Assiut University **Faculty of Science**

Third Year (Physics ,Phys.&Chem.),2nd Semester Time : 3 Hours

Nuclear Physics · 342ph Exm.Date : 5 /7/2021

Part (I) Complete the following (each of 1 grade)

1 The atomic number is equivalent to ( )

2- ( ) is an atomic particle has the smallest mass

3 -(-) is the number of neutrons in the nucleus ${}_zX^A$

4 - There are ( ) electrons are in ${}_8O^{16}$

5- Rutherford used ( ) law to estimate the nuclear size

6- The nuclear energy levels more complex than electron energy levels because (

7- ( ) force is responsible for radioactive decay of the nucleus

8- Binding energy is (

9- If m_p is the proton mass , m_n is the mass of a neutron, and M is the atomic mass of the atom, the mass defect will take the form

$\Delta m =$

10- When nucleons form a stable nucleus, binding energy is

11- A nuclear unit is the (=) for length

12- Isobars are two nuclei of the same number of ( )

13- Isotones are two nuclei of the same number of ( )

14- A nuclear unit is the (=) for energy

15- Isotopes are two nuclei of the same number of ( )

Part(II) Choose the correct (each of 1 grade)

1-An unknown element is formula ${}_{Z}X^{A}$ What is the name of Z?

A. mass number B. atomic number C. principle quantum number

2-Why are nuclear energy levels complex than electron energy levels?

a-Nuclear energy levels depend only on attractive forces.

b-Nuclear energy levels depend on attractive and repulsive forces.

c-Nuclear energy levels are one hundred times as great as electron energy levels.

d-Electron energy levels depend on the interaction between neutrons and electrons.

e-Electron energy levels have greater energy than the nuclear energy levels.

3-What force is responsible for the radioactive decay of the nucleus?

a-Gravitational b-Weak Nuclear c-Strong Nuclear d-Electromagnetic

4-Binding energy is:

a-the energy required to break nucleus into protons and neutrons.

b-the energy required to break nucleus into electrons and neutrons.

c-the energy released when neutrons change energy levels.

d-the energy released when protons change energy levels.

5-When nucleons form a stable nucleus, binding energy is:

A. created from nothing.

B. destroyed into nothing.

C. transformed into visible light.

D. absorbed as high energy photons or particles.

E. released as high energy photons or particles.

6-An isotope with a high Binding Energy per nucleon:

A. will decay in a short period of time.

B. is very unstable.

C. is very stable

D. has very few electrons.

E. has more protons than neutrons.

7-Which of the following is the alpha particle?

a. $_{+1}e^{0}$ **b.** $_{-1}e^{0}$ **c.** $_{0}n^{1}$ **d.** $_{+1}H^{1}$ **e.** $_{2}He^{4}$

8-Which of the following is the β^- particle?

a. $_{+1}e^0$ **b.** $_{-1}e^0$ **c.** $_0n^1$ **d.** $_{+1}H^1$ **e.** $_2He^4$

9-Which type of radiation is stopped by a sheet of paper?

A. alpha B. beta C. Gamma D . X-ray E. Ultraviolet radiation

10-What is the missing element from the following equation :

$$_6C^{14} \text{ ----->> } ? + {}_{-1}e^0$$

a. $_7N^{13}$ b. $_6C^{12}$ c. $_8O^{17}$ d. $_8O^{16}$ e. $_7N^{14}$

11-A reaction that releases more energy than is put into it is called:

A. endothermic B. Exothermic C. Nuclear D. chemical

12- The nuclear reaction $_1H^2 + {}_1H^3$ --------> $_2He^4 + {}_0n^1$ is called :

A. fusion B. fission C. alpha decay D. beta decay E. gamma decay

14-The intensity of a radioactive radiation should be decreased by an absorber to approx. 1/1000 of the original intensity. How many times wider layer than the half-value layer must be used?

a. 4 b. 5 c. 9 d. 10

15 -The range of alpha radiation in air is about :

a . 1 cm b. 10 cm c. 100 cm

16 - The photo effect as the interaction of X-rays or gamma-rays with

6- The half-life of a radioactive material is always longer than the average lifetime of the radioactive nuclei (yes – No)

7- If the half-life of a radioactive material is 1 day, the number of radioactive nuclei become zero after 10 days (yes – No)

8- After 9 (nine) half-lives the number of radioactive nuclei decays to the 256^{th} of the initial number (yes – No)

9- Alpha-radiation is composed of helium nuclei (yes – No)

10- Negative beta-radiation is composed of electrons (yes – No)

11- Alpha, beta and gamma-radiations all have continuous energy spectrum (yes – No)

12- The mass number of the nucleus decreases by 4 in the case of alpha-radiation (yes – No)

13- During the emission of negative beta-radiation the atomic number does not change (yes – No)

14- During emission of positive beta-radiation the mass number does not change (yes – No)

15- During electron capture (K-capture) the atomic number decreases by one (yes – No)

16- Alpha particle is composed of 4 identical nucleons (yes – No)

****** The END *** Regards *** Prof. G. S. Hassan *****

matter results in

a. infrared emission b. ionization of atom c. annihilation of an electron

17- During the photoelectric effect the gamma-photon interacts with :

a. the nucleus b. an outer-shell electron

c. an inner-shell electron d. an arbitrary electron

18- Minimum energy of a photon that can cause pair production :

a.0.75 Mev b. 1.00 Mev c. 0.95Mev d.1.02 Mev e. 1.32 MeV

19- What type of radiation is produced during annihilation?

A. neutron radiation b. electron and positron radiation

c. electromagnetic radiation d. positive and negative beta radiation

Part(III) Check however is it (each of 1 grade)

1 -with increasing atomic mass number, the neutron/proton ratio decreases (yes – no)

2- The *strong interaction* between nucleons follows the $1/r^2$ distance dependence (yes – No)

3- The definition of total binding energy of a nucleus is the energy emitted during negative beta-decay(yes – No)

4- The absolute (positive) value of the binding energy per nucleon has its maximum in the case of an iron nucleus (yes – No)

5- A radioactive sample has 10 Bq (Becquerel) activity, its decay rate is 10 decays / second (yes – No)

Part(IV) Choose the correct (each of 1 grade)

(خاص بأعمال الفصل ٤٠ درجة)

1How does the *neutron/proton ratio* change with increasing atomic mass number?

It decreases.

It does not change.

It increases.

2The *strong interaction* between nucleons

does not depend on the (electric) charge. has a high range.

may be attractive or repulsive. follows the $1/r^2$ distance dependence.

4What is the definition of total binding energy of a nucleus?

The energy needed to break the nucleus down into free protons and neutrons.

The energy calculated with the $E=mc^2$ formula

The energy emitted during negative beta-decay.

The energy released during the emission of gamma radiation.

4The absolute (positive) value of the binding energy per nucleon

has its maximum in the case of an iron nucleus.

is directly proportional to the mass number.

is inversely proportional to the mass number.

is a periodic function of the mass number.

does not depend on the mass number.

5A radioactive sample has 10 Bq activity, its decay rate is

10 decays / min.

10 decays / second.

10 decays / hour.

1 decay / 10 seconds.

1 decay / 10 min.

6The radioactive decay probability per unit time

is greater than one.

is positive, but smaller than one.

can have any value.

can only be zero or one.

is always an even number.

7The decay probability of radioactive nuclei

is influenced by an external high-frequency magnetic field.

is influenced by external pressure.

is influenced by temperature.

is influenced by the oxygen content of the medium.

is not influenced at all by external physical conditions.

8The number of decayed nuclei per unit time in a radioactive sample depends on :

the temperature.

the external pressure.

the number of radioactive nuclei in the sample.

the external magnetic field.

the external electric field.

the 64th.

the 256th.

the 512th.

the 1024th.

the 2048th of the initial number.

14 Which one of the following statements is true?

Alpha-radiation is composed of helium-atoms.

Negative beta-radiation is composed of photons.

Positive beta-radiation is composed of positrons (anti-electrons).

Gamma-radiation is composed of neutrons.

X-rays are composed of electrons.

15 Which part of the atom the gamma-radiation originates from?

The nucleus.

The inner electron shells.

The outer electron shells.

Both in the inner electron shells and the nucleus.

16 Gamma-radiation

is generated when fast electrons are decelerated.

is an electromagnetic wave of nuclear origin.

consists of electrically neutral particles which can be deflected by magnetic field.

is generated by transitions between two energy states of internal electron orbits.

17 Which of the following statements is true?

The alpha-, beta- and gamma-radiations all have continuous

9 What is the relationship between the rate constant of the radioactive decay and half-life (time)?

Greater rate constant corresponds to longer half-life.

Greater rate constant corresponds to shorter half-life.

They are not related to each other.

10 What is the relationship of half-life and average lifetime of a radioactive nuclei?

No relation (they are independent of each other).

They are linearly proportional to each other.

They are inversely proportional to each other.

They depend on each other according to another function.

11 The half-life of a radioactive material

is the same as the average lifetime of the radioactive nuclei.

is always longer than the average lifetime of the radioactive nuclei.

is always shorter than the average lifetime of the radioactive nuclei.

can be longer or shorter than the average lifetime of the radioactive nuclei.

