Faculty of Science | **Date: 13 June, 2019**
Physics Department | **Time: 3 hours**

Final Examination in (X-ray Diffraction & Applications 352P)
Teaching Staff: Prof. Dr. Abdulaziz Abualfadl

Constants: h= 6.626 x 10^{-34}J.s, 1 eV= 1.6 x 10^{-19} J, k_B= 1.38 x 10^{-23}J/K, e=1.6 x 10^{-19}C, c= 3 x 10^{8}m/s, N_A= 6.02 x1 0^{23} atom/mole, m_e=9.1x10^{-31} kg, m_n=6.7x10^{-27} kg

Answer 5 questions from the following: [10 marks for each]

1- (a): How the laue technique particularly convenient for checking the orientation of crystals. Show why laue method cannot be used for crystal structure determination?.
(b): Calculate the three smallest Bragg angles that arise from the diffraction of 150 keV electrons in face-centered cubic (fcc) copper with lattice parameter at room temperature equal 3.615 A°?

2- (a)- Define or Explain the following terms: i)- Bravai Lattice, ii)- Basis, iii)- Primitive Unit Cell, iv)- Diad Inversion Axis ($\overline{2}$) v)- Glide Plane.
(b)- A crystal has a cubic unit cell of 4.2 °A. Using a wavelength of 1.54 °A. What is the angle (2θ) for the (101) peak?

3- (a)- Describe, briefly, the determination of the crystal structure using a single crystal, give a schematic diagram of the experimental tools to show the produced diffraction pattern of the transmitted X-ray beam.
(b)- Determine unit cell dimension when Bragg's angle of 30° is observed during first order reflection in a cubic crystal having Miller indices (121). Given the wavelength of the X-ray used is 1.418 A°.

4- (a)- Find the atomic packing factor for body centered cubic (B.C.C) crystal.
(b)- The lattice parameter of a crystal is 1.5 A° and the angle for the first order reflection in (111) plane is 60°. Determine the energy of the X-rays in eV.

5- (a)- Discuss in brief the factors affecting X-ray spectrum.
(b)- What is the relationship between the lattice vectors (lengths and angles) in the 7 basic crystal systems? And what is a screw transformation? Describe a screw transformation that transforms one of the basis points to another.

6- (a) What are the advantages and disadvantages of using neutron diffraction for structure determination?
(b)- Explain and derives Bragg's law of X-ray diffraction from a crystal. Then draw the [111], [220] directions within a cubic unit cell and sketch the planes (100) and (110).

انتهت الأسئلة مع أطيب الأمنيات بالتوفيق

Assiut University		Term: fall 2018 - 2019
Faculty of Science		Date : June. 15. 2019
Department of Physics		Time: 3 hours

Final Exam/ Course Title: Electromagnetic theory & Electrodynamics (P312)

The exam in 2 pages (50 marks)

Answer the THREE following questions:

Question (I) True or false and comment in details (with derivations if required):

(10 Marks, 1 mark per each)

1. The divergence of the magnetic flux density B is 0 as well as the curl of the electric field intensity E is 0.

2. In the case of a time-varying magnetic density $B(t)$ that penetrates a moving closed path with an area S and length L, the electromotive force is equal to $-\oiint(\partial B/\partial t)\cdot dS$.

3. In a circuit composed of a filamentary loop and a parallel-plate capacitor, the displacement current is equivalent to the conduction current passed in the loop.

4. In a conductive material, the vectors of conduction and displacement current density are perpendicular in directions.

5. The choice of the vector and scalar potentials A and V is unchangeable (or unique) for the same E and B.

6. The absolute charge q of a moving or fixed charge distribution having a density ρ_v over a volume $\acute{\tau}$ at a retarded time t_r is the same for an observer, that is $\oiiint \rho_v(\acute{r}, t_r)d\acute{\tau} = q$.

7. The radiation field of a moving charge depends on the velocity of the charge.

8. The gradient of the magnitude of the position vector $r = \sqrt{x^2 + y^2 + z^2}$ is the unit vector $\hat{\boldsymbol{r}}$.

