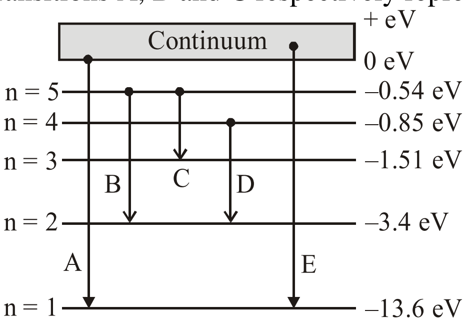
MODERN PHYSICS

1. Given below are two statements :
Statement-I : Two photons having equal linear momenta have equal wavelengths.
Statement-II : If the wavelength of photon is decreased, then the momentum and energy of a photon will also decrease.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are true
(2) Statement I is false but Statement II is true
(3) Both Statement I and Statement II are false
(4) Statement I is true but Statement II is false

2. In the given figure, the energy levels of hydrogen atom have been shown along with some transitions marked A, B, C, D and E. The transitions A, B and C respectively represent :



(1) The ionization potential of hydrogen, second member of Balmer series and third member of Paschen series.
(2) The first member of the Lyman series, third member of Balmer series and second member of Paschen series.
(3) The series limit of Lyman series, third member of Balmer series and second member of Paschen series.
(4) The series limit of Lyman series, second member of Balmer series and second member of Paschen series.

3. The de Broglie wavelength of a proton and α-particle are equal. The ratio of their velocities is :
(1) 4 : 3 (2) 4 : 1 (3) 4 : 2 (4) 1 : 4

4. An X-ray tube is operated at 1.24 million volt. The shortest wavelength of the produced photon will be :
(1) 10^{-3} nm (2) 10^{-1} nm
(3) 10^{-2} nm (4) 10^{-4} nm

5. According to Bohr atom model, in which of the following transitions will the frequency be maximum ?
(1) n = 4 to n = 3 (2) n = 2 to n = 1
(3) n = 5 to n = 4 (4) n = 3 to n = 2

6. An α particle and a proton are accelerated from rest by a potential difference of 200 V. After this, their de Broglie wavelengths are λ_α and λ_p respectively. The ratio $\frac{\lambda_p}{\lambda_\alpha}$ is :
(1) 3.8 (2) 8 (3) 7.8 (4) 2.8

7. Two radioactive substances X and Y originally have N_1 and N_2 nuclei respectively. Half life of X is half of the half life of Y. After three half lives of Y, number of nuclei of both are equal. The ratio $\frac{N_1}{N_2}$ will be equal to :
(1) $\frac{1}{8}$ (2) $\frac{3}{1}$ (3) $\frac{8}{1}$ (4) $\frac{1}{3}$

8. The wavelength of the photon emitted by a hydrogen atom when an electron makes a transition from n = 2 to n = 1 state is :
(1) 194.8 nm (2) 913.3 nm
(3) 490.7 nm (4) 121.8 nm

9. An electron of mass m_e and a proton of mass $m_p = 1836\, m_e$ are moving with the same speed. The ratio of their de Broglie wavelength $\frac{\lambda_{electron}}{\lambda_{proton}}$ will be :
(1) 1836 (2) 1
(3) 918 (4) $\frac{1}{1836}$

10. The stopping potential for electrons emitted from a photosensitive surface illuminated by light of wavelength 491 nm is 0.710 V. When the incident wavelength is changed to a new value, the stopping potential is 1.43 V. The new wavelength is :
(1) 329 nm (2) 309 nm
(3) 382 nm (4) 400 nm

11. The wavelength of an X-ray beam is 10Å. The mass of a fictitious particle having the same energy as that of the X-ray photons is $\frac{x}{3}h$ kg. The value of x is_________. (h = Planck's constant)

12. If λ_1 and λ_2 are the wavelengths of the third member of Lyman and first member of the Paschen series respectively, then the value of $\lambda_1 : \lambda_2$ is :
(1) 1 : 9 (2) 7 : 108
(3) 7 : 135 (4) 1 : 3

13. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : An electron microscope can achieve better resolving power than an optical microscope.

Reason R : The de Broglie's wavelength of the electrons emitted from an electron gun is much less than wavelength of visible light.

In the light of the above statements, choose the correct answer from the options given below:

(1) A is true but R is false.

(2) Both A and R are true and R is the correct explanation of A.

(3) Both A and R are true but R is NOT the correct explanation of A.

(4) A is false but R is true.

14. The recoil speed of a hydrogen atom after it emits a photon in going from n = 5 state to n = 1 state will be :

(1) 4.17 m/s (2) 2.19 m/s

(3) 3.25 m/s (4) 4.34 m/s

15. A radioactive sample is undergoing α decay. At any time t_1, its activity is A and another time t_2, the activity is $\frac{A}{5}$. What is the average life time for the sample ?

(1) $\frac{\ell n5}{t_2 - t_1}$ (2) $\frac{t_1 - t_2}{\ell n5}$

(3) $\frac{t_2 - t_1}{\ell n5}$ (4) $\frac{\ell n(t_2 + t_1)}{2}$

16. Two stream of photons, possessing energies equal to twice and ten times the work function of metal are incident on the metal surface successively. The value of ratio of maximum velocities of the photoelectrons emitted in the two respective cases is x : y. The value of x is ....

17. The stopping potential in the context of photoelectric effect depends on the following property of incident electromagnetic radiation :

(1) Phase (2) Intensity

(3) Amplitude (4) Frequency

18. The first three spectral lines of H-atom in the Balmer series are given λ_1, λ_2, λ_3 considering the Bohr atomic model, the wave lengths of first and third spectral lines $\left(\frac{\lambda_1}{\lambda_3}\right)$ are related by a factor of approximately 'x' $\times 10^{-1}$. The value of x, to the nearest integer, is ________.

19. The de-Broglie wavelength associated with an electron and a proton were calculated by accelerating them through same potential of 100 V. What should nearly be the ratio of their wavelengths ? (m_P = 1.00727 u, m_e = 0.00055u)

(1) 1860 : 1 (2) $(1860)^2$: 1

(3) 41.4 : 1 (4) 43 : 1

20. The half-life of Au^{198} is 2.7 days. The activity of 1.50 mg of Au^{198} if its atomic weight is 198 g mol^{-1} is, ($N_A = 6 \times 10^{23}$/mol)

(1) 240 Ci (2) 357 Ci

(3) 535 Ci (4) 252 Ci

21. Calculate the time interval between 33% decay and 67% decay if half-life of a substance is 20 minutes.

(1) 60 minutes (2) 20 minutes

(3) 40 minutes (4) 13 minutes

22. If an electron is moving in the n^{th} orbit of the hydrogen atom, then its velocity (v_n) for the n^{th} orbit is given as :

(1) $v_n \propto n$ (2) $v_n \propto \frac{1}{n}$

(3) $v_n \propto n^2$ (4) $v_n \propto \frac{1}{n^2}$

23. An electron of mass m and a photon have same energy E. The ratio of wavelength of electron to that of photon is : (c being the velocity of light)

(1) $\frac{1}{c}\left(\frac{2m}{E}\right)^{1/2}$ (2) $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$

(3) $\left(\frac{E}{2m}\right)^{1/2}$ (4) c $(2mE)^{1/2}$

24. Which level of the single ionized carbon has the same energy as the ground state energy of hydrogen atom?

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

25. If 2.5×10^{-6} N average force is exerted by a light wave on a non-reflecting surface of 30 cm^2 area during 40 minutes of time span, the energy flux of light just before it falls on the surface is ____ W/cm^2. (Round off to the Nearest Integer)

(Assume complete absorption and normal incidence conditions are there)

26. The atomic hydrogen emits a line spectrum consisting of various series.Which series of hydrogen atomic spectra is lying in the visible region ?