12 If the half-life of a radioactive material is 1 day, in what time will the number of radioactive nuclei become zero?

0,5 day.

1 day.

2 days.

4 days.

A very long time.

13 After 9 (nine) half-lives the number or radioactive nuclei decays to

increases by two.

increases by one.

does not change.

decreases by one.

decreases by two.

22 During electron capture (K-capture) the atomic number

increases by two.

increases by one.

does not change.

decreases by one.

decreases by two.

23 Electron capture (K-capture)

is accompanied by positron-emission.

is accompanied by proton-emission.

is accompanied by neutron-emission.

is accompanied by emission of characteristic X-rays.

is not accompanied by any radiation.

24 For isotopes it is true that

they are radioactive variants of elements.

the are low binding energy variants of elements.

their mass decreases during radioactive decay.

they contain an even number of nucleons.

they cannot be distinguished chemically.

26 The order of magnitude of the radius of the atomic nucleus

energy spectrum.

The alpha-, beta- and gamma-radiations all have line type

energy spectrum.

The spectra of alpha and beta-radiation are continuous, while gamma-spectra is a line spectrum.

The spectra of the alpha and gamma-radiation are continuous, while beta-radiation is a line spectrum.

The spectrum of the beta-radiation is continuous, while alpha- and gamma- radiation are line spectra.

18 The mass number of the nucleus

decreases by 4 in the case of alpha-radiation.

decreases by 1 (one) in the case of positive beta-radiation.

increases by 1 (one) in the case of negative beta-radiation.

19 During the emission of negative beta-radiation the atomic number

increases by two.

increases by one.

does not change.

decreases by one.

decreases by two.

20 During the emission of negative beta-radiation the mass number

increases by two.

increases by one.

does not change.

decreases by one.

decreases by two.

21 During the emission of positive beta-radiation the atomic number

30 Pair production can take place if a photon gets close to an atom and its energy is

arbitrary.

minimum 1.02 MeV.

minimum 0.9 MeV.

maximum 1.4 MeV.

maximum 1.02 MeV.

31 The intensity of a radioactive radiation should be decreased by an absorber to approx. 1/1000 of the original intensity. How many times wider layer than the half-value layer must be used?

4.

5.

9.

10

The attenuation does not depend on the absorber thickness.

32 The range of alpha radiation in air is about

1 cm

10 cm.

100 cm.

33 The photo effect as the interaction of X-rays or gamma-rays with matter results in

emission of infrared radiation.

production of an electron-positron pair.

ionization of the atom.

annihilation of an electron.

1 fm (10^{-15} m)

1 pm (10^{-12} m).

1 Å (10^{-10} m).

1 nm.

1 μm.

1 mm.

27 The absorption of X-rays depends on

the atomic number of the absorber.

the density of the absorber.

the wavelength of X-ray radiation.

all the above parameters.

28 The absorption of the X-rays does not depend on

the material of the absorber

the wavelength of X-rays.

the duration of the radiation.

the thickness of the absorber.

29 How does the linear ion density of alpha-radiation depends on the thickness of the absorber?

Increases linearly.

Decreases linearly.

It is constant at first, then it increases steeply and finally it suddenly decreases. It is constant at first, reaches a minimum, finally it increases.

It changes periodically.

38 What is the minimum energy of a photon that can cause pair production?

0.75 MeV.

1.00 MeV.

0.95 MeV.

1.02 MeV.

1.32 MeV.

39 What type of radiation is produced during annihilation?

Neutron radiation.

Electron- and positron radiation.

Electromagnetic radiation

Positive beta-radiation.

Negative beta-radiation.

40 The specific ionization of the gamma-radiation in air

1 pair of ions / cm.

10 pair of ions / cm.

100 pair of ions / cm.

1000 pair of ions / cm.

The gamma-radiation does not cause ionization.

********** The End **********

34 During the photoelectric effect the gamma-photon

interacts with the nucleus.

interacts with an outer-shell electron.

interacts with an inner-shell electron.

interacts with an arbitrary electron.

35 The Compton effect is

the interaction of gamma-photons with the atomic nucleus.

production of gamma-photons during the annihilation of an electron-positron pair.

scattering of photons on the outer electronic shells of an atom.

ejection of electrons from the surface of an illuminated metal.

scattering of electrons on the outer electronic shells of an atom.

36 The particles produced during pair production are

alpha- and beta-particle.

proton and neutron.

electron and positron.

proton and electron.

37 Which one of the following formulas is used to calculate the minimum photon energy needed for pair production

$E = 0.5\ mc^2$

$E = 0.5\ mv^2$

$E = mc^2$

$E = mv^2$

$E = 2mc^2$

$E = 2mv^2$

Assiut University **Faculty of Science** **Physics Department**		**Final Exam 2021** **Date**: July 7th, 2021 **Allowed Time**: 2 hours

Course Name: ***Solid State Physics (350P)*** **Coordinator:** Dr. *Alaa Abd-Elnaiem*

Answer all the following questions

Question (I): Put (√) or (×) for all the following sentences: (35 Marks/1 each point)

Part I: for Midterm exam section (10 Marks)

1. Crystal structure = base + lattic ( ).
2. A crystalline material is one in which the atoms are randomly distributed relative to each other ( ).
3. The unit cell is the basic structural unit or building block of the crystal structure and defines the crystal structure by virtue of its geometry and the atom positions within ( ).
4. The primitive unit cell contains the same kind of atoms, while the Bravais lattice contains only one lattice point ( ).
5. Non-crystalline or amorphous materials are not crystallized, or the atoms are randomly arranged ( ).
6. The primitive cell is a large cell and contains more than one lattice point ( ).
7. In Bravais lattice, all lattice points are equivalent and all atoms in the crystal are of the same kind ( ).
8. In a simple cubic (SC) crystal structure, the number of atoms per unit cell is 2 ( ).
9. The cubic system has the greatest degree of symmetry, but the orthorhombic system has the least symmetry ( ).
10. In a simple cubic (SC) crystal structure, the Atomic packing factor (APF) for this structure is 0.57 ( ).

Part II: for Oral exam section (10 Marks)

11. The coordination number is the number of nearest-neighbor or touching atoms ( ).
12. In a simple cubic (SC) crystal structure, the coordination number for this structure is 6 ( ).
13. The unit cell geometry is completely defined in terms of six parameters (lattice parameters of a crystal structure): the three edge lengths a, b, and c, and the three inter-axial angles α, β, and γ ( ).
14. In Face-Centered Cubic (FCC) crystal structure, the relation between atomic radius, R, and unit cell length, a, given by $a=2\sqrt{2}R$ ( ).
15. In the cubic system $a = b = c$ and $\alpha = \beta = \gamma = 120^\circ$ ( ).
16. In the triclinic system $a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma$ ( ).
17. In the simple cubic (SC) crystal structure, the relation between atomic radius, R, and unit cell length, a, is given by R=2a ( ).
18. In Body-Centered Cubic (BCC) crystal structure, the coordination number for this structure is 8 ( ).
19. In Face-Centered Cubic (FCC) crystal structure, the number of atoms per unit cell is 6 ( ).
20. In the Hexagonal Close-Packed (HCP) crystal structure, the coordination number for this structure is 8 ( ).

Part III: for Final exam section (15 Marks)

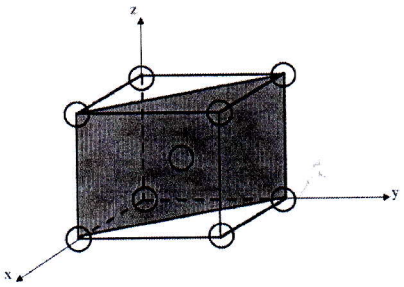
21. In Face-Centered Cubic (FCC) crystal structure, the Atomic packing factor (APF) for this structure is 0.74 ( ).
22. In Hexagonal Close-Packed (HCP) crystal structure, the ratio between c and a is $\frac{\sqrt{8}}{3}$ ( ).
23. In Body-Centered Cubic (BCC) crystal structure, the number of atoms per unit cell is 4 ( ).
24. In Face-Centered Cubic (FCC) crystal structure, the coordination number for this structure is 10 ( ).
25. In Body-Centered Cubic (BCC) crystal structure, the atomic packing factor (APF) for this structure is 0.54 ( ).
26. In the Hexagonal Close-Packed (HCP) crystal structure, the atomic packing factor (APF) for this structure is 0.74 ( ).
27. In Body-Centered Cubic (BCC) crystal structure, the relation between atomic radius, R, and unit cell length, a, given by $a = \frac{4\sqrt{3}R}{3}$ ( ).
28. The substance in which measured properties are independent of the direction of measurement is isotropic material ( ).
29. In the Hexagonal Close-Packed (HCP) crystal structure, the number of atoms per unit cell is 4 ( ).
30. In Hexagonal Close-Packed (HCP) crystal structure, the relation between atomic radius, R, and unit cell length, a, given by $a = 2R$ ( ).
31. Planar density (PD): is taken as the number of atoms per unit area that are centered on a particular crystallographic plane ( ).
32. The atomic radius (R) is defined as the distance between the atom center and the atom surface. ( ).
33. Linear density (LD): is defined as the number of atoms per unit length whose centers lie on the direction vector for a specific crystallographic direction ( ).
34. A single crystal is a crystalline solid, in which the atom's periodic and arrangement are perfect or extends throughout the entirety of the specimen without interruption ( ).
35. The most efficient packing is present in BCC and SC cells ( ).

