PHYSICS

BOOKS - DC PANDEY PHYSICS (HINGLISH)

MODERN PHYSICS

Example

1. The intensity of direct sunlight befor it passes through the earth's atmosphere is $1.4kW \mid m^2$. If it is completely absorbed, find the corresponding radiation pressure.

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2. An electron is accelerated by a potential difference of 25 volt . Find the de- Broglie wavelength associated with it.

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3. A partical of mass M at rest decays into two Particles of masses m_1 and m_2 having non-zero velocities. The ratio of the de - Broglie wavelengths

of the particles $\lambda_1 | \lambda_2$ is

(a) m_1 / m_2 (b)m_2 / m_1 (c) 1 (d)$\sqrt{,}_2 / \sqrt{\_}1$

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4. The energy of a photon is equal to the kinetic energy of a

proton. The energy of the photon is E. Let $\lambda_1$be the de-Broglie wavelength of the

proton and λ_2 be the wavelength of the photon. The ratio $\frac{\lambda_1}{\lambda_2}$ is proportional to

(a)E^0 (b) $E^{1/2}$ (c) E^{-1} (d)E^{-2}

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5. An α- particle and a proton are accelerated from rest by a potential difference of 100V. After this, their de-Broglie wavelengths are λ_a and λ_p respectively. The ratio $\frac{\lambda_p}{\lambda_a}$, to the nearest integer, is.

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6. The potential energy of a partical varies as

. $U(x) = E_0 f \text{ or } 0 \leq x \leq 1 \quad = 0 f \text{ or } x > 1 F \text{ or } 0 \leq x \leq 1,$ de-Broglie wavelength is λ_1 and for xgt the de-Broglie wavelength is λ_2. Total energy of the partical is 2E_0. find $\frac{\lambda_1}{\lambda_2}$.

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7. Using the known values for haydrogen atom, calculate

. (a) radius of thirdj orbit for Li^{+2}

. (b) speed of electron in fourth orbit for He^{+}

. (c) angular momentum of electron in 3rd orbit of He^{+}.

A. $O.53 \text{Å}\ 2.19 \times 10^{6} m/s\ 3\left(\frac{h}{2\pi}\right)$

B. $1.59 \text{Å}\ 2.19 \times 10^{6} m/s\ 3\left(\frac{h}{3\pi}\right)$

C. $1.59 \text{Å}\ 2.19 \times 10^{-6} m/s\ 3\left(\frac{h}{2\pi}\right)$

D. $1.59 \text{Å}\ 2.19 \times 10^{6} m/s\ 3\left(\frac{h}{2\pi}\right)$

Answer: D

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8. A doubly ionized lithium atom is hydrogen like with atomic

. number 3. Find the wavelength of the radiation to excite the electron in

. $Li++$ form the first to the third Bohr orbit. The ionization energy of

the hydrogen

. Atom is 13.6V.

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9. Find variation of angular speed and time period of single

. electron of hydrogen like atoms with n and Z.

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10. find kinetic energy, electrostatic potential energy and total

. energy of single electron in 2nd excited state of Li^{+2} atom.

A. $E = -13.6 eV \; K.E = 13.6 eV \; P.E = 27.2 eV$

B. $E = 13.6 eV \; K.E = 13.6 eV \; P.E = 27.2 eV$

C. $E = -13.6 eV \; K.E = 13.6 eV \; P.E = -27.2 eV$

D. $E = 13.6 eV \; K.E = 13.6 eV \; P.E = -27.2 eV$

Answer: C

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11. Find the kinetic energy, potential energy and total energy in

first and second orbit of hydrogen atom if potential energy in first orbit is

taken

to be zero.

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12. A small particle of mass m moves in such a way that the

potential energy $U = ar^2$, where a is constant and r is the distance of

the

particle from the origin. Assuming Bhor model of quantization of angular

momentum and circular orbits, find the rodius of nth allowed orbit.

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13. Calculate (a) the wavelength and (b) the frequencey of the $H\beta$

line of the Balmer series for hydrogen.

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14. Find the largest and shorted wavelengths in the Lyman

series for hydrogen. In what region of the electromagnetic spectrum does

each

series lie?

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15. In a hypothetical atom, mass of electron is doubled, value

of atomic number is $Z = 4$. Find wavelength of photon when this

electron jumps

from 3rd excited state to 2nd orbit.

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16. Find the cut off walelength for the continuous X - rays coming

form an X-ray tube operating at 40 kv.

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17. Use Moseley's law with b = 1 to find the frequency of the K_{α} X-ray of $La(Z = 57)$ if the frequency of the K_{α} X-ray of $Cu(Z = 29)$ is known to be $1 \cdot 88 \times 10^{18}$ Hz.

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18. Electrons with de - Brogli wavelengtyh λ fall on the target in an X-ray tube.The cut off wavelength of the emitted Xrays is

(a) $\lambda_0 = \frac{2mc\lambda^2}{h}$ (b)$\lambda_0 = \frac{2h}{mc}$

(c) $\lambda_0 \frac{2m^2c^2\lambda^3}{h^2}$ (d)$\lambda_0 = \lambda$

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19. Electrons with energy $80keV$ are incident on the tungsten target of an X - rays tube , k- shell electrons of tungsten have $72.5keV$ energy X-rays emitted by the tube contain only

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20. A metal plate is placed 5m from a monchromatic ligth

soure whose power output is 10^{-3}W. Consider that a given ejected

photoelectron may collect its energy from a circular area of the plate as

large as

ten atomic diameters 10^{-9} m in radius. The energy required to remove

an electron through the metal surface is about 5.0 eV. Assuming light to

be a

wave, how long would it take for such a 'target' to soak up this much

energy

from such a light source.

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21. The photoelectric work - function of potassium is 2.3 eV. If light

having a wavelength of 2800Å falls on potassium, find

(a) the kinetic energy in electron volts of the most energetic electrons ejected.

(b) the stopping potential in volts.

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22. When a beam of 10.6 eV photons of intensity $2.0W/m^2$ falls on a platinum surface of area $1.0 \times 10^{-4}m^2$ and work function 5.6 eV, 0.53% of the incident photons eject photoelectrons. Find the number of photoelectrons emitted per second and their minimum and maximum energy (in eV). Take $1eV = 1.6 \times 10^{-19}J$.

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23. Maximum kinetic energy of photoelectrons from a metal surface is K_0 when wavelngth of incident light is λ. If wavelength is decreased to $\lambda \mid 2$, the maximum kinetic energy of photoelectrons becomes

(a) $= 2K_0$ (b) $> 2K_0$ (c) $< 2K_0$

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24. Intensity and frequency of incident light both are doubled.

Then, what is the effect on stopping potential and saturation current.

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25. When a monochromatic point source of light is at a distance

of 0.2 m from a photoelectric cell, the cut off voltage and the saturation

current

are respectively 0.6 V and 18.0 mA. If the same source is placed 0.6 m away

from the photoelectric cell, then

(a) the stopping potential will be 0.2 V

(b) the stopping potential will be 0.6 V

(c) the saturation current will be 6.0 mA

(d) the saturation current will be 2.0 mA

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26. The threshold wavelength for photoelectric emission for a material is $5200A^{\circ}$. Will the photoelectrons be emitted when this material is illuminated with monochromatic radiation from 1 watt ultra violet lamp?

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27. Mass number of a nucleus X is A and atomic number is Z. Find mass number and atomic number of the new nucleus (say Y) after the emission of m-alpha particles and n-beta particles.

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28. At time $t=0$, number of nuclei of a radioactive substance are 100. At $t=1$ s these numbers become 90. Find the number of nuclei at $t=2s$.

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29. At time $t = 0$, activity of a radioactive substance is 1600 Bq, at t=8 s activity remains 100 Bq. Find the activity at t=2 s.

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30. From a radioactive substance n_1 nuclei decay per second at an instant when total number of nuclei are n_2. Find half-life of the radioactive substance.

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31. Half-life of a radioactive substance is T. At time t_1 activity of a radioactive substance is R_1 and at time t_2 it is R_2. Find the number of nuclei decayed in this interval of time.

