MODERN PHYSICS

1. The time period of revolution of electron in its ground state orbit in a hydrogen atom is 1.6×10^{-16} s. The frequency of revolution of the electron in its first excited state (in s^{-1}) is:

(1) 6.2×10^{15} (2) 5.6×10^{12}

(3) 7.8×10^{14} (4) 1.6×10^{14}

2. A beam of electromagnetic radiation of intensity 6.4×10^{-5} W/cm^2 is comprised of wavelength, λ = 310 nm. It falls normally on a metal (work function φ = 2eV) of surface area of 1 cm^2. If one in 10^3 photons ejects an electron, total number of electrons ejected in 1 s is 10^x. (hc=1240 eVnm, 1eV=1.6×10^{-19} J), then x is____.

3. The activity of a radioactive sample falls from 700 s^{-1} to 500 s^{-1} in 30 minutes. Its half life is close to :

(1) 66 min (2) 52 min

(3) 72 min (4) 62 min

4. An electron (of mass m) and a photon have the same energy E in the range of a few eV. The ratio of the de-Broglie wavelength associated with the electron and the wavelength of the photon is (c = speed of light in vacuum)

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

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

5. When photon of energy 4.0 eV strikes the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV end de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photon of energy 4.50 eV is $T_B = (T_A - 1.5)$ eV. If the de-Broglie wavelength of these photoelectrons $\lambda_B = 2\lambda_A$, then the work function of metal B is :

(1) 3eV (2) 2eV

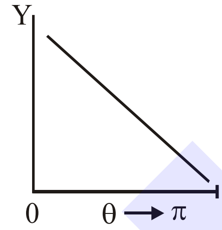
(3) 4eV (4) 1.5eV

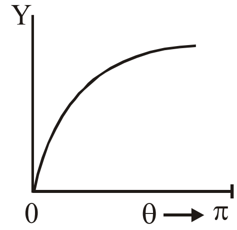
6. The graph which depicts the results of Rutherform gold foil experiment with α-particales is :

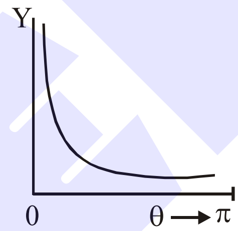
θ : Scattering angle

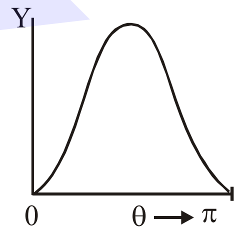
Y : Number of scattered α-particles detected

(Plots are schematic and not to scale)

(1) 

(2) 

(3) 

(4) 

7. An electron (mass m) with initial velocity $\vec{v} = v_0\hat{i} + v_0\hat{j}$ is in an electric field $\vec{E} = -E_0\hat{k}$. If λ_0 is initial de-Broglie wavelength of electron, its de-Broglie wave length at time t is given by :

(1) $\frac{\lambda_0\sqrt{2}}{\sqrt{1+\frac{e^2E^2t^2}{m^2v_0^2}}}$ (2) $\frac{\lambda_0}{\sqrt{2+\frac{e^2E^2t^2}{m^2v_0^2}}}$

(3) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E^2t^2}{2m^2v_0^2}}}$ (4) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$

8. The first member of the Balmer series of hydrogen atom has a wavelength of 6561 Å. The wavelength of the second member of the Balmer series (in nm) is:

9. A particle moving with kinetic energy E has de Broglie wavelength λ. If energy ΔE is added to its energy, the wavelength become $\lambda/2$. Value of ΔE, is :

(1) 2E (2) E (3) 3E (4) 4E

10. Radiation, with wavelength 6561 Å falls on a metal surface to produce photoelectrons. The electrons are made to enter a uniform magnetic field of 3×10^{-4} T. If the radius of the largest circular path followed by the electrons is 10 mm, the work function of the metal is close to :
(1) 1.8eV (2) 1.1eV (3) 0.8eV (4) 1.6eV

11. The energy required to ionise a hydrogen like ion in its ground state is 9 Rydbergs. What is the wavelength of the radiation emitted when the electron in this ion jumps from the second excited state to the ground state ?
(1) 35.8 nm (2) 24.2 nm
(3) 8.6 nm (4) 11.4 nm

