University of Baghdad
College of Science
Department of Physics
Date: 22 /6/ 2017

Qualifying Examination
for Ph.D Students
Year : 2017 -2018
Time : 3 Hours

الامتحان التنافسي للمتقدمين للدراسات العليا (الدكتوراه) لقسم الفيزياء / كلية العلوم/جامعة بغداد

للعام الدراسي 2017- 2018

الاختصاص : فيزياء النووية(الورقة العامة)

1-Multiple Choice Questions (MCQ)

Q.1) If a generalized coordinate has the dimensions of velocity, generalized Velocity has the dimensions of

(a) Displacement
(b) Velocity
(c) Acceleration
(d) Force

Q.2) Choose the correct statements:

(a) The angular momentum is conserved for system possessing rotational symmetry.
(b) If the Lagrangian of a system is invariant under translation along a direction, the corresponding linear momentum is conserved.
(c) If the lagrangian of a system is invariant under translation a long a direction, we cannot say anything about the corresponding linear momentum.
(d) For a conservation system, the Hamiltonian is equal to the sum of kinetic and potential energies.

Q.3) A particle is moving on elliptical path under inverse square law force of the form $\mathbf{F(r)= (-K/r^2)}$, the eccentricity of the orbit is

(a) A function of total energy.
(b) Independent of total energy.
(c) A function of angular momentum.
(d) Independent of angular momentum.

Q.4) The binding energy of alkali metal is -------- than of alkali halide crystal

a- equal
b- Higher
c- More higher
d- Less

Q.5) The space lattice in diamond structure is ------

a- Bcc
b- Hexagonal
c- Cubic
d- Fcc

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Q.6) Bragg law satisfied only for wavelength ---------

a- $\lambda \geq 2d$
b- $\lambda = 2d$
c- $2\lambda \geq 2d$
d- $\lambda \leq 2d$

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

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

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

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

(a) $e^{x_1+x_2}$,

(b) e^{x_1/x_2},

(c) $e^{x_1-x_2}$,

(d) $e^{x_1 x_2}$.

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 expectation value of the kinetic energy of the one dimensional harmonic oscillator in the ground state is

A: 0 ħω B: 1 ħω C: 1/2 ħω

Q.11) In Angular momentum By Ladder Operators, $[L_x, L_y\ ] =$

A: $i\hbar L_z$ B: 0 C: 1

Q.12) In one dimensional harmonic oscillator , $a\psi_1$ =

A: ψ_0 B: ψ_1 C: ψ_2

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2-Short Note Questions (MCQ)

Q.1) If F=(2xy+z^2) ĭ + x^2 ĵ + 2xz Ќ newton ,then show that it is conservation. Calculate the amount of work done by this force in moving a particle from **(0,1,2)** to**(5,2,7) m** .

Q.2) A particle of mass (m) move on plane in the field of force given by polar Coordinate (**F= - KrcosΘ ř)** , where **(K)** is constant and**(ř)** is the radial unit vector

(a) Will the angular momentum of the particle about the origin be conserved? Justify your statement.
(b) Obtain the differential equation of the orbit of the particle.

Q.3) Explain the structure factor of Fcc lattice

Q.4) What is Brilloiun zone

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

Q6.) Find $\frac{dy}{dx}$ for $y = \cosh^2 5x - \sinh^2 5x.$

Q.7) In Angular momentum By Ladder Operators Prove that $[L^2, L\ ] = 0$

Q.8) Represent L^2 it in a matrix form if you given that

$$\langle \ell' m' | L^2 | \ell m \rangle = \hbar^2 \ell(\ell+1)\delta_{\ell'\ell}\delta_{m'm}$$

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1-Multiple Choice Questions (MCQ)

Q.1) Rubidium $^{87}_{37}Rb$ is a naturally occurring nuclide that undergoes beta-minus decay. The nuclide, which is the product of the decay, is:

a) $^{87}_{38}\mathrm{Kr}$ b) $^{88}_{37}\mathrm{Rb}$ c) $^{87}_{36}\mathrm{Kr}$ d) $^{87}_{38}\mathrm{Sr}$

