EXERCISE - O

SINGLE CORRECT TYPE QUESTIONS

Photo Electric Effect

1. Photon of frequency *n* has a momentum associated with it. If *c* is the velocity of light, the momentum is-

(A) ν/c (B) $h\nu c$ (C) $h\nu/c^2$ (D) $h\nu/c$

PMP088

2. Two monochromatic light sources, *A* and *B*, emit the same number of photons per second. The wavelength of *A* is $\lambda_A = 400\ nm$, and that of *B* is $\lambda_B = 600\ nm$. The power radiated by source *B* is

(A) equal to that of source *A*

(B) less than that of source *A*

(C) greater than that of source *A*

(D) cannot be compared to that from source *A* using the available data.

PMP089

3. When the light of frequency $2\nu_0$ (where ν_0 is threshold frequency), is incident on a metal plate, the maximum velocity of electrons emitted is v_1. When the frequency of the incident radiation is increased to $5\nu_0$, the maximum velocity of electrons emitted from the same plate is v_2. The ratio of v_1 to v_2 is :

(A) 1 : 2 (B) 1 : 4 (C) 4 : 1 (D) 2 : 1

PMP103

4. For photoelectric emission from certain metal the cut-off frequency is ν. If radiation of frequency 2ν impinges on the metal plate, the maximum possible velocity of the emitted electron will be (*m* is the electron mass) :

(A) $2\sqrt{hv/m}$ (B) $\sqrt{hv/(2m)}$ (C) $\sqrt{hv/m}$ (D) $\sqrt{2hv/m}$

PMP104

5. A photoelectric surface is illuminated successively by monochromatic light of wavelength λ and λ/2. If the maximum kinetic energy of the emitted photoelectrons in the second case is 3 times that in the first case, the work function of the surface of the material is :

(*h* = Plank's constant, *c* = Speed of light)

(A) $\frac{hc}{3\lambda}$ (B) $\frac{hc}{2\lambda}$ (C) $\frac{hc}{\lambda}$ (D) $\frac{2hc}{\lambda}$

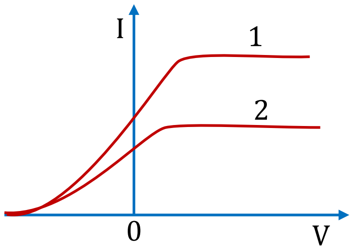
PMP105

6. Photons with energy 5 *eV* are incident on a cathode *C* in a photoelectric cell. The maximum energy of emitted photoelectrons is 2 *eV*. When photons of energy 6 *eV* are incident on *C*, no photoelectrons will reach the anode *A*, if the stopping potential of *A* relative to *C* is :

(A) – 1 *V* (B) – 3 *V* (C) + 3 *V* (D) + 4 *V*

PMP106

7. A photocathode can be illuminated by the light from two sources, each of which emits monochromatic radiation. The sources are positioned at equal distances from the photocathode. The dependence of the photocurrent on the voltage between the cathode and the anode is depicted by curve 1 for one source and by curve 2 for the other. In what respect do these sources differ?



(A) Highest frequency photon

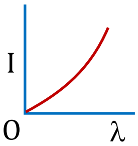
(B) Number of photons emitted per second

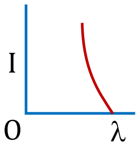
(C) Number of photoelectrons emitted per second

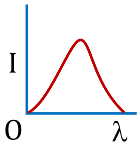
(D) None of these

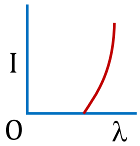
PMP107

8. The anode voltage of a photocell is kept fixed. The wavelength *l* of the light falling on the cathode is gradually changed. The plate current *I* of the photocell varies as follows :

(A) 

(B) 

(C) 

(D) 

PMP108

9. When a monochromatic point-source of light is at a distance of 0.2 *m* from a small photoelectric cell, the stopping potential and the saturation current are respectively 0.6 volt and 18.0 *mA*. If the same source is placed 0.6 *m* away from the photoelectric cell, then :-

(A) The stopping potential will be 0.2 volt
(B) The stopping potential will be 1.8 volt
(C) The saturation current will be 6.0 *mA*
(D) The saturation current will be 2.0 *mA*

PMP116

10. A silver sphere (work function 4.6 *eV*) is suspended in a vacuum chamber by an insulating thread. Ultraviolet light of wavelength 0.2 μ *m* strikes on the sphere. The maximum electric potential of the sphere will be (hc = 12400 $eV\text{Å}$):

(A) 4.6 *V*
(B) 6.2 *V*
(C) 1.6 *V*
(D) 3.2 *V*

PMP119

11. Light coming from a discharge tube filled with hydrogen falls on the cathode of the photoelectric cell. The work function of the surface of cathode is 4 *eV*. Which one of the following values of the anode voltage (in Volts) with respect to the cathode will likely to make the photo current zero.

(A) – 4
(B) – 6
(C) – 8
(D) – 10

PMP150

12. If light of wavelength of maximum intensity emitted from surface at temperature T_1 is used to cause photoelectric emission from a metallic surface, the maximum kinetic energy of the emitted electron is 6 *eV*, which is 3 times the work function of the metallic surface. If light of wavelength of maximum intensity emitted from a surface at temperature T_2 ($T_2 = 2T_1$) is used, the maximum kinetic energy of the photoelectrons emitted is :-

(A) 2 *eV*
(B) 4 *eV*
(C) 14 *eV*
(D) 18 *eV*

PMP159

De Broglie

13. A free particle with initial kinetic energy E and de–broglie wavelength λ enters a region in which it has potential energy U. What is the particle's new de–Broglie wavelength?

(A) $\lambda(1 - U/E)^{-1/2}$ (B) $\lambda(1 - U/E)$ (C) $\lambda(1 - E/U)^{-1}$ (D) $\lambda(1 + U/E)^{1/2}$

PMP096

14. After absorbing a slowly moving neutron of mass m_N (momentum ~ 0) a nucleus of mass M breaks into two nuclei of masses m_1 and $3m_1(4m_1 = M + m_N)$, respectively. If the de Broglie wavelength of the nucleus with mass m_1 is λ, then de-Broglie wavelength of the other nucleus will be:-

(A) 9λ (B) 3λ (C) $\frac{\lambda}{3}$ (D) λ

PMP098

X-rays

15. An X-ray tube is run at 50 kV. The current flowing in it is 20 mA. The power of the tube is :

(A) 1000 W (B) 200 W (C) 20000 W (D) 20 W

PMP160

16. The X-ray beam coming from an X-ray tube will be

(A) monochromatic

(B) having all wavelengths smaller than a certain maximum wavelength

(C) having all wavelengths larger than a certain minimum wavelength

(D) having all wavelengths lying between a minimum and a maximum wavelength

PMP161

17. Characteristic X-ray

(A) Have only discrete wavelength which are characteristic of the target.

(B) Have all the possible wavelength.

(C) Are characteristic of speed of projectile electrons.

(D) None

PMP162

18. In an X-ray experiment target is made up of copper ($Z = 29$) having some impurity. The K_α line of copper have wavelength λ_0. It was observed that another K_α line due to impurity have wavelength $\frac{784}{625}\lambda_0$. The atomic number of the impurity element is

(A) 22 (B) 23 (C) 24 (D) 26

PMP163

19. Following statements are given for atom in ground state. Choose CORRECT statement :-

(A) Helium (He) can not emit K_β characteristic X-rays but can emit K_α characteristic X-rays.

(B) Helium (He) can emit K_α as well as K_β characteristic X-rays.

(C) Lithium (Li) can not emit K_β characteristic X-rays but can emit K_α characteristic X-rays.

(D) Lithium (Li) can emit K_α as well as K_β characteristic X-rays.

PMP164

20. The energy of a K-electron in tungsten is $-20\ keV$ and of an L-electrons is $-2\ keV$. The wave length of X-rays emitted when there is electron jump from L to K shell :

(A) 0.3443 Å (B) 0.6887 Å (C) 1.3982 Å (D) 2.78 Å

PMP165

21. The intensity of gamma radiation from a given source is I. On passing through 36 mm of lead, it is reduced to $I/8$. The thickness of lead, which will reduce the intensity to $I/2$ will be

(A) 6 mm (B) 9 mm (C) 18 mm (D) 12 mm

PMP166

22. Choose the INCORRECT statement.

(A) Cut-off wavelength of X-rays is independent of filament voltage.

(B) Presence of K_α-line in X-ray spectrum means that L-series will also be present.

(C) Increase in filament current increases intensity of X-ray.

(D) Presence of L-series in X-ray spectrum means that K-series will also be present.

PMP169

23. The K, L and M energy levels of platinum lie roughly at 78, 12 and 3 keV respectively. The ratio of wavelength of K_α line to that of K_β line in X-ray spectrum is-

(A) $\frac{22}{3}$ (B) $\frac{3}{22}$ (C) $\frac{22}{25}$ (D) $\frac{25}{22}$

PMP170

24. In producing X-rays a beam of electrons accelerated by a potential difference V is made to strike a metal target. For what value of V of the following X-rays have the lowest wavelength :

(A) 10 kV (B) 20 kV (C) 30 kV (D) 40 kV

PMP171

25. Electrons with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut-off wavelength of the emitted X-rays is

(A) $\lambda_0 = \frac{2mc\lambda^2}{h}$ (B) $\lambda_0 = \frac{2h}{mc}$ (C) $\lambda_0 = \frac{2m^2c^2\lambda^3}{h^2}$ (D) $\lambda_0 = \lambda$

PMP173

26. Which one of the following statements is WRONG in the context of X-rays generated from a X-ray tube ?

(A) Wavelength of characteristic X-rays decreases when the atomic number of the target increases.

(B) Cut-off wavelength of the continuous X-rays depends on the atomic number of the target.

(C) Intensity of the characteristic X-rays depends on the electrical power given to the X-rays tube.

(D) Cut-off wavelength of the continuous X-rays depends on the energy of the electrons in the X-ray tube.

PMP174

Atomic Structure

27. A hydrogen like gas atoms absorb radiations of wavelength λ_0 and consequently emit radiations of 6 difference wavelengths of which, three wavelengths are shorter than λ_0. Choose the correct alternative(*s*).

(A) The final excited state of the atoms is n = 3.

(B) The final excited state of the atoms is n = 4.

(C) The initial state of the atoms is n =1.

(D) The initial state of the atoms is n =3.

PMP120

28. The de-Broglie wavelength of an electron in the first Bohr orbit is

(A) equal to the circumference of first orbit (B) equal to $\frac{1}{2}$ × (circumference of first orbit)

(C) equal to $\frac{1}{4}$ × (circumference of first orbit) (D) equal to $\frac{3}{4}$ × (circumference of first orbit)

PMP121

29. According to Bohr model, magnetic field at the centre (at the nucleus) of a hydrogen atom due to the motion of the electron in nth orbit is proportional to

(A) $1/n^3$ (B) $1/n^5$ (C) n^5 (D) n^3

PMP122

30. Consider 3rd orbit of He^+ (Helium), using non-relativistic approach, the speed of electron in this orbit will be [given $K = 9 \times 10^9$ constant, Z = 2 and h (Planck's Constant) = 6.6×10^{-34} *Js*]

(A) 1.46×10^6 *m/s* (B) 0.73×10^6 *m/s* (C) 3.0×10^8 *m/s* (D) 2.92×10^6 *m/s*

PMP123

31. Let the potential energy of a hydrogen atom in the ground state be zero. Then its energy in the first excited state will be :

(A) 10.2 *eV* (B) 13.6 *eV* (C) 23.8 *eV* (D) 27.2 *eV*

PMP124

32. In a hydrogen atom, the electron is in nth excited state. It may come down to second excited state by emitting ten different wavelengths. What is the value of n:

(A) 6 (B) 7 (C) 8 (D) 5

PMP125

33. The radius of the first permitted Bohr orbit for the electron, in a hydrogen atom equals 0.51 Å and its ground state energy equals –13.6 *eV*. If the electron in the hydrogen atom is replaced by muon [charge same as electron and mass 207 m_e], the first Bohr radius and ground state energy will be :

(A) 0.53×10^{-13} *m*, –3.6 *eV* (B) 25.6×10^{-13} *m*, –2.8 *eV*

(C) 2.56×10^{-13} *m*, –2.8 *keV* (D) 2.56×10^{-13} *m*, –13.6 *eV*

PMP126

34. In the spectrum of single ionised helium, the wavelength of a line observed is almost the same as the first line of Balmer series of hydrogen. It is due to transition of electron from

(A) n_1 = 6 to n_2 = 4 (B) n_1 = 5 to n_2 = 3 (C) n_1 = 4 to n_2 = 2 (D) n_1 = 3 to n_2 = 2

PMP127

35. The wave number of a line corresponding to He^+ is 'x' cm^{-1}. Then for the same line wave number for Be^{3+} will be

(A) $x\ cm^{-1}$ (B) $4\ x\ cm^{-1}$ (C) $x/4\ cm^{-1}$ (D) $16\ x\ cm^{-1}$

PMP128

36. A photon of 10.2 eV energy collides with a hydrogen atom in ground state inelastically. After few microseconds one more photon of energy 15 eV collides with the same hydrogen atom. Then what can be detected by a suitable detector.