12. An electron of mass m and magnitude of charge |e| initially at rest gets accelerated by a constant electric field E. The rate of change of de-Broglie wavelength of this electron at time t ignoring relativistic effects is :
(1) $\frac{-h}{|e|Et^2}$ (2) $\frac{|e|Et}{h}$
(3) $-\frac{h}{|e|E\sqrt{t}}$ (4) $-\frac{h}{|e|Et}$

13. In a reactor, 2 kg of $_{92}U^{235}$ fuel is fully used up in 30 days. The energy released per fission is 200 MeV. Given that the Avogadro number, N = 6.023×10^{26} per kilo mole and 1 eV = 1.6×10^{-19} J. The power output of the reactor is close to :
(1) 125 MW (2) 60 MW
(3) 35 MW (4) 54 MW

14. When radiation of wavelength λ is used to illuminate a metallic surface, the stopping potential is V. When the same surface is illuminated with radiation of wavelength 3λ, the stopping potential is $\frac{V}{4}$. If the threshold wavelength for the metallic surface is $n\lambda$ then value of n will be _______.

15. In a hydrogen atom the electron makes a transition from $(n + 1)^{th}$ level to the n^{th} level. If n>>l, the frequency of radiation emitted is proportional to :
(1) $\frac{1}{n^4}$ (2) $\frac{1}{n^3}$ (3) $\frac{1}{n^2}$ (4) $\frac{1}{n}$

16. A particle is moving 5 times as fast as an electron. The ratio of the de-Broglie wavelength of the particle to that of the electron is 1.878×10^{-4}. The mass of the particle is close to :
(1) 4.8×10^{-27} kg
(2) 1.2×10^{-28} kg
(3) 9.1×10^{-31} kg
(4) 9.7×10^{-28} kg

17. When the wavelength of radiation falling on a metal is changed from 500 nm to 200 nm, the maximum kinetic energy of the photoelectrons becomes three times larger. The work function of the metal is close to :
(1) 0.61 eV (2) 0.52 eV
(3) 0.81 eV (4) 1.02 eV

18. In a radioactive material, fraction of active material remaining after time t is 9/16. The fraction that was remaining after t/2 is :
(1) $\frac{3}{4}$ (2) $\frac{7}{8}$ (3) $\frac{4}{5}$ (4) $\frac{3}{5}$

19. The radius of R of a nucleus of mass number A can be estimated by the formula $R = (1.3 \times 10^{-15})A^{1/3}$ m. It follows that the mass density of a nucleus is of the order of:

$$\left(M_{prot.} \cong M_{neut.} \simeq 1.67\times10^{-27}\text{kg}\right)$$

(1) 10^{24} kg m^{-3}
(2) 10^{3} kg m^{-3}
(3) 10^{17} kg m^{-3}
(4) 10^{10} kg m^{-3}

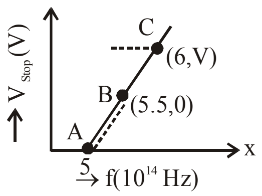
20. Hydrogen ion and singly ionized helium atom are accelerated, from rest, through the same potential difference. The ratio of final speeds of hydrogen and helium ions is close to:
(1) 5 : 7 (2) 1 : 2
(3) 10 : 7 (4) 2 : 1

21. Two sources of light emit X-rays of wavelength 1 nm and visible light of wavelength 500 nm, respectively. Both the sources emit light of the same power 200 W. The ratio of the number density of photons of X-rays to the number densitty of photons of the visible light of the given wavelengths is :

(1) $\frac{1}{500}$ (2) 500

(3) 250 (4) $\frac{1}{250}$

22. Given figure shows few data points in a photo electric effect experiment for a certain metal. The minimum energy for ejection of electron from its surface is : (Plancks constant $h = 6.62 \times 10^{-34}$ J.s)



