Assiut University

# Final Exam: Physical Measurements
## Code: 462P

**Teaching Staff: Dr. M. A. Sabet**
**Date: 16/6/2022**
**Time: 3 hours**

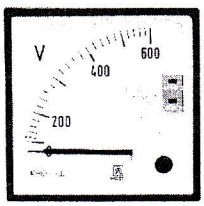
Faculty of Science
Physics Department

لاحظ:

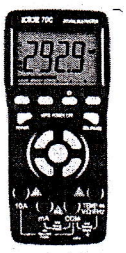
- في حالة اختيار أكثر من إجابة للنقطة الواحدة سيتم احتساب الإجابة خاطئة
- يجب أن يكون التظليل واضح ومعتم للدائرة
- لا يمكن تعديل الإجابة بعد تظليل الدائرة ومن حق الطالب/ة ورقة إجابة واحدة فقط
- لن يلتفت إلى أي إجابات مدونة خارج الجدول الموجود في صفحة الإجابة في آخر الورقة الامتحانية

## First Question: True or False (37 Marks) (Each 1 Mark)

1. As an example of the analogue readings, the values given by the shown voltmeter.

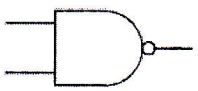



2. The readings given by the multimeter shown in Fig is a digital value.

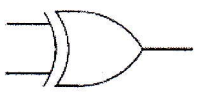


3. The expression "Hot or cold water" is a digital expression.
4. Numbering of week days (Sat, Sun, Mon ... etc.) is an octal system.
5. The radix of the decimal number is 10, while the radixes of the octal and hexadecimal are 8 and 15, respectively.
6. For the decomposition of the decimal number 315 we need at least 4 powers of 10.
7. In the binary system we can represent any decimal number by a combination of 0 and 1 symbols.
8. One bit in the octal numbering system is replaced by three bits while conversion to a binary number and vice versa.
9. One bit in the hexadecimal system is represented by four bits in the binary system.
10. $\mathbf{122_3 = 101_4 = 32_5}$.
11. $\mathbf{111_2 + 100_2 = C_{16}}$
12. The fractional part of a number is represented as the sum of the positive powers of the radix of the numeration system.

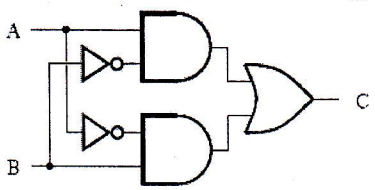
13. In the Sign-magnitude representation the sign bit is the number at the left and is set to 0 if the number is negative.
14. $\mathbf{101_{SM} = -1_{10}\ while\ 101_2 = -5_{10}}$.
15. When the binary representation corresponds to an infinite sequence and if the absolute error (in decimal) is $\pm 5 \times 10^{-3}$, the expansion in powers of $2^{-n}$ will then stop at the $(n+1)^{th}$ term according to $2^{-n} \leq 5 \times 10^{-3}$.
16. For any bivalent variable A, $(NOT\ NOT\ A = A), i.e. \left(\bar{\bar{A}} = A\right)$.
17. For any bivalent variable A, $(A.1 = A)$
18. For any bivalent variable A, $(A + 0 = A)$
19. For any bivalent variable A, $(A + \bar{A} = 1)$
20. For any bivalent variable A, $(A.\bar{A} = 0)$
21. For the AND logic function, the output variable takes the high logic level (or the value 1) if and only if the input variables are at the high logic level (or the value 1).
22. For the OR logic function, the output takes the logic level 1 if at least one of the inputs is at the logic level 1.
23. The XOR logic function is represented by a plus within a circle ($\oplus$) and the output takes logic level 1, when only inputs are at logic level 0.
24. The shown Fig. represents the NOR function.



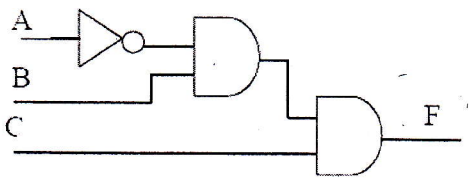
25. The shown Fig. represents the XNOR function $\overline{A \oplus B}$



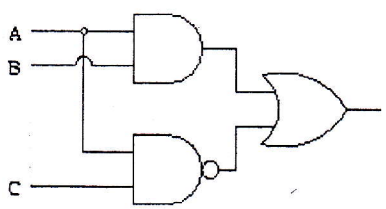
26. The shown Fig. represents the XOR function $C = A \oplus B$



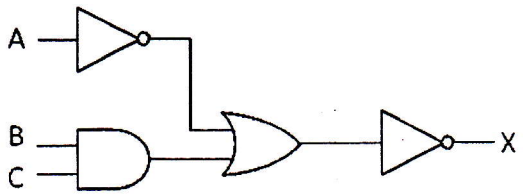

27. The next logic gate represents $\boldsymbol{F = \bar{A}.B.C}$




28. The next logic gate represents $A.B + \overline{A.C}$



29. The next logic gate represents $\overline{X} = \overline{A} + B.C$




30. For any bivalent variables A and B, $A + (B\,.\,C) = (A + B)\,.\,(A + C)$.

31. De Morgan's theorem informs that for any bivalent variables A and B, $\overline{A + B} = \overline{A}\,.\,\overline{B}$ and this results in $(A\,.B) + (A\,.\overline{B}) = A$