(A) one photon of 10.2 eV and an electron of energy 1.4 eV

(B) 2 photons of energy 10.2 eV

(C) 2 photons of energy 3.4 eV

(D) 1 photon of 3.4 eV and one electron of 1.4 eV

PMP131

37. Energy levels A, B and C of a certain atom correspond to increasing values of energy i.e. $E_A < E_B < E_C$. If λ_1, λ_2 and λ_3 are wave lengths of radiations corresponding to transitions C to B, B to A and C to A respectively, which of the following relations is correct :

(A) $\lambda_3 = \lambda_1 + \lambda_2$ (B) $\lambda_3 = \dfrac{\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$ (C) $\lambda_1 + \lambda_2 + \lambda_3 = 0$ (D) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

PMP132

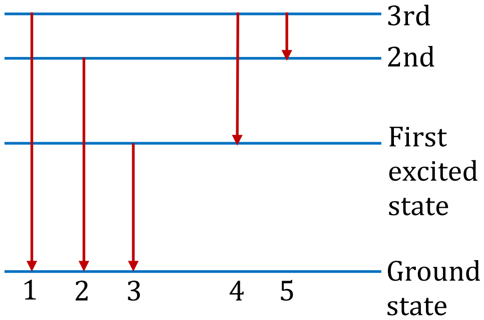
38. The ionization energy of the electron in the hydrogen atom in its ground state is 13.6 eV. The atoms are excited to higher energy levels to emit radiations of 6 wavelengths. Maximum wavelength of emitted radiation corresponds to the transition between :

(A) $n = 4$ to $n = 3$ states (B) $n = 3$ to $n = 2$ states

(C) $n = 3$ to $n = 1$ states (D) $n = 2$ to $n = 1$ states

PMP133

39. The figure indicates the energy level diagram of an atom and the origin of five spectral lines in emission spectra. Which of the spectral lines will also occur in the absorption spectra?



(A) 1, 2, 4 (B) 2, 3, 4, 5 (C) 1, 2, 3 (D) 1,2,3,4,5

PMP137

40. Consider the spectral line resulting from the transition $n = 2 \to n = 1$ in the atoms and ions given below. The shortest wavelength is produced by :

(A) hydrogen atom (B) deuterium atom

(C) singly ionized helium (D) doubly ionized lithium

PMP138

41. A stationary hydrogen atom of mass M emits a photon corresponding to the longest wavelength of Balmer series. The recoil velocity acquired by the atom is

(R = Rydberg constant and h = Plank's constant)

(A) $\frac{Rh}{M}$ (B) $\frac{Rh}{4M}$ (C) $\frac{3}{4}\frac{Rh}{M}$ (D) $\frac{5}{36}\frac{Rh}{M}$

PMP146

42. A force of attraction between the positively charged nucleus and the negatively charged electron in the hydrogen atom is given by $F = \frac{ke^2}{r^2}$ where k is the constant. The electron, initially moving in a circle of radius R_1 about the nucleus, jumps suddenly into a circular orbit of radius R_2. The total energy of the atom decreased in this process is :-

(A) $ke^2\left[\frac{1}{R_1}+\frac{1}{R_2}\right]$ (B) $\frac{ke^2}{2}\left[\frac{1}{R_2}-\frac{1}{R_1}\right]$ (C) $ke^2\left[\frac{R_1R_2}{R_2-R_1}\right]$ (D) $ke^2\left[\frac{R_1R_2}{R_1+R_2}\right]$

PMP148

43. The attractive potential for an atom is given by $v = v_0 \ln\left(r/r_0\right)$, v_0 and r_0 are constant and r is the radius of the orbit. The radius r of the n^{th} Bohr's orbit depends upon principal quantum number n as:

(A) $r \propto n$ (B) $r \propto 1/n^2$ (C) $r \propto n^2$ (D) $r \propto 1/n$

PMP149

Nuclear Physics

44. Two hydrogen atoms are in excited state with electrons residing in n = 2. First one is moving towards left and emits a photon of energy E_1 towards right. Second one is moving towards left with same speed and emits a photon of energy E_2 towards left. Taking recoil of nucleus into account during emission process:

(A) $E_1 > E_2$ (B) $E_1 < E_2$ (C) $E_1 = E_2$ (D) Information insufficient

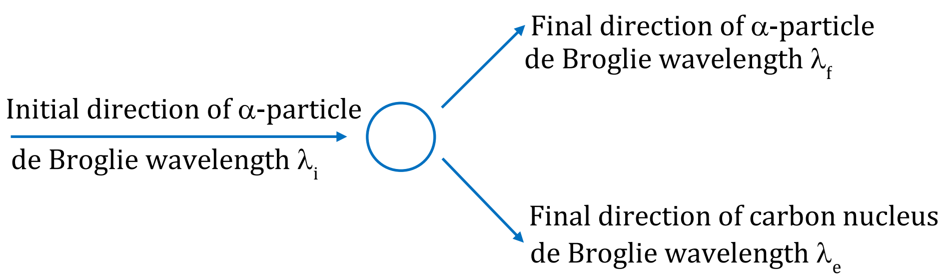
PMP141

45. A neutron having kinetic energy 13.6 eV collides with a hydrogen atom in ground state at rest. Assume that the mass of neutron and hydrogen atoms are same and the neutron does not leave its line of motion. Then which of the following is the possible KE of the neutron after the collision?

(A) Zero (B) 3.4 eV (C) 1.5 eV (D) 6.8 eV

PMP142

46. An α-particle having a de Broglie wavelength λ_i collides with a stationary carbon nucleus. The α-particle moves off in a different direction as shown below.



After the collision, the de Broglie wavelength of the α-particle and the carbon nucleus are λ_f and λ_e respectively. Which of the following relations about de Broglie wavelength is correct?

(A) $\lambda_i < \lambda_f$ (B) $\lambda_i > \lambda_f$ (C) $\lambda_f = \lambda_e$ (D) $\lambda_i = \lambda_e$

PMP145

47. A nucleus of uranium decays at rest into nuclei of Thorium and Helium. Then :

(A) The Helium nucleus has less kinetic energy than the Thorium nucleus

(B) The Helium has more kinetic energy than the Thorium nucleus

(C) The Helium nucleus has less momentum than the Thorium nucleus

(D) The Helium nucleus has more momentum than the Thorium nucleus

PMP176

48. Binding energy per nucleon of a fixed nucleus X^A is 8 MeV. It absorbs a neutron moving with kinetic energy 2 MeV and converts into Y, emitting two photon of energy 1 MeV and 4 MeV respectively one after the other. The binding energy of per nucleon of Y (in MeV) is

(A) $\frac{(8A-7)}{(A+1)}$ (B) $\frac{(8A+3)}{(A+1)}$ (C) $\frac{(8A+7)}{(A+1)}$ (D) $\frac{(8A-7)}{(A+1)}$

PMP178

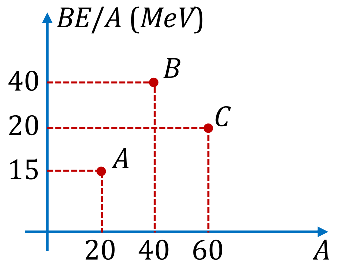
49. Which one of the following is a possible nuclear reaction ?

(A) ${}^{10}_{5}B + {}^{4}_{2}He \longrightarrow {}^{13}_{7}N + {}^{1}_{1}H$ (B) ${}^{23}_{11}Na + {}^{1}_{1}H \longrightarrow {}^{22}_{10}Ne + {}^{4}_{2}He$

(C) ${}^{239}_{93}Np \longrightarrow {}^{239}_{94}Pu + \beta^- + \bar{\nu}$ (D) ${}^{11}_{7}N + {}^{1}_{1}H \longrightarrow {}^{12}_{6}C + \beta^- + \nu$

PMP179

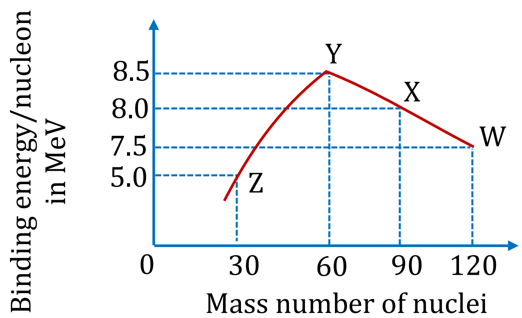
50. The graph shows BE/A values for three hypothetical elements A, B, C. The energy released when C disintegrates into A and B is :



(A) 1000 MeV (B) 1200 MeV (C) 700 MeV (D) 500 MeV

PMP180

51. Binding energy per nucleon versus mass number curve for nuclei is shown in figure. W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is :



(A) $Y \rightarrow 2Z$ (B) $W \rightarrow X + Z$ (C) $W \rightarrow 2Y$ (D) $X \rightarrow Y + Z$

PMP181

52. The Binding energy per nucleon of ${}^{7}_{3}Li$ and ${}^{4}_{2}He$ nuclei are 5.60 MeV and 7.06 MeV, respectively. In the nuclear reaction ${}^{7}_{3}Li + {}^{1}_{1}H \rightarrow 2{}^{4}_{2}He + Q$, the value of energy Q released is :

(A) 19.6 MeV (B) –2.4 MeV (C) 8.4 MeV (D) 17.3 MeV

PMP184

53. In the uranium radioactive series the initial nucleus is ${}_{92}U^{238}$, and the final nucleus is ${}_{82}Pb^{206}$. When the uranium nucleus decays to lead, the number of α – particles emitted is..... and the number of β-particles emitted is ....

(A) 6, 8 (B) 8, 6 (C) 16, 6 (D) 32, 12

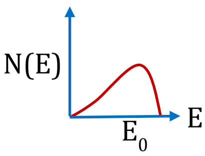
PMP185

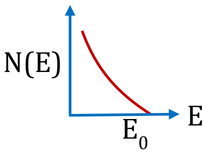
54. A nuclear transformation is denoted by $X(n, \alpha) \rightarrow {}^{7}_{3}Li$. Which of the following is the nucleus of element X ?

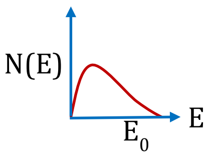
(A) ${}^{12}_{6}C$ (B) ${}^{10}_{5}B$ (C) ${}^{9}_{5}B$ (D) ${}^{11}_{4}Be$

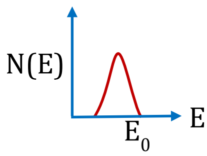
PMP186

55. The energy spectrum of β-particles, number $N(E)$ as a function of β-energy E emitted from a radioactive source is-

(A) 

(B) 

(C) 

(D) 

PMP187

56. In the options given below, let E denote the rest mass energy of a nucleus and n a neutron. The correct option is :

(A) $E\left({}^{236}_{92}U\right) > E\left({}^{137}_{53}I\right) + E\left({}^{97}_{39}Y\right) + 2E(n)$

(B) $E\left({}^{236}_{92}U\right) < E\left({}^{137}_{53}I\right) + E\left({}^{97}_{39}Y\right) + 2E(n)$

(C) $E\left({}^{236}_{92}U\right) < E\left({}^{140}_{56}Ba\right) + E\left({}^{94}_{36}Kr\right) + 2E(n)$

(D) $E\left({}^{236}_{92}U\right) = E\left({}^{140}_{56}Ba\right) + E\left({}^{94}_{36}Kr\right) + 2E(n)$

PMP203

57. If a star converts all of its Helium into oxygen nucleus, find the amount of energy released per nucleus of oxygen. O = 15.9994 amu and He = 4.0026 amu

(A) 7.26 MeV (B) 7 MeV (C) 10.24 MeV (D) 5.12 MeV

PMP207

58. If each fission in a U^{235} nucleus releases 200 MeV, how many fissions must occurs per second to produce a power of 1 KW

(A) 1.325×10^{13} (B) 3.125×10^{13} (C) 1.235×10^{13} (D) 2.135×10^{13}

PMP208

Radioactivity

59. The decay constant of the end product of a radioactive series is

(A) zero (B) infinite

(C) finite (non zero) (D) depends on the end product.

