) $(|q|B)/m$

44. The Solar Corona is lenuous plasma with temperature up to?

a) 2KeV b) 300KeV c) 200KeV d) 200eV

45. Which of the following is a characteristic of a plasma?

a) It has a definite shape
b) It has a definite volume
c) It can conduct electricity
d) It is a good insulator

46. Which of the following is a key parameter used to describe a plasma?

a) Pressure
b) Temperature
c) Density
d) All of the above

47. Which of the following devices is used to confine and control a plasma using

a) Tokamak
b) Van de Graaff generator
c) Particle accelerator
d) Cathode ray tube

48. What is the term for the state of a plasma when it becomes self-sustaining and does not require external heating?

a) Equilibrium b) Ionization c) Ignition d) Neutrality

49. Which of the following devices is used to generate and accelerate plasma particles to high speeds?

a) Particle accelerator
b) Van de Graaff generator
c) Tokamak
d) Cathode ray tube

50. What is the term for the device used to measure the density of a plasma?

a) Spectrometer
b) Mass spectrometer
c) Particle detector
d) Langmuir probe

51. Which of the following phenomena is associated with plasma physics?

a) Aurora borealis
b) Solar flares
c) Lightning
d) All of the above

52. Which of the following parameters is used to describe the average kinetic energy of particles in a plasma?

a) Pressure
b) Density
c) Temperature
d) All of the above

53. The plasma diagnostic techniques can be used to measure:

a) the electron and ion temperatures,
b) electron density and the thermal structure of the plasma,
c) its chemical composition and ionization state,
d) All of the above

54. The process that gives rise to the emission of radiation from the plasma namely

a) Bremsstrahlung,
b) recombination
c) radiative decay.
d) All of the above

55. How does a plasma display create images?

a) By manipulating electric currents to control the brightness of pixels.
b) By using a backlight to illuminate liquid crystals.
c) By exciting phosphors with ultraviolet light to emit visible light.
d) By modulating the intensity of organic light-emitting diodes (OLEDs)

56. In a plasma, what happens to the electrons?

a) They gain energy and move freely
b) They lose energy and become tightly bound
c) They remain stationary
d) They combine with protons to form neutrons

57. The number of electrons in a Debye sphere for n - 10^{17} m^{-3}, KT. -10 eV is approximately

a) 135 b) 0.14 c) 7.4 X 103 d) 1.7 X 10^5

58. The Townsend mechanism explains the phenomenon of breakdown

a) Only at low pressure
b) Only at high pressure
c) Only at very high pressure
d) Only bat very low pressure

59. Which theory explains the mechanism for breakdown under different conditions?

a) Townsend theory
b) Streamer theory
c) Clump theory
d) Only (a) and (b)

60. Light is produced in electric discharge lamps by

a) Cathode ray emission
b) Ionisation in a gas or vapour
c) Heating effect of current
d) Heating effect of current

61. Experiments on electrical discharge through gases ultimately lead to the discovery of

a) nucleus b) electrons c) protons d) neutrons

62. Corona is –

a) Partial breakdown of air.
b) Complete breakdown of air.
c) Sparking between lines.
d) None of these.

63. Which of the following statements is true regarding corona–

a) Corona takes place at a voltage lower than breakdown voltage.
b) Corona takes place at a voltage higher than breakdown voltage.
c) Corona is a current phenomenon.
d) Corona increases the transmission line efficiency.

64. Corona is accompanied by–

a) Violet visible discharge in darkness.
b) Hissing sound and Vibration.
c) Power loss, Radio interference and Ozone.
d) All of the above

65. The resistance of the arc may be increased by

a) increasing the length
b) cooling the arc
c) splitting the arc
d) All of the above

Part III. Answer the following questions. (20 Points)

1. Describe in brief a method for generating medical plasma.

A1.

2. Discuss in brief how we can use physical plasma in medicine.

A2.

3. **Write three effects most important for a medical application?**

A3:

4. **What is the medical application of physical plasma?**

A4.

END OF EXAM

Faculty of Science	Undergraduate Final Exam 2nd Semester 2023_2024 Course: Physical Measurements Using Computers Code: (P462) Time: 3 hours Date: 1-6-2024	Assiut University

Q1: Multi Choice Question (MCQ). [15 Degree]

1 The truth table shown is for

a. a NAND gate b. a NOR gate
c. an exclusive-OR gate d. an exclusive-NOR gate

Inputs A	Inputs B	Output X
0	0	1
0	1	0
1	0	0
1	1	1

2 The fractional binary number 0.11 has a decimal value of

a. ¼ b. ½ c. ¾ d. none of the above

3 The truth table for a 2-input AND gate is

a.

Inputs A	Inputs B	Output X
0	0	0
0	1	1
1	0	1
1	1	0

b.

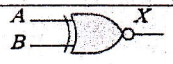
Inputs A	Inputs B	Output X
0	0	1
0	1	0
1	0	0
1	1	0

c.

Inputs A	Inputs B	Output X
0	0	0
0	1	0
1	0	0
1	1	1

d.

Inputs A	Inputs B	Output X
0	0	0
0	1	1
1	0	1
1	1	1

4 The symbol  is for a(n)

a. OR gate b. AND gate c. XNOR gate d. XOR gate

5 The expression $X = A \oplus B$ means

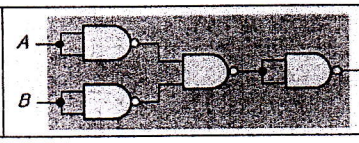
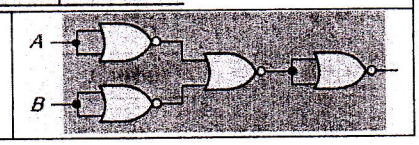
a. A OR B b. A AND B c. A XOR B d. A XNOR B

6 If the period of a clock signal is 500 ps, the frequency is

a. 20 MHz b. 200 MHz c. 2 GHz d. 20 GHz

7 The decimal number 21 is equivalent to the binary number

a. 10101 b. 10001 c. 10000 d. 11111

8	The circuit shown is equivalent to an a. AND gate b. XOR gate c. NOR gates d. none of the above	
9	The hexadecimal number 2C has a decimal equivalent value of a. 14 b. 44 c. 64 d. none of the above	
10	The 2's complement of 1000 is a. 0111 b. 1000 c. 1001 d. 1010	
11	A logic gate that produces a HIGH output only when all of its inputs are HIGH is a(n) a. OR gate b. AND gate c. NOR gate d. NAND gate	
12	The Boolean equation AB + AC = A(B+ C) illustrates a. the distribution law b. the commutative law c. the associative law d. DeMorgan's theorem	
13	The associative law for addition is normally written as a. A + B = B + A b. (A + B) + C= A+ (B + C) c. AB = BA d. A + AB = A	
14	The truth table for a 2-input NOR gate is a. b. c. d.	
15	The circuit shown is equivalent to a. an NAND gate b. an XOR gate c. an OR gates d. none of the above	

a.