(1) Brackett series (2) Paschen series

(3) Lyman series (4) Balmer series

27. Two identical photocathodes receive the light of frequencies f_1 and f_2 respectively. If the velocities of the photo-electrons coming out are v_1 and v_2 respectively, then

(1) $v_1^2 - v_2^2 = \frac{2h}{m}[f_1 - f_2]$

(2) $v_1^2 + v_2^2 = \frac{2h}{m}[f_1 + f_2]$

(3) $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{\frac{1}{2}}$

(4) $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{1/2}$

28. A particle of mass m moves in a circular orbit in a central potential field $U(r) = U_0 r^4$. If Bohr's quantization conditions are applied, radii of possible orbitals r_n vary with $n^{1/\alpha}$, where α is___________.

29. Imagine that the electron in a hydrogen atom is replaced by a muon (μ). The mass of muon particle is 207 times that of an electron and charge is equal to the charge of an electron. The ionization potential of this hydrogen atom will be :-

(1) 13.6 eV (2) 2815.2 eV
(3) 331.2 eV (4) 27.2 eV

30. A particle is travelling 4 times as fast as an electron. Assuming the ratio of de-Broglie wavelength of a particle to that of electron is 2 : 1, the mass of the particle is :-

(1) $\frac{1}{16}$ times the mass of e^-
(2) 8 times the mass of e^-
(3) 16 times the mass of e^-
(4) $\frac{1}{8}$ times the mass of e^-

31. A proton and an α-particle, having kinetic energies K_p and K_α, respectively, enter into a magnetic field at right angles.
The ratio of the radii of trajectory of proton to that of α-particle is 2 : 1. The ratio of $K_p : K_\alpha$ is :

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

32. The decay of a proton to neutron is :

(1) not possible as proton mass is less than the neutron mass
(2) possible only inside the nucleus
(3) not possible but neutron to proton conversion is possible
(4) always possible as it is associated only with β^+ decay

33. The speed of electrons in a scanning electron microscope is 1×10^7 ms^{-1}. If the protons having the same speed are used instead of electrons, then the resolving power of scanning proton microscope will be changed by a factor of:

(1) 1837 (2) $\frac{1}{1837}$
(3) $\sqrt{1837}$ (4) $\frac{1}{\sqrt{1837}}$

34. A radioactive material decays by simultaneous emissions of two particles with half lives of 1400 years and 700 years respectively. What will be the time after the which one third of the material remains ? (Take ln 3 = 1.1)

(1) 1110 years (2) 700 years
(3) 340 years (4) 740 years

35. A nucleus of mass M emits γ-ray photon of frequency 'ν'. The loss of internal energy by the nucleus is :
[Take 'c' as the speed of electromagnetic wave]

(1) $h\nu$ (2) 0
(3) $h\nu\left[1 - \frac{h\nu}{2Mc^2}\right]$ (4) $h\nu\left[1 + \frac{h\nu}{2Mc^2}\right]$

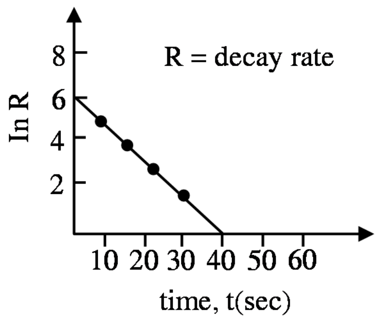
36. The radiation corresponding to $3 \rightarrow 2$ transition of a hydrogen atom falls on a gold surface to generate photoelectrons. These electrons are passed through a magnetic field of 5×10^{-4} T. Assume that the radius of the largest circular path followed by these electrons is 7 mm, the work function of the metal is : (Mass of electron $= 9.1 \times 10^{-31}$ kg)

(1) 1.36 eV (2) 1.88 eV
(3) 0.16 eV (4) 0.82 eV

37. An electron having de-Broglie wavelength λ is incident on a target in a X-ray tube. Cut-off wavelength of emitted X-ray is :

(1) 0 (2) $\frac{2m^2c^2\lambda^2}{h^2}$
(3) $\frac{2mc\lambda^2}{h}$ (4) $\frac{hc}{mc}$

38. For a certain radioactive process the graph between In R and t(sec) is obtained as shown in the figure. Then the value of half life for the unknown radioactive material is approximately :



(1) 9.15 sec (2) 6.93 sec
(3) 2.62 sec (4) 4.62 sec

39. A certain metallic surface is illuminated by monochromatic radiation of wavelength λ. The stopping potential for photoelectric current for this radiation is $3V_0$. If the same surface is illuminated with a radiation of wavelength 2λ, the stopping potential is V_0. The threshold wavelength of this surface for photoelectric effect is_____λ.

40. A radioactive substance decays to $\left(\frac{1}{16}\right)^{th}$ of its initial activity in 80 days. The half life of the radioactive substance expressed in days is____.

41. A nucleus with mass number 184 initially at rest emits an α-particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the α-particle.

(1) 5.0 MeV (2) 5.5 MeV
(3) 0.12 MeV (4) 5.38 MeV

42. An electron of mass m_e and a proton of mass m_P are accelerated through the same potential difference. The ratio of the de-Broglie wavelength associated with the electron to that with the proton is :-

(1) $\frac{m_P}{m_e}$ (2) 1
(3) $\sqrt{\frac{m_P}{m_e}}$ (4) $\frac{m_e}{m_p}$

43. What should be the order of arrangement of de-Broglie wavelength of electron (λ_e), an α-particle (λ_α) and proton (λ_p) given that all have the same kinetic energy ?

