competishun Power of real gurus	CAPS-16
PHYSICS	**MODERN PHYSICS**
TARGET : JEE- Advanced 2023	

SCQ (Single Correct Type) :

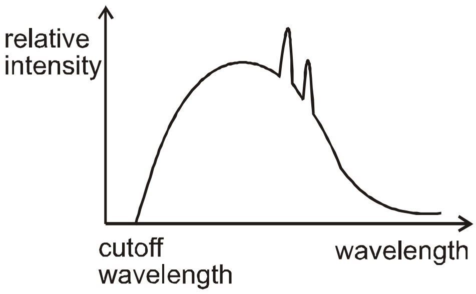
1. A charge particle q_0 of mass m_0 is projected along the y-axis at t = 0 from origin with a velocity V_0. If a uniform electric field E_0 also exists along the x-axis, then the time at which debroglie wavelength of the particle becomes half of the initial value is :

(A) $\frac{m_0V_0}{q_0E_0}$ (B) $2\frac{m_0V_0}{q_0E_0}$ (C) $\sqrt{3}\ \frac{m_0V_0}{q_0E_0}$ (D) $3\frac{m_0V_0}{q_0E_0}$

2. Radius of nucleus is given by the relation $R = R_oA^{\frac{1}{3}}$. where $R_0 = 1.3 \times 10^{-15}$ m and A is mass number. For a nucleon inside a nucleus, de-broglie, wavelength is given by the diameter of the nucleus. Average kinetic energy of a nucleon in the Cu^{64} nucleus based on above information will be –

(A) 7.6 Mev (B) 10 Mev (C) 2.2 Mev (D) 12 Mev.

3. A beam of electrons striking a copper target produces X-rays.Its spectrum is as shown. Keeping the voltage same if the copper target is replaced with a different metal, the cut-off wavelength and characteristic lines of the new spectrum will change in comparision with old as :



(A) Cut-off wavelength will remain unchanged while characteristic lines will be different.

(B) Both cut-off wavelength and characteristic lines will remain unchanged.

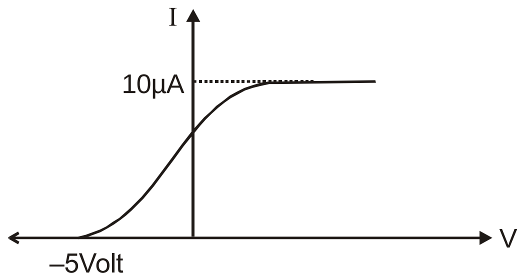
(C) Both cut-off wavelength and characteristic lines will be different.

(D) Cut-off wavelength will be different while characteristic lines will remain unchanged.

4. In a Coolidge tube, the potential difference used to accelerate the electrons is increased from 12.4 kV to 24.8 kV. As a result the difference between $\lambda_{K\alpha}$ and λ_{min} increases three fold. The wavelength of K_α line is - ($\frac{hc}{e}$ = 12.4 kV Å)

(A) 1 Å (B) 1.25 Å (C) 1.5 Å (D) None of these

5. In the photoelectric experiment, if we use a monochromatic light, the I - V curve is as shown. If work function of the metal is 2eV, estimate the power of light used. (Assume efficiency of photo emission = 10^{-3}%, i.e. number of photoelectrons emitted are 10^{-3}% of number of photons incident on metal.)



(A) 2 W (B) 5 W (C) 7 W (D) 10 W

6. Light of intensity I is incident on a fixed plane surface at an angle 30º with the surface. If 50% light is reflected and remaining light is absorbed then radiation pressure on the plate is (speed of light is c):

(A) $\frac{2I}{c}$ (B) $\frac{3I}{8c}$ (C) $\frac{9I}{8c}$ (D) $\frac{I}{4c}$

MCQ (One or more than one correct) :

7. A proton and an electron are moving with the same de–Broglie wavelength (consider the non–relativistic case). Then :

(A) in a magnetic field both the particles describe circles of same radius

(B) both the particles have the same momentum

(C) the speed of the proton and the electron are in the ratio m_e / m_p, where m_e is the electron mass and m_p, the proton mass

(D) the product of mass and kinetic energy is the same for both particles

8. 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 and at rest. 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. The mass of neutron and proton can be assumed to be nearly same. Use hc = 12400 eVÅ.

(A) The gas is helium

(B) This gas is lithium

(C) minimum possible value of kinetic energy of the neutrons for this to be possible is 63.75 eV

(D) minimum possible value of kinetic energy of the neutrons for this to be possible is 12.75 eV

9. In a photo electric experiment, the collector plate is at 2.0 V with respect to the emitter plate made of copper (ϕ = 4.5 eV). The emitter is illuminated by a source of monochromatic light of wavelength 200 nm.

(A) the minimum kinetic energy of the photo electrons on the collector is 0.

(B) the maximum kinetic energy of the photo electrons on the collector is 3.7 eV

(C) if the polarity of the battery is reversed then the minimum kinetic energy of the photo electrons on the collector is 0.

(D) if the polarity of the battery is reversed then the maximum kinetic energy of the photo electrons on the collector is 3.7 eV

10. An electron makes a transition from n = 2 to n = 1 state in a hydrogen like atom.

(A) magnetic field at the site of nucleus is decreased by 16 times.