(1) 2.27 eV
(2) 2.59 eV
(3) 1.93 eV
(4) 2.10 eV

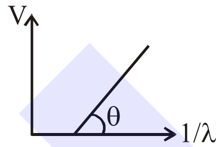
23. Particle A of mass $m_A = \frac{m}{2}$ moving along the x-axis with velocity v_0 collides elastically with another particle B at rest having mass $m_B = \frac{m}{3}$.
If both particles move along the x-axis after the collision, the change $\Delta\lambda$ in de-Broglie wavelength of particle A, in terms of its de-Broglie wavelength (λ_0) before collision is :

(1) $\Delta\lambda = 4\lambda_0$ (2) $\Delta\lambda = \frac{5}{2}\lambda_0$

(3) $\Delta\lambda = 2\lambda_0$ (4) $\Delta\lambda = \frac{3}{2}\lambda_0$

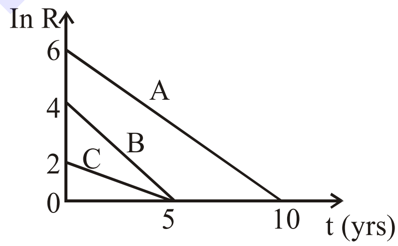
24. In the line spectra of hydrogen atom, difference between the largest and the shortest wavelengths of the Lyman series is 304 Å. The corresponding difference for the Paschan series in Å is : ______.

25. In a photoelectric effect experiment, the graph of stopping potential V versus reciprocal of wavelength obtained is shown in the figure. As the intensity of incident radiation is increased :



(1) Slope of the straight line get more steep
(2) Straight line shifts to left
(3) Graph does not change
(4) Straight line shifts to right

26. Activities of three radioactive substances A, B and C are represented by the curves A, B and C, in the figure. Then their half-lives $T_{\frac{1}{2}}(A):T_{\frac{1}{2}}(B):T_{\frac{1}{2}}(C)$ are in the ratio :



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

27. A particle of mass 200 MeV/c^2 collides with a hydrogen atom at rest. Soon after the collision the particle comes to rest, and the atom recoils and goes to its first excited state. The initial kinetic energy of the particle (in eV) is $\frac{N}{4}$.
The value of N is :
(Given the mass of the hydrogen atom to be 1 GeV/c^2) ________.

28. A radioactive nucleus decays by two different processes. The half life for the first process is 10 s and that for the second is 100s. the effective half life of the nucleus is close to:

(1) 9 sec (2) 55 sec
(3) 6 sec (4) 12 sec

29. The surface of a metal is illuminated alternately with photons of energies E_1 = 4eV and E_2 = 2.5 eV respectively. The ratio of maximum speeds of the photoelectrons emitted in the two cases is 2. The work function of the metal in (eV) is ______.

30. An electron, a doubly ionized helium ion (He^{++}) and a proton are having the same kinetic energy. The relation between their respective de-Broglie wavelengths λ_e, $\lambda_{He^{++}}$ and λ_P is:

(1) $\lambda_e < \lambda_P < \lambda_{He^{++}}$

(2) $\lambda_e < \lambda_{He^{++}} = \lambda_P$

(3) $\lambda_e > \lambda_{He^{++}} > \lambda_P$

(4) $\lambda_e > \lambda_P > \lambda_{He^{++}}$

31. You are given that Mass of ${}^7_3Li$ = 7.0160 u,

Mass of ${}^4_2He$ = 4.0026 u

and Mass of ${}^1_1H$ = 1.0079 u.

When 20 g of ${}^7_3Li$ is converted into ${}^4_2He$ by proton capture, the energy liberated, (in kWh), is: [Mass of nudeon = 1 GeV/c^2]

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

32. Given the masses of various atomic particles m_p = 1.0072u, m_n = 1.0087u, m_e = 0.000548u, $m_{\bar{\nu}}$ = 0, m_d = 2.0141u, where p ≡ proton, n ≡ neutron, e ≡ electron, $\bar{\nu}$ ≡ antineutrino and d ≡ deuteron. Which of the following process is allowed by momentum and energy conservation ?