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

44. A particle of mass 4M at rest disintegrates into two particles of mass M and 3M respectively having non zero velocities. The ratio of de-Broglie wavelength of particle of mass M to that of mass 3M will be :

(1) 1 : 3 (2) 3 : 1
(3) 1 : $\sqrt{3}$ (4) 1 : 1

45. Some nuclei of a radioactive material are undergoing radioactive decay. The time gap between the instances when a quarter of the nuclei have decayed and when half of the nuclei have decayed is given as :
(where λ is the decay constant)

(1) $\frac{1}{2}\frac{\ln 2}{\lambda}$ (2) $\frac{\ln 2}{\lambda}$
(3) $\frac{2\ln 2}{\lambda}$ (4) $\frac{\ln\frac{3}{2}}{\lambda}$

46. The half-life of ^{198}Au is 3 days. If atomic weight of ^{198}Au is 198 g/mol then the activity of 2 mg of ^{198}Au is [in disintegration/second] :

(1) 2.67×10^{12} (2) 6.06×10^{18}
(3) 32.36×10^{12} (4) 16.18×10^{12}

47. When radiation of wavelength λ is incident on a metallic surface, the stopping potential of ejected photoelectrons is 4.8 V. If the same surface is illuminated by radiation of double the previous wavelength, then the stopping potential becomes 1.6 V. The threshold wavelength of the metal is :

(1) 2 λ (2) 4 λ (3) 8 λ (4) 6 λ

48. A light beam of wavelength 500 nm is incident on a metal having work function of 1.25 eV, placed in a magnetic field of intensity B. The electrons emitted perpendicular to the magnetic field B, with maximum kinetic energy are bent into circular arc of radius 30 cm. The value of B is _______ $\times 10^{-7}$ T.
Given hc = 20 $\times$ 10^{-26} J-m, mass of electron = 9×10^{-31} kg

49. From the given data, the amount of energy required to break the nucleus of aluminium $^{27}_{13}$Al is _____ x $\times$ 10^{-3} J.
Mass of neutron = 1.00866 u
Mass of proton = 1.00726 u
Mass of Aluminium nucleus = 27.18846 u
(Assume 1 u corresponds to x J of energy)
(Round off to the nearest integer)

50. The nuclear activity of a radioactive element becomes $\left(\frac{1}{8}\right)^{th}$ of its initial value in 30 years. The half-life of radioactive element is ______ years.

51. If 'f' denotes the ratio of the number of nuclei decayed (N_d) to the number of nuclei at t = 0 (N_0) then for a collection of radioactive nuclei, the rate of change of 'f' with respect to time is given as : [λ is the radioactive decay constant]

(1) $-\lambda(1 - e^{-\lambda t})$ (2) $\lambda(1 - e^{-\lambda t})$

(3) $\lambda e^{-\lambda t}$ (4) $-\lambda e^{-\lambda t}$

52. In Bohr's atomic model, the electron is assumed to revolve in a circular orbit of radius 0.5 Å. If the speed of electron is 2.2×16^6 m/s, then the current associated with the electron will be __________ $\times 10^{-2}$ mA. [Take π as $\frac{22}{7}$]

53. A radioactive sample has an average life of 30 ms and is decaying. A capacitor of capacitance 200 μF is first charged and later connected with resistor 'R'. If the ratio of charge on capacitor to the activity of radioactive sample is fixed with respect to time then the value of 'R' should be ______Ω.

54. A particle of mass 9.1×10^{-31} kg travels in a medium with a speed of 10^6 m/s and a photon of a radiation of linear momentum 10^{-27} kg m/s travels in vacuum. The wavelength of photon is _______ times the wavelength of the particle.

55. An electron and proton are separated by a large distance. The electron starts approaching the proton with energy 3 eV. The proton captures the electrons and forms a hydrogen atom in second excited state. The resulting photon is incident on a photosensitive metal of threshold wavelength 4000 Å. What is the maximum kinetic energy of the emitted photoelectron?

(1) 7.61 eV

(2) 1.41 eV

(3) 3.3 eV

(4) No photoelectron would be emitted

56. Consider the following statements :

A. Atoms of each element emit characteristics spectrum.

B. According to Bohr's Postulate, an electron in a hydrogen atom, revolves in a certain stationary orbit.

C. The density of nuclear matter depends on the size of the nucleus.

D. A free neutron is stable but a free proton decay is possible.

E. Radioactivity is an indication of the instability of nuclei.

Choose the correct answer from the options given below :

(1) A, B, C, D and E (2) A, B and E only

(3) B and D only (4) A, C and E only

57. The K_α X-ray of molybdenum has wavelength 0.071 nm. If the energy of a molybdenum atoms with a K electron knocked out is 27.5 keV, the energy of this atom when an L electron is knocked out will be ______ keV. (Round off to the nearest integer) [$h = 4.14 \times 10^{-15}$ eVs, $c = 3 \times 10^8$ ms^{-1}]

58. A particular hydrogen like ion emits radiation of frequency 2.92×10^{15} Hz when it makes transition from n = 3 to n = 1. The frequency in Hz of radiation emitted in transition from n = 2 to n = 1 will be :

(1) 0.44×10^{15} (2) 6.57×10^{15}

(3) 4.38×10^{15} (4) 2.46×10^{15}

59. In a photoelectric experiment ultraviolet light of wavelength 280 nm is used with lithium cathode having work function $\phi = 2.5$ eV. If the wavelength of incident light is switched to 400 nm, find out the change in the stopping potential. ($h = 6.63 \times 10^{-34}$ Js, $c = 3 \times 10^8$ ms^{-1})

(1) 1.3 V (2) 1.1 V

(3) 1.9 V (4) 0.6 V

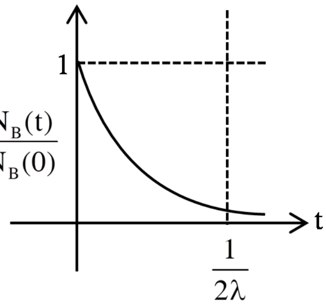
60. The de-Broglie wavelength of a particle having kinetic energy E is λ. How much extra energy must be given to this particle so that the de-Broglie wavelength reduces to 75% of the initial value ?

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

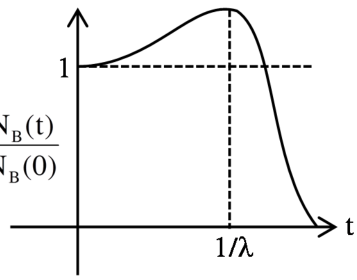
61. At time t = 0, a material is composed of two radioactive atoms A and B, where $N_A(0) = 2N_B(0)$. The decay constant of both kind of radioactive atoms is λ. However, A disintegrates to B and B disintegrates to C. Which of the following figures represents the evolution of $N_B(t) / N_B(0)$ with respect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

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

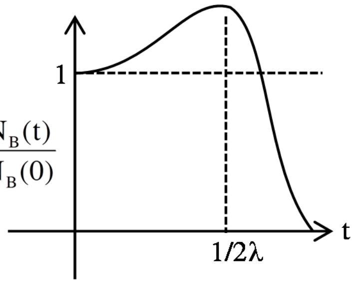
(1) $\dfrac{N_B(t)}{N_B(0)}$



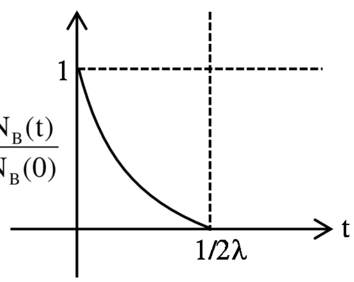
(2) $\dfrac{N_B(t)}{N_B(0)}$



(3) $\dfrac{N_B(t)}{N_B(0)}$



(4) $\dfrac{N_B(t)}{N_B(0)}$



62. There are 10^{10} radioactive nuclei in a given radioactive element, Its half-life time is 1 minute. How many nuclei will remain after 30 seconds ? $\left(\sqrt{2} = 1.414\right)$

(1) 2×10^{10} (2) 7×10^{9}
(3) 10^{5} (4) 4×10^{10}

63. In a photoelectric experiment, increasing the intensity of incident light :

(1) increases the number of photons incident and also increases the K.E. of the ejected electrons
(2) increases the frequency of photons incident and increases the K.E. of the ejected electrons.
(3) increases the frequency of photons incident and the K.E. of the ejected electrons remains unchanged
(4) increases the number of photons incident and the K.E. of the ejected electrons remains unchanged

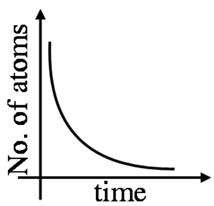
64. A monochromatic neon lamp with wavelength of 670.5 nm illuminates a photo-sensitive material which has a stopping voltage of 0.48 V. What will be the stopping voltage if the source light is changed with another source of wavelength of 474.6 nm?