Inputs		Output
A	*B*	*X*
0	0	0
0	1	1
1	0	1
1	1	0

b.

Inputs		Output
A	*B*	*X*
0	0	1
0	1	0
1	0	0
1	1	0

c.

Inputs		Output
A	*B*	*X*
0	0	0
0	1	0
1	0	0
1	1	1

d.

Inputs		Output
A	*B*	*X*
0	0	0
0	1	1
1	0	1
1	1	1

Q2: Convert the following **[15 Degree]**

a) into their equivalent **binary** numbers
   (i) $(336)_{10}$ (ii) $(679)_{10}$

b) into their equivalent **decimal** numbers
   (i) $(1010111)_2$ (ii) $(1110101)_2$ (iii) $(100010011)_2$

c) to **binary** and then to **octal**
   (i) $(2BAFC)_{16}$ (ii) $(67DEF)_{16}$

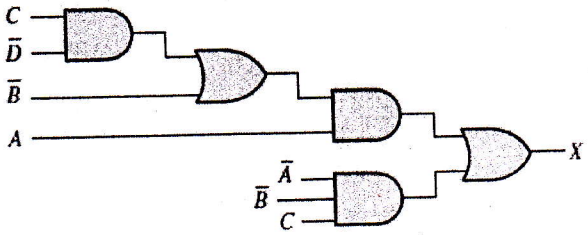
d) into their **decimal** equivalent
   (i) $(26775)_8$ (ii) $(67344)_8$

e) into their equivalent **octal** and **hexadecimal** numbers

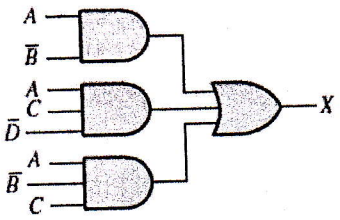
(i) $(798562)_{10}$ (ii) $(179856)_{10}$

Q3: Answer the Following Questions: **[20 Degrees]**

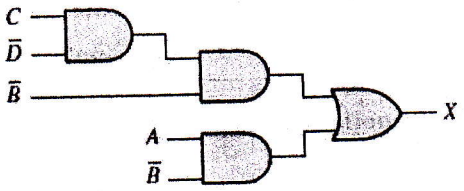
1- Determine which of the logic circuits in Figure are equivalent (b &d) [6 Degrees]



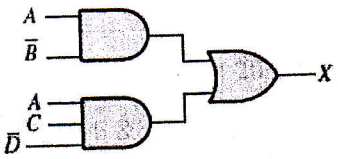
(a)



(b)

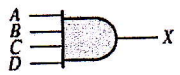


(c)

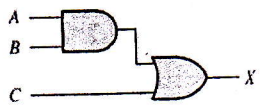


(d)

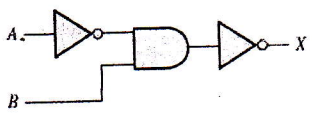
2- Write the Boolean expression for each of the logic circuits in Figure [4 Degrees]



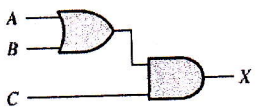
(a)



(b)



(c)



(d)

3- Convert the following expressions to sum-of-product (SOP)& product-of-sum (POS) forms: [6 Degrees]

1 $A\bar{B}C + \bar{A}\bar{B} + AB\bar{C}D$

2 $(A + \bar{B} + C)(\bar{B} + C + \bar{D})(A + \bar{B} + \bar{C} + D)$

4- Using Boolean algebra techniques, simplify the following expressions as much as possible, with Draw circuit before and after simplify: [4 Degrees]

1 $AB + A(B + C) + B(B + C)$

Best wishes,,,,,,
Dr. Ghada Salaheldin

Assiut University **Faculty of Science** **Physics Department**		**Final Exam:** 2023-2024 **Exam Date:** June 6h, 2024 **Time:** 3 hours

Course Name: Nanomaterials Science and its Applications **458P (50%)** **Coordinator:** Dr. Alaa Abd-Elnaiem

Part I: Answer the following questions

Question (I): Chose the correct answer for the following questions: (20 Marks)

