Modern Physics

1. The fraction of the original number of nuclei of a radioactive atom having a mean life of 10 days, that decays during the 5^{th} day is **[NSEP-2017]**

(A) 0.15 (B) 0.30 (C) 0.045 (D) 0.064

2. The photoelectric threshold wavelength of tungsten is 230 nm. The energy of electrons ejected from its surface by ultraviolet light of wavelength 180 nm is **[NSEP-2017]**

(A) 0.15 eV (B) 1.5 eV (C) 15 eV (D) 1.5 keV

3. The maximum wavelength that can ionize a hydrogen atom initially in the ground state is **[NSEP-2018]**

(A) 660.0 nm. (B) 364.5 nm. (C) 121.9 nm. (D) 91.4 nm.

4. The wavelength of the waves associated with a proton and a photon are the same. Therefore, the two have equal. **[NSEP-2018]**

(A) mass. (B) velocity. (C) momentum. (D) kinetic energy.

5. Which of the following sources emits light having highest degree of coherence? **[NSEP-2018]**

(A) Light Emitting Diode. (B) LASER diode.
(C) Neon lamp. (D) Incandescent lamp.

6. An electron in hydrogen atom jumps from a level n = 4 to n = 1. The momentum of the recoiled atom is **[NSEP-2018]**

(A) 6.8×10^{-27} kg-m/s (B) 12.75×10^{-19} kg-m/s
(C) 13.6×10^{-19} kg-m/s (D) zero.

7. A stationary hydrogen atom emits photon corresponding to the first line (highest wave length) of Lyman series. If R is the Rydberg constant and M is the mass of the atom, the recoil velocity of the atom is: **[NSEP-2019]**

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

8. A source emits photons of energy 5 eV which are incident on a metallic sphere of work function 3.0 eV. The radius of the sphere is $r = 8 \times 10^{-3}$ m. It is observed that after some time emission of photoelectrons from the metallic sphere is stopped. Charge on the sphere when the photoemission stops is. **[NSEP-2019]**

(A) 1.77×10^{-16} C (B) 1.77×10^{-12} C
(C) 1.11×10^{-12} C (D) 1.11×10^{-10} C

9. In an experiment on photoelectric effect, the slope of straight line graph between the stopping potential and the frequency of incident radiation gives **[NSEP-2019]**

(A) Electron charge (e) (B) Planck constant (h)
(C) $\frac{h}{e}$ (D) Work function (W)

10. According to Bohr's theory the ionization energy of H atom is 13.6 eV. The energy needed to remove an electron from Helium ion (He^+) is: **[NSEP-2019]**

(A) 13.6 eV (B) 16.8 eV (C) 27.2 eV (D) 54.4 eV

11. The phenomenon inverse to photo electric effect is: **[NSEP-2019]**

(A) Compton effect
(B) Pair production
(C) Raman effect
(D) Production of X-rays in Coolidge tube

12. A stationary hydrogen atom emits a photon of wavelength 1025 Å. Its angular momentum changes by **[NSEP-2019]**

(A) $\frac{h}{\pi}$ (B) $\frac{2h}{\pi}$ (C) $\frac{h}{2\pi}$ (D) $\frac{3h}{2\pi}$

13. A number of identical absorbing plates are arranged in between a source of light and a photo cell. When there is no plate in between, the photo current is maximum. Under the circumstances let us focus on the two statements – **[NSEP-2019]**

(1) The photo current decreases with the increase in number of absorbing plates.
(2) The stopping potential increases with the increase in number of absorbing plates.
(A) Statements (1) and (2) are both true and (1) is the cause of (2).
(B) Statements (1) and (2) are both true but (1) and (2) are independent.
(C) Statement (1) is true while (2) is not true and (1) and (2) are independent.
(D) Statement (1) is true while (2) is not true and (2) is the effect of (1).

