University of Baghdad
College of Science
Department of Physics
Date: 18 / 7 / 2016

نموذج ٣

Qualifying Examination
for Ph.D Students
Year:2016-2017
Time: 3 Hours

الامتحان التنافسي للمتقدمين للدراسات العليا (الدكتوراه) لقسم الفيزياء-كلية العلوم جامعة بغداد للعام الدراسي ٢٠١٦-٢٠١٧

الاختصاص: الفيزياء النووية والبيئية

اولاً:الورقة العامة ٢٠%

1- Multiple Choice Questions:

Q.1) A baseball has a mass of 0.145kg. The resultant force required to given this baseball an acceleration of 400m/sec^2 is: **a)** 85N, **b)** 58 N, **c)** 77 N, **d)** 60 N.

Q.2) An electric motor exerts a force of 400N on a cable and pulls it a distance of 30m in 1 min. the power supplied by the motor is : **a)** 200 watt, **b)** 150 watt, **c)** 300 watt, **d)** 234 watt.

Q.3) The Hamilton's function for one-dimension harmonic oscillator is:

a) $H=\frac{p^2}{2m}+\frac{k}{2}x^2$, **b)** $H=\frac{m}{2}v^2+\frac{k}{2}x^2$, **c)** $H=\frac{p^2}{2m}-\frac{k}{2}x^2$, **d)** $H=\frac{m}{2}v^2-\frac{k}{2}x^2$.

Q.4) The space lattice of Diamond is --------
a)HCP **b)**FCC **c)**BCC **d)**SC

Q.5) The number of lattice in tetragonal system is ------
a)1 **b)** 2 **c)** 4 **d)** 3

Q.6) The structure factor is defined as an integral over ------ cell
a)primitive **b)**single **c)**multiple **d)**symmetry

Q.7) $\cosh^2x+\sinh^2x=$ **a)**$-\cosh(2x)$ **b)**$\sinh(2x)$ **c)**$\tanh(2x)$ **d)**$\cosh(2x)$

Q.8) Variables of linear equation is implicitly raised to
a)first power **b)**second power **c)**third power **d)**four power

Q.9) General form of positive number with exponential power of real value b^m multiply b^n can be written as

a)$2b^{m-n}$ **b)**b^{m+n} **c)**b^{m-n} **d)**$2b^{m+n}$

Q.10) The single particle energy for a particle moves in one dimension harmonic oscillator has one of the following values :
a) $n\hbar\omega$ **b)** $(n+1/2)\hbar\omega$ **c)** $n^2\hbar\omega$ **d)** $\ell(\ell+1)\hbar^2$

Q.11) Which of the following relations are not correct

a) $L^2\,|lm>=h\;\;l(l+1)\,|lm>$ **b)** $[L^2,L^{\rightarrow}]=0$

c) $H=\frac{p_x^2}{2m}+\frac{1}{2}m\omega^2x^2$ **d)** $F_l^l(\theta,\phi)=P(\theta)Q(\phi)$

Q.12)A particle in three dimensional box is represented according to one of the following set of quantum numbers

a)(n_x,n_y,n_z) **b)** $(n\;\;,l\;\;,m_l)$ **c)** $(S\;\;,S_z,T,T_z)$ **d)** non of the forgoing options

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2- Short Note Questions:

Q.1) A pendulum bob with a weight of 20N hangs from a cord. A horizontal force sufficient to bring the cord to an angle of 25^0 with the vertical is applied to the bob. Find the tension in the cord?

Q.2) A ball is thrown horizontally with a velocity of 50ft/sec from a tower 100ft high. Find the time of flight?

Q.3) Write about reciprocal lattice vector

Q.4)Write about polytypism

Q.5) Find the volume V of the parallelepiped with sides $\vec{A}=2\hat{i}+3\hat{j}+3\hat{k}$,

$\vec{B}=5\hat{i}+4\hat{j}+6\hat{k}$ and $\vec{C}=7\hat{i}+8\hat{j}+10\hat{k}$.

Q.6) Express $\dfrac{1+2i}{1-3i}$ in the polar form ($Z=r(\cos\theta+i\sin\theta)$).

