JEE-Main (Previous Year Questions)

1. 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 ene0rgy 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

2. Match List-I (Fundament Experiment) with List-II (its conclusion) and select the correct option from the choices given below the list: **[JEE(Main)-2015]**

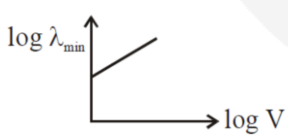
List-I	List-II
(A) Franck-Hertz Experiment	(i) Particle nature of light
(B) Photo-electric Experiment	(ii) Discrete energy levels of atom
(C) Davison-Germer Experiment	(iii) Wave nature of electron
	(iv) Structure of atom

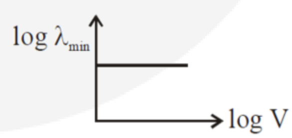
(1) A-ii, B-i, C-iii (2) A-iv, B-iii, C-ii (3) A-i, B-iv, C-iii (4) A-ii, B-iv, C-iii

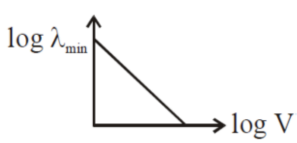
3. Radiation of wavelength λ, is incident on a photocell. The fastest emitted electron has speed v. If the wavelength of changed to $\frac{3\lambda}{4}$, the speed of the fastest emitted electron will be: **[JEE(Main)-2016]**

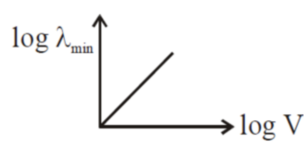
(1) $= v\left(\frac{3}{5}\right)^{1/2}$ (2) $> v\left(\frac{4}{3}\right)^{1/2}$ (3) $< v\left(\frac{4}{3}\right)^{1/2}$ (4) $= v\left(\frac{4}{3}\right)^{1/2}$

4. 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]**

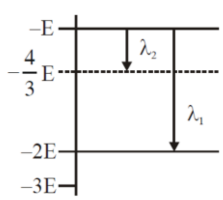
(1) 

(2) 

(3) 

(4) 

5. Some energy levels of a molecule are shown in the figure. The ratio of the wavelengths $r = \lambda_1/\lambda_2$, is given by: **[JEE(Main)-2017]**



(1) $r = \frac{3}{4}$ (2) $r = \frac{1}{3}$ (3) $r = \frac{4}{3}$ (4) $r = \frac{2}{3}$

6. A particle A of mass m and initial velocity v collides with a particle B of mass $\frac{m}{2}$ which is at rest. The collision is head on and elastic. The ratio of the de–Broglie wavelengths λ_A to λ_B after the collision is: **[JEE(Main)-2017]**

(1) $\frac{\lambda_A}{\lambda_B} = \frac{2}{3}$ (2) $\frac{\lambda_A}{\lambda_B} = \frac{1}{2}$ (3) $\frac{\lambda_A}{\lambda_B} = \frac{1}{3}$ (4) $\frac{\lambda_A}{\lambda_B} = 2$

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

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

8. 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 wavelengths of the electron in 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) $\Lambda_n^2 \approx \lambda$ (2) $\Lambda_n \approx A + \frac{B}{\lambda_n^2}$ (3) $\Lambda_n \approx A + B\lambda_n$ (4) $\Lambda_n^2 \approx A + B\lambda_n^2$

9. Surface of certain metal is first illuminated with light of wavelength λ_1 =350 nm and then, by light of wavelength λ_2 = 54 nm. It is found that the maximum speed of the photo electron in the two cases differ by a factor of 2. The work function of the metal (in eV) is close to:

(Energy of photon = $\frac{1240}{\lambda(\text{innm})}$ eV) **[JEE(Main)-2019]**

(1) 1.8 (2) 1.4 (3) 2.5 (4) 5.6

10. The magnetic field associated with a light wave is given, at the origin, by B = B_0 [sin(3.14 × 10^7)ct + sin(6.28 × 10^7)ct]. If this light falls on a silver plate having a work function of 4.7 eV, what will be the maximum kinetic energy of the photo electrons?

