



الاختصاص: فيزياء التحسس النائي والمعالجة الصورية

2 Short Note Questions

- Q.1) Describe briefly the steps that should be followed to perform the Block-Truncation Coding Technique.
- Q.2) What is the difference between the Average (mean) filter and the Median Filter. Which of them has minimum blurring effect?
- Q.3) The Fast Fourier Transformation Algorithm reduces the summing and multiplication operations from N^2 to $N \log_2 N$ operation. Explain How?
- Q.4) Describe briefly the steps of implementing the histogram equalization enhancement technique.
- Q.5) Contrast between cross truck and along truck scanner.
- Q.6) List four major characteristics of imaging satellites orbits.
- Q.7) List the variation that can be detected by remote sensing systems.
- Q.8) Discuss in brief the remote sensing model.



2- Short Note Questions:

Q.1) An ideal pendulum, its small-angle period is measured on the moon to be 0.4 second long. What must be the length of the pendulum arm? (Hint: assume that $m_{\text{moon}} = (1/6) m_{\text{earth}}$, exactly).

Q.2) A disk of mass M is constrained to roll down an inclined plane without slipping. Solve the Lagrange equations for motion.

Q.3) By plotting the temperature dependence of electrical resistivity, show how to differentiate between metal and semiconductor.

Q.4) There is no perfect solid due to the defects and dislocations, name them.

Q.5) Evaluate $\int \frac{\cos x \, dx}{\sin x}$.

Q.6) Find $\frac{dy}{dx}$ for $y = \cosh^2 5x - \sinh^2 5x$.

Q.7) Prove that : $H = \hbar \omega \left(a^\dagger a + \frac{1}{2} \right)$, where H is the Hamiltonian of the one dimensional harmonic oscillator, $a^\dagger$ is the rising operator and a is the lowering operator.

Q.8) Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 t / \hbar}$

What is the probability of measurements which give $E = E_2$?



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جامعة بغداد للعام الدراسي ٢٠١٥-٢٠١٦
الاختصاص: فيزياء التحسس النائي والمعالجة التصويرية
اولاً: الورقة العامة ٢٠%

1-Multiple Choice Questions:

Q.7) The absolute value of the real number x is defined by:

- (a) $|x| = \begin{cases} x, & \text{if } x < 0 \\ -x, & \text{if } x \geq 0 \end{cases}$ (b) $|x| = \begin{cases} x, & \text{if } x \geq 0 \\ -x, & \text{if } x < 0 \end{cases}$
(c) $|x| = x$ for $-\infty < x < \infty$, (d) $|x| = -x$ for $-\infty < x < \infty$.

Q.8) The result of $(e^{x_1})^{x_2}$ is given by:

- (a) $e^{x_1+x_2}$, (b) e^{x_1/x_2} , (c) $e^{x_1-x_2}$, and (d) $e^{x_1x_2}$.

Q.9) The Domain (D_0) and Range (R_0) of the function $y = \sqrt{x+4}$ are given by:

- (a) $D_0: x \geq -4$, $R_0: y \geq 0$ (b) $D_0: -\infty < x < \infty$, $R_0: y = 0$
(c) $D_0: x = 0$, $R_0: y = -4$. (d) $D_0: x \geq -4$, $R_0: y = 0$.

Q.10) The energy operator in quantum mechanics, $\hat{H} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} + V$

(here given for one particle in one dimension) is called the

- (a) Lagrangian (b) Hamiltonian
(c) Hermitian (d) Angular momentum

Q.11) The commutator $[L^2, L_x] =$:

- (a) 0 (b) $i\hbar L_x$ (c) $-i\hbar L_z$

Q.12) The probability of finding a particle in differential region dx is:

- (a) $\psi(x,t) dx$ (b) $\psi(x,t)/\psi^*(x,t) dx$ (c) $\psi^*(x,t)\psi(x,t) dx$



الاختصاص: فيزياء التحسس النائي والمعالجة الصورية

2 Multiple Choice Question:

- Q.1) Image Histogram Enhancement Methods are:
(a) Frequency enhancement methods; (b) Neighborhood dependent method;
(c) Pixel based enhancement method; (d) None of them.
- Q.2) Low-pass filters are performed in the:
(a) Spatial Domain (b) Frequency Domain (c) Time Domain (d) None of them.
- Q.3) Image Sharpening can be performed by;
(a) Averaging Filters (b) Contrast Enhancement Filters;
(c) High-Pass Filters; (d) High-Frequency Skipped Filters.
- Q.4) Lossless Compression Performance is Limited by:
(a) Correlation Factor (b) Fourier Transform Factor
(c) Entropy Factor; (d) Statistical Invariant Factor.
- Q.5) Convolution Process can be Presented in the Fourier Domain as:
(a) Additive Process (b) Logarithmic Process;
(c) Product Process; (d) Down Sampling Process.
- Q.6) Block Truncation Compression is:
(a) Lossless compression method (b) Entropy compression method;
(c) Frequency Domain Compression Method (d) Lossy compression method.
- Q.7) The Radiometric and Geometric corrections are classified as
(preprocessing, classification).
- Q.8) The GPS system operate in modes. (2, 4, & 3)
- Q.9) The remote sensors are used to record portions of spectrum.
(reflected, emitted, Both).
- Q.10) The Additive Color are, ..., and (MYC, RGB)
- Q.11) The most suitable spectral band for water detection is (Red, FIR, NIR)
- Q.12) Quick-Bird, & IKONOS are Imaging satellites. (Earth resources, high resolution).

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الاختصاص: فيزياء الليزر والكهرو بصريات

2- Short Note Questions:

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What is the probability of measurements which give $E = E_2$?



الاختصاص: فيزياء الليزر والكهربوبصريات

2 Multiple Choice Question:

Q.1) The detection range of spectrum for silicon detector is:

- (a) UV range (b) IR range (c) From UV – Vis to IR range.

Q.2) Laser dimensions is:

- (a) Much greater than (b) less than (c) equal to, laser wavelength

Q.3) The preferential operator of laser with:

- (a) Two levels (b) three levels (c) four levels system.

Q.4) The energy gap of nanocrystal material is:

- (a) greater than (b) less than (c) equal to bulk energy value.

Q.5) The laser stability condition of concentric parallel mirrors is:

- (a) (0,0) (b) (1,1) (c) (-1, -1)

Q.6) The measurement of the laser wavelength by using :

- (a) Refractometer (b) Electrometer (c) Monochrometer

Q.7) Laser operation with C.W when time transition is:

- (a) $\tau_1 > \tau_{21}$ (b) $\tau_1 < \tau_{21}$ (c) $\tau_1 = \tau_{21}$

Q.8) The main propagation phenomena in conventional fiber is:

- (a) Total internal reflection (b) Bragg phenomena (c) others.

Q.9) The mains difference between photonic crystal fiber & conventional fiber are:

- (a) construction (b) types (c) others.

Q.10) The types of attenuation of the laser light propagation in atmosphere are:

- (a) absorption (b) scattered (c) both of them

Q.11) The divergence of semiconductor laser is:

- (a) Less than (b) greater than (c) equal to other types of laser.

Q.12) Quantum dot nanocrystal meaning that the confinement in:

- (a) one dimension (b) two dimensions (c) Three dimensions



الاختصاص: فيزياء الليزر والكهرو بصريات

2 Short Note Questions

- Q.1) The types of laser are
- Q.2) The absorption rate equation is
- Q.3) Laser properties are
- Q.4) The definition of Maser is
- Q.5) The definition of Laser is
- Q.6) Fiber optics consist of.....
- Q.7) The types of photonic crystal fiber are.....
- Q.8) Spectroscopy meaning.....



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جامعة بغداد للعام الدراسي ٢٠١٥-٢٠١٦

الاختصاص: فيزياء التحسس النانوي والمعالجة الصورية
أولاً: الورقة العامة ٢٠٪

1- Multiple Choice Questions:

- Q.1) The Coriolis force for dynamics of a particle in a rotating coordinate system is given as:
- (a) $F = -m\dot{\omega} \times r$ (b) $F = -2m\dot{\omega} \times \dot{r}$
(c) $F = -m\omega \times (\omega \times r)$ (d) $F = m\ddot{r}$
- Q.2) Semiconductor nano crystals are classified as :
- (a) 1D (b) 0D (c) 3D (d) 2D
- Q.3) The nature of binding for a crystal with alternate and evenly spaced positive and negative ions is:
- (a) Ionic (b) metallic (c) covalent (d) Vander walls
- Q.4) The characteristic impedance Z_o of free space encountered by electromagnetic wave has the SI units of
- (a) Henry (b) Farad. Ohm (c) Ohm (d) $\frac{1}{\text{Farad} \cdot \text{Sec}}$
- Q.5) What is the quantum number n of a particle of mass m confined to a one dimensional box of length L when its energy is $2h^2 / mL^2$?
- (a) 4 (b) 8 (c) 2 (d) 16
- Q.6) Particles in degenerate energy levels all have the same
- (a) Energy. (b) Momentum. (c) Quantum numbers. (d) Velocity.



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الاختصاص: فيزياء الاغشية الرقيقة

اولاً: الورقة العامة ٢٠ %

1- Multiple Choice Questions:

Q.1) The Coriolis force for dynamics of a particle in a rotating coordinate system is given as:

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الاختصاص: فيزياء الليزر والكهربوبصريات

اولاً: الورقة العامة ٢٠ %

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الاختصاص: فيزياء الليزر والكهرو بصريات

اولاً: الورقة العامة ٢٠ %

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الاختصاص: فيزياء المواد

1 Multiple Choice Question:

- Q.1) When two atoms approach each other, the energy will (decrease, increase, become zero) and the forces of (attraction, repulsion) will increase at a distance (R), the potential energy reaches (minimum, maximum).
- Q.2) The distance between the adjacent nuclei corresponding to the (maximum, minimum) potential energy is called bond length.
- Q.3) A space lattice can be considered as an infinite array of (points, particles, atoms) in space.
- Q.4) Lattice coordinates describe a position of a (point, vector, plane) on or within a unit cell.
- Q.5) The crystalline state of polymers (differs, similar) from typical crystalline solids.
- Q.6) Nuclei begin to form when the (liquid, melt) is cooled below its (freezing, melting) point.
- Q.7) The modulus of rigidity depends on two parameters (shear stress, stress, shear strain, strain).
- Q.8) Fracture is a separation of (body, bonds, lattice) by forces into two or more parts.
- Q.9) The hardness of a material can be measured by (tensile, Rockwell, creep) test.
- Q.10) Twinning usually requires a (higher, lower) shear stress than slip.
- Q.11) In homogeneous nucleation, nucleus is controlled by (free energy, surface energy, free energy and surface energy).
- Q.12) Diffusion in liquid phase is (faster, slower) than solid phase.

2 Short Note Questions

- Q.1) State types of polymers.
- Q.2) What are the benefits of the lever Rule for Alloys.
- Q.3) Plot the diagram for binary system (solubility in liquid and insolubility in solid state).
- Q.4) Explain and define Addition polymerization.
- Q.5) State and define types for composites.
- Q.6) Explain the typical stress-strain curve.
- Q.7) Define the refractory materials.
- Q.8) What are the open mold and close mold processes.



Q.10) The expectations value of a function $f(x)$ when the wave function depends only on x is given by $\langle f(x) \rangle =$

- (a) $\int_{-\infty}^{\infty} \psi^*(x) f(x) \psi(x) dx$ (b) $\int_{-\infty}^{\infty} f(x) \psi(x) dx$
(c) $\int_{-\infty}^{\infty} f(x) \psi^*(x) dx$ (d) $\int_{-\infty}^{\infty} \sqrt{f(x)} \psi(x) dx$

Q.11) The coupling of two angular moment, j_1 and j_2 gives the following number of substates:

- (a) $j_1 + j_2$ (b) Values from j_1 to j_2 , in integer steps.
(c) Values from $|j_1 - j_2|$ to $|j_1 + j_2|$, in integer steps.

Q.12) A particle has a total energy that is less than that of a potential barrier. When the particle penetrates the barrier, its wave function is

- (a) A positive constant. (b) Oscillatory.
(c) Exponentially increasing. (d) Exponentially decreasing

2- Short Note Questions

Q.1) What is the meaning of simple harmonic motion?

Q.2) What is the magnitude of the resultant sum of the following three displacement vectors?

$$\vec{D}_1 = (20, 5)\text{m}, \vec{D}_2 = (-12, -28)\text{m}, \vec{D}_3 = (-3, 7)\text{m}$$

Q.3) 1-Discuss, briefly 3 ways to measure the binding energy of the excitons.

Q.4) By plotting the temperature dependence of the heat capacity, show how to differentiate between metals and dielectric materials in general.

Q.5) Convert $2\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$ into the rectangular form.

Q.6) Find $\vec{A} \times \vec{B}$, where $\vec{A} = 2\vec{i} - 3\vec{j} - \vec{k}$ and $\vec{B} = \vec{i} + 4\vec{j} - 2\vec{k}$.

Q.7) The wave function of a particle at given time is given by $\psi(x) = \frac{e^{ikx}}{\sqrt{x^2 + a^2}}$, where k and a are constants. Is $\psi(x)$ normalized? If not, find the normalization constant.

Q.8) Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 t / \hbar}$

What is the probability of measurements which give $E = E_1$?



Q.10) The expectations value of a function $f(x)$ when the wave function depends only on x is given by $\langle f(x) \rangle =$

- (a) $\int_{-\infty}^{\infty} \psi^*(x) f(x) \psi(x) dx$ (b) $\int_{-\infty}^{\infty} f(x) \psi(x) dx$
(c) $\int_{-\infty}^{\infty} f(x) \psi^*(x) dx$ (d) $\int_{-\infty}^{\infty} \sqrt{f(x)} \psi(x) dx$

Q.11) The coupling of two angular moment, j_1 and j_2 gives the following number of substates:

- (a) $j_1 + j_2$ (b) Values from j_1 to j_2 , in integer steps.
(c) Values from $|j_1 - j_2|$ to $|j_1 + j_2|$, in integer steps.

Q.12) A particle has a total energy that is less than that of a potential barrier. When the particle penetrates the barrier, its wave function is

- (a) A positive constant. (b) Oscillatory.
(c) Exponentially increasing. (d) Exponentially decreasing

2- Short Note Questions

Q.1) What is the meaning of simple harmonic motion?

Q.2) What is the magnitude of the resultant sum of the following three displacement vectors?

$$\vec{D}_1 = (20, 5)\text{m}, \vec{D}_2 = (-12, -28)\text{m}, \vec{D}_3 = (-3, 7)\text{m}$$

Q.3) 1-Discuss briefly 3 ways to measure the binding energy of the excitons.

Q.4) By plotting the temperature dependence of the heat capacity, show how to differentiate between metals and dielectric materials in general.

Q.5) Convert $2\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$ into the rectangular form.

Q.6) Find $\vec{A} \times \vec{B}$, where $\vec{A} = 2\vec{i} - 3\vec{j} - \vec{k}$ and $\vec{B} = \vec{i} + 4\vec{j} - 2\vec{k}$.

Q.7) The wave function of a particle at given time is given by $\psi(x) = \frac{e^{ikx}}{\sqrt{x^2 + a^2}}$, where k and a are constants. Is $\psi(x)$ normalized? If not, find the normalization constant.

Q.8) Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 t / \hbar}$

What is the probability of measurements which give $E = E_1$?



ثانياً: الورقة الخاصة ٨٠ ٪

Multiple Choice Questions:

Q.1) The type of atomic bonding most common in semiconductor is

- (a) Metallic (b) ionic (c) chemical (d) covalent

Q.2) Ionization within a P-N junction causes a layer on each side of the barrier called the:

- (a) Junction (b) depletion region (c) barrier voltage (d) forward voltage.

Q.3) Which material may also be considered a semiconductor element?

- (a) Carbon (b) ceramic (c) mica (d) argon

Q.4) What can a semiconductor sense?

- (a) Magnetism (b) temperature (c) pressure (d) all of them

Q.5) Elements with 1, 2, or 3 valence electrons usually make excellent:

- (a) conductors (b) semiconductors (c) insulators (d) neutral

Q.6) Minority carriers are many times activated by:

- (a) Heat (b) pressure (c) dopants (d) forward bias.