PMP189

60. Starting with a sample of pure 66 Cu, 7/8 of it decays into Zn in 15 min. The corresponding half-life is-

(A) 10 min (B) 15 min (C) 5 min (D) $7\frac{1}{2}$ min

PMP190

61. Two radioactive nuclei P and Q in a given sample decay into a stable nucleus R. At time $t = 0$, number of P species are 4 N_0 and that of Q are N_0. Half-life of P (for conversion to R) is 1 minute where as that of Q is 2 minutes. Initially there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be :

(A) $2N_0$ (B) $3N_0$ (C) $\frac{9N_0}{2}$ (D) $\frac{5N_0}{2}$

PMP191

62. A mixture consists of two radioactive materials A_1 and A_2 with half lives of 20s and 10s respectively. Initially the mixture has 40g of A_1 and 160g of A_2. The active amount of the two in the mixture will becomes equal after :

(A) 20s (B) 40s (C) 60s (D) 80s

PMP192

63. A certain radio active substance has a half life of 5 years. Thus for a nucleus in a sample of the element, the probability of decay in ten years is

(A) 50% (B) 75% (C) 100% (D) 60%

PMP193

64. Two radioactive material A_1 and A_2 have decay constants of 10 λ_0 and λ_0. If initially they have same number of nuclei, the ratio of number of their undecayed nuclei will be $(1/e)$ after a time

(A) $\frac{1}{\lambda_0}$ (B) $\frac{1}{9\lambda_0}$ (C) $\frac{1}{10\lambda_0}$ (D) 1

PMP194

65. A radioactive source in the form of a metal sphere of diameter 3.2×10^{-3} m emits b-particle at a constant rate of 6.25×10^{10} particle/sec. The source is electrically insulated and all the β-particle are emitted from the surface. The potential of the sphere will rise to 1 V in time

(A) 180 μ sec (B) 90 μ sec (C) 18 μ sec (D) 9 μ sec

PMP195

66. The half life of a radioactive isotope 'X' is 20 years. It decays to another element 'Y' which is stable. The two elements 'X' and 'Y' were found to be in the ratio 1 : 7 in a sample of a given rock. The age of the rock is estimated to be:

(A) 100 years (B) 40 years (C) 60 years (D) 80 years

PMP196

67. The half life of a radioactive substance is 20 minutes. The approximate time interval $(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$ of it has decayed and time t_1 when $\frac{1}{3}$ of it had decayed is :

(A) 20 min (B) 28 min (C) 7 min (D) 14 min

PMP198

68. The decay constant of a radio isotope is λ. If A_1 and A_2 are its activities at times t_1 and t_2 respectively, the number of nuclei which have decayed during the time $(t_1 - t_2)$:

(A) $A_1 - A_2$ (B) $(A_1 - A_2)/\lambda$ (C) $\lambda(A_1 - A_2)$ (D) $A_1t_1 - A_2t_2$

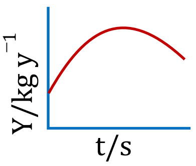
PMP199

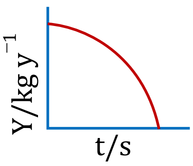
69. Half life of radium is 1620 years. How many radium nuclei decay in 5 hours in 5 *gm* radium? (Atomic weight of radium = 223)

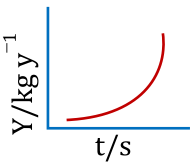
(A) 9.1×10^{12} (B) 3.23×10^{15} (C) 1.72×10^{20} (D) 3.3×10^{17}

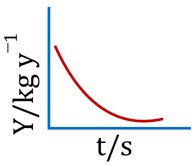
PMP200

70. The radioactive nucleus of an element *X* decays to a stable nucleus of element *Y*. A graph of the rate of formation of *Y* against time would look like

(A) 

(B) 

(C) 

(D) 

PMP201

71. A radioactive substance is dissolved in a liquid and the solution is heated. The activity of the solution:

(A) is smaller than that of element

(B) is greater than that of element

(C) is equal to that of element

(D) will be smaller or greater depending upon whether the solution is weak or concentrated.

PMP204

72. A 280 days old radioactive substance shows an activity of 6000 *dps*, 140 days later it's activity becomes 3000*dps*. What was its initial activity.

(A) 20000 *dps* (B) 24000 *dps* (C) 12000 *dps* (D) 6000 *dps*

PMP205

73. A radioactive sample S_1 having an activity of $5\mu Ci$ has twice the number of nuclei as another sample S_2 which has an activity of $10\mu Ci$. The half lives of S_1 and S_2 can be :

(A) 20 years and 5 years, respectively (B) 20 years and 10 years, respectively

(C) 10 years each (D) 5 years each

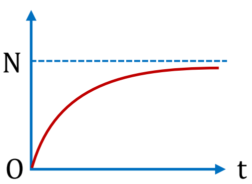
PMP210

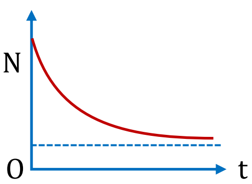
74. In a certain nuclear reactor, a radioactive nucleus is being produced at a constant rate = 1000 /*s*. The mean life of the radionuclide is 40 minutes. At steady state, the number of radionuclide will be

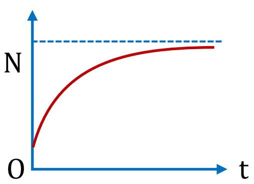
(A) 4×10^4 (B) 24×10^4 (C) 24×10^5 (D) 24×10^6

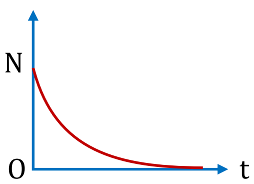
PMP211

75. In the above question, if there were 20×10^5 radionuclide at $t = 0$, then the graph of N v/s t is

(A) 

(B) 

(C) 

(D) 

PMP212

76. The half-life of substance X is 45 years, and it decomposes to substance Y. A sample from a meteorite was taken which contained 2% of X and 14% of Y by quantity of substance. If substance Y is not normally found on a meteorite, what is the approximate age of the meteorite?

(A) 270 years (B) 135 years (C) 90 years (D) 45 years

PMP213

77. The activity of a sample reduces from A_0 to $A_0/\sqrt{3}$ in one hour. The activity after 3 hours more will be

(A) $\frac{A_0}{3\sqrt{3}}$ (B) $\frac{A_0}{9}$ (C) $\frac{A_0}{9\sqrt{3}}$ (D) $\frac{A_0}{27}$

PMP215

78. A radioactive material of half-life T was produced in a nuclear reactor at different instants, the quantity produced second time was twice of that produced first time. If now their present activities are A_1 and A_2 respectively then their age difference equals:

(A) $\frac{T}{\ln 2}\left|\ln\frac{A_1}{A_2}\right|$ (B) $T\left|\ln\frac{A_1}{A_2}\right|$ (C) $\frac{T}{\ln 2}\left|\ln\frac{A_2}{2A_1}\right|$ (D) $T\left|\ln\frac{A_2}{2A_1}\right|$

PMP216

MULTIPLE CORRECT TYPE QUESTIONS

Photo Electric Effect

79. A small plate of area 1 cm^2 is placed at a distance of $\frac{1}{\sqrt{\pi}}$ m from an isotropic point source emitting light of frequency $\frac{1}{6.63}\times10^{14}$ Hz, at a power of 2.00 mW. Assume the plate to be normal to the incident photons. [where $h = 6.63 \times 10^{-34}$ J-s]. Select CORRECT alternative(s)

(A) Energy possessed by each photon is 10^{-20} J

(B) Photon emission rate is 2×10^{17} s^{-1}

(C) The fraction of area of beam intercepted by the plate is $\frac{1}{4}\times10^{-4}$

(D) The rate of photons striking the plate is 5×10^{12} per second.

PMP091

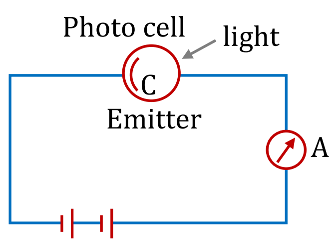
80. The figure shows a photo cell circuit. The cathode of the photo cell is illuminated by a monochromatic light. If the intensity is kept constant and the frequency of the incident light is increased, then the

(A) photo electric current in the circuit increases

(B) photo electric current in the circuit decreases

(C) maximum kinetic energy of the photo electrons increases

(D) photo electric current in the circuit can be reduced to zero, when the polarity of the terminals is reversed



PMP109

81. Photoelectric effect supports quantum nature of light because:

(A) there is minimum frequency of light below which no photoelectrons are emitted.

(B) the maximum kinetic energy of photo-electrons depends only on the frequency of light and not on its intensity.

(C) even when the metal surface is faintly illuminated, the photoelectrons leave the surface immediately.

(D) electric charge of photo-electrons is quantized.

PMP110

82. In photoelectric effect, stopping potential depends on:

(A) frequency of the incident light.

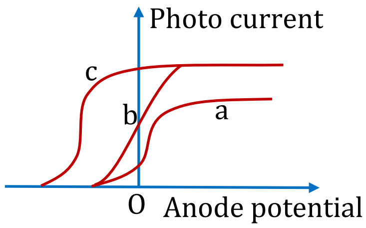
(B) intensity of the incident light by varies source distance.

(C) emitter's properties.

(D) frequency and intensity of the incident light.

PMP111

83. The figure shows the variation of photo current with anode potential for a photosensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b and c respectively. Choose correct options:



(A) $f_a = f_b$ (B) $I_a < I_b$

(C) $f_c < f_b$ (D) $I_c > I_b$

PMP112

84. Light of wavelength λ_1 and λ_2 are falling on two metal surface A and B. For wavelength λ_1 electron ejected from both the surfaces and for wavelength λ_2 electron ejected from only surface B. On the basis of these facts which one of the following is a false statement:

(A) more energy is required for ejection of electron from metal 'A'.

(B) $\lambda_1 > \lambda_2$

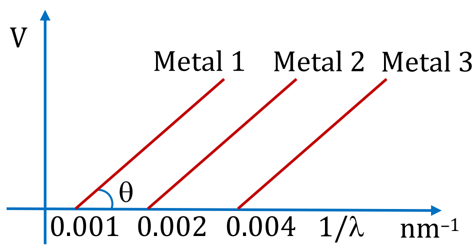
(C) threshold wavelength for A is greater than B.

(D) energy of electron ejected from metal A will be greater than electron ejected from metal B for wavelength λ.

PMP113

85. The graph between $1/\lambda$ and stopping potential (V) of three metals having work functions ϕ_1, ϕ_2 and ϕ_3 in an experiment of photo-electric effect is plotted as shown in the figure. Which of the following statement(s) is/are correct?

[Here λ is the wavelength of the incident ray].



(A) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 1 : 2 : 4$

(B) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 4 : 2 : 1$

(C) tan θ is directly proportional to hc/e, where h is Planck's constant and c is the speed of light

(D) The violet colour light can eject photoelectrons from metals 2 and 3.

PMP114

86. The collector of the photocell (in photoelectric experiment) is made of tungsten while the emitter is of Platinum having work function of 10 eV. Monochromatic radiation of wavelength 124 $\mathring{A}$ and power 100 watt is incident on emitter which emits photo electrons with a quantum efficiency of 1%. The accelerating voltage across the photocell is of 10,000 volts. (Use : hc = 12400e$V\mathring{A}$)

(A) The power supplied by the accelerating voltage source is 100 watt

(B) The minimum wavelength of radiation coming from the tungsten target (collector) is 1.23 Å

(C) The power supplied by the accelerating voltage source is 10 watt

(D) The minimum wavelength of radiation coming from the tungsten target (collector) is 2.23 Å

PMP115

87. In a photoelectric effect experiment, if f is the frequency of radiations incident on the metal surface and I is the intensity of the incident radiations, then choose the correct statement(s).

(A) If f is increased keeping I and work function constant then maximum kinetic energy of photoelectron increases.

(B) If distance between cathode and anode is increased stopping potential increases

(C) If I is increased keeping f and work function constant then stopping potential remains same and saturation current increases.

(D) Work function is decreased keeping f and I constant then stopping potential increases.

PMP117

88. A metallic sphere of radius r remote from all other bodies is irradiated with a radiation of wavelength λ which is capable of causing photoelectric effect.

(A) the maximum potential gained by the sphere will be independent of its radius.

(B) the net positive charge appearing on the sphere after a long time will depend on the radius of the sphere.

(C) the maximum kinetic energy of the electrons emanating from the sphere will keep on declining with time.

(D) the kinetic energy of the most energetic electrons emanating from the sphere initially will be independent of the radius of the sphere.

PMP118

89. The accelerating potential (V) applied between a photocathode and the respective anode is such that the fastest photoelectron can fly only one fourth of the distance between the cathode and the anode. If the distance between photocathode and anode is reduced to $(1/4)^{th}$ of the original value while maintaining the accelerating potential constant, then:

(A) The fastest electron will reach the anode.

(B) The fastest electron will reach upto one fourth of the new distance between the cathode and the anode.

(C) Kinetic energy of the fastest photoelectron emitted from photocathode will not change due to change in plate separation (keeping V constant).

(D) Kinetic energy of the fastest photoelectron will increase due to decrease in plate separation (keeping V constant).

PMP158

De Broglie

90. Two electrons are moving with the same speed v. One electron enters a region of uniform electric field while the other enters a region of uniform magnetic field, then after sometime if the de–Broglie wavelengths of the two are λ_1 and λ_2, then select the possible option(s) :-

(A) $\lambda_1 = \lambda_2$ (B) $\lambda_1 > \lambda_2$ (C) $\lambda_1 < \lambda_2$ (D) $\lambda_1 > \lambda_2$ or $\lambda_1 < \lambda_2$

PMP099

91. A particle moves in a closed orbit around the origin, due to a central force which is directed towards the origin. The de Broglie wavelength of the particle varies cyclically between two values λ_1, λ_2 with $\lambda_1 > \lambda_2$. Which of the following statements is/are true ?

(A) The particle could be moving in a circular orbit with origin as centre.

(B) The particle could be moving in an elliptic orbit with origin as its focus.

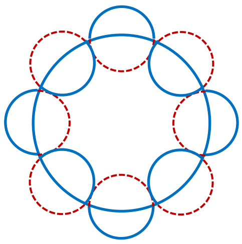
(C) When the de Broglie wave length is λ_1, the particle is nearer the origin than when its value is λ_2.

(D) When the de Broglie wavelength is λ_2, the particle is nearer the origin than when its value is λ_1.

PMP100

Atomic Structure

92. Figure shows stationary orbit of an hydrogen atom upon the transition of electron from given excited state to ground state.