<u>Question</u> (II): Chose the correct answer **(26 Marks/2 each point)**

1. **Iridium has an FCC crystal structure, a density of 22.4 g/cm^3, and an atomic weight of 192.2 g/mol, then the radius of an iridium atom equal:**

   A. 0.553nm B. 0.439nm C. 0.363nm D. 0.136nm

2. Miller indices for the indicated plane at the below figure is:



A. (001) B. (110) C. (101) D. $(\bar{1}01)$

3. Iron has a BCC crystal structure, an atomic radius of 0.124 nm, and an atomic weight of 55.85 g/mol; its theoretical density closest to [Hint: $N_A=6.025\times10^{23}$ atoms/mol]:

A. 9.92 g/cm^3 B. 8.40 g/cm^3 C. 7.90 g/cm^3 D. 6.35 g/cm^3

4. The linear density expression for FCC [100] direction in terms of the atomic radius R is:

A. $\frac{1}{2\sqrt{2}R}$ B. $\frac{1}{\sqrt{2}R}$ C. $\frac{1}{2\sqrt{6}R}$ D. $\frac{1}{6R}$

5. Which of the following is not a characteristic of a crystalline solid?

A. Definite and characteristic heat of fusion.
B. Isotropic nature.
C. A regular periodically repeated pattern of arrangement of a constituent.
D. Particles in the entire crystal.

6. Copper has a density of 8.89 g/cm^3, an FCC crystal structure, and an atomic weight of 63.5 g/mol. Then its atomic radius in nm [Hint: $N_A=6.023\times10^{23}$ atoms/mol]:

A. 0.63 B. 0.128 C. 0.612 D. 1.59

7. Aluminum has FCC cubic structure of lattice constant a=4.04 Å, then the inter planner spacing d_{100} in Å is:

A. 3.73 B. 8.18 C. 8.6 D. 4.04

8. For BCC iron, calculate the diffraction angle (2θ) for the (220) set of planes. If the lattice parameter for iron is 0.2866 nm. Also, assume that monochromatic radiation having a wavelength of 0.1790 nm is used, and the order of reflection is 1.

A. 124.26° B. 35.66° C. 88.42° D. 100.36°

9. In which pair of most efficient packing is present?

A. HCP and BCC.
B. HCP and FCC.
C. BCC and FCC.
D. BCC and SC.

10. Which of the following statement is not true about the hexagonal close packing?

A. The coordination number is 12.
B. It has a 74% packing efficiency.
C. Tetrahedral voids of the second layer are covered by the spheres of the third layer.
D. In this arrangement spheres of the fourth layer are exactly aligned with those of the first layer.

11. For which set of crystallographic planes (hkl) will a first-order diffraction peak occur at a diffraction angle of 46.21 for BCC iron when monochromatic radiation having a wavelength of 0.0711 nm is used? (Hint: radius of the iron atom is 0.1241 nm)

A. (310) B. (101) C. (002) D. (300)

12. Rhodium has an atomic radius of 0.1345 nm, its atomic weight is 102.91 g/mol, and a density of 12.41 g/cm^3. Then the crystal structure of Rhodium should be:

A. SC B. FCC C. BCC D. HCP

13. If the atomic radius of aluminum is 0.143 nm and has an FCC crystal structure, then the volume of its unit cell in cubic meters:

A. $1.3\times10^{-25}m^3$ B. $6.62\times10^{-29}m^3$ C. $7.2\times10^{14}m^3$ D. $3.2\times10^{-27}m^3$

Part III: for Final exam section (15 Marks)

21. In Face-Centered Cubic (FCC) crystal structure, the Atomic packing factor (APF) for this structure is 0.74 ( ).
22. In Hexagonal Close-Packed (HCP) crystal structure, the ratio between c and a is $\frac{\sqrt{8}}{3}$ ( ).
23. In Body-Centered Cubic (BCC) crystal structure, the number of atoms per unit cell is 4 ( ).
24. In Face-Centered Cubic (FCC) crystal structure, the coordination number for this structure is 10 ( ).
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27. In Body-Centered Cubic (BCC) crystal structure, the relation between atomic radius, R, and unit cell length, a, given by $a = \frac{4\sqrt{3}R}{3}$ ( ).
28. The substance in which measured properties are independent of the direction of measurement is isotropic material ( ).
29. In the Hexagonal Close-Packed (HCP) crystal structure, the number of atoms per unit cell is 4 ( ).
30. In Hexagonal Close-Packed (HCP) crystal structure, the relation between atomic radius, R, and unit cell length, a, given by $a = 2R$ ( ).
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32. The atomic radius (R) is defined as the distance between the atom center and the atom surface. ( ).
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Question (IV): **(9 Marks)**

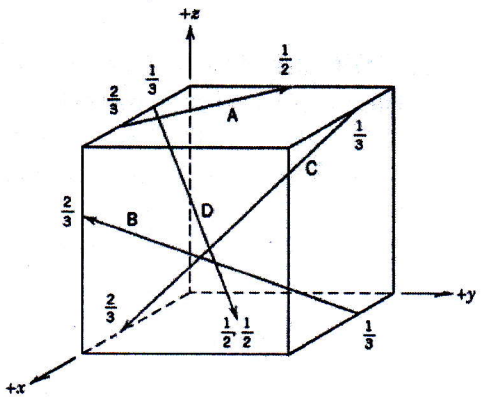
(A) Give reasons for <u>Two</u> from the following **(4 Marks)**

-X-rays can be used to detect the crystallinity of materials.

-The atomic packing factor always less than 1.

-The physical properties of single crystals of some substances depend on the crystallographic direction in which measurements are taken.

(B) Within the following cubic unit cell, determine **<u>Two only</u>** of the following directions A, B, C and D. Locate within a below cubic unit cell $11\frac{1}{2}$ point and Sketch (101) plane. **(5 Marks)**



BEST WISHES,,,

ASSIUT UNIVERSITY
FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS

Mathematical Physics – PHYS316 – Final Exam June 25, 2021 **Time 3 Hours**

Part #1 Written Exam ..... (50 Marks)

Circle the correct answer for the following questions: (*all questions carry the same weight* 2 points)

1- which is the following is an "even" function of t?

a) t^2 b) t^2-4t c) $\sin 3t+2t$ d) t^3+6

2- A "periodic function" is given by a function which:

a) has a period $T=2\pi$ b) satisfies $f(t+T)=f(t)$ c) satisfies $f(t+T)=-f(t)$ d) has a period $T=\pi$

3- If $2x-2y=10$ and $x+y=5$ then x equals

a) 8 b) 6 c) 7 d) 5

4- Which of the following is true

a) $\Gamma(n+1)=n\,\Gamma(n)$ for any real number
b) $\Gamma(n)=n\,\Gamma(n+1)$ for any real number
c) $\Gamma(n+1)=n\,\Gamma(n)$ for $n>1$
d) $\Gamma(n)=n\,\Gamma(n+1)$ for $n>1$

5- $\Gamma(n+1)=n!$ can be used when .....

a) n is any integer
b) n is a positive integer
c) n is a negative integer
d) n is any real number

6- Which of the following is not a definition of Gamma function

a) $\Gamma(n)=n!$

b) $\Gamma(n)=\int_0^{\infty} e^{-x}\,x^{n-1}\,dx$

c) $\Gamma(n+1)=n\,\Gamma(n)$

d) $\Gamma(n)=\int_0^{1} (\ln\frac{1}{y})^{n-1}\,dy$

7- What is the value of $\Gamma(1/2)$

a) $\sqrt{\pi}$ b) $\sqrt{\pi}/\sqrt{2}$ c) $\sqrt{\pi}/2$ d) $\pi/2$

8- What is the value of $\int_{-\infty}^{\infty} e^{-x^2}\,dx$

a) $\sqrt{\pi}$ b) $\sqrt{\pi}/\sqrt{2}$ c) $\sqrt{\pi}/2$ d) $\pi/2$

9- What is the value of $\Gamma(9/4)$

a) $(5/4)\times(1/4)\times\Gamma(1/4)$ b) $(9/4)\times(5/4)\times(1/4)\times\Gamma(1/4)$ c) $(9/4)\times\Gamma(5/4)$ d) $(1/4)\times\Gamma(1/4)$

10- What is the value of $\Gamma(5.5)$

a) $\frac{(11\times9\times7\times5\times3\times1\times\sqrt{\pi})}{32}$ b) $\frac{(9\times7\times5\times3\times1\times\sqrt{\pi})}{32}$ c) $\frac{(9\times7\times5\times3\times1\times\sqrt{\pi})}{64}$ d) $\frac{(11\times9\times7\times5\times3\times1\times\sqrt{\pi})}{64}$

11- What is the value of integral $\int_0^{\pi/2} \sqrt{\tan\theta}\,d\theta$

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

12- What is the value of integral $\int_0^1 \frac{x^2\,dx}{\sqrt{1-x^4}}$

a) $2\sqrt{\pi}\ \Gamma(\frac{5}{4})/\Gamma(\frac{1}{4})$ b) $2\pi\ \Gamma(\frac{3}{4})/\Gamma(\frac{1}{4})$ c) $\sqrt{\pi}\ \Gamma(\frac{3}{4})/\Gamma(\frac{1}{4})$ d) $2\sqrt{\pi}\ \Gamma(\frac{3}{4})/\Gamma(\frac{5}{4})$