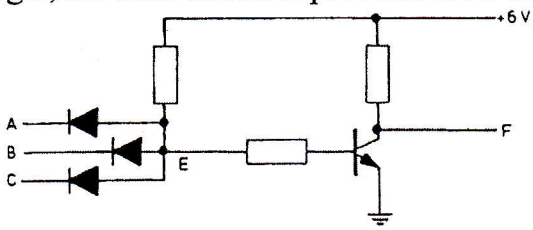
32. For the following truth table, the function F can be assumed to be given by $\overline{F} = \overline{A}\overline{B}\overline{C} + \overline{A}\overline{B}C + \overline{A}B\overline{C} + A\overline{B}\overline{C}$

| A | B | C | Output |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

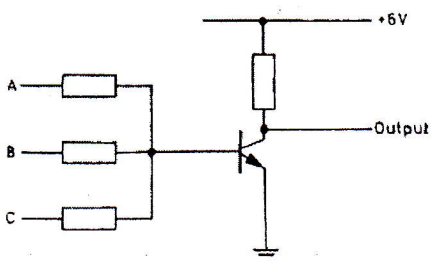
33. Assuming the negative logic, the next voltage table represents the OR function

| A | B | F (output) |
|---|---|---|
| 0 V | 0 V | 0 V |
| 0 V | +6 V | 0 V |
| +6 V | 0 V | 0 V |
| +6 V | +6 V | +6 V |

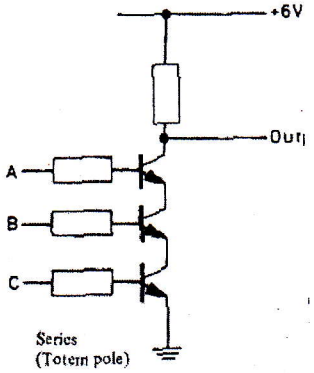
34. Assuming the positive logic, the next circuit represents the **NAND** function



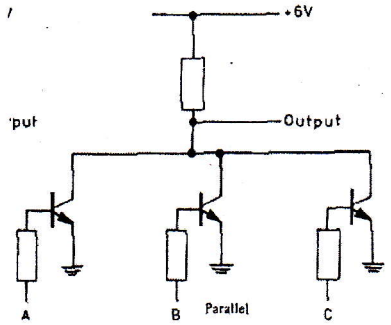

35. Assuming the positive logic, the next circuit represents the **NOR** function



36. Assuming the positive logic, the next circuit represents the **NAND** function




37. Assuming the positive logic, the next circuit represents the **NOR** function




## Second Question: Choose the most accurate answer (13 Marks) (Each 1 Mark)

38. The number $86_{10}$ can be written as
    a) $1010110_2$
    b) $1110110_2$
    c) $0110001_2$
    d) $0110111_2$
39. The number $247_8$ is represented in the binary system as
    a) $010100111_2$
    b) $111001010_2$
    c) $001100110_2$
    d) $010100100_2$
40. The number $10FE_{16}$ is equivalent to
    a) 4350
    b) 3251
    c) 4341
    d) 10155
41. $ABC_{16}$ = ....
    a) $101010111100_2$
    b) $100110111100_2$
    c) $000100110111_2$
    d) $111011001000_2$

42. The number of bits needed to represent $623_{10}$ in the binary system is
    a) 8
    b) 9
    c) 10
    d) 11
43. In the binary system, the arithmetic operation 1100101+101101=…
    a) 010010111
    b) 100101111
    c) 010010010
    d) 101010010
44. In the binary system, the arithmetic operation 1100101-101101=…
    a) 101000
    b) 110110
    c) 111000
    d) 100000
45. The digit $11011.1101_2$ equals to the decimal…
    a) 27.8125
    b) 27.13
    c) 13.27
    d) 445
46. The decimal 171144 represents the digit …
    a) $5748_{32}$
    b) $AF88_{32}$
    c) $B125_{32}$
    d) $F148_{32}$
47. Karnaugh map for 3 variables consists of … cells.
    a) 3
    b) 6
    c) 8
    d) 9
48. The next Karnaugh map can be minimized in the form of ….

| AB \ CD | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 1 | 1 | 1 | 1 |
| 01 | | | | |
| 11 | | | | |
| 10 | 1 | 1 | 1 | 1 |

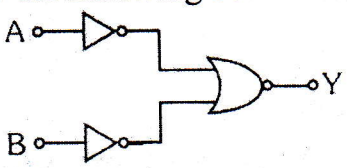
    a) $AB$
    b) $AB + CD$
    c) $\bar{B}$
    d) $\bar{A}$