Q.7) If conductance increases as temperature increases, this is known as a:

- (a) positive coefficient
(b) negative current flow
(c) negative coefficient
(d) positive resistance



Q.8) What would be a typical magnitude for the reverse current in a general- purpose Silicon diode?

- (a) A few picampers
- (b) A few nanoampers
- (c) A few microampers
- (d) A few milliamperes

Q.9) If the drift velocity of holes under a field gradient of 100 V/m is 5 m/p, the mobility is

- (a) 0.05
- (b) 0.5
- (c) 50
- (d) 500

Q.10) when a p-n junction is unbiased, the junction electric current at equilibrium is

- (a) Zero as no charges cross the junction.
- (b) Zero as equal number of carriers cross the barrier.
- (c) Mainly due to diffusion of majority carriers.
- (d) Mainly due to diffusion of minority carriers.

Q.11) The junction capacitance of linearly graded junction varies with the applied reverse bias, V as

- (a) V^{-1}
- (b) $V^{-1/2}$
- (c) $V^{-1/3}$
- (d) $V^{1/2}$

Q.12) The leakage electric current of a p-n junction is caused by

- (a) Heat energy.
- (b) Chemical energy.
- (c) Barrier potential.
- (d) Majority carriers.



2-Short Note Questions

- Q.1) Explain briefly, what happens when the p-n junction in (a) forward biased and (b) Reverse biased .Illustrate your answer with relevant diagrams.
- Q.2) What is the meaning of:
- 1- Hall Effect.
 - 2- Mass- action law.
 - 3- The basic methods to fabricate the junction.
- Q.3) What is the conditions to get rectifying contacts when the metal have a contact with semiconductor explain this case.
- Q.4) Thermoelectric power is the one of methods to determine the type of carriers for semiconductor explain this method.
- Q.5) Explain how the Fermi level shifts when the semiconductor doped as n or p-type.
- Q.6) Speak about the absorption edge and the relation between the absorption coefficient and the photon energy.
- Q.7) What is the meaning of the d.c conductivity? Talk about the mechanisms of conductance with temperature.
- Q.8) Compare between LED and Laser diode.



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الاختصاص: فيزياء الاغشية الرقيقة
اولاً: الورقة العامة ٢٠%

1- Multiple Choice Questions:

Q.1) 120 Pa is equal to

- (a) 1.2×10^4 atm, (b) 1.2×10^{-4} atm, (c) 1.2×10^3 atm, (d) 1.2×10^{-3} atm.

Q.2) While you are sitting on your chair, the earth is exerting you a gravitational force and you are exerting the earth -----force.

- (a) Same (b) greater (c) smaller (d) no

Q.3) Hamilton's principle is an example of a:

- (a) Hamiltonian (b) Lagrange multiplier (c) stationary point (d) vibrational principle.

Q.4) The bulk superconductor is

- (a) Perfect paramagnetic (b) Perfect piezomagnetic (c) Perfect diamagnetic.

Q.5) Hall coefficient determines:

- (a) the concentration of charge carriers. (b) the concentration and type of charge carriers. (c) the magnetic field.

Q.6) The conventional unit cube of the diamond structure contains :

- (a) 4 atoms. (b) 8 molecules (c) 8 atoms

Q.7) For cross products,

- (a) the commutative and associative laws are valid
(b) the commutative and associative laws are not valid
(c) the commutative law is not valid while the associative law is valid
(d) the commutative law is valid while the associative law is not valid.

Q.8) The necessary and sufficient condition that the field $\vec{F}$ be a conservative is that

- (a) $\text{div } \vec{F} = 0$, (b) $\text{grad } \vec{F} = 0$, (c) $\text{curl } \vec{F} = 0$, (d) $\text{div grad } \vec{F} = 0$.

Q.9) The following equation: $\oint_C M dx + N dy = \iint_R \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y} \right) dx dy$ is the definition of

- (a) Green's theorem in the plane (b) Stoke's theorem (c) divergence theorem of Gauss



الامتحان التنافسي للمتقدمين للدراسات العليا (الدكتوراه) المحاولة الثانية لقسم الفيزياء-كلية العلوم / جامعة بغداد للعام الدراسي ٢٠١٥-٢٠١٦
الاختصاص: فيزياء المواد
أولاً: الورقة العامة ٢٠%

1- Multiple Choice Questions:

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- Q.2) While you are sitting on your chair, the earth is exerting you a gravitational force and you are exerting the earth -----force.
(a) Same (b) greater (c) smaller (d) no
- Q.3) Hamilton's principle is an example of a:
(a) Hamiltonian (b) Lagrange multiplier (c) stationary point (d) vibrational principle.
- Q.4) The bulk superconductor is
(a) Perfect paramagnetic (b) Perfect piezomagnetic (c) Perfect diamagnetic.
- Q.5) Hall coefficient determines:
(a) the concentration of charge carriers. (b) the concentration and type of charge carriers. (c) the magnetic field.
- Q.6) The conventional unit cube of the diamond structure contains :
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(a) Green's theorem in the plane (b) Stoke's theorem (c) divergence theorem of Gauss



Q.8) What diode operates only with majority carriers?

- (a) Laser
- (b) Schottky
- (c) Tunnel
- (d) Step-recovery

Q.9) A strip of copper and another of germanium cooled from room temperature to 80 K. The resistance of

- (a) Each of these increases
- (b) Each of these decreases
- (c) Copper strip increases and that of germanium decreases
- (d) Copper strip decreases and that of germanium increases

Q.10) In a p-n junction, the depletion layer consists of

- (a) Electrons
- (b) Protons
- (c) Mobile ions
- (d) Immobile ions

Q.11) Light emitting diode yields

- (a) Electron
- (b) X-ray
- (c) Photon
- (d) Hole

Q.12) The depletion layer in the p-n junction region is caused by

- (a) Drift of holes
- (b) Drift of electrons
- (c) Diffusion of charge carriers
- (d) Migration of impurity ions



2-Short Note Questions

- Q.1) Explain types of conductivity (with equations)
- Q.2) Describe the types of optical transitions
- Q.3) Determine I-V characteristic and energy band diagram of p-n junction (with equations)
- Q.4) Hole mobility in Ge at room temperature is $1900 \text{ cm}^2/\text{V.s}$. Find the diffusion coefficient?
- Q.5) Write in brief the difference between photonic and thermal detectors
- Q.6) Explain the principle mechanism of Tunnel diode
- Q.7) What is the physical meaning of Fermi - Dirac distribution at $T=0\text{K}$ and $T>0\text{K}$
- Q.8) What is the meaning of:
- a) Degenerate and non degenerate semiconductors
 - b) Ohmic contact
 - c) Fermi level and Fermi energy



2- Short Note Questions:

Q.1) An ideal pendulum, its small-angle period is measured on the moon to be 0.4 second long. What must be the length of the pendulum arm? (Hint: assume that $m_{\text{moon}} = (1/6) m_{\text{earth}}$, exactly).

Q.2) A disk of mass M is constrained to roll down an inclined plane without slipping. Solve the Lagrange equations for motion.

Q.3) By plotting the temperature dependence of electrical resistivity, show how to differentiate between metal and semiconductor.

Q.4) There is no perfect solid due to the defects and dislocations, name them.

Q.5) Evaluate $\int \frac{\cos x dx}{\sin x}$.

Q.6) Find $\frac{dy}{dx}$ for $y = \cosh^2 5x - \sinh^2 5x$.

Q.7) Prove that : $H = \hbar\omega \left(a^\dagger a + \frac{1}{2} \right)$, where H is the Hamiltonian of the one dimensional harmonic oscillator, $a^\dagger$ is the rising operator and a is the lowering operator.

Q.8) Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 t / \hbar}$

What is the probability of measurements which give $E = E_2$?



ثانياً: الورقة الخاصة ٨٠%

Multiple Choice Questions:

Q.1) In forward bias, the width of potential barrier in a p-n junction diode

- (a) Decreases (b) remains constant (c) increases (d) first increases, then decreases

Q.2) Which capacitance dominates in the reverse bias region?

- a) Conversion (b) diffusion (c) depletion (d) none of the above

Q.3) Fermi energy level for intrinsic semiconductors lies

- (a) close to conduction band
(b) close to valence band
(c) at the middle of the energy gap
(d) none

Q.4) Flow of electrons is affected by the following

- (a) thermal vibrations (b) impurity atoms (c) crystal defects (d) all

Q.5) In n-type semiconductors, number of holes _____ number of electrons

- (a) cannot define (b) greater than (c) equal (d) less than

Q.6) Which of the following statements is incorrect?

- (a) Conduction within pure semiconductors is termed intrinsic conduction
(b) The dominant charge carriers within a doped semiconductor are called majority charge carriers
(c) At room temperature, pure semiconductors make excellent conductors
(d) Doping pure semiconductor material with small amounts of donor impurities produces an n-type semiconductor

Q.7) What is a typical conduction voltage for silicon diode?

- (a) 0.25 V
(b) 0.50 V
(c) 0.70 V
(d) 1.10 V



الاختصاص: فيزياء المواد

2 Multiple Choice Question:

- Q.1) The distance between the adjacent nuclei or corresponding to the (maximum, minimum) potential energy is called the bond length.
- Q.2) The (metallic, ionic) bond arises from electrostatic attraction between the oppositely charged ions
- Q.3) The (hydrogen, covalent) bond is formed by hydrogen between two strongly electronegative atoms or groups of atoms (oxygen, nitrogen)
- Q.4) Most metallic solids (crystallize, not crystalline) in the most densely packed structures such as FCC structure.
- Q.5) (Crystals, glasses) are built up from an irregular three- dimensional network of polyhedral
- Q.6) In a polymer chain the atoms of the backbone chain are connected by (covalent, van der waals) bonds.
- Q.7) The crystalline stat of polymers differs from typical crystalline solids in that it is not associated with any (regularity, irregularity) of external form.
- Q.8) Phase transformation, involve the (changes, stability) occurring between phases.
- Q.9) An amorphous material such as glass or a high polymer is cooled from its (solid, molten) state, crystallization does not occur.
- Q.10) Solid solution in alloy systems may be (two, one) kinds substitutional and interstitial.
- Q.11) The solid eutectic consists of intimate (mixture, powder) of fine crystals arranged in the form of lamellae or rodlike or spherical particles.
- Q.12) the mass transport phenomena within a solid and between solid – solid, solid-liquid and solid –gas are controlled by (diffusion, migration).



الاختصاص: فيزياء المواد

2 Short Note Questions

Q.1) Explain the addition polymerization

Q.2) Plot

- a- Variation of potential energy with interatomic distance (for two atoms)
- b- Tetragonal, Monoclinic
- c- Cooling curves for solid solution alloys

Q.3) Explain the mechanism of diffusion in solids

Q.4) Explain homogenous nucleation

Q.5) The difference between continuous phase and dispersed phase

Q.6) Stats the types of composites

Q.7) Define 1-dimensional 2-dim and 3-dimensional nanocomposites

Q.8) The difference between AFM and SEM



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جامعة بغداد للعام الدراسي ٢٠١٥-٢٠١٦

الاختصاص: فيزياء الاغشية الرقيقة

اولاً: الورقة العامة ٢٠ %

1- Multiple Choice Questions:

Q.7) The absolute value of the real number x is defined by:

- (a) $|x| = \begin{cases} x, & \text{if } x < 0 \\ -x, & \text{if } x \geq 0 \end{cases}$ (b) $|x| = \begin{cases} x, & \text{if } x \geq 0 \\ -x, & \text{if } x < 0 \end{cases}$
(c) $|x| = x$ for $-\infty < x < \infty$, (d) $|x| = -x$ for $-\infty < x < \infty$.

Q.8) The result of $(e^{x_1})^{x_2}$ is given by:

- (a) $e^{x_1+x_2}$, (b) e^{x_1/x_2} , (c) $e^{x_1-x_2}$, and (d) $e^{x_1x_2}$.

Q.9) The Domain (D_0) and Range (R_x) of the function $y = \sqrt{x+4}$ are given by:

- (a) $D_0: x \geq -4$, $R_x: y \geq 0$ (b) $D_0: -\infty < x < \infty$, $R_x: y = 0$
(c) $D_0: x = 0$, $R_x: y = -4$ (d) $D_0: x \geq -4$, $R_x: y = 0$.

Q.10) The energy operator in quantum mechanics, $\hat{H} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} + V$

(here given for one particle in one dimension) is called the

- a) Lagrangian b) Hamiltonian
c) Hermitian d) Angular momentum

Q.11) The commutator $[L^2, L_x] =$:

- a) 0 b) $i\hbar L_x$ c) $-i\hbar L_z$

Q.12) The probability of finding a particle in differential region dx is:

- a) $\psi(x,t) dx$ b) $\psi(x,t)/\psi^*(x,t) dx$ c) $\psi^*(x,t)\psi(x,t) dx$



2- Short Note Questions:

Q.1) An ideal pendulum, its small-angle period is measured on the moon to be 0.4 second long. What must be the length of the pendulum arm? (Hint: assume that $m_{\text{moon}} = (1/6) m_{\text{earth}}$, exactly).

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جامعة بغداد للعام الدراسي ٢٠١٥-٢٠١٦

الاختصاص: فيزياء المواد

اولاً: الورقة العامة ٢٠ %

1- Multiple Choice Questions:

Q.7) The absolute value of the real number x is defined by:

- (a) $|x| = \begin{cases} x, & \text{if } x < 0 \\ -x, & \text{if } x \geq 0 \end{cases}$ (b) $|x| = \begin{cases} x, & \text{if } x \geq 0 \\ -x, & \text{if } x < 0 \end{cases}$
(c) $|x| = x$ for $-\infty < x < \infty$, (d) $|x| = -x$ for $-\infty < x < \infty$.

Q.8) The result of $(e^{x_1})^{x_2}$ is given by:

- (a) $e^{x_1+x_2}$, (b) e^{x_1/x_2} , (c) $e^{x_1-x_2}$, and (d) $e^{x_1x_2}$.

Q.9) The Domain (D_f) and Range (R_f) of the function $y = \sqrt{x+4}$ are given by:

- (a) $D_f: x \geq -4$, $R_f: y \geq 0$ (b) $D_f: -\infty < x < \infty$, $R_f: y = 0$
(c) $D_f: x = 0$, $R_f: y = -4$, (d) $D_f: x \geq -4$, $R_f: y = 0$.

Q.10) The energy operator in quantum mechanics, $\hat{H} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} + V$

(here given for one particle in one dimension) is called the

- a) Lagrangian b) Hamiltonian
c) Hermitian d) Angular momentum

Q.11) The commutator $[L^2, L_z] = :$

- a) 0 b) $i\hbar L_x$ c) $-i\hbar L_z$

Q.12) The probability of finding a particle in differential region dx is:

- a) $\psi(x,t) dx$ b) $\psi(x,t)/\psi^*(x,t) dx$ c) $\psi^*(x,t)\psi(x,t) dx$



الاختصاص: فيزياء البلازما

2 Multiple Choice Question:

Q.1) The percentage of the plasma in the universe is

- (a) 1%, (b) 25% (c) 50% (d) 99%.

Q.2) All matter exist in plasma form above

- (a) 100 Kelvin (b) 1000 Kelvin (c) 10000 Kelvin (d) 100000 Kelvin.

Q.3) The one, of various regions in glow discharge, represents plasma is

- (a) Aston dark space (b) cathode glow (c) negative glow (d) positive column.

Q.4) The trajectory of charged particle in uniform B field is

- (a) straight line (b) circle (c) helix (d) not of them.

Q.5) The magnetic mirror is a plasma confinement scheme based on the

- (a) variant of (b) invariant of (c) variant of (d) invariant of .

Q.6) A mixed of two fully ionized gases plasma must be treated as

- (a) one fluid (b) two fluids (c) three fluids (d) five fluids.

Q.7) In high frequency electron waves, the plasma approximation is

- (a) not valid (b) valid (c) sometime not valid (d) almost valid.

Q.8) In any finite system, plasma oscillation will

- (a) not propagate (b) propagate (c) be local (d) not of them.

Q.9) The condition for a plasma to be ideal is

- (a) $\Gamma < 1$ (b) $\Gamma > 1$ (c) $\Gamma \ll 1$ (d) $\Gamma \gg 1$

Q.10) Ionization of atoms, by a chain of collisions with electrons, is called

- (a) stepwise ionization, (b) direct ionization

- (c) collisional ionization (d) chain ionization.