13- $\Gamma(m).\Gamma(1\text{-}m) = \pi/\sin(m\pi)$, Check if the statement is true or false

a) True
b) False

14- What is the value of integral $\int_0^\infty \frac{dx}{(1+x^4)}$

a) $\sqrt{2}\ \pi/4$ b) $\sqrt{3}\ \pi/6$ c) $\sqrt{2}\ \pi/6$ d) $\sqrt{3}\ \pi/4$

15- Find a_n if the function $f(x) = x - x^3$

a) finite value b) infinite value c) zero d) can't be found

16- $\beta(m,n) = \beta(n,m)$ is the statement is true or false

a) True
b) False

17- Which of the following function is not called the Beta function:

a) $\beta(m,n) = \int_0^1 x^{m-1}\,(1-x)^{n-1}\,dx, \quad (m>0, n>0)$ b) $\beta(m,n) = 2\int_0^{\pi/2} \sin^{2m-1}(\theta)\cos^{2n-1}(\theta)\,d\theta$

c) $\beta(m,n) = \int_0^\infty \frac{y^{m-1}}{(1+y)^{m+n}}\,dy$ d) $\beta(m,n) = \int_0^{\pi/2} \sin^{2m-1}(\theta)\cos^{2n-1}(\theta)\,d\theta$

18- What is the value of $\beta(m, 1/2)$

a) $\sqrt{\pi}\,\Gamma(m)/\Gamma(m+\pi)$ b) $\sqrt{\pi}\,\Gamma(m)/\Gamma(m+1/2)$ c) $\Gamma(m)/2\Gamma(m+1/2)$ d) $\Gamma(m)/2\Gamma(m+\pi)$

19- What is the value of $\beta(3,2)$

a) $1/14$ b) $1/16$ c) $1/12$ d) $1/10$

20- What is the value of $\beta(3/2, 2)$

a) $4\sqrt{2}/15$ b) $8/15$ c) $\sqrt{2}/15$ d) $4/15$

21- What is the value of integral $\int_0^\infty \frac{dy}{(1+y)^5}$

a) $1/2$ b) $1/3$ c) $1/4$ d) $1/5$

22- What is the value of integral $\int_0^\infty \frac{dx}{1+x^4}$

a) $\pi\sqrt{2}/4$ b) $16\pi/9\sqrt{3}$ c) $1/4\ \ \beta(1/4, 3/4)$ d) $1/4\sqrt{3}\ \ \beta(1/2, 3/4)$

23- What is the value of integral $\int_0^1 \frac{y^5 + y^2}{(1+y)^9}\, dy$

a) $1/158$ b) $2/167$ c) $1/146$ d) $1/168$

24- What is the value of integral $\int_0^1 x^5 (1-x)^6 \, dx$

a) $\frac{1}{11\times9\times8\times7}$ b) $\frac{1}{12\times11\times10\times9\times8}$ c) $\frac{1}{12\times11\times10\times9\times8}$ d) $\frac{1}{12\times11\times10\times9\times8\times7\times6}$

25- What is the Fourier series expansion of the function in the interval (c, c+2π)

a) $\frac{a_o}{2} + \sum_{n=1}^{\infty} a_n \cos(nx) + \sum_{n=1}^{\infty} b_n \sin(nx)$ b) $a_o + \sum_{n=1}^{\infty} a_n \cos(nx) + \sum_{n=1}^{\infty} b_n \sin(nx)$

c) $\frac{a_o}{2} + \sum_{n=0}^{\infty} a_n \cos(nx) + \sum_{n=0}^{\infty} b_n \sin(nx)$ d) $a_o + \sum_{n=0}^{\infty} a_n \cos(nx) + \sum_{n=0}^{\infty} b_n \sin(nx)$

Part #2 Duties ..... (10 Marks)

1- Laplace of function f(t) is given by

a) $f(s) = \int_0^{\infty} e^{-st} f(t)\, dt$ b) $F(t) = \int_{-\infty}^{\infty} e^{-t} f(t)\, dt$ c) $f(s) = \int_{-\infty}^{\infty} e^{-st} f(t)\, dt$ d) $f(t) = \int_{-\infty}^{\infty} e^{-t} f(t)\, dt$

2- Laplace transform if $\sin(at)$ is

a) $s/(a^2+s^2)$ b) $a/(a^2+s^2)$ c) $s^2/(a^2+s^2)$ d) $a^2/(a^2+s^2)$

3- Laplace transform if $\cos(at)$ is

a) $s/(a^2+s^2)$ b) $a/(a^2+s^2)$ c) $s^2/(a^2+s^2)$ d) $a^2/(a^2+s^2)$

4- Laplace transform if $e^t \sin(at)$ is

a) $a/(a^2+(s+1)^2)$ b) $a/(a^2+(s-1)^2)$ c) $(s+1)/(a^2+(s+1)^2)$ d) $(s+1)/(a^2+(s-1)^2)$

5- Laplace transform if $t^2 \sin(2t)$ is

a) $\frac{12s^2-16}{(s^2+4)^4}$ b) $\frac{3s^2-4}{(s^2+4)^3}$ c) $\frac{12s^2-16}{(s^2+4)^6}$ d) $\frac{12s^2-16}{(s^2+4)^3}$

Part #3 Oral Exam ..... (10 Marks)

1- Find the Laplace transform of $t^{5/2}$

a) $\frac{15}{8}\frac{\sqrt{\pi}}{s^{5/2}}$ b) $\frac{15}{8}\frac{\sqrt{\pi}}{s^{7/2}}$ c) $\frac{9}{4}\frac{\sqrt{\pi}}{s^{7/2}}$ d) $\frac{15}{4}\frac{\sqrt{\pi}}{s^{7/2}}$

2- If $f(t) = \sinh(at)$, then its Laplace transform is

a) e^{at} b) $s/(s^2-a^2)$ c) $a/(s^2-a^2)$ d) exists only if 't' is complex

3- If $f(t)=\cosh(at)$, then its Laplace transform is

a) $s/(s^2-a^2)$ b) $(s+a)/(s-a)$ c) indeterminate d) $(sinh(at))^2$

4- If $f(t)=e^{at}\sin(bt)$, then its Laplace transform is given by

a) $(s^2-a^2)/(s-a)^2$ b) $(s+a)/(s-a)$ c) indeterminate d) $b/(s-a)^2+b^2$

5- If $f(t)=e^{at}\cos(bt)$, then its Laplace transform is given by

a) $2a^3/(s^2+a^2)$ b) $b/(s+a)^2+b^2$ c) indeterminate d) $(s-a)/(s-a)^2+b^2$

Part #4 Midterm Exam ..... (30 Marks)

1- if the function f(x) is even, then which of the following is zero

a) a_o b) b_n c) a_n d) nothing is zero

2- if the function f(x) is odd, then which of the only coefficient is present

a) a_o b) b_n c) a_n d) everything is present

3- If $f(t)=1$, then its Laplace transform is given by

a) s b) $1/s$ c) does not exist d) 1

4- If $f(t)=t^n$, where n is an integer greater than zero, then its Laplace transform is given by?

a) n! b) t^{n+1} c) does not exist d) $n!/s^{n+1}$

5- If $f(t)=\sqrt{t}$, then its Laplace transform is given by

a) $\sqrt{\pi}/2\sqrt{s}$ b) $1/s$ c) does not exist d) $\sqrt{\pi}/2s^{3/2}$

6- If $f(t)=t\cos(at)$, then the Laplace transform is

a) $1/(s-a)$ b) $(s^2-a^2)/(s^2+a^2)^2$ c) s^2 at d) indeterminate

7- What is the value of $\int_0^\infty e^{-x^4}\,dx$

a) $\Gamma(5)$ b) $\Gamma(1/4)/4$ c) $\Gamma(1/4)$ d) $\Gamma(1/5)$

8- What is the value of $\int_0^{\infty} e^{-5x^3}\,dx$

a) $\frac{\Gamma(1/3)}{3\sqrt[3]{5}}$ b) $\frac{\Gamma(3)}{3}$ c) $\frac{\Gamma(1/3)}{3\sqrt{5}}$ d) $\frac{\Gamma(1/3)}{15}$

9- Find a_0 if the function $f(x) = 5x - 8x^5$

a) finite value b) infinite value c) zero d) can't be found

10- What is the value of $\Gamma(-1/2)$

a) $-2\sqrt{\pi}$ b) $\sqrt{\pi}/2$ c) $-2/\sqrt{\pi}$ d) $-\sqrt{\pi}$

11- What is the value of $\int_0^{\pi} \sin^5 u\,du$

a) 12π b) $\sqrt{\pi}$ c) 5! d) 16/15

12- What is the value of $\int_0^{2\pi} \cos^6 u\,du$

a) $15\pi/8$ b) $\sqrt{\pi}/8$ c) $5\pi/8$ d) $15\pi/48$

13- What is the value of $\int_0^{\pi/2} \cos^3 u \sin^5 u\,du$

a) 24 b) 1/24 c) $\pi/2$ d) 1/12

14- If $f(t)=e^{at}$, then its Laplace transform is given by

a) $s-a$ b) $1/(s-a)$ c) does not exist d) $1/s$

15- If $f(t)=4e^{-5t}$, then its Laplace transform is given by

a) $s+5$ b) $1/(s+5)$ c) $4/(s+5)$ d) $4/(s-5)$

Best wishes
Prof Dr A. A. Ebrahim

جامعة أسيوط - كلية العلوم – قسم الفيزياء

Final Exam - Second Term: (2021) – June 19, 2021

Methods of Crystal growth and Physical Properties of Crystals (354P)