1. **The creation of nanoscale materials by chemically or physically breaking down the larger materials is known as ..... approach in nanotechnology.**
   a. Top-down **b.** Bottom-up **c.** Bottom-down **d.** None of them
2. **Which one of the following is an example of a top-down approach?**
   a. Sol-gel **b.** Ball milling **c.** Chemical precipitation **d.** Hydrothermal
3. **Carbon nanotubes are made up of ..... sheets with nanosized diameter.**
   a. Silver **b.** Graphite **c.** Silicon **d.** Fumed silica
4. **The size of nanoparticles is between ..... . nm.**
   a. 100 to 1000 **b.** 0.1 to 10 **c.** 1 to 100 **d.** 0.01 to 1
5. **..... is a nanostructured material that is used in tyers of cars to increase the life of tyers.**
   a. Carbon black **b.** Gold **c.** Graphite **d.** Fumed silica
6. **Nanorod is an example of ..... nanostructures.**
   a. 0D **b.** 1D **c.** 2D **d.** 3D
7. **time Which ratio decides the efficiency of nanosubstances?**
   a. Weight/Volume **b.** Surface area/volume **c.** Volume/weight **d.** Pressure/volume
8. **Why is the conductivity of a nanowire much less than that of the corresponding bulk material?**
   a. Due to precise control of the heating mechanism.
   b. Due to a greater mean free path.
   c. Due to scattering from wire boundaries.
   d. Due to the response of nanowires to an applied load.
9. **Which of the following is not a requirement for an ideal semiconductor nanostructure?**
   a. Density **b.** Uniformity **c.** Confinement potential **d.** Low melting point
10. **The coagulation phenomenon of nanoparticles results in .....**
    a. a reduction in surface energy **b.** a reduction in surface area **c.** a and b **d.** None
11. **The greater the surface tension of a liquid, the worse the wetting would be of a solid surface.**
    a. True **b.** False
12. **The smaller the particles, the longer the mean free path.**
    a. True **b.** False
13. **When semiconductors are reduced to nanometers they become pure conductors.**
    a. True **b.** False
14. **Which Nobel laureate in Physics invented the transmission electron microscope?**
    a. Ernst Ruska **b.** Richard Feynmann **c.** Gerhard Binnig **d.** No one of them
15. **Why is the melting point of nanoparticles lower than the corresponding bulk?**
    a. The chemical bonds in the bulk of nanoparticles are weakened in proportion to the nanoparticle volume.
    b. Large surface relative to bulk leads to less bonds to be broken by thermal energy.
    c. Surface plasmons provide additional kinetic energy which leads to less thermal energy is required.

16. **plasmon resonance is:**
    a. a resonant light emission from quantized states in semiconductors.
    b. a resonance between the surface charge and the electric field of light on metallic nanoparticles.
    c. a resonance between a plasma and a surface
17. **The energy levels in a quantum structure become closer to each other:**
    a. when the structure size decreases.
    b. when the structure size increases.
    c. when the band-gap difference between the two materials increases.
18. **The particles in nanopowder are ..... the wavelength of visible light.**
    a. smaller than **b.** greater than **c.** equal **d.** very large
19. **In an Electron microscope, the light source is replaced by a beam of very fast-moving:**
    a. Electron **b.** Neutron **c.** Photon **d.** Proton
20. **..... types of waves have the shortest wavelength.**
    a. Radio waves **b.** X-ray **c.** Microwave **d.** UV

Part II: answer <u>three questions</u> only from the following:

Question (II): Write short notes on the following: (10 Marks)

1. Nanoparticle synthesis by spray pyrolysis method.
2. The novel properties of carbon nanotubes (CNTs).
3. The size-dependent properties of nanomaterials.
4. Gleiter's classification of nanostructured materials.

Question (III): Answer in detail the following: (10 Marks)

1. Discuss in detail the influence of size reduction on the properties (Structural, Mechanical, Thermal, Thermodynamic, Kinetic, Electrical, Electronic, Magnetic, Optical, and Chemical) of the nanoparticle.
2. Describe the principles and processes in chemical and physical vapor deposition (CVD and PVD) methods for the synthesis of nanomaterials.

Question (IV): Compare between the following couples: (10 Marks)

1. Physical self-assembly and Chemical self-assembly.
2. Bottom-up and top-down approaches.
3. Nanocomposite and Nanoparticles.
4. Nanophysics and Nanoelectronics.
5. The principles of scanning probe microscope and atomic force microscope.

Question (V): Answer briefly the following: (10 Marks)

1. Outline the significance of impedance measurements on the characterization of nanomaterials.
2. What are the concepts of "**surface form engineering**" in nanomaterial science?
3. Draw a flow chart for the sol-gel method of nanoparticle synthesis.
4. Give in detail the structural behavior of core-shell nanocomposites.
5. Describe by plots the change of magnetization energy with decreasing particle size and related phase transitions from ferromagnetic to paramagnetic state.

Good luck,,,

Assiut University
Faculty of science – Physics department

Exam time	3 hours	**Course**	Radiation physics P444
degree	50	**Exam**	Final term

1. Choose the correct answer (20 degrees)

1. A radioactive element has a half-life of 2 days. Which fraction represents the amount of an original sample of this element remaining after 6 days?
   A. 1/8
   B. 1/2
   C. 1/3
   D. 1/4

2. What form of radioactive decay is shown in the following reaction?
   $^{4}_{2}He + {}^{11}_{5}B \rightarrow {}^{15}_{7}N + \cdots$
   A. Beta negative.
   B. Beta positive.
   C. Alpha decay.
   D. Gamma decay

3. As the temperature of a sample of a radioactive element decreases, the half-life of the element will.
   A. Decrease.
   B. Increase.
   C. Remain the same.

4. Characteristic x-ray photons produced during the photoelectric effect can contribute to increasing patient dose.
   A. True
   B. false

5. The energy losses by an electron moving through a medium with density ρ are described by the total mass energy
   A. Stopping power
   B. Specific ionization
   C. The range

6. An 80 milligram sample of a radioactive isotope decays to 5 milligram in 32 days. What is the half-life of this element?
   A. 8 days.
   B. 2 days.
   C. 16 days.
   D. 4 days.

7. A bone sample contains only 1/2 of its original radioactive C^{14} content. How old is the bone sample?
   A. 1 C^{14} half-life
   B. 2 C^{14} half-lives
   C. 9 C^{14} half-lives
   D. 4 C^{14} half-lives

8. An original sample of a radioisotope has a mass of 10 grams. After 2 days, 5 grams of the radioisotope remains unchanged. What is the half-life of this radioisotope?
   A. 1 day
   B. 2 days
   C. 5 days
   D. 4 days

9. The number of ion pairs produced per unit track length is
   A. Specific ionization
   B. Stopping power
   C. The range

10. Radium-221 has a half-life of 30 sec. How long will it take for 95% of a sample to decay?
    A. 60 sec.
    B. 2.16 min.
    C. 3.285 min.
    D. 180 sec.

2. Answer the following questions: (30 degrees)

1. The half-life of ^{14}C is 5568 years. How long will it take a 20 mg sample to decay to a mass of 5 mg?

2. In a radioactive transformation, the parent element has a half-life T_p, which is very much greater than the half-life T_D of the daughter element. Find out the time required, in terms of T_D, to have transient equilibrium between the parent and daughter, and calculate it within 75%.