(1) 0.96 V (2) 1.25 V
(3) 0.24 V (4) 1.5 V

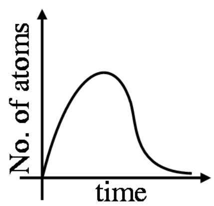
65. X different wavelengths may be observed in the spectrum from a hydrogen sample if the atoms are exited to states with principal quantum number n = 6 ? The value of X is _______.

66. A sample of a radioactive nucleus A disintegrates to another radioactive nucleus B, which in turn disintegrates to some other stable nucleus C. Plot of a graph showing the variation of number of atoms of nucleus B vesus time is : (Assume that at t = 0, there are no B atoms in the sample)

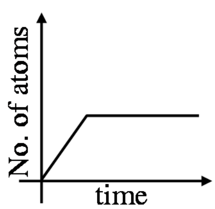
(1)



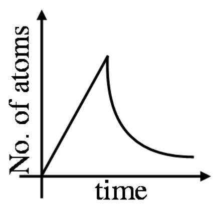
(2)



(3)



(4)



67. A moving proton and electron have the same de-Broglie wavelength. If K and P denote the K.E. and momentum respectively. Then choose the correct option :

(1) $K_p < K_e$ and $P_p = P_e$
(2) $K_p = K_e$ and $P_p = P_e$
(3) $K_p < K_e$ and $P_p < P_e$
(4) $K_p > K_e$ and $P_p = P_e$

68. A free electron of 2.6 eV energy collides with a H^+ ion. This results in the formation of a hydrogen atom in the first excited state and a photon is released. Find the frequency of the emitted photon. ($h = 6.6 \times 10^{-34}$ Js)

(1) 1.45×10^{16} MHz (2) 0.19×10^{15} MHz
(3) 1.45×10^{9} MHz (4) 9.0×10^{27} MHz

69. Consider two separate ideal gases of electrons and protons having same number of particles. The temperature of both the gases are same. The ratio of the uncertainty in determining the position of an electron to that of a proton is proportional to :-

(1) $\left(\frac{m_p}{m_e}\right)^{3/2}$ (2) $\sqrt{\frac{m_e}{m_p}}$ (3) $\sqrt{\frac{m_p}{m_e}}$ (4) $\frac{m_p}{m_e}$

70. The temperature of an ideal gas in 3-dimensions is 300 K. The corresponding de-Broglie wavelength of the electron approximately at 300 K, is :

[m_e = mass of electron = 9×10^{-31} kg
h = Planck constant = 6.6×10^{-34} Js
k_B = Boltzmann constant = 1.38×10^{-23} JK^{-1}]

(1) 6.26 nm (2) 8.46 nm
(3) 2.26 nm (4) 3.25 nm

71. The half life period of 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) x and y have same decay rate initially and later on different decay rate.
(4) x and y decay at the same rate always.

SOLUTION

1. Official Ans. by NTA (4)

Sol. If linear momentum are equal then wavelength also equal

$$p = \frac{h}{\lambda}, E = \frac{hc}{\lambda}$$

On decreasing wavelength, momentum and energy of photon increases.

2. Official Ans. by NTA (3)

Sol. A $\rightarrow$ Series limit of Lymen series.

B $\rightarrow$ Third member of Balmer series.

C $\rightarrow$ Second member of Paschen series.

3. Official Ans. by NTA (2)

Sol. $\lambda = \frac{h}{mv}$

$\lambda_P = \lambda_\alpha$

$m_P v_P = m_\alpha v_\alpha$

$m_P v_P = 4m_p v_\alpha$ $\quad$ $(m_\alpha = 4m_P)$

$\frac{v_P}{v_\alpha} = 4$ $\quad$ (Option 2) is correct

4. Official Ans. by NTA (1)

Sol. $\lambda_{min} = \frac{1240}{\Delta V}(nm)$

$$= \frac{1240}{1.24 \times 10^6} = 10^{-3} nm$$

Option (1) is correct.

5. Official Ans. by NTA (2)

Sol. $\Delta E = 13.6\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = h\nu$

It is maximum if $n_1 = 1$ and $n_2 = 2$

n = 5 .... –0.544 eV

n = 4 .... –0.850 eV

n = 3 .... –1.511 eV

n = 2 .... –3.4 eV

n = 1 .... –13.6 eV

Option (2) is correct.

6. Official Ans. by NTA (4)

Sol. $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m\,qV}}$

$$\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha q_\alpha}{m_p q_p}} = \sqrt{\frac{4m_p \times 2e}{m_p \times e}} = \sqrt{8} = 2\sqrt{2}$$

$= 2\sqrt{2}$

$\frac{\lambda_p}{\lambda_\alpha} = 2 \times 1.4 = 2.8$

7. Official Ans. by NTA (3)

Sol. $T_x = t$; $T_y = 2t$

$3T_y = 6t$,

$N_1' = N_2'$

$N_1 e^{-\lambda_1 6t} = N_2 e^{-\lambda_2 6t}$

$$\frac{N_1}{N_2} = e^{(\lambda_1 - \lambda_2)6t} = e^{ln2\left(\frac{1}{t} - \frac{1}{2t}\right)\times 6t} = e^{(ln2)\times 3} = e^{ln8} = 8$$

$\frac{N_1}{N_2} = \frac{8}{1}$

8. Official Ans. by NTA (4)

Sol. $\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$

$\lambda = 121.8$ nm.

9. Official Ans. by NTA (1)

Sol. $$\frac{\lambda_e}{\lambda_p} = \frac{\frac{h}{m_e v}}{\frac{h}{m_p v}} = 1836$$

10. Official Ans. by NTA (3)

Sol. $\frac{hc}{\lambda} = \phi + eV_s$

$\frac{1240}{491} = \phi + 0.71.$ $\quad$ ...(1)

$\frac{1240}{\lambda} = \phi + 1.43$ $\quad$ ...(2)

$\therefore \lambda = 382$ nm Ans.