14. The mass of an electron can be expressed as **[NSEP-2019]**

(A) 0.512 MeV
(B) 8.19×10^{-14} J/c^2
(C) 9.1×10^{-31} kg
(D) 0.00055 amu

where c is speed of light in vacuum

15. The Nucleus ${}^{23}_{10}\text{Ne}$ decays by $\beta-$ emission through the reaction ${}^{23}_{10}\text{Ne} \rightarrow {}^{23}_{11}\text{Na} + {}^{0}_{-1}\beta + \bar{\nu} +$ energy

The atomic masses are ${}^{23}_{10}\text{Ne} = 22.994466\text{u}$ and ${}^{23}_{11}\text{Na} = 22.989770\text{u}$, ${}^{0}_{-1}\beta = 0.000549\text{u}$. The maximum kinetic energy that the emitted electron can ever have is **[NSEP-2020]**

(A) 4.374MeV (B) 3.862MeV (C) 2.187MeV (D) 1.931MeV

16. Even the radiation of highest wave length in the ultraviolet region of hydrogen spectrum is just able to eject photoelectrons from a metal. The value of threshold frequency for the given metal is **[NSEP-2020]**

(A) 3.83×10^{15} Hz (B) 4.33×10^{14} Hz (C) 2.46×10^{15} Hz (D) 7.83×10^{14} Hz

17. Positronium is a short-lived $\left(\approx 10^{-9}\,\text{s}\right)$ bound state of an electron and a positron (a positively charged particle with mass and charge equal (in magnitude) to an electron) revolving round their common centre of mass. If E_0, v_0 and a_0 are respectively the ground state energy, the orbital speed of electron in first orbit and the radius of the first $(n = 1)$ Bohr orbit for Hydrogen atom, the corresponding quantities E, v and a for the positronium are **[NSEP-2021]**

(A) $E = \frac{E_0}{2}$ (B) $a = a_0$ (C) $a = 2a_0$ (D) $E = E_0, v = v_0, a = a_0$

18. When a sample of atoms is irradiated by neutrons, radioactive atoms are produced at a constant rate R, which decay with decay constant λ. The number of radioactive atoms accumulated after an irradiation time t is given by **[NSEP-2022]**

(A) N (t) = Rte^{-lt} (B) N (t) = $\frac{R}{\lambda}e^{-\lambda t}$ (C) N (t) = $\frac{R}{\lambda}\left(1 - e^{-\lambda t}\right)$ (D) N (t) = Rt $(1-e^{-\lambda t})$

19. A hydrogen atom is in ground state $(n=1)$. The magnetic field produced by revolving electron, at centre of atom is B_0. Atom is excited to state $_{n=4}$. According to Bohr model, the correct alternative(s) is/are **[NSEP-2022]**

(A) Magnetic field at centre of atom for $(n=4)$ becomes $B_4 = \frac{B_0}{64}$

(B) Energy absorbed by atom in going from $(n=1)$ to $(n=4)$ is 12.75eV

(C) Change in magnitude of angular momentum of electron is $\frac{3h}{2\pi}$

(D) Assume that this excited atom $(n=4)$ is at rest and it makes transition to ground state $(n=1)$ in a single quantum jump of an electron, (Take mass of atom $M_H = 1.67\times10^{-27}\text{Kg}$) the recoil speed of atom will be nearly $v = 4.1\text{ms}^{-1}$.

20. In an experimental set up to study the photoelectric effect a point source of light of power 3.2mW is used. The source emits mono energetic photons of energy 5eV and is located at a distance $d = 0.8\text{m}$ from centre of a stationary metallic sphere of work function $W = 3.0\text{eV}$. The radius of the sphere is $R = 8\text{mm}$. Assume that the sphere is isolated and photo electrons are instantly swept away after emission. Also assume that the efficiency off photoelectric emission is one for every 10^6 photons. In the present set up **[NSEP-2022]**

(A) The de Broglie wavelength of fastest moving photoelectron is nearly 8.7Å

(B) It is observed that after some time emission of photoelectrons from the surface of metal sphere is stopped, the charge on sphere just when the electron emission stops is $64\pi\epsilon_0 \times 10^{-3}\text{C}$

(C) Time after which photo electric emission stops is nearly 111s

(D) The light source emits 4×10^{15} photons per second.

21. A target of ^7Li is bombarded with a proton beam of current 10^{-4} ampere for 1 hour to produce ^7Be of activity 1.8×10^8 disintegrations per second. Assuming that bombarding of 1000 protons produces one ^7Be radioactive nucleus, the half-life of ^7Be is estimated to be approximately

(A) 6887 hour (B) 4332 hour (C) 2407 hour (D) 2195 hour **[NSEP-2023]**

22. Two nuclides A and B are isotopes. The nuclides B and C are isobars. All the three nuclides A, B and C are radioactive. You may then conclude that **[NSEP-2023]**