(1) $n + p \rightarrow d + \gamma$
(2) $e^+ + e^- \rightarrow \gamma$
(3) $n + n \rightarrow$ deuterium atom
(electron bound to the nucleus)
(4) $p \rightarrow n + e^+ + \bar{\nu}$

33. Assuming the nitrogen molecule is moving with r.m.s. velocity at 400 K, the de-Broglie wavelength of nitrogen molecule is close to :
(Given : nitrogen molecule weight : 4.64×10^{-26}kg,
Boltzman constant : 1.38×10^{-23} J/K,
Planck constant : 6.63×10^{-34} J.s)

(1) 0.34 Å (2) 0.24 Å (3) 0.20 Å (4) 0.44 Å

34. Find the bindng energy per nucleon for ${}^{120}_{50}Sn$. Mass of proton m_p = 1.00783 U, mass of neutron m_n = 1.00867 U and mass of tin nucleus m_{Sn} = 119.902199 U. (take 1U = 931 MeV)

(1) 8.5 MeV (2) 7.5 MeV
(3) 8.0 MeV (4) 9.0 MeV

SOLUTION

1. NTA Ans. (3)

Sol. Time period of revolution of electron in n^{th} orbit

$$T=\frac{2\pi r}{V}=\frac{2\pi a_0\left(\frac{n^2}{Z}\right)}{V_0\left(\frac{Z}{n}\right)}$$

$$\Rightarrow T\propto\frac{n^3}{Z^2}$$

$$\frac{T_2}{T_1}=\frac{(2)^3}{(1)^3}=8 \Rightarrow T_2 = 8\times 1.6\times 10^{-16}$$

Now frequency $f_2=\frac{1}{T_2}=\frac{10^{16}}{8\times1.6}\approx 7.8\times10^{14}$ Hz.

2. NTA Ans. (11)

Sol. Power incident $P = I \times A$

n = no. of photons incident/second

$nE_{ph} = IA$

$$n=\frac{IA}{E_{ph}}$$

$$n=\frac{IA}{\left(\frac{hc}{\lambda}\right)}=\frac{6.4\times10^{-5}\times1}{\frac{1240}{310}\times1.6\times10^{-19}}$$

$n = 10^{+14}$ per second

Since efficiency $= 10^{-3}$

no. of electrons emitted $= 10^{+11}$ per second.

x = 11.

3. NTA Ans. (4)

Sol. $A = A_0\left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

$$500 = 700\left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

$$0.7\approx\left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

$$\left(\frac{1}{2}\right)^{1/2}\approx\frac{t}{T_{1/2}}$$

$$\frac{30}{T_{1/2}}\approx\frac{1}{2}\Rightarrow T_{1/2}=60$$

4. NTA Ans. (2)

Sol. $\frac{\lambda_{electron}}{\lambda_{photon}}=?$

$$E=\frac{hc}{\lambda_{photon}} \quad ....(1)$$

$$\lambda_{electron}=\frac{h}{\sqrt{2mE}} \quad ....(2)$$

from (1) and (2)

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

5. NTA Ans. (3)

Sol. $\lambda_B = 2\lambda_A$

$$\Rightarrow \frac{h}{\sqrt{2T_Bm}}=\frac{2h}{\sqrt{2T_Am}}$$

$T_A = 4T_B$ ....(i)

and $T_B = (T_A - 1.5)$ eV ....(ii)

from (i) and (ii)

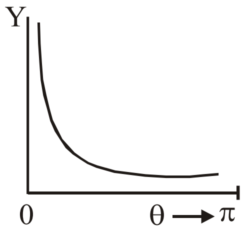
$3T_B$ 1.5 eV $\Rightarrow T_B = 0.5$ eV

$T_B = 0.5$ eV $= 4.5$ eV $-\phi_B$

$\phi = 4$eV

6. NTA Ans. (3)

Sol.