Q.11) Electromagnetic waves will propagate through plasma if their frequencies are ----- the frequency of plasma oscillations.

- (a) less than, (b) greater than, (c) equal to, (d) more greater than

Q.12) Q-machine produces a plasma by

- (a) thermal ionization, (b) Collision ionization,
(c) Photo ionization, (d) electric field ionization.



الاختصاص: فيزياء البلازما

2 Short Note Questions

- Q.1) What is plasma (briefly)?
- Q.2) Prove that, plasma does not occur naturally in our environment.
- Q.3) Although electron temperature inside a fluorescent light bulb is about 2000°K it doesn't feel that hot. Explain that.
- Q.4) What is the main difference between local and remote plasma diagnostics?
- Q.5) What is the meaning of the self-maintaining discharge?
- Q.6) An ion engine has a 1 -T magnetic field, and hydrogen plasma is to be shot out at $E \times B$ velocity of 1000 km/sec. How much internal electric field must be present in the plasma?
- Q.7) Give a brief over view for plasma applications
- Q.8) Lightning is a powerful electrical breakdown between a cloud and the Earth, between two clouds, or within one cloud. How it occurs?



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الاختصاص: فيزياء المواد

اولاً: الورقة العامة ٢٠%

1- Multiple Choice Questions:

Q.1) The Coriolis force for dynamics of a particle in a rotating coordinate system is given as:

- (a) $F = -m\dot{\omega} \times r$ (b) $F = -2m\dot{\omega} \times \dot{r}$
(c) $F = -m\omega \times (\omega \times r)$ (d) $F = m\ddot{r}$

Q.2) Semiconductor nano crystals are classified as :

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

Q.3) The nature of binding for a crystal with alternate and evenly spaced positive and negative ions is:

- (a) Ionic (b) metallic (c) covalent (d) Vander walls

Q.4) The characteristic impedance Z_0 of free space encountered by electromagnetic wave has the SI units of

- (a) Henry (b) Farad. Ohm (c) Ohm (d) $\frac{1}{\text{Farad} \cdot \text{Sec}}$

Q.5) What is the quantum number n of a particle of mass m confined to a one dimensional box of length L when its energy is $2h^2 / mL^2$?

- (a) 4 (b) 8 (c) 2 (d) 16

Q.6) Particles in degenerate energy levels all have the same

- (a) Energy. (b) Momentum. (c) Quantum numbers. (d) Velocity.



2 Multiple Choice Question:

Q.1) The moment of inertia for a tetrafluoromethane, CF_4 , molecule. The C-F bond length in tetrafluoromethane is 1.315 Å. is:-

- (a) $1.455 \times 10^{-45} \text{ kg m}^2$ (b) $5.456 \times 10^{-46} \text{ kg m}^2$ (c) $1.637 \times 10^{-45} \text{ kg m}^2$ (d) $3.286 \times 10^{-45} \text{ kg m}^2$

Q.2) The degeneracy of the rotational energy level with $J = 4$ for a heteronuclear diatomic molecule. is: (a) 1 (b) 2 (c) 4 (d) 9

Q.3) Absorption of what type of electromagnetic radiation results in transitions among allowed rotational motions?

- (a) radio waves (b) infrared light (c) ultraviolet light (d) X-rays (e) microwaves

Q.4) The force constant for a Br-Br bond, given that the harmonic vibrational wavenumber of the $^{79}\text{Br}^{81}\text{Br}$ isotopomer of the bromine molecule is 323.2 cm^{-1} , is:-

- (a) 246 N m^{-1} (b) 984 N m^{-1} (c) 323 N m^{-1} (d) 107 N m^{-1}

Q.5) The rotational structure in the Raman spectrum of carbon dioxide, CO_2 , is offset from the wavenumber of the incident radiation by 2.3622 cm^{-1} , 5.5118 cm^{-1} , 8.6614 cm^{-1} . The rotational constant of carbon dioxide is:-

- (a) 0.3937 cm^{-1} (b) 1.1811 cm^{-1} (c) 0.5906 cm^{-1} (d) 2.3622 cm^{-1}

Q.6) The second harmonic generation of Nd:YAG laser is:

- (a) Red light (b) green light (c) Blue light

Q.7) The wavelength of CO_2 laser occurred at.

- (a) UV region (b) Visible region (c) IR region (d) Micro wave region

Q.8) The normal modes of vibrational are possible for a benzene molecule. is:-

- (a) 6 (b) 30 (c) 12 (d) 31

Q.9) In tetragonal hybridization, p-orbitals are hybridized with s-orbital as in:

- (a) C_2H_4 molecule (b) CH_4 molecule (c) C_2H_6 molecule (d) C_2H_2 molecule

Q.10) The atomic model that neglects the nuclei motion is:

- (a) Born-Openheimer (b) Quantum model (c) Shell model (d) Bohr model

Q.11) For two fields interacting with an atom or molecule, it will be getting:

- (a) single-photon process (b) Two-photon process (c) multiphoton process (d) None of them

Q.12) He-Ne laser is a :

- (a) Solid laser (b) gas laser (c) semiconductor laser (d) liquid dye laser



الاختصاص: فيزياء البلازما

2 Short Note Questions

- Q.1) Does plasma a new (forth) state of matter? Why?
- Q.2) Does plasma occurs naturally in the environment when we live? Why?
- Q.3) Although electron temperature inside a fluorescent light bulb is about 20000°K it doesn't feel that hot. Explain that.
- Q.4) One can define plasma as a weakly ionized gas whose Debye radius is small compared with its size L . Explain that.
- Q.5) At the boundaries between ideal and dense plasmas, the ideality parameter, γ , can have the value 0.09, what is the number of plasma particles in Debye sphere at that boundary? Discuss your result.
- Q.6) An ion engine has a 1-T magnetic field, and hydrogen plasma is to be shot out at $E \times B$ velocity of 1000 km/sec. How much internal electric field must be present in the plasma?
- Q.7) A space capsule making a reentry into the earth's atmosphere suffers a communication blackout because plasma is generated by the shock wave in front of capsule. If the radio operates at a frequency of 300 MHz, what is the minimum plasma density during the blackout?
- Q.8) Lightning is a powerful electrical breakdown between a cloud and the Earth, between two clouds, or within one cloud. How it occurs?



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الاختصاص: فيزياء البلازما
اولاً: الورقة العامة ٢٠ %

1- Multiple Choice Questions:

- Q.1) 120 Pa is equal to
(a) 1.2×10^4 atm, (b) 1.2×10^{-4} atm, (c) 1.2×10^3 atm, (d) 1.2×10^{-3} atm.
- Q.2) While you are sitting on your chair, the earth is exerting you a gravitational force and you are exerting the earth -----force.
(a) Same (b) greater (c) smaller (d) no
- Q.3) Hamilton's principle is an example of a;
(a) Hamiltonian (b) Lagrange multiplier (c) stationary point (d) vibrational principle.
- Q.4) The bulk superconductor is
(a) Perfect paramagnetic (b) Perfect piezomagnetic (c) Perfect diamagnetic.
- Q.5) Hall coefficient determines:
(a) the concentration of charge carriers. (b) the concentration and type of charge carriers. (c) the magnetic field.
- Q.6) The conventional unit cube of the diamond structure contains :
(a) 4 atoms. (b) 8 molecules (c) 8 atoms
- Q.7) For cross products,
(a) the commutative and associative laws are valid
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(c) the commutative law is not valid while the associative law is valid
(d) the commutative law is valid while the associative law is not valid.
- Q.8) The necessary and sufficient condition that the field $\vec{F}$ be a conservative is that
(a) $\text{div } \vec{F} = 0$, (b) $\text{grad } \vec{F} = 0$, (c) $\text{curl } \vec{F} = 0$, (d) $\text{div grad } \vec{F} = 0$.
- Q.9) The following equation: $\oint_C M dx + N dy = \iint_R \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y} \right) dx dy$ is the definition of
(a) Green's theorem in the plane (b) Stoke's theorem (c) divergence theorem of Gauss



Q.10) The expectations value of a function $f(x)$ when the wave function depends only on x is given by $\langle f(x) \rangle =$

- (a) $\int_{-\infty}^{\infty} \psi^*(x) f(x) \psi(x) dx$ (b) $\int_{-\infty}^{\infty} f(x) \psi(x) dx$
(c) $\int_{-\infty}^{\infty} f(x) \psi^*(x) dx$ (d) $\int_{-\infty}^{\infty} \sqrt{f(x)} \psi(x) dx$

Q.11) The coupling of two angular moment, j_1 and j_2 gives the following number of substates:

- (a) $j_1 + j_2$ (b) Values from j_1 to j_2 , in integer steps.
(c) Values from $|j_1 - j_2|$ to $|j_1 + j_2|$, in integer steps.

Q.12) A particle has a total energy that is less than that of a potential barrier. When the particle penetrates the barrier, its wave function is

- (a) A positive constant. (b) Oscillatory.
(c) Exponentially increasing. (d) Exponentially decreasing

2- Short Note Questions

Q.1) What is the meaning of simple harmonic motion?

Q.2) What is the magnitude of the resultant sum of the following three displacement vectors?

$$\vec{D}_1 = (20, 5)m, \vec{D}_2 = (-12, -28)m, \vec{D}_3 = (-3, 7)m$$

Q.3) Discuss briefly 3 ways to measure the binding energy of the excitons.

Q.4) By plotting the temperature dependence of the heat capacity, show how to differentiate between metals and dielectric materials in general.

Q.5) Convert $2\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$ into the rectangular form.

Q.6) Find $\vec{A} \times \vec{B}$, where $\vec{A} = 2\vec{i} - 3\vec{j} - \vec{k}$ and $\vec{B} = \vec{i} + 4\vec{j} - 2\vec{k}$.

Q.7) The wave function of a particle at given time is given by $\psi(x) = \frac{e^{ikx}}{\sqrt{x^2 + a^2}}$, where k and a are constants. Is $\psi(x)$ normalized? If not, find the normalization constant.

Q.8) Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 t / \hbar}$

What is the probability of measurements which give $E = E_1$?



الاختصاص: فيزياء الليزر والجزيئية

2- Short Note Questions:

Q.1) An ideal pendulum, its small-angle period is measured on the moon to be 0.4 second long. What must be the length of the pendulum arm? (Hint: assume that $m_{\text{moon}} = (1/6) m_{\text{earth}}$, exactly).

Q.2) A disk of mass M is constrained to roll down an inclined plane without slipping. Solve the Lagrange equations for motion.

Q.3) By plotting the temperature dependence of electrical resistivity, show how to differentiate between metal and semiconductor.

Q.4) There is no perfect solid due to the defects and dislocations, name them.

Q.5) Evaluate $\int \frac{\cos x \, dx}{\sin x}$.

Q.6) Find $\frac{dy}{dx}$ for $y = \cosh^2 5x - \sinh^2 5x$.

Q.7) Prove that : $H = \hbar \omega \left(a^\dagger a + \frac{1}{2} \right)$, where H is the Hamiltonian of the one dimensional harmonic oscillator, $a^\dagger$ is the rising operator and a is the lowering operator.

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What is the probability of measurements which give $E = E_2$?



2 Multiple Choice Question:

- Q.1) In general, the term plasma means;
(a) collection of charged particles, (b) the ionized state of matter,
(c) the fourth state of the matter, (d) an ionized gas.
- Q.2) All matter exist in plasma form above
(a) 100 Kelvin, (b) 1000 Kelvin, (c) 10000 Kelvin, (d) 100000 Kelvin.
- Q.3) Plasma charged particles (e and i) in gravitational field will drift in
(a) Same direction, (b) opposite directions,
(c) perpendicular directions, (d) random directions.
- Q.4) The magnetic mirror is a plasma confinement scheme based on the
(a) variant of μ , (b) invariant of μ , (c) variant of B , (d) invariant of B .
- Q.5) A mixed of two partially ionized gases plasma must be treated as
(a) one fluid, (b) two fluids, (c) three fluids, (d) five fluids.
- Q.6) In high frequency electron waves, the plasma approximation is
(a) not valid, (b) valid, (c) sometime not valid, (d) almost valid.
- Q.7) In any finite system, plasma oscillation will
(a) not propagate, (b) propagate, (c) be local, (d) not of them.
- Q.8) The condition for a plasma to be complex is
(a) $\Gamma < 1$, (b) $\Gamma > 1$, (c) $\Gamma \ll 1$, (d) $\Gamma \gg 1$
- Q.9) ionization of atoms, by a chain of collisions with electrons, is called
(a) stepwise ionization, (b) direct ionization,
(c) collisional ionization, (d) chain ionization.
- Q.10) The ionosphere prevents long electromagnetic waves from propagating therein if
their frequencies are ----- the frequency of plasma oscillations.
(a) less than, (b) greater than, (c) equal to, (d) more greater than
- Q.11) The presence of particles in plasma can alter its
(a) ionization equilibrium, (b) thermal equilibrium,
(c) other properties, (d) not of them.
- Q.12) The breakdown electric field strength of dry air is about
(a) 2.5 V/cm, (b) 2.5 kV/cm, (c) 25 V/cm, (d) 25 kV/cm



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الاختصاص: فيزياء البلازما

أولاً: الورقة العامة ٢٠ %

1- Multiple Choice Questions:

Q.7) The absolute value of the real number x is defined by:

(a) $|x| = \begin{cases} x, & \text{if } x < 0 \\ -x, & \text{if } x \geq 0 \end{cases}$ (b) $|x| = \begin{cases} x, & \text{if } x \geq 0 \\ -x, & \text{if } x < 0 \end{cases}$

(c) $|x| = x$ for $-\infty < x < \infty$, (d) $|x| = -x$ for $-\infty < x < \infty$.

Q.8) The result of $(e^{i\theta})^{1/2}$ is given by:

(a) $e^{i\theta/2}$, (b) $e^{i\theta/2}$, (c) $e^{i\theta/2}$, and (d) $e^{i\theta/2}$.

Q.9) The Domain (D_0) and Range (R_x) of the function $y = \sqrt{x+4}$ are given by:

(a) $D_0 : x \geq -4$, $R_x : y \geq 0$ (b) $D_0 : -\infty < x < \infty$, $R_x : y = 0$

(c) $D_0 : x = 0$, $R_x : y = -4$ (d) $D_0 : x \geq -4$, $R_x : y = 0$.

Q.10) The energy operator in quantum mechanics, $\hat{H} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} + V$

(here given for one particle in one dimension) is called the

- a) Lagrangian b) Hamiltonian
c) Hermitian d) Angular momentum

Q.11) The commutator $[L^2, L_z] =$:

- a) 0 b) $i\hbar L_x$ c) $-i\hbar L_z$

Q.12) The probability of finding a particle in differential region dx is:

- a) $\psi(x,t) dx$ b) $\psi(x,t)/\psi^*(x,t) dx$ c) $\psi^*(x,t)\psi(x,t) dx$



2- Short Note Questions:

Q.1) An ideal pendulum, its small-angle period is measured on the moon to be 0.4 second long. What must be the length of the pendulum arm? (Hint: assume that $m_{\text{moon}} = (1/6) m_{\text{earth}}$ exactly).

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الاختصاص: فيزياء الليزر والجزيئية

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الاختصاص: فيزياء البلازما

أولاً: الورقة العامة ٢٠ %

1- Multiple Choice Questions:

Q.1) The Coriolis force for dynamics of a particle in a rotating coordinate system is given as:

- (a) $F = -m\omega \times r$ (b) $F = -2m\omega \times \dot{r}$
(c) $F = -m\omega \times (\omega \times r)$ (d) $F = m\ddot{r}$

Q.2) Semiconductor nano crystals are classified as :

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

Q.3) The nature of binding for a crystal with alternate and evenly spaced positive and negative ions is:

- (a) Ionic (b) metallic (c) covalent (d) Vander walls

Q.4) The characteristic impedance Z_0 of free space encountered by electromagnetic wave is the SI units of

- (a) Henry (b) Farad. Ohm (c) Ohm (d) $\frac{1}{\text{Farad} \cdot \text{Sec}}$

Q.5) What is the quantum number n of a particle of mass m confined to a one dimensional box of length L when its energy is $2h^2 / mL^2$?