Q.7) given that the spherical harmonics is represented by the following relation,

$$Y_l^m(\theta,\phi)=(-1)^{l+m}\frac{1}{2^l l!}\sqrt{\frac{(2l+1)!(l-m)!}{4\pi(l+m)!2l!}}e^{im\phi}*sin^{-m}\theta\frac{d^{(l+m)}}{d(cos^{(l+m)}\theta)}sin^{2l}\theta$$

Find $Y_l^0(\theta,\phi)$

Q.8) write down the formula of energy for a particle in three dimensional box

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2 Short Note Questions

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

Q.2)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.3)Give the evidences that the electron is a good probe to study the nuclear structure.

Q.4)Determine the stable nucleus that has a radius 1/3 that of ^{189}Os.

Q.5)An electron of momentum 330 MeV/c is scattered at an angle of 10◦ by a calcium nucleus. Calculate the Mott differential cross section

Q.6) $^{27}_{14}Si$ and $^{27}_{13}Al$ are mirror nuclei. The former is a positron emitter with Emax =3.48 MeV. Determine r_o.

Q.7)How much energy is required to remove a proton from $^{56}Fe(Z=26)$? Calculate the binding energy per nucleon for ^{56}Fe and compare with your value for the proton separation energy. Can you explain any differences? $M(^{56}Fe) = 55.934939u$, $M(^{55}Mn) = 54.938047u$)

Q.8)In odd-odd nuclei, an interaction between the last odd neutron and the last odd proton must be taken into account in order to explain the ground state spins. On this basis determine the ground state spin and parity for the ^{14}N (Z=7) nucleus, giving a sketch of the occupation of levels as prescribed by the shell model.

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Multiple Choice Question:

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Q.1) The mass density of a nucleus varies with mass number A as
a) A^2 **b)** A **c)** constant **d)** 1/A

Q.2) The neutron constructed from particles called quarks of types
a) up-up-down **b)** down-down-up **c)** up-anti down-up **d)** bottom-anti up

Q.3) 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.4) Calculate the binding energy per nucleon (MeV/nucleon) for tritium, ${}^{3}_{1}H$ a radioactive isotope of hydrogen. Assume:

$m_p = 1.007825$ u $m_n = 1.008665$ u $m_t = 3.01605$ u u $= 1.66 \times 10^{-27}$ kg

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

Q.5) 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)** $Z = 7; A = 14$

C) Mott cross-section assume the nucleus is
a) sphere of static charges **b)** deformed charge distribution
c) point charge **d)** spherical charge distribution

Q.7) Which of the following statements is true for nuclear forces
a) they are equal in strength to the electromagnetic forces
b) they are short range forces
c) they obey the inverse third power law of distance
d) they obey the inverse square law of distance

Q.8) According to Yukawa the nuclear force arises though the exchange between nucleons of
a) proton **b)** photon **c)** positron **d)** meson

Q.9) 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.10). In nuclear physics, the unit of magnetic moment is the nuclear magneton given by

$\mu_N = \dfrac{e\hbar}{2mc\, g_l}$ $\mu_N = \dfrac{e\hbar}{2mc\, g_s}$ $\mu_N = \dfrac{e\hbar}{2mc}$ $\mu_N = \dfrac{e\hbar}{2mc\, J}$

Q.11) The Q-value for the following reaction, Be (α, n) C, is (in MeV)
$M_{alpha} = 4.002603$ u, $M_{Be} = 9.012182$ u, $M_n = 1.008665$ u, $M_C = 12.000$ u
1 u $= 1.66 \times 10^{-27}$ kg
a) 8.4 **b)** 6.2 **c)** 7.3 **d)** 5.7

Q.12)Naturally occurring tellurium, ${}^{123}_{52}\mathrm{Te}$ transforms by electron capture, according to the reaction ${}^{123}_{52}\mathrm{Te} + e^- \rightarrow X + \nu$ the product nuclide, denoted by X, is:

a) ${}^{123}_{53}\mathrm{I}$ b) ${}^{123}_{52}\mathrm{Te}$ c) ${}^{123}_{51}\mathrm{Sb}$ e) ${}^{121}_{50}\mathrm{Sn}$