(A) Average change in angular momentum is $\frac{3h}{2\pi}$.

(B) The ratio of de-Broglie wavelengths in final state to initial state is 4.

(C) Energy of emitted photon is nearly 12.75 eV.

(D) Ratio of orbital time period in final state to initial state is 4^3.

PMP130

93. A beam of ultraviolet light of all wavelengths passes through hydrogen gas at room temperature, in the x-direction. Assume that all photons emitted due to electron transition inside the gas emerge in the y-direction. Let A and B denote the lights emerging from the gas in the x and y directions respectively.

(A) Some of the incident wavelengths will be absent in A.

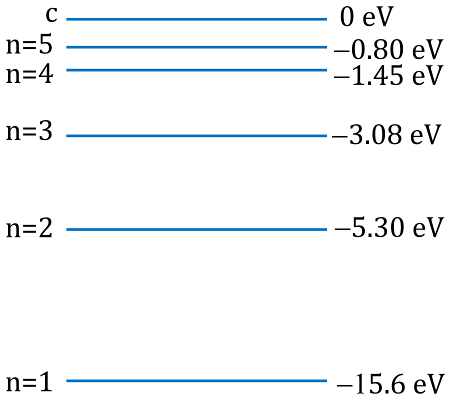
(B) Only those wavelengths will be present in B which are absent in A.

(C) B will contain some visible light.

(D) B will contain some infrared light.

PMP134

94. The energy levels of a hypothetical one electron atom are shown in the figure:



(A) The ionization potential of this atom is 15.6 *V*.

(B) The short wavelength limit of the series terminating at $n = 2$ is 2339 Å.

(C) The excitation potential for the state $n = 3$ is 12.52 *V*.

(D) Wave number of the photon emitted for the transition $n = 3$ to $n = 1$ is $1.009 \times 10^7\ m^{-1}$.

PMP135

95. Energy liberated in the de-excitation of hydrogen atom from 3rd level to 1st level falls on a photo- cathode. Later when the same photocathode is exposed to a spectrum of some unknown hydrogen like gas, excited to 2nd energy level, it is found that the de-Broglie wavelength of the fastest photoelectrons, now ejected has decreased by a factor of 3. For this new gas, difference of energies of 2nd Lyman line and 1st Balmer line is found to be 3 times the ionization potential of the hydrogen atom. Select the correct statement(s) :

(A) The gas is lithium

(B) The gas is helium

(C) The work function of photocathode is 8.5 *eV*

(D) The work function of photocathode is 5.5 *eV*

PMP136

96. Choose the correct statement(s) for hydrogen and deuterium atoms (considering motion of nucleus)

(A) The radius of first Bohr orbit of deuterium is less than that of hydrogen.

(B) The speed of electron in the first Bohr orbit of deuterium is more than that of hydrogen.

(C) The wavelength of first Balmer line of deuterium is more than that of hydrogen.

(D) The angular momentum of electron in the first Bohr orbit of deuterium is more than that of hydrogen.

PMP147

97. A particular hydrogen like atom has its ground state binding "energy 122.4*eV* ". Its is in ground state. Then:

(A) Its atomic number is 3.

(B) An electron of 90 *eV* can excite it.

(C) An electron of kinetic energy nearly 91.8 *eV* can be brought to almost rest by this atom.

(D) An electron of kinetic energy 2.6 *eV* may emerge from the atom when electron of kinetic energy 125 *eV* collides with this atom.

PMP140

98. A neutron collides head-on with a stationary hydrogen atom in ground state. Which of the following statements are correct. (Assume that the hydrogen atom and neutron has same mass) :

(A) If kinetic energy of the neutron is less than 20.4 eV collision must be elastic.

(B) If kinetic energy of the neutron is less than 20.4 eV collision may be inelastic.

(C) Inelastic collision may be take place only when initial kinetic energy of neutron is greater than 20.4 eV.

(D) Perfectly inelastic collision cannot take place.

PMP143

99. A free hydrogen atom in ground state is at rest. A neutron of kinetic energy 'K' collides with the hydrogen atom. After collision hydrogen atom emits two photons in succession one of which has energy 2.55 eV. (Assume that the hydrogen atom and neutron has same mass)

(A) minimum value of 'K' is 25.5 eV.

(B) minimum value of 'K' is 12.75 eV.

(C) the other photon has energy 10.2 eV if K is minimum.

(D) the upper energy level is of excitation energy 12.75 eV.

PMP144

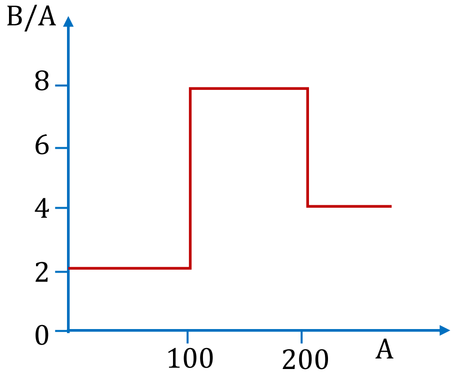
Nuclear Physics

100. Let m_p be the mass of a proton, m_n the mass of a neutron, M_1 the mass of a ${}^{20}_{10}Ne$ nucleus and M_2 the mass of a ${}^{40}_{20}Ca$ nucleus. Then

(A) $M_2 = 2M_1$ (B) $M_2 > 2M_1$ (C) $M_2 < 2M_1$ (D) $M_1 < 10(m_n + m_p)$

PMP175

101. Assume that the nuclear binding energy per nucleon (B/A) versus mass number (A) is as shown in the figure. Use this plot to choose the correct choice(s) given below :



(A) Fusion of two nuclei with mass numbers lying in the range of $1 < A < 50$ will release energy.

(B) Fusion of two nuclei with mass numbers lying in the range of $51 < A < 100$ will release energy.

(C) Fission of a nucleus lying in the mass range of $100 < A < 200$ will release energy when broken into two equal fragments.

(D) Fission of a nucleus lying in the mass range of $200 < A < 260$ will release energy when broken into two equal fragments.

PMP182

102. In β-decay, the Q-value of the process is E. Then

(A) $K.E.$ of a β-particle cannot exceed E.

(B) $K.E.$ of anti neutrino emitted lies between Zero and E.

(C) N/Z ratio of the nucleus is altered.

(D) Mass number (A) of the nucleus is altered.

PMP188

103. Which of the following statement(s) is/are correct?

(A) The rest mass of a stable nucleus is less than the sum of the rest masses of its separated nucleons.

(B) The rest mass of a stable nucleus is greater than the sum of the rest masses of its separated nucleons.

(C) In nuclear fusion, energy is released by fusion of two nuclei of medium mass (approx. 100 amu)

(D) In nuclear fusion, energy is released by fragmentation of a very heavy nucleus.

PMP206

COMPREHENSION TYPE QUESTIONS

De Broglie

PARAGRAPH FOR QUESTIONS NO. 104 TO 105

Some phenomenon's of light can be explained by wave theory and other some phenomenon's show the particle nature of light. De–Broglie proposed a hypothesis based on the dual nature of light. According to De–Broglie each moving particle consists of a wave. This wave is known as De–Broglie wave or matter wave and its wavelength is given by $\lambda = \frac{h}{p}$. Actually, this expression correlate wave and particle nature. (λ) represent the wave nature and momentum (p) represent the particle nature.

104. When electron accelerated through the 150 volt potential difference. The wavelength associated with it

(A) 1 $Å$ (B) 2 $Å$ (C) 1/2 $Å$ (D) 4 $Å$

PMP093

105. A proton and α particle have equal kinetic energies. If λ_α and λ_p are the De–Broglie wavelengths of α particle and proton, then the ratio of $\frac{\lambda_\alpha}{\lambda_p}$ is

(A) 2 (B) 1 (C) 1/2 (D) 1/4

PMP094

EXERCISE - S

Photo Electric Effect

1. A 5 watt source emits monochromatic light of wavelength 5000 Å. When placed 0.5 m away, it liberates photoelectrons from a photosensitive metallic surface. When the source is moved to a distance of 1.0 m, the number of photo electrons liberated will be reduced by a factor of :

PMP090

2. A cooling object was emitting radiations of time varying wavelength $\lambda = 3000 + 40t$, where λ is in Å and t is in second is incident on a metal sheet (of work function $2eV$) such that the power incident on sheet is constant at 100 watt. This signal is switched on and off for time intervals of 2 minutes and 1 minute respectively. Each time the signal is switched on, λ again starts from fresh value of 3000 Å. If the metal plate is grounded so that it always remains neutral and electron clouding is negligible then find the maximum photocurrent(mA). The photoemission efficiency is 0.01% and remains constant. (Take hc = 12400 eV-Å)

PMP219

3. A light of wavelength 3540 Å falls on a metal having work function of 2.5 eV. If ejected electron collides with another target metal inelastically and its total kinetic energy is utilized to raise the temperature of target metal. The mass of target metal is 10^{-3} kg and its specific heat is 160 $J/kg/°C$. If 10^{18} electrons are ejected per second, then find the rate of raise of temperature (in $°C/s$) of the metal.

[Assume there is no loss of energy of ejected electron by any other process, all the electrons are reaching the target metal with max kinetic energy and take hc = 12400 ev-Å]

PMP220

4. The peak emission from a black body at a certain temperature occurs at a wavelength of 6000 Å. On increasing its temperature, the total radiation emitted is increased 16 times. These radiations are allowed to fall on a metal surface. Photoelectrons emitted by the peak radiation at higher temperature can be bought to rest by applying a potential equivalent to the excitation potential corresponding to the transition for the level $n = 4$ to $n = 2$ in the Bohr's hydrogen atom. The work function of the metal is given by $\frac{\alpha}{100}$ eV where α is the numerical constant. Find the value of α.

[Take : hc = 12420 eV-Å]

PMP221

5. A neutron beam, in which each neutron has same kinetic energy, is passed through a sample of hydrogen like gas (but not hydrogen) in ground state. Due to collision of neutrons with the ions of the gas, ions are excited and then they emit photons. Six spectral lines are obtained in which one of the lines is of wavelength (6200/51) nm. What is the minimum possible value of kinetic energy of the neutrons for this to be possible. The mass of neutron and proton can be assumed to be nearly same. Find the answer in the form $25\alpha \times 10^{-2}$ eV and fill value of α.

PMP222

De Broglie

6. The potential energy of a particle varies as $U(x) = E_0$ for $0 < x < 1$ and $U(x) = 0$ for $x > 1$ For $0 \le x \le 1$. de–Broglie wavelengths is λ_1 and for $x > 1$ the de–Broglie wavelength is λ_2.

Total energy of the particle is $2E_0$. Find $\frac{\lambda_1}{\lambda_2}$.

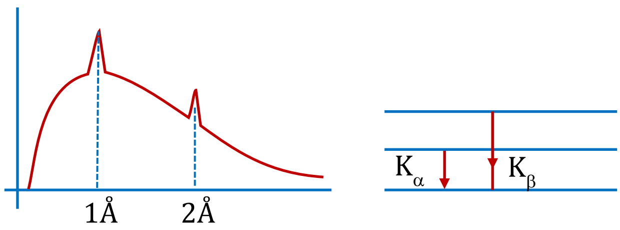
PMP101

7. Two identical nonrelativistic particles move at right angles to each other, possessing De Broglie wavelengths, λ_1 and λ_2. Find the De Broglie wavelength of each particle in the frame of their centre of mass.

PMP102

X-rays

8. Figure shows K_α & K_β X-rays along with continuous X-ray. Find the energy of L_α X-ray.
(Use $hc = 12420$ evÅ).



PMP167

9. An X-rays tube is working at a potential difference of 38.08 kV. The potential difference is decreased to half its initial value. It is found that difference of the wavelength of K_α X-ray and the most energetic continuous X-rays becomes 4 times of the difference prior to the change of voltage. Assuming K_α line is present in both cases, find the atomic number of the target element. [Take $Rch = 13.6$ eV]

PMP172

Atomic Structure

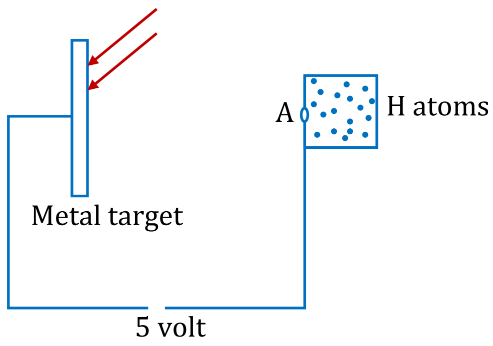
10. There are some atoms in ground energy level and rest of all in some upper energy level in a gas of identical hydrogen-like atoms. The atoms jump to higher energy state after absorbing photon of energy 1.89 eV and as a result emit radiations of 3 different photon energies. Find the principal quantum number of initially excited level :-

PMP129

11. Monochromatic radiation emitted when electron on hydrogen atom jumps from first excited to the grounds state irradiates a photosensitive material. The stopping potential is measured to be 3.57 V. The threshold frequency of the material is $x \times 10^{14}$ Hz, then find value of x.