Exam in 6 pages

Part I: Final Exam (50 marks)

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

1. In Bridgmann method the compression of the solid by the contracting container during cooling can lead to the development of stresses ..... enough to nucleate dislocations in the material.
   (a) Average (b) high (c) Low (d) very Low
2. Czochralski method is ..... used for growing semi conducting material crystal
   (a) simple (b) complex (c) widely (d) distress
3. In Pulling method Technique The shape of the crystal is .....
   (a) fettered (b) free (c) complex (d) simple
4. Czochralski method used extensively in the ..... industry
   (a) conductive (b) conductor (c) insulator (d) semiconductor
5. In general ..... method is not suitable for incongruently melting compounds
   (a) Bridgmann (b) Skull. (c) Czochralski (d) Vernuil
6. There is no container which eliminates the problem of physical-chemical interaction between the melt and the container material in ..... method.
   (a) Vernuil (b) Czochralski (c) Bridgmann (d) Skull
7. The ... degree of perfection and less number of defects have been observed in gel growth
   (a) high (b) lessen (c) small (d)Lange
8. In ....., a liquid zone is created by melting a small amount of materials in a relatively large or long solid charge.
   (a) vernuil method (b) Skull method
   (c) Bridgmann method (d) Zone melting
9. In Zone melting technique, impurities tend to be .... in the melted portion of the sample
   (a) pure (b) un pure (c) concentrated (d) pure
10. VAPOUR GROWTH Techniques for growing crystals from vapour is divided into...
    (a) Chemical transport method. (b) Physical transport method.
    (c) A and B (d) none of above
11. When you imagine new nanowire-based structures with new properties and functionalities, you must consider:
    a) the degree of confinement including possible quantum confinement
    b) the large surface-to-volume ratio intrinsic to nanowires
    c) the length scale defined by the nanowire diameter and the quality of the nanowire growth
    d) All mentioned
12. Nanowire dimensions determine the degree of confinement, and consequently affects
    a) The behavior of charge carriers in quantum electronic devices
    b) The number of charges in quantum electronic devices

c) The behavior of charge carriers in classical electronic devices
d) In changing the quantum characteristics in electronic devices

13. Phase purity is essential because it directly has effect on
a) The electronic properties of the nanowires
b) The band-structure and electronic properties of the nanowires
c) The band-structure properties of the nanowires
d) None of the above

14. During the annealing and growth processes, the Au nanoparticle alloys with specific ..... elements to form a liquid or solid alloy.
a) group III and group IV b) group III
c) group III and group V d) group IV

15. Binary and ternary phase diagrams indicate which alloy phases are stable at ....., during annealing, and at ..... .
a) room temperature, the growth temperature
b) growth temperature, the room temperature
c) zero kelvin temperature, the growth temperature
d) 380 °C, 273°C

16. According to the conventional VLS and VSS mechanisms, reaction species dissolve into the nanoparticle and are transported to the growth interface via ..... through the nanoparticle
a) growth interface b) bulk diffusion c) high solubility d) nucleation

17. There are two major growth modes taking place during Au-assisted nanowire growth by MOCVD:
a) axial growth and radial growth
b) Non-uniform lateral growth and Uniform normal growth
c) Laser-heated pedestal growth and conformal growth
d) Low-temperature solution growth and Hydro-Thermal Growth

18. ..... morphologies, whereby nanowires exhibit wider bases and taper to narrower Au-capped tips, are a consequence of radial growth.
a) Condensed nanowire b) Electronic nanowire
c) Tapered nanowire d) None of the above

19. ..... is used to identify general nanowire morphology, including facet planes, diameter, and height.
a) Cathodoluminescence microscope
b) Transmission electron microscopy
c) Energy-dispersive X-ray spectroscopy
d) Field emission scanning electron microscopy

20. The X-ray radiation most commonly used is that emitted by .....
a) Iron b) Aluminum c) Copper d) Sulfur

21. .....is a non-destructive analytical technique which provides detailed information about the internal lattice of crystalline substances.
a) polycrystalline X-ray Diffraction
b) Single-crystal X-ray Diffraction
c) Single-crystal gamma-ray Diffraction
d) polycrystalline gamma-ray Diffraction

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

23. Filter fluorometers often employ.....
    a) a high-pressure mercury vapor lamp
    b) a low Viscosity mercury liquid lamp
    c) a low-pressure mercury vapor lamp
    d) a high Viscosity mercury liquid lamp

24. ..... the most popular vibrational spectroscopic technique used to identify the functional groups in organic and inorganic compounds.
    a) Thermal analyses technique.
    b) Power Compensation.
    c) Infrared spectroscopic technique.
    d) Micro hardness technique.

25. Thermo gravimetric analysis has widely been used in .....
    a) testing of sample purity b) study of organic compounds
    c) oxide mixtures and glass technology d) all of them.

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

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

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

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

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

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

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

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

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

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

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

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

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

39. X-rays occur in that portion of the electromagnetic spectrum between gamma-rays and the .....
a) visible light
b) ultraviolet rays.
c) infrared rays
d) radio waves.

40. X-ray crystallography may be used to determine the material structure such as .....
a) how the atoms pack together.
b) what the interatomic distance.
c) what is the angle.
d) all of them.

41. In the equation, $\tan\delta=1/\omega RC$, $\tan\delta$ is referred to as the .....
(a) dielectric emission
b) dielectric reflection.
c) dielectric absorption
d) dielectric loss.

42. In equation, $D = \varepsilon_{\circ} E$, $\varepsilon_{\circ}$, is called .....
a) the absolute permittivity
b) The magnetic permeability.
c) relative permeability
d) Other

43. In equation, $D = \varepsilon_{\circ} E$, D is called the.....
a) Permittivity
b) Charge density
c) Electric field
d) Magnetic field

44. In the diffraction of X-rays, the Path difference between two waves is .....
a) $\lambda = dsin\theta$
b) $\lambda = 2dsin\theta$
c) $n\lambda = dsin\theta$
d) $n\lambda = 2dsin\theta$

45. In the diffraction of X-rays, the constructive interference between two waves is .....
a) $n\lambda = x$
b) $\lambda = 2x$
c) $n\lambda = 2x$
d) $\lambda = x$

46. The equation of Bragg's law is .....
a) $n\lambda = 2dsin\theta$
b) $n\lambda = 2d$
c) $n\lambda = 2xsin\theta$
d) $n\lambda = 2x$

47. When the incident beam strikes a powder sample, diffraction occurs in every possible orientation of an angle equals to.....
a) θ
b) 2θ
c) 3θ
d) 4θ

48. X-ray diffractometers consist of.....
    a) X-ray tube
    b) X-ray detector
    b) Sample holder
    d) All of them
49. UV-Visible spectroscopy is useful in characterizing the..... of variety of technologically important materials such as pigments.
    a) absorption
    c) reflectivity
    b) transmission
    d) all of them.
50. Spectrofluorometers need a ..... radiation source and are often equipped with a 75-450 W high-pressure Xenon arc lamp.
    a) Continuous
    c) Both (a) and (b).
    b) Hesitating
    d) None of all.

Part II (30 marks)

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

51. Nanowire-based optical sensors use the evanescent molecules
52. Nanowire-based LEDs employing quantum-dot sections embedded within a nanowire
53. Coaxial nanowire structures can work as solar cells
54. Template-directed method relies on anisotropy of growth rates
55. III–V nanowires are compatible with existing semiconductor technologies can be readily integrated with Si-based microelectronics
56. Crystallographic defects such as stacking faults and twin planes
57. The VSS mechanism, so-called due to the vapor, liquid and solid phases involved
58. Deposition of III–V material occurs preferentially at the nanoparticle–substrate interface, so that nanowire nucleation takes place
59. Fluorescence spectrometers use double-beam optics to compensate for power fluctuations in the source.
60. The most important applications of thermo gravimetric are found in weight loss of material.
61. Thermograms give information about decomposition mechanisms for material.
62. In Differential thermal analysis, vapor is applied to the system. (False) Heat
63. In equation $Hv = \frac{1.8544\,P}{d^2}\ Kg/mm\ (or) pascal$, d is the diagonal length of the indentation mark in mm.
64. Dielectric measurement is one of the useful characterizations of magnetic response of solids.
65. The dielectric loss is a measure of the energy absorbed by a dielectric
66. The complete combustion in Elemental Analyzer occurs with special or expensive catalysts.
67. Each crystalline solid has its unique characteristic X-ray powder pattern which may be used as a fingerprint for its identification.
68. X-ray powder diffraction is most widely used for the identification of unknown crystalline materials such as minerals and inorganic compounds.
69. The FTIR varies from the traditional dispersive spectrometer mainly due to the use of the interferometer instead of a monochromator.
70. Infrared spectroscopy is extensively applied to various samples such as liquid, gas and solid-sate matter to identify the unknown materials.
71. Fluorometers use filters to restrict excitation and emission beam wavelengths.