- (a) 4 (b) 8 (c) 2 (d) 16

Q.6) Particles in degenerate energy levels all have the same

- (a) Energy. (b) Momentum. (c) Quantum numbers. (d) Velocity.



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What is the probability of measurements which give $E = E_1$?



2 Multiple Choice Question:

- Q.1) Absorption of what type of electromagnetic radiation results in ionization?
(a) microwaves (b) X-rays (c) infrared light (d) radio waves (e) ultraviolet light
- Q.2) A nonlinear molecule with n atoms generally has _____ fundamental vibrational modes.
(a) $2n$ (b) $2n - 2$ (c) $3n - 6$ (d) $3n - 3$ (e) $3n$
- Q.3) Which molecule has the largest dipole moment?
(a) HCl (b) CCl_4 (c) H_2S (d) CO_2
- Q.4) Which of the following properties is the same for all electromagnetic waves in a vacuum?
(a) amplitude (b) frequency (c) speed (d) wavelength
- Q.5) Which of the following properties determines a color in the visible light region of the electromagnetic spectrum?
(a) acceleration (b) amplitude (c) frequency (d) speed
- Q.6) Planck's constant has the same units as
(a) angular momentum (b) the Hamiltonian (c) frequency (d) quantum number
(e) de Broglie wavelength
- Q.7) For the hydrogen atom, which of the following orbitals has the lowest energy?
(a) $4s$ (b) $4p$ (c) $4d$ (d) $4f$ (e) They all have the same energy
- Q.8) The benzene molecule C_6H_6 has how many vibrational modes
(a) 6 (b) 12 (c) 24 (d) 30 (e) 36
- Q.9) Which of the following is a true statement about the fluorescence of a molecule whose ground state is a singlet:
(a) Its dissociation must proceed by a unimolecular mechanism.
(b) The excited state must be a triplet
(c) The excited state must have the same geometry as the ground state.
(d) Fluorescence can occur in the visible region after absorption in the ultraviolet.
(e) Intersystem crossing must have occurred.
- Q.10) The Beer-Lambert Law is .
(a) a linear relationship between the intensity of a UV absorbance and the concentration of the analyte.
(b) an inverse relationship between the IR stretching frequency and the energy of light.
(c) used to calculate the chemical shift (δ) of an NMR resonance relative to that of the tetramethylsilane standard.
(d) used to derive a molecular formula from the mass-to-charge ratio of an analyte.
- Q.11) The multiplicity of energy states depends
(a) Parity (b) Total angular momentum (c) Degeneracy
(d) Total spin number
- Q.12) The wave length of Nd-glass laser occurred at
(a) UV region (b) Visible region (c) IR region (d) Micro wave region



الاختصاص: فيزياء الليزر والجزيئية

2 Short Note Questions

Q1) Completes each statement:

- 1- Absorption _____ is the measurement of the amount of light absorbed by a compound as a function of the wavelength of light.
- 2- In an IR spectrometer, the _____ uses prisms or diffraction gratings to allow only one frequency of light to enter the detector at a time.

Q2) Answers these questions?

- a- Which has the higher speed in a vacuum, ultraviolet or infrared light?
- b- Which region of the electromagnetic spectrum, IR or UV, contains photons of the higher energy?

Q3) Arrange the following regions of the electromagnetic spectrum in order of increasing energy: microwave, UV, visible, and IR.

Q4) What wavelength in mm is equivalent to a wavenumber of 1750 cm^{-1} ?

Q5) What spectroscopic technique can be used to determine the molecular formula of a compound?

Q6) Explain homogeneous and inhomogeneous broadening?

Q7) (i) Explain briefly vibronic transitions. (ii) Give two examples of vibronic lasers. (iii) Can one call $\text{Nd}^{+3}:\text{YAG}$ a vibronic laser material?

Q8) The active medium $\text{Nd}:\text{YAG}$ has refractive index of $n = 1.82$ and gain line width of $\Delta\nu_0 = 120\text{GHz}$. A $\text{Nd}:\text{YAG}$ laser ($\lambda = 1.064\mu\text{m}$) has a cavity length $L=50\text{cm}$, within which a $\text{Nd}:\text{YAG}$ crystal of length $l=10 \text{ cm}$ is placed. Determine the number of longitudinal modes supported within the FWHM gain spectral range.



الاختصاص: فيزياء النووية والبيئية

2 Short Note Questions

Q.1) Give briefly the properties of the nuclear force and draw the nuclear potential with illustrating the effect of each region?

Q.2) Determine the stable nucleus that has a radius $1/3$ that of ^{189}Os .

Q.3) Compute the energy requires to remove a neutron and binding energy per nucleon for $^{42}_{20}\text{Ca}$ nucleus, where:
 $M_{^{42}\text{Ca}}=42.958780\text{u}$, $M_{^{41}\text{Ca}}=41.958625\text{u}$, $M_n=1.008665\text{u}$, $M_p=1.007825\text{u}$.

Q.4) According to the nuclear shell model, find the ground-state total angular momentum J of the nuclei: a) $^{15}_8\text{O}$ b) $^{39}_{19}\text{K}$ c) $^{20}_{10}\text{Ne}$

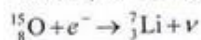
Q.5) Determine the unknown particle X in the following nuclear reactions:

a) $^{15}_8\text{O}(d,p)X$ b) $X(p,\alpha)^{87}_{39}\text{Y}$ c) $^{122}_{52}\text{Te}(X,d)^{124}_{53}\text{I}$.

Q.6) Photomultiplier tube is an important component of a scintillation detector, explain why?

Sketch a diagram for the internal construction of this tube.

Q.7) Determine the energy and momentum of the daughter and the neutrino are produced when ^7_4Be undergo electron capture at rest:



$M_{\text{Be}}=7.016929\text{u}$, $M_{\text{Li}}=7.016004\text{u}$.

Q.8) Define briefly three of the following:

- Cerenkov Radiation,
- electric quadrupole Moment,
- compound nucleus,
- plateau region of the detectors.



الاختصاص: فيزياء الليزر والجزيئية

2 Short Note Questions

- Q.1) Arrange the following regions of the electromagnetic spectrum in order of increasing energy: microwave, UV, visible, and IR.
- Q.2) What wavenumber corresponds to the wavelength of $4\mu\text{m}$?
- Q.3) a- What is the different between laser and maser?
b- What is the different between fluorescent, phosphorescent, delay fluorescent?
- Q.4) Define: Maser, Delay fluorescence, Spectrum, Spontaneous emission, Hot band?
- Q.5) Compare between
1- Homogeneous broadening and inhomogeneous
2- Three level laser and four level laser.
- Q.6) Find the relative population of two states at room temperature if $\Delta E = 0.5\text{eV}$.
- Q.7) For a tungsten lamp that works at temperature 2000°K and emission frequency $5 \times 10^{14}\text{Hz}$, find R?
- Q.8) Find the divergence angle, if the wavelength for laser is $10.6\mu\text{m}$ and ω_0 equal to 3.6mm .



الاختصاص: فيزياء النووية والبيئية

2 Multiple Choice Question:

- Q.1) The density (ρ) of nuclear matter varies with nucleon number (A) as
(a) $\rho \propto A^{-1}$ (b) $\rho \propto A^{-2}$ (c) $\rho \propto A^0$ (d) $\rho \propto A^2$.
- Q.2) Suppose a radioactive mother nucleus emits a β -particle. Are the mother and daughter nuclei
(a) isotones (b) isobars. (c) isotopes (d) isomers.
- Q.3) Half life of radium (${}^{226}_{88}\text{Ra}$) is 1620 years. What is the activity of 2 gram of radium?
(a) 3.6×10^{10} Bq (b) 7.2×10^{10} Bq (c) 1.44×10^{11} Bq (d) 2.88×10^{11} Bq.
- Q.4) Which one of the following will be better shield against β - rays?
(a) heavy water (b) lead (c) perspex (d) aluminium.
- Q.5) Internal Conversion involves:
(a) the emission of a gamma-ray (b) the conversion of a neutron to a proton
(c) K-capture (d) none of the above processes.
- Q.6) The type of gamma-ray transition is likely predominant if the initial and final states of the nucleus are $1/2^+ \rightarrow 3/2^-$.
(a) M1 (b) E1 (c) M2 (d) E2.
- Q.7) Which of these units is the unit of the radiation dose equivalent
(a) rad (b) Bq (c) rem (d) Ci.
- Q.8) Naturally occurring tellurium, ${}^{123}_{52}\text{Te}$ transforms by electron capture, according to the reaction ${}^{123}_{52}\text{Te} + e^- \rightarrow X + \nu$ the product nuclide, denoted by X, is:
(a) ${}^{123}_{53}\text{I}$ (b) ${}^{123}_{52}\text{Te}$ (c) ${}^{123}_{51}\text{Sb}$ (d) ${}^{121}_{50}\text{Sn}$
- Q.9) An alpha particle is emitted from a radioactive source with an energy of 5 MeV. How fast is it moving (in m/s)? ($m = 4.002603$ u, $1 \text{ u} = 1.66 \times 10^{-27}$ kg.)
(a) 2.4×10^7 (b) 1.5×10^7 (c) 3.7×10^7 (d) 4.6×10^7 .
- Q.10) Thermal neutrons have energy around
(a) 100eV (b) 10eV (c) 1eV (d) 0.025 eV.
- Q.11) According to Yukawa the nuclear force arises though the exchange between nucleons of
(a) proton (b) photon (c) positron (d) meson
- Q.12) The Q value for the following reaction, $\text{Be}(\alpha, n) \text{C}$, is (in MeV)
 $M_{\alpha} = 4.002603$ u, $M_{\text{Be}} = 9.012182$ u, $M_n = 1.008665$ u, $M_{\text{C}} = 12.000$ u
 $1 \text{ u} = 1.66 \times 10^{-27}$ kg
(a) 8.4 (b) 6.2 (c) 7.3 (d) 5.7



الاختصاص: فيزياء النووية والبيئية

2 Multiple Choice Question:

- Q.1) β^+ - disintegration is possible, if the mass of the parent nucleus is greater than the mass of the daughter nucleus by at least
 (a) 1.022 MeV, (b) the electron binding energy, (c) 0.511 MeV, (d) none of these.
- Q.2) The excited nucleus can de-excite itself by the emission of
 (a) γ - ray, (b) α - particles, (c) β - particles, (d) none of these.
- Q.3) Which of the following emissions has electromagnetic phenomenon
 (a) α - particles, (b) γ - ray, (c) β - particles, (d) none of these?
- Q.4) Isomeric states are mostly found among nuclei for which either N (the neutron number) or Z (the proton number) is near
 (a) the end of the shell, (b) the mid-shell,
 (c) the beginning of the shell, (d) none of these.
- Q.5) Radioactive $^{215}_{83}\text{Bi}$ decays into $^{215}_{84}\text{Po}$. Which of these particles is released in the decay?
 (a) a proton, (b) an electron, (c) a positron,
 (d) an alpha particle, (e) a neutron, (f) none of these.
- Q.6) For all stable nuclei (a) there are equal numbers of protons and neutrons, (b) there are more protons than neutrons, (c) there are more neutrons than protons, and (d) none of the above have to be true.
- Q.7) Of the hypothetical nuclear reactions below, which would violate conservation of charge?
 (a) $^{10}_5\text{B} + ^4_2\text{He} \rightarrow ^{13}_7\text{N} + ^1_1\text{H}$, (b) $^{10}_5\text{B} + ^1_0\text{n} \rightarrow ^{11}_5\text{B} + \beta^- + \bar{\nu}$,
 (c) $^{23}_{11}\text{Na} + ^1_1\text{H} \rightarrow ^{20}_{10}\text{Ne} + ^4_2\text{He}$, (d) $^{14}_7\text{N} + ^1_1\text{H} \rightarrow ^{13}_6\text{C} + \beta^+ + \nu$,
 (e) none of them, (f) all of them, (g) all except for (c), and (h) (a) and (d).
- Q.8) Of the hypothetical nuclear reactions below, which would violate conservation of nucleon number?
 (a) $^{10}_5\text{B} + ^4_2\text{He} \rightarrow ^{13}_7\text{N} + ^1_1\text{H}$, (b) $^{10}_5\text{B} + ^1_0\text{n} \rightarrow ^{11}_5\text{B} + \beta^- + \bar{\nu}$,
 (c) $^{23}_{11}\text{Na} + ^1_1\text{H} \rightarrow ^{20}_{10}\text{Ne} + ^4_2\text{He}$, (d) $^{14}_7\text{N} + ^1_1\text{H} \rightarrow ^{13}_6\text{C} + \beta^+ + \nu$.
- Q.9) In a fusion reaction, two deuterons produce a helium-3 nucleus. What is other product of the reaction?
 (a) an electron, (b) a proton, (c) a neutron,
 (d) an alpha particle, (e) a positron, (f) a neutrino.
- Q.10) Which of these are appropriate units for the decay constant λ of a radioactive nuclide?
 (a) sec, (b) rad, (c) MeV, (d) sec^{-1} , (e) rem, (f) curie, (g) Becquerel.
- Q.11) The nucleus $^{244}_{94}\text{Pu}$ is an alpha-particle emitter. Into which of the following nuclei does it decay?
 (a) $^{240}_{92}\text{Np}$, (b) $^{240}_{92}\text{U}$, (c) $^{248}_{96}\text{Cm}$, (d) $^{244}_{95}\text{Am}$?
- Q.12) Suppose that a $^{238}_{92}\text{U}$ nucleus swallows a neutron and then decays not by fission but by beta decay, emitting an electron and a neutrino. Which nucleus remains after this decay?
 (a) $^{239}_{94}\text{Pu}$, (b) $^{238}_{93}\text{Np}$, (c) $^{239}_{93}\text{Np}$, (d) $^{238}_{91}\text{Pa}$?



الاختصاص: فيزياء النووية والبيئية

2 Short Note Questions

Q.1) The activity of a radioactive nuclide decreases to $\frac{1}{8}$ its initial value in a time interval of 96 days. Determine the value of the half-life of the radioactive nuclide.

Q.2) What type of gamma-ray transition is likely predominant if the initial and final states of the nucleus are $3/2^- \rightarrow 7/2^-$.

Q.3) What target isotope must be used to form the compound nucleus ^{21}F when the projectile is (a) an alpha-particle, (b) a proton, (c) a neutron?

Q.4) The radius of a spherical nucleus is measured, by electron scattering methods, to be 3.6 fm. What is the likely mass number of the nucleus?

Q.5) Calculate the value of the density of nuclear matter ρ_{nucl} . Use $m = 1.6 \times 10^{-27} \text{ kg}$ for the mass of the nucleon.

Q.6) If the atomic masses of ^{239}Pu , ^1H and ^1_0n (i.e. a neutron) are 239.05216 u, 1.00783 u and 1.00867 u, respectively. What is the binding energy per nucleon for ^{239}Pu .

Q.7) Calculate the energy released during the alpha decay of ^{238}U , where the decay process is $^{238}\text{U} \rightarrow ^{234}\text{Th} + ^4\text{He}$ and the atomic masses of the concerned nuclei are: $^{238}\text{U} = 238.05079 \text{ u}$, $^{234}\text{Th} = 234.04363 \text{ u}$, and $^4\text{He} = 4.00260 \text{ u}$.