3. What are the different sources of radiation exposures to man?

4. In an archaeological expedition, charcoal from an ancient fire-pit was excavated. This sample showed a ^{14}C activity of 11.3 counts per gm per min. The absolute activity of ^{14}C is 15.3 counts per gm per min. Estimate the age of the charcoal sample.

5. Find the stopping power of water for protons with energy 10 MeV. Knowing that the volume of water is 3 m^3.

6. What is the difference between external and internal radiation exposures?

With my best regards

Assiut University
Faculty of Science
Physics Department
Physics and Electronics Program
2nd Semester, Final Exam, 2024

Course: Electronic Circuits (2)
Course Code: EE422
Time: 3 Hours, Marks: 50

Important remarks

- **No. of Pages: 3**
- **No of Questions : 5**
- **Answer All the Questions**

QUESTION 1: [10 POINTS] – [1 POINT EACH]

Choose the correct answer:

1. Ideally, the midrange gain of an amplifier.....
   (a) increases with frequency (b) remains constant with frequency
   (c) decreases with frequency (d) depends on the coupling capacitors

2. When the voltage gain of an amplifier is increased, the bandwidth.....
   (a) is not affected (b) increases
   (c) decreases (d) becomes distorted

3. The low-frequency response of an amplifier is determined in part by .....
   (a) the voltage gain (b) the type of transistor
   (c) the supply voltage (d) the coupling capacitors

4. The high-frequency response of an amplifier is determined in part by .....
   (a) the gain-bandwidth product (b) the bypass capacitor
   (c) the internal transistor capacitances (d) the roll-off

5. An oscillator differs from an amplifier because the oscillator
   (a) has more gain (b) requires no input signal
   (c) requires no dc supply (d) always has the same output

6. One condition for oscillation is
   (a) a gain around the feedback loop of one-third (b) a phase shift around the feedback loop of 180°
   (c) a gain around the feedback loop of less than (d) a phase shift around the feedback loop of 0°

7. In a certain oscillator, $A_v = 50$, The attenuation of the feedback circuit must be
   (a) 1 (b) 0.01 (c) 10 (d) 0.02

8. The Wien-bridge oscillator's positive feedback circuit is
   (a) an RL circuit (b) an LC circuit (c) a voltage divider (d) a lead-lag circuit

9. In a Wien-bridge oscillator, if the resistances in the positive feedback circuit are decreased, the frequency
   (a) remains the same (b) increases (c) decreases

10. For conversion to a four digits binary number by analog to digital converter, ...comparators are required.
    (a) 5 (b) 10
    (c) 15 (d) 20

QUESTION 2: [15 POINTS]

For the amplifier circuit shown in Figure (1), determine

a) Critical frequencies associated with the low-frequency response **[3 Points]**

b) Dominant critical low frequency **[3 Points]**.

c) Critical frequencies associated with the high-frequency response **[3 Points]**.

d) Dominant critical high frequency **[3 Points].**

e) The bandwidth of the amplifier **[3 Points].**

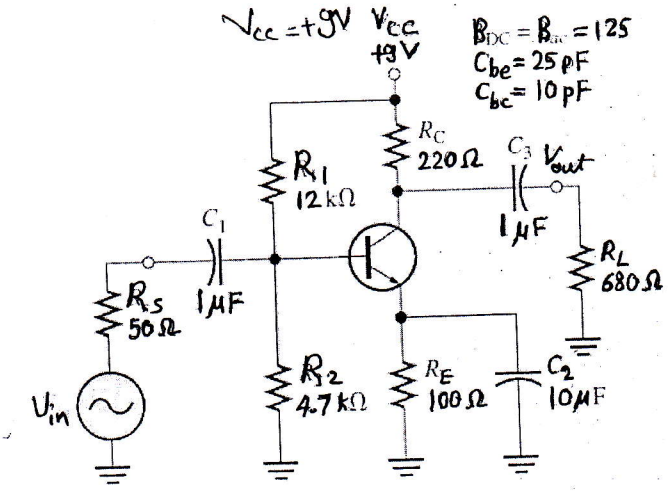


Figure (1)

QUESTION 3: [10 POINTS]

For the oscillator circuit shown in Figure (2), assume Q>>10:

a) State type of the oscillator **[2 points]**

b) Determine the frequency of oscillation **[4 points].**

c) If the oscillator is loaded to a point where the Q drops to 8, determine the new value of the oscillation frequency **[4 points].**

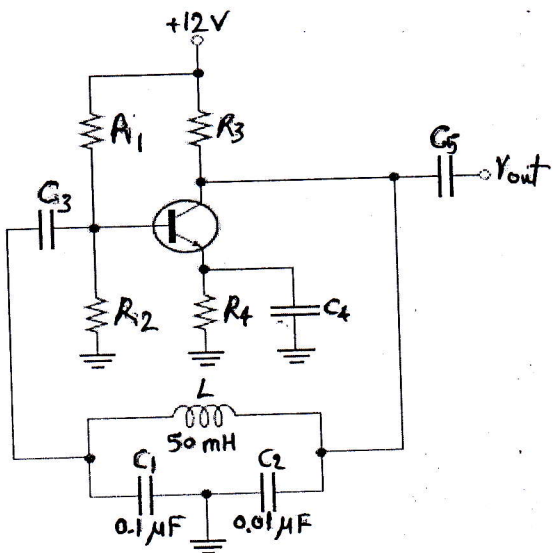


Figure (2)

QUESTION 4: [5 POINTS]

A negative-feedback amplifier has a closed-loop gain $A_f = 100$ and an open-loop gain $A = 10^4$. What is the feedback factor β? If a manufacturing error results in a reduction of A to 10^3, what closed-loop gain results? What is the percentage change in A_f corresponding to this factor of 10 reduction in A?

QUESTION 5: [10 POINTS]

Figure (3) shows the schematic diagram of a three-digit analog-to-digital converter (ADC), if the analog input signal and the sampling pulses as shown are applied to the ADC circuit, write in the table the binary number sequence of the three-digit output, assume $V_{REF} = 8V$.