$$Y \propto \frac{1}{\left(\sin\frac{\theta}{2}\right)^4}$$

7. NTA Ans. (3)

Sol. By de-Broglie hypothesis

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

$$\lambda_0 = \frac{h}{m\sqrt{2}v_0} \quad ....(1)$$

$$\lambda' = \frac{h}{\sqrt{v_0^2 + v_0^2 + \left(\frac{eE_0t}{m}\right)^2}}$$

$$= \frac{h}{m\sqrt{2v_0^2 + \frac{e^2E_0^2t^2}{m^2}}} \quad ....(2)$$

By (1) and (2)

$$\lambda' = \frac{\lambda_0}{\sqrt{1 + \frac{e^2E_0^2t^2}{2m^2v_0^2}}}$$

8. NTA Ans. (486)

Sol. For Balmer series,

$$\frac{1}{\lambda} = R_H\left(\frac{1}{2^2} - \frac{1}{n_2^2}\right)$$

$$\frac{\lambda_2}{\lambda_1} = \frac{\left(\frac{1}{2^2} - \frac{1}{3^2}\right)}{\left(\frac{1}{2^2} - \frac{1}{4^2}\right)}$$

$$\frac{\lambda_2}{6561} = \frac{5/36}{3/16}$$

$$\lambda_2 = \frac{20}{27} \times 6561$$

$\lambda_2 = 4860$ Å $= 486$ nm

9. NTA Ans. (3)

Sol. Given, de-Broglie wavelength $= \frac{h}{\sqrt{2mE}} = \lambda$

Also, $\frac{h}{\sqrt{2m(E+\Delta E)}} = \frac{\lambda}{2}$

$\therefore \frac{E + \Delta E}{E} = 4 \Rightarrow \Delta E = 3E.$

10. NTA Ans. (2)

Sol. Let the work function be ϕ.

$$\therefore \; KE_{max} = \frac{hc}{\lambda} - \phi$$

Again, $R_{max} = \frac{\sqrt{2mKE_{max}}}{qB} = \frac{\sqrt{2m\left(\frac{hc}{\lambda} - \phi\right)}}{qB}$

$$\therefore \; \frac{R_{max}^2 q^2 B^2}{2m} = \frac{hc}{\lambda} - \phi$$

$$\therefore \; \phi = \frac{hc}{\lambda} - \frac{R_{max}^2 q^2 B^2}{2m} = 1.0899 \text{ eV} \approx 1.1\text{eV}$$

11. NTA Ans. (4)

Sol. 1 Rydberg energy = 13.6 eV

So, ionisation energy = $(13.6\ Z^2)$eV

= 9 × 13.6eV

Z = 3

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{1^2} - \frac{1}{3^2}\right) = 1.09 \times 10^7 \times 9 \times \frac{8}{9}$$

λ = 11.4 nm

12. NTA Ans. (1)

Sol. $a = \frac{eE}{m}$

$$v = u + at = \left(\frac{eE}{m}\right)t$$

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

$$\frac{d\lambda}{dt} = \frac{-(hm)\cdot\frac{dv}{dt}}{(mv)^2} = -\frac{ah}{mv^2} = -\frac{h}{|e|Et^2}$$

∴ Correct answer (1)

13. Official Ans. by NTA (2)

Sol. Number of uranium atoms in 2kg

$$= \frac{2 \times 6.023 \times 10^{26}}{235}$$

energy from one atom is 200×10^6 e.v. hence total energy from 2 kg uranium

$$= \frac{2 \times 6.023 \times 10^{26}}{235} \times 200 \times 10^6 \times 1.6 \times 10^{-19}\,J$$

2 kg uranium is used in 30 days hence this energy is recieved in 30 days hence energy recived per second or power is

$$\text{Power} = \frac{2 \times 6.023 \times 10^{26} \times 200 \times 10^6 \times 1.6 \times 10^{-19}}{235 \times 30 \times 24 \times 3600}$$

Power = 63.2×10^6 watt or 63.2 Mega Watt

14. Official Ans. by NTA (9)

Sol. $\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + eV$ .....(i)

$\frac{hc}{3\lambda} = \frac{hc}{\lambda_0} + \frac{e \cdot V}{4}$ .....(ii)

(multiply by 4)

$\frac{4hc}{3\lambda} = \frac{4hc}{\lambda_0} + eV$ ....(iii)

From (i) & (iii)

$$\frac{hc}{\lambda} - \frac{hc}{\lambda_0} = \frac{4hc}{3\lambda} - \frac{4hc}{\lambda_0}$$

$$-\frac{hc}{3\lambda} = -\frac{3hc}{\lambda_0}$$

$$\boxed{9\lambda = \lambda_0}$$

n = 9

15. Official Ans. by NTA (2)

Sol. In hydrogen atom,

$$E_n = \frac{-E_0}{n^2}$$

Where E_0 is Ionisation Energy of H.

