



الامتحان التنافسي للمتقدمين للدراسات العليا (الدكتوراه) لقسم الفيزياء-كلية العلوم
جامعة بغداد للعام الدراسي ٢٠١٥-٢٠١٦

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:

- (a) $F = -m\dot{\omega} \times r$ (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

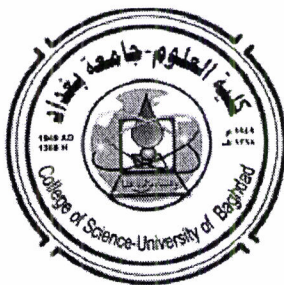
- (a) Henry (b) Farad. Ohm (c) Ohm (d) $\frac{1}{\text{Farad} \cdot \text{Sec}}$

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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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_g) of the function $y = \sqrt{x+4}$ are given by:

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

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

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

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

a) Lagrangian

b) Hamiltonian

c) Hermitian

d) Angular momentum

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

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) $\psi(x,t)/\psi^*(x,t) dx$

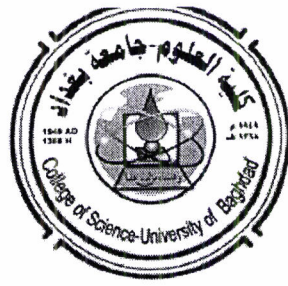
c) $\psi^*(x,t)\psi(x,t) dx$



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).
- 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 : $H = \hbar\omega \left({}^+ a a + \frac{1}{2} \right)$, where H is the Hamiltonian of the one dimensional harmonic oscillator, ${}^+ a$ is the rising operator and a is the lowering operator.
- Q.8)** Hydrogen atom in the state $\psi(\vec{r}, t) = \sqrt{\frac{3}{4}} \psi_{100}(\vec{r}) e^{-iE_1 t / \hbar} + \sqrt{\frac{1}{4}} \psi_{211}(\vec{r}) e^{-iE_2 / \hbar}$

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

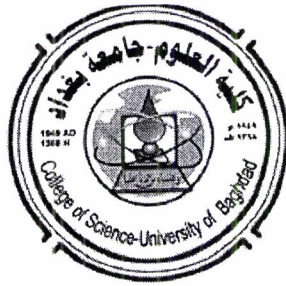
- (a) cannot define (b) greater than (c) equal (d) less than

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



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

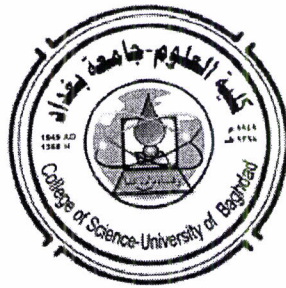
- (a) Electrons
- (b) Protons
- (c) Mobile ions
- (d) Immobile ions

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:
- Degenerate and non degenerate semiconductors
 - Ohmic contact
 - Fermi level and Fermi energy