Q.8) Match the items in these two columns:

- | | |
|--------------|------------------|
| (1) Muon | (a) Quark |
| (2) Kaon | (b) Lepton |
| (3) Lambda | (c) Meson |
| (4) Positron | (d) Baryon |
| (5) Strange | (e) Antiparticle |

University of Baghdad
College of Science
Department of Physics
Date: 2 / 9 / 2015



Qualifying Examination
for Ph.D Students
Year: 2015-2016
Time: 3 Hours

الامتحان التنافسي للمتقدمين للدراسات العليا (الدكتوراه) المحاولة الثانية لقسم الفيزياء كلية العلوم / جامعة بغداد للعام الدراسي ٢٠١٥-٢٠١٦
الاختصاص: فيزياء النووية

اولاً: الورقة العامة ٢٠٪

1- Multiple Choice Questions:

- Q.1) 120 Pa is equal to
(a) 1.2×10^4 atm, (b) 1.2×10^{-4} atm, (c) 1.2×10^3 atm, (d) 1.2×10^{-3} atm.
- Q.2) While you are sitting on your chair, the earth is exerting you a gravitational force and you are exerting the earth -----force.
(a) Same (b) greater (c) smaller (d) no
- Q.3) Hamilton's principle is an example of a:
(a) Hamiltonian (b) Lagrange multiplier (c) stationary point (d) vibrational principle.
- Q.4) The bulk superconductor is
(a) Perfect paramagnetic (b) Perfect piezomagnetic (c) Perfect diamagnetic.
- Q.5) Hall coefficient determines:
(a) the concentration of charge carriers. (b) the concentration and type of charge carriers. (c) the magnetic field.
- Q.6) The conventional unit cube of the diamond structure contains :
(a) 4 atoms. (b) 8 molecules (c) 8 atoms
- Q.7) For cross products,
(a) the commutative and associative laws are valid
(b) the commutative and associative laws are not valid
(c) the commutative law is not valid while the associative law is valid
(d) the commutative law is valid while the associative law is not valid.
- Q.8) The necessary and sufficient condition that the field $\vec{F}$ be a conservative is that
(a) $\text{div } \vec{F} = 0$, (b) $\text{grad } \vec{F} = 0$, (c) $\text{curl } \vec{F} = 0$, (d) $\text{div grad } \vec{F} = 0$.
- Q.9) The following equation: $\oint_C M dx + N dy = \iint_R \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y} \right) dx dy$ is the definition of
(a) Green's theorem in the plane (b) Stoke's theorem (c) divergence theorem of Gauss



Q.10) The expectations value of a function $f(x)$ when the wave function depends only on x is given by $\langle f(x) \rangle =$

- (a) $\int_{-\infty}^{\infty} \psi^*(x) f(x) \psi(x) dx$ (b) $\int_{-\infty}^{\infty} f(x) \psi(x) dx$
(c) $\int_{-\infty}^{\infty} f(x) \psi^*(x) dx$ (d) $\int_{-\infty}^{\infty} \sqrt{f(x)} \psi(x) dx$

Q.11) The coupling of two angular moment, j_1 and j_2 gives the following number of substates:

- (a) $j_1 + j_2$ (b) Values from j_1 to j_2 , in integer steps.
(c) Values from $|j_1 - j_2|$ to $|j_1 + j_2|$, in integer steps.

Q.12) A particle has a total energy that is less than that of a potential barrier. When the particle penetrates the barrier, its wave function is

- (a) A positive constant. (b) Oscillatory.
(c) Exponentially increasing. (d) Exponentially decreasing.

2- Short Note Questions

Q.1) What is the meaning of simple harmonic motion?

Q.2) What is the magnitude of the resultant sum of the following three displacement vectors?

$$\vec{D}_1 = (20, 5)\text{m}, \vec{D}_2 = (-12, -28)\text{m}, \vec{D}_3 = (-3, 7)\text{m}$$

Q.3) 1-Discuss briefly 3 ways to measure the binding energy of the excitons.

Q.4) By plotting the temperature dependence of the heat capacity, show how to differentiate between metals and dielectric materials in general.

Q.5) Convert $2\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$ into the rectangular form.

Q.6) Find $\vec{A} \times \vec{B}$, where $\vec{A} = 2\vec{i} - 3\vec{j} - \vec{k}$ and $\vec{B} = \vec{i} + 4\vec{j} - 2\vec{k}$.

Q.7) The wave function of a particle at given time is given by $\psi(x) = \frac{e^{ikx}}{\sqrt{x^2 + a^2}}$, where k and a are constants. Is $\psi(x)$ normalized? If not, find the normalization constant.

Q.8) Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 t / \hbar}$

What is the probability of measurements which give $E = E_1$?



2- Short Note Questions

- Q.1) The wave function of a particle at given time is given by $\psi(x) = \frac{e^{ikx}}{\sqrt{x^2 + a^2}}$, where k and a are constants. Is $\psi(x)$ normalized? If not, find the normalization constant.
- Q.2) Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 t / \hbar}$
What is the probability of measurements which give $E = E_1$?
- Q.3) Define the term binding energy, and which particle can be added to the nucleus without affecting its chemical properties?
- Q.4) What do you understand by "background radiation"? State two sources of this radiation.
- Q.5) In magnetism, we can write that $\nabla \cdot \mathbf{B} = 0$, what is the meaning of that, then does that valid in the electricity, and why?
- Q.6) If the electric field intensity is given by: $\vec{E} = (x \hat{x} + y \hat{y} + z \hat{z})$ volt/m, find the potential difference between $p_1(2,0,0)$ and $p_2(1,2,3)$.
- Q.7) Light travels from air into an optical fiber with an index of refraction of 1.44:
(a) In which direction does the light bend?
(b) If the angle of incidence on the end of the fiber is 22° . What is the angle of refraction inside the fiber? (c) Sketch the path of light as it changes media.
- Q.8) A-Monochromatic light falling on two slits 0.016 mm apart produces the fifth-order fringe at an 8.8° angle. What is the wavelength of the light used?
- Q.9) Plot (111) plane for a cubic crystal with lattice constant a .
- Q.10) What is the difference between hexagonal and hexagonal close packed structures.
- Q.11) Convert $2 \left(\cos \frac{\pi}{6} + i \sin \frac{\pi}{6} \right)$ into the rectangular form.
- Q.12) Find $\vec{A} \times \vec{B}$, where $\vec{A} = 2\vec{i} - 3\vec{j} - \vec{k}$ and $\vec{B} = \vec{i} + 4\vec{j} - 2\vec{k}$.
- Q.13) What is the requirement needed in the laser active media for achieving minimum value of population inversion?
- Q.14) In gaseous lasers, we cannot achieve the population inversion by optical pumping. Why?
- Q.15) If the thermodynamic probability is given by the relation $\Omega = \prod_i \frac{(N_i + g_i)!}{N_i! g_i!}$, then derive the relation which give us the particle distribution and then classified.
- Q.16) From Fermi-Dirac distribution we have $N_i = g_i / (e^{(E_i - E_F) / kT} + 1)$, find the Fermi energy at zero Kelvin and draw the diagram for Fermi function.



2- Short Note Questions:

Q.1) An ideal pendulum, its small-angle period is measured on the moon to be 0.4 second long. What must be the length of the pendulum arm? (Hint: assume that $m_{\text{moon}} = (1/6) m_{\text{earth}}$, exactly).

Q.2) A disk of mass M is constrained to roll down an inclined plane without slipping. Solve the Lagrange equations for motion.

Q.3) By plotting the temperature dependence of electrical resistivity, show how to differentiate between metal and semiconductor.

Q.4) There is no perfect solid due to the defects and dislocations, name them.

Q.5) Evaluate $\int \frac{\cos x dx}{\sin x}$.

Q.6) Find $\frac{dy}{dx}$ for $y = \cosh^2 5x - \sinh^2 5x$.

Q.7) Prove that : $H = \hbar \omega \left(a^\dagger a + \frac{1}{2} \right)$, where H is the Hamiltonian of the one dimensional harmonic oscillator, $a^\dagger$ is the rising operator and a is the lowering operator.

Q.8) Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 t / \hbar}$

What is the probability of measurements which give $E = E_2$?



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1- Multiple Choice Questions:

1.1) The energy operator in quantum mechanics, $\hat{H} = -\frac{\hbar^2}{2m} \frac{\partial^2 \psi}{\partial x^2} + V$ (here given for one particle in one dimension) is called the

- (a) Lagrangian (b) Hamiltonian (c) Hermitian (d) Angular momentum

1.2) The commutator $[L^2, L_z] =$:

- (a) 0 (b) $i\hbar L_x$ (c) $-i\hbar L_z$

1.3) The probability of finding a particle in differential region dx is:

- (a) $\psi(x,t) dx$ (b) $\psi(x,t)/\psi^*(x,t) dx$ (c) $\psi^*(x,t)\psi(x,t) dx$

1.4) Radioactivity is the process of:

- (a) an unstable nucleus becoming stable (b) an electron moving to a higher energy shell
(c) an electron moving to a lower energy shell (d) a stable nucleus becoming unstable

1.5) The isotope $^{234}\text{U}_{92}$ undergoes five successive alpha decays. Identify the daughter nucleus at each step.

- a) $^{230}\text{Th}_{90} \rightarrow ^{226}\text{Ra}_{88} \rightarrow ^{222}\text{Rn}_{86} \rightarrow ^{218}\text{Po}_{84} \rightarrow ^{214}\text{Pb}_{82}$
b) $^{232}\text{Th}_{90} \rightarrow ^{228}\text{Ra}_{88} \rightarrow ^{224}\text{Rn}_{86} \rightarrow ^{220}\text{Po}_{84} \rightarrow ^{216}\text{Pb}_{82}$
c) $^{228}\text{Th}_{90} \rightarrow ^{224}\text{Ra}_{88} \rightarrow ^{220}\text{Rn}_{86} \rightarrow ^{216}\text{Po}_{84} \rightarrow ^{212}\text{Pb}_{82}$
d) $^{233}\text{Th}_{90} \rightarrow ^{229}\text{Ra}_{88} \rightarrow ^{225}\text{Rn}_{86} \rightarrow ^{221}\text{Po}_{84} \rightarrow ^{217}\text{Pb}_{82}$

1.6) Identify the nucleus designated by X in each of the following a) $^{226}\text{Ra}_{88} \rightarrow X + \alpha$ b) $^{233}\text{Pa}_{91} \rightarrow X + \beta^-$ c) $^{59}\text{Fe}_{26} \rightarrow X + \gamma$

- a) $^{212}\text{Rn}_{86}$ b) $^{239}\text{U}_{92}$ c) $^{51}\text{Fe}_{26}$
b) a) $^{232}\text{Rn}_{86}$ b) $^{231}\text{U}_{92}$ c) $^{58}\text{Fe}_{26}$
c) a) $^{230}\text{Rn}_{86}$ b) $^{234}\text{U}_{92}$ c) $^{60}\text{Fe}_{26}$
d) a) $^{222}\text{Rn}_{86}$ b) $^{233}\text{U}_{92}$ c) $^{59}\text{Fe}_{26}$

1.7) Tesla is a unit of

- a) field strength (b) inductance (c) flux density (d) flux.

1.8) A magnetic field exists around

- a) iron (b) copper (c) aluminum (d) moving charges.

1.9) The Biot-Savart's law is a general modification of ----- law.

- a) Kirchhoff's (b) Lenz's (c) Ampere's (d) Faraday's.



- Q.22) The space lattice for NaCl crystal is :
(a) simple cubic (b) face centered cubic (c) body centered cubic
- Q.23) Electronic heat capacity for metals at very low temperature is proportional to
(a) temperature (b) pressure (c) crystal structure
- Q.24) Debye Temperature is proportional to
a- Debye mode. b- Debye frequency. c- Debye velocity.
- Q.25) A 50 kg object starts from rest and is subject to a constant force of 5 N. what is the acceleration of the object:
(a) 1 m/s^2 (b) 0.1 m/s^2 (c) 0.01 m/s^2
- Q.26) A pendulum of length L supporting mass M swings back and forth with period T. If the mass is doubled, what is the new period?
(a) T (b) $T/2$ (c) $2T$
- Q.27) A ball is thrown straight downward with an initial speed of 25 m/s. It strikes the ground after 2.0 seconds. How high is the building?
(a) 30m (b) 50m (c) 70m
- Q.28) At low temperature a body emits radiation of
(a) Shorter wavelength (b) High frequencies (c) Longer wavelength (d) Low frequencies
- Q.29) Compton effect is observed for
(a) visible light (b) UV rays (c) X rays (d) γ rays
- Q.30) The maximum kinetic energy of photo electrons depend upon light's
(a) Intensity (b) Frequency (c) Wavelength (d) Energy
- Q.31) Hysteresis refers to the _____ between flux density of the material and the magnetizing force applied.
(a) Leading effect (b) Ratio (c) Equality (d) Lagging effect
- Q.32) The energy stored in an electrostatic field or electromagnetic field is called
(a) Electromagnetic energy (b) Kinetic energy
(c) Potential energy (d) Rest energy
- Q.33) When the ferromagnetic substance is inserted in a current- carrying solenoid, the magnetic field is
(a) Greatly decreased (b) Greatly increased
(c) Slightly decreased (d) Slightly increased
- Q.34) If the vector $a\mathbf{i} + \mathbf{j} - \mathbf{k}$ is perpendicular to the vector $\mathbf{i} + 2\mathbf{j} - 3\mathbf{k}$, the value of a is:
(a) -3 (b) 5 (c) -5
- Q.35) The Hamilton's function (H) of any system is equal to:
(a) $H = T - V$ (b) $H = T + V$ (c) $H = L - T$
- Q.36) If the force field $\mathbf{F} = ixy + jxz + kyz$ is not conservative, the curl of F is:
(a) $i(y-z) + j(z-x)$ (b) zero (c) $i(z-x) + k(z-x)$



2- Short Note Questions

Q.1) Prove that : $H = \hbar\omega \left(a^\dagger a + \frac{1}{2} \right)$, where H is the Hamiltonian of the one dimensional harmonic oscillator, $a^\dagger$ is the rising operator and a is the lowering operator.

Q.2) Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 t / \hbar}$

What is the probability of measurements which give $E = E_2$?

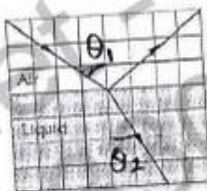
Q.3) Why must Geiger Muller tube for detecting α -particles have a very thin end window? Why does a Geiger Muller tube for detecting γ -rays not need a window at all?

Q.4) Discuss the advantages and disadvantages of fusion power from the point of safety, pollution and resources.

Q.5) What are the differences between Laplace's and Poisson's equations?

Q.6) What will be the magnetic potential difference across the air gap of 2 cm length in magnetic field of 200 AT/m?

Q.7) A ray of light is shown reflected and refracted at the surface of a liquid. From the diagram determine the speed of light in this liquid.



Q.8) Find the critical angles for glass to water and water to air?

Q.9) Evaluate $\int \frac{\cos x dx}{\sin x}$.

Q.10) Find $\frac{dy}{dx}$ for $y = \cosh^2 5x - \sinh^2 5x$.

Q.11) State the type of losses inside the laser cavity?

Q.12) A He-Ne laser tube 50 cm long has a gain of 1.08; find the gain coefficient?

Q.13) In the classical perfect gas the number of molecules in the range p to $p+dp$ is:

$$n_p(p) dp = \frac{4\pi N}{(2\pi mkT)^{3/2}} e^{-\frac{p^2}{2mkT}} p^2 dp, \text{ Find the number of molecules in the range of } v \text{ to } v+dv.$$

Q.14) From Fermi-Dirac distribution we have $N_i = g_i / (e^{(E_i - E_F)/kT} + 1)$, find the Fermi energy at zero Kelvin and draw the diagram for Fermi function.

Q.15) Plot and discuss the dispersion relation for linear diatomic lattice.

Q.16) Discuss and plot the effect of increasing temperature on the electrical conductivity of

metals



- Q.17) An object moving with a speed of 25 m/s is uniformly accelerated at a rate of 2 m/s^2 . What is the speed after 12 s of acceleration?
- Q.18) What is the gravitational force between two balls with masses of 49.5 kg and 0.775 kg, when the center of these balls was separated by a distance of 0.2 m? (Hint: take $G = 6.73 \times 10^{-11} \text{ N.m}^2/\text{kg}^2$).
- Q.19) What is the mass of an object moving with speed $0.6c$? (c is speed of light in free space)
- Q.20) 1. What is a relation for the momentum of photon in term of frequency?
2. Calculate the ionizing energy (in eV) of Li^{++} atom ($z=3$)?
- Q.21) Why should the cross section of potentiometer wire be uniform?
- Q.22) Define Magnetic Dipole Moment ($\vec{\mu}$) for a current carrying loop.
- Q.23) What is the moment of inertia of a thin uniform rod of length L and mass m , for an axis perpendicular to the rod at one end?
- Q.24) Find the equation of motion of one-dimension harmonic oscillator by using Lagrangian equation?