11. Official Ans. by NTA (10)

Sol. $\frac{hc}{\lambda} = mc^2$

$m = \frac{h}{c\lambda}$

12. Official Ans. by NTA (3)

Sol. $\frac{1}{\lambda_1} = R\left[\frac{1}{1^2} - \frac{1}{4^2}\right]$

$\frac{1}{\lambda_2} = R\left[\frac{1}{3^2} - \frac{1}{4^2}\right]$

$$\frac{\lambda_1}{\lambda_2} = \frac{\left[\frac{1}{9} - \frac{1}{16}\right]}{\left[1 - \frac{1}{16}\right]} = \frac{7}{9 \times 15}$$

$\frac{\lambda_1}{\lambda_2} = \frac{7}{135}$

Ans. (3)

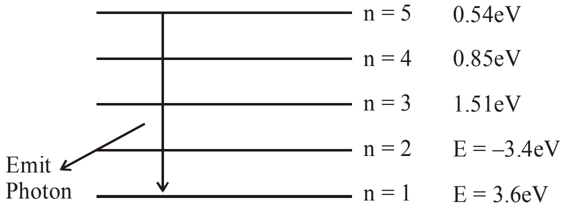
13. Official Ans. by NTA (2)

Sol. Resolving power $\propto \frac{1}{\lambda}$

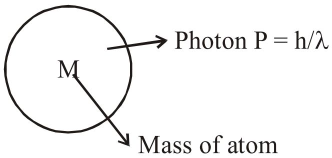
Since wavelength of electron is much less than visible light, its resolving power will be much more.

14. Official Ans. by NTA (1)

Sol.



(ΔE) Releases when photon going from n = 5 to n = ΔE = (13.6 – 0.54) eV = 13.06 eV.



$P_i = P_f$ (By linear momentum conservation)

$$0 = \frac{h}{\lambda} - Mv = V_{Recoil} = \frac{h}{\lambda M} \quad \ldots(i)$$

$$\& \ \ \Delta E = \frac{hc}{\lambda} = \frac{hc}{\lambda M} \times M \Rightarrow McV_{Recoil}$$

$$V_{Recoil} = \frac{\Delta E}{Mc} = \frac{13.06 \times 1.6 \times 10^{-19}}{1.67 \times 10^{-27} \times 3 \times 10^{8}} = 4.17 \text{ m / sec}$$

15. Official Ans. by NTA (3)

Sol. Let initial activity be A_0

$$A = A_0 e^{-\lambda t_1} \quad \ldots(i)$$

$$\frac{A}{5} = A_0 e^{-\lambda t_2} \quad \ldots(ii)$$

(i) ÷ (ii)

$$5 = e^{\lambda(t_2 - t_1)}$$

$$\lambda = \frac{\ell n 5}{t_2 - t_1} = \frac{1}{\tau}\ ; \quad \tau = \frac{t_2 - t_1}{\ell n 5}$$

16. Official Ans. by NTA (1)

Sol. $KE_{max} = h\nu - \phi$

$$\frac{1}{2} mv^2 = h\nu - \phi$$

$$v = \sqrt{\frac{2(h\nu - \phi)}{m}}$$

Given $h\nu_1 = 2\phi$

$h\nu_2 = 10\ \phi$

$$\therefore \frac{v_1}{v_2} = \sqrt{\frac{h\nu_1 - \phi}{h\nu_2 - \phi}}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{2\phi - \phi}{10\phi - \phi}} = \frac{1}{3}$$

17. Official Ans. by NTA (4)

Sol. Stopping potential changes linearly with frequency of incident radiation.

18. Official Ans. by NTA (15)

Sol. For 1st line

$$\frac{1}{\lambda_1} = Rz^2 \left(\frac{1}{2^2} - \frac{1}{3^2} \right)$$

$$\frac{1}{\lambda_1} = Rz^2 \frac{5}{36} \quad \ldots..(i)$$

For 3rd line

$$\frac{1}{\lambda_3} = Rz^2 \left(\frac{1}{2^2} - \frac{1}{5^2} \right)$$

$$\frac{1}{\lambda_3} = Rz^2 \frac{21}{100} \quad \ldots..(ii)$$

(ii) + (i)

$$\frac{\lambda_1}{\lambda_3} = \frac{21}{100} \times \frac{36}{5} = 1.512 = 15.12 \times 10^{-1}$$

$x \approx 15$

19. Official Ans. by NTA (4)

Sol. $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2mqV}}$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{m_2}{m_1}}$$

$$\frac{\lambda_e}{\lambda_P} = \sqrt{\frac{m_P}{m_e}} = \sqrt{1831.4} = 42.79$$

20. Official Ans. by NTA (2)

Sol. $A = \lambda N$

$N = nN_A \qquad \left(t_{1/2} = \frac{\ln 2}{\lambda} \right)$

$$N = \left(\frac{1.5 \times 10^{-3}}{198} \right) N_A$$

$$A = \left(\frac{\ln 2}{t_{1/2}} \right) N$$

1 Curie = 3.7×10^{10} Bq

A = 365 Bq

21. Official Ans. by NTA (2)

Sol. $N_1 = N_0 e^{-\lambda t_1}$

$\frac{N_1}{N_0} = e^{-\lambda t_1}$

$0.67 = e^{-\lambda t_1}$

$\ln(0.67) = -\lambda t_1$

$N_2 = N_0 e^{-\lambda t_2}$

$\frac{N_2}{N_0} = e^{-\lambda t_2}$

$0.33 = e^{-\lambda t_2}$

$\ln(0.33) = -\lambda t_2$

$\ln(0.67) - \ln(0.33) = \lambda t_1 - \lambda t_2$

$\lambda(t_1 - t_2) = \ln\left(\frac{0.67}{0.33}\right)$

$\lambda(t_1 - t_2) \cong \ln 2$

$t_1 - t_2 \simeq \frac{\ln 2}{\lambda} = t_{1/2}$

Half life = $t_{1/2}$ = 20 minutes.

22. Official Ans. by NTA (2)

Sol. We know velocity of electron in n^{th} shell of hydrogen atom is given by

$v = \frac{2\pi kZe^2}{nh} \therefore v \propto \frac{1}{n}$

23. Official Ans. by NTA (2)

Sol. $\lambda_1 = \frac{h}{\sqrt{2mE}}$; $\lambda_2 = \frac{hc}{E}$; $\frac{\lambda_1}{\lambda_2} = \frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$

24. Official Ans. by NTA (2)

Sol. Energy of H-atom is $E = -13.6\ Z^2/n^2$

for H-atom Z = 1 & for ground state, n = 1

$\Rightarrow E = -13.6 \times \frac{1^2}{1^2} = -13.6$ eV

Now for carbon atom (single ionised), Z = 6

$E = -13.6\ \frac{Z^2}{n^2} = -13.6$ (given)

$\Rightarrow n^2 = 6^2 \Rightarrow n = 6$

25. Official Ans. by NTA (25)

Sol. $F = \frac{IA}{C}$

$I = \frac{FC}{A} = \frac{2.5\times10^{-6}\times3\times10^{8}}{30} = 25\ \text{W/cm}^2$

26. Official Ans. by NTA (4)

Sol. (4) Conceptual

27. Official Ans. by NTA (1)

Sol. (1) $\frac{1}{2}mv_1^2 = hf_1 - \phi$

$\frac{1}{2}mv_2^2 = hf_2 - \phi$

$v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$

28. Official Ans. by NTA (3)

Sol. $F = \frac{-dU}{dr} = -4U_0 r^3 = \frac{mv^2}{r}$

$mv^2 = 4U_0 r^4$

$v \propto r^2$

$mvr = \frac{nh}{2\pi}$

$r^3 \propto n$

$r \propto n1/3 = 3$

29. Official Ans. by NTA (2)

Sol. $E \propto \frac{1}{r}$ $r \propto \frac{1}{m}$

$E \propto m$

Ionization potential = $13.6 \times \frac{(\text{Mass}_\mu)\text{eV}}{(\text{Mass}_e)}$