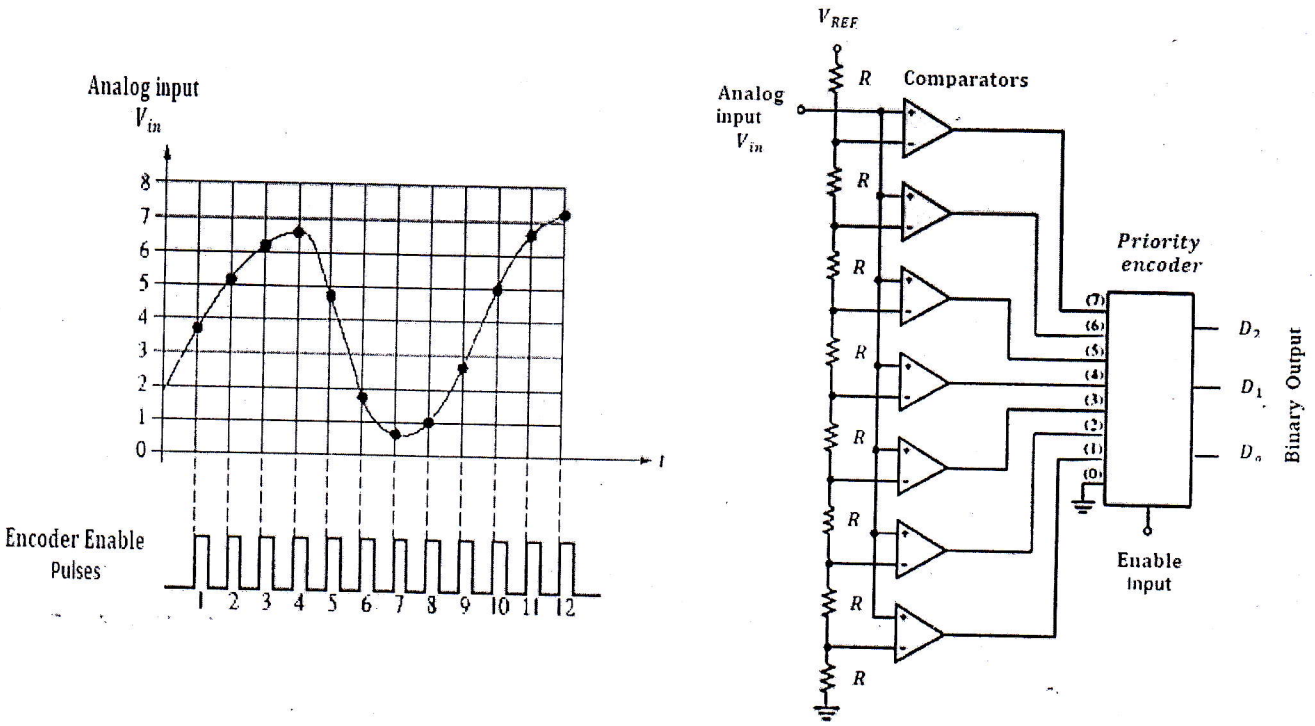


Figure (3)

Binary Output

D_0												
D_1												
D_2												

********** End, Best Wishes **********

Assiut University
Faculty of Science
Department of Physics
Second semester 2024

Course: *Atomic and Molecular Spectroscopy*
Code: P432
Time: 3 Hour
Final Exam (50%)

Q1 (24)	Q2 (26)	Total (50)

Answer the following questions

Question (1): (1.5 mark for each one, 24 Marks)

Choose the correct answer

1. When electrons move from the higher energy level to a lower energy level, energy is
   a. absorbed
   b. emitted
   c. both a) & b)
   d. none of these
2. The different types of energies associated with a molecule are …
   a. electronic energy
   b. vibrational energy
   c. rotational energy
   d. all the mentioned

2- The correct order of different types of molecular energies is
   a. $E_{rot.} > E_{vib.} > E_{elect.}$
   b. $E_{vib.} > E_{rot.} > E_{elect.}$
   c. $E_{elect.} > E_{rot.} > E_{vib.}$
   d. $E_{elect.} > E_{vib.} > E_{rot.}$

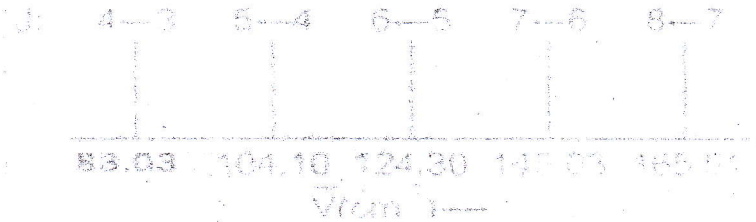
3-The splitting of spectral lines because of in the presence of electric field is known as
   a. Zeeman effect
   b. Paschen back effect
   c. Stark effect
   d. Doppler effect

4. Which one of the following exhibits rotation spectra:
   a. CO
   b. N_2
   c. CO_2
   d. H_2

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

a) $2\pi h$ b) $\frac{h}{2}$ c) $\frac{h}{2\pi}$ d) $\frac{h}{\pi}$

6. The region of electromagnetic spectrum for rotational spectra is...
   a. Uv-visible region
   b. x-ray
   c. microwave
   d. visible light
7. The number of normal Zeeman splitting components of $P \rightarrow D$ transition is
   a. 3
   b. 4
   c. 8
   d. 9
8. The rotational (microwave) spectrum of a rigid diatomic rotor consists of equallyspaced lines with spacing equal to:
   a. $\overline{B}$
   b. $2\overline{B}$
   c. $3\overline{B}/2$
   d. $\overline{B}/2$
9. The rotational absorption spectrum of HCl shows the following lines
   Neglecting the centrifugal distortion, Calculate the value of rotational constant $\overline{B}$ in cm^{-1}



   a) 3
   b) 5
   c) 10
   d) 20

10. If $n = 5$, which one of the following is not an allowed orbital quantum number l
   a. 5
   b. 2
   c. 4
   d. 0
11. In a rotational spectrum, transitions are only observed between rotational levels of ΔJ =...
   a. ± 1
   b. ± 2
   c. 5
   d. ± 3
12. The expression for the second overtone frequency in the vibrational absorption spectra of a diatomic molecule in terms of the harmonic frequency w_e and anharmonicity constant χ_e is
   a. $2w_e(1 - \chi_e)$
   b. $2w_e(1 - 3\chi_e)$
   c. $3w_e(1 - 2\chi_e)$
   d. $3w_e(1 - 4\chi_e)$