→ For transition from (n + 1) to n, the energy of emitted radiation is equal to the difference in energies of levels.

$$\Delta E = E_{n+1} - E_n$$

$$\Delta E = E_0\left(\frac{1}{n^2} - \frac{1}{(n+1)^2}\right)$$

$$\Delta E = h\nu = E_0\left(\frac{(n+1)^2 - n^2}{n^2(n+1)^2}\right)$$

$$h\nu = E_0\left[\frac{2n+1}{n^4\left(1+\frac{1}{n}\right)^2}\right]$$

$$h\nu = E_0\left[\frac{n\left(2+\frac{1}{n}\right)}{n^4\left(1+\frac{1}{n}\right)^2}\right]$$

Since n >>> 1

Hence, $\frac{1}{n} \simeq 0$

$$h\nu = E_0\left[\frac{2}{n^3}\right]$$

$$\nu \propto \frac{1}{n^3}$$

16. Official Ans. by NTA (4)

Sol. Let mass of particle = m

Let speed of e^- = V

⇒ speed of particle = 5V

Debroglie wavelength $\lambda_d = \frac{h}{P} = \frac{h}{mv}$

$$\Rightarrow (\lambda_d)_P = \frac{h}{m(5V)} \quad .....(1)$$

$$\Rightarrow (\lambda_d)_e = \frac{h}{m_e.V} \quad .....(2)$$

According to question

$$\frac{(1)}{(2)} = \frac{m_e}{5m} = 1.878 \times 10^{-4}$$

$$\Rightarrow m = \frac{m_e}{5 \times 1.878 \times 10^{-4}}$$

$$\Rightarrow m = \frac{9.1 \times 10^{-31}}{5 \times 1.878 \times 10^{-4}}$$

⇒ m = 9.7 × 10^{-28} kg

17. Official Ans. by NTA (1)

Sol. $$\frac{3}{1} = \frac{\frac{hc}{200\text{ nm}} - \phi}{\frac{hc}{500\text{ nm}} - \phi}, \quad hc = 1240 \text{ eV-nm}$$

On solving ϕ = 0.61 eV

18. Official Ans. by NTA (1)

Sol. First order decay

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

Given $N(t) / N_0 = 9/16 = e^{-\lambda t}$

Now, $N(t/2) = N_0\, e^{-\lambda t/2}$

$$\frac{N(t/2)}{N_0} = \sqrt{e^{-\lambda t}} = \sqrt{9/16}$$

$N(t/2) = 3/4\ N_0$

19. Official Ans. by NTA (3)

Sol.

$$\rho_{nucleus} = \frac{mass}{volume} = \frac{A}{(4/3)\pi r_0^3 A} = \frac{3}{4\pi r_0^3} = 2.3 \times 10^{17} \text{kg/m}^3$$

20. Official Ans. by NTA (4)

Sol. $$q\Delta V = \frac{1}{2}mV^2 \Rightarrow v = \sqrt{\frac{2q\Delta V}{m}}$$

$$\therefore \frac{V_1}{V_2} = \sqrt{\frac{e}{m}\frac{4m}{e}} = 2$$

21. Official Ans. by NTA (1)

Sol. $$P = \frac{nhc}{\lambda t}$$

$$\therefore \frac{n_1}{n_2} = \frac{\lambda_1}{\lambda_2} = \frac{1}{5}$$

22. Official Ans. by NTA (1)

Sol. Graph of V_s and f given (B 5.5, 0)

$h\nu = \phi + eV_s$

at B $V_s = 0$, $\nu = 5.5$

⇒ h × 5.5 × 10^{14} = ϕ

$$\phi = \frac{6.62 \times 10^{-34} \times 5.5 \times 10^{14}}{1.6 \times 10^{-19}} eV = 2.27 eV$$

23. Official Ans. by NTA (1)

Sol. (m/2) $\xrightarrow{V_0}$ A (m/s) • B (lest) (m/2) → (A) V_A → V_B (B) (m/3)