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32. Two radioactive X_1 and X_2 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 X_1 to that of X_2will be $1/e$ after a time .

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33. The half-life period of a radioactive element x is same as the mean life time of another radioactive element y. Initially, both of them have the same number of atoms. Then,

(a) x and y have the same decay rate initially

(b) x and y decay at the same rate always

(c) y will decay at a faster rate than x

(d) x will decay at a faster rate than y

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34. A radioactive sample consists of two distinct species having equal number of atoms initially. The mean life of one species is τ and that of the other is 5τ. The decay products in both cases are stable. A plot is made of the total number of radioactive nuclei as a function of time. Which of the following figure best represents the form of this plot?

(a), (b), (c), (d)

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35. A radio nuclide X is produced at constant rate α. At time $t = 0$, number of nuclei of X are zero. Find

(a) the maximum number of nuclei of X.

the number of nuclei at time t.

Decay constant of X is λ.

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36. In the above problem if each decay produces E_0 energy, then find

(a) power produced at time t

(b) total energy produced upto time t

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37. Find the increase in mass of water when $1.0kg$ of water absorbs 4.2×10^3 J of energy to produce a temperature rise of $1K$.

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38. In the fusion reaction $_1^2H +_1^2 H \rightarrow_2^3 He +_0^1 n$, the masses of deuteron, helium and neutron expressed in amu are 2.015, 3.017 and 1.009 respectively. If 1 kg of deuterium undergoes complete fusion, find the amount of total energy released. 1 amu $= 931.5MeV/c^2$.

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39. A nucleus with mass number 220 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.

(a) 4.4 MeV (b) 5.4 MeV (c) 5.6 MeV (d) 6.5 MeV

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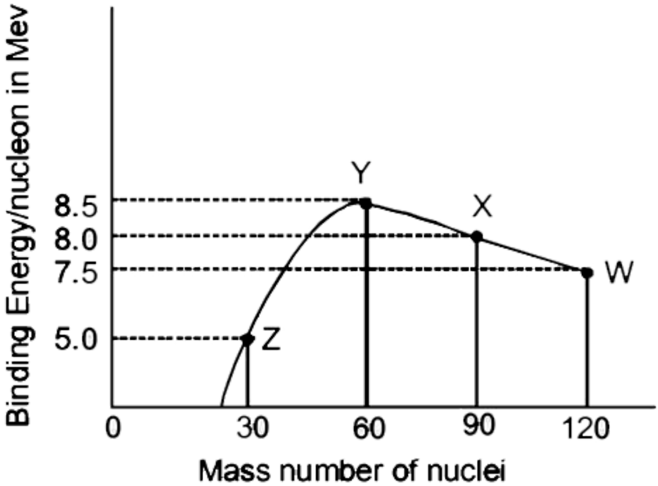
40. Binding energy per nucleons vs mass curve for nucleus is shown in the figure W, X, Y and Z are four nuclei indicated on the curve . The process that would release energy is



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41. A star initially has 10^{40} deuterons. It produces energy via the processes $_1H^2 +_1 H^2 \rightarrow_1 H^3 + p$ and $_1H^2 +_1 H^3 \rightarrow_2 He^4 + n$. If the average power radiated by the star is 10^{16} W, the deuteron supply of the star is exhausted in a time of the order of

(a) $10^6 s$ (b) $10^8 s$ (c) $10^{12} s$

The masses of the nuclei are as follows

$M(H^2) = 2.014$ amu, $M(n) = 1.008$ amu,

$M(p) = 1.007$ amu,$M(He^4) = 4.001$amu

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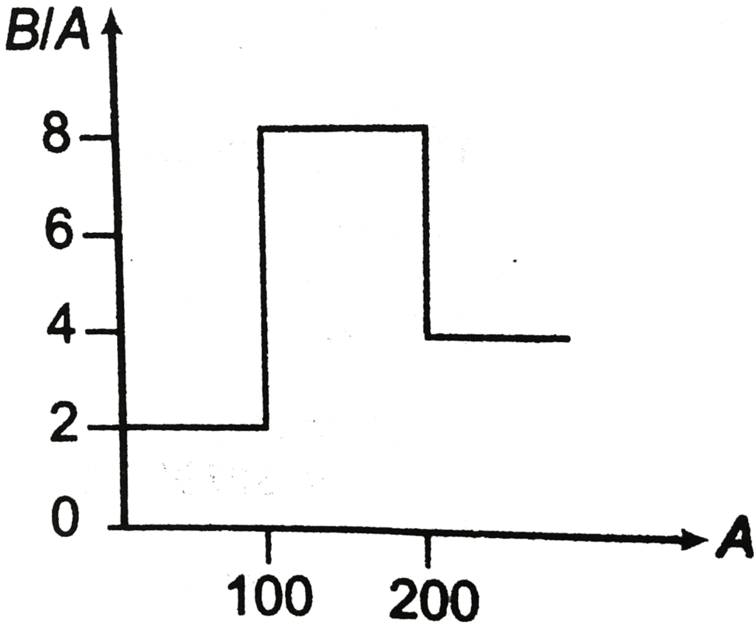
42. Assume that the nuclear binding energy per nucleon (B/A) versus mass number (A) is as shown in figure. Use this plot to choose the correct choice(s) given below.

(a) Fusion of two nuclei with mass numbers, lying in the range of $1 < A < 50$ will release energy.

Fusion of two nuclei with mass numbers lying in the range of $51 < A < 100$ will release energy.

(c) Fission of a nucleus lying in the mass range of $100 < A < 200$ will release energy when broken into two equal fragements.

(d) Fission of a nucleus lying in the mass range of $200 < A < 260$ will release energy when broken into two equal fragments.



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Example Type 1

1. A proton is fired from very for away towards a nucleus with charge Q = 120 e, where e is the electronic charge. It makes a closest approach of 10fm to the nucleus. The de - Broglie wavelength (in units of fm) of the proton at its start is [take the proton mass,

$m_p = (5/3 \times 10^{-27} kg, h \leq \ = 4.2 \times 10^{-15} J - s/C,$

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 m/F, 1 fm = 10^{-15}\Big]$

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2. Find de-Broglie wavelength of single electron in 2 nd orbit of hydrogen atom by two methods.

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3. At a given instant there are 25% undecayed radioactive nuclei in a sample. After 10 s the number of undecayed nuclei reduces to 12.5%. Calculate

(a) mean life of the nuclei,

(b) the time in which the number of undecayed nuclei will further reduce to 6.25% of the reduced number.

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4. A radioactive element decays by $\beta - emission$. A detector records n beta particles in 2 s and in next 2 s it records 0.75 n beta particles. Find mean life correct to nearest whole number. Given ln $|2| = 0.6931$, ln $|3| = 1.0986$.

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5. A small quantity of solution containing Na^{24} radio nuclide (half-life=15 h) of activity 1.0 microcurie is injected into the blood of a person. A sample of the blood of volume $1cm^3$ taken after 5h shows an activity of 296 disintegrations per minute. Determine the total volume of the blood in the body of the person. Assume that the radioactive solution mixes uniformly in the blood of person.

(1 curie $= 3.7 \times 10^{10}$ disintegrations per second)

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6. A radioactive nucleus X decays to a nucleus Y with a decay constant $\lambda_X = 0.1 s^{-1}$, Y further decays to a stable nucleus Z with a decay constant

$\lambda_Y = 1/30 s^{-1}$. Initially, there are only X nuclei and their number is $N_0 = 10^{20}$. Set up the rate equations for the populations of X, Y and Z. The population of Y nucleus as a function of time is given by $N_Y(t) = \{N_0 \lambda_X / (\lambda_X - \lambda_Y)\}[\exp(-\lambda_Y t) - \exp(-\lambda_X t)]$.

Find the time at which N_Y is maximum and determine the population X and Z at that instant.