13. In rotational -vibrational spectrum the frequency of R- branch lines is .... the fundamental frequency.
    a. smaller than
    b. equal to
    c. higher than
    d. both a & b

14. *What is the cause of the R branch lines moving closer together as energy* increase in a real spectrum of molecule?
    a. Rotational -vibrational coupling
    b. Independent Rotation and vibration
    c. Rigid rotor only
    d. Harmonic oscillation only

15. For P branch ΔJ should be ....
    a. $\Delta J = 0$
    b. $\Delta J = -1$
    c. $\Delta J = +1$
    d. $\Delta J = \pm 2$

16. The energy separation in the normal Zeeman effect is
    a. $\Delta E = m_l \mu B\ B$
    b. $\Delta E = g m_j \mu B\ B$
    c. $\Delta E = g m_s \mu B\ B$
    d. $\Delta E = (2m_s + m_l)\ \mu B\ B$

Question (2): **(26 marks)**

Answer the following:

i. Stern–Gerlach experiment clearly showed evidence for space quantization and demonstrated the existence of a spin magnetic moment for the electron, discuss that. (4 marks)

ii. **Describe diatomic molecule as a rigid- rotator and explain rotational energy level, wavenumber, selection rules, spectra and the information obt from spectra. (5 marks)**

iii. **Describe Bohr's assumptions for atomic model and write down the success of Bohr's model. (6 marks)**

escribe the differences between two types of symmetric top molecule and then write the energy level equation, selection rules and its spectra. (5marks)

v. From the vibration spectra of NO molecule it is found that the fundamental line at 1876.06 cm^{-1} and the first overtone at 3724.2 cm^{-1}. Calculate

A. the oscillation frequency w_e

B. the anharmonicity constant χ_e.

(6 marks)

Electron chaege e	1.6×10^{-19} C		Plank's constant h	6.626×10^{-34} Joul.sec
Electron mass m_e	9.1×10^{-31} kg		Light velocity c	3×10^{8} m.sec^{-1}
Proton mass m_p	1.672×10^{-27} kg		Coulomb constant k	9×10^{9} J.m.C^{-2}
Bohr radius a_o	0.529×10^{-10} m		Rydberg constant R	1.097×10^{7} m^{-1}
Bohr magneton μ_B	9.274×10^{-24}J.T^{-1}		Ionization energy of the hydrogen atom E_o	13.6 eV
mass of Nitrogen atom	2.32×10^{-26} kg		mass of an oxygen atom	2.6567×10^{-26}kg

WITH MY BEST WISHES

Dr. Azza M. Hassan

اختبار نهاية الفصل الدراسي الثاني

2024/2023م

في

مقرر " فيزياء الليزر وتطبيقاته" 472 ف

ملاحظات هامة:(أ) أي شطب أوتغيير يلغي الدرجة

(ب) لكل فقرة درجتان

أولا: الجزء التحريري

أجب عن **5 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. ( ) ( ).

جامعة أسيوط – كلية العلوم
قسم الفيزياء

الاختبار النهائي للفصل الثاني للعام الدراسي 2024/2023م
في مقرر فيزياء الليزر وتطبيقاتها 472 ف

اجب عن أربعة اسئلة

السؤال الأول

ا. عرف المصطلحات الليزرية التالية
(الاتزان الحراري – انقلاب التعداد – المادة الفعالة)

ب . اكتب مقالة علمية تاريخية عن الضوء

السؤال الثاني

تكلم مع التوضيح بالرسم عن الستويات الطاقية لليزرات التي تم دراستها بالمقرر .

السؤال الثالث

ا. عرف المصطلحات الليزرية التالية :-
(انعدام الاتزان الحراري – الضخ الليزري – المستوي الأكثر استقراراً)

ب . أكتب مع التوضيح بالرسم أحد الليزرات الصلبة التي تم دراستها بالمقرر.

السؤال الرابع

تكلم عن تفاعل الموجات الكهرومغناطيسية مع المادة مع التوضيح بالرسم ،

السؤال الخامس

تكلم عن مايأتي :-
1 – مميزات أشعة الليزر.
2 – خصائص أشعة الليزر.
3 – بعض فوائد أشعة الليزر الهامة .

مع التوفيق بالنجاح

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Final Exam

The exam is equivalent to 50 marks
Examiner Dr. Mohamed Sabet

23/5/2024
Time allowed: 3 hours

Semiconductors,
Code: 451P

First Question: True (T) or False (F) **(20 Marks, 1 Mark for Each)**

1. An electron is a negatively charged particle.
2. Electrons are part of the nucleus of an atom.
3. Maximum number of electrons in any shell are given by $N_e=2n^2$ where n is the shell number.
4. Valence electrons exist in the inner shells of an atom.
5. The value of the band gap has no effect on the number of carriers present at room temperature
6. The donor and acceptor binding energies are relatively smaller than the band gap energy.
7. The Fermi function gives the number of available states at an energy E while the density of states gives the probability that these states are occupied at a temperature T.
8. At higher temperatures, the extrinsic semiconductor then looks like an intrinsic one.
9. As a result of the spin of the electrons and Pauli Exclusion Principle, each state occupied by two electrons.
10. If the Fermi-Dirac Function is $f(E)$, then 1- $f(E)$ is the probability that a state at given energy E is occupied by an electron.
11. For T > 0 K, the Fermi function at Fermi energy $f(E_f) = ½$.
12. If the Fermi energy is E_f, the absolute temperature is T, Boltzmann's constant is k, the Fermi-Dirac function at energy E is given by

$$\frac{1}{1+e^{(E-E_f)/kT}}$$

13. For non-degenerate semiconductor, the Fermi level at E_f is positioned such that for all energies in the conduction band E_c, $(E_c - E_f) > 3kT$ (where k is Boltzmann's constant and T is the absolute temperature.
14. In any given material at fixed temperature the product of the electron and hole and concentrations depends on the doping.
15. In an indirect band gap semiconductor, the minimum energy level in the conduction band and the maximum energy level in the valence band have the same crystal momentum (k-vectors).
16. For a given temperature, the mobility increases with increasing impurity concentration because of enhanced impurity scatterings then saturates.
17. The mobility decreases with increasing temperature because of increasing lattice vibration with increasing temperature.
18. Mathiessen's rule states that each scattering mechanism is associated with a specific mobility and the lowest mobility is the dominating one.