9. $\nabla \cdot \hat{\boldsymbol{r}}/r^2 = 0$ where $\hat{\boldsymbol{r}}$ is the unit vector of a position vector $\boldsymbol{r}$.

10. If the electric field $\boldsymbol{E} = 1800\cos(10^7\pi t - \beta z)\,\widehat{\boldsymbol{a}}_x$ V/m and the magnetic field $\boldsymbol{H} = 3.8\cos(10^7\pi t - \beta z)\,\widehat{\boldsymbol{a}}_y$ A/m of a uniform plane wave propagating at a velocity 1.4×10^8 m/s in a perfect dielectric, the relative permeability $\mu_r \sim 4$.

Question (II): (10 Marks)

1. Using cylindrical coordinates (ρ, ϕ, z), assume the potential vector is $\boldsymbol{A} = 50\rho^2\widehat{\boldsymbol{a}}_z$ Wb/m in free space. Find (a) the current density $\boldsymbol{J}$. (b) the total current crossing the surface $0 \leq \rho \leq 1$, $0 \leq \phi \leq 1$, $z = 0$. **(4 Marks)**

2. In free space, if the charge density $\rho_v = 200\epsilon_0/r^{2.4}$, calculate the scalar potential V assuming that $r^2 E_r \to 0$ when $r \to 0$ and also that $V \to 0$ when $r \to \infty$. **(3 Marks)**

3. Assuming a complex permittivity of a dielectric where the wavenumber of a propagating EM wave can be written as $k = \beta - j\alpha$, derive expressions for attenuation (or gain) coefficient α and β coefficient. **(3 Marks)**

Question (III): (15 Marks, 5 marks per each)

1. Describe how the Green theory can solve the equation of the vector potential $\nabla^2\boldsymbol{A} = -\mu_0\boldsymbol{J}$. **(5 Marks)**

2. Prove that the scalar potential of a point charge moving with a constant velocity v is given by

$$V = \frac{1}{4\pi\epsilon_0}\frac{q}{R\sqrt{1-(v/c)^2\sin^2\theta}}$$

where $\boldsymbol{R} = \boldsymbol{r} - \boldsymbol{v}t$ and θ is the angle between the vector $\boldsymbol{R}$ and the velocity $\boldsymbol{v}$. **(6 Marks)**

3. In region 1, $z < 0$, we have $\epsilon_1 = 2 \times 10^{-11}$ F/m, $\mu_1 = 2 \times 10^{-6}$ H/m, and $\sigma_1 = 4 \times 10^{-3}$ S/m. In region 2, $z > 0$, we have $\epsilon_2 = \epsilon_1/2$, $\mu_2 = 2\mu_1$, and $\sigma_2 = \sigma_1/4$. If the electric field in the region 1 at a point $P(0,0,0)$ is $\boldsymbol{E}_1 = (30\hat{a}_x + 20\hat{a}_y + 10\hat{a}_z)\cos(10^9 t)$, find the tangential component $\boldsymbol{E}_{t2}$, the normal component $\boldsymbol{E}_{n2}$, and the tangential current density $\boldsymbol{J}_{t2}$ in region 2. **(4 Marks)**

Answer ONLY ONE question from the following questions:

Question (IV): (15 Marks, 5 marks per each)

1. Using the generalized Coulomb electric field, calculate the electric and magnetic fields of a point charge moving with constant velocity and comments on the distribution of fields.

2. Prove that normal components of magnetic flux density $\boldsymbol{B}$ on either side of a boundary separating two media are equal while the tangential components of $\boldsymbol{H}$ may NOT be equal.

3.

(a) Using Maxwell equations, derive an expression for the Poynting vector explaining its Physical meaning.