= 13.6 × 207 eV = 2815.2 eV

30. Official Ans. by NTA (4)

Sol. $\lambda = \frac{h}{p}$

$\frac{\lambda_p}{\lambda_e} = \frac{p_e}{p_p} = \frac{m_e v_e}{m_p v_p}$

$2 = \frac{m_e}{m_p}\left(\frac{v_e}{4v_e}\right)$

$\therefore m_p = \frac{m_e}{8}$ Ans. (4)

31. Official Ans. by NTA (4)

Sol. $r = \frac{mv}{qB} = \frac{p}{qB}$ $\qquad \frac{m_\alpha}{m_p} = 4$

$$\frac{r_p}{r_\alpha} = \frac{p_p}{q_p}\frac{q_\alpha}{p_\alpha} = \frac{2}{1}$$

$$\frac{p_p}{p_\alpha} = \frac{2q_p}{q_\alpha} = 2\left(\frac{1}{2}\right)$$

$$\frac{p_p}{p_\alpha} = 1$$

$$\frac{K_p}{K_\alpha} = \frac{p_p^2}{p_\alpha^p}\frac{m_\alpha}{m_p} = (1)\,(4)$$

32. Official Ans. by NTA (2)

Sol. It is possible only inside the nucleus and not otherwise.

33. Official Ans. by NTA (1)

Sol. Resolving power (RP) $\propto \frac{1}{\lambda}$

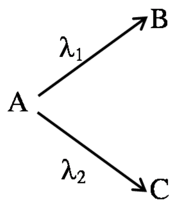
$$\lambda = \frac{h}{P} = \frac{h}{mv}$$

So (RP) $\propto \frac{mv}{h}$

RP $\propto$ P
RP $\propto$ mv
RP $\propto$ m

34. Official Ans. by NTA (4)

Sol.



Given $\lambda_1 = \frac{\ell n2}{700}$ / year , $\lambda_2 = \frac{\ell n2}{1400}$ / year

$$\therefore \lambda_{net} = \lambda_1 + \lambda_2 = \ell n2\left[\frac{1}{700} + \frac{1}{1400}\right]$$

$$= \frac{3\ell n2}{1400} \text{ / year}$$

Now, Let initial no. of radioactive nuclei be No.

$$\therefore \frac{N_0}{3} = N_0 e^{-\lambda_{net} t}$$

$$\Rightarrow \ell n\frac{1}{3} = -\lambda_{net} t$$

$$\Rightarrow 1.1 = \frac{3 \times 0.693}{1400} t \Rightarrow t \approx 740 \text{ years}$$

Hence option 4.

35. Official Ans. by NTA (4)

Sol. Energy of γ ray $[E_\gamma] = h\nu$

Momentum of γ ray $\left[P_\gamma\right] = \frac{h}{\lambda} = \frac{h\nu}{C}$

Total momentum is conserved.

$$\vec{P}_\gamma + \vec{P}_{Nu} = 0$$

Where $\vec{P}_{Nu}$ = Momentum of decayed nuclei

$$\Rightarrow P_\gamma = P_{Nu}$$

$$\Rightarrow \frac{h\nu}{C} = P_{Nu}$$

$\Rightarrow$ K.E. of nuclei

$$= \frac{1}{2}Mv^2 = \frac{(P_{Nu})^2}{2M} = \frac{1}{2M}\left[\frac{h\nu}{C}\right]^2$$

Loss in internal energy = E_γ + K.E_{Nu}

$$= h\nu + \frac{1}{2M}\left[\frac{h\nu}{C}\right]^2$$

$$= h\nu\left[1 + \frac{h\nu}{2MC^2}\right]$$

36. Official Ans. by NTA (4)

Sol.
1.51 ———————— n = 3
3.4 ———————— n =
13.6 ———————— n = 1

$3 \rightarrow 2 \Rightarrow 1.89$ eV
5×10^{-4} T $\qquad$ r = 7mm

$$r = \frac{mv}{qB} \Rightarrow mv = qrB \Rightarrow E = \frac{P^2}{2m} = \frac{(qRB)^2}{2m}$$

$$= \frac{\left(1.6\times10^{-19}\times7\times10^{-3}\times5\times10^{-4}\right)^2}{2\times9.1\times10^{-31}\text{Joule}}$$

$$= \frac{3136\times10^{-52}}{18.2\times10^{-31}\times1.6\times10^{-19}}\text{eV}$$

= 1.077 eV

We know work function = energy incident – $(KE)_{electron}$

ϕ = 1.89 – 1.077 = 0.813 eV

37. Official Ans. by NTA (3)

Sol. $\lambda = \frac{h}{mv}$

kinetic energy, $\frac{P^2}{2m} = \frac{h^2}{2m\lambda^2} = \frac{hc}{\lambda_c}$

$\lambda_C = \frac{2m\lambda^2 c}{h}$

38. Official Ans. by NTA (4)

Sol. $R = R_0 e^{-\lambda t}$

$\ell nR = \ell nR_0 - \lambda t$

$-\lambda$ is slope of straight line

$\lambda = \frac{3}{20}$

$t_{1/2} = \frac{\ell n2}{\lambda} = 4.62$

39. Official Ans. by NTA (4)

Sol. KE = $\frac{hc}{\lambda} - \phi$ hc

$e(3V_0) = \frac{hc}{\lambda_0} - \phi$ …(i)

$eV_0 = \frac{hc}{2\lambda_0} - \phi$ …(ii)

Using (i) & (ii)

$\phi = \frac{hc}{4\lambda_0} = \frac{hc}{\lambda_t}$ $\lambda_t = 4\lambda_0$

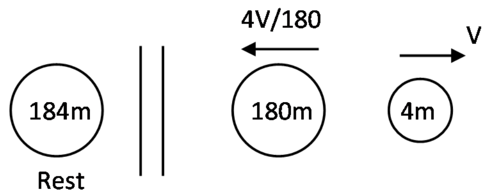
40. Official Ans. by NTA (20)

Sol. $N_0 \xrightarrow{t_{\frac{1}{2}}} \frac{N_0}{2} \xrightarrow{t_{\frac{1}{2}}} \frac{N_0}{4} \xrightarrow{t_{\frac{1}{2}}} \frac{N_0}{8} \xrightarrow{t_{\frac{1}{2}}} \frac{N_0}{16}$

$4 \times t_{1/2} = 80$

$t_{1/2} = 20$ days

41. Official Ans. by NTA (4)



Sol.