PMP139

12. Electromagnetic waves of wavelength 1242 Å are incident on a metal of work function $2eV$. The target metal is connected to a 5volt cell, as shown. The electrons pass through hole A into a gas of hydrogen atoms in their ground state. Find the number of spectral lines emitted when hydrogen atoms come back to their ground states after having been excited by the electrons. Assume all excitations in H-atoms from ground state only. (hc = 12420 eVÅ)



PMP223

13. A He^{+} ion in ground state is fired towards a Hydrogen atom in ground state and at rest. What should be the minimum kinetic energy (in eV) of He^{+} ion so that both single electron species may get excited.

PMP224

14. A lithium atom has three electrons, Assume the following simple picture of the atom. Two electrons move close to the nucleus making up a spherical cloud around it and the third moves outside this cloud in a circular orbit. Bohr's model can be used for the motion of this third electron but $n = 1$ states are not available to it. Calculate the ionization energy of lithium in ground state using the above picture.

PMP225

15. A small particle of mass m moves in such a way that the potential energy $U = ar^2$ where a is a constant and r is the distance of the particle from the origin. Assuming Bohr's model of quantization of angular momentum and circular orbits, find the radius of n^{th} allowed orbit.

PMP226

16. An imaginary particle has a charge equal to that of an electron and mass 100 times the mass of the electron. It moves in a circular orbit around a nucleus of charge + 4e. Take the mass of the nucleus to be infinite. Assuming that the Bohr's model is applicable to the system.

(a) Derive and expression for the radius of n^{th} Bohr orbit.

(b) Find the wavelength of the radiation emitted when the particle jumps from fourth orbit to the second.

PMP227

17. An electron is orbiting in a circular orbit of radius r under the influence of a constant magnetic field of strength B. Assuming that Bohr's postulate regarding the quantisation of angular momentum holds good for this electron, find:

(a) the allowed values of the radius 'r' of the orbit.

(b) the kinetic energy of the electron in orbit

(c) The potential energy of interaction between the magnetic moment of the orbital current due to the electron moving in its orbit and the magnetic field B.

(d) The total energy of the allowed energy levels.

PMP228

18. A neutron with an energy of 4.6 MeV collides with protons and is retarded. Assuming that upon each collision neutron is deflected by 45° find the number of collisions which will reduce its energy to 0.23 eV.

PMP229

Nuclear Physics

19. The surface area of a nucleus varies with mass number A as $A^{k/3}$, find k.

PMP177

20. In an α-decay the Kinetic energy of a particle is 48 MeV and Q-value of the reaction is 50 MeV. The mass number of the mother nucleus is: (Assume that daughter nucleus is in ground state)

PMP183

21. Consider the beta decay $^{198}Au \rightarrow {}^{198}Hg^* + \beta^- + \bar{\nu}$ where $^{198}Hg^*$ represents a mercury nucleus in an excited state at energy 1.088 MeV above the ground state. What can be the maximum kinetic energy of the electron emitted? The atomic mass ^{198}Au is 197.968233 u and that of ^{198}Hg is 197.966760 u.

PMP230

Radioactivity

22. A certain radioactive substance has a half-life of 5 years. Thus, for a nucleus in a sample of the element, the probability of decay in ten years (in %) is $3n$. Find n.

PMP202

23. U^{238} and U^{235} occur in nature in an atomic ratio 140 : 1. Assuming that at the time of earth's formation the two isotopes were present in equal amounts. Calculate the age of the earth.
(Half life of $u^{238} = 4.5 \times 10^9$ yrs & that of $U^{235} = 7.13 \times 10^8$ yrs)

PMP209

24. The activity of a freshly prepared radioactive sample is 10^{10} disintegrations per second, whose mean life is $10^9 s$. The mass of an atom of this radioisotope is 10^{-25} kg. The mass (in mg) of the radioactive sample is

PMP214

25. The age of a rock containing lead and uranium is equal to 1.5×10^9 yrs. The uranium is decaying into lead with half-life equal to 4.5×10^9 yrs. Find the ratio of lead to uranium present in the rock, assuming initially no lead was present in the rock. (Given $2^{1/3} = 1.259$)

PMP217

26. A nickel crystal is used as a diffraction grating for X-rays. Then the same crystal is used to diffract electrons. If the two diffraction patterns are identical, and the energy of each X-ray photon is $E = 20.0$ keY. What is the kinetic energy of each electron?

PMP231

27. Atomic furnace wall has a hole having a diameter of δ. At a distance of L from the furnace wall, we kept a plane screen which can detect atoms striking it. Assume that atoms of mass m moving with velocity v in x direction emerge from the hole. Using de Broglie's hypothesis, find the smallest radius (in mm) of the spot on the screen.
(Take : $h = 6.4 \times 10–34$ $kg\ m^2/s$, $L = 1m$, $m = 1.6 \times 10^{-27}$ kg, $v = 10^3$ m/s, $\delta = 0.2$ μm.

PMP232

EXERCISE - JEE (Main) PYQ

1. The radiation corresponding to $3 \rightarrow 2$ transition of hydrogen atom falls on a metal surface to produce photoelectrons. These electrons are made to enter a magnetic field of $3 \times 10^{-4} T$. If the radius of the largest circular path followed by these electrons is 10.0 mm, the work function of the metal is close to:- **[JEE (Main) 2014]**

(1) 0.8 eV (2) 1.6 eV (3) 1.8 eV (4) 1.1 eV

PMP033

2. Hydrogen $({}_1H^1)$, Deuterium $({}_1H^2)$, singly ionised Helium $({}_2He^4)^+$ and doubly ionised lithium $({}_3Li^6)^{++}$ all have one electron around the nucleus. Consider an electron transition from $n = 2$ to $n = 1$. If the wave lengths of emitted radiation are λ_1, λ_2, λ_3 and λ_4 respectively then approximately which one of the following is **correct** ? **[JEE (Main) 2014]**

(1) $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$ (2) $\lambda_1 = 2\lambda_2 = 3\lambda_3 = 4\lambda_4$

(3) $4\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$ (4) $\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$

PMP034

3. As an electron makes a transition from an excited state to the ground state of a hydrogen - like atom/ion : **[JEE (Main) 2015]**

(1) kinetic energy decreases, potential energy increases but total energy remains same

(2) kinetic energy and total energy decrease but potential energy increases

(3) its kinetic energy increases but potential energy and total energy decreases

(4) kinetic energy, potential energy and total energy decrease

PMP035

4. Radiation of wavelength λ, is incident on a photocell. The fastest emitted electron has speed v. If the wavelength is changed to $\frac{3\lambda}{4}$, the speed of the fastest emitted electron will be :- **[JEE (Main) 2016]**

(1) $= v\left(\frac{3}{5}\right)^{1/2}$ (2) $> v\left(\frac{4}{3}\right)^{1/2}$ (3) $< v\left(\frac{4}{3}\right)^{1/2}$ (4) $= v\left(\frac{4}{3}\right)^{1/2}$

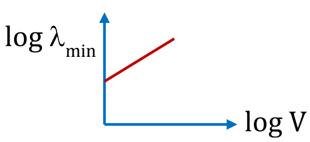
PMP036

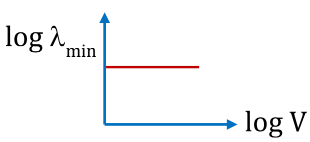
5. Half-lives of two radioactive elements A and B are 20 minutes and 40 minutes, respectively. Initially, the samples have equal number of nuclei. After 80 minutes, the ratio of decayed numbers of A and B nuclei will be :- **[JEE (Main) 2016]**

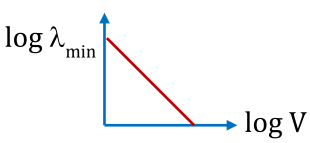
(1) 5 : 4 (2) 1 : 16 (3) 4 : 1 (4) 1 : 4

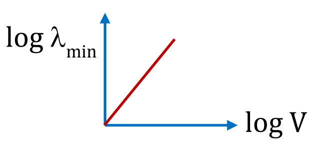
PMP037

6. An electron beam is accelerated by a potential difference V to hit a metallic target to produce X-rays. It produces continuous as well as characteristic X-rays. If λ_{min} is the smallest possible wavelength of X-ray in the spectrum, the variation of log λ_{min} with log V is correctly represented in: **[JEE (Main) 2017]**

(1) 

(2) 

(3) 

(4) 

PMP038

7. A radioactive nucleus A with a half life T, decays into a nucleus B. At $t = 0$, there is no nucleus B. At sometime t, the ratio of the number of B to that of A is 0.3. Then, t is given by:

[JEE (Main) 2017]

(1) $t = T\log(1.3)$ (2) $t = \dfrac{T}{\log(1.3)}$ (3) $t = \dfrac{T}{2}\dfrac{\log 2}{\log 1.3}$ (4) $t = T\dfrac{\log 1.3}{\log 2}$

PMP039

8. If the series limit frequency of the Lyman series is ν_L, then the series limit frequency of the P-fund series is : **[JEE (Main) 2018]**

(1) 16 ν_L (2) $\nu_L/16$ (3) $\nu_L/25$ (4) 25 ν_L

PMP040

9. An electron from various excited states of hydrogen atom emit radiation to come to the ground state. Let λ_n, λ_g be the De-Broglie wavelength of the electron in the n^{th} state and the ground state respectively. Let Λ_n be the wavelength of the emitted photon in the transition from the n^{th} state to the ground state. For large n, (A, B are constants) **[JEE (Main) 2018]**

(1) $\Lambda_n \approx A + B\lambda_n$ (2) $\Lambda_n^2 \approx A + B\lambda_n^2$ (3) $\Lambda_n^2 \approx \lambda$ (4) $\Lambda_n \approx A + \dfrac{B}{\lambda_n^2}$

PMP041

10. Half lives of two radioactive nuclei A and B are 10 minutes and 20 minutes, respectively. If initially a sample has equal number of nuclei, then after 60 minutes, the ratio of decayed numbers of nuclei A and B will be : **[JEE (Main) 2019]**

(1) 9 : 8 (2) 1 : 8 (3) 8 : 1 (4) 3 : 8

PMP042

11. In a reactor, 2 kg of $^{235}_{92}U$ fuel is fully used up in 30 days. The energy released per fission is 200 MeV. Given that the Avogadro number, $N = 6.023 \times 10^{26}$ per kilo mole and 1 $eV = 1.6 \times 10^{-19}$ J. The power output of the reactor is close to : **[JEE (Main) 2020]**

(1) 125 MW (2) 60 MW (3) 35 MW (4) 54 MW

PMP043

12. You are given that Mass of $^{7}_{3}Li$ = 7.0160 u,

Mass of $^{4}_{2}He$ = 4.0026 u

and Mass of $^{1}_{1}H$ = 1.0079 u.

When 20 g of $^{7}_{3}Li$ is converted into $^{4}_{2}He$ by proton capture, the energy liberated, (in kWh), is:

[Mass of nucleon = 1 GeV/c^2] **[JEE (Main) 2020]**

(1) 8×10^6 (2) 1.33×10^6 (3) 6.82×10^5 (4) 4.5×10^5

PMP044

13. The De-Broglie wavelength of a particle having kinetic energy E is λ. How much extra energy must be given to this particle so that the De-Broglie wavelength reduces to 75% of the initial value ?

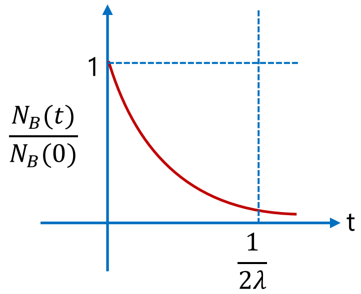
[JEE (Main) 2021]

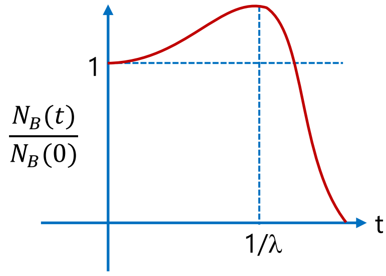
(1) $\dfrac{1}{9}E$ (2) $\dfrac{7}{9}E$ (3) E (4) $\dfrac{16}{9}E$

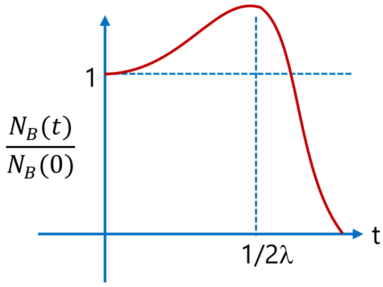
PMP045

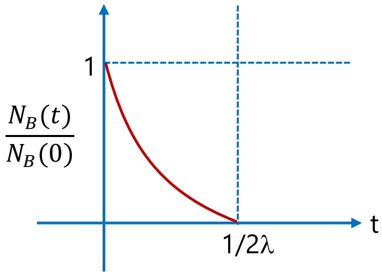
14. At time $t = 0$, a material is composed of two radioactive atoms A and B, where $N_A(0) = 2N_B(0)$. The decay constant of both kind of radioactive atoms is λ. However, A disintegrates to B and B disintegrates to C. Which of the following figures represents the evolution of $N_B(t) / N_B(0)$ with respect to time t? **[JEE (Main) 2021]**

$$\begin{bmatrix} N_A(0) = \text{No. of } A \text{ atoms at } t = 0 \\ N_B(0) = \text{No. of } B \text{ atoms at } t = 0 \end{bmatrix}$$

(1) 

(2) 