(b) Let the intrinsic impedance $\eta = 250 + j30\ \Omega$ and the propagation constant $jk = 0.2 + j2\ \mathrm{m}^{-1}$ for a uniform plane wave propagating in the z-direction in a dielectric having some finite conductivity. If the amplitude of the phasor electric field is $|\boldsymbol{E}_s| = 400\ \mathrm{V/m}$, find the time-average value of the Poynting vector.

Question (V): (15 marks, 5 marks per each)

1. Using the retarded potentials, derive Jefimenko's equations.

2. Obtain an expression for the propagation constant in good conductors and explain the skin effect.

3. A lossy dielectric has an intrinsic impedance of $200\angle 30°\ \Omega$ at a particular frequency. If, at that frequency, the plane wave propagating through the dielectric has the magnetic field component

$$\boldsymbol{H} = 10e^{-\alpha x}\cos(\omega t - x)\,\hat{\boldsymbol{a}}_y\ \mathrm{A/m}$$

Find $\boldsymbol{E}$ and α. Also, determine the skin depth and the electric field polarization.

Hints: *In below, length and volume elements; gradient, divergence, curl, and Laplacian operators in spherical (on left-hand side) and cylindrical (on right-hand side) coordinates.*

SPHERICAL $\quad d\ell = dr\hat{r} + rd\theta\hat{\theta} + r\sin\theta d\phi\hat{\phi} \qquad d^3r = r^2\sin\theta dr d\theta d\phi$

$$\nabla\psi = \frac{\partial\psi}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial\psi}{\partial\theta}\hat{\theta} + \frac{1}{r\sin\theta}\frac{\partial\psi}{\partial\phi}\hat{\phi}$$

$$\nabla\cdot\mathrm{A} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2A_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\sin\theta A_\theta) + \frac{1}{r\sin\theta}\frac{\partial A_\phi}{\partial\phi}$$

$$\nabla\times\mathrm{A} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial\theta}(\sin\theta A_\phi) - \frac{\partial A_\theta}{\partial\phi}\right]\hat{r} + \left[\frac{1}{r\sin\theta}\frac{\partial A_r}{\partial\phi} - \frac{1}{r}\frac{\partial}{\partial r}(rA_\phi)\right]\hat{\theta} + \frac{1}{r}\left[\frac{\partial}{\partial r}(rA_\theta) - \frac{\partial}{\partial}\right.$$

$$\nabla^2\psi = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial\psi}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial\psi}{\partial\theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2\psi}{\partial\phi^2}$$

CYLINDRICAL $\quad d\ell = d\rho\hat{\rho} + \rho d\phi\hat{\phi} + dz\hat{z} \qquad d^3r = \rho d\rho d\phi dz$

$$\nabla\psi = \frac{\partial\psi}{\partial\rho}\hat{\rho} + \frac{1}{\rho}\frac{\partial\psi}{\partial\phi}\hat{\phi} + \frac{\partial\psi}{\partial z}\hat{z}$$

$$\nabla\cdot\mathrm{A} = \frac{1}{\rho}\frac{\partial}{\partial\rho}(\rho A_\rho) + \frac{1}{\rho}\frac{\partial A_\phi}{\partial\phi} + \frac{\partial A_z}{\partial z}$$

$$\nabla\times\mathrm{A} = \left(\frac{1}{\rho}\frac{\partial A_z}{\partial\phi} - \frac{\partial A_\phi}{\partial z}\right)\hat{\rho} + \left(\frac{\partial A_\rho}{\partial z} - \frac{\partial A_z}{\partial\rho}\right)\hat{\phi} + \frac{1}{\rho}\left[\frac{\partial}{\partial\rho}(\rho A_\phi) - \frac{\partial A_\rho}{\partial\phi}\right]\hat{z}$$

$$\nabla^2\psi = \frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial\psi}{\partial\rho}\right) + \frac{1}{\rho^2}\frac{\partial^2\psi}{\partial\phi^2} + \frac{\partial^2\psi}{\partial z^2}$$

End of exam,

Best wishes!