49. The adjacent cells of cell no. 16 are ....

| AB \ CD | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 1 | 2 | 3 | 4 |
| 01 | 5 | 6 | 7 | 8 |
| 11 | 9 | 10 | 11 | 12 |
| 10 | 13 | 14 | 15 | 16 |

a) 4,12,13,15
b) 11,12,15
c) 12,15
d) 1,15

50. Which logic is represented by the following combination of logic gates?




a) NAND
b) NOR
c) AND
d) OR

**END OF QUESTIONS**

جامعة أسيوط – كلية العلوم

قسم الفيزياء

## الإختبار النهائي للفصل الثاني للعام الدراسي 2022/2021م

## 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

Assiut-A.R.E71516
Telephone; 088- 2412122
Fax: 088- 2342223
E-mail: physics_department @yahoo .com
أسيوط – جمهورية مصر العربية 71516
ت: 088- 2412122
فاكس : 088- 2342223

جامعة أسيوط - كلية العلوم – قسم الفيزياء
جمهورية مصر العربية – أسيوط - ت : ٠٠٢٠٨٨٢٣٣٣٨٣٧ فاكس : ٠٠٢٠٨٨٢٣٤٢٧٠٨

**Final Exam - Second Term: 2021/2022 - Course Title: Physics of low temperature - Code P- 422- Time: 3 h - Teaching Staff: Prof. Dr. Ahmed Sedky**

---

**Q1(30 marks): Choose the correct answer (MCQ):**

1- The RT (288 K) of a superconductors occurs at a pressure of;

**(a) 200 GPa (b) 192 GPa (c) 267 GPa**

2- The critical field $Hc_2$ of Bi:2212 is about;

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

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

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

4-The $T_c$ of a superconductor is obtained when

**(a) I = zero (b)T= zero (c) nV reach zero**

5- The crystal structure of FeSeTe system is;

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

6- The specific heat of a superconductor at $T_c$ equals ;

**(a) Zero (b) ≈ 3Cen (c) << 3Cen**

7- The condensation energy at a critical field of 12 T equal;

**(a) 5.742 J (b) 5.732 J (c) 5.712 J**

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

**(a) 2.877 T (b) 2.778 T (c) 2.768 T**

9- According to London equation, the field at London depth equals;

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

10- If $\lambda(0) = 5.1\ \mu m$, then $H_{c1}$ equals;

**(a) $1.207\times10^{-5}$ T (b) $1.267\times10^{-5}$ T (c) $1.246\times10^{-5}$ T**

11-The energy gap at 0 K for $T_c$ = 40 K superconductor equals;

**(a) $1.943\times10^{-21}$ J (b) $1.916\times10^{-23}$ J (c) $1.966\times10^{-20}$ J**

12- The surface sheath of type (I) superconductor occurs when

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

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

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

14- The G-L parameter of type (I) superconductors is

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

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

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

16- Electron pairs formation occurs as a result of interaction between;

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

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

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

18- The activation energy $E_a$ of flux bundles can be obtained from the relation between;
**(a) ln $f$ and $T_p$ (b) $f$ and $1/T_p$ (c) ln $f$ and $1/T_p$**
19- 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**
20- If a = 3.883 Å and b = 3.891 for Y:123, the orthorhombic distortion OD equals;
**(a) $2.06\times10^{-3}$ (b) $2.01\times10^{-3}$ (c) $2.1\times10^{-3}$**
21- If $\xi(0) = 2.1$ μm, then $H_{c2}$ equals;
**(a) $7.407\times10^{-5}$ T (b) $7.474\times10^{-5}$ T (c) $7.496\times10^{-5}$ T**
22- If $\xi = 0.81$ μm and $\lambda = 0.6$ μm, then $\delta_{ns}$ equals;
**(a) $8.06\times10^{-9}$ $H_c$ (b) $8.36\times10^{-9}$ $H_c$ (c) $8.96\times10^{-9}$ $H_c$**
23- 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**
24- If G-L parameter $\kappa_{GL} = 0.511$ and $H_c = 0.21$ T, then $Hc_3$ equal;
**(a) 0.247 T (b) 0.257 T (c) 0.237 T**
25- If r = 0.45 μm and $H_c = 0.125$ T, then $I_c$ equal;
**(a) $2.5\times10^{-8}$ (A) (b) $2.81\times10^{-8}$ (A) (c) $3.01\times10^{-8}$ (A)**
26-If $n(0) = 12.16 \times 10^{21}$ $cm^{-3}$, $T_c = 150$ K , then n (100 K) equals;
**(a) $9.758 \times 10^{21}$ /$cm^{-3}$ (b) $9.558 \times 10^{21}$ /$cm^{-3}$ (c) $9.798 \times 10^{21}$ /$cm^{-3}$**
27-If $T_c = 150$ K, $\lambda(0) = 0.51$ μm, then $\lambda$ (100 K) equals;
**(a) 0.569 μm (b) 0.549 μm (c) 0.579 μm**
28- 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**
29- If $Hc_2 = 20$ T , $\rho_n = 5\times10^{-5}$ (Ω.m), then $\gamma$ for Hg:1223 under pressure equals;
**(a) 0.079 (J/Kg.K) (b) 0.088 (J/Kg.K) (c) 0.069 (J/Kg.K)**
30- Onset of diamagnetism occurs when;
**(a) $\chi'$ is zero (b) $\chi''$ is maximum (c) $\chi'$ is maximum**

