



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)  $1.2 \times 10^4$  atm, (b)  $1.2 \times 10^{-4}$  atm, (c)  $1.2 \times 10^3$  atm, (d)  $1.2 \times 10^{-3}$  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.

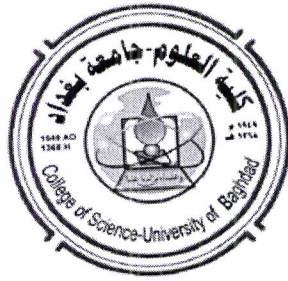
**Q.5)** Convert  $2\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$  into the rectangular form.

**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  $E = E_1$ ?



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**2 Multiple Choice Question:**

- Q.1)** The density ( $\rho$ ) 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  $\beta$ -particle. Are the mother and daughter nuclei  
(a) isotones (b) isobars. (c) isotopes (d) isomers.
- Q.3)** Half life of radium ( ${}_{88}\text{Ra}^{226}$ ) is 1620 years. What is the activity of 2 gram of radium?  
(a)  $3.6 \times 10^{10}$  Bq (b)  $7.2 \times 10^{10}$  Bq (c)  $1.44 \times 10^{11}$  Bq (d)  $2.88 \times 10^{11}$  Bq.
- Q.4)** Which one of the following will be better shield against  $\beta$ - 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,  ${}_{52}^{123}\text{Te}$  transforms by electron capture, according to the reaction  ${}_{52}^{123}\text{Te} + e^- \rightarrow X + \nu$  the product nuclide, denoted by X, is:  
(a)  ${}_{53}^{123}\text{I}$  (b)  ${}_{52}^{123}\text{Te}$  (c)  ${}_{51}^{123}\text{Sb}$  (d)  ${}_{50}^{121}\text{Sn}$
- 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)  $2.4 \times 10^7$  (b)  $1.5 \times 10^7$  (c)  $3.7 \times 10^7$  (d)  $4.6 \times 10^7$ .
- 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



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**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?

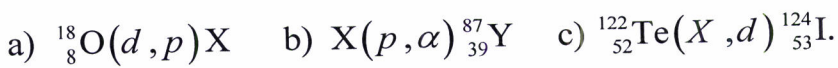
**Q.2)** Determine the stable nucleus that has a radius 1/3 that of  $^{189}\text{Os}$ .

**Q.3)** Compute the energy requires to remove a neutron and binding energy per nucleon for  $^{43}_{20}\text{Ca}$  nucleus, where:

$$M_{43\text{Ca}}=42.958780\text{u}, M_{42\text{Ca}}=41.958625\text{u}, M_n=1.008665\text{u}, M_p=1.007825\text{u}.$$

**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)  $^{20}_{10}\text{Ne}$

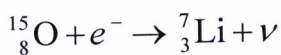
**Q.5)** Determine the unknown particle X in the following nuclear reactions:



**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  $^{7}_4\text{Be}$  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.