Dr. Hesham Fares

Assiut University
Faculty of Science
Department of Physics

Term: Spring 2018- 2019
Date: 12 June, 2019
Time: 3 Hours

Course Title: Mathematical Physics – Code P316 – Final Exam. (50%)

Answer the following question: (*all questions carry the same weight* 10 points)

1- **Find** the Fourier cosine series of the function: $f(x) = \pi^2 - 3x^2$ in the interval $(-\pi,\pi)$, also **find** the function $x(\pi^2 - x^2)$ in the same interval and then prove that:

(i) $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n^2} = \frac{\pi^2}{12}$ (ii) $\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$

2- **Find** the Laplace transform of **only two** of the following:

(i) $\cos(\sqrt{t})/\sqrt{t}$ (ii) $F(t) = \begin{cases} \sin(t) & 0 \le t \le \pi \\ 0 & \pi \le t < 2\pi \end{cases}$

(iii) $e^{2t}(3\sin 4t - 4\cos t)$

3- Express **only two** from the following integrals in terms of the gamma or beta functions:

(i) $\int_0^{\infty} \frac{dx}{\sqrt[4]{x^3}\,(1+x)^3}$ (ii) $\int_0^4 y^{3/2}\sqrt{16-y^2}\,dy$ (iii) $\int_0^{\pi} \frac{\sqrt{\sin x}}{(5+3\cos x)^{3/2}}\,dx$

4- Solve **only two** from the following :

(i) $\int_0^1 J_1(\sqrt[3]{x})\,dx$ (ii) $\int J_o(x)\cos x\,dx$ (iii) $\int J_3(x)\,dx$

5- (i) **Prove** that $P_3(\cos\theta) = \frac{1}{8}(3\cos\theta + 5\cos 3\theta)$

(ii) **Express** $f(x) = x^3 - 3x^2 + 2x$ in terms *of* Hermit *Polynomials* $\sum_{n=0}^{\infty} a_n H_n(x)$

******Good Luck******

Prof. Dr. A. A. Ebrahim

Assiut University faculty of Science Physics Department	Final examination 2^{nd} Term 2018/2019 Plasma Physic (P332) 3^{rd} level (physics)	Allowable time:3 hours Date: 25/5/2019 Total marks: 50 degree

Answer the following questions

I-a- Derive an expression for the maximum transferred energy due to the elastic collision between an electron of mass m and an atom of mass M. what does mean this expression.

b- Deduce an expression for the particle diffusion current and the diffusion coefficient in the absence and presens of a magnetic field.

II-a- Study the motion of charged particles in: a time dependent magnetic field and non-uniform magnetic field. Prove that the plasma magnetic moment is constant in these two cases.

b-i- Draw an indicative figure for the magnetic mirror

ii- Calculate the angle θ at which the particle orbit makes with the z-axis at the central plane of magnetic mirror where the minimum magnetic field equals (0.2 Tesla) and the maximum magnetic field equal (6.76 Tesla)

III-a- Deduce an expression for the plasma dielectric constant and the store energy in a plasma medium.

b- Discuss with draw the pinch effect occurs on plasma. Derive the relationship between the plasma temperature and the current in the formed narrow filament in this case

c- For a plasma of density $N= 2x10^{15} cm^{-3}$ and radius of the formed filament r=17.846 cm. Calculate the required current to make the plasma temperature is reached to 100 eV, where 1 eV=$1.6x10^{-19}$ Joule and KT in joule.

IV-a-i: Give a short account on the types of oscillations in a fully-ionized plasma and derive an expression for the plasma natural frequency f_p. Write the relation which gives the value of this frequency f_p.

ii- Use the equation of ion wave dispersion relation to get an expression for the propagation constant K_x of this wave. Show when this K_x is real and very large.