$\frac{1}{2}(4m)v^2 + \frac{1}{2}(180m)\left(\frac{4v}{180}\right)^2 = 5.5\text{MeV}$

$\Rightarrow$ $\frac{1}{2}4mv^2\left[1 + 45\left(\frac{4}{180}\right)^2\right] = 5.5\text{MeV}$

$\Rightarrow$ $K.E_\alpha = \frac{5.5}{1 + 45.\left(\frac{4}{180}\right)^2}\text{MeV}$

$K.E_\alpha = 5.38\text{MeV}$

42. Official Ans. by NTA (3)

Sol. KE = $e\Delta V$

$\lambda_e = \frac{h}{\sqrt{2m_e(e\Delta V)}}$

$\lambda_P = \frac{h}{\sqrt{2m_p(e\Delta V)}} \Rightarrow \frac{\lambda_e}{\lambda_P} = \sqrt{\frac{m_P}{m_e}}$

43. Official Ans. by NTA (3)

Sol. $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}} \propto \frac{1}{\sqrt{m}}$

$m_\alpha > m_p > m_e$

so $\lambda_e > \lambda_p > \lambda_\alpha$

44. Official Ans. by NTA (4)

Sol. $\lambda = \frac{h}{p}$

both the particles will move with momentum same in magnitude & opposite in direction.

So De-Broglie wavelength of both will be same i.e. ratio 1 : 1

45. Official Ans. by NTA (4)

Sol. $\frac{3N_0}{4} = N_0 e^{-\lambda t_1}$

$\frac{N_0}{2} = N_0 e^{-\lambda t_2}$

$\ln(3/4) = -\lambda t_1$ .....(i)

$\ln(1/2) = -\lambda t_2$ .....(i)

$\ln(3/4) - \ln(1/2) = \lambda(t_2 - t_1)$ .....(i)

$\Delta t = \frac{\ln(3/2)}{\lambda}$

46. Official Ans. by NTA (4)

Sol. $A = \lambda N$

$\lambda = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{3 \times 24 \times 60 \times 60}\sec^{-1} = 2.67 \times 10^{-6}\sec^{-1}$

N = Number of atoms in 2 mg Au

$= \frac{2 \times 10^{-3}}{198} \times 6 \times 10^{23} = 6.06 \times 10^{15}$

$A = \lambda N = 1.618 \times 10^{13} = 16.18 \times 10^{12}$ dps

47. Official Ans. by NTA (2)

Sol. $V_S = h\nu - \phi$

$4.8 = \frac{hc}{\lambda} - \phi$ … (i)

$1.6 = \frac{hc}{2\lambda} - \phi$ … (ii)

Using above equation (i) – (ii)

$3.2 = \frac{hc}{\lambda} - \frac{hc}{2\lambda}$

$3.2 = \frac{hc}{2\lambda}$ … (iii)

$\left[\lambda = \frac{hc}{6.4}\right]$

Put in equation (ii)

$\phi = 1.6$

$\frac{hc}{\lambda_{th}} = 1.6$

$\lambda_{th} = \frac{hc}{1.6} = \left(\frac{hc}{6.4}\right) \times 4 = 4\lambda$

48. Official Ans. by NTA (125)

Sol. By photoelectric equation

$\frac{hc}{\lambda} - \phi = k_{max}$

$k_{max} = \frac{1240}{500} - 1.25 \approx 1.25$

$r = \frac{\sqrt{2mk}}{eB}$

$B = \frac{\sqrt{2mk}}{er}$ = 125×10^{-7}T

49. Official Ans. by NTA (27)

Sol. $\Delta m = (Zm_P + (A - Z)m_n) - M_{A\ell}$

$= (13 \times 1.00726 + 14 \times 1.00866) - 27.18846$

$= 27.21562 - 27.18846$

$= 0.02716$ u

$E = 27.16 \text{ x} \times 10^{-3}$ J

50. Official Ans. by NTA (10)

Sol. $A = A_0e^{-\lambda t}$

$\frac{A_0}{8} = A_0e^{-\lambda t} \Rightarrow \lambda t = \ln 8$

$\lambda t = 3\ln 2$

$\frac{\ln 2}{\lambda} = \frac{t}{3} = \frac{30}{3}$ = 10 years

51. Official Ans. by NTA (3)

Sol. $N = N_0e^{-\lambda t}$

$N_d = N_0 - N$

$N_d = N_0 (1 - e^{-\lambda t})$

$\frac{N_d}{N_0} = f = 1 - e^{-\lambda t}$

$\frac{df}{dt} = \lambda e^{-\lambda t}$

52. Official Ans. by NTA (112)

Sol. $I = \frac{e}{T} = \frac{e\omega}{2\pi} = \frac{eV}{2\pi r}$

$I = \frac{1.6 \times 10^{-19} \times 2.2 \times 10^6 \times 7}{2 \times 22 \times 0.5 \times 10^{-10}}$

= 1.12 mA

112×10^{-2} mA

53. Official Ans. by NTA (150)

Sol. $T_m = 30$ ms

$C = 200\ \mu F$

$\frac{q}{N} = \frac{Q_0e^{-t/RC}}{N_0e^{-\lambda t}} = \frac{Q_0}{N_0}e^{t\left(\lambda - \frac{1}{RC}\right)}$

Since q/N is constant hence

$\lambda = \frac{1}{RC}$

$R = \frac{1}{\lambda C} = \frac{T_m}{C} = \frac{30 \times 10^{-3}}{200 \times 10^{-6}} = 150\ \Omega$

54. Official Ans. by NTA (910)

Sol. For photon $\lambda_1 = \frac{h}{P} = \frac{6.6 \times 10^{-34}}{10^{-27}}$

For particle $\lambda_2 = \frac{h}{mv} = \frac{6.6 \times 10^{-34}}{9.1 \times 10^{-31} \times 10^6}$

$\therefore \frac{\lambda_1}{\lambda_2} = 910$

55. Official Ans. by NTA (2)

Sol. Initially, energy of electron = +3eV

finally, in 2nd excited state,

energy of electron = $-\frac{(13.6\text{eV})}{3^2}$

$= -1.51$eV

Loss in energy is emitted as photon,

So, photon energy $\frac{hc}{\lambda}$ = 4.51 eV

Now, photoelectric effect equation

$KE_{max} = \frac{hc}{\lambda} - \phi = 4.51 - \left(\frac{hc}{\lambda_{th}}\right)$

$= 4.51 \text{ eV} - \frac{12400 \text{ eVÅ}}{4000\text{ Å}}$

56. Official Ans. by NTA (2)

Sol. (A) True, atom of each element emits characteristic spectrum.

(B) True, according to Bohr's postulates

$mvr = \frac{nh}{2\pi}$ and hence electron resides into orbits of specific radius called stationary orbits.

(C) False, density of nucleus is constant

(D) False, A free neutron is unstable decays into proton and electron and antineutrino.

(E) True unstable nucleus show radioactivity.