Q.2) Nucleus "a" contains 5 protons and 5 neutrons and has radius *R*. The radius of nucleus "b", which contains 35 protons and 45 neutrons, is closest to:

(a) 8R (b) R (c) 2R (d) 1.4R

Q.3) The negative pion constructed from particles called quarks of types

(a) up-up-down (b) down-down-up (c) anti up-down (d) bottom-anti up

Q.4) The De Broglie wavelength of the electron in the energy region of 100 MeV is:

(a) 3 fm (b) 2.5 fm (c) 2 fm (d) 0.5 fm.

Q.5) What value of Z (atomic number) and A (mass number) result in the following alpha decay? $^{238}_{92}\mathrm{U} \rightarrow {}^{A}_{Z}X + \alpha$

(a) Z = 92; A = 238 (b) Z = 91; A = 238 (c) Z = 90; A = 234 (d) Z = 93; A = 238

Q.6) Prolate shape of nucleus means it has an electric quadrupole moment Q

(a) Q is +ve (b) Q =0 (c) Q is –ve (d) both +ve and –ev

Q.7) Calculate the binding energy per nucleon (MeV/nucleon) for tritium, **t** (Z=1, A=3) a radioactive isotope of hydrogen. Assume:
m_p = 1.007825 u m_n = 1.008665 u m_t = 3.01605 u u = 1.66×10^{-27} kg

(a) 2.8 (b) 3.1 (c) 1.0 (d) 8.5

Q.8) What value of *Z* (atomic number) and *A* (mass number) result in the following *beta*-decay?

$^{14}_{6}C \rightarrow {}^{A}_{Z}X + \beta^{-} + \bar{\upsilon}$

(a) $Z = 5; A = 14$ (b) $Z = 4; A = 10$ (c) $Z = 6; A = 14$ (d) $Z = 7; A = 14$

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Q.9). Rutherford cross-section assume the nucleus is

(a) Sphere of static charges.
(b) Deformed charge distribution.
(c) Point charge.
(e) Spherical charge distribution.

Q.10) Which of the following statements is not true for nuclear force?
(a) For two protons in close proximity, the nuclear force and the electric force have comparable magnitudes.
(b) The nuclear force has a short range, of the order of nuclear dimensions.
(c) The nuclear force does not depend on charge.
(d) The nuclear force favors binding of pairs of protons or neutrons with opposite spin angular momenta.

Q.11) 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.12) In nuclear physics, the unit of magnetic moment is the nuclear magneton given by

a) $\mu_N = \frac{e\hbar}{2mc\, g_l}$ b) $\mu_N = \frac{e\hbar}{2mc\, g_s}$ c) $\mu_N = \frac{e\hbar}{2mc}$ d) $\mu_N = \frac{e\hbar}{2mc\, J}$

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2-Short Note Questions (MCQ)

Q.1) Explain briefly with diagram the neutrons and protons drip lines regions and exotic nuclei?

Q.2) Sketch Feynman diagram of the electron-nucleus scattering process.

Q.3) Explain briefly the physical meaning of Schmidt lines?

Q.4) Compute the expected shell-model quadrupole moment of $^{209}_{83}Bi$ $(9/2^-)$

Q.5) The deuteron is a bound state of a proton and a neutron of total angular momentum J= 1. It is known to be principally an s (l = 0) state with a small admixture of a d (l = 2) state. Explain why a p-state cannot contribute.

Q.6) Compute the values of the magnetic dipole moments expected from the shell model of the $^{17}_{8}O(5/2^+)$

Q.7) Give the expected shell-model spin and parity assignments for the ground states of following nuclei

(a) $^{17}_{8}O$ (b) $^{19}_{9}F$ (c) $^{141}_{59}Pr$

Q.8) An electron of momentum 330 MeV/c is scattered at an angle of 10° by a calcium nucleus. Calculate the Mott differential cross section.