**Q2 - Choose True (T) or False (F) (20 marks):**

31- The transport vehicles of super-train float on strong superconducting to increase friction.
**(a) F (b) T**
32- Superconductivity sensors can be used to increase penetration of electromagnetic field in radar.
**(a) F (b) T**
33- The sign of thermoelectric power (TEP) of a superconductor is usually negative.
**(a) F (b) T**
34- The Cooper pairs move as a super-current with highly dissipation.
**(a) F (b) T**
35- The electron pairs require energy less than their binding energy for their breaking.
**(a) F (b) T**

جامعة أسيوط - كلية العلوم – قسم الفيزياء
جمهورية مصر العربية – أسيوط - ت : ٠٠٢٠٨٨٢٣٣٣٨٣٧ فاكس : ٠٠٢٠٨٨٢٣٤٢٧٠٨

**36-** The jump of specific heat at $T_c$ is due enhancing the order parameter.

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

**37-** When $I > I_c$ , the voltage appears and linearly increases with increasing I.

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

**38-** The slope (dV/dI) defines the flux flow resistance $R_f$ .

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

**39-**The entropy of the electrons in the NS is higher than SS.

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

**40-** In the normal core of mixed state, $\psi(r)$ increases over a length equal $\xi$ .

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

**41-** The $T_c$ of La : 214 is about 68 K

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

**42-** The $T_c$ of Y : 123 is about 38 K

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

**43-** The $T_c$ of Bi: 2223 is about 89 K

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

**44-** Flux quantum in superconductor equals $4.14 \times 10^{-14}$ (Web).

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

**45-** Is the relation; $H_{c1}(0) = \frac{150.5T_c}{\rho_n} \ln(1.15\times10^{-2}\rho_n\beta^{\frac{1}{2}})$ correct.

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

**46-** When $F_L > F_p$, the vortex lines will move as well as flux flow.

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

**47-** When $F_L = F_p$ , the vortex will localized at the top of the well.

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

**48-** Superconductivity is quenched when the flux flow starts.

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

**49-** The peak of $\chi''$ is due to current penetration up to the center of superconductor.

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

**50-** Superconducting power cable is an application of critical current.

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

## Question № 1 (20 degrees) Total (50 degrees)

**Write in the attached table the symbol indicating the correct answer**

1. Some materials have: *A. strong attraction B. weak attractions* and: *A. refuse to loss electrons B. allow electrons to be lost,* these are called: *A. insulators B. conductors*
2. Receiving an electric shock from a doorknob is an example of:
   *A. Current electricity B. Static electricity C. Spontaneous electricity*
3. Our body behaves as: *(A) a conductor (B) an insulator.* and there is potential difference between the source and ground thus we will shock
4. ..... is the energy required to jump the electron from one energy level to other
   *A. Excitation potential B. Ionization potential*
5. ...is the energy required to remove an electron from an atom
   *A. Excitation potential B. Ionization potential*
6. The difference between an insulator and a semiconductor is
   *A. Wider forbidden gap B. The number of free electrons C. The atomic structure D. All of the above*
7. Ohm's law is not obeyed by: *A. Conductor B. Semiconductor C. None of the above*
8. In a semiconductor, the energy gap between the valence band and conduction band is about
   *A. 5 eV B. 10 eV C. 15 eV D. 1 eV*
9. The resistivity of a semiconductor ... conductors and insulators
   *A. More than that of B. Lies between that of C. Less than that of*
10. A semiconductor generally has ___valence electrons. *A. 14 B. 32 C. 4*
11. A pure Si wafer is said to act as: *A. insulator B. conductor*
12. The most commonly used semiconductor is: *A. Germanium B. Carbon C. Silicon*
13. In an intrinsic semiconductor, the number of free electrons: *A. Equals the number of holes B. Is greater than the number of holes C.Is less than the number of holes*
14. At room temperature, the charge carried in an intrinsic semiconductor is:
   *A. Free Electrons B. Holes C. Free electrons and holes D. Holes and ions*
15. When a pure semiconductor is heated, its resistance
   *A. Goes down B. Goes up C. Remains the same D. None of the above*
16. When a pentavalent impurity is added to a pure semiconductor it becomes:
   *A. Intrinsic B. n-type C. p-type D. None of the above*
17. Addition of pentavalent impurity to semiconductors creates many
   *A. Free Electrons B. Holes C. Valence electrons*
18. A pentavalent impurity is called.....impurity *A. Donor B. Acceptor C. Ionic*
19. When a trivalent impurity added to a pure semiconductor it becomes
   *A. Intrinsic B. n-type C. p-type*
20. Addition of trivalent impurity to semiconductors creates many:
   *A. Free Electrons B. Holes C. Valence electrons*