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جامعة بغداد للعام الدراسي ٢٠١٥-٢٠١٦

الاختصاص: فيزياء النووية والبيئية

اولاً: الورقة العامة ٢٠ %

1- Multiple Choice Questions:

Q.1) The Coriolis force for dynamics of a particle in a rotating coordinate system is given as:

- (a) $F = -m\omega \times r$ (b) $F = -2m\omega \times \dot{r}$
(c) $F = -m\omega \times (\omega \times r)$ (d) $F = m\ddot{r}$

Q.2) Semiconductor nano crystals are classified as :

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

Q.3) The nature of binding for a crystal with alternate and evenly spaced positive and negative ions is:

- (a) Ionic (b) metallic (c) covalent (d) Vander walls

Q.4) The characteristic impedance Z_0 of free space encountered by electromagnetic wave has the SI units of

- (a) Henry (b) Farad. Ohm (c) Ohm (d) $\frac{1}{\text{Farad} \cdot \text{Sec}}$

Q.5) What is the quantum number n of a particle of mass m confined to a one dimensional box of length L when its energy is $2h^2 / mL^2$?

- (a) 4 (b) 8 (c) 2 (d) 16

Q.6) Particles in degenerate energy levels all have the same

- (a) Energy. (b) Momentum. (c) Quantum numbers. (d) Velocity.



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الاختصاص: فيزياء النووية والبيئية

أولاً: الورقة العامة ٢٠ %

1- Multiple Choice Questions:

Q.7) The absolute value of the real number x is defined by:

- (a) $|x| = \begin{cases} x, & \text{if } x < 0 \\ -x, & \text{if } x \geq 0 \end{cases}$ (b) $|x| = \begin{cases} x, & \text{if } x \geq 0 \\ -x, & \text{if } x < 0 \end{cases}$
(c) $|x| = x$ for $-\infty < x < \infty$, (d) $|x| = -x$ for $-\infty < x < \infty$.

Q.8) The result of $(e^{i\theta})^{i\phi}$ is given by:

- (a) $e^{i\theta+i\phi}$, (b) $e^{i\theta/\phi}$, (c) $e^{i\theta-\phi}$, and (d) $e^{i\theta\phi}$.

Q.9) The Domain (D_f) and Range (R_f) of the function $y = \sqrt{x+4}$ are given by:

- (a) $D_f: x \geq -4$, $R_f: y \geq 0$ (b) $D_f: -\infty < x < \infty$, $R_f: y = 0$
(c) $D_f: x = 0$, $R_f: y = -4$. (d) $D_f: x \geq -4$, $R_f: y = 0$.

Q.10) The energy operator in quantum mechanics, $\hat{H} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} + V$

(here given for one particle in one dimension) is called the

- a) Lagrangian b) Hamiltonian
c) Hermitian d) Angular momentum

Q.11) The commutator $[L^2, L_z] = :$

- a) 0 b) $i\hbar L_x$ c) $-i\hbar L_z$

Q.12) The probability of finding a particle in differential region dx is:

- a) $\psi(x,t) dx$ b) $\psi(x,t)/\psi^*(x,t) dx$ c) $\psi^*(x,t)\psi(x,t) dx$



Short Note Questions

Q.17) A 50 kg object starts from rest and is subject to a constant force of 5N. What is the magnitude and the direction of the acceleration?

Q.18) Two identical objects are separated by a distance of 1m. If the gravitational force between them is 6.7×10^{-9} N, what is the mass of each object? (Hint take $G = 6.73 \times 10^{-11}$ N.m²/kg²).

Q.19) For the emission line (from $n=4$ to $n=1$) of He⁺ atom ($z=2$). Calculate:

1. The wavelength of this emission?
2. The velocity and linear momentum of the electron in the innermost orbit ($n=1$)?

Q.20) Compare between ionic bonding and covalent bonding?

Q.21) Complete the following:

- (a) The direction of the magnetic field at any point is to the magnetic field line at that point.
- (b) magnetic poles repel each other, and magnetic poles attract each other.

Q.22) What is the magnitude of the repulsive electrostatic force between two protons separated by 4×10^{-15} m?

Q.23) Obtain Hamilton's equation of motion for a one dimensional harmonic oscillator?

Q.24) Find the force for the following potential energy: $V = \alpha x^2 + \beta y^2 + \gamma z^2 + C$?

Handwritten calculations:

$$\frac{12}{156} = \frac{1}{13}$$
$$\frac{0.0054 \times 10^{-10}}{100} = 5.4 \times 10^{-15}$$



Q.13) The space lattice for CsCl crystal is:

- (a) simple cubic .
- (b) face centered cubic.
- (c) body centered cubic.

Q.14) Bragg law can be satisfied only for wavelength:

- (a) $\lambda \leq 2d$.
- (b) $\lambda > 2d$.
- (c) $\lambda = d$.

Q.15) There are:

- (a) 14 lattice types in 3 dimensions.
- (b) 7 lattice types in 3 dimensions.
- (c) 8 lattice types in 3 dimensions.

Q.16) For cross products,

- (a) the commutative and associative laws are valid
- (b) the commutative and associative laws are not valid
- (c) the commutative law is not valid while the associative law is valid
- (d) the commutative law is valid while the associative law is not valid.

Q.17) The necessary and sufficient condition that the field $\vec{F}$ be a conservative is that

- (a) $\text{div } \vec{F} = 0$,
- (b) $\text{grad } \vec{F} = 0$,
- (c) $\text{curl } \vec{F} = 0$,
- (d) $\text{div grad } \vec{F} = 0$.

Q.18) The following equation: $\oint_C M dx + N dy = \iint_R \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y} \right) dx dy$ is the definition of

- (a) Green's theorem in the plane
- (b) Stoke's theorem
- (c) divergence theorem of Gauss



Q.19) In stimulated emission process, the number of coherent laser photons are:

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

Q.20) Intensity distribution of transverse laser modes is measured

- (a) along the optical axis of the laser
(b) perpendicular to the optical axis of the laser
(c) both A and B
(d) None of them

Q.21) The lifetime of metastable state in comparison to excited state is

- (a) smaller (b) greater (c) Equal (d) much greater

Q.22) The relation between permeation and combination is :

- (a) $C(n, r) = \frac{p(n, r)}{r!}$ (b) $C(n, r) = p(n, r) * r!$
(c) $C(n, r) = p(n, r)$ (d) None of them

Q.23) The particles, like α - particles, ^2H , ^4He , mesons, photons and phonons, are applied in

- (a) Bose-Einstein (B-E) Statistics (b) Maxwell - Boltzmann (M - B) statistics
(c) Fermi - Dirac Statistics (d) Boltzmann thermal distribution law

Q.24) The Monatomic gases has degrees of freedom equal to

- (a) $f = 3$ (b) $f = 2$ (c) $f = 1$ (d) $f = 4$



- Q.31) Coulomb's law describes the electrostatic force between
(a) charged objects at rest and separated by a distance r ,
(b) charged objects not at rest and separated by a distance r ,
(c) point electric charges at rest and separated by a distance r ,
(d) point electric charges not at rest and separated by a distance r .

- Q.32) Electric charge is
(a) quantized but not conserved,
(b) conserved but not quantized,
(c) quantized and conserved
(d) not quantized and not conserved.

- Q.33) The magnetic force $\vec{F}_B$ acting on a charged particle moving with velocity $\vec{v}$ through a magnetic field $\vec{B}$ is always
(a) perpendicular to $\vec{v}$ and $\vec{B}$,
(b) parallel to $\vec{v}$ and $\vec{B}$,
(c) parallel to $\vec{v}$ and perpendicular to $\vec{B}$,
(d) perpendicular to $\vec{v}$ and parallel to $\vec{B}$.

- Q.34) A 120-lb person stands on bathroom spring scale while riding in an elevator. If the elevator has upward acceleration of $g/4$, the weight indicated on the scale is:

- (a) $5/4 \text{ mg}$ (b) $3/4 \text{ mg}$ (c) $7/5 \text{ mg}$

- Q.35) The magnitude of the sum of the two vectors $A=(1,0,2)$ and $B=(0,1,1)$ is equal to:
(a) $\sqrt{9}$ (b) $\sqrt{13}$ (c) $\sqrt{11}$

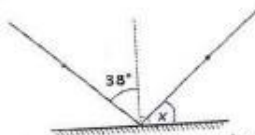
- Q.36) If we have two vectors $A=2i+j-k$, $B=i-j+2k$, the $A \times B$ is equal:

- (a) $i-5j-3k$ (b) $3i-4j+k$ (c) $i-5j-2k$



Q10.) Helium-neon laser light ($\lambda = 6.33 \times 10^{-7} \text{ m}$) is sent through a 0.30 mm-wide single slit. What is the width of the central maximum on a screen 1.0 m from the slit?
(a) 2.0 cm (b) 4.2 mm (c) 1.1 cm (d) 2.0 mm (e) 0.70 mm

Q11.) You are holding a flashlight so the beam strikes a plane mirror at an incident angle of 38. What is the measure of angle x between the reflected light ray and the mirror?
(a) 38 (b) 52 (c) 90 (d) 155



Q12.) What happens to the refracted ray if the angle of incidence is greater than the critical angle of the medium?
(a) It is bent toward the normal. (b) It is bent along the normal. (c) It exits the medium. (d) It does not exit the medium

Q13.) The absolute value of the real number x is defined by:

(a) $|x| = \begin{cases} x, & \text{if } x < 0 \\ -x, & \text{if } x \geq 0 \end{cases}$ (b) $|x| = \begin{cases} x, & \text{if } x \geq 0 \\ -x, & \text{if } x < 0 \end{cases}$
(c) $|x| = x$ for $-\infty < x < \infty$, (d) $|x| = -x$ for $-\infty < x < \infty$.

Q14.) The result of $(e^{x_1})^{x_2}$ is given by:

(a) $e^{x_1 x_2}$ (b) e^{x_1 / x_2} (c) $e^{x_1 - x_2}$ (d) $e^{x_1 / 2}$

Q15.) The Domain (D_f) and Range (R_f) of the function $y = \sqrt{x+4}$ are given by:

(a) $D_f: x \geq -4, R_f: y \geq 0$ (b) $D_f: -\infty < x < \infty, R_f: y = 0$
(c) $D_f: x = 0, R_f: y = -4$ (d) $D_f: x \geq -4, R_f: y = 0$

Q16.) Why was Towne's early work with stimulated emission done with microwaves?
(a) He was not concerned with light amplification. (b) It was easier to work with longer wavelengths.

(c) His partner Schawlow had already begun work on the laser (d) The laser had already been developed

Q17.) For a constructive interference in a Laser cavity, the distance L between the two mirrors should
(a) $n\lambda$ (b) $(n+1)\lambda$ (c) $(n-1)\lambda$ (d) $n\lambda/2$

Q18.) In a semiconductor Laser, the population inversion followed by a stimulated emission is controlled by
(a) Resistance (b) Temperature (c) Current (d) Impedance

Q19.) the particles are called "fermions" have spin quantum number equal:

(a) $S = 1/2, 3/2, 5/2$ (b) $S = 0, 1, 2, 3$ (c) $S = -2, -1, 0, 1, 2$ (d) None of them

Q20.) The equation of the Fermi - Dirac statistics

(a) $N_i = \frac{g_i}{e^{(E_i - E_F)/kT} + 1}$ (b) $N_i = \frac{g_i}{e^{(-E_F)/kT} + 1}$ (c) $N_i = \frac{g_i}{e^{(E_i - E_F)/kT}}$ (d) $N_i = \frac{g_i}{e^{(E_i - E_F)/kT} - 1}$

Q21.) Debye eqn of molal specific heat, C_v , for non-metallic crystals at high temperature equal to

(a) $C_v = 3R$ (b) $C_v \sim R$ (c) $C_v \gg R$ (d) $C_v = R$



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1- Multiple Choice Questions:

Q.1) The expectations value of a function $f(x)$ when the wave function depends only on x is given by $\langle f(x) \rangle =$

(a) $\int_{-\infty}^{\infty} \sqrt{f(x)} \psi(x) dx$

(b) $\int_{-\infty}^{\infty} f(x) \psi(x) dx$

(c) $\int_{-\infty}^{\infty} \psi^*(x) f(x) \psi(x) dx$

(d) $\int_{-\infty}^{\infty} f(x) \psi^*(x) dx$

Q.2) The coupling of two angular moment, j_1 and j_2 gives the following number of substates:

(a) $j_1 + j_2$ (b) Values from j_1 to j_2 , in integer steps.

(c) Values from $|j_1 - j_2|$ to $|j_1 + j_2|$, in integer steps.

Q.3) A particle has a total energy that is less than that of a potential barrier. When the particle penetrates the barrier, its wave function is

(a) A positive constant.

(b) Oscillatory.

(c) Exponentially increasing.

(d) Exponentially decreasing

Q.4) If a radioactive isotope of silver have a half-life of about 7.5 days. After 15 days the remaining isotope of its original is

(a) 25%

(b) 50%

(c) 7.5%

(d) 15%

Q.5) In Positron Emission:

(a) Z increases by 1 and A remains the same

(b) Z decreases by 1 and A remains the same

(c) Z remains the same and A decreases by 1

(d) Z remains the same and A increases by 1

Q.6) The following reaction: ${}^2_1\text{H} + {}^3_1\text{H} \rightarrow {}^4_2\text{He} + {}^1_0\text{n}$ is called:

(a) Fusion

(b) Fission

(c) alpha decay

(d) beta decay

(e) gamma decay



- Q.7) The units of $\vec{\nabla} \times \vec{H}$ is
(a) Ampere (b) Ampere/m (c) Ampere/m² (d) Tesla
- Q.8) The trajectory of charged particle in uniform E and B fields is a
(a) straight line (b) a circle (c) helix, (d) not of them.
- Q.9) Lenz's law is a consequence of the law of conservation of
(a) induced current, (b) charge, (c) energy, (d) induced e.m.f.
- Q.10) An object is 4 cm in front of a converging lens with a focal length of 8 cm, its image is at?
(a) 4 cm (b) 8 cm
(c) -4 cm, (d) -8 cm.
- Q.11) The phase velocity of the wave described by $\psi = A \sin(kx + \sigma t)$ is:
(a) x/t (b) σ/k
(c) A/σ (d) $\pi/2k$
- Q.12) An expression for the absolute index of refraction is:
(a) v/c (b) $c / \sqrt{\epsilon\mu}$
(c) $c \sqrt{\epsilon\mu}$ (d) $\sqrt{\epsilon_0\mu_0 / (\epsilon\mu)}$



- Q.25) A 100kg man climbs a ladder to a height of 5m. the work has he made is
(a) zero, (b) 5000 N.m, (c) 50000 N.m, (d) 2500 N.m
- Q.26) The weight of man at the surface of the earth is 1200N, the weight of this man on the surface of the planet Mars (where $g=3.7\text{m/s}^2$) is;
(a) 439N (b) 465 (c) 444N
- Q.27) A ball is projected upwards with a velocity of 50m/s at an angle 60° to the velocity of projectile after 1 second is ;
(a) 45.7 m/s (b) 55.9 m/s (c) 33.5 m/s
- Q.28) Theory of relativity is valid only when
(a) Object is moving with large velocity
(b) Observer is moving with large velocity
(c) Both A and B are true
(d) Both A and B are false
- Q.29) Which phenomenon is best explained by particle nature of light?
(a) The Doppler effect
(b) The photoelectric effect
(c) Polarization
(d) Interference
- Q.30) The velocity of electron in second Bohr orbit as compared to the velocity in first orbit is
(a) Equal
(b) 2 times
(c) One fourth

(2015-2016)

Ph.D. Competitive Exam. in Organic Chemistry

Q1 Choose the correct answer for each of the followings:

1- The reaction of phenylmagnesium bromide with propanal followed by hydrolysis yields: ① 2-phenyl-1-propanol ② 1-phenyl-1-propanol ③ 2-phenyl-2-propanol

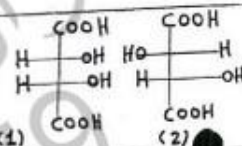
2- Which pair of reagents would be used to form the following amine by reductive amination? $? + ? \xrightarrow{H_2/Pd} CH_3CH_2\overset{CH_3}{CH}-CH_2NHCH_3$

- ① methyl amine and 2-methyl butanoic acid
② methyl amine and 2-methyl butanal
③ NH_3 and 3-methyl-2-pentanone
④ dimethyl amine and 2-butanone

3- Crossed Cannizzaro reaction may be represented by this equation:

- ① $2PhCHO + KOH \rightarrow PhCOOK + PhCH_2OH$
② $PhCHO + CH_3CHO \xrightarrow{OH^-} PhC(=O)CH_2CH_3 + H_2O$
③ $PhCHO + HCHO \xrightarrow{OH^-} HCOO^- + PhCH_2OH$

4- The relationship between compound (1) and compound (2) is: ① identical ② Diastereoisomers ③ Enantiomers



5- Which one of the followings would not be a suitable solvent for Grignard reagents
① $CH_3CH_2OCH_2CH_3$ ② THF ③ CH_3CH_2OH

6- What is the final product of the following sequence of reactions

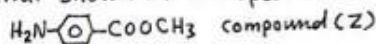
- $(CH_3)_2CHCOOH \xrightarrow[④ H_2O]{① LiAlH_4} \xrightarrow{PBr_3} \xrightarrow[DMSO]{KCN} \xrightarrow[A]{H_2O/H^+}$
① $(CH_3)_2CHCH_2CH_2NH_2$ ② $(CH_3)_2C=CHCOOH$ ③ $(CH_3)_2CHCHBrCOOH$ ④ $(CH_3)_2CHCH_2COOH$

7- Phenyl diazonium salts lose N_2 in: ① Coupling reaction ② Sandmeyer reaction ③ Williamson reaction

8- Which of the following is the strongest acid: ① FCH_2CO_2H ② $ClCH_2CO_2H$
③ $BrCH_2CO_2H$ ④ ICh_2CO_2H

Q2 Answer the followings:

① Write the main absorption bands that shown in IR spectrum of compound (Z) indicating their positions



② Oxidation, reduction and substitution reactions in anthracene happened only at positions (9) and (10) explain the reason.