(c = 3 × 10^8 ms^{-1}, h = 6.6 × 10^{-34} J-s) **[JEE(Main)-2019]**

(1) 12.5 eV (2) 8.52 eV

(3) 6.82 eV (4) 7.72 eV

11. A metal plate of area 1 × 10^{-4} m^2 is illuminated by a radiation of intensity 16 mW/m^2. The work function of the metal is 5eV. The energy of the incident photons is 10eV and only 10% of it produces photo electrons. The number of emitted photo electrons per second and their maximum energy, respectively, will be: [1 eV = 1.6 × 10^{-19}J] **[JEE(Main)-2019]**

(1) 10^{12} and 5 eV (2) 10^{10} and 5 eV

(3) 10^{14} and 10 eV (4) 10^{11} and 5 eV

12. A hydrogen atom, initially in the ground state is excited by absorbing a photon of wavelength 980 Å. The radius of the atom in the excited state, it terms of Bohr radius a_0, will be: (hc = 12500 eV – Å) **[JEE(Main)-2019]**

(1) $9a_0$ (2) $4a_0$

(3) $25a_0$ (4) $16a_0$

13. If the de-Broglie wavelength of an electron is equal to 10^{-3} times the wavelength of a photon of frequency 6×10^{14} Hz, then the speed of electron is equal to: **[JEE(Main)-2019]**
(Speed of light = 3×10^8 m/s
Planck's constant = 6.63×10^{-34} J.s
Mass of electron = 9.1×10^{-31} kg)
(1) 1.7×10^6 m/s (2) 1.45×10^6 m/s (3) 1.1×10^6 m/s (4) 1.8×10^6 m/s

14. In a hydrogen like atom, when an electron jumps from the M - shell to the L- shell, the wavelength of emitted radiation is λ. If an electron jumps from N-shell to the L-shell, the wavelength of emitted radiation will be: **[JEE(Main)-2019]**
(1) $\frac{27}{20}\lambda$ (2) $\frac{20}{27}\lambda$ (3) $\frac{16}{25}\lambda$ (4) $\frac{25}{16}\lambda$

15. In a photoelectric experiment, the wavelength of the light incident on a metal is changed from 300 nm to 400 nm. The decrease in the stopping potential is close to: $\left(\frac{hc}{e} = 1240\text{nm} - \text{V}\right)$ **[JEE(Main)-2019]**
(1) 2.0 V (2) 1.0 V (3) 0.5 V (4) 1.5 V

16. A particle A of mass 'm' and charge 'q' is accelerated by a potential difference of 50 V. Another particle B of mass '4 m' and charge 'q' is accelerated by a potential difference of 2500 V. The ratio of de-Broglie wavelengths $\frac{\lambda_A}{\lambda_B}$ is close to: **[JEE(Main)-2019]**
(1) 10.00 (2) 0.07 (3) 4.47 (4) 14.14

17. A particle of mass m moves in a circular orbit in a central potential field U(r) = $\frac{1}{2}kr^2$. If Bohr's quantization conditions are applied, radii of possible orbitals and energy levels vary with quantum number n as: **[JEE(Main)-2019]**
(1) $r_n \propto \sqrt{n}, E_n \propto \frac{1}{n}$ (2) $r_n \propto n^2, E_n \propto \frac{1}{n^2}$ (3) $r_n \propto \sqrt{n}, E_n \propto n$ (4) $r_n \propto n, E_n \propto n$

18. When a certain photosensitive surface is illuminated with monochromatic light of frequency ν, the stopping potential for the photo current is $-V_0/2$. When the surface is illuminated by monochromatic light of frequency $\nu/2$, the stopping potential is $-V_0$. The threshold frequency for photoelectric emission is: **[JEE(Main)-2019]**
(1) 2ν (2) $\frac{4\nu}{3}$ (3) $\frac{3\nu}{2}$ (4) $\frac{5\nu}{3}$

19. In a Frank-Hertz experiment, an electron of energy 5.6 eV passes through mercury vapour and emerges with an energy 0.7 eV. The minimum wavelength of photons emitted by mercury atoms is close to: **[JEE(Main)-2019]**
(1) 220 nm (2) 1700 nm (3) 250 nm (4) 2020 nm

20. Radiation coming from transitions n = 2 to n = 1 of hydrogen atoms fall on He^+ ions in n = 1 and n = 2 states. The possible transition of helium ions as they absorb energy from the radiation is: **[JEE(Main)-2019]**

(1) $n = 2 \rightarrow n = 5$
(2) $n = 2 \rightarrow n = 4$
(3) $n = 2 \rightarrow n = 3$
(4) $n = 1 \rightarrow n = 4$

21. Two particles move at right angle to each other. The de Broglie wavelengths are λ_1 and λ_2 respectively. The particles suffer perfectly inelastic collision. The de Broglie wavelength λ, of the final particle, is given by **[JEE(Main)-2019]**