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

21. A trivalent impurity is called..... impurity: *A. Donor* *B. Acceptor* *C. Ionic*

22. A hole in a semiconductor is defined as a free.....

*A. electron* *B. proton* *C. neutron* *D. None of the above*

23. As a general rule, holes are found only in: *A. Metals* *B. Semiconductor* *C. Insulator*

24. The magnitude of the charge of a hole is:

*A. Zero* *B. Equal to that of a proton* *C. Equal to that of an electron*

25. By adding impurities in semiconductor, the bulk resistance of a semiconductor

*A. Decreases* *B. Remain the same* *C. Increases*

26. *P-Type* semiconductor is: *A. +ve charged* *B. –ve charged* *C. uncharged*

27. The random motion of holes and free electrons due to thermal agitation is called:

*A. Ionization* *B. Pressure* *C. Diffusion*

28. Which causes the barrier layer in a *PN* junction? *A. Doping* *B. Recombination* *C. Ions*

29. The depletion region contains: *A. Sea of Electrons* *B. Holes* *C. Immobilized charge carriers*

30. A forward biased PN junction has a resistance of the Order of: *A. Ω* *B. KΩ* *C. MΩ*

31. The battery connections required to forward bias PN junction are:

*A. +ve terminal to p and -ve terminal to n* *B. -ve terminal to p and +ve terminal to n*

*C.-ve terminal to p and -ve terminal to n*

32. When a diode is forward biased, the recombination of the free electrons and holes may produce: *A. Heat* *B. Light* *C. Radiation* *D. All of the above*

33. When the diode is forward biased, it is equivalent to: *A. An off switch* *B. An On switch*

34. The leakage current is least in: *A. Germanium* *B. Silicon* *C. Carbon*

35. When a reverse bias is applied to a diode, it will: *A. Raise the potential barrier*

. *B. Lower the potential barrier* *C. Increases the majority-carrier a current greatly*

36. Avalanche breakdown in a diode occurs when: *A. Potential barrier is reduced to zero.*

*B. Forward current exceeds certain value* *C. Reverse bias exceeds a certain value.*

37. What does LED stand for? *A. Light Emitting Display* *B. Low Energy Display*

*C. Light Emitting Diode* *D. Light Emitting Detector*

38. What are the 2 types of transistors? *A. Positive, Negative* *B. X, Y* *C. NPN, PNP*

39. CD player is an example of a system using: *A. a digital method* *B. an analog method* *C. all of the above*

40. To change the digital data into an analog signal & Vice versa, we use:

*A. (DAC)* *B. (ADC)* *C. all the above*

| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| | | | | | | | | | |

## Question № 2 (20 degrees)

**Write in the attached table the symbol (T) *for true answer* or (F) *for false answer***

1. Matter annihilates, energy appears. Energy disappears, matter appears
2. Our mission - only - is to follow the behaviors and actions of the universe to produce what we need
3. Any amount of mass, no matter how small, contains an enormous amount of energy
4. Energy has no priority over mass or mass over energy
5. The origins of the universe, in order, are: Noor –light - radiation - energy – matter
6. Some materials have: strong attractions and refuse to electrons loss, these are called insulators
7. Some materials have: weak attractions and allow electrons to be lost, these are called insulators
8. Examples of insulating mat.: air, glass, rubber, plastics
9. Our body behaves as: an insulator, and there is potential difference between the source and ground thus we will shock
10. Ionization potential: is the energy required to jump the electron from one energy level to other
11. Excitation potential is the energy required to remove an electron from an atom
12. The forbidden energy gap in a semiconductor is: 0 eV
13. In insulators the electrons in the valence band are separated by a large gap from the conduction band
14. In conductors like metals the valence band overlaps the conduction band
15. In semiconductors there is a small enough gap between the valence and conduction bands that thermal or other excitations can bridge the gap.
16. The resistivity of a semiconductor *is More than that of* conductors and insulators
17. The resistivity of a semiconductor *Lies between that of* conductors and insulators
18. A semiconductor generally has $8$ valence electrons.
19. Atoms in a pure silicon wafer contains four electrons in outer orbit (called valence electrons)
20. In pure form, Si wafer does not contain any free charge carriers.
21. An applied voltage across pure Si wafer does not yield electron flow through the wafer.
22. In the crystalline lattice structure of Si, the valence electrons of every Si atom are locked up in covalent bonds with the valence electrons of four neighboring Si atoms
23. A semiconductor is formed by covalent bonds
24. A semiconductor is formed by ionic bonds