(A) the nuclides A, B and C must belong to the same element

(B) the nuclides A, B and C may belong to the same element

(C) it is possible that A may change to B through a radioactive decay process

(D) it is possible that B may change to C through a radioactive decay process

23. Heavy stable nuclei have more neutrons than protons. This is because of the fact that

(A) neutrons are heavier than protons **[NSEP-2023]**

(B) the electrostatic forces between protons are repulsive

(C) neutrons decay into protons through beta decay

(D) the nuclear forces between neutrons are weaker than those between protons

24. During the processes of annihilation of a stationary electron of mass m_0 with a stationary positron of equal mass, a radiation is emitted. The wavelength of the resulting radiation is

(A) $\frac{h}{m_0 c}$ (B) $\frac{2h}{m_0 c}$ (C) $\frac{m_0}{hc}$ (D) $\frac{m_0 c}{h}$ **[NSEP-2023]**

25. In an X ray tube the electrons are expected to strike the target with a velocity that is 10% of the velocity of light. The applied voltage should be **[NSEP-2017]**

(A) 517.6 V (B) 1052 V (C) 2.559 kV (D) 5.680 kV

26. In and atom an electron excites to the fourth orbit. When it jumps back to the energy levels a spectrum is formed. Total number of spectral lines in this spectrum would be **[NSEP-2017]**

(A) 3 (B) 4 (C) 5 (D) 6

27. The energy of the characteristic X-ray photon in a Coolidge tube comes from **[NSEP-2018]**

(A) the kinetic energy of striking electron.
(B) the kinetic energy of the free electrons of the target.
(C) the kinetic energy of the ions of the target.
(D) the electronic transition of the target atom.

28. An alpha particle with kinetic energy K approaches a stationary nucleus having atomic number Z. The distance of closest approach is b. Therefore, the distance of closest approach for a nucleus of atomic number 2Z is **[NSEP-2018]**

(A) b/2. (B) $\sqrt{2}$ b. (C) 2 b. (D) 4 b.

29. In a nuclear reaction, two photons each of energy 0.51 MeV are produced by electron-positron annihilation. The wavelength associated with each photon is: **[NSEP-2019]**

(A) 2.44×10^{-12} m (B) 2.44×10^{-8} m (C) 1.46×10^{-12} m (D) 3.44×10^{-10} m

30. Natural Uranium is a mixture of $^{238}_{92}U$ and $^{235}_{92}U$ with a relative mass abundance of 140 :1. The ratio of radioactivity contributed by the two isotopes of natural uranium, if their half-lives are 4.5×10^9 years and 7.0×10^8 years respectively is **[NSEP-2020]**

(A) 99.3: 0.7 (B)50.3: 49.7 (C) 95.6: 04.4 (D) cannot be estimated

31. If the specific activity of C^{14} nuclide in a certain ancient wooden toy is known to be $\frac{3}{5}$ of that in a recently fallen tree of the same class, the age of the ancient wooden toy is (The half life of C^{14} is 5570 years) **[NSEP-2021]**

(A) 5570 years (B) 4105 years (C) 3342 years (D) 2785 years

32. Fission of one nucleus of. ^{235}U releases 200 MeV energy in average. Minimum amount of. ^{235}U required to run 1000 MW reactor per year of continuous operation (assuming 30% efficiency) is **[NSEP-2022]**

(A) 1280 ton (B) 1.28 ton (C) 1.1 ton (D) 1.1×10^5ton

33. A hydrogen atom$\left(M_H = 1.67 \times 10^{-27}\text{kg}\right)$, initially at rest, emits a photon and goes from the excited state $n = 5$ to the ground state. The recoil speed of the atom is nearly **[NSEP-2023]**

(A) 4.2ms^{-1} (B) $4 \times 10^{-4}\text{ms}^{-1}$ (C) $2 \times 10^{-2}\text{ms}^{-1}$ (D) $8 \times 10^{2}\text{ms}^{-1}$

34. Continuous and Characteristic X - rays are produced when electron beam accelerated by a high potential difference of V volt (say) is made to hit the metallic target such as Molybdenum in a modern Coolidge tube. Let λ_{min} be the smallest possible wavelength of continuous X - rays and $\lambda_{L\alpha}$ be the maximum wavelength of the characteristic X - rays. Then **[NSEP-2023]**

(A) $\lambda_{L\alpha}$ increases with increase in V (B) $\lambda_{l,\alpha}$ decreases with increase in V
(C) λ_{min} increases with increase in V (D) λ_{min} decreases with increase in V