When the ion wave exhibits the characteristics of sound wave propagating in the plasma medium

b-i- Prove that the plasma dielectric constant given by $\varepsilon=[1-(\omega p/\omega)^2]$, where ωp is the plasma angular frequency and ω is the angular frequency of an electromagnetic wave propagates through the plasma medium

ii- Derive the magnetohydrodynamic (M.H.D) wave equation for quasi - neutral plasma. Calculate the approximate speed of Alfven waves in a plasma of mass density 10^{-6} kgm^{-3} and a magnetic flux density= 10Tesla

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With my best wishes

Prof. Dr. Abdel-Haleem Turky

Assiut University

Department of Physics

Nuclear Physics 1 – Code P342 – Final Exam (50 pts.)

May 27, 2019 Time: 3 hours

Answer the following question: (*all questions carry the same weight* 10 pts.)

Question #1

A. In a scattering experiment it was found that ^{12}C has a nuclear radius of $2.7\ fm$. The experiment is then repeated with another, unknown element and it is found the nuclear radius is twice as big. **What** is the mass number of this unknown element?.

B. The Q value for the reaction $^{9}Be + p \rightarrow {}^{8}Be + {}^{2}H$ is 559.5 KeV. Using the masses of ^{9}Be=9.01218u and ^{2}H=2.014u to **find** the mass of ^{8}Be in MeV.

C. Suggest a simple reason why the $^{12}_{6}C$ nuclide has a higher binding energy (more stable) than $^{12}_{7}N$, even though they are isobars?.

D. Calculate the ratio of the surface energy term per nucleon for ^{42}Ca to that of ^{208}Pb.

E. Show that the electric quadrupole moment of a nucleus vanishes for spherically symmetric charge distribution.

Question #2

A. by-product of some fission reactors is the isotope ^{239}Pu which is an α-emitter having a half-life of 24120 *yrs*. Consider 1.0 *kg* of ^{239}Pu at t=0.

i. **What** is the number of ^{239}Pu nuclei present at t=0?

ii. **What** is the initial activity?

B. ***Show*** that the nucleons are not elementary particles but have an internal structure?.

Question #3

A. The various terms in the Semi-Empirical Mass Formula.
[NB: detailed mathematical expressions and values of constants are not required].

B. The Q values for the reactions $^{2}H(d,\ n)^{3}He$ and $^{2}H(d,\ p)^{3}H$ are 3.27MeV and 4.03MeV, respectively.

Show that the difference between the binding energy of the ^{3}H nucleus and that of the ^{3}He nucleus is 0.76*MeV* and **verify that** this is approximately the magnitude of Coulomb energy due to the two protons of the ^{3}He nucleus. (Distance between the protons in the nucleus $1.3\times3^{1/3}$ *fm*).

Question #4

A. The mass spectrometer is a very useful machine for measuring the masses of atoms (ions) and their relative abundances. **Explain** this very briefly?.

B. Nucleus of mass number A=235 was divided into two nuclei if their mass ratio (2:3). **Calculate** the radii of the products?.

Question #5

A. ^{242}Cm decays via alpha emission to an excited state of ^{238}Pu, which further decays to the ground state via gamma emission. The Q value of alpha decay is 4.6*MeV* and the gamma ray energy is 2.1*MeV*. **Draw** an energy level diagram of the decay processes.

B. Thermal neutrons are captured by $^{10}_{5}$B to form $^{11}_{5}$B which decays by α-particle emission to ^{7}Li. Write down the reaction equation and **calculate**

(a) **The Q-Value** of the decay in MeV.

(b) **The Kinetic energy** of the α-particles in MeV.

(Atomic masses: $^{10}_{5}$B = 10.01611*u*; $^{1}_{0}n$ = 1.008987*u*; $^{7}_{3}$Li = 7.01822*u*; $^{4}_{2}He$ = 4.003879*u*; 1 amu = 931.5*MeV*)

Constants:

$R_0 = 1.3\,fm$, $e^2 = 1.44\,MeV\text{-}fm$, $m_e = 0.511\,MeV$, $c^2 = 931.5\,MeV$, $1y = 3.15\times10^7\,sec$,