57. Official Ans. by NTA (10)

Sol. $E_{k_\alpha} = E_k - E_L$

$$\frac{hc}{\lambda_{k_\alpha}} = E_k - E_L$$

$$E_L = E_k - \frac{hc}{\lambda_{k_\alpha}}$$

$$= 27.5\text{ KeV} - \frac{12.42\times10^{-7}\text{ eVm}}{0.071\times10^{-9}\text{m}}$$

E_L = (27.5 – 17.5) keV = 10 keV = 1.41 eV

58. Official Ans. by NTA (4)

Sol. $nf_1 = k\left(\frac{1}{1}-\frac{1}{3^2}\right)$

$$nf_2 = k\left(1-\frac{1}{2^2}\right)$$

$$\frac{f_1}{f_2} = \frac{8/9}{3/4} \Rightarrow f_2 = 2.46\times10^{15}$$

Option (4)

59. Official Ans. by NTA (1)

Sol. $KE_{max} = eV_S = \frac{hc}{\lambda} - \phi$

$$\Rightarrow eV_S = \frac{1240}{280} - 2.5 = 1.93\text{eV}$$

$$\rightarrow V_{S_1} = 1.93\text{V} \dots \text{(i)}$$

$$\rightarrow eV_{S_2} = \frac{1240}{400} - 2.5 = 0.6\text{eV}$$

$$\Rightarrow V_{S_2} = 0.6\text{V} \dots \text{(ii)}$$

$$\Delta V = V_{S_1} - V_{S_2} = 1.93 - 0.6 = 1.33\text{V}$$

Option (1)

60. Official Ans. by NTA (2)

Sol. $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$, $mv = \sqrt{2mE}$

$$\lambda \propto \frac{1}{\sqrt{E}}$$

$$\frac{\lambda_2}{\lambda_1} = \sqrt{\frac{E_1}{E_2}} = \frac{3}{4},\ \lambda_2 = 0.75\,\lambda_1$$

$$\frac{E_1}{E_2} = \left(\frac{3}{4}\right)^2$$

$$E_2 = \frac{16}{9}E_1 = \frac{16}{9}E \qquad (E_1 = E)$$

Extra energy given $= \frac{16}{9}E - E = \frac{7}{9}E$

Ans. 2

61. Official Ans. by NTA (3)

Sol. $A \rightarrow B,\ B \rightarrow C$

$$\frac{dN_B}{dt} = \lambda N_A - \lambda N_B$$

$$\frac{dN_B}{dt} = 2\lambda N_{B_0} e^{-\lambda t} - \lambda N_B$$

$$e^{-\lambda t}\left(\frac{dN_B}{dt} + \lambda N_B\right) = 2\lambda N_{B_0} e^{-\lambda t} \times e^{\lambda t}$$

$\frac{d}{dt}\left(N_B e^{\lambda t}\right) = 2\lambda N_{B_0}$, on integrating

$$N_B e^{\lambda t} = 2\lambda t N_{B_0} + N_{B_0}$$

$$N_B = N_{B_0}[1 + 2\lambda t]e^{-\lambda t}$$

$$\frac{dN_B}{dt} = 0 \text{ at } -\lambda[1+2\lambda t)e^{-\lambda t} + 2\lambda e^{-\lambda t} = 0$$

$$N_{B_{max}} \text{ at } t = \frac{1}{2\lambda}$$

62. Official Ans. by NTA (2)

Sol. $\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$

$$\frac{N}{10^{10}} = \left(\frac{1}{2}\right)^{\frac{30}{60}}$$

$$\Rightarrow N = 10^{10} \times \left(\frac{1}{2}\right)^{\frac{1}{2}} = \frac{10^{10}}{\sqrt{2}} \approx 7 \times 10^9$$

63. Official Ans. by NTA (4)

Sol. → Increasing intensity means number of incident photons are increased.

→Kinetic energy of ejected electrons depend on the frequency of incident photons, not the intensity.

64. Official Ans. by NTA (2)

Sol. $kE_{max} = \dfrac{hc}{\lambda_i} + \phi$

or $eV_o = \dfrac{hc}{\lambda_i} + \phi$

when $\lambda_i = 670.5$ nm ; $V_o = 0.48$
when $\lambda_i = 474.6$ nm ; $V_o = ?$

So, $e(0.48) = \dfrac{1240}{670.5} + \phi$ ...(1)

$e(V_o) = \dfrac{1240}{474.6} + \phi$ ...(2)

(2) – (1)

$$e(V_o - 0.48) = 1240\left(\frac{1}{474.6} - \frac{1}{670.5}\right)eV$$

$$V_o = 0.48 + 1240\left(\frac{670.5 - 474.6}{474.6 \times 670.5}\right) \text{ Volts}$$

$V_o = 0.48 + 0.76$
$V_o = 1.24\text{ V} \simeq 1.25\text{ V}$

65. Official Ans. by NTA (15)

Sol. No. of different wavelengths $= \dfrac{n(n-1)}{2}$

$= \dfrac{6\times(6-1)}{2} = \dfrac{6\times 5}{2} = 15$

66. Official Ans. by NTA (2)

Sol. $A \longrightarrow B \longrightarrow C$ (stable)

Initially no. of atoms of B = 0 after t = 0, no. of atoms of B will starts increasing & reaches maximum value when rate of decay of B = rate of formation of B.

After that maximum value, no. of atoms will starts decreasing as growth & decay both are exponential functions, so best possible graph is (2)

Option (2)

67. Official Ans. by NTA (1)

Sol. $\lambda_P = \dfrac{h}{P_P}$ $\lambda_e = \dfrac{h}{P_e}$

$\because \lambda_P = \lambda_e$

$\Rightarrow P_P = P_e$

$(K)_P = \dfrac{P_P^2}{2m_P}$

$(K)_e = \dfrac{P_e^2}{2m_e}$

$K_P < K_e$ as $m_P > m_e$ Option (1)

68. Official Ans. by NTA (3)

Sol. For every large distance P.E. = 0

& total energy = 2.6 + 0 = 2.6 eV

Finally in first excited state of H atom total energy = –3.4 eV

Loss in total energy = 2.6 – (–3.4)
= 6eV

It is emitted as photon

$\lambda = \dfrac{1240}{6} = 206$ nm

$f = \dfrac{3\times 10^8}{206\times 10^{-9}} = 1.45 \times 10^{15}$ Hz

$= 1.45 \times 10^9$ Hz

69. Official Ans. by NTA (3)

Sol. $\Delta x.\Delta p \geq \dfrac{h}{4\pi}$

$\Delta x = \dfrac{h}{4\pi m \Delta v}$ $v = \sqrt{\dfrac{3KT}{m}}$

$\dfrac{\Delta x_e}{\Delta x_p} = \sqrt{\dfrac{m_p}{m_e}}$

70. Official Ans. by NTA (1)

Sol. De-Broglie wavelength

$\lambda = \dfrac{h}{mv} = \dfrac{h}{\sqrt{2mE}}$

Where E is kinetic energy

$E = \dfrac{3kT}{2}$ for gas

$$\lambda = \frac{h}{\sqrt{3mkT}} = \frac{6.6\times 10^{-34}}{\sqrt{3\times 9\times 10^{-31}\times 1.38\times 10^{-23}\times 300}}$$

$\lambda = 6.26 \times 10^{-9}$ m = 6.26 nm

Option (1)

71. Official Ans. by NTA (2)

Sol. $(t_{1/2})_x = (\tau)_y$

$\Rightarrow \dfrac{\ell n 2}{\lambda_x} = \dfrac{1}{\lambda_y} \Rightarrow \lambda_x = 0.693\ \lambda_y$

Also initially $N_x = N_y = N_0$

Activity $A = \lambda N$

As $\lambda_x < \lambda_y \Rightarrow A_x < A_y$

$\Rightarrow$ y will decay faster than x

Option (2)