(3) 

(4) 

PMP046

15. The light of two different frequencies whose photons have energies 3.8 eV and 1.4 eV respectively, illuminate a metallic surface whose work function is 0.6 eV successively. The ratio of maximum speeds of emitted electrons for the two frequencies respectively will be: **[JEE (Main) 2022]**

(1) 1 : 1 (2) 2 : 1 (3) 4 : 1 (4) 1 : 4

PMP047

16. In Bohr's atomic model of hydrogen, let K, P and E are the kinetic energy, potential energy and total energy of the electron respectively. Choose the correct option when the electron undergoes transitions to a higher level : **[JEE (Main) 2022]**

(1) All K, P and E increase

(2) K decreases, P and E increase

(3) P decreases, K and E increase

(4) K increases, P and E decrease

PMP048

17. A sample contains 10^{-2} kg each of two substances A and B with half lives 4s and 8s respectively. The ratio of then atomic weights is 1 : 2. The ratio of the amounts of A and B after 16s is $\frac{x}{100}$. The value of x is ______. **[JEE (Main) 2022]**

PMP049

18. An electron of a hydrogen like atom, having $Z = 4$, jumps from 4^{th} energy state to 2^{nd} energy state, the energy released in this process, will be:
(Given $Rch = 13.6\ eV$)
Where R = Rydberg constant, c = Speed of light in vacuum, h = Planck's constant
[JEE (Main) 2023]

(1) 13.6 eV (2) 10.5 eV (3) 3.4 eV (4) 40.8 eV

PMP234

19. A radioactive nucleus decays by two different process. The half-life of the first process is 5 minutes and that of the second process is 30s. The effective half-life of the nucleus is calculated to be $\frac{\alpha}{11}$ s. The value of α is ______. **[JEE (Main) 2023]**

PMP235

20. An α-particle, a proton and an electron have the same kinetic energy. Which one of the following is correct in case of their De-Broglie wavelength? **[JEE (Main) 2023]**

(1) $\lambda_\alpha > \lambda_p > \lambda_e$ (2) $\lambda_\alpha < \lambda_p < \lambda_e$ (3) $\lambda_\alpha = \lambda_p = \lambda_e$ (4) $\lambda_\alpha > \lambda_p < \lambda_e$

PMP236

21. From the photoelectric effect experiment, following observations are made. Identify which of these are correct

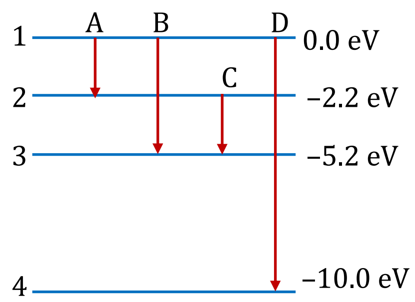
A. The stopping potential depends only on the work function of the metal.
B. The saturation current increases as the intensity of incident light increases.
C. The maximum kinetic energy of a photo electron depends on the intensity of the incident light.
D. Photoelectric effect can be explained using wave theory of light.

Choose the correct answer from the options given below: **[JEE (Main) 2023]**

(1) B, C only (2) A, C, D only (3) B only (4) A, B, D only

PMP237

22. The energy levels of an atom is shown is figure. Which one of these transitions will result in the emission of a photon of wavelength 124.1 nm ? Given ($h = 6.62 \times 10^{-34}\ Js$) **[JEE (Main) 2023]**



(1) B (2) A (3) C (4) D

PMP238

EXERCISE - JEE (Advanced) PYQ

PARAGRAPH FOR QUESTION NO. 1 AND 2

The mass of a nucleus ${}_{Z}^{A}X$ is less than the sum of the masses of $(A - Z)$ number of neutrons and Z number of protons in the nucleus. The energy equivalent to the corresponding mass difference is known as the binding energy of the nucleus. A heavy nucleus of mass M can break into two light nuclei of masses m_1 and m_2 only if $(m_1 + m_2) < M$. Also, two light nuclei of masses m_3 and m_4 can undergo complete fusion and form a heavy nucleus of mass M' only if $(m_3 + m_4) > M'$. The masses of some neutral atoms are given in the table below :- **[JEE (Advanced) 2013]**

${}_{1}^{1}H$	$1.007825\,u$	${}_{1}^{2}H$	$2.014102\,u$	${}_{1}^{3}H$	$3.016050\,u$	${}_{2}^{4}He$	$4.002603\,u$
${}_{3}^{6}Li$	$6.015123\,u$	${}_{3}^{7}Li$	$7.016004\,u$	${}_{30}^{70}Zn$	$69.925325\,u$	${}_{34}^{82}Se$	$81.916709\,u$
${}_{64}^{152}Gd$	$151.919803\,u$	${}_{82}^{206}Pb$	$205.974455\,u$	${}_{83}^{209}Bi$	$208.980388\,u$	${}_{84}^{210}Po$	$209.982876\,u$

$(1u = 932\ MeV/c^2)$

1. The kinetic energy (in keV) of the alpha particle, when the nucleus ${}_{84}^{210}Po$ at rest undergoes alpha decay, is :-

(A) 5319 (B) 5422 (C) 5707 (D) 5818

PMP071

2. The correct statement is :-

(A) The nucleus ${}_{3}^{6}Li$ can emit an alpha particle

(B) The nucleus ${}_{84}^{210}Po$ can emit a proton

(C) Deuteron and alpha particle can undergo complete fusion

(D) The nuclei ${}_{30}^{70}Zn$ and ${}_{34}^{82}Se$ can undergo complete fusion

PMP072

3. A freshly prepared sample of a radioisotope of half-life 1386 sec. has activity 10^3 disintegrations per second. Given that $\ell n2 = 0.693$, the fraction of the initial number of nuclei (expressed in nearest integer percentage) that will decay in the first 80 s after preparation of the sample is.

[JEE (Advanced) 2013]

PMP073

4. Match List I of the nuclear processes with List II containing parent nucleus and one of the end products of each process and then select the correct answer using the codes given below the lists:

[JEE (Advanced) 2013]

	List I		**List II**
P.	Alpha decay	1.	${}_{8}^{15}O \rightarrow {}_{7}^{15}N + ...$
Q.	β^+ decay	2.	${}_{92}^{238}U \rightarrow {}_{90}^{234}Th + ...$
R.	Fission	3.	${}_{83}^{185}Bi \rightarrow {}_{82}^{184}Pb + ...$
S.	Proton emission	4.	${}_{94}^{239}Pu \rightarrow {}_{57}^{140}La + ...$

Codes:

	P	Q	R	S
(A)	4	2	1	3
(B)	1	3	2	4
(C)	2	1	4	3
(D)	4	3	2	1

PMP074

5. If λ_{Cu} is the wavelength of K_α X-ray line of copper (atomic number 29) and λ_{Mo} is the wavelength of the K_α X-ray line of molybdenum (atomic number 42), then the ratio $\dfrac{\lambda_{Cu}}{\lambda_{Mo}}$ is close to :-

[JEE (Advanced) 2014]

(A) 1.99 (B) 2.14 (C) 0.50 (D) 0.48

PMP075

6. Match the nuclear processes given in column-I with the appropriate option(s) in column-II.

[JEE (Advanced) 2015]

	Column-I		Column-II
(A)	Nuclear fusion	(P)	Absorption of thermal neutrons by $^{235}_{92}U$
(B)	Fission in a nuclear reactor	(Q)	$^{60}_{27}Co$ nucleus
(C)	β-decay	(R)	Energy production in stars via hydrogen conversion to helium
(D)	γ-ray emission	(S)	Heavy water
		(T)	Neutrino emission

PMP076

7. The isotope $^{12}_{5}B$ having a mass 12.014 u undergoes β-decay to $^{12}_{6}C \cdot$ $^{12}_{6}C$ has an excited state of the nucleus ($^{12}_{6}C^*$) at 4.041 $M\,eV$ above its ground state. If $^{12}_{5}B$ decays to $^{12}_{6}C^*$, the maximum kinetic energy of the β-particle in units of $M\,eV$ is (1u = 931.5 $M\,eV/c^2$, where c is the speed of light in vacuum).

[JEE (Advanced) 2016]

PMP077

8. The electrostatic energy of Z protons uniformly distributed throughout a spherical nucleus of radius R is given by $E=\dfrac{3}{5}\dfrac{Z(Z-1)e^2}{4\pi\varepsilon_0 R}$.

The measured masses of the neutron, $^{1}_{1}H$, $^{15}_{7}N$ and $^{15}_{8}O$ are 1.008665 u, 1.007825 u, 15.000109 u and 15.003065 u respectively. Given that the radii of both the $^{15}_{7}N$ and $^{15}_{8}O$ nuclei are same, $1u = 931.5\ M\,eV/c^2$ (c is the speed of light) and $\dfrac{e^2}{(4\pi\varepsilon_0)}$ = 1.44 $M\,eV\,fm$. Assuming that the difference between the binding energies of $^{15}_{7}N$ and $^{15}_{8}O$ is purely due to the electrostatic energy, the radius of either of the nuclei is ($1fm = 10^{-15}m$)

[JEE (Advanced) 2016]

(A) 2.85 fm (B) 3.03 fm (C) 3.42 fm (D) 3.80 fm

PMP078

9. An electron in a hydrogen atom undergoes a transition from an orbit with quantum number n_i to another with quantum number n_f. V_i and V_f are respectively the initial and final potential energies of the electron. If $\frac{V_i}{V_f} = 6.25$, then the smallest possible n_f is. **[JEE (Advanced) 2017]**

PMP079

10. In a radioactive decay chain, ${}^{232}_{90}Th$ nucleus decays to ${}^{212}_{82}Pb$ nucleus. Let N_α and N_β be the number of α and β^- particles, respectively, emitted in this decay process. Which of the following statements is (are) true ? **[JEE (Advanced) 2018]**

(A) $N_\alpha = 5$ (B) $N_\alpha = 6$ (C) $N_\beta = 2$ (D) $N_\beta = 4$

PMP080

11. Suppose a ${}^{226}_{88}Ra$ nucleus at rest and in ground state undergoes α-decay to a nucleus in its excited state. The kinetic energy of the emitted α particle is found to be 4.44 MeV. ${}^{222}_{86}Rn$ nucleus then goes to its ground state by γ-decay. The energy of the emitted γ-photon is ______ keV.

[Given: atomic mass of ${}^{226}_{88}Ra = 226.005u$, atomic mass of ${}^{222}_{86}Rn = 222.000u$, atomic mass of α particle = 4.000u, 1u = 931 MeV/c^2, c is speed of the light] **[JEE (Advanced) 2019]**

PMP081

12. In an X-ray tube, electrons emitted from a filament (cathode) carrying current I hit a target (anode) at a distance d from the cathode. The target is kept at a potential V higher than the cathode resulting in emission of continuous and characteristic X-rays. If the filament current I is decreased to $\frac{I}{2}$, the potential difference V is increased to $2V$ and the separation distance d is reduced to $\frac{d}{2}$, then

[JEE (Advanced) 2020]

(A) the cut-off wavelength will reduce to half and the wavelengths of the characteristic X-rays will remain the same

(B) the cut-off wavelength as well as the wavelengths of the characteristic X-rays will remain the same

(C) the cut-off wavelength will reduce to half and the intensities of all the X-rays will decrease

(D) the cut-off wavelength will become two times larger, and the intensity of all the X-rays will decrease

PMP082

13. A heavy nucleus Q of half-life 20 minutes undergoes alpha-decay with probability of 60% and beta-decay with probability of 40%. Initially, the number of Q nuclei is 1000. The number of alpha-decays of Q in the first one hour is **[JEE (Advanced) 2021]**

(A) 50 (B) 75 (C) 350 (D) 525

PMP083

14. In a photoemission experiment, the maximum kinetic energies of photoelectrons from metals P, Q and R are E_P, E_Q and E_R respectively and they are related by $E_P = 2E_Q = 2E_R$. In this experiment, the same source of monochromatic light is used for metals P and Q while a different source of monochromatic light is used for the metal R. The work functions for metals P, Q and R are 4.0 eV, 4.5 eV and 5.5 eV respectively. The energy of the incident photon used for metal R, in eV, is ______.

[JEE (Advanced) 2021]

PMP084

15. The minimum kinetic energy needed by an alpha particle to cause the nuclear reaction ${}^{16}_{7}N + {}^{4}_{2}He \rightarrow {}^{1}_{1}H + {}^{19}_{8}O$ in a laboratory frame is n (in MeV). Assume that ${}^{16}_{7}N$ is at rest in the laboratory frame. The masses of ${}^{16}_{7}N$, ${}^{4}_{2}He$, ${}^{1}_{1}H$ and ${}^{19}_{8}O$ can be taken to be 16.006 u, 4.003 u, 1.008 u and 19.003 u, respectively, where 1 u = 930 $MeVc^{-2}$. The value of n is________.

[JEE (Advanced) 2022]

PMP085

16. The binding energy of nucleons in a nucleus can be affected by the pairwise Coulomb repulsion. Assume that all nucleons are uniformly distributed inside the nucleus. Let the binding energy of a proton be E_b^p and the binding energy of a neutron be E_b^n in the nucleus. Which of the following statement(s) is(are) correct? **[JEE (Advanced) 2022]**

(A) $E_b^p - E_b^n$ is proportional to $Z(Z-1)$ where Z is the atomic number of the nucleus.