72. Elemental Analysis is the measurement of the difference in temperature (ΔT) between sample and a reference, as heat is applied to the system.
73. Fluorometers use either interference or absorption filters while Spectrofluorometers are usually fitted with grating monochromators.
74. Photomultiplier tubes are in common use as detectors.
75. DSC refers to the Differential Scanning calorimetry.
76. DSC is a commercially available instrument which has two types: Heat Flux Type and Power Compensation Type.
77. The action of an electric field brings the charges of the molecules of the dielectric into a certain ordered arrangement in space.
78. Dark current is not a constant background current but also has fluctuations or noise.
79. In a nonlinear process, the oscillation of electrons will eventually become a harmonic.
80. Nonlinear optical phenomena find wide applications in the area of laser technology, laser communication, and data storage technology

Best wishes, Prof. Mohamed Amokhtar

كلية العلوم – قسم الفيزياء

جامعة اسيوط

Final Exam. "Diffraction rays & its applications" (352 P)

June. 2021

time: 3 hours

Answer the following Question:

A) Choose the right answer between brackets:

1) Crystallographic planes with different atomic arrangement are existing in(polycrystalline solids - unit cell - space lattice)

2) The value of the packing factor of simple cubic must be (lower- higher – equal) than that of the FCC- cubic system.

3) If d-spacing have the same order of magnitude of lattice parameter the crystalline plane is (*010, 011, 110, 101*).

4) The diameter of cubic face must includes two atoms in (S. cubic – FCC – BCC).

5) The highest intensity of the X-ray beam is produced when the electron jumping from (M → L- M → K- L → K) level.

6) A monochromatic X-ray beam used to study the crystal structure of (single crystal–poly crystalline–crystalline) material.

7) The wavelength of the linear X-ray spectrum depends on the (accelerating voltage – type of the target – both of them).

B) Transfer the following sentences after putting a check mark right or wrong:

1) Space lattice represents an infinite arrangement of array points in one dimension

2) One can not prepare the perfect crystal due to surface effects.

3) For the 2nd order reflections the wavelength of the incident X-ray beam must be equal the d- spacing.

4) Packing atoms through simple cubic required that each face includes only one atom.

5) A continuous X-ray beam used to study the crystal structure of poly crystalline material.

6) The linear X-ray spectrum is characterized by two different peaks with different intensities.

7) All the grains of the poly crystalline material having the same atomic arrangement.

8) The energy of the incident neutron beam must be equal the vibration energy at high temperature.

Answer only three Questions:

2. a) Prove that the Bragg's low for n-order reflections is expressed as: $n\lambda = 2d\sin\theta$, explain in details the necessary conditions required for applying this low.

b) A certain crystal reflect monochromatic X-rays strongly when the Bragg's angle of the 3d order is 51^0, satisfy the Bragg's reflection for the 1st and 2nd order spectrum.

c) Explain the steps involved in producing the linear spectrum of the X-ray.

3. a) Find the dependence of the atomic radius on the lattice constant for the simple and BCC structures.

b) Illustrate with the eqns. that the lattice parameter of cubic system is related to d-spacing of the set parallel crystalline planes having the same Miller indices (*hkl*) as: $a = d(h^2 + k^2 + \ell^2)^{1/2}$. Apply this eqn. to find the d-spacing ratio for (*010*)-crystalline plane of the BCC and FCC cubic system.

c) Aluminum has FCC structure with the atomic radius 1.43 A^0, If energetic X-ray beam of 7.38 KeV incident on (100) plane, calculate the Bragg's angle considering the1St order reflection (h = 6.62×10^{-34} J.sec).

للأسئلة بقية فى الورقة التالية ←

4. a) Prove that the quantity: $[1-\frac{(1-\mu^2)}{sin^2\theta}]^{1/2}$ represents the modification of Bragg's low for the higher reflections of X-ray beam , where μ is the refractive index of the crystal.

b) Show with the eqn. a theoretical method used for identification of the crystallographic planes. If the Miller indices satisfy that: $h^2+k^2+\ell^2 = 14$, 7, and 22 determine the different available crystalline planes.

c) Explain by the eqns. the necessary conditions for studying the crystal structure by neutron diffraction.

---

5. a) Explain an experimental method used to study the crystal structure by applying the XRD data.

b) X-ray beam with energy 2.7 KeV incident on BCC crystal with angle 30^0 , determine the crystalline plane reflected the 1st the order spectrum (given: atomic radius of 0. 2 nm, and h = $6.62\text{x}10^{-27}$ erg.sec)

c) Write short notes about: (i) Braggs reflections, (ii) diatomic crystal structure, and (iii) X-ray absorption.

انتهت الأسئلة

تمنياتي بالتوفيق .....أ.د. عبد المنعم سلطان

Physics Department

Second Term Final Exam 2020/2021

Electromagnetic Theory & Electrodynamics (phy312)

Section A: (Final Term Exam): Identify the choice that best completes the statement or answers the question. **[50 marks]**

1) When a particle of charge q and mass m enters into a uniform magnetic field B moving with a velocity v perpendicular to the direction for the field it describes a circular path of radius

a) $R=qB/mV$ b) $R=mV/qB$

c) $R=qmV/B$ d) $R=qmB/V$

2) Given that $f(x,y,z) = sin(xyz)$ what is del f?

a) $xz\ sin\ (xyz)\ \mathbf{i} + xz\ sin\ (xyz)\ \mathbf{j} + xz\ sin\ (xyz)\ \mathbf{k}$

b) $xy\ cos\ (xyz)\ \mathbf{i} + yz\ cos\ (xyz)\ \mathbf{j} + xz\ cos\ (xyz)\ \mathbf{k}$

c) $yz\ cos\ (xyz)\ \mathbf{i} + xz\ cos\ (xyz)\ \mathbf{j} + xy\ cos\ (xyz)\ \mathbf{k}$

d) $yz\ cos\ (xyz)\ \mathbf{i} + xz\ sin\ (xyz)\ \mathbf{j} + xz\ cos\ (xyz)\ \mathbf{k}$

3) Given that $f(x,y,z) = xyz + xy + z$ what is del f?

a) $(yz + y)\ \mathbf{i} + (xy + 1)\ \mathbf{j} + (xz + y)\ \mathbf{k}$ b) $(yz + y)\ \mathbf{i} + (xy + 1)\ \mathbf{j} + (xz + y)\ \mathbf{k}$

c) $(xy + z)\ \mathbf{i} + xyz\ \mathbf{j} + xy\ \mathbf{k}$ d) $(yz + y)\ \mathbf{i} + (xz + x)\ \mathbf{j} + (xy + 1)\ \mathbf{k}$

4) What is the divergence of the vector field $\mathbf{F}$ where $\mathbf{F} = sin\ x\ \mathbf{i} + sin\ y\ \mathbf{j} + sin\ z\ \mathbf{k}$?

a) $cos\ x + cos\ y + cos\ z$ b) $cos\ x + sin\ y + sin\ z$

c) $sin\ x + sin\ y + sin\ z$ d) $sin\ x + cos\ y + cos\ z$

5) What is the divergence of the vector field $\mathbf{F}$ where $\mathbf{F} = xy\ \mathbf{i} + z\ \mathbf{k}$?

a) $x + 1$ b) $y + 1$ c) $z + 1$ d) $x + y + z$

6) The electric field intensity at a point situated 4 metres from a point charge is 200 N/C. If the distance is reduced to 2 meters, the field intensity will be

a) 400 N/C b) 600 N/C c) 800 N/C d) 1200 N/C

7) The force between two charges is 120 N. If the distance between the charges is doubled, the force will be

a) 60N b) 30N c) 40N d) 15N

8) What is the divergence of the vector field **F** where $\mathbf{F} = xyz\,\mathbf{i} + xyz\,\mathbf{j} + xyz\,\mathbf{k}$?

a) $yz + xz + xy$ b) $xyz + xy + x$ c) $xyz + yz + z$ d) *infinity*

9) What is the curl of the vector field **F** where $\mathbf{F} = x\mathbf{i} + yz\mathbf{j}$?

a) $-x\,\mathbf{i}$ b) $-y\,\mathbf{i}$ c) $-x\,\mathbf{j}$ d) $-y\,\mathbf{j}$

10) What is the curl of the vector field **F** where $\mathbf{F} = yz\,\mathbf{i} + xy\,\mathbf{j} + xz\,\mathbf{k}$?

a) $(x + y)\,\mathbf{j} + (x + z)\,\mathbf{k}$ b) $(x - y)\,\mathbf{j} + (x - z)\,\mathbf{k}$

c) $(y - z)\,\mathbf{j} + (y - z)\,\mathbf{k}$ d) $(x + z)\,\mathbf{j} + (x + z)\,\mathbf{k}$

11) What is the curl of the vector field **F** where $\mathbf{F} = x\,\mathbf{i} + xyz\,\mathbf{j} + z\,\mathbf{k}$?