(1) $\frac{1}{\lambda^2} = \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2}$
(2) $\lambda = \sqrt{\lambda_1 \lambda_2}$
(3) $\frac{2}{\lambda} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$
(4) $\lambda = \frac{\lambda_1 + \lambda_2}{2}$

22. The ratio of mass densities of nuclei of ^{40}Ca and ^{16}O is close to: **[JEE(Main)-2019]**

(1) 1
(2) 0.1
(3) 2
(4) 5

23. A nucleus A, with a finite de–broglie wavelength λÅ, undregoes spontaneous fission into two nuclei B and C of equal mass. B flies in the same direction as that of A, while C flies in the opposite direction with a velocity equal to half of that of B. The de–Broglie wavelengths λ_B and λ_C of B and C are respectively: **[JEE(Main)-2019]**

(1) $\lambda_A, \frac{\lambda_A}{2}$
(2) $2\lambda_A, \lambda_A$
(3) $\frac{\lambda_A}{2}, \lambda_A$
(4) $\lambda_A, 2\lambda_A$

24. The electric field of the light wave is given as $\vec{E} = 10^{-3} \cos\left(\frac{2\pi x}{5 \times 10^{-7}} - 2\pi \times 6 \times 10^{14} t\right)\hat{x}\frac{N}{C}$. This light falls on a metal plate of work function 2 eV. The stopping potential of the photo-electrons is:

Given, E (in eV) = $\frac{12375}{\lambda(\mathring{A})}$ **[JEE(Main)-2019]**

(1) 0.48 V
(2) 2.0 V
(3) 0.72 V
(4) 2.48 V

25. Taking the wavelength of first Balmer line in hydrogen spectrum (n = 3 to n = 2) as 660 nm, the wavelength of the 2^{nd} Balmer line (n = 4 to n = 2) will be: **[JEE(Main)-2019]**

(1) 388.9 nm
(2) 488.9 nm
(3) 642.7 nm
(4) 889.2 nm

26. A particle 'P' is formed due to a completely inelastic collision of particles 'x' and 'y' having de-Broglie wavelengths 'λ_x' and 'λ_y' respectively. If x and y were moving in opposite directions, then the de-Broglie wavelength of 'P' is: **[JEE(Main)-2019]**

(1) $\frac{\lambda_x \lambda_y}{\lambda_x + \lambda_y}$
(2) $\frac{\lambda_x \lambda_y}{|\lambda_x - \lambda_y|}$
(3) $\lambda_x + \lambda_y$
(4) $\lambda_x - \lambda_y$

27. A He^+ ion is in its first excited state. Its ionization energy is: **[JEE(Main)-2019]**

(1) 6.04 eV
(2) 54.40 eV
(3) 48.36 eV
(4) 13.60 eV

28. In a photoelectric effect experiment the threshold wavelength of light is 380 nm. If the wavelength of incident light is 260 nm, the maximum kinetic energy of emitted electrons will be: **[JEE(Main)-2019]**

(1) 15.1 eV (2) 4.5 eV (3) 3.0 eV (4) 1.5 eV

29. Two radioactive materials A and B have decay constants 10λ and λ, respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of A to that of B will be 1/e after a time: **[JEE(Main)-2019]**

(1) $\frac{1}{11\lambda}$ (2) $\frac{11}{10\lambda}$ (3) $\frac{1}{9\lambda}$ (4) $\frac{1}{10\lambda}$

30. A 2 mW laser operates at a wavelength of 500 nm. The number of photons that will be emitted per second is: **[JEE(Main)-2019]**

[Given Planck's constant $h = 6.6\times10^{-34}$ Js, speed of light $c = 3.0\times10^{8}$ m/s]

(1) 2×10^{16} (2) 1×10^{16} (3) 1.5×10^{16} (4) 5×10^{15}

31. In Li^{++}, electron in first Bohr orbit is excited to a level by a radiation of wavelength λ. When the ion gets deexcited to the ground state in all possible ways (including intermediate emissions), a total of six spectral lines are observed. What is the value of λ?