19. The carrier mobility varies directly with the amount of scattering taking place within the semiconductor.
20. The Einstein relations show that mobility and the diffusion constant are proportional to each other at fixed temperature.

Second Question: Choose the most accurate answer **(30 Marks, 1 Mark for Each)**

1. An atom consists of …
   (a) one nucleus and only one electron
   (b) one nucleus and one or more electrons
   (c) protons, electrons, and neutrons
   (d) answers (b) and (c)
2. Valence electrons are …
   (a) in the closest orbit to the nucleus
   (b) in the most distant orbit from the nucleus
   (c) in various orbits around the nucleus
   (d) not associated with a particular atom
3. The difference between an insulator and a semiconductor is …
   (a) a wider energy gap between the valence band and the conduction band
   (b) the number of free electrons
   (c) the atomic structure
   (d) answers (a), (b), and (c)
4. The energy band in which free electrons exist is the …
   (a) first band
   (b) second band
   (c) conduction band
   (d) valence band
5. In a semiconductor crystal, the atoms are held together by …
   (a) the interaction of valence electrons
   (b) forces of attraction
   (c) covalent bonds
   (d) answers (a), (b), and (c)
6. Electron-hole pairs are produced by …
   (a) recombination
   (b) thermal energy
   (c) ionization
   (d) doping
7. Recombination is when …
   (a) an electron falls into a hole
   (b) a positive and a negative ion bond together
   (c) a valence electron becomes a conduction electron
   (d) a crystal is formed
8. The current in a semiconductor is produced by …
   (a) electrons only

(b) holes only
(c) negative ions
(d) both electrons and holes

9. In an intrinsic semiconductor, …
(a) there are no free electrons
(b) the free electrons are thermally produced
(c) there are as many electrons as there are holes
(d) answers (b) and (c)

10. The process of adding an impurity to an intrinsic semiconductor is called …
(a) doping
(b) recombination
(c) atomic modification
(d) ionization

11. A trivalent impurity is added to silicon to create
(a) germanium
(b) a p-type semiconductor
(c) an n-type semiconductor
(d) a depletion region

12. The majority carriers in an n-type semiconductor are …
(a) holes
(b) valence electrons
(c) conduction electrons
(d) protons

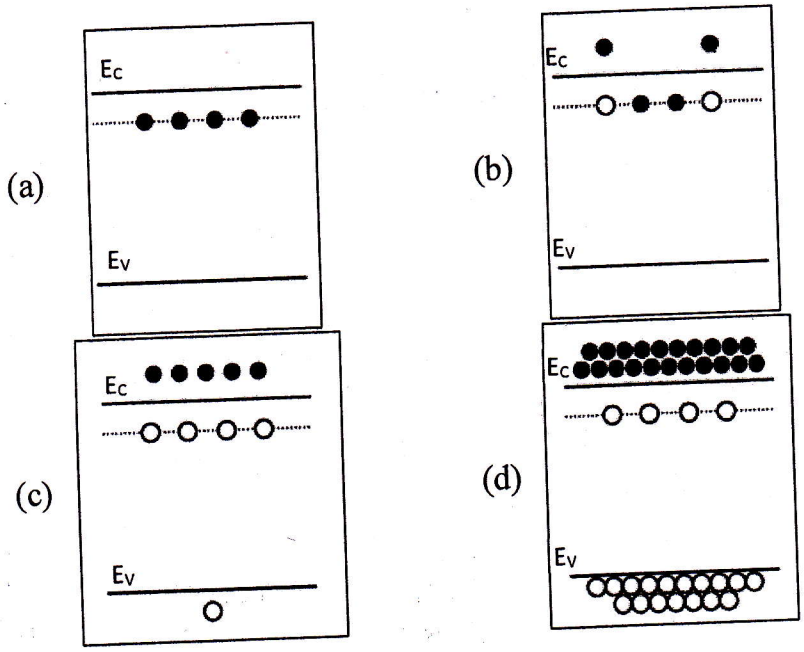
13. Holes in an n-type semiconductor are …
(a) minority carriers that are thermally produced
(b) minority carriers that are produced by doping
(c) majority carriers that are thermally produced
(d) majority carriers that are produced by doping

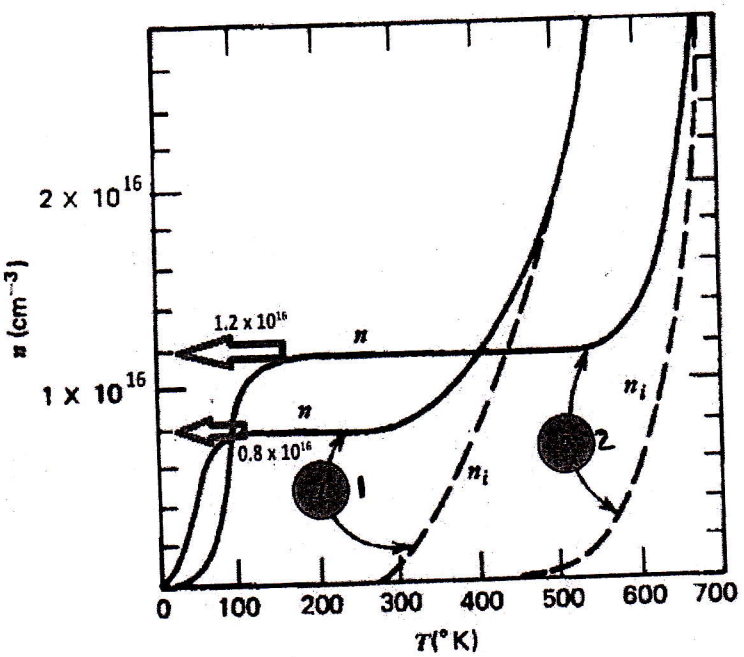
14. A PN junction is formed by …
(a) the recombination of electrons and holes
(b) ionization
(c) the boundary of a p-type and an n-type material
(d) the collision of a proton and a neutron