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Example Type 2

1. The electirc potential between a proton and an electron is given by $V = V_0 \in \frac{r}{r_0}$, where r_0 is a constant. Assuming Bhor model to be applicable, write variation of r_n with n, being the principal quantum number. (a) $r_n \propto n$ (b) $r_n \propto \frac{1}{n}$ (c) r_n^2 (d)$r_n \propto \frac{1}{n^2}$

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2. Imagine an atom made up of a proton and a hypothetical particle of double the mass of the electron but having the same charge as the electron . Apply the Bohr atom model and consider all possible transitions of this hypothetical particle that will be emitted level . The longest wavelength photon that will be emitted has longest wavelength λ (given in terms of the Rydberg constant R for the hydrogen atom) equal to

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3. The recoil speed of a hydrogen atom after it emits a photon is going form n=5 state to n =1 state is ..... m/s.

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4. A hydrogen like atom (described by the Borh model) is observed to emit six wavelength, originating from all possible transitions between a group of levels. These levels have energies between - 0.85 eV and 0.544 eV (including both these values). (a)Find the atomic number of the atom.

(b) Calculate the smallest wavelength emitted in these transitions.

(Take, hc = 1240 eV - nm, ground state energy of hydrogen atom =-13.6 eV)

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5. A hydrogen like atom number Z is in an excited state of quantum number 2n. It can emit a maximum energy photon of 204 eV. If it makes a transition ot quantum state n, a photon of energy 40.8 eV is emitted. Find n, Z and the ground state energy (in eV) of this atom. Also calculate the minimum energy of hydrogen atom is -13.6 ev.

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6. A hydrogen like atom (atomic number Z) is in a higher excited state of quantum number n. The excited atom can make a transition ot the first excited state by successively emitting two photons of energy 10.2 eV and 17.0 eV, respectively. Alternatively, the atom from the same excited state can make a transition to the second excited state by successively emitting two photons of energies 4.25 eV and 5.95 eV, respectivley Determine the values of n and Z. (Ionization energy of H-atom = 13.6 eV)

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7. In a nuclear reactor $\hat{} 235U$ undergoes fission liberating 200 MeV of energy. The reactor has a 10% efficiency and produces 1000 MW power. If the reactor is to function for 10 yr, find the total mass of uranium required.

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8. The element curium $_96^{248}Cm$ has a mean life of $10^{13}s$. Its primary decay modes are spontaneous fission and α-decay, the former with a probability of 8% and the later with a probability of 92%, each fission releases 200 MeV of energy. The masses involved in decay are as follows

$_96^{248}Cm = 248.072220u$,

$_94^{244}P_u = 244.064100u$ and $_2^4He = 4.002603u$. Calculate the power output from a sample of 10^{20} Cm atoms. ($1u = 931MeV/c^2$)

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9. A nucleus X, initially at rest, undergoes alpha-decay according to the equation.

$_92^A X \rightarrow_Z^{228} Y + \alpha$

(a) Find the values of A and Z in the above process.

(b) The alpha particle produced in the above process is found in move in a circular track of during the process and the binding energy of the parent nucleus X.

Given that $m(Y) = 228.03u$, $m($_0^1n)=1.009um($\_ 2^4 He) = 4.003u$, $m($

_1^1H)=1.008u`

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10. It is proposed to use the nuclear fusion reaction,

$\_ 1^2 H +_1^2 H \rightarrow_2^4 He$

in a nuclear reactor 200 MW rating. If the energy from the above reaction is used with a 25 per cent efficiency in the reactor, how many grams of deuterium fuel will be needed per day?(The masses of $\_ 1^2 H$ and `_2^4He are 2.0141 atommic mass units and 4.0026 atomic mass units respectively.)

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Example Type 3

1. Determine the energy of the characteristic X-ray $\left(K_{\beta}\right)$ emitted from a tungsten (Z = 74) target when an electron drops from the M-shell (n=3) to a vacancy in the K-shell (n=1)

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2. The potential difference applied to an X-ray tube is 5k V and the current through it is 3.2 mA. Then, the number of electrons striking the target per second is. (a) 2×10^{16} (b) 5×10^{6} (c) 1×10^{17} (d) 4×10^{15}.

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3. Highly energetic electron are bombarded in a target of an element containing 30 neutrons Tne ratio of nucleus to that of Helium nucleus is $(14)^{1/3}$. Find (a) atomic number of the nucleus (b) the frequency of k_{a} line of the X- rays producted $\left(R = 1.1 \times 10^{7} m^{-1} \text{ and } c = 3 \times 10^{8} m/s\right)$

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4. Stopping potential of 24, 100, 110 and 115 k V are measured for photoelectrons emitted from a certain element when it is radiated with monochromatic X-ray . If this element is used as a target in an X-ray tube,what will be the wavelength of K_a - line?

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Example Type 4

1. A monochromatic light soure of frequency f illuminates a metallic surface and ejects photoelectrons. The photoelectrons having maximum energy are just able to ionize the hydrogen atoms in ground state. When the whole experiment is repeated with an incident radiation of frequency $\frac{5}{6}f$, the photoelectrons so emitted are able to excite the hydrogen atom beam which then emits a radiation of wavelength 1215Å. (a) What is the frequency of radiation? (b) Find the work- function of the metal.

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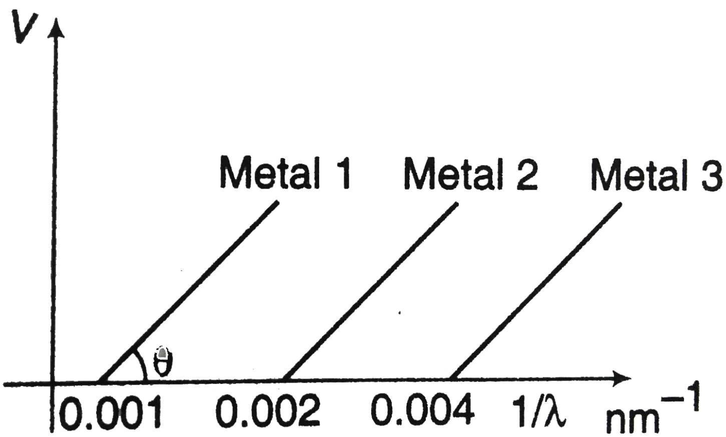
2. The graph between $1/\lambda$ and stopping potential (V) of three metals having work- functions Φ_1, Φ_2 and Φ_3 in an experiment of photoelectric effect is plotted as shown in the figure. Which of the following statement(s) is/are correct? (Here, λ is the wavelength of the incident ray). (a) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 1:2:4$ (b) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 4:2:1$ (c) tan θ is directly proportional to hc / e, where h is Planck constant and c is the speed of light (d) The violet colour light can eject photoelectrons from metals 2 and 3 .



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3. A beam of light has three wavelengths 4144Å, and 6216Å with a total instensity of $3.6 \times 10^{-3} Wm^{-2}$ equally distributed amongst the three wavelengths. The beam falls normally on an area $1.0 cm^2$ of a clean metallic surface of work function 2.3 eV. Assume that there is no loss of light by reflection number of photoelectrons liberated in two seconds.

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Miscellaneous Examples

1. Two metallic plate A and B , each of area $5 \times 10^{-4} m^2$, are placed parallel to each at a separation of $1 cm$ plate B carries a positive charge of $33.7 \times 10^{-12} C$ A monocharonatic beam of light , with photoes of energy $5 eV$ each , starts falling on plate A at $t = 0$ so that 10^{16} photons fall on it per square meter per second. Assume that one photoelectron is emitted for every 10^6 incident photons fall on it per square meter per second. Also assume that all the emitted photoelectrons are collected by plate B and the work function of plate A remain constant at the value

$2eV$ Determine

(a) the number of photoelectrons emitted up to $i = 10s$,

(b) the magnitude of the electron field between the plate A and B at $i = 10s$, and

(c) the kinetic energy of the most energotic photoelectrons emitted at $i = 10s$ whenit reaches plate B

Negilect the time taken by the photoelectrons to reach plate B Take $\varepsilon_0 = 8.85 \times 10^{-12} C^2 N - m^2$

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2. Photoelectrons are emitted when 400 nm radiation is incident on a surface of work - function 1.9 eV. These photoelectrons pass through a region containing a-particles. A maximum energy electron combines with an a -particle to from 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. $\left[Take, h = 4.14 \times 10^{-15} eV - s\right]$

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3. Light form a dicharge tube containing hydrogen atoms falls on the surface of a piece of sodium. The kinetic energy of the fastest photoelectrons emitted from sodium is 0.73 eV. The work function for sodium is 1.82 eV. Find (a) the energy of the photons causing the photoelectrons emission.