(Given: $h = 6.63 \times 10^{-34}$ Js; $c = 3 \times 10^{8}$ ms^{-1}) **[JEE(Main)-2019]**

(1) 12.3 nm (2) 9.4 nm (3) 11.4 nm (4) 10.8 nm

32. Light is incident normally on a completely absorbing surface with an energy flux of 25 Wcm^{-2}. If the surface has an area of 25 cm^2, the momentum transferred to the surface in 40 min time duration will be: **[JEE(Main)-2019]**

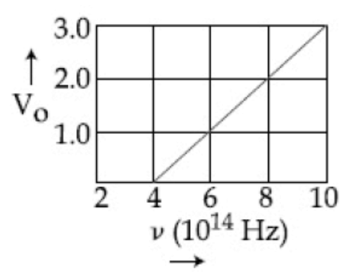
(1) 6.3×10^{-4} Ns (2) 1.4×10^{-6} Ns (3) 5.0×10^{-3} Ns (4) 3.5×10^{-6} Ns

33. An excited He^+ ion emits two photons in succession, with wavelengths 108.5 nm and 30.4 nm, in making a transition to ground state. The quantum number n, corresponding to its initial excited state is (for photon of wavelength λ, energy $E = \frac{1240\,\text{eVnm}}{\lambda(\text{in nm})}$) **[JEE(Main)-2019]**

(1) n = 5 (2) n = 6 (3) n = 4 (4) n = 7

34. The stopping potential V_0 (in volt) as a function of frequency (υ) for a sodium emitter, is shown in the figure. The work function of sodium, from the data plotted in the figure, will be:

(Given: Planck's constant (h) = 6.63×10^{-34} Js, electron charge $e = 1.6\times10^{-19}$ C) **[JEE(Main)-2019]**



(1) 1.66 eV (2) 1.82 eV (3) 1.95 eV (4) 2.12 eV

35. 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) 3 : 8 (2) 1 : 8 (3) 8 : 1 (4) 9 : 8

36. Consider an electron in a hydrogen atom, revolving in its second excited state (having radius 4.65 Å). The de-Broglie wavelength of this electron is: **[JEE(Main)-2019]**

(1) 3.5 Å (2) 12.9 Å (3) 6.6 Å (4) 9.7 Å

37. The electron in a hydrogen atom first jumps from the third excited state to the second excited state and subsequently to the first excited state. The ratio of the respective wavelengths, $\frac{\lambda_1}{\lambda_2}$, of the photons emitted in this process is: **[JEE(Main)-2019]**

(1) $\frac{27}{5}$ (2) $\frac{7}{5}$ (3) $\frac{20}{7}$ (4) $\frac{9}{7}$

38. 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: **[JEE(Main)-2020]**

(1) 6.2×10^{15} (2) 5.6×10^{12}
(3) 7.8×10^{14} (4) 1.6×10^{14}

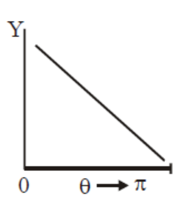
39. A beam of electromagnetic radiation of intensity 6.4×10^{-5} W/cm^2 is comprised of wavelength, λ = 310 nm. It falls normally on a metal (work function φ = 2eV) of surface area of 1 cm^2. If one in 10^3 photons ejects an electron, total number of electrons ejected in 1 s is 10^x.
(hc = 1240eVnm, 1eV=1.6×10^{-19} J), then x is_______. **[JEE(Main)-2020]**

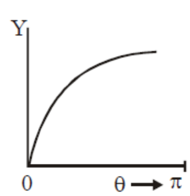
40. An electron (of mass m) and a photon have the same energy E in the range of a few eV. The ratio of the de-Broglie wavelength associated with the electron and the wavelength of the photon is (c = speed of light in vacuum) **[JEE(Main)-2020]**

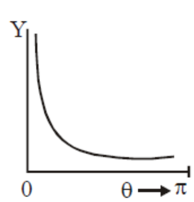
(1) $\left(\frac{E}{2m}\right)^{1/2}$ (2) $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$

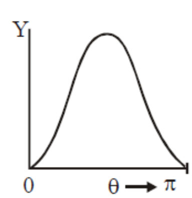
(3) $c(2mE)^{1/2}$ (4) $\frac{1}{c}\left(\frac{2E}{m}\right)^{1/2}$

41. The graph which depicts the results of Rutherford gold foil experiment with α-particles is: θ : Scattering angle Y : Number of scattered α-particles detected (Plots are schematic and n to scale) **[JEE(Main)-2020]**

(1) 

(2) 

(3) 

(4) 

42. 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: **[JEE(Main)-2020]**

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

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

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

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

43. 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: **[JEE(Main)-2020]**

44. 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: **[JEE(Main)-2020]**

(1) $\dfrac{-h}{|e|Et^2}$

(2) $\dfrac{|e|Et}{h}$

(3) $\dfrac{h}{|e|Et^2}$

(4) $-\dfrac{h}{|e|Et}$

45. In a hydrogen atom the electron makes a transition from (n + 1)th level to the nth level. If n>>l, the frequency of radiation emitted is proportional to: **[JEE(Main)-2020]**