(B) $E_b^p - E_b^n$ is proportional to $A^{-\frac{1}{3}}$ where A is the mass number of the nucleus.

(C) $E_b^p - E_b^n$ is positive.

(D) E_b^p increases if the nucleus undergoes a beta decay emitting a positron.

PMP086

17. In a radioactive decay chain reaction, ${}^{230}_{90}Th$ nucleus decays into ${}^{214}_{84}Po$ nucleus. The ratio of the number of α to number of β^- particles emitted in this process is _______. **[JEE (Advanced) 2022]**

PMP087

18. A Hydrogen-like atom has atomic number Z. Photons emitted in the electronic transitions from level $n = 4$ to level $n = 3$ in these atoms are used to perform photoelectric effect experiment on a target metal. The maximum kinetic energy of the photoelectrons generated is 1.95 eV. If the photoelectric threshold wavelength for the target metal is 310 nm, the value of Z is ______.

[Given: hc = 1240 eV-nm and Rhc = 13.6 eV, where R is the Rydberg constant, h is the Planck's constant and c is the speed of light in vacuum] **[JEE (Advanced) 2023]**

PMP239

19. In a radioactive decay process, the activity is defined as $A = -\frac{dN}{dt}$, where $N(t)$ is the number of radioactive nuclei at time t. Two radioactive sources, S_1 and S_2 have same activity at time $t = 0$. At a later time, the activities of S_1 and S_2 are A_1 and A_2, respectively. When S_1 and S_2 have just completed their 3rd and 7th half-lives, respectively, the ratio A_1/A_2 is _________. **[JEE (Advanced) 2023]**

PMP240

JEE (Main) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

  Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
  Zero Marks : 0, if none of the bubbles is darkened.
  Negative Marks : −1 in all other cases.

1. In radioactive decay process, the negatively charged emitted β-particles are :
(1) the electrons orbiting around the nucleus
(2) the electrons present inside the nucleus
(3) the electrons produced as a result of the decay of neutrons inside the nucleus
(4) the electrons produced as a result of collisions between atoms

PMP001

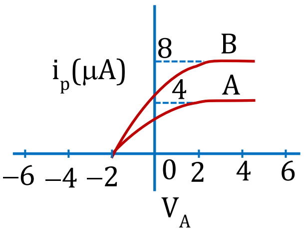
2. Light of frequency 7.21×10^{14} Hz is incident on a metal surface. Electrons with a maximum speed of 6.0×10^{5} m/s are ejected from the surface. The threshold frequency for photoemission of electrons is
(1) 4.73×10^{14} Hz (2) 4.73×10^{10} Hz (3) 2.08×10^{10} Hz (4) None of these

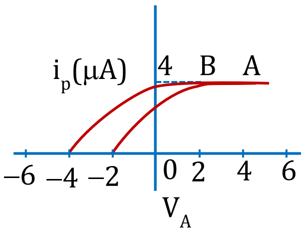
PMP002

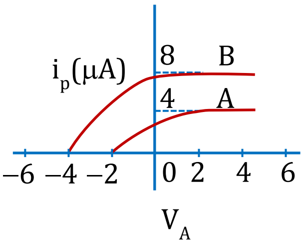
3. The threshold frequency for a certain metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on the metal, the cutoff voltage for the photoelectric emission is.
(1) 8 V (2) 6 V (3) 2 V (4) 4 V

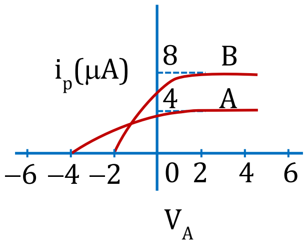
PMP003

4. In a photoelectric effect experiment, photons of energy 5 eV are incident on the photo-cathode of work function 3 eV. For photon intensity $I_A = 10^{15}$ $m^{-2}s^{-1}$, saturation current of 4.0 μA is obtained. Sketch of the variation of photocurrent i_p against the anode voltage V_a for photon intensity I_A (curve A) and $I_B = 2 \times 10^{15}$ m^{-2} s^{-1} (curve B) will be :

(1)


(2)


(3)


(4)


PMP004

5. The threshold frequency for a metallic surface corresponds to an energy of 6.2 eV and the stopping potential for a radiation incident on this surface is 5 V. The incident radiation lies in-

(1) ultra-violet region (2) infra-red region
(3) visible region (4) X-ray region

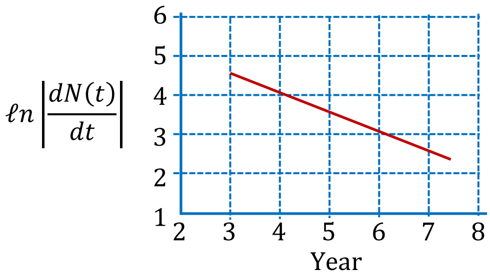
PMP005

6. The binding energies of nuclei X and Y are E_1 and E_2 respectively. Two atoms of X fuse to give one atom of Y and an energy Q is released. Then:

(1) $Q = 2E_1 - E_2$ (2) $Q = E_2 - 2E_1$ (3) $Q = 2E_1 + E_2$ (4) $Q = 2E_2 + E_1$

PMP006

7. To determine the half life of a radioactive element, a student plots a graph of $\ell n\left|\frac{dN(t)}{dt}\right|$ versus t. Here $\frac{dN(t)}{dt}$ is the rate of radioactive decay at time t. If the number of radioactive nuclei of this element decreases by a factor of p after 4.16 years, the value of p is



(1) 6 (2) 8
(3) 10 (4) 12

PMP007

8. In a radioactive element the fraction of initial amount remaining after its mean life time is

(1) $1-\frac{1}{e}$ (2) $\frac{1}{e^2}$ (3) $\frac{1}{e}$ (4) $1-\frac{1}{e^2}$

PMP008

9. 90% of a radioactive sample is left undecayed after time t has elapsed. What percentage of the initial sample will decay in a total time $2t$:

(1) 20% (2) 19% (3) 40% (4) 38%

PMP009

10. The half-life period of a radioactive element X is same as the mean life time of another radioactive element Y. Initially they have the same number of atoms. Then-

(1) X will decay faster than Y (2) Y will decay faster than X
(3) Y and X have same decay rate initially (4) X and Y decay at same rate always

PMP010

11. A nucleus with $Z = 92$ emits the following in a sequence : $\alpha, \alpha, \beta^-, \beta^-, \alpha, \alpha, \alpha, \alpha, \beta^-, \beta^-, \alpha, \beta^+, \beta^+, \alpha$. The Z of the resulting nucleus is-

(1) 76 (2) 78 (3) 82 (4) 74

PMP011

12. A nucleus disintegrates into two nuclear parts which have their velocities in the ratio 2 : 1 The ratio of their nuclear sizes will be-

(1) $2^{1/3} : 1$ (2) $1 : 3^{1/2}$ (3) $3^{1/2} : 1$ (4) $1 : 2^{1/3}$

PMP012

13. A γ ray photon produces an electron positron pair. If the rest mass energy of electron is 0.51 MeV and the total kinetic energy of electron - positron pair is 0.78 MeV then the energy of ray photon in MeV is :

(1) 0.78 (2) 1.8 (3) 1.28 (4) 0.28

PMP013

14. The largest wavelength in the ultraviolet region of the hydrogen spectrum is 122 nm. The smallest wavelength in the infrared region of the hydrogen spectrum (to the nearest integer) is

(1) 802 nm (2) 823 nm (3) 1882 nm (4) 1648 nm

PMP014

15. In a Rutherford scattering experiment when a projectile of charge z_1 and mass M_1 approaches a target nucleus of charge z_2 and mass M_2, the distance of closest approach is r_0. The energy of the projectile is :

(1) directly proportional to mass M_1
(2) directly proportional to M_1M_2
(3) directly proportional to z_1z_2
(4) inversely proportional to z_1

PMP015

16. According to Bohr's theory of hydrogen atom, for the electron in the nth permissible orbit,

(1) linear momentum $\propto \frac{1}{n}$
(2) radius of orbit $\propto n$
(3) kinetic energy $\propto \frac{1}{n}$
(4) angular momentum $\propto n^2$

PMP016

17. If the binding energy of the electron in a hydrogen atom is 13.6 eV, the energy required to remove the electron from the first excited state of Li^{2+} is-

(1) 30.6 eV
(2) 13.6 eV
(3) 3.4 eV
(4) 122.4 eV

PMP017

18. The wavelength of K_α X-ray of an element having atomic number $Z = 11$ is λ . The wavelength of K_α X-ray of another element of atomic number Z' is 4λ. Then Z' is

(1) 11
(2) 44
(3) 6
(4) 4

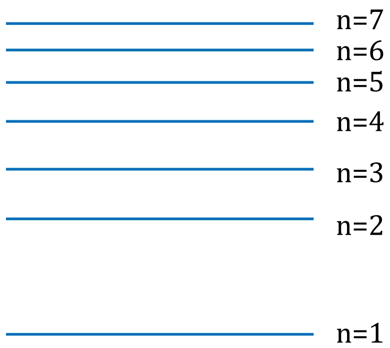
PMP018

19. The wavelength of characteristic K_α-line emitted by a hydrogen like element is 2.5 Å. Find the wavelength of the K_γ-line emitted by the same element (in Å). [Assume the shielding effect to be same as of K_α]

(1) 0
(2) 1
(3) 2
(4) 3

PMP019

20. The maximum number of emission lines for atomic hydrogen that you would expect to see with naked eye if the only electronic levels involved are those shown in the figure, is



(1) 6
(2) 5
(3) 21
(4) ∞

PMP020

SECTION–B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4,	if only correct answer is given.
Zero Marks	:	0,	if no answer is given.
Negative Marks	:	–1	for incorrect answer.

1. The energy flux of sunlight reaching the surface of the earth is $1.388 \times 10^3\ W/m^2$. If photons (nearly) per square metre are incident on the Earth per second is x $\times 10^{21}\ ph/\text{sec}\ m^2$. Assume that the photons in the sunlight have an average wavelength of 550 nm. Find the value of x.

PMP021

2. The electron in the hydrogen atom jumps from excited state (n = 3) to its ground state (n = 1) and the photons thus emitted irradiate a photosensitive material. If the work function of the material is 5.1 eV, the stopping potential (in volts) is estimated to be
(The energy of the electron in n^{th} state)

PMP022

3. The threshold frequency for a photosensitive metal is $3.3 \times 10^{14}\ Hz$. If light of frequency $8.2 \times 10^{14}\ Hz$ is incident on this metal, then the cut-off voltage (in volts) for the photoelectric emission is nearly (Round of to the nearest integer)

PMP023

4. Hydrogen atoms in ground state are excited by monochromatic radiation of wavelength 975 Å. The number of lines in the resulting spectrum will be :

PMP024

5. A certain metallic surface is illuminated with monochromatic light of wavelength, λ. The stopping potential for photo-electric current for this light is $3V_0$. If the same surface is illuminated with light of wavelength 2λ, the stopping potential is V_0. The threshold wavelength for this surface for photoelectric effect is nλ, then find n.

PMP025

6. If radius of the $^{27}_{13}Al$ nucleus is estimated to be 3.6 fermi, then the radius of $^{125}_{52}Te$ nucleus (in fermi) will be nearly-

PMP026

7. Suppose that the Sun consists entirely of hydrogen atom and releases the energy by the nuclear reaction, $4\,^1_1H \rightarrow ^4_2He$ with 26 MeV of energy released. If the total output power of the Sun is assumed to remain constant at $3.9 \times 10^{26}\ W$, then the time it will take to burn all the hydrogen is $8/3 \times 10^n$ sec, find n. [Take the mass of the Sun as 1.7×10^{30} kg]

PMP027

8. The binding energy per nucleon of deuteron $\left(^2_1H\right)$ and helium nucleus $\left(^4_2He\right)$ is 1.1 MeV and 7 MeV respectively. If two deuteron nuclei react to form a single helium nucleus, then the energy released is $236 \times 10^{-n}\ MeV$. Find the value of n.

PMP028

9. In an α-decay the Kinetic energy of α particle is 48 MeV and Q-value of the reaction is 50 MeV. The mass number of the mother nucleus is: (Assume that daughter nucleus is in ground state)

PMP029

10. Given a sample of Radium-226 having half-life of 4 days. The probability is $\frac{n}{4}$. If a nucleus disintegrates within 2 half lives. Then find the value n.

PMP030

JEE (Advanced) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–I

- This section contains **EIGHT** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

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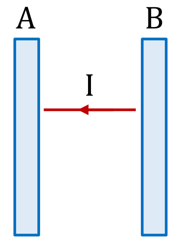
1. If p represents radiation pressure, c represents the speed of light and q represents radiation energy incident per unit area per second, then for what values of x, y and z, the quantity $p^x q^y c^z$ will be dimensionless?