a) $-xz\,\mathbf{i} + xy\,\mathbf{j}$ b) $-xz\,\mathbf{i} + yz\,\mathbf{k}$ c) $-xy\,\mathbf{j} + yz\mathbf{k}$ d) $-xy\,\mathbf{i} + yz\,\mathbf{k}$

12) Which of the following theorem use the curl operation?

a) Green's theorem b) Gauss Divergence theorem

c) Stoke's theorem d) Maxwell equation

13) Find the curl of $\mathbf{A} = (y\cos ax)\mathbf{i} + (y + e^x)\mathbf{k}$

a) $2\mathbf{i} - e^x\,\mathbf{j} - \cos ax\,\mathbf{k}$ b) $\mathbf{i} - e^x\,\mathbf{j} - \cos ax\,\mathbf{k}$

c) $2\mathbf{i} - e^x\,\mathbf{j} + \cos ax\,\mathbf{k}$ d) $\mathbf{i} - e^x\,\mathbf{j} + \cos ax\,\mathbf{k}$

14) Given the potential $V = 25\sin\theta$, in free space, determine whether V satisfies Laplace's equation

a) Yes b) No

c) Data sufficient d) Potential is not defined

15) Find the Laplace equation value of the following potential field $V = x^2 - y^2 + z^2$

a) 0 b) 2 c) 4 d) 6

16) Calculate the Green's value for the functions $F = y^2$ and $G = x^2$ for the region $x = 1$ and $y = 2$ from origin.

a) 0 b) -2 c) 2 d) 1

17) Find the Laplace equation value of the following potential field

$V = \rho \cos\varphi + z$

a) 0 b) 1 c) 2 d) 3

18) The Laplace equation value of the following potential $V = 3x^2 - y^2 + z^2$

a) 0 b) 2 c) 4 d) 6

19) Find the electric field intensity of two charges *2C* and *-1C* separated by a distance *1m* in air.

a) $18 X 10^9 N/C$ b) $9 X 10^9 N/C$ c) $36 X 10^9 N/C$ d) $-18 X 10^9 N/C$

20) Which of the following theorem convert line integral to surface integral?

a) Gauss divergence and Stoke's theorem b) Stoke's theorem only

c) Green' s theorem only d) Stoke's and Green's theorem

21) The electric field intensity of two charges *2C* and *-1C* separated by a distance *1m* in air.

a) $18 X 10^9 N/C$ b) $9 X 10^9 N/C$

c) $36 X 10^9 N/C$ d) $-18 X 10^9 N/C$

22) The Stoke's theorem uses which of the following operation?

a) Divergence b) Curl c) Gradient d) Laplacian

23) The electric field intensity is defined as

a) Force per unit charge b) Force on a test charge

c) Force per unit charge on a test charge d) Product of force and charge

24) The divergence theorem value for the function given by $(e^z, \sin x, y^2)$

a) 1 b) 0 c) -1 d) 2

25) The force on a charge *2C* in a field *1V/m*

a) *0 N* b) *1 N* c) *2 N* d) *3 N*

26) Find the Gauss value for a position vector in Cartesian system from the origin to one unit in three dimensions

a) *0* b) *3* c) *-3* d) *1*

27) A point charge 2nC is located at origin. What is the potential at *(1,0,0)*?

a) *12* b) *14* c) *16* d) *18*

28) Find the angle at which the potential due a dipole is measured, when the distance from one charge is 12cm and that due to other is 11cm, separated to each other by a distance of 2cm.

a) 15° b) 30° c) 45° d) 60°

29) A point charge $0.4\,nC$ is located at *(2, 3, 3)*. Find the potential differences between *(2, 3, 3)m* and *(-2, 3, 3)m* due to the charge

a) *2.5* b) *2.6* c) *2.7* d) *2.8*

30) In a magnetic field of $2.50 \times 10^{-3}\ T$, if magnetic force is equal to proton's weight, then the proton moves with the speed of

a) $4.09\times10^{-5} m/s$ b) $9 \times 10^{-2}\ m/s$ c) $5.4\times10^{-2}\ m/s$ d) $1.4\times10^{-2} m/s$

31) If $\int H.dL = 0$, then which statement will be true?

a) $\mathbf{E} = -\text{Grad}(V)$ b) $\mathbf{B} = -\text{Grad}(\mathbf{D})$

c) $\mathbf{H} = -\text{Grad}(V_m)$ d) $\mathbf{D} = -\text{Grad}(\mathbf{A})$

32) A total charge of 6.3×10^{-8} C is distributed uniformly throughout a 2.7 cm radius sphere. The volume charge density is:

a) $6.9 \times 10^{-6}\ C/m^3$ b) $6.9 \times 10^{-6}\ C/m^2$

c) $2.5 \times 10^{-4}\ C/m^3$ d) $7.6 \times 10^{-4}\ C/m^3$

33) A cylinder has a radius of 2.1 cm and a length of 8.8 cm. Total charge 6.1×10−7 C is distributed uniformly throughout. The volume charge density is:

a) $5.3 \times 10^{-5}\ C/m^2$ b) $8.5 \times 10^{-4}\ C/m^3$

c) $6.3 \times 10^{-5}\ C/m^2$ d) $5.0 \times 10^{-3}\ C/m^3$

34) Find the potential due the dipole when the angle subtended by the two charges at the point P is perpendicular.

a) 0 b) Unity c) ∞ d) $-\infty$

35) A point particle with charge q is at the center of a Gaussian surface in the form of a cube. The electric flux through any one face of the cube is:

a) q/ε_o b) $q/4\pi\varepsilon_o$ c) $q/3\pi\varepsilon_o$ d) $q/6\varepsilon_o$

36) A particle with a charge of $5.5\times10^{-8}C$ is $3.5\ cm$ from a particle with a charge of $-2.3\times10^{-8}\ C$, The potential energy of this two-particle system, relative to the potential energy at infinite separation, is:

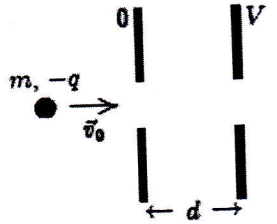
a) 3.2×10^{-4} J b) -3.2×10^{-4} J

c) 9.3×10^{-3} J d) -9.3×10^{-3} J

37) If $500J$ of work are required to carry a charged particle between two points with a potential difference of $40V$, the magnitude of the charge on the particle is:

a)0.040C b) 12.5C c) 20C d) 200C

38) A particle with mass m and charge $-q$ is projected with speed v_o into the region between two parallel plates as shown. The potential difference between the two plates is V and their separation is d. The change in kinetic energy of the particle as it traverses this region is:



a) $-qV/d$ b) $2qv/m_o^2$ c) qV d) $6qv/m_o^2$

39) An electric dipole consists of a particle with a charge of $+6\times10^{-6}C$ at the origin and a particle with a charge of $-6 \times 10^{-6}C$ on the x axis at $x = 3\times 10^{-3}m$. Its dipole moment is:

a.) $1.8 \times 10^{-8}\ C\cdot m$, in the positive x direction

b.) $1.8 \times 10^{-8}\ C\cdot m$, in the negative x direction

c.) 0 because the net charge is 0

d.) $1.8 \times 10^{-8}\ C\cdot m$, in the positive y direction

40) The potential due to the dipole on the midpoint of the two charges will be

a) 0 b) Unity c) ∞ d) $-\infty$

41) Two protons are about 10^{-10} m apart. Their relative motion is chiefly determined by:

a) gravitational forces
b) electrical forces
c) nuclear forces
d) magnetic forces

42) An electron is launched with velocity **v** in a uniform magnetic field **B**. The angle θ between **v** and **B** is between 0 and 90°. As a result, the electron follows a helix, its velocity vector **v** returning to its initial value in a time interval of:

a) $2\pi m/eB$
b) $2\pi mv/eB$
c) $2\pi mv \sin\theta/eB$
d) $2\pi mv \cos\theta/eB$

43) The potential due to a dipole at a point P from it is the

a) Sum of potentials at the charges
b) Difference of potentials at the charges
c) Multiplication of potentials at the charges
d) Ratio of potentials at the charges

44) The units of volume charge density are

a) Coulomb/metre^3
b) Coulomb/metre^2
c) Coulomb/metre
d) Coulomb^2/metre

45) An electron enters a region of uniform perpendicular E and **B** fields. It is observed that the velocity **v** of the electron is unaffected. A possible explanation is:

a) **v** is parallel to **E** and has magnitude E/B
b) **v** is parallel to **B**
c) **v** is perpendicular to both **E** and **B** and has magnitude B/E
d) **v** is perpendicular to both **E** and **B** and has magnitude E/B

46) An ion with a charge of $+3.2\times10^{-19}\ C$ is in a region where a uniform electric field of $5\times10^{4}\ V/m$ is perpendicular to a uniform magnetic field of $0.8T$. If its acceleration is zero then its speed must be:

a) 0
b) $1.6 \times 10^{4}\ m/s$
c) $4.0 \times 10^{4}\ m/s$
d) $6.3 \times 10^{4}\ m/s$

47) Calculate the distance between two charges of 4C forming a dipole, with a dipole moment of 6 units.