(b) the quatum numbers of the two levels involved in the emission of these photons.

(c) the change in the angular momentum of the electron in the hydrogen atom, in the above transition, and

(d) the recoil speed of the emitting atom assuming it to be at rest before the transition. (Ionization potential of hydrogen is 13.6 eV.)

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4. If an X-ray tube operates at the voltage of 10kV, find the ratio of the de-broglie wavelength of the incident electrons to the shortest wavelength of X-ray producted. The specific charge of electron is $1.8 \times 10^{11} \frac{C}{k} g$.

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5. The wavelength of the first line of Lyman series for hydrogen is identical to that of the second line of Balmer series for some hydrogen like ion x. Calculate the atomic no of ion

A. 1

B. 3

C. 4

D. 2

Answer: D

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6. A moving hydrogen atom makes a head on collision with a stationary hydrogen atom. Befor collision both atoms are in in ground state and after collision they move together. What is the minimum value of the kinetic energy of the moving hydrogen atom, such that one of the atoms reaches one of the excited state?

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7. An imaginary particle has a charge equal to that of an electron and mass 100 times tha mass of the electron. It moves in a circular orbit around a nucleus of charge + 4 e. Take the mass of the nucleus to be infinite. Assuming that the Bhor model is applicable to this system. (a)Derive an experssion for the radius of nth Bhor orbit. (b) Find the wavelength of the radiation emitted when the particle jumps from fourth orbit to the second orbit.

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8. The energy levels of a hypothetical one electron atom are given by

$$E_n = -\frac{18.0}{n^2} eV$$

where n = 1,2,3,.... (a) Compute the four lowest energy levels and construct the energy levels diagram. (b) What is the first excitation potential (c) What wavelength (Å) can be emitted when these atoms in the ground state are bombarged by electrons that have been accelerated through a potential difference of 16.2 V? (e) what is the photoelectric threshold wavelength of this atom?

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9. In a photocell the plates P and Q have a separation of 5 cm, which are connected through a galvanometer without any cell. Bichromatic light of wavelengths 4000Å and 6000Å are incidenton plate Q whose work-functionis 2.39 eV. If a uniform magnetic field B exists parallel to the plates, find the minimum value of B for which the galvanometer shows zero deflection.

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10. Find the minimum kinetic energy of an α-particle to cause the reaction $\hat{}\ 14N(\alpha, p)^{17}O$. The masses of $\hat{}\ 14N$, $\hat{}\ 4He$, $\hat{}\ 1H$ and $\hat{}\ 17O$ are respectively 14.00307u, 4.00260u, 1.00783u and 16.99913u.

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11. Neon-23 decays in the following way,

$$\_\ 10^{23}Ne \rightarrow^{23}_{11} Na +^{0}_{-1} e + \bar{v}$$

Find the minimum and maximum kinetic energy that the beta particle $\left(\_(-1)^{0}e\right)$ can have. The atomic masses of $\hat{}\ 23Ne$ and $\hat{}\ 23Na$ are $22.9945u$ and $22.9898u$, respectively.

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12. The mean lives of an unstable nucleus in two different decay processes are 1620 yr and 405 yr, respectively. Find out the time during which three-fourth of a sample will decay.

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13. In the chemical analysis of a rock the mass ratio of two radioactive isotopes is found to be $100:1$. The mean lives of the two isotopes are 4×10^9 years and 2×10^9 years, respectively. If it is assumed that at the time of formation the atoms of both the isotopes were in equal propotional, calculate the age of the rock. Ratio of the atomic weights of the two isotopes is $1.02:1$.

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14. A proton is bombarded on a stationary lithium nucleus. As a result of the collision, two α-particles are produced. If the direction of motion of the α-particles with the initial direction of motion makes an angles $\cos^{-1}(1/4)$, find the kinetic energy of the striking proton. Given, binding energies per nucleon of Li^7 and He^4 are 5.60 and 7.06 MeV, respectively. (Assume mass of proton $\approx$ mass of neutron).

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15. A $\hat{}\ 7Li$ target is bombarded with a proton beam current of 10^{-4} A for 1 hour to produce $\hat{}\ Be$ of activity 1.8×10^8 disintegrations per second.

Assuming that $\hat{}\ 7Be$ radioactive nucleus is produced by bombarding 1000 protons, determine its half-life.

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16. A ^{118}Cd radio nuclide goes through the transformation chain.

$$^{118}Cd \xrightarrow[30\,\text{min}]{} {}^{118}In \xrightarrow[45\,\text{min}]{} {}^{118}Sn(\text{stable})$$

The half-lives are written below the respective arrows. At time $t = 0$ only Cd was present. Find the fraction of nuclei transformed into stable over 60 minutes.

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17. Natural uranium is a mixture of three isotopes $\_92^{234}U$, $\_92^{234}U$, $\_92^{235}U$ and $\_92^{238}U$ with mass percentage 0.01%, 0.71% and 99.28% respectively. The half-life of three isotopes are $2.5 \times 10^5 yr$, $7.1 \times 10^8 yr$ and $4.5 \times 10^9 yr$ respectively.

Determine the share of radioactivity of each isotope into the total activity of the natural uranium.

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18. Uranium ores on the earth at the present time typically have a composition consisting of 99.3% of the isotope $\_92U^{238}$ and 0.7% of the isotope $\_92U^{235}$. The half-lives of these isotopes are $4.47 \times 10^9 yr$ and $7.04 \times 10^8 yr$, respectively. If these isotopes were equally abundant when the earth was formed, estimate the age of the earth.

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Exercise 33.1

1. Find the energy and mometum of a photon of ultraviolet radiation of 280 nm wavelength.

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2. A small plate of a metal is placed at a distance of 2m from a monochromatic light source of wavelenght $4.8 \times 10^{-7} m$ and power 1.0 Watt. The light falls normally on the plate. Find the number of photons striking the metal plate per square metre per second.

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3. A proton and deuteron are accelerated by same potential difference.Find the ratio of their de-Broglie wavelengths.

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4. A deuteron and an α - partical have same kinetic energy. Find the ratio of their de-Broglie wavelengths.

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5. Two protons are having same kinetic energy. One proton enters a uniform magnetic field at right angles ot it. Second proton enters a uniform electric field in the direction of field. After some time their de Broglie wavelengths are λ_1 and λ_2 then (a) $\lambda_1 = \lambda_2$ (b) $\lambda_1 < \lambda_2$ (c) $\lambda_1 > \lambda_2$ (d) some more information is required

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6. Find the de-Broglie wavelengths of (a) a 46 g golf ball with a velocity of 30m/s (b) an electron with a velocity of $10^7 m/s$.

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Exercise 33.2

1. Find the ionisation energy of a doubly Ionized lithium atom.

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2. A hydrogen atom is in a state with energy $-1.51eV$. in the Bohr model, what is the angular momentum of the electron in the atom with respect to an axis at the nucleus?

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3. As an electron makes a transition from an excited state to the ground state of a hydrogen like atom/ion

(a) kinetic energy, potential energy and total energy decrease

(b) kinetic energy decreases, potential energy increases but total energy remains same

(c) kinetic energy and total energy decrease but potential energy increases

(d) its kinetic energy increases but potential energy and total energy decrease

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4. The wavelength of the ultraviolet region of the hydrogen spectrum is 122 nm. The wavelength of the second sperctral line in the Balmer series of singly ionized helium atom is (a) $1215Å$ (b) $1640Å$ (C) $2430Å$ (d) $4687Å$

A. $1215Å$

B. $1649Å$

C. $2430Å$

D. $4687Å$

Answer: A

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5. The largest wavelength in the ultraviolet region of the hydrogen spectrum is 122nm. The smallest wavelength in the infrared region of the hydrogen spectrum (to the nearest interger) is (a) 802 nm (b) 823 nm (c) 1882 nm (d) 1648 nm.