③ Write the reagent (W) that is used in this reaction:
 $PhCH_2CH_2COOH \xrightarrow{W} PhCH_2CH(Cl)COOH$

④ Write the products in this equation (A, B, C):
 $CH_3CH=C(CH_3)-CH_2CH_2CH=CHC_2H_5 \xrightarrow{O_3} \xrightarrow{Zn/H_2O} A+B+C$

⑤ Write chemical equation that describes Diels-Alder reaction.



Explain the following using suitable equations and relations:

- 1- The effect of catalysis on rate of reaction?
- 2- The composition of Saturated Calomel Electrode, is this electrode is a reverse electrode for Hg or Cl⁻ ions.
- 3- Lambert –beers law in UV-spectroscopy application.
- 4- Joblonski diagram in photo chemistry.
- 5- Conductivity titration curve, when 0.1N HCl added to 0.1N NaOH solution.
- 6- Dalton's law for a mixture of gases.
- 7- How Arrhenius equation reflect the temperature dependence on a reaction rate.
- 8- The energy spacing between vibrational energy levels for one mole of hydrogen.
- 9- The units of rate constant for first, second and zero orders reaction, what is the n-order rate equation and 1st –order rate equation.
- 10- The different in the thermodynamic parameters of mixing between ideal and non-ideal solutions, which one have zero enthalpy change (two component system).

Best wishes

Inorganic Chemistry- Competitive Examination (2015-2016)
Ph.D Applicants

Q1-(60 deg) -Choose the right answer for each of the following statements:

- a- The molecule of sp^3d hybridization (SO_3 , I_3^- , $[SnCl_3]^-$, $S_2O_4^{2-}$)
- b- Following the Lewis octet rule, the formal charge of Cl = +3 in ($HClO_4$, $HClO_3$, $HOCl$, ClF_3)
- c- The octet rule of central atom is obeyed in (ClF_3 , ICl_4^- , IF_6^+ , BF_4^-)
- d- According to MOT, the molecule of the highest bond order (CN , O_2 , NO , CO)
- e- The complex that shows d-d transitions is ($[Os(H_2O)_6]^{3+}$, HgI_4^{2-} , $[Sc(H_2O)_6]^{3+}$, $[Y(H_2O)_6]^{3+}$)
- f- The term symbol for the ground state of Pt (g) is (^2D , ^3F , ^1S , ^3D , ^3G)
- g- The Lewis acid is (R_3As , $SiCl_4$, CF_4 , SO_4^{2-})
- h- The complex that obeys the 18 electron rule ($Mn(CO)_5$, NiF_6^{4-} , $Ni(PPh_3)_4$, $Co(CO)_4$,)
- i- The strongest oxidizing agent (FeO_4^{2-} , OsO_4^{2-} , RuO_4^{2-})
- j- The molecule of D_{4h} point group (SO_4^{2-} , ClO_4^- , $PtCl_4^{2-}$, CH_4 ,)

Q2-(20 deg) Arrange the followings according to specified order

- a- IF_7 , NCl_3 , ICl_4^- , BrF_3 (increased degree of hybridization, specify the types of hybridizations)
- b- $[Os(H_2O)_6]^{3+}$, $[Ru(H_2O)_6]^{3+}$, $[Fe(H_2O)_6]^{3+}$ (increased value of Δ^o)
- c- $Ni(CO)_4$, $Ni(CO)_3PF_3$, $Ni(CO)_3(PPh_3)$, $[Fe(CO)_4]^{2-}$ (increased degree of back donation)
- d- NiF_6^{2-} , $RhCl_6^{4-}$, $[Ni(NH_3)_6]^{2+}$ (highest value of spin magnetic moment μ_{so} , give the values of μ_{so})
- e- PO_4^{3-} , SO_2 , SO_3^{2-} (Increased resonance structures- draw the resonance structures)

Q3- a (10 deg) -Give the electron arrangement and energy level diagrams for the complex $[Co(NH_3)_6]^{3+}$ following both CFT and MOT arrangements.

- b- (10 deg) Choose the most stable oxidation state of each of the following metals in their chloride salts : (Pb^{2+} , Pb^{4+}) (Mn^{4+} , Mn^{2+} , Mn^{7+}) (Cr^{3+} , Cr^{6+}), (Tl^+ , Tl^{3+} , Tl^{2+}), (Si^{2+} , Si^{4+}), (Bi^{3+} , Bi^{5+})

(2015-2016) Ph.D. Competitive Exam. in Organic Chemistry

Q₁ Write the products of the following equations:

- ① c1ccccc1OC2H5 + PhLi ->
- ② cyclohexanone + CH2(CN)2 \xrightarrow{base}
- ③ c1ccccc1C2=CC=CC=C2 + maleic anhydride ->

Q₂ a- Explain the reason:

- ① Reaction of cyclohexene with KMnO_4 gives only the Cis-diol.
- ② 1,3-dihydroxy pentane doesn't oxidize with HIO_4 .

● b- Write equations that represent the followings:

- ① Nucleophilic substitution reaction performed by $\text{S}_{\text{N}}1$ Mechanism.
- ② Wittig Reaction

Q₃ a- Write chemical structures of A and B in the following reactions:

- ① 2 moles acetophenone $\xrightarrow[\text{-H}_2\text{O}]{\text{OH}^-}$ A $\xrightarrow{\text{9-BBN}}$ B
- ② CH3CH2C(=O)N(C)C(C)C $\xrightarrow[\text{EtBr}]{\text{1) n-BuLi}}$ A $\xrightarrow[\text{H}_2\text{SO}_4]{\text{EtOH}}$ B

● b- How can you distinguish by one chemical test between p-Toluidine and N-methyl aniline? (with equations).

Q₄ Write chemical structures of Reagents R_1 - R_3 that are used in performing these reactions:

- ① C2H5-C6H4-C(=O)NH2 \xrightarrow{R_1} C2H5-C6H4-NH2
- ② c1ccccc1C(=C)C \xrightarrow{R_2} c1ccccc1C(C)CBr
- ③ Cl-C6H4-C(=O)C3H7 \xrightarrow{R_3} Cl-C6H4-C4H9

University of Baghdad
College of Science
Department of Chemistry
Examiner: prof. khulood
Date: 13 / 8 / 2015



Graduate Studies
Ph.D.
Competitive examination
Subject: physical chemistry

Explain the following using suitable equations and relations:

- 1-Quantum yield. 2- Joblonski diagram in photo chemistry.
- 3-Ionic strength for 0.1 M KCl solution. 4-Saturated Calomel electrode reaction.
- 5-Specific conductivity of solution. 6-What is the maximum number of phases that can be in equilibrium in one, two and three- component system.
- 7- Reaction temperature dependence followed Arrhenius equation and the effect of catalysis.
- 8-The energy spacing between vibrational energy levels for hydrogen.
- 9-The rate equation for first, second and 0.5 orders reaction, what is the rate constant units.
- 10- The different between; isothermal and adiabatic process, which one give higher work value.

Iraq net - 07703309779

Inorganic Chemistry- Competitive Examination (2015-2016)
Ph.D Applicants

Q1-(60 deg) -Choose the right answer for each of the following statements:

- a- The molecule of sp^3d hybridization (SO_3 , I_3^- , $[SnCl_3]^-$, $S_2O_4^{2-}$)
- b- Following the Lewis octet rule, the formal charge of Cl = +3 in ($HClO_4$, $HClO_3$, $HOCl$, ClF_3)
- c- The octet rule of central atom is obeyed in (ClF_3 , ICl_4^+ , IF_6^+ , BF_4^-)
- d- According to MOT, the molecule of the highest bond order (CN , O_2 , NO , CO)
- e- The complex that shows d-d transitions is ($[Os(H_2O)_6]^{3+}$, HgI_4^{2-} , $[Sc(H_2O)_6]^{3+}$, $[Y(H_2O)_6]^{3+}$)
- f- The term symbol for the ground state of Pt (g) is (^2D , ^3F , ^1S , ^3D , ^3G)
- g- The Lewis acid is (R_3As , $SiCl_4$, CF_4 , SO_4^{2-})
- h- The complex that obeys the 18 electron rule ($Mn(CO)_5$, NiF_6^{4-} , $Ni(PPh_3)_4$, $Co(CO)_4$,)
- i- The strongest oxidizing agent (FeO_4^{2-} , OsO_4^{2-} , RuO_4^{2-})
- j- The molecule of D_{4h} point group (SO_4^{2-} , ClO_4^- , $PtCl_4^{2-}$, CH_4 ,)

Q2-(20 deg) Arrange the followings according to specified order

- a- IF_7 , NCl_3 , ICl_4^- , BrF_3 (increased degree of hybridization, specify the types of hybridizations)
- b- $[Os(H_2O)_6]^{3+}$, $[Ru(H_2O)_6]^{3+}$, $[Fe(H_2O)_6]^{3+}$ (increased value of Δ^o)
- c- $Ni(CO)_4$, $Ni(CO)_3PF_3$, $Ni(CO)_3(PPh_3)$, $[Fe(CO)_4]^{2-}$ (increased degree of back donation)
- d- NiF_6^{2-} , $RhCl_6^{4-}$, $[Ni(NH_3)_6]^{2+}$ (highest value of spin magnetic moment μ_{so} , give the values of μ_{so})
- e- PO_4^{3-} , SO_2 , SO_3^{2-} (Increased resonance structures- draw the resonance structures)

Q3- a (10 deg) -Give the electron arrangement and energy level diagrams for the complex $[Co(NH_3)_6]^{3+}$ following both CFT and MOT arrangements.

- b- (10 deg) Choose the most stable oxidation state of each of the following metals in their chloride salts : (Pb^{2+} , Pb^{4+}) (Mn^{4+} , Mn^{2+} , Mn^{7+}) (Cr^{3+} , Cr^{6+}), (Tl^+ , Tl^{3+} , Tl^{2+}), (Si^{2+} , Si^{4+}), (Bi^{3+} , Bi^{5+})

Ph.D. Competitive exam (Analytical Chemistry) 2015-2016

- Q1- A compound was analyzed and found to contain 13.5g Ca, 10.8 g O and 0.675 g H. What is the empirical formula of the compound:
- Q2- Calculate the pH of a solution resulting from mixing of 12 m.mol of CH_3COOH ($\text{pK}_a = 4.74$) and 8 m.mol of CH_3COONa in 100 ml
- Q3- Calculate the ionic strength of mixing $\text{KNO}_3 + \text{Na}_2\text{SO}_4$ have 0.1 M to each one
- Q4- Calculate the pAg for a solution resulting from 50 ml of 0.1M NaCl titration with 10 ml of 0.1 M AgNO_3 ($\text{K}_{\text{sp AgCl}} = 1.32 \times 10^{-10}$)
- Q5- A solution has absorbance 0.235 at 630 nm. What is the % transmittance of the solution at this wavelength
- Q6- UV-VIS Spectroscopy is very useful in determining the ratio between a ligand and a metal; numerate those methods: 1....., 2....., 3.....
- Q7- Classification chromatography method based on mobile phase, :
- Q8- The equation of calculated N at 4.4 %
- Q9- Calculate the $t_{\text{in mb.ph.}}$, $t_{\text{in stat. ph.}}$ & **Corrected retention volume** from the giving : retention time of mobile phase = 30 sec, retention time of analyte in stationary phase = 4.5 min, flow rate of mobile phase = 75ml/min :&
- Q10- Describe Tg, DTA & DSC curves (plotting only)
- Q11- The types of interferences in AAS :&.....
- Q12- Numerate two line sources in AAS :&
- Q13- Main steps of MS :&
- Q14- What use the main component of Laser
- Q15- The ion-selective electrode for calcium ion analysis is While the use of SCE as a
- Q16- If the specific conductivity for an electrolyte solution 0.1 N is $8.3 \times 10^3 \text{ Sm}^{-1}$, therefore the equivalent conductivity for the same electrolyte at this concentration is :

Ph.D. Competative examination (Analytical Chemistry)

Answer the following questions according to the request quoted with each .

Q1: Atomic Absorption relies on the formation of in the ground state, otherwise interferences will occur; which could be,

a)..... interferences. Or b) interferences, c) interferences.

Q2: Tick the correct phrase;

a) GC work under high vacuum while mass spectrometry require high pressure

b) GC work under high pressure while mass spectrometry work under vacuum.

Q3 : Three explanation is regarded as best to describe the mechanisim of Microwave and how it works, they are as follows; a)..... b)..... C).....

Q4: When an electron strike a solid material it releases different kinds of effects

, numerate four of them; a)..... B)..... c)..... d).....

Q5: Soft X-Ray (white X-Ray) can be generated by of released X-Ray photon to a target .

Q6: Numerate three factors that will affect precipitation from homogeneous solution,

a)..... b)..... c).....

Q7: A) solution has $1 \times 10^{-7} \text{M-HCl}$; The PH of the solution will be (pick one of the following);

a) < 7 b) > 7 c) $= 7$.

B) Arrange the following in the order of increasing acidity;

HBr , HCl , HI .

Q8: In chromatography the number of theoretical plates at 50%peak height is expressed as N which is Equal to

Q9: A) In gas chromatography the detectors that are used ; a)..... b)..... C).....

B) CHN- analyser is used to determine the formula .

Q10: Electrophoresis deals with Compound.

Q11: Silver ion is usually determined indirectly by Volhard method by titration with using indicator.

Q12: Laser spectroscopy is based on FOUR steps and they are; a)..... b)..... c)..... d).....

Q13: There are many kinds of reference electrodes. Numerate three; a)..... b)..... c).....

Q14: A) Give with simple examples the meaning of Von Weimarn relation.

B) Give two differences between Turbidimetry & Nephelometry .

Q15: Polarography relies on the use of as an indicator electrode to measure and the use of Solution to eliminate the migration current.

Time:-30 minutes.

Competition Examination [For Ph.D candidate]

Q1) Write down the chemical structure & the names of:-

- a- The final product (s) of the complete oxidation of glucose in the presence of oxygen.
- b- The product(s) of beta -oxidation of saturated fatty acid.

Q2) what is the main difference between the following terms:-

- a- Nucleotide & Nucleoside.?
- b- Catabolism & Anabolism.
- c- Hormone& Enzyme.
- d- Allosteric enzyme & enzyme that follow Michalis-Menton kinetics.