Initial Final

Applying momentum conservation

$$\frac{m}{2}\times V_0+\frac{m}{3}\times(0)=\frac{m}{2}V_A+\frac{m}{3}V_B$$

$$=\frac{V_0}{2}=\frac{V_A}{2}+\frac{V_B}{3} \quad .... (1)$$

Since, collision is elastic (e = 1)

$$e=1=\frac{V_B-V_A}{V_0} \Rightarrow V_0=V_B-V_A \quad ... (2)$$

On solving (1) & (2) : $V_A=\frac{V_0}{5}$

Now, De-Broglie wavelength of A before collision :

$$\lambda_0=\frac{h}{m_AV_0}=\frac{h}{\left(\frac{m}{2}\right)V_0}$$

$$\Rightarrow \lambda_0=\frac{2h}{mV_0}$$

Final De-Broglie wavelength :

$$\lambda_f=\frac{h}{m_AV_0}=\frac{h}{\frac{m}{2}\times\frac{V_0}{5}} \Rightarrow \lambda_f=\frac{10h}{mV_0}$$

Now $\Delta\lambda=\lambda_f-\lambda_0$

$$\Delta\lambda=\frac{10h}{mV_0}-\frac{2h}{mV_0}$$

$$\Rightarrow \Delta\lambda=\frac{8h}{mv_0} \quad \Rightarrow \Delta\lambda=4\times\frac{2h}{mv_0}$$

$\Rightarrow \Delta\lambda=4\lambda_0$

option (1) is correct.

24. Official Ans. by NTA (10553)
Official Ans. by ALLEN (10553.14)

Sol. $\lambda=\frac{c}{\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)}$

for lyman series

$$\lambda_1=\frac{c}{\frac{1}{1^2}-\frac{1}{\infty^2}}=c\ (n=\infty \text{ to } n=1)$$

$$\lambda_2=\frac{c}{\frac{1}{1^2}-\frac{1}{2^2}}=\frac{4c}{3}\ (n=2 \text{ to } n=1)$$

$$\Delta\lambda=\lambda_2-\lambda_1=\frac{c}{3}=304\text{Å}\Rightarrow c=912\text{Å}$$

for paschen series

$$\lambda_1=\frac{c}{\frac{1}{3^2}-\frac{1}{\infty^2}}=9c\ \ (n=\infty \text{ to } n=3)$$

$$\lambda_2=\frac{c}{\frac{1}{3^2}-\frac{1}{4^2}}=\frac{144c}{7}\ (n=4 \text{ to } n=3)$$

$$\Delta\lambda=\lambda_2-\lambda_1=\frac{144c}{7}-9c=\frac{81c}{7}=\frac{81\times912}{7}$$

= 10553.14 Å

25. Official Ans. by NTA (3)

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

$$V=\left(\frac{hc}{e}\right)\left(\frac{1}{\lambda}\right)-\phi$$

Slope of the line in above equation and all other terms are independent of intensity.
The graph does not change.

26. Official Ans. by NTA (3)

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

$\ln R=\ln R_0-\lambda t$

$$\lambda_A=\frac{6}{10} \Rightarrow T_A=\frac{10}{6}\ln 2$$

$$\lambda_B=\frac{6}{5} \Rightarrow T_B=\frac{5\ln 2}{6}$$

$$\lambda_C=\frac{2}{5} \Rightarrow T_C=\frac{5\ln 2}{2}$$

$$\frac{10}{6}:\frac{5}{6}:\frac{15}{6}::2:1:3$$

27. Official Ans. by NTA (51.00)

Sol. $mV_0 = MV = p$

$$10.2 = \frac{p^2}{2m} - \frac{p^2}{2M} = \frac{p^2}{2m}\left(1-\frac{m}{M}\right)$$

$$= \frac{p^2}{2m}(1-0.2)$$

$$\Rightarrow \frac{p^2}{2m} = K = \frac{10.2}{0.8}$$

28. Official Ans. by NTA (1)

Sol.