(1) $\dfrac{1}{n^4}$

(2) $\dfrac{1}{n^3}$

(3) $\dfrac{1}{n^2}$

(4) $\dfrac{1}{n}$

46. Given below are two statements: **[JEE(Main)-2021]**

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

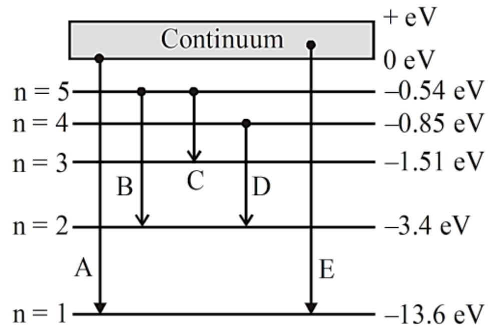
(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are false

(4) Statement I is true but Statement II is false

47. 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:

[JEE(Main)-2021]



(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.

48. The de Broglie wavelength of a proton and α-particle are equal. The ratio of their velocities is:

[JEE(Main)-2021]

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

49. An X-ray tube is operated at 1.24 million volt. The shortest wavelength of the produced photon will be: **[JEE(Main)-2021]**

(1) 10^{-3} nm (2) 10^{-1} nm (3) 10^{-2} nm (4) 10^{-4} nm

50. The wavelength of the photon emitted by a hydrogen atom when an electron makes a transition from n = 2 to n = 1 state is: **[JEE(Main)-2021]**

(1) 194.8 nm (2) 913.3 nm (3) 490.7 nm (4) 121.8 nm

51. 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: **[JEE(Main)-2021]**

(1) 329 nm (2) 309 nm (3) 382 nm (4) 400 nm

52. 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)

[JEE(Main)-2021]

53. 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: **[JEE(Main)-2021]**

(1) 1 : 9 (2) 7 : 108 (3) 7 : 135 (4) 1 : 3

54. The stopping potential in the context of photoelectric effect depends on the following property of incident electromagnetic radiation: **[JEE(Main)-2021]**

(1) Phase
(2) Intensity
(3) Amplitude
(4) Frequency

55. Choose the correct option from the following options given below: **[JEE(Main)-2022]**

(1) In the ground state of Rutherford's model electrons are in stable equilibrium. While in Thomson's model electrons always experience a net-force
(2) An atom has a nearly continuous mass distribution in a Rutherford's model but has a highly non-uniform mass distribution in Thomson's model
(3) A classical atom based on Rutherford's model is doomed to collapse.
(4) The positivity charged part of the atom possesses most of the mass in Rutherford's model but not in Thomson's model

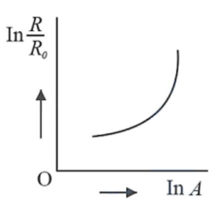
56. In Bohr's atomic model of hydrogen, let K.P and E are the kinetic energy, potential energy and total energy of the electron respectively. Choose the correct option when the electron undergoes transition to a higher level: **[JEE(Main)-2022]**

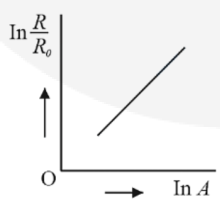
(1) All K.P and E increase.
(2) K decreases. P and E increase
(3) P decreases. K and E increase.
(4) K increases. P and E decrease

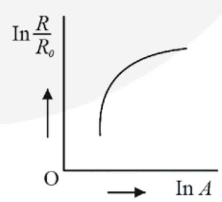
57. The ratio for the speed of the electron in the 3^{rd} orbit of He^+ to the speed of the electron in the 3^{rd} orbit of hydrogen atom will be: **[JEE(Main)-2022]**

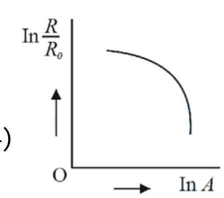
(1) 1 : 1
(2) 1 : 2
(3) 4 : 1
(4) 2 : 1

58. Which of the following figure represents the variation of $\ln\left(\frac{R}{R_0}\right)$ with ln A (If R = radius of a nucleus and A = its mass number) **[JEE(Main)-2022]**

(1) 

(2) 

(3) 

(4) 

59. When light of frequency twice the threshold frequency is incident on the metal plate, the maximum velocity of emitted election is v_1. When the frequency of incident radiation is increased to five times the threshold value, the maximum velocity of emitted electron becomes v_2. If $v_2 = x\, v_1$, the value of x will be ________. **[JEE(Main)-2022]**

60. 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

61. Given below are two statements: **[JEE(Main)-2022]**

Statement I: Davission-Germer experiment establishes the wave nature of electrons.