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6. A photon collides with a stationary hydrogen atom in ground state inelastically. Energy of the colliding photon is 10.2 eV. After a time interval of the order of micro second another photon collides with same hydrogen atom inelastically with an energy of 15eV. What wil be observed by the detector?

(a) 2 photons of energy 10.2 eV

(b) 2 photons of energy 1.4 eV

(c) One photon of energy 10.2 eV and an electron of energy 1.4 eV

(d) One photon of energy 10.2 eV and another photon of energy 1.4 eV

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7. A hydrogen atom and a Li^{2+} ion are both in the second excited state. If l_H and l_{Li} are their respective electronic angular momenta, and E_H and E_{Li} their respective energies, then (a) $l_H > l_{Li}$ and $|E_H| > |E_{Li}|$ (b) $l_H = l_{Li}$ and $|E_H| < |E_{Li}|$ (C) $l_H = l_{Li}$ and $|E_H| > |E_{Li}|$ (d) $l_H < l_{Li}$ and $|E_H| < |E_{Li}|$

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8. The transition from the state n=4 to n=3 in a hydrogen like atom results in ultraviolet radiation. Infreared radiaton will be obtained in the transition (a) $2 \to 1$ (b) $3 \to 2$ (c) $4 \to 2$ (d) $5 \to 4$

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9. As per Bohr model , the minimum energy (in eV) required to remove electron from the ground state of doubly ioinized Li alom $(Z = 3)$ is

A. -122.4 eV

B. 122.4 eV

C. -13.6 eV

D. 13.6 eV

Answer: B

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10. Consider the spectral line resulting from the transition $n = 2 \rightarrow n = 1$ in the atoms and ions given . The shortest wavelength is produced by

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11. The energy levels of a cartain atom are shown in figure. If a photon of

.....5E

frequency f is emitted when there is an electron transition from 5E to E .....

4E

what frequencies of photons could be produced by other energy level transitions?..... E

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12. Find the longest wavelength present in the Balmer series of hydrogen.

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Exercise 33.3

1. if λ_{Cu} is the wavelength of K_{α}, X-ray line fo copper (atomic number 29) and λ_{Mo} is the wavelength of the K_{α} X-ray line of molybdenum (atomic number 42), then the ratio $\frac{\lambda_{Cu}}{\lambda_{Mo}}$ is close to

(a) 1.99 (b) 2.14

(c) 0.50 (d) 0.48

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2. Which one of the following statement is $WRONG$ in the context of X-rays generated from X- rays tube ?

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3. K_{α} wavelength emitted by an atom of atomic number Z=11 is λ. Find the atomic number for an atom that emits K_{α} radiation with wavelength 4λ. (a) Z=6 (b) Z=4

(c) Z=11 (d) Z=44.

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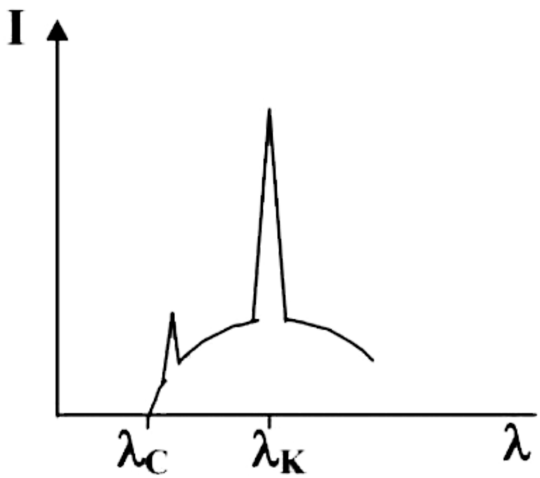
4. The intensity of X- ray from a coolidge tube is plotted againest wavelength λ as shown in the figure . The minimum wavelength found λ_c and the wavelength of thek_a line is λ_{λ}, As the accelerating voliage is increase



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5. X-ray are produced in an X-ray tube operating at a given accelerating voltage. The wavelength of the continuous X-ray has values from. (a) $0 \rightarrow \infty$

(b) $\lambda_{\min} \rightarrow \infty, where \lambda_{\min} > 0$

(c) 0 to $\lambda_{\max}, where \lambda_{\max} < \infty$

(d) $\lambda_{\min} ot \lambda_{\max}$, where $0 < \lambda(\min) < \lambda_{\max} < \infty$

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6. Characteristic X-rays of frequency 4.2×10^{18} Hz are produced when transitions from L-shell to K-shell take place in a cartain target meterial. Use Mosley's law to determine the atoic number of the target matderial. Given Rydberg constant $R = 1.1 \times 10^7 m^{-1}$.

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Exercise 33.4

1. Light of wavelength 2000Å is incident on a metal surface of work function 3.0 eV. Find the minimum and maximum kinetic energy of the photoelectrons.

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2. Is it correct to say that $K_{\max}$ is proportional to f ? If not what would a correct statement of the relationship between $K_{\max}$ and f?

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3. When a metal is illuminated with light of frequency f, the maximum kinetic energy of the photoelectrons is 1.2 eV. When the frequency is increased by 50% the maximum kinetic energy increases to 4.2 eV. What is the threshold frequency for this metal?

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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 μ_1 and mu_2 $respectively. If the ratio$u_1: u_2 = 2:1 and hc= 1240 eV` nm, the work function of the metal is neraly. (a)3.7 eV (b) 3.2 eV (c) 2.8eV (d) 2.5eV.

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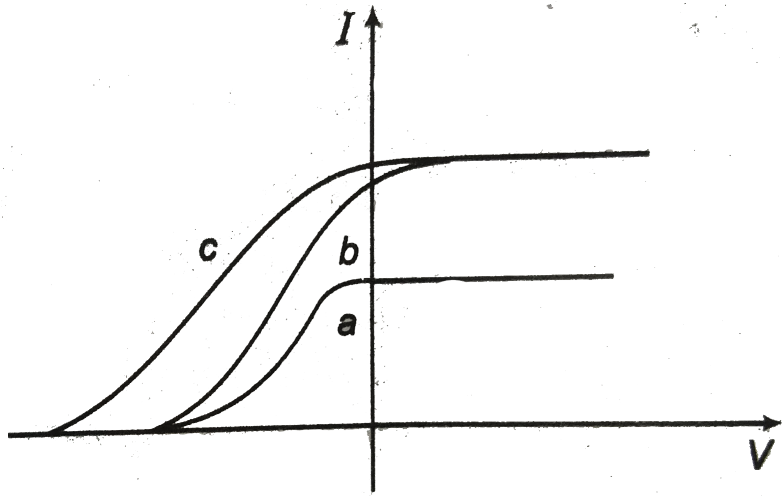
5. The figure shows the variation of photocurrent with anode potential for a photosensitve surface for three different radiations. Let l_a, l_b and l_c be the curves a, b and c, respectively



(a) $f_a = f_b$ and $l_a \neq l_b$ (b) $f_a = f_c$ and $l_a = l_c$

(c) $f_a = f_b$ and $l_a = l_b$ (d) $f_b = f_c$ and $l_b = l_c$

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6. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately. (a) 540 nm (b) 400nm (c) 310 nm (d) 220 nm

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7. The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4eV. The stopping potential in volt is

(a)2 (b) 4 (c) 6 (d) 10

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8. Photoelectric effect supports quantum nature of light because

(a) there is a minimum frequency of light below which no photoelectrons are emitted

(b) the maximum kinetic energy of photoelectrons depends only on the frequency of light and not onits intensity

(c) even when the metal surface is faintly illuminated, the photoelectrons leave the surface immediately

(d) electric charge of the photoelectrons is quantised

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Level -1 Assertion And Reason

1. Assertion: X-rays cannot be deflected by electric or magnetic fields

. Reason: These are electromagnetic waves.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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2. Assertion: if wavelength of light is doubled, energy and momentum of photons are reduced to half.