$$A \xrightarrow{T_1} B \qquad A \xrightarrow{T_2} C$$

$$\frac{1}{T_{eff}} = \frac{1}{T_1} + \frac{1}{T_2}$$

$$T_{eff} = \frac{T_1T_2}{T_1+T_2} = \frac{1000}{110} = \frac{100}{11} = 9.09$$

$$T_{eff} \cong 9$$

29. Official Ans. by NTA (2.00)

Sol. $E_1 = \phi + K_1$ ...(1)

$E_2 = \phi + K_2$ ...(2)

$E_1 - E_2 = K_1 - K_2$

Now $\frac{V_1}{V_2} = 2 \quad \Rightarrow \frac{K_1}{K_2} = 4$

$K_1 = 4K_2$

Now from equation (2)

$\Rightarrow 4{-}2.5 = 4K_2 - K_2$

$1.5 = 3K_2$

$K_2 = 0.5\text{eV}$

Now putting This

Value in equation (2)

$2.5 = \phi + 0.5\text{eV}$

$$\boxed{\phi = 2ev}$$

30. Official Ans. by NTA (4)

Sol. $$\lambda = \frac{h}{P} = \frac{h}{\sqrt{2m(KE)}}$$

$$\lambda \propto \frac{1}{\sqrt{m}} \Rightarrow \lambda = \frac{C}{\sqrt{m}}$$

$$m_{He^{++}} > m_P > m_e$$

$$\therefore \lambda_{He^{++}} < \lambda_P < \lambda_e$$

$\therefore$ correct option is (4)

31. Official Ans. by NTA (2)

Sol. $${}^7_3Li + {}^1_1H \rightarrow 2\left({}^4_2He\right)$$

$$\Delta m \Rightarrow [m_{Li} + m_H] - 2[M_{He}]$$

Energy released in 1 reaction $\Rightarrow \Delta mc^2$.

In use of 7.016 u Li energy is Δmc^2

In use of 1gm Li energy is $\frac{\Delta mc^2}{m_{Li}}$

In use of 20 gm energy is $\Rightarrow \frac{\Delta mc^2}{m_{Li}} \times 20gm$

$$\Rightarrow \frac{[(7.016+1.0079) - 2\times 4.0026]u \times c^2}{7.016\times 1.6\times 10^{-24}gm} \times 20gm$$

$$\Rightarrow \left(\frac{0.0187\times 1.6\times 10^{-19}\times 10^9}{7.016\times 1.6\times 10^{-24}gm}\times 20gm\right) \text{ Joule}$$

$\Rightarrow 0.05 \times 10^{+14}$ J

$\Rightarrow 1.4 \times 10^{+6}$ kwh

[1 J $\Rightarrow 2.778 \times 10^{-7}$ kwh]

32. Official Ans. by NTA (1)

Sol. Only in case-I, $M_{LHS} > M_{RHS}$ i.e. total mass on reactant side is greater then that on the product side. Hence it will only be allowed.

33. Official Ans. by NTA (2)

Sol. $$v_{rms} = \sqrt{\frac{3KT}{m}}$$

$m \rightarrow$ mass of one molecule (in kg) $= \frac{\text{molar mass}}{\text{NA}}$

de-Broglie wavelenth,

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

given, $v = v_{rms}$

$$\lambda = \frac{h}{m\sqrt{\frac{3KT}{m}}} \qquad \Rightarrow \lambda = \frac{h}{\sqrt{3KTm}}$$

$$= \frac{6.63\times 10^{-34}}{\sqrt{3\times 1.38\times 10^{-23}\times 400\times\left(\frac{28\times 10^{-3}}{6.023\times 10^{-23}}\right)}}$$

$$\lambda = \frac{6.63\times 10^{-11}}{2.77} = 2.39\times 10^{-11}\text{m}$$

$\lambda = 0.24$ Å

34. Official Ans. by NTA (1)

Sol. B.E. = $[\Delta m].c^2$

$M_{expected} = ZM_p + (A - Z)M_n$

$= 50\,[1.00783] + 70\,[1.00867]$

$M_{actual} = 119.902199$

$$B.E. = \left[50\left[1.00783\right]+70\left[1.00867\right]-119.902199\right] \times 931$$

$= 1020.56$

$$\frac{BE}{nucleon}=\frac{1020.56}{120}=8.5\ \text{MeV}$$