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

25. The number of free electrons and holes in an intrinsic semiconductor increase when the temperature Increases
26. When a pure semiconductor is heated, its resistance remains the same
27. When a pentavalent impurity is added to a pure semiconductor, it becomes: P-type.
28. A pentavalent impurity is called Acceptor impurity
29. Free Electrons cannot move
30. Some of application areas of semiconductor diodes include: Communication & radar systems, computer & power supply systems, television system
31. Electron combines with the hole is equivalent to moving from a higher orbit to a lower energy orbit.
32. In a reverse biased diode, some current flows through the depletion region. This current is called leakage current
33. The leakage current of diode is the current that the diode will leak when a reverse voltage is applied to it
34. The p-side is called anode and the n-side is called cathode.
35. The p-side is called cathode and the n-side is called anode
36. The transistor replaces the Vacuum Tubes
37. A quantity having continuous values is: a digital quantity
38. A quantity having a discrete set of values is a digital quantity
39. Digital has certain advantages over analog in electronics applications
40. Compared to analog systems, digital systems are less prone to noise

| 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| | | | | | | | |

## Question № 3 (10 degrees)

Circle the wrong word or words and correct them in the specified place

| |
|---|
| 1. Excitation potential is the energy required to remove an electron from an atom |
| 2. A semiconductor generally has 8 valence electrons. |
| 3. A semiconductor is formed by ionic bonds |
| 4. A quantity having continuous values is: a digital quantity |
| 5. Compared to analog systems, digital systems are more prone to noise |

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | | | | |

انتهت اسئلة اشباه الموصلات والاغشبة الرقيقة مع التمنيات بالتوفيق___اسم الممتحن د / حسام وحيد

# Physics 432P – Atomic and Molecular Spectroscopy

## FINAL EXAM

**THIS TEST HAS THIRTEEN PAGES**

## DURATION OF TEST: THREE HOURS

## Date: 12th June 2022

## Examiner: Dr. Ahmed Mostafa Amry

*Fundamental Constants*

| Constant | Symbol | Value | Uncertainty |
|---|---|---|---|
| Speed of Light | $c$ | $2.99792458 \times 10^{10}$ cm s$^{-1}$ | (exact) |
| | $c^2$ | $8.9875517873681764 \times 10^{20}$ cm$^2$ s$^{-2}$ | (exact) |
| Second | $s$ | 9192631770 Caesium cyles | (exact) |
| Gravitation constant | $G$ | $6.673(10) \times 10^{-8}$ cm$^3$ g$^{-1}$ s$^{-2}$ | $1.5 \times 10^{-3}$ |
| Standard gravity | $g_n$ | 980.665 cm s$^{-2}$ | (exact) |
| Planck constant | $h$ | $6.62606876(52) \times 10^{-27}$ erg s | $7.8 \times 10^{-8}$ |
| in eV s | | $4.13566727(16) \times 10^{-15}$ eV s | $3.9 \times 10^{-8}$ |
| $h/2\pi$ | $\hbar$ | $1.054571596(82) \times 10^{-27}$ erg s | $7.8 \times 10^{-8}$ |
| Electron charge (ESU) | $e$ | $4.803204196 \times 10^{-10}$ | $3.9 \times 10^{-8}$ |
| Electron charge (EMU) | e | $1.602176462 \times 10^{-19}$ C | $3.9 \times 10^{-8}$ |
| Electron Volt | eV | $1.602176462 \times 10^{-12}$ erg | $3.9 \times 10^{-8}$ |
| Electron Mass | $m_e$ | $9.10938188 \times 10^{-28}$ g | $3.9 \times 10^{-8}$ |
| Proton Mass | $m_p$ | $1.67262158 \times 10^{-24}$ g | $7.9 \times 10^{-8}$ |

*Physico-Chemical Constants*

| | | |
|---|---|---|
| Boltzmann constant | $k$ | $1.3806503(24) \times 10^{-16}$ erg K$^{-1}$ |
| Atomic Mass Unit ($^{12}$C = 12) | $m_u$ | $1.66053873(13) \times 10^{-24}$ g |
| Hydrogen ($^1$H) Mass | $m_H$ | $1.007825050(12)\, m_u$ |
| Rydberg constant for $^1$H | $R_H$ | $1.09677558306(13) \times 10^5$ cm$^{-1}$ |

1 u = 1.660 538 73 × 10$^{-27}$ kg

## Answer ALL questions in sections A and B.

A. Multiple Choice: Identify the choice that best completes the statement or answers the question. **[25 marks]**

1. According to Bohr's atomic model, the angular momentum of orbits is multiple of

   a) $h/2\pi$ b) $2\pi/h$ c) $2h/\pi$ d) $\pi/2h$

2. Radius of the hydrogen atom on going to the first excited state is _____ of Bohr's radius.

   a) double b) half c) 4 times d) Same

3. The radius of the Bohr orbit depends on which of the following?

   a) $1/n$ b) $n$ c) $1/n^2$ d) $n^2$

4. Which of the following cannot be conserved during Raman scattering?

   a) Total Energy
   b) Momentum
   c) Kinetic Energy
   d) Electronic Energy

5. The Raman and IR spectra can tell us whether

   a) A molecule is linear or non-linear,
   b) A molecule is symmetrical or asymmetrical.
   c) Neither of the above.
   d) Both of the above.