Statement II: If electrons have wave nature, they can interference and show diffraction.

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) Both statement and Statement II are false

(3) Statement I is true but Statement II is false

(4) Statement I is false but Statement II is true

62. A proton, a neutron, an electron and an α-particle have same energy. If $\lambda_P, \lambda_n, \lambda_e$ and λ_α are the de-Broglie's wavelength of proton, neutron, electron and α particle respectively, then choose the correct relation from the following: **[JEE(Main)-2022]**

(1) $\lambda_P = \lambda_n > \lambda_e > \lambda_\alpha$

(2) $\lambda_\alpha < \lambda_n < \lambda_P < \lambda_e$

(3) $\lambda_e < \lambda_P = \lambda_n > \lambda_\alpha$

(4) $\lambda_e = \lambda_P = \lambda_n = \lambda_\alpha$

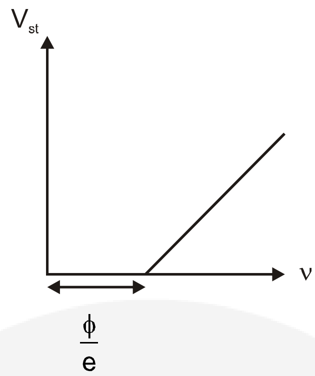
ANSWER KEY

1.	(3)	**2.**	(1)	**3.**	(2)	**4.**	(3)	**5.**	(2)	**6.**	(4)	**7.**	(1)
8.	(2)	**9.**	(1)	**10.**	(4)	**11.**	(4)	**12.**	(4)	**13.**	(2)	**14.**	(2)
15.	(2)	**16.**	(4)	**17.**	(3)	**18.**	(3)	**19.**	(4)	**20.**	(2)	**21.**	(1)
22.	(1)	**23.**	(3)	**24.**	(1)	**25.**	(2)	**26.**	(2)	**27.**	(4)	**28.**	(4)
29.	(3)	**30.**	(3)	**31.**	(4)	**32.**	(3)	**33.**	(1)	**34.**	(1)	**35.**	(4)
36.	(4)	**37.**	(3)	**38.**	(3)	**39.**	11	**40.**	(2)	**41.**	(3)	**42.**	(3)
43.	486	**44.**	(1)	**45.**	(2)	**46.**	(4)	**47.**	(3)	**48.**	(2)	**49.**	(1)
50.	(4)	**51.**	(3)	**52.**	10	**53.**	(3)	**54.**	(4)	**55.**	(3)	**56.**	(2)
57.	(4)	**58.**	(2)	**59.**	2	**60.**	(2)	**61.**	(1)	**62.**	(2)		

JEE-Advanced (Previous Year Questions)

1. The work functions of Silver and sodium are 4.6 and 2.3 eV, respectively. The ratio of the slope of the stopping potential versus frequency plot for Silver to that of Sodium is:

[JEE(Advanced)-2013]



2. The radius of the orbit of an electron in a Hydrogen-like atom is 4.5 a_0, where a_0 is the Bohr radius. Its orbital angular momentum is $\frac{3h}{2\pi}$. It is given that h is Planck constant and R is Rydberg constant. The possible wavelength (s), when the atom de-excites, is (are)

[JEE(Advanced)-2013]

(A) $\frac{9}{32R}$ (B) $\frac{9}{16R}$

(C) $\frac{9}{5R}$ (D) $\frac{4}{3R}$

3. If λ_{cu} is the wavelength of K_α X-ray line of copper (atomic number 29) and λ_{M_o} is the wavelength of the K_α X-ray line of molybdenum (atomic number 42), then the ratio $\lambda_{cu} / \lambda_{M_o}$ is close to

[JEE(Advanced)-2014]

(A) 1.99 (B) 2.14

(C) 0.50 (D) 0.48

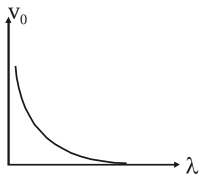
4. A metal surface is illuminated by light of two different wavelengths 248 nm and 310 nm. The maximum speeds of the photoelectrons corresponding to these wavelengths are u_1 and u_2, respectively. If the ratio $u_1 : u_2 = 2 : 1$ and hc = 1240 eV nm, the work function of the metal is nearly **[JEE(Advanced)-2014]**