a) *1* b) 1.5 c) *2* d) *2.5*

48) Electrons (mass m, charge $-e$) are accelerated from rest through a potential difference V and are then deflected by a magnetic field **B** that is perpendicular to their velocity. The radius of the resulting electron trajectory is:

a) $(\sqrt{2eV/m})/B$ b) $B\sqrt{2eV}\ /m$

c) $(\sqrt{2mV/e}\ )/B$ d) $B\sqrt{2mV}\ /e$

49) Gauss' law for magnetism tells us that:

a) the net charge in any given volume

b) the line integral of a magnetic field around any closed loop must vanish

c) the magnetic field of a current element

d) magnetic monopoles do not exist

50) Calculate the dipole moment of a dipole with equal charges 2C and -2C separated by a distance of 2cm.

a) 0.02 b) 0.04 c) 0.06 d) 0.08

Section B: (Midterm Exam, Oral Exam & Semester Activities): [50 marks]

Section B1: Identify the choice that best completes the statement or answers the question:

51) If ∇ is an operator, then ∇V means:

a) Gradient of a Scalar field b) Curl of a vector field

c) Divergence of a Vector field d) None of these

52) Which of the following is a vector quantity?

a) Relative permeability b) Magnetic field intensity

c) Flux density d) Magnetic potential

53) The curl of $\bar{F}(x,y,z) = 3x^2\bar{\imath} + 2z\bar{\jmath} - x\bar{k}$ is

a) $-2\bar{\imath} + \bar{\jmath}$ b) $x + 2$ c) $x + y$ d) None of these

54) The divergence of the vector $y\bar{\imath} + z\bar{\jmath} + x\bar{k}$

a) 0 b) -1 c) 2 d) 3

55) Select the divergence of $\bar{F}(x,y) = \frac{x}{y}\bar{\imath} + (2x - 3y)\bar{\jmath}$.

a) $\frac{x}{y} - 3$ b) $\frac{x}{y^2} + 2$ c) $\frac{1}{y} - \frac{x}{y^2}$ d) None of these

56) The mathematical perception of the gradient is said to be

a) Tangent b) Chord c) Slope d) Arc

57) Divergence of gradient of a vector function is equivalent to

a) Laplacian operation b) Curl operation

c) Double gradient operation d) Null vector

58) In electromagnetic waves, the electric field will be perpendicular to which of the following?

a) Magnetic field intensity b) Wave propagation

c) Both H and wave direction d) It propagates independently

59) Find the curl of the vector and state its nature at (1,1,-0.2) $\mathbf{F} = 30\,\boldsymbol{i} + 2xy\,\boldsymbol{j} + 5xz^2\,\boldsymbol{k}$

a)$\sqrt{4.01}$ b)$\sqrt{4.02}$ c)$\sqrt{4.03}$ d)$\sqrt{4.04}$

60) Find the curl of $\mathbf{A} = (y \cos ax)\,\boldsymbol{i} + (y + e^x)\,\boldsymbol{k}$

a) $2\boldsymbol{i} - e^x\,\boldsymbol{j} - \cos ax\,\boldsymbol{k}$ b) $\boldsymbol{i} - e^x\,\boldsymbol{j} - \cos ax\,\boldsymbol{k}$

c) $2\boldsymbol{i} - e^x\,\boldsymbol{j} + \cos ax\,k$ d) $\boldsymbol{i} - e^x\,\boldsymbol{j} + \cos ax\,\boldsymbol{k}$

61) Find the curl of $\mathbf{A} = yz\,\boldsymbol{i} + 4xy\,\boldsymbol{j} + y\,\boldsymbol{k}$

a) $x\boldsymbol{i} + \boldsymbol{j} + (4y - z)\boldsymbol{k}$ b) $x\boldsymbol{i} + y\boldsymbol{j} + (z - 4y)\boldsymbol{k}$

c) $\boldsymbol{i} + \boldsymbol{j} + (4y - z)\boldsymbol{k}$ d) $i + yj + (4y - z)k$

62) Curl cannot be employed in which one of the following?

a) Directional coupler b) Magic Tee

c) Isolator and Terminator d) Waveguides

63) Find the value of divergence theorem for $A = xy^2\,i + y^3\,j + y^2z\,k$ for a cuboid given by $0<x<1$, $0<y<1$ and $0<z<1$.

a) 1 b) 4/3 c) 5/3 d) 2

64) The ultimate result of the divergence theorem evaluates which one of the following?

a) Field intensity b) Field density c) Potential d) Charge and flux

65) Find the value of divergence theorem for the field $D = 2xy\ i + x^2\ j$ for the rectangular parallelepiped given by x = 0 and 1, y = 0 and 2, z = 0 and 3.

a) 10 b) 12 c) 14 d) 16

66) Calculate the electric field intensity of a line charge of length 2m and potential 24V.

a) 24 b) 12 c) 0.083 d) 12.67

67) Calculate potential of a metal plate of charge 28C and capacitance 12 mF.

a) 3.33 kV b) 2.33 kV c) 3.33 MV d) 2.33 MV

68) The divergence theorem converts

a) Line to surface integral b) Surface to volume integral

c) Volume to line integral d) Surface to line integral

69) Find the charged enclosed by a sphere of charge density ρ and radius a.

a) $\rho\ (4\pi a^2)$ b) $\rho(4\pi a^3/3)$ c) $\rho(2\pi a^2)$ d) $\rho(2\pi a^3/3)$

70) If a function is said to be harmonic, then

a) Curl(Grad V) = 0 b) Div (Curl V) = 0

c) Div(Grad V) = 0 d) Grad(Curl V) = 0

71) The Laplacian operator cannot be used in which one the following?

a. Two dimensional heat equation b. Two dimensional wave equation

c. Poisson equation d. Maxwell equation

72) When a potential satisfies Laplace equation, then it is said to be

a) Solenoidal b) Divergent c) Lamellar d) Harmonic

73) Find the value of Stoke's theorem for $y\ \boldsymbol{i} + z\boldsymbol{j} + x\ \mathbf{k}$.

a. $i + j$ b. $j + k$ c. $i + j + k$ d. $-i - j - k$

74) The magnitude of the conduction current density for a magnetic field intensity of a vector yi + zj + xk will be

a) 1.414 b) 1.732 c) -1.414 d) -1.732

75) The Stoke's theorem can be used to find which of the following?

a) Area enclosed by a function in the given region

b) Volume enclosed by a function in the given region

c) Linear distance

d) Curl of the function

76) Differential form of Gauss's law in magneto statics is

a) div B = ρ/ε_o .

b) div B = 0

c) div B = -dB/dt

d) div B = μJ

77) Magnetic field can be produced by

a) Conduction current

b) Displacement current

c) Both a) and b)

d) It is produced naturally

78) If the velocity of a charged particle in perpendicular electric and magnetic field is 7.27 × 10^6m/s and the Electric field is 6 × 10^6 N/c, what should be the value of magnetic field for velocity sector?

a) *0.45 T* b) *0.78 T* c) *0.83 T* d) *0.94 T*

79) Which of the following laws do not form a Maxwell equation?

a) Planck's law

b) Gauss's Law

c) Faraday's law

d) Ampere's Law

80) Find the Maxwell first law value for the electric field intensity is given by A sin wt az

a) 0 b) 1 c) -1 d) A

Section B2: Read the statements carefully and identify whether they are true or false.

81) The divergence concept can be illustrated using Pascal's law. State, True/False.

a) True

b) False

82) Curl is defined as the angular velocity at every point of the vector field. State True/False.

a) True b) False

83) If potential $V = 20/(x^2 + y^2)$. The electric field intensity for V is $40(x\,\mathbf{i} + y\,\mathbf{j})/(x^2 + y^2)^2$. State True/False.

a) True b) False

84) Gradient of a function is a constant. State True/False.

a) True b) False

85) The divergence of a vector is a scalar. State True/False.

a) True b) False

86) Electromagnetic waves are longitudinal in nature. State True/False.

a) True b) False

87) The given equation satisfies the Laplace equation. $V = x^2 + y^2 - z^2$.

a) True b) False

88) Gauss law for electric field uses surface integral. State True/False

a) True b) False

89) Coulomb's law can be derived from Gauss law. State True/ False

a) True b) False

90) The fundamental theorem for divergences states that: $\oint_S \bar{D} \cdot d\bar{a} = \int_{vol} \nabla \cdot \bar{D} dv$

a) True b) False

91) The *flux* of **E** through a surface *S is* : $\varphi_E = \int_S \boldsymbol{E}.\boldsymbol{da}$

a) True b) False

92) The Lorentz force law is $\bar{F} = Q[\bar{E} + (\bar{v} \times \bar{B})]$

a) True b) False

93) The principle of superposition states that the interaction between any two charges is completely unaffected by the presence of others

a) True b) False

94) An electromagnet can produce very strong magnetic force as compared to permanent magnet.

a) True b) False

95) The *flux* of **E** through a surface *S* is a measure of the "number of field lines" passing through *S*.

a) True b) False

96) The entire theory of electromagnetic waves is contained in Maxwell's equations.

a) True b) False

97) Magnetic field has magnitude as well as direction.

a) True b) False

98) Magnetic poles exist in pairs.

a) True b) False

99) Magnetic field increases as we go away from a magnet.

a) True b) False

100) Magnetic lines of force always cross each other.

a) True b) False

End of Exam....Best Wishes.