$N_A = 6.022\times10^{26}\,atom/kg$, $1Cu = 3.7\times10^{10}\,deacy/sec$

*****Good Luck *****

Prof. Dr. A. A. Ebrahim

Assiut University	Radiation Physics	المستوي : الثالث Level: III
Faculty of science	P 344	10/6/2019
Physics department	2018–2019	Time: 3 hours

Question No.1: (8 deg.),,,,, Choose the correct answer-(Or answers):

1. Nature is the: *(A) material* *(B) energy* *(C) all of the above*
2. Physics is the science which study the properties of the…: *(A) material (B) radiation (C) all of the above*
3. Atoms are stable, when: *(A)* $p \cong n$ *(B)* $p = e$ *(C)* $p > n$
4. ……. are examples of particulate radiation: *(A) Alpha* *(B) Beta* *(C) Gamma*
5. ……. are examples of electromagnetic radiation: *(A) X-rays* *(B) Beta* *(C) Gamma*
6. The isotope has the same number of: *(A) protons* *(B) neutrons*
   but a different number of: *(A) protons* *(B) neutrons*
7. Gamma radiation originates in the.. *(A) electronic shells* *(B) nucleus …..*
   While x- ray comes from *(A) electronic shells* *(B) nucleus*
8. Beta decay occurs when .. is emitted from the nucleus. *(A) neutron (B) proton (C) electron*
   when this occurs, the atomic number *(A) decreases (B) increases* By: *(A) one* *(B) two*
9. X-rays are a form of radiation similar to: *(A)α radiation* *(B) β radiation* *(C) ϒ radiation*
10. X- rays are produced mainly by: *(A) natural sources* *(B)artificial* *(C)radioactive subs*
11. The major sources of public exposure to natural radiation is:
    (A) cosmic radiation *(B) inhalation* *(C) ingestion*
12. Exposure to natural radiation can occur from indoors (in building materials) as a result of the presence of ……. Traces *(A) Uranium* *(B) Thorium* *(C) Germanium*
13. Exposure through inhalation comes from:*(A)Uranium + thorium* *(B)Radon + Thoron* *(C) Ne + C*
14. Energy "deposited" in a Kg. of substance by the radiation:
    (A) Absorbed dose *(B) equivalent dose* *(C) effective dose*
15- equivalent dose weighted for susceptibility to harm of different tissues:
    (A) Absorbed dose *(B) equivalent dose* *(C) effective dose*
16- The conventional unit of the radiation absorbed dose is: *(A) joule* *(B) rad* *(C) gray*

Question No.2: (17 deg.) Choose and discuss the correct answer-(Or answers):

1. Radiation that comes from a source can be considered as:
   (A) energy *(B)waves* *(C) particles*

………

………

2. Radiation is one of the elements of: *(A) light* *(B) material* *(C) energy*

………

………

3. Nonionizing radiation can be considered as: *(A) particles* *(B) waves* *(C) energy*

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4. Ionizing radiation can be considered as: *(A) particles (B) waves (C) energy*

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5. Electrons move around the nucleus according to: *(A) Newton's laws (B) Einstein's laws*

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6. Radioactive decay leads to: *(A) instability (B) stability*

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7. Radiation can be defined as the emission of : *(A) excess mass (B) excess energy*

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8. The radioactive decay occurs when the atom ejects:

(A) electrons (B) protons (C) neutrons

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9. Beta decay occurs when .... Is emitted from the nucleus :

(A) an electron (B) proton (C) neutron

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10. Gamma radiation can be considered as:.

(A)an energy (B)waves (C)particles

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11. Half-life is the time it takes for a radioisotope to decay to half of its starting

(A) mass (B) activity (C) volume

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12- Natural radioisotopes produced due to the presence of :.