6. Photoelectric emission occurs only when the incident light has more than a certain minimum

   a) power b) wavelength c) intensity d) frequency

7. Which of the following when falls on a metal will emit photoelectrons?

   a) UV radiations
   b) Infrared radiation
   c) Radio waves
   d) Microwaves

8. The work-function of a metal is

a) The minimum current required to take out electron from the metal surface.

b) The maximum frequency required to take out electron from the metal surface.

c) The minimum amount of energy required to take out the electron from the metal surface.

d) None of these.

9. What will be the longest wavelength in the Balmer series of hydrogen spectrum?

a) $6557\times10^{-10}$ m  b) $5557\times10^{-10}$ m  c) $9557\times10^{-10}$ m  d) $1557\times10^{-10}$ m

10. A hydrogen atom in its ground state absorbs 10.2 eV of energy. What is the orbital angular momentum is increased by?

a) $4.22\times10^{-3}$ Js  b) $2.11\times10^{-34}$ Js  c) $3.16\times10^{-34}$ Js  d) $1.05\times10^{-34}$ Js

11. Which of the following is true regarding the Bohr model of atoms?

a) Assumes that the angular momentum of electrons is quantized.

b) Uses Faraday's laws.

c) Predicts continuous emission spectra for atoms.

d) Predicts the same emission spectra for all types of atoms.

12. Hydrogen atoms are excited from ground state to the state of principal quantum number 4. Then, what will be the number of spectral lines observed?

a) 3  b) 6  c) 5  d) 2

13. What is the wavelength of electromagnetic radiation which has a frequency of $4.464\times10^{14}\ s^{-1}$?

a) $1.338\times10^{23}$ m  b) 1.489 nm  c) $1.489\times10^{-6}$ m  d) $6.716\times10^{-7}$ m

14. According to the uncertainty principle for an electron, time measurement will become uncertain if which of the following is measured with high certainty?

a) Energy  b) Momentum  c) Location  d) Velocity

15. An electron is moving in an orbit of a hydrogen atom at the $4^{th}$ energy level. Find the number of spectral lines for a transition from here to the ground state.

a) 8 b) 3 c) 6 d) 10

16. The change in orbital angular momentum when a hydrogen atom emits a photon of energy 12.75 eV is

a) $5h/\pi$ b) $3h/2\pi$ c) $h/\pi$ d) $4h/3\pi$

17. Which atomic orbital is spherical in shape?

a) 2s b) 3p c) 3d d) 4f

18. Which statement about the four quantum numbers which describe electrons in atoms is **incorrect**?

a) n = principal quantum number, n = 1, 2, 3, .....

b) l = subsidiary (or azimuthal) quantum number, l = 1, 2, 3, ... , (n+1)

c) $m_l$ = magnetic quantum number, $m_l$ = (-l), .... , 0, .... , (+l)

d) $m_s$ = spin quantum number, $m_s$ = +1/2 or -1/2.

19. The energy in joules of photons of radio waves that leave an FM station that has a 90.0-MHz broadcast frequency. (J = $10^7$ ergs) is:

a) $4.18 \times 10^{-25}$J b) $1.11 \times 10^{-25}$ J c) $7.1 \times 10^{-43}$ J d) $5.96 \times 10^{-26}$J

20. If 5eV of energy is supplied to an electron with a binding energy of 2.3eV, with what kinetic energy will the electron be launched?

a) 4.23eV b) 4.73eV c) 4.115eV d) 2.7eV

21. The quantum mechanical model describes electrons as:

a) Particles
b) Waves
c) Particles with wave-like properties
d) Small, hard spheres

22. Heisenberg's Uncertainty Principle states that the ___ and ___ of an electron cannot be known simultaneously.

a) Position, mass
b) Position, charge
c) Momentum, speed
d) Position, momentum

23. Zeeman effect is the splitting of spectral line in the presence of

a) Electric Field
b) Magnetic Field
c) Inert Environment
d) Vacuum

24. A wavefunction:

a) Is the solution to a differential equation known as a wave equation that describes the structure of an electron?
b) Is the solution to a differential equation known as a wave equation that describes the structure of an atom?
c) Is the differential equation used to describe the structure of an atom?
d) Is the differential equation used to describe the structure of an electron?

25. The magnetic quantum number describes the:

a) Shape of the orbital.
b) Spatial orientation of the orbital.
c) Average distance of the most electron-dens regions from the nucleus.
d) Number of electrons.

26. What is the Pauli Exclusion Principle?

a) An atomic orbital can only hold a maximum of 2 electrons, each with opposite spins.
b) An atomic orbital can hold a minimum of 6 electrons, each with opposite spins.
c) An atomic orbital can hold a maximum of 6 electrons, each with the same spin.
d) An atomic orbital can hold a minimum of 2 electrons, each with opposite spins.