Reason: By increasing the wavelength, speed of photons will decrease.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: C

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3. Assertion: we can increases the saturation current in photoelectric experiment without increasing the intensity of light.

Reason: Instensity can be increased by increasing the frequency of incident photons.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A::B

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4. Assertion: Photoelectric effect proves the particle nature of light.

Reason: Photoemission starts as soon as light is incident on the metal surface, provided frequency of incident light is greater than or equal to the threshold frequency.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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5. Assertion: During de-excitation from n=6 to n=3 , total six emission lines may be obtained.

Reason: From $n = n \to n = 1 \to tal\left(n\frac{n-1}{2}\right.$ emission lines are obtained.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A::B

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6. Assertion: If frequency of incident light is doubled, the stopping potential will also become two times

Reason: Stopping potential is given by $V_0 = \frac{h}{e}(v - v_0)$

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

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7. Assertion: X-rays cannot be obtained in the emission spectrum of hydrogen atom.

Reason: Maximum energy of photons emitted form hydroen spectrum is 13.6 eV.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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8. Assertion: If applied potential difference in coolidge tube is increased, then difference in coolidge tube.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: B

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9. Assertion: In n=2, energy of electron in hydrogen like atoms is more compared to n=1

.Reason: Electrostatic potential energy in n=2 is more.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: B

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10. Assertion: In continuous X-ray spectrum, all wavelength can be otained

. Reason: Accelerated (or retarded) charged particles rediate enrgy. This is the cause of production of continuous X-rays.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

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Level 1 Objective

1. According to Einstein's photoelectric equation, the plot of the maximum kinetic energy of the emitted photoelectrons from a metal versus frequency of the incident radiation gives a straight line whose slope

A. depends on the nature of metal used

B. depends on the intensity or radiation

C. depends on both intensity of radiation and the nature of metal used

D. is the same for all metals and independent of the instensity or radiation

Answer: D

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2. The velocity of the electron in the first Bohr orbit as compared to that of light is about

A. 1/300

B. 1/500

C. 1/137

D. 1/187

Answer: C

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3. $\_ 86A^{222} \rightarrow_{84} B^{210}$. In this reaction, how many α and β particles are emitted?

A. $6\alpha, 3\beta$

B. $3\alpha, 4\beta$

C. $4\alpha, 3\beta$

D. $3\alpha, 6\beta$

Answer: B

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4. An X-ray tube is operated at 20 kV. The cut off wavelength is

A. 0.89Å

B. 0.75Å

C. 0.62Å

D. None of these

Answer: C

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5. An X-ray tube is opearted at 18 kV. The maximum velocity of electron striking the target is

A. $8 \times 10^7 m/s$

B. $6 \times 10^7 m/s$

C. $5 \times 10^7 m/s$

D. None of these

Answer: A

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6. what is the ratio of de-Broglie wavelength of electron in the second and third Bohr orbits in the hydrogen atoms?

A. $2/3$

B. $3/2$

C. $4/3$

D. $3/4$

Answer: A

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7. The energy of a hydrogen like atom (or ion) in its ground state is -122.4 eV. It may be

A. hydrogen atom

B. He^{+}

C. Li^{2+}

D. Be^{3+}

Answer: C

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8. The operating potential in an x-ray tube is increased by 2%. The percentage change in the cut off wavelength is

A. 1% increase

B. 2% increase

C. 2% decrease

D. 1% decrease

Answer: C

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9. The energy of an atom or ion in the first excited state is -13.6 eV. It may be

A. He^{+}

B. Li^{++}

C. Hydrogen

D. Deuterium

Answer: A

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10. in order that the short wavelength limit of the continuous X-ray spectrum be 1Å, the potential difference through which an electron must be accelerated is

A. 124 kV

B. 1.24 kV

C. 12.4 kV

D. 1240 kV

Answer: C

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11. The momentum of an x-ray photon with $\lambda = 0.5\text{Å}$ is

A. $13.26 \times 10^{-26} kg - m / s$

B. $1.326 \times 10^{-26} kg - m / g$

C. $13.26 \times 10^{-24} kg - m / s$

D. $13.26 \times 10^{-22} kg - m / s$

Answer: C

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12. The work function of a substance is 1.6 ev. The longest wavelength of light that can produce potoemisson form the substance is

A. 7750Å

B. 3875Å

C. 5800Å

D. 2900Å

Answer: A

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13. Find the binding anergy of an electron in the ground state of a hydrogen like atom in whose spectrum the thrid Balmer line is equal to 108.5 mm.

A. $54.4eV$

B. $13.6eV$

C. $112.4eV$

D. None of these

Answer: A

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14. What is the energy of a hydrogen atom in the first excited state if the potential energy is taken to be zero in the ground state?

A. 10.2 eV

B. 13.6 eV

C. 23.8 eV

D. 27.2 eV

Answer: C

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15. Light of wavelength 330nm falling on a piece of metal ejects electrons with sufficient energy with required voltage V_0 to prevent them reaching a collector. In the same set up, light of wavelength 220 nm ejects electrons which require twice the voltage V_0 to stop them in reaching a colleator. the numerical value of voltage V_0 is

A. $\frac{16}{15}V$

B. $\frac{15}{16}V$

C. $\frac{15}{8}V$

D. $\frac{8}{15}V$

Answer: C

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16. Maximum kinetic energy of a photoelectron is E when the wavelength of incident light is λ. If energy becomes four times when wavelength is reduced to one thrid, then work function of the metal is

A. $\frac{3hc}{\lambda}$

B. $\frac{hc}{3\lambda}$

C. $\frac{hc}{\lambda}$

D. $\frac{hc}{2\lambda}$

Answer: B

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17. if the frequency fo K_a X-ray emitted from the element with atomic number 31 is f, then the frequency of K_a x-ray emitted from the elemet with atomic number 51 would be

A. $\frac{5f}{3}$

B. $\frac{51f}{31}$

C. $\frac{9f}{25}$

D. $\frac{25f}{9}$

Answer: D

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18. According to Mseley's law, the ratio of the slope of graph between $\sqrt{f}$ and Z for K_{β} and K_{α} is

A. $\left(\frac{\sqrt{32}}{27}\right)$

B. $\left(\frac{\sqrt{27}}{32}\right)$

C. $\left(\frac{\sqrt{5}}{36}\right)$

D. $\left(\frac{\sqrt{36}}{5}\right)$

Answer: A

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19. if the electron in hydrogen orbit jumps form third orbit to second orbit, the wavelength of the emitted radiation is given by

A. $\lambda = \frac{R}{6}$

B. $\lambda = \frac{R}{6}$

C. $\lambda = \frac{36}{5R}$

D. $\lambda = \frac{5R}{36}$

Answer: C

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20. A potential of 10000 V is applied across an x-ray tube. Find the ratio of de-Broglie wavelength associated with incident electrons to the minimum wavelength associated with x-rays.

A. 10

B. 20

C. $1/10$

D. $1/20$

Answer: C

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21. When a metallic surface is illuminated with monochromatic light of wavelength λ, the stopping potential is $5V_0$. When the same surface is illuminated with the light of wavelength 3λ, the stopping potential is V_0. Then, the work function of the metallic surface is

A. $hc/6\lambda$

B. $hc/5\lambda$

C. $hc/4\lambda$

D. $2hc/4\lambda$

Answer: A

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22. The threshold frequency for a certain photosensitive metal is v_0. When it is illuminated by light of frequency $v = 2v_0$, the stopping potential for photoelectric current is V_0. What will be the stopping potential when the same metal is illuminated by light of frequency $v = 3v_0$?

A. $1.5V_0$

B. $2V_0$

C. $2.5V_0$

D. $3V_0$

Answer: B

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23. The frequency of the first line in Lyman series in the hydrogen spectrum is v. What is the frequency of the corresponding line in the spectrum of doubly ionized Lithium?

A. v

B. 3 v

C. 9 v

D. 2 v

Answer: C

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24. Which enrgy state of doubly ionized lithium $(Li^{++}$ has the same energy as that of the gorund state of hydrogen?