(A) solar system (B) cosmic rays (C) atmosphere

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13- **The deep penetrating type of radiation is:**

(A) α *(B)* β *(C)* γ ………. **Because of its:**

(A) Mass *(B) charge* *(C) velocity*

14. **1 (G_y) of α $rad.$ ………. Harmful to tissue than 1 (G_y) of β rad :**

(A) more *(B) less* *(C) less or equal*

15. **Regions at higher altitudes receive ……….. cosmic radiation:**

(A) more *(B) less* *(C) less or equal*

16. **DNA contains information and predictions about genetic:**

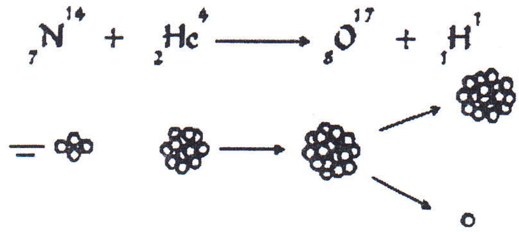
(A) disease *(B) mutation* *(C) disorders*

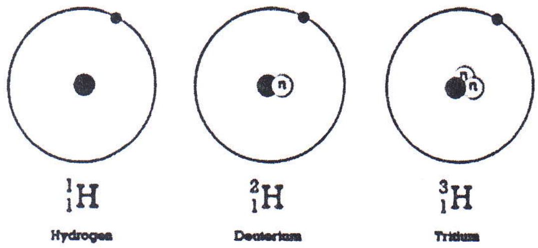
17. **The main factors influencing radiation dose are**

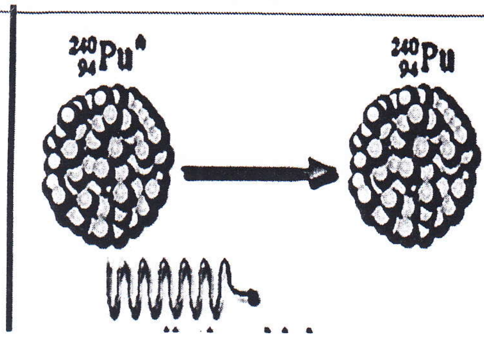
(A)time *(B) distance* *(C) shielding*

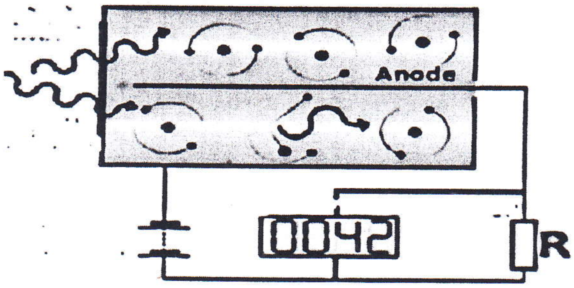
Question No.3: (25 deg.)

A). Comment shortly on the following images :(18 deg.)






240 94 Pu*
240 94 Pu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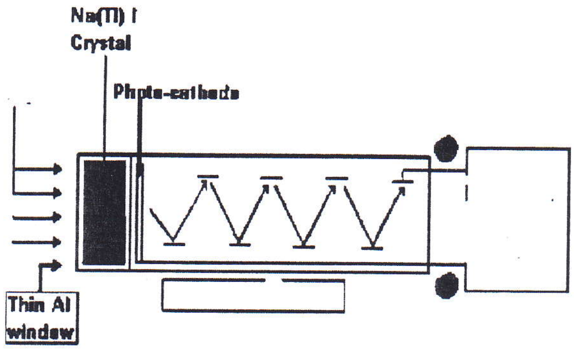
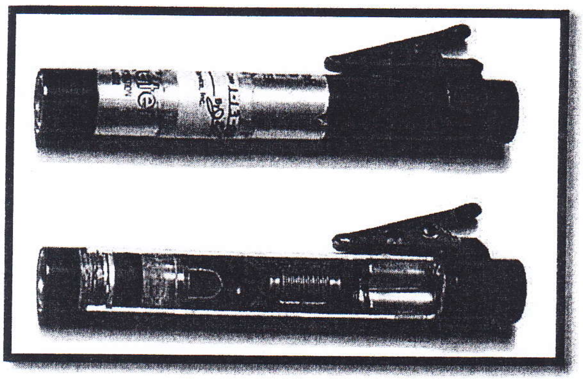