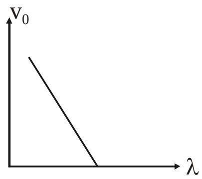
(A) 3.7 eV (B) 3.2 eV

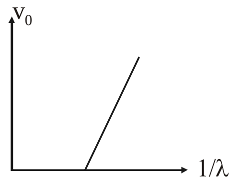
(C) 2.8 eV (D) 2.5 eV

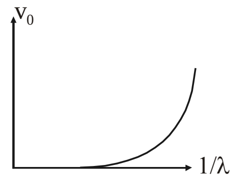
5. Consider a hydrogen atom with its electron in the n^{th} orbital. An electromagnetic radiation of wavelength 90 nm is used to ionize the atom. If the kinetic energy of the ejected electron is 10.4 eV, then the value of n is (hc = 1242 eV nm) **[JEE(Advanced)-2015]**

6. For photo-electric effect with incident photon wavelength λ, the stopping potential is V_0. Identify the correct variation(s) of V_0 with λ and $1/\lambda$. **[JEE(Advanced)-2015]**

(A) 

(B) 

(C) 

(D) 

7. Planck's constant h, speed of light c and gravitational constant G are used to form a unit of length L and a unit of mass M. Then the correct option(s) is(are) **[JEE(Advanced)-2015]**

(A) $M \propto \sqrt{c}$ (B) $M \propto \sqrt{G}$ (C) $L \propto \sqrt{h}$ (D) $L \propto \sqrt{G}$

8. An electron in an excited state of Li^{2+} ion has angular momentum $3h/2\pi$. The de Broglie wavelength of the electron in this state is $p\pi a_0$ (where a_0 is the Bohr radius). The value of p is **[JEE(Advanced)-2015]**

9. In a historical experiment to determine Planck's constant, a metal surface was irradiated with light of different wavelengths. The emitted photoelectron energies were measured by applying a stopping potential. The relevant data for the wavelength (λ) of incident light and the corresponding stopping potential (V_0) are given below:

λ(μm)	V_0(Volt)
0.3	2.0
0.4	1.0
0.5	0.4

Given that $c = 3\times10^8$ ms^{-1} and $e = 1.6 \times 10^{-19}$ C, Planck's constant (in units of Js) found from such an experiment is: **[JEE(Advanced)-2016]**

(A) 6.0×10^{-34} (B) 6.4×10^{-34} (C) 6.6×10^{-34} (D) 6.8×10^{-34}

10. Highly excited states for hydrogen like atom (also called Rydberg states) with nuclear charge Ze are defined by their principal quantum number n, where n >> 1. Which of the following statement(s) is (are) true? **[JEE(Advanced)-2016]**

(A) Relative change in the radii of two consecutive orbitals does not depend on Z

(B) Relative change in the radii of two consecutive orbitals varies as 1/n

(C) Relative change in the energy of two consecutive orbitals varies as $1/n^3$

(D) Relative change in the angular momenta of two consecutive orbitals varies as 1/n

11. A hydrogen atom in its ground state is irradiated by light of wavelength 970 Å. Taking $\frac{hc}{e} = 1.237\times10^{-6}$ eV m and the ground state energy of hydrogen atom as –13.6 eV, the number of lines present in the emission spectrum is **[JEE(Advanced)-2016]**

12. 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]**

13. A photoelectric material having work-function ϕ_0 is illuminated with light of wavelength $\lambda, \left(\lambda < \frac{hc}{\phi_0}\right)$. The fastest photoelectron has a de Broglie wavelength λ_d. A change in wavelength of the incident light by $\Delta\lambda$ results in a change $\Delta\lambda_d$ in λ_d. Then the ratio $\Delta\lambda_d / \Delta\lambda$ is proportional to **[JEE(Advanced)-2017]**

(A) λ_d/λ (B) λ_d^2/λ

(C) λ_d^3/λ (D) λ_d^3/λ^2

14. In a photoelectric experiment a parallel beam of monochromatic light with power of 200 *W* is incident on a perfectly absorbing cathode of work function 6.25 *eV*. The frequency of light is just above the threshold frequency so that the photoelectrons are emitted with negligible kinetic energy. Assume that the photoelectron emission efficiency is 100%. A potential difference of 500 *V* is applied between the cathode and the anode. All the emitted electrons are incident normally on the anode and are absorbed. The anode experiences a force $F = n \times 10^{-4}$ N due to the impact of the electrons. The value of n is __________. Given Mass of the electron $m_e = 9 \times 10^{-31}$ *kg* and 1.0 *eV* = 1.6×10^{-19} J. **[JEE(Advanced)-2018]**