(B) magnetic field at the site of nucleus is increased by 32 times

(C) angular momentum of electron is changed

(D) none of these

11. Which of the following statements is/are correct for an x-ray tube ?

(A) On increasing potential difference between filament and target, photon flux of x-rays increases

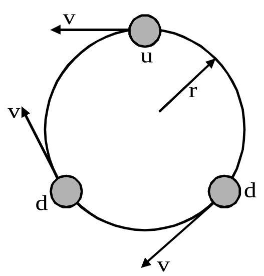
(B) On increasing potential difference between filament and target, frequency of x-rays increases

(C) On increasing filament current, cut–off wavelength increases

(D) On increasing filament current, intensity of x-rays increases

Comprehension Type Question:

The neutron is a particle with zero charge still it has a non–zero magnetic moment with z–component 9.66 × 10^{-27} A–m^2. This can be explained by the internal structure of the neutron. The evidence indicates that a neutron is composed of three fundamental particles called quarks : an "up" (u) quark, of charge $+\frac{2e}{3}$, and two "down" (d) quarks, each of charge $-\frac{e}{3}$. The combinations of the three quarks produces a net charge of $\frac{2e}{3} - \frac{e}{3} - \frac{e}{3} = 0$.



If the quarks are in motion they can produce a non–zero magnetic moment. As a very simple model, suppose the u quark moves in a counter clockwise circular path and the d quarks move in a clockwise circular path, all of the radius r and all with the same speed v see figure.

12. The current due to the circular motion of the u quark :–

(A) $\frac{ev}{6\pi r}$ (B) $\frac{ev}{3\pi r}$ (C) $\frac{ev}{\pi r}$ (D) $\frac{2ev}{\pi r}$

13. Determine the magnitude of the magnetic moment due to the circular u quark :–

(A) $\frac{evr}{3}$ (B) $\frac{2evr}{3}$ (C) $\frac{4evr}{3}$ (D) evr

14. Determine the magnitude of the magnetic moment of the three–quark system :–

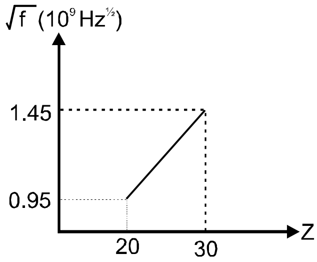
(A) $\frac{evr}{3}$ (B) $\frac{2evr}{3}$ (C) evr (D) 2evr

15. If all Quarks start moving in the same direction then what will be the magnetic moment of the neutron:–

(A) $\frac{evr}{3}$ (B) $\frac{2evr}{3}$ (C) evr (D) None of these

Numerical based Questions :

16. Moseley plot for k_α - X–ray is shown. If Moseley equation is given by $\sqrt{f}$ = a (Z – b). If constants 'a' is given by 5×10^P $Hz^{1/2}$ then 'P' is :



17. Atoms of a hydrogen like gas are in a particular excited energy level. When these atoms de–excite they emits photons of different energies. Maximum and minimum energies of emitted photons are E_{max} = 52.224 eV and E_{min} = 1.224 eV respectively. Calculate the principal quantum number of initially excited level. (Ionisation energy of hydrogen atom = 13.6 eV)

Matrix Match Type :

18. A gas of hydrogen–like atoms has some atoms at ground level and the rest in an excited level A. These atoms absorb monochromatic light of photon energy 22.95 eV, and subsequently emit radiation of six different photon energies, some of them more than 22.95 eV and some less. Then, match the following :

	Column–I		**Column–II**
(A)	out of the initial two groups (ground state, and level A) how many absorbed the radiation of 22.95 eV ? (Answer 1 if only one group absorbs, else 2)	(p)	1
(B)	principal quantum number of level A	(q)	2
(C)	principal quantum number of the level to which atoms are raised by the radiation	(r)	3
(D)	the atomic number of the element	(s)	4

Subjective Type Questions :

19. A positronium consists of an electron and a positron revolving about their common centre of mass. Derive and calculate

(i) Separation between the electron and positron in their first excited state.

(ii) Kinetic energy of the electron in ground state.

20. Electrons in a hydrogen like atom (Z = 3) make transitions from 5th to 4th orbit and from the 4th to the 3rd orbit. The resulting radiation is incident normally on a metal plate and the photo-electrons are ejected. The stopping potential for the photoelectrons ejected by light of shorter wavelength is 3.95 V. Calculate the work function of the metal and the stopping potential of the photo-electrons for the longer wavelength.

21. One milliwatt of light of wavelength 4560 Å is incident on a cesium surface. Calculate the photoelectric current produced, if the efficiency of the surface for photoelectric emission is only 0.5%.

22. Photoelectrons are emitted when 400 nm radiations are incident on a surface of work function 1.9 eV. These photoelectrons pass through a region containing α-particles. A maximum energy electron combines with an α-particle to form a He^+ ion, emitting a single photon in this process. He^+ ions thus formed are in their fourth excited state. Find the energies in eV of the photons, lying in the 2 to 4 eV range, that are likely to be emitted during and after the combination.

23. 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 the variation of photocurrent i_p against the anode voltage V_a for photon intensity I_A and $I_B = 2 \times 10^{15}\ m^{-2}s^{-1}$.

24. A point source of radiation power P is placed on the axis of completely absorbing disc. The distance between the source and the disc is 2 times the radius of the disc. Find the force that light exerts on the disc.

25. Suppose the potential energy between electron & proton at a distance *r* is given by $\frac{-ke^2}{3r^3}$. Use Bohr's theory to obtain energy levels of such a hypothetical hydrogen atom.