Na(Tl) I
Crystal
Photo-cathode
Thin Al
window



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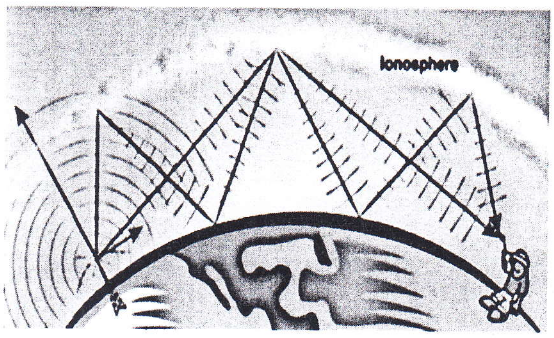
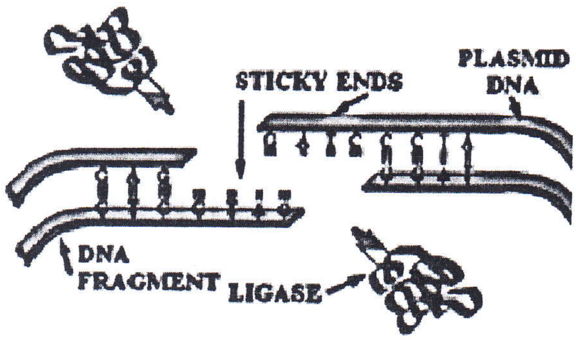

Ionosphere


STICKY ENDS
PLASMID
DNA
DNA
FRAGMENT
LIGASE

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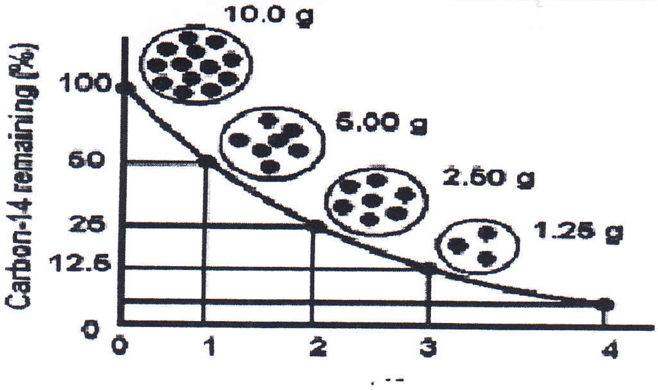

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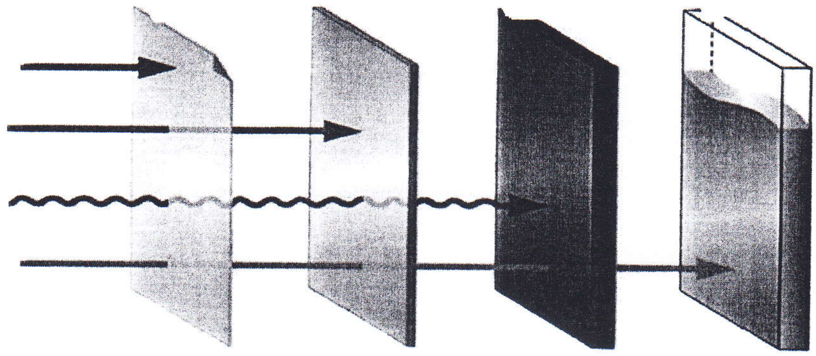
B). Suggest a title for the following .....: (7 deg.)

$H1_1 + H_1^1 \longrightarrow H_1^2(D) + e_{+1}^0 + v + energy$ ....

$H_1^1 + H_1^2 \longrightarrow He_2^3 + energy$ ....

$He_2^3 + He_2^3 \longrightarrow He_2^4 + H_1^1 + H_1^1 + h.energy$ ....



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حسام وحيد __Best wishes________ إنتهت الاسئلة مع التمنيات بالتوفيق______

Draft