A. n=1

B. n=2

C. n =3

D. n=4

Answer: C

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25. Two identical photo-cathodes receive light of frequencies v_1 and v_2. If the velocities of the photoelectrons (of mass m) coming out are v_1 and v_2 respectively, then

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

B. $v_1^2 - v_2^2 = \frac{2h}{m}(v_1 - v_2)$

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

D. $v_1^2 - v_2^2 = \frac{2h}{m}(v_1 - v_2)$

Answer: B

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26. The longest wavelength of the Lyman series for hydrogen atom is the same as the wavelength of a certain line in the spectrum of He^{+} when the electron makes a trensiton from $n \rightarrow 2$. The value of n is

A. 3

B. 4

C. 5

D. 6

Answer: B

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27. The wavelength of the K_a line for the uranium is $(Z = 92)\left(R = 1.0973 \times 10^7 m^{-1}\right.$

A. 1.5Å

B. 0.5Å

C. 0.15Å

D. 2.0Å

Answer: C

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28. The frquencies of K_{α}, K_{β} and L_{α} X-rays of a materail are γ_1, γ_2 and γ_3 respectively. Which of the following relation holds good?

A. $\gamma_2 = \sqrt{\gamma_1 + \gamma_3}$

B. $\gamma_2 = \gamma_1 + \gamma_3$

C. $\gamma_2 = \frac{\gamma_1 + \gamma_3}{2}$

D. $\gamma_3 = \sqrt{\gamma_1 \gamma_2}$

Answer: B

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29. A proton and an α - particle are accelerated through same potential difference. Then, the ratio of de-Broglie wavelength of proton and α-particle is

A. $\sqrt{2}$

B. $\frac{1}{\sqrt{2}}$

C. $2\sqrt{2}$

D. None of these

Answer: C

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30. If E_1, E_2 and E_3 represent respectively the kinetic energies of an electron, an $\alpha - partic \leq$ and a proton each having same de-Broglie wavelength, then

A. $E_1 > E_3 > E_2$

B. $E_2 > E_3 > E_1$

C. $E_1 > E_2 > E_3$

D. $E_1 = E_2 = E_3$

Answer: A

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31. if the potential energy of a hydrogen atom in the ground state is assumed to be zero, then total energy of $n = \infty$ is equal to

A. $13.6eV$

B. $27.2eV$

C. zero

D. None of these

Answer: B

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32. A 1000 W transmitter works at a frequency of 880kHz. The number of photons emitted per second Is

A. 1.7×10^{28}

B. 1.7×10^{30}

C. 1.7×10^{23}

D. 1×10^{25}

Answer: B

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33. Electromagnetic radiation of wavelength 3000Å is incident on an isolated platinum surface of work- function 6.30 eV. Due to the radiation, the

A. sphere becomes positively charged

B. sphere becomes negatively charged

C. sphere remains neutral

D. maximum kinetic energy of the ejected photoelectrons would be 2.03 eV

Answer: C

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34. The energy of a hydrogen atom in its ground state is $-13.6eV$. The energy of the level corresponding to the quantum number n=5 is

A. $-0.54eV$

B. $-5.40eV$

C. $-0.85eV$

D. $-2.72eV$

Answer: A

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35. Ultraviolet radiation of 6.2 eV falls on an aluminium surface (work - function = 4.2 eV). The kinetic energy in joule of the fastest electrons amitted is

A. 3.2×10^{-21}

B. 3.2×10^{-19}

C. 3.2×10^{-17}

D. 3.2×10^{-15}

Answer: B

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36. what should be the velocity of an electron so that its momentum becoumes equal to that of a photn of wavelength $5200 \mathring{A}$

A. 700 m/s

B. 1000 m/s

C. 1400 m/s

D. 2800 m/s

Answer: C

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37. Photoelectric work- function of a metal is 1 eV. Light of wavelength $\lambda = 3000 \mathring{A}$ falls on it. The photoelectrons come out with maximum velocity

A. 10 m/s

B. `10^3m//s

C. 10^4 m//s`

D. $10^6 m / s$

Answer: D

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38. For uranium nucleus how does its mass vary with volume?

A. (a) $m \propto V$

B. (b) $m \propto 1 / V$

C. (c) $m \propto \sqrt{V}$

D. (d) $m \propto V^2$

Answer: A

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39. Order of magnitude of density of uranium nucleus is , [m = 1.67 xx 10^(-27 kg]`

A. (a) $10^{20} kg / m^3$

B. (b) $10^{17} kg / m^3$

C. (c) $10^{14} kg / m^3$

D. (d) $10^{11} kg / m^3$

Answer: B

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40. During a beta decay

A. (a) an atomic electron is ejected

B. (b) an electron present inside the nucleus is ejected

C. (c) a neutron in the nucleus decays emitting and electron

D. (d) a part of the binding energy is converted into electron

Answer: C

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41. In the nucleus of helium if $F_1 isthe \ne tf$ or $cebetweentwopro \rightarrow ns$, F_2 $isthe \ne tf$ or $cebetweentwo \ne utrons$ and F_3` is the net force between a proton and a neutron. Then,

A. (a) $F_1 = F_2 = F_3$

B. (b) $F_1 > F_2 > F_3$

C. (c) $F_2 > F_3 > F_1$

D. (d) $F_2 = F_3 > F_1$

Answer: A

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42. What are the respective number of α and β-particles emitted in the following radioactive decay?

A. (a) 6 and 8

B. (b) 6 and 6

C. (c) 8 and 8

D. (d) 8 and 6

Answer: D

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43. If an atom of $\_\ 92^{235}U$, after absorbing a slow neutron, undergoes fission to form an atom of $-54^{138}Xe$ and an atom of $\_\ 38^{94}Sr$, the other particles produced are

A. (a) one proton and two neutrons

B. (b) three neutrons

C. (c) two neutrons

D. (d) one proton and one neutron

Answer: B

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44. Nucleus A is converted into C through the following reactions,

$A \rightarrow B + \alpha$

$B \rightarrow C + 2\beta$

then,

A. (a) A and B are isotopes

B. (b) A and C are isobars

C. (c) A and B are isobars

D. (d) A and C are isotopes

Answer: D

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45. The binding energy of α-particle is

(if $m_p = 1.00785u, m_n = 1.00866u$ and $m_\alpha = 4.00274u$)

A. (a) 56.42 MeV

B. (b) 2.821 MeV

C. (c) 28.21 MeV

D. (d) 32.4 MeV

Answer: C

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46. $\frac{7}{8}th$ of the active nuclei present in a radioactive sample has decayed in 8 s. The half-life of the sample is

A. (a) 2s

B. (b) 1s

C. (c) 7s

D. (d) 8/3 s

Answer: D

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47. A radioactive element disintegrates for a time interval equal to its mean life. The fraction that has disintegrated is

A. $\frac{1}{e}$

B. $1-\frac{1}{e}$

C. $\frac{0.693}{e}$

D. $0.693\left(1-\frac{1}{e}\right)$

Answer: B

Watch Video Solution

48. Starting with a sample of pure $\hat{}\ 66Cu, \frac{3}{4}$ of it decays into Zn in 15 minutes. The corresponding half-life is

A. (a) 5 minutes

B. (b) 7.5 minutes

C. (c) 10 minutes

D. (d) 3.5 minutes

Answer: B

Watch Video Solution

49. A sample of radioactive substance loses half of its activity in 4 days. The time in which its activity is reduced to 5% is

A. (a) 12 days

B. (b) 8.3 days

C. (c) 17.3 days

D. (d) None of these

Answer: C

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50. On bombardment of U^{235} by slow neutrons, 200 MeV energy is released. If the power output of atomic reactor is 1.6 MW, then the rate of fission will be

A. (a) 5×10^{16} per second

B. (b) 10×10^{16} per second

C. (c) 15×10^{16} per second

D. (d) 20×10^{16} per second

Answer: A

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51. Atomic masses of two heavy atoms are A_1 and A_2. Ratio of their respective nuclear densities will be approximately

A. (a) $\frac{A_1}{A_2}$

B. (b) $\left(\frac{A_1}{A_2}\right)^{\frac{1}{3}}$

C. (c) $\left(\frac{A_2}{A_1}\right)^{\frac{1}{3}}$

D. (d) 1

Answer: D

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52. A radioactive element is disintegrating having half-life 6.93 s. The fractional change in number of nuclei of the radioactive element during 10 s is

A. (a) 0.37

B. (b) 0.63

C. (c) 0.25

D. (d) 0.50

Answer: B

Watch Video Solution

53. The activity of a radioactive sample goes down to about 6% in a time of 2 hour. The half-life of the sample in minute is about

A. (a) 30

B. (b) 15

C. (c) 60

D. (d) 120

Answer: A

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54. What is the probability of a radioactive nucleus to survive one mean life?

