



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

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

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 $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 / \hbar}$

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