15. The depletion region consists of …
(a) nothing but minority carriers
(b) positive and negative ions
(c) no majority carriers
(d) answers (b) and (c)

16. In a silicon crystal the bonds are … coordinated
(a) tetrahedral
(b) hexagonal
(c) tetragonal
(d) triclinic

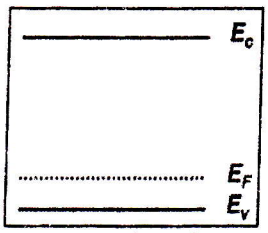
17. In intrinsic semiconductors the number of electrons … the number of holes.
    (a) equal to
    (b) larger than
    (c) less than
    (d) not related to
18. All electrons in the conduction band have the same …, while all the holes in the valence band have the same …
    (a) Kinetic energy, kinetic energy
    (b) Potential energy, kinetic energy
    (c) Kinetic energy, potential energy
    (d) Potential energy, potential energy
19. Increasing the temperature of the semiconductor results in …
    (a) increase the intrinsic carrier concentration
    (b) decrease the intrinsic carrier concentration
    (c) increase then decrease the intrinsic carrier concentration
    (d) decrease then increase the intrinsic carrier concentration
20. Increasing the temperature of the semiconductor results in …
    (a) increase the energy of the band gap
    (b) decrease the energy of the band gap
    (c) increase then decrease the energy of the band gap
    (d) decrease then increase the energy of the band gap
21. The effect of increasing the semiconductor temperature on the intrinsic carrier concentration is … than the effect on the energy of band gap.
    (a) larger than
    (b) equal all time
    (c) smaller than
    (d) firstly equal then unpredictable with
22. In doped semiconductor, the donor level is …
    (a) closer to the conduction band
    (b) closer to the valence band
    (c) in the mid-range between the valence band and conduction band
    (d) higher than the minimum of the conduction band or lower than the maximum of the valence band
23. In doped semiconductor, the acceptor level is …
    (a) closer to the conduction band
    (b) closer to the valence band
    (c) in the mid-range between the valence band and conduction band
    (d) higher than the minimum of the conduction band or lower than the maximum of the valence band
24. Which of the following represents a n-type semiconductor at high temperatures? (Black dots represent the electrons, white dots represent the holes)





25. Previous figure depicts the electron concentration for two n-type materials 1 and 2. The donor concentration for material 1 is … cm^{-1}
    (a) 0
    (b) 0.8×10^{16}
    (c) 1.2×10^{16}
    (d) 2.0×10^{16}
26. From the previous figure, the energy of the band gap of material 1 is … the energy of the band gap of material 2.
    (a) larger than
    (b) equal all time

(c) smaller than
(d) firstly equal then unpredictable with



27. The previous figure represent the energy band structure of …
    (a) N-type semiconductor
    (b) P-type semiconductor
    (c) Intrinsic semiconductor
    (d) Unknown
28. The number of electrons per cubic centimeter in the entire conduction band is … (E_c is onset energy of the conduction band, k is Boltzmann's constant and T is the absolute temperature, E_f is Fermi level energy, $N_c$is the effective density of states)
    (a) $N_C e^{(E_c - E_f)/kT}$
    (b) $\frac{N_C}{e^{(E_c - E_f)/kT}}$
    (c) $\frac{e^{(E_c - E_f)/kT}}{N_C}$
    (d) $N_C e^{(E_f - E_C)/kT}$
29. If an electric field is applied to semiconductor and increased, the carrier velocity …
    (a) increases
    (b) decreases
    (c) increases then saturate
    (d) decreases then saturate
30. The free electrons thermal velocity can be obtained by … (assume that k is Boltzmann's constant and T is the absolute temperature, m is electron mass)
    (a) $\sqrt{\frac{3kT}{2m}}$
    (b) $\sqrt{\frac{3kT}{m}}$
    (c) $\sqrt{\frac{kT}{m}}$
    (d) $\sqrt{\frac{kT}{2m}}$

End of questions

Answer sheet

- استخدم قلم جاف اسود/ازرق.
- فى حالة اختيار أكثر من إجابة للنقطة الواحدة سيتم احتساب الإجابة خاطئة.
- لا يمكن مسح او تعديل او شطب الإجابة بعد تظليل الدائرة.
- قد يؤدى استخدام الكوريكتور الى احتساب الاجابة خاطئة.

لا يمكن تعديل الإجابة بعد تظليل الدائرة

First Question
True or False

	True	False
1	○	○
2	○	○
3	○	○
4	○	○
5	○	○
6	○	○
7	○	○
8	○	○
9	○	○
10	○	○
11	○	○
12	○	○
13	○	○
14	○	○
15	○	○
16	○	○
17	○	○
18	○	○
19	○	○
20	○	○

Second Question
Choose the correct

	A	B	C	D
21	○	○	○	○
22	○	○	○	○
23	○	○	○	○
24	○	○	○	○
25	○	○	○	○
26	○	○	○	○
27	○	○	○	○
28	○	○	○	○
29	○	○	○	○
30	○	○	○	○
31	○	○	○	○
32	○	○	○	○
33	○	○	○	○
34	○	○	○	○
35	○	○	○	○
36	○	○	○	○
37	○	○	○	○
38	○	○	○	○
39	○	○	○	○
40	○	○	○	○
41	○	○	○	○
42	○	○	○	○
43	○	○	○	○
44	○	○	○	○
45	○	○	○	○
46	○	○	○	○
47	○	○	○	○
48	○	○	○	○
49	○	○	○	○
50	○	○	○	○

لا يمكن تعديل الإجابة بعد تظليل الدائرة