15. Consider a hydrogen-like ionized atom with atomic number *Z* with a single electron. In the emission spectrum of this atom, the photon emitted in the n = 2 to n = 1 transition has energy 74.8 *eV* higher than the photon emitted in the n = 3 to n = 2 transition. The ionization energy of the hydrogen atom is 13.6 *eV*. The value of Z is __________. **[JEE(Advanced)-2018]**

16. A free hydrogen atom after absorbing a photon of wavelength λ_a gets excited from the state n = 1 to the state n = 4. Immediately after that the electron jumps to n = m state by emitting a photon of wavelength λ_e. Let the change in momentum of atom due to the absorption and the emission are Δp_a and Δp_e respectively. If $\lambda_a/\lambda_e = \frac{1}{5}$, which of the option(s) is/are correct?

[JEE(Advanced)-2019]

[**Use:** hc = 1242 eV nm; 1 nm = 10^{-9} m, h and c are Planck's constant and speed of light, respectively]

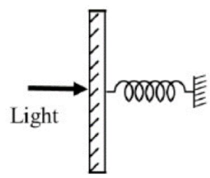
(A) m = 2

(B) $\Delta p_a/\Delta p_e = \frac{1}{2}$

(C) The ratio of kinetic energy of the electron in the state n = m to the state n = 1 is $\frac{1}{4}$

(D) $\lambda_e = 418$ nm

17. A perfectly reflecting mirror of mass M mounted on a spring constitutes a spring-mass system of angular frequency Ω such that $\frac{4\pi M\Omega}{h} = 10^{24}\ m^{-2}$ with h as Planck's constant. N photons of wavelength $\lambda = 8\pi \times 10^{-6}$ m strike the minor simultaneously at normal incidence such that the minor gets displaced by 1 μm. If the value of N is $X \times 10^{12}$, then the value of X is______.
[Consider the spring as massless] **[JEE(Advanced)-2019]**



18. A particle of mass m moves in circular orbits with potential energy V(r) = Fr, where F is positive constant and r its distance from the origin. Its energies are calculated using the Bohr model. If the radius of the particle's orbit is denoted by R and its speed and energy are denoted by v and E, respectively, then for the n^{th} orbit (here h is the Planck's constant) **[JEE(Advanced)-2020]**

(A) $R \propto n^{1/3}$ and $v \propto n^{2/3}$
(B) $R \propto n^{2/3}$ and $v \propto n^{1/3}$
(C) $E = \frac{3}{2}\left(\frac{n^2h^2F^2}{4\pi^2 m}\right)^{1/3}$
(D) $E = 2\left(\frac{n^2h^2F^2}{4\pi^2 m}\right)^{1/3}$

19. 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

20. Which of the following statement(s) is(are) correct about the spectrum of hydrogen atom?
[JEE(Advanced)-2021]

(A) The ratio of the longest wavelength to the shortest wavelength in Balmer series is 9/5
(B) There is an overlap between the wavelength ranges of Balmer and Paschen series
(C) The wavelength of Lyman series are given by $\left(1+\frac{1}{m^2}\right)\lambda_0$, where λ_0 is the shortest wavelength of Lyman series and m is an integer
(D) The wavelength ranges of Lyman and Balmer series do not overlap

21. 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 metal 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]**

22. When light of a given wavelength is incident on a metallic surface, the minimum potential needed to stop the emitted photoelectrons is 6.0 V. This potential drops to 0.6 V if another source with wavelength four times that of the first one and intensity half of the first one is used. What are the wavelength of the first source and the work function of the metal, respectively? [Take $\frac{hc}{e} = 1.24 \times 10^{-6} \text{Jm C}^{-1}$.] **[JEE(Advanced)-2022]**

(A) 1.72×10^{-7} m, 1.20 eV
(B) 1.72×10^{-7} m, 5.60 eV
(C) 3.78×10^{-7} m, 5.60 eV
(D) 3.78×10^{-7} m, 1.20 eV

ANSWER KEY

1.	1	**2.**	(AC)	**3.**	(B)	**4.**	(A)	**5.**	2	**6.**	(AC)	**7.**	(ACD)
8.	2	**9.**	(B)	**10.**	(ABD)	**11.**	6	**12.**	5	**13.**	(D)	**14.**	24.00
15.	3.00	**16.**	(AC)	**17.**	1.00	**18.**	(BC)	**19.**	(AC)	**20.**	(AD)	**21.**	6
22.	(A)												