Q3) Choose the correct answer:-

- 1) All the 20 a.a.s are optically active except:-
a-lysine. b-the aromatic a.a.s. c-glycine. d-serine. e-cysteine.
- 2) A codon consists of:-
a-one molecule of aminoacyl-tRNA. b- Two complementary base pairs.
c- three consecutive base pairs. d-an individual ribosome e- four individual nucleotides.
- 3)All the following contain glucose as a structural unit except:-
a-maltose. b-glycogen. c-mannose. d-lactose. e-sucrose.
- 4) Hydrolysis of a mixture of phosphoglycerides may yield all the following except:-
a-serine. b-choline. c-galactose. d-glycerol. e-phosphate.
- 5)The major source of extracellular cholesterol for human tissue is :-
a-VLDL. b-LDL. c-HDL. d- albumin. e- gama globulin.
- 6) Which one of the following is characteristic of low insulin levels:-
a- increase glycogen synthesis. b- decrease gluconeogenesis from lactate;
c-increase formation of hydroxybutyrate d-decrease glycogenolysis.
- 7)A peptide bond:-
a- is ionized at the physiological pH. b- is cleaved by agents that denature proteins
c- occur most commonly in the cis configuration. e-has a partial double bond character.
- 8) The rate of DNA synthesis in a culture of cells could be most accurately determined by
Measuring the incorporation of which of the following
a- phosphate. b-adenine. c-gaunine. d-thymidine. e-uridine.

Competition Examination for PhD study Candidate (Biochemistry)

Q1) Write down the chemical structure & the name of:-

- a- The final product(s) of complete oxidation of purine nitrogen base?
- b- The precursor of cholesterol biosynthesis?

Q2) what is (are) the main differences between:-

- a- DNA & RNA?
- b- The secondary structure of the protein & The tertiary structure of the protein?
- c- Maltose & Mannose?
- d- Cholesterol & glycerol?

Q3) Choose the correct answer:-

1- All the following contain glucosyl except:-

- a- cellulose. b- lactose. c- amylose. d- galactose.

2- The anticodon:-

- a- is present in the mRNA.
- b- is a component of tRNA.
- c- Consists of four nucleotides.
- d- is a part of the gene.

3- The peptide bond is:-

- a- a covalent bond. b- an ionic bond. c- non covalent bond.

4- Lactose is :-

- a- a galactosyl-glucose. b- is a non-reducing sugar.
- c- is present in the honey. d- is a polysaccharide.

5- Neutral fat is composed of :-

- a- cholesterol + fatty acids. b- glycerol + phosphatidic acid.
- c- glycerol + fatty acids. d- sphingosine + fatty acid.

6- DNA refers to:-

- a- dinucleotides. b- deoxy nucleotide acid. c- deoxy nucleic acid.

7- The enzyme catalyzes the chemical reaction by:-

- a- increase the initial energy. b- increase the kinetics energy of reactants.
- b- lower the activation energy of the reaction.

8- The TCA cycle :-

- a- occurs in all living cells. b- is specific for CHO.
- b- occurs in the cytoplasm. c- takes place in the mitochondria.



Q1: Choose the right answer for the following.

- 1-The most stable oxidation state of Bi element is (+1, +3, +5).
- 2-The structure of NH_3 molecule is (tetrahedral, octahedral, square planar, trigonal pyramid and the hybridization of nitrogen atom is (SP^2 , SP^3d^2 , SP^3)).
- 3-The inversion center is found in (H_2O , SF_6 , CO).
- 4- $^1\text{S}_0$ is the term symbol for Ni^{2+} , Co^{2+} , Cu^{2+} , Zn^{2+} in the ground state.
- 5-The hybridization of the Cobalt ion in $\text{K}_3[\text{Co}(\text{CN})_6]$ is (SP^3d^2 , dSP^2 , d^2SP^3).
- 6- NH_3 , NO_3^- , ClO_4^- are (soft acids, hard bases, soft bases, hard acids).
- 7-The metal with inert nS^2 electron is (Sn, Ge, P, Bi).
- 8- D_{3h} is a point group of (C_2H_6 staggered, CH_4 , PCl_5).
- 9-The point group of H_2S molecule is (C_{3v} , C_{2h} , C_{5v}).
- 10-The electronic configuration of $_{78}\text{Pt}$ is ($[\text{Xe}]4f^{14}5d^96s^2$, $[\text{Xe}]4f^{14}5d^96s^1$, $[\text{Xe}]4f^{14}5d^{10}6s^0$).

Q2: Answer by "True" or "False".

- 1-The four quantum numbers of the valance electron of Cu element are $n=4$, $l=1$, $m_l=0$, $m_s=+1/2$.
- 2-The hybridization of I_3^- ion is SP^3d .
- 3-There are two π -bonds in the structure of H_3PO_4 molecule.
- 4- $[\text{PtCl}_4]^{2-}$ is a square planar species.
- 5- The value of Z_{eff} of the valance electron for ($_{23}\text{V}$) element is equal to 3.3.

Q3: Arrange the following according to specified orders.

- 1- SiO_2 , PbO_2 , SnO_2 , GeO_2 , CO_2 (increased basic properties).
- 2- AsCl_3 , NCl_3 , PCl_3 , BiCl_3 (increased ionic character).
- 3-N, Cs, F, Sr, P (increased electronegativity).
- 4- NO_3^- , NO_2^+ , NO_2^- (increased bond angle).
- 5- $[\text{Co}(\text{NH}_3)_6]^{3+}$, $[\text{Ir}(\text{NH}_3)_6]^{3+}$, $[\text{Ni}(\text{NH}_3)_6]^{2+}$ (increased absorption energy).



مستتر 2015

Q1: Arrange the following according to specified orders.

- 1-SiO₂, PbO₂, SnO₂, GeO₂, CO₂ (increased basic properties).
- 2-AsCl₃, NCl₃, PCl₃, BiCl₃ (increased ionic character).
- 3-N, Cs, F, Sr, P (increased electronegativity).
- 4-NO₃⁻, NO₂⁺, NO₂⁻ (increased bond angle).
- 5-[Co(NH₃)₆]³⁺, [Ir(NH₃)₆]³⁺, [Ni(NH₃)₆]²⁺ (increased absorption energy).

Q2: Answer by "True" or "False".

- 1-The four quantum numbers of the valance electron of Zn element are
 $n=4$ $l=1$ $m_l=0$ $m_s=+1/2$
- 2-The hybridization of N₃⁻ ion is SP¹.
- 3-There are three π -bonds in the structure of HNO₃ molecule.
- 4-[PtCl₄]²⁻ is a tetrahedral species.
- 5- The value of Z_{eff} of the valance electron for (23V) element is equal to 3.5.

Q3: Choose the right answer for the following.

- 1-The most stable oxidation state of Cs element is (+1, +3, +4).
- 2-The structure of PCl₃ molecule is (tetrahedral, octahedral, square planar, trigonal pyramid and the hybridization of nitrogen atom is (SP², SP³d², SP³).
- 3-The inversion center is found in (H₂S, SF₆, CO₂).
- 4>¹S₀ is the term symbol for Ni²⁺, Co²⁺, Cu¹⁺, Mn²⁺ in the ground state.
- 5-The hybridization of the Cobalt ion in K₃[CoCl₆] is (SP³d², dSP², d²SP³).
- 6-NH₃, NO₃⁻, ClO₄⁻ are (soft acids, hard bases, soft bases, hard acids).
- 7-The metal with inert nS² electron is (Sn, Ge, P, Sb).
- 8-D_{3h} is a point group of (C₂H₆ staggered, CH₄, PH₅).
- 9-The point group of H₂O molecule is (C_{3v}, C_{2h}, C_{2v}).
- 10-The electronic configuration of ⁷⁸Pt is ([Xe]4f¹⁴5d⁹6s², [Xe]4f¹⁴5d⁹6s¹, [Xe]4f¹⁴5d¹⁰6s⁰).

Good Luck



Q1: Choose the correct answer (put circle) for the following: (12 M)

- According to reaction rate law, the rate is a proportional with integer power of the concentrations of: a) reactants. b) products.
- The reaction rate constant unit is usually: a) $\text{mol}^{1-n} \cdot \text{L}^{n-1} \cdot \text{time}^{-1}$ b) $\text{mol}^{n-1} \cdot \text{L}^{1-n} \cdot \text{time}^{-1}$, when n is reaction order.
- The differential equation for a first order reaction ($A \rightarrow B$) is: a) $\frac{d[A]}{dt} = k[A]$
b) $-\frac{d[A]}{dt} = k[A]$
- In the integral rate equation for second order reaction ($kt = \frac{1}{[A]} - \frac{1}{[A_0]}$), the half-life ($t_{1/2}$) is given by: a) $t_{1/2} = \frac{1}{k[A_0]}$ b) $t_{1/2} = \frac{1}{k[A]}$
- If the half-life of a first order reaction ($A \rightarrow B$) was 10 minutes, the percent of A remains after one hour will be: a) 1.56% b) 3.36%
- In the reversible reaction ($A + B \xrightleftharpoons[k_2]{k_1} C$) at equilibrium, the differential rate equation is:
a) $\frac{d[C]}{dt} = k_1[A][B] - k_2[C]$ b) $-\frac{d[C]}{dt} = k_1[A][B] - k_2[C]$
- If the slope of the line in a first order reaction ($A \rightarrow B$) is (-2.7) according to equation ($\log[A] = -\frac{kt}{2.303} + \log[A_0]$), the rate constant (k) is: a) 6.22 time^{-1} b) 1.17 time^{-1}
- For the kinetic reaction ($A + 2B \rightarrow C$), the rate is: a) $\frac{d[C]}{dt} = k[A][B]^2$
b) $-\frac{d[C]}{dt} = k[A]^{n_1}[B]^{n_2}$, when n_1, n_2 are experimental value.
- The coulomb is the quantity of electricity carried by: a) a current of (1 amp) in (1 sec).
b) a voltage of (1 volt) in (1 sec).
- The quantity of electricity necessary to deposit (1 mole) of Cu from Cu(II) solution, is:
a) 96500 coulombs b) 2(96500) coulombs.
- The number of electrons in one faraday is: a) 6.02×10^{23} electron b) 1.602×10^{19} electron
- In conductance cell, the relation between conductivity (L) and resistance (R) of any electrolytic conductor is given by: a) $L = K_{\text{cell}} \cdot R$ b) $L = K_{\text{cell}} / R$
- The molar conductivity (ρ by mho. $\text{cm}^2 \cdot \text{mol}^{-1}$) is defined for solution its concentration (M by mol. L^{-1}) and its conductivity (L by simens. cm^{-1}) as follow:
a) $\rho = 1000 L/M$ b) $\rho = L/M$
- The conductivity (L) of an electrolytic substance (its resistivity (r)) is:
a) $L = 1/r$ b) $L = K_{\text{cell}}/r$, when K_{cell} is cell constant.



Q1: Choose the correct answer/s (put circle) for the following: (60 Mark)

- For an ideal gas is: a) $(\frac{\partial U}{\partial T})_P = 0$ b) $(\frac{\partial U}{\partial V})_T = 0$ c) $(\frac{\partial H}{\partial P})_T = 0$
- The work function (A) define by thermodynamic equation:
a) $A = U + PV$ b) $A = H - PV$ c) $A = U - TS$
- For monatomic gases, the constant volume heat capacity (C_V) equal to:
a) $\frac{1}{2}R$ b) $1R$ c) $\frac{3}{2}R$
- In the reaction ($A + B \rightleftharpoons C$) at equilibrium state is: a) $\Delta G^0 = 0$ b) $\Delta G = 0$ c) $\Delta G^0 = -RT \ln K$
- According to quantum mechanics, the linear momentum of photon (P) is given by the equation: a) $P = E / \lambda$ b) $P = h \cdot \lambda$ c) $P = h / \lambda$
- General unit of rate constant in the chemical reaction is:
a) $\text{mol}^n \cdot \text{L}^{-n} \cdot \text{time}^{-1}$ b) $\text{mol}^{n-1} \cdot \text{L}^{1-n} \cdot \text{time}^{-1}$ c) $\text{mol}^{1-n} \cdot \text{L}^{n-1} \cdot \text{time}^{-1}$
- The kinetic equation for the second order reaction ($A \rightarrow B$) is:
a) $-\frac{dA}{dt} = kB^2$ b) $-\frac{dA}{dt} = kA^2$ c) $\frac{dB}{dt} = kA^2$
- The integral equation for a first order reaction ($A \rightarrow B$) is:
a) $A = A_0 \cdot e^{kT}$ b) $A = A_0 \cdot e^{-kT}$ c) $A = A_0 \cdot (0.5)^{t/t_{1/2}}$
- If the half-life of a first order reaction ($A \rightarrow B$) was 20 min., the ratio of A remains after one hour will be: a) 0.100 b) 0.120 c) 0.125
- The specific conductance (L) of solution its resistance (R) and resistivity (r) in electrical cell is: a) $L = K_{\text{cell}} / r$ b) $L = 1 / r$ c) $L = K_{\text{cell}} / R$
when K_{cell} is cell constant.
- The number of electrons in two faraday is: a) 3.20×10^{19} b) 18.06×10^{23} c) 12.04×10^{23}
- The coulombs number necessary to deposit (1 mol) of Ag from Ag(I) solution is:
a) 1.6×10^{19} b) 6.02×10^{23} c) 96500



13. The coulomb represents quantity of electricity carried by:

- a) (1 amp) in (2 sec) b) (1 amp) in (1 sec) c) (0.5 amp) in (2 sec)

14. In electric conductance cell, the relation between resistance (R) and conductivity (L) for electrolytic solution is given by the equations :

- a) $R = L / K_{cell}$ b) $R = L \cdot K_{cell}$ c) $R = K_{cell} / L$

when K_{cell} is cell constant.

Q2: Answer on the following questions: (40 Mark)

- 1) Write only equations to calculate translational, rotational and vibrational components of internal energies for CO gas at (T) temperature.
- 2) Show that the function $\varphi = 8e^{5x}$ is an eigen function of the operator (d/dx) . What is the eigen value?
- 3) Write down only equations of the following concepts: a) Lambert – Beer's law
b) Max plank's equation.
- 4) For the following first order reactions: $A \xrightarrow{k_1} B \xrightarrow{k_2} C$

Determine the rate equations of $\frac{dB}{dt}$ and $\frac{dC}{dt}$

ملاحظة مهمة: إجابة السؤال الأول تقتصر فقط على وضع دائرة حول الاختيارات الصحيحة إمام كل رقم لسؤال الاختيار.



15. The relation between the conductivities (κ) of solution and its components is:
a) $\kappa_{\text{solution}} = \kappa_{\text{solute}} - \kappa_{\text{solvent}}$ b) $\kappa_{\text{solute}} = \kappa_{\text{solution}} - \kappa_{\text{solvent}}$
16. Photon energy calculates from the equation: a) $E = h\nu$ b) $E = mc^2$
17. Lambert-beer's law represents the equation formula: a) $\log I_0/I = \epsilon \cdot C \cdot L$ b) $\log I/I_0 = \epsilon \cdot C \cdot L$
18. Conversion factor between the energy (by MeV) and mass (by amu) is:
a) $931.5 \text{ MeV.amu}^{-1}$ b) $913.5 \text{ MeV.amu}^{-1}$
19. For an ideal gas: a) $(\frac{\partial U}{\partial V})_T = 0$ b) $(\frac{\partial U}{\partial T})_P = 0$
20. The gas constant is: a) $8.314 \text{ J.mol}^{-1}.\text{K}^{-1}$ b) $0.082 \text{ atm.mol}^{-1}.\text{K}^{-1}$
21. The process of changing a solid to a gas state is called: a) vaporization b) sublimation
22. Exothermic process means a value of: a) $\Delta H = +$ b) $\Delta H = -$
23. The internal energy (U) define by equation: a) $U = H - PV$ b) $U = H - RT$
24. The mass density of nitrogen gas (its MW 28 g.mol^{-1}) at STP is approximately:
a) 1.251 g.L^{-1} b) 1.25 g. ml^{-1}

Q2: Answer on the following questions: (8 Marks)

- 1) If $V = f(P, T)$, write the total differential equation for the V .
- 2) For the following Arrhenius equation $k = A \cdot e^{-E_a/RT}$. Draw diagram to calculate (E_a) and (A).
- 3) Draw schematic figure shows energy levels of molecular orbitals and the different electronic transitions.
- 4) Write down equation of de Broglie, then shows (by equations only) how can you calculate the linear momentums of photon and electron.