(A) $x = y = z = 1$ (B) $x = -y = z$ (C) $x = y = -z = 1$ (D) $x = -y = -z = 1$

PMP050

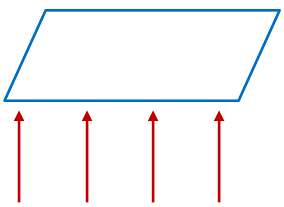
2. A parallel beam of light of intensity I is incident normally on a plane surface A which absorbs 50% of the incident light. The reflected light falls on B which is perfect reflector, the light reflected by B is again partly reflected and partly absorbed and this process continues. For all absorption by A, absorption coefficient is 0.5. The pressure experienced by A due to light is :-



(A) $\frac{1.5I}{c}$ (B) $\frac{I}{c}$ (C) $\frac{3I}{2c}$ (D) $\frac{3I}{c}$

PMP051

3. A plate of mass 20 gm is in equilibrium in air due to force exerted by light beam on plate as shown is figure. Calculate power of the beam if plate is perfectly absorbing.



(A) $7 \times 10^7\ W$ (B) $6 \times 10^8\ W$
(C) $6 \times 10^7\ W$ (D) $7 \times 10^8\ W$

PMP052

4. When two deuterons ($_1H^2$) fuse to from a helium nucleus $_2He^4$, 23.6 MeV energy is released. Find the binding energy of helium if it is 1.1 MeV for each nucleon of deuterium.

(A) 28 MeV (B) 32 MeV (C) 35 MeV (D) 39 MeV

PMP053

5. A body of mass 'm_0' is placed on a smooth horizontal surface. The mass of the body is decreasing exponentially with decay constant 'λ'. Assuming the body is ejecting mass backwards at a constant relative velocity 'u' and initially it was at rest; then its velocity after 't' seconds will be :-

(A) $u\lambda t$ (B) $2\ u\lambda t$ (C) $\frac{u}{\lambda t}$ (D) $\frac{2u}{\lambda t}$

PMP054

6. The binding energies of the atom of elements A and B are E_a and E_b respectively. Three atoms of the element B fuse to give one atom of element A. This fusion process is accompanied by release of energy e. Then E_a, E_b are related to each other as

(A) $E_a + e = 3E_b$ (B) $E_a = 3E_b$ (C) $E_a - e = 3E_b$ (D) $E_a + 3E_b + e = 0$

PMP055

7. A nucleus of mass $M + \Delta m$ is at rest and decays into two daughter nuclei of mass $\frac{M}{4}$ and $\frac{3M}{4}$ each. Speed of light is c. The speed of daughter nucleus of mass $\frac{M}{4}$ is:

(A) $c\sqrt{\frac{\Delta m}{M+\Delta m}}$ (B) $c\frac{\Delta m}{M+\Delta m}$ (C) $c\sqrt{\frac{2\Delta m}{M}}$ (D) $c\sqrt{\frac{6\Delta m}{M}}$

PMP056

8. A free nucleus of mass 24 amu, initially at rest emits a gamma photon. The energy of the photon is 7 MeV. The kinetic energy of recoiling nucleus is approximately equal to :-

[Take : 1 amu = 931 MeV]

(A) 1.1 keV (B) 2.25 keV (C) 3.3 keV (D) 4.4 keV

PMP057

SECTION-II

- This section contains **SIX** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 if only (all) the correct option(s) is (are) chosen.

Partial Marks : +3 if all the four options are correct but ONLY three options are chosen.

Partial Marks : +2 if three or more options are correct but ONLY two options are chosen, both of which are correct options.

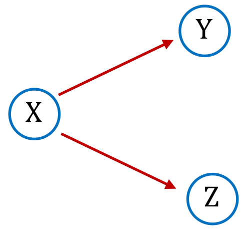
Partial Marks : +1 if two or more options are correct but ONLY one option is chosen and it is a correct option.

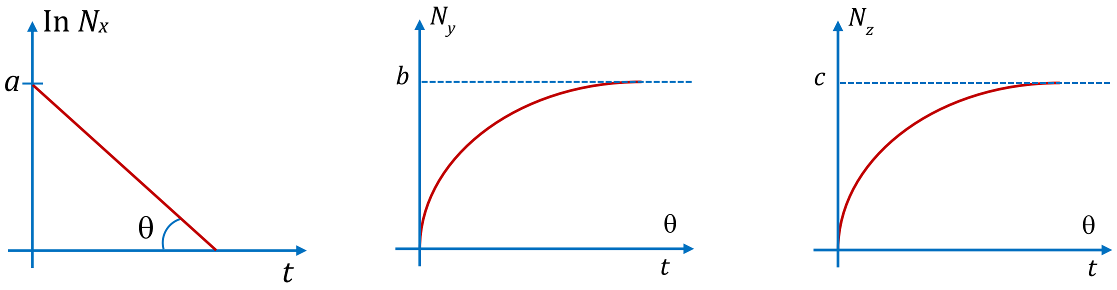
Zero Marks : 0 if none of the options is chosen (i.e. the question is unanswered).

Negative Marks : –2 in all other cases.

For Example : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in –2 marks.

9. A sample of unstable radioactive nuclei X can decay into two stable nuclei Y and Z.
At $t = 0$ there are no nuclei of Y and Z. Three graphs $\ell n\, N_x$ versus t, N_y versus t and N_z versus t are drawn as shown in figure.
N_x, N_y and N_y are number of nuclei at any time t.





(A) Ratio of $N_y : N_z$ at any time is constant.

(B) Decay constant for decay of X into Y is $\dfrac{b\tan\theta}{b+c}$

(C) Decay constant for decay of X into Z is $\dfrac{c\tan\theta}{e^a}$

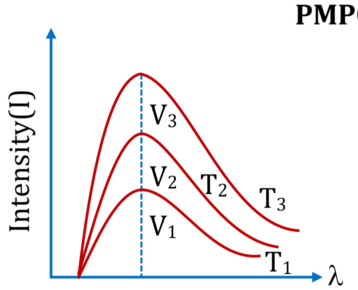
(D) Ratio of $N_y : N_z$ is time dependent.

PMP058

10. The potential difference between the target and the cathode of an X-ray tube is 50 kV. The current in the tube is 20 mA. Only 1% of the total energy is emitted as X-rays.
(Take: $hc = 1240\ eV\ nm$)
(A) The maximum frequency of the emitted x-rays is approx 1.2×10^{19} Hz.
(B) The heat should be removed at 900 W to keep the target at constant temperature
(C) A wavelength of 0.2 nm can be emitted by this tube
(D) Electrons are being emitted at the rate of 1.25×10^{17}/sec by the cathode

PMP059

11. The continuous X-ray spectrum for the three potential differences between target and cathode, V_1, V_2 and V_3 is shown. Temperatures of filament in these cases are T_1, T_2 and T_3 respectively, then:
(A) $V_1 > V_2 > V_3$
(B) $T_1 > T_2 > T_3$
(C) $V_1 = V_2 = V_3$
(D) $T_1 < T_2 < T_3$



PMP060

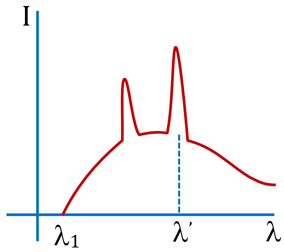
12. An X-ray tube is operating at 50 kV and 20 mA. The target material of the tube has a mass of 1.0 kg and specific heat 495 $J\ kg^{-1}\ °C^{-1}$. One percent of the supplied electric power is converted into X-rays and entire remaining energy goes into heating the target. Then:
(A) the average rate of rise of temperature of the target would be 2°C/sec
(B) the minimum wavelength of the X-rays emitted is about 0.25×10^{-10} m
(C) a suitable target material must have a low melting temperature
(D) a suitable target material must have low thermal conductivity

PMP061

13. An X-ray tube is operating at 50 kV and 10 mA. The target material of the tube has mass of 1 kg and specific heat 495 $J\ kg^{-1}°C^{-1}$. One percent of applied electric power is converted into X-rays and the remaining energy goes into heating the target. Then :
(A) a suitable target material must have high melting temperature
(B) a suitable target material must have low thermal conductivity
(C) the average rate of rise of temperature of the target would be 1°C/sec
(D) the minimum wavelength of X-rays emitted is about 0.25×10^{-10} m

PMP062

14. The diagram below describes the intensity of X-ray photons versus their wave length, coming out of a tube, when potential difference across the tube is V and atomic number of the target element is Z. If V is changed to V_1 and Z to Z_1, choose the **CORRECT** statement :



(A) for $V_1 > V$ and $Z_1 = Z$, λ_m will decrease whereas λ' will remain same

(B) for $V_1 > V$ and $Z_1 = Z$, λ_m and λ' both will decrease

(C) for $V_1 = V$ and $Z_1 > Z$, λ_m will remain same whereas λ' will decrease

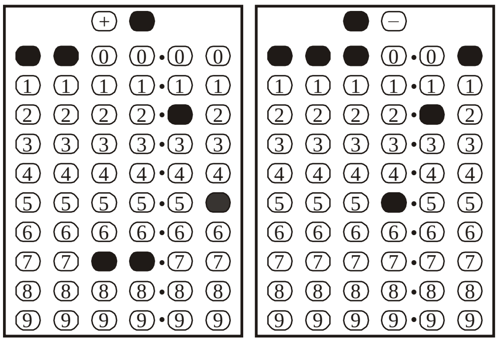
(D) for $V_1 > V$ and $Z_1 > Z$, λ_m and λ' both will decrease

PMP063

SECTION-III

- This section contains **FOUR** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.

  For Example : If answer is –77.25, 5.2 then fill the bubbles as follows:



- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : +3 if ONLY the correct numerical value is entered as answer.

  Zero Marks : 0 in all other cases.

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15. Find the ratio between centripetal acceleration of the electron in singly ionized helium atom and hydrogen atom (both in ground state).

PMP064

16. The shortest wavelength of the Bracket series of a hydrogen–like atom (atomic number = Z) is the same as the shortest wavelength of the Balmer series of hydrogen atom. Find the value of Z.

PMP065

17. The ratio of series limit wavelength of Balmer series to wavelength of first line of Paschen series is 'a' write your answer as $36a$:

PMP066

18. A radioactive sample decays with an average-life of 20 ms. A capacitor of capacitance 100 μF is charged to some potential and then the plates are connected through a resistance R. What should be the value of R so that the ratio of the charge on the capacitor to the activity of the radioactive sample remains constant in time?

PMP233

ANSWER KEY

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	B	A	D	B	B	B	B	D	C
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	D	C	A	D	A	C	A	D	C	B
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	D	D	D	D	A	B	B	A	B	A
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	C	A	C	A	B	A	B	A	C	D
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	D	B	A	B	A	A	B	B	C	C
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	C	D	B	B	C	A	C	B	A	C
Que.	61	62	63	64	65	66	67	68	69	70
Ans.	C	B	B	B	C	C	A	B	B	D
Que.	71	72	73	74	75	76	77	78	79	80
Ans.	C	B	A	C	C	B	B	C	ABCD	BCD
Que.	81	82	83	84	85	86	87	88	89	90
Ans.	ABC	AC	ABD	BCD	AC	AB	ACD	ABD	BC	ABCD
Que.	91	92	93	94	95	96	97	98	99	100
Ans.	BD	ACD	ACD	ABCD	BC	BD	ACD	AC	ACD	CD
Que.	101	102	103	104	105					
Ans.	BD	ABC	AD	A	C					

EXERCISE - S

1. 4
2. 5
3. 1
4. 159
5. 255
6. $\sqrt{2}$
7. $\lambda = \dfrac{2\lambda_1\lambda_2}{\sqrt{\lambda_1^2+\lambda_2^2}}$
8. 6210 eV
9. 41
10. 2
11. 16
12. 6
13. 255
14. 3.4 eV
15. $r = \left(\dfrac{n^2h^2}{8am\pi^2}\right)^{1/4}$
16. (a) $\dfrac{n^2h^2\varepsilon_0}{400\ \ \pi me^2}$ (b) 3.0 $\mathring{A}$
17. (a) $\sqrt{\dfrac{nh}{2\pi Be}}$ (b) $\dfrac{nhBe}{4\pi m}$ (c) $\dfrac{nheB}{4\pi m}$ (d) $\dfrac{nheB}{2\pi m}$
18. 24
19. 2
20. 100
21. 0.2806 MeV
22. 25
23. 6.04×10^9 yrs
24. 1
25. 0.259
26. 391eV
27. 2.44

EXERCISE - JEE (Main) PYQ

Question	1	2	3	4	5	6	7	8	9	10
Answer	4	1	3	2	1	3	4	3	4	1
Question	11	12	13	14	15	16	17	18	19	20
Answer	2	2	2	3	2	2	50	4	300	2
Question	21	22								
Answer	3	4								

EXERCISE - JEE (Advanced) PYQ

Question	1	2	3	4	5	6		
Answer	A	C	4	C	B	(A-R or R,T), (B-P,S), (C-Q,T), (D-R)		
Question	7	8	9	10	11	12	13	14
Answer	9	C	5	AC	135	AC	D	6
Question	15	16	17	18	19			
Answer	2.32 to 2.33	ABD	2	3	16			

JEE (Main) Practice Paper

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	3	1	3	1	1	2	2	3	2	2
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	2	4	2	2	3	1	1	3	3	2
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	4	7	2	6	4	6	18	1	100	3

JEE (Advanced) Practice Paper

Section-I	Q.	1	2	3	4	5	6	7	8
	A.	B	D	C	A	A	A	D	A
Section-II	Q.	9	10	11	12	13	14		
	A.	AB	ACD	CD	AB	ACD	ACD		
Section-III	Q.	15	16	17	18				
	A.	8	2	7	200 Ω.s				