27. The number of splitting levels of in 2p orbital would be

a) 1
b) 2
c) 3
d) 4

28. Zeeman Effect could not be proved by

a) Quantum Mechanics
b) Bohr's Model
c) Hamiltonian operators
d) L-S coupling

29. The number of split levels in the magnetic field is

a) 2n
b) 2n + 1
c) 2l
d) 2l + 1

30. Microwave spectrum of a molecule yields three rotational constants. Molecule is

a) Spherical top
b) Oblate symmetric top
c) Asymmetric top
d) Prolate symmetric top

31. Which one of the following exhibit rotational spectroscopy?

a) $CO_2$ b) $H_2$ c) $N_2$ d) CO

32. Raman effect is scattering of:

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

33. In Raman spectroscopy, the radiation lies in the

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

34. What is the ratio of minimum to maximum wavelength in the Balmer series?

a) 5:9 b) 5:36 c) 1:4 d) 3:47

35. Find out the minimum energy required to take out the only one electron from the ground state of Li+?

a) 13.6 eV b) 122.4 eV c) 25.3 eV d) 67.9 eV

36. What is the energy required to ionize an H-atom from the third excited state, if ground state ionization energy of H-atom is 13.6 eV?

a) 1.5 eV b) 3.4 eV c) 13.6 eV d) 12.1 eV

37. The correct order of different types of energies is:

a) $E_{el} >> E_{vib} >> E_{rot} >> E_{tr}$
b) $E_{el} >> E_{rot} >> E_{vib} >> E_{tr}$
c) $E_{el} >> E_{vib} >> E_{tr} >> E_{rot}$
d) $E_{tr} >> E_{vib} >> E_{rot} >> E_{el}$

38. The transition zone for Raman spectra is:

a) Between vibrational and rotational levels.
b) Between electronic levels.
c) Between magnetic levels of nuclei.
d) Between magnetic levels of unpaired electrons.

39. During Einstein's Photoelectric Experiment, what changes are observed when the frequency of the incident radiation is increased?

a) The value of saturation current increases.

b) No effect.

c) The value of stopping potential increases.

d) The value of stopping potential decreases.

40. The work function of lithium is 2.5 eV. The maximum wavelength of light that can cause the photoelectric effect in lithium is

a) 3980 Å b) 4980 Å c) 5980 Å d) 6980 Å

41. The Kinetic energy of a photoelectron emitted on shining a light of wavelength 6.2 X $10^{-6}$ m on a metal surface of work function 0.1 eV is:

a) 0.01 eV b) 0.02 eV c) 0.1 eV d) 1 eV

42. Which of the following is an application of molecular spectroscopy?

a) Structural investigation.

b) Basis of understanding of colors.

c) Study of energetically excited reaction products.

d) All of the mentioned.

43. The ionization energy of an electron in the ground state of helium atom is 24.6 eV. The energy required to remove both the electron is

a) 51.8 eV b) 79 eV c) 38.2 eV d) 449.2 eV

44. The energy of 1st orbit in a hydrogen atom :

a) $3.18\times10^{-12}$ J b) $-2.18\times10^{-18}$ J

c) $-3.18\times10^{-18}$ J d) $2.18\times10^{-18}$ J

45. What is the ratio of the atomic radius of the $5^{th}$ orbit in chlorine atom and $3^{rd}$ orbit in Helium atom?

a) 153:50 b) 50:153 c) 153:100 d) 100:153

46. The magnetic quantum number specifies

a) Size of orbitals
b) Shape of orbitals
c) Orientation of orbitals
d) Nuclear Stability

47. Vibrational spectroscopy is

a) a large mass on a weak spring.
b) a flashlight through a prism and shake it.
c) a class of spectroscopic techniques which analyzes molecular motions.
d) an Infrared spectroscopy

48. Why are rotational transitions of little use to a spectroscopist?

a) Because the energy required to induce a rotational transition is so small that it cannot be measured.
b) Because rotational transitions are extremely rare.
c) Because, in liquids and solids, spectral lines corresponding to rotational transitions are broadened as the result of molecular collisions and other interactions.
d) All of the above.

49. The square of the magnitude of the wave function is called:

a) current density
b) probability density
c) zero density
d) volume density

50. If the particle moving in a _____ potential then the solution of the wave equation are describe as a stationary states

a) time independent
b) time dependent
c) velocity dependent
d) velocity independent

B. Problems: Answer the following questions. **[5 marks]**

1. An electron is confined to the size of a magnesium atom with a 150 pm radius. **What** is the minimum uncertainty in its velocity?

Solution:

**2. Calculate the energies of the $J$ =7 and $J$ = 8 levels. At what wavenumber does the $J$ = 7 → 8 transition occur?**

Solution:

3. Show that the (a) wavelength of 100 nm occurs within the Lyman series, that (b) wavelength of 500 nm occurs within the Balmer series, and that (c) wavelength of 1000 nm occurs within the Paschen series. Identify the spectral regions to which these wavelengths correspond.

Solution:

4. For the following particles (a) an electron with a kinetic energy of 50eV, (b) a proton with a kinetic energy of 50 eV , and (c) an electron in the second Bohr orbit of a hydrogen atom, calculate the de Broglie wavelength of each.

Solution:

5. a) Calculate the energy of a photon that is produced when an electron in a hydrogen atom goes from an orbit with $n=4$ to an orbit with n=1.

b) What happens to the energy of the photon as the initial value of $n$ approaches infinity?

Solution:

END OF EXAM.....BEST WISHES