A. (a) $\frac{1}{e}$

B. (b) $\frac{1}{e+1}$

C. (c) $1-\frac{1}{e}$

D. (d) $\frac{1}{e}-1$

Answer: A

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Level 1 Subjective

1. For a given element the wavelength of the K_{α}- line is 0.71 nm and of the K_{β}- line it is 0.63 nm. Use this information to find wavelength of the L_{α} line.

Watch Video Solution

2. The energy of the n=2 state in a given element is $E_2 = -2870 eV$. Given that the wavelengths of lthe K_α and K_β lines are 0.71 nm and 0.63 nm respectively, determine the energies E_1 and E_3.

Watch Video Solution

3. 1.5 mW of 400 nm light is directed at a photoelectric cell. If 0.1% of the incident photons produce photoelectrons, find the current in the cell.

Watch Video Solution

4. A photon has momentum of magnitude $8.24 \times 10^{-28} kg - m/s$. (a) What is the energy of this photon? Given your answer in joules and in electron volts

(b) What is the wavelength of this photon? In what region of the electormagnetic spectrum does lie?

Watch Video Solution

5. A 75 W light source emits light of wavelength 600 nm. (a) Calculate the frequency of the emitted light.

(b) How many photons per second does the source emit?

Watch Video Solution

6. An excited nucleus emits a gamma-ray photon with energy of 2.45 MeV.

(a) What is the photon frequency?

(b) what is the photon wavelength?

Watch Video Solution

7. (a) A proton is moving at a speed much less than the speed of light. It has kinetic energy K_1 and momentum p_1. If the momentum of the proton is doubled, so $p_2 = 2p_1$, how is its new kinetic energy K_2 related to $K - 1$?

(b)A photon with energy E_1 has momentum p_1 . if another photon has momentum p_2 that is twice p_1, how is the energy E_2 of the second photon related to E_1?

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8. A parellel beam of monochromatic light of wavelength 500 nm is incident normally on a perfectly absorbing surface. The power through any cross section of the beam is 10 W. Find

(a) the number of photons absorbed per second by the surface and

(b) the force exerted by the light beam on the surface.

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9. A beam of white light is incident normaly on a plane surface absorbing 70% of the light and reflecting the rest. If the incident beam carries 10 w of power, find the force exerated by it on the surface.

Watch Video Solution

10. A parallel beam of monochromatic light of wavelength 663 nm is incident on a totally reflection plane mirror. The angle of incidence is 60° and the number of photons striking the mirror per second is 1.0×10^{19}. Calculate the force exerted by the light beam on the mirror.

Watch Video Solution

11. wavelength of Bullet. Calculate the de-Brogli wavelength of a 5.00 g bullet that is moving at 340 m/s will it exhibite wave like properties?

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12. (a) An electron moves with a speed of 4.70×10^{6} m//s. What is its de-Broglie wavelength?

(b) A proton moves with the same speed. Determine its de - Broglie wavelength.

Watch Video Solution

13. An electron has a de Broglie wavelength of 2.80×10^{-10} m. Determine

(a) the magnitude of its momentum,

(b) its kinetci energy(in joule and in electron volt).

Watch Video Solution

14. Find de-Broglie wavelength corresponding to the root-mean square velocity of hydrogen molecules at room temperature $(20^{\circ} C)$.

Watch Video Solution

15. An electron, in a hydrogen like atom , is in excited state. It has a total energy of -3.4 eV, find the de-Broglie wavelength of the electron.

Watch Video Solution

16. In the Bohr model of the hydrogen atom, what is the de-Broglie wavelength for the electron when it is in (a) the n=1 level?

(b) Then n=4 level? In each case, compare the de-Broglie wavelength to the circumference $2\pi r_n$ of the orbit.

Watch Video Solution

17. The binding energy of an electron in the gorund state of He atom is equal to $E_0 = 24.6eV$. Find the energy required to remove both electrons form the atom.

Watch Video Solution

18. Hydrogen atom is its ground state is excited by means of monochromatic radiation of wavelength 1023Å. How many different lines are possible in the resulting spectrum? Calculate the longes wavelength among them. You may assume the ionization energy of hydrogen atom as 13.6 eV.

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19. A doubly ionized lithium atom is hydrogen like with atomic number 3. Find the wavelength of the radiation required to excite the electron in Li^{++} from to the third Bohr orbit (ionization energy of the hydrogen atom equals 13.6 eV).

Watch Video Solution

20. Find the quantum number n corresponding to nth excited state of He^{++} ion if on transition to the ground state the ion emits two photons in succession with wavelength 108.5 nm and 30.4 nm. The ionization energy of the hydrogen atom is 13.6 eV.

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21. A hydrogen like atom (described by the Bohr model) is observed ot emit ten wavelengths, originating from all possible transition between a group of levels. These levels have energies between - 0.85 eV and -0.544 eV (including both these values). (a) Find the atomic number of the atom. (b) Calculate the smallest wavelength emitted in these transitions. (Take ground state energy of hydrogen atom =- 13.6 eV)

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22. The energy levels of a hypothetical one electron atom are shown in the figure. (a)Find the ionization potential of this atom.

(b) Find the short wavelength limit of the series terminating at n=2

(c) Find the excitaion potential for the state n=3.

(d) find wave number of the photon emitted for the transiton n=3 to n=1

$\propto\_\ \_\_\ \_\_\ \_\_\ \_\_\ \_0eV$

$n=5\_\ \_\_\ \_\_\ \_\_\ \_\_\ \_\_\ \_-0.80eV$

n=4 ____________ -1.45 eV$n=3_\ __\ __\ __\ __\ __\ _-3.08eV$

n=2_____________ -5.30 eVn=1 _________________ -15.6 eV`.

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23. (a) An atom initally in an energy level with E = - 6.52 eV absorbs a photon that has wavelength 860 nm. What is the internal energy of the atom after it absorbs the photon?

(b) An atom initially in anergy level with E =-2.68 ev emits a photon that has wavelength 420 nm. What is the internal energy of the atom after it emits the photon?

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24. A silver balll is suspended by a string in a vacuum chamber and ultraviolet light of wavelength 2000Å is directed at it. What electrical potential will the ball acquire as a result? Work function of silver is 4.3 eV.

Watch Video Solution

25. A small particle of mass m move in such a way the potential energy $\left(U = \frac{1}{2}m^2\omega^2r^2\right)$ when a is a constant and r is the distance of the particle from the origin Assuming Bohr's model of quantization of angular momentum and circular orbits , show that radius of the nth allowed orbit is proportional to in

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26. Wavelength of K_{α} line of an element is λ_0. Find wavelength of K_{β} -line for the same elemetn.

Watch Video Solution

27. x-rays are produced in an X-ray tube by electrons asselerated through an electric potential difference fo 50.0 kV. An electron makes three collisions in the target coming to rest and loses half its remaining kinetic energy in each of the first two collisions. Determine the wavelenght of the resulting photons. (Neglecting the recoil of the heavey target atoms).

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28. From what meterial is the anod of an X-ray tube made if the K_{α} line wavelength of thej characteristic spectrum is 0.76Å?

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29. The short-wavelength limit shifts by 26 pm when the operating voltage in an X-ray tube is increased to 1.5 times the original value. What was the original value of the operating voltage?

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30. The k_{α} X-rays of aluminium (Z = 13) and zinc (Z = 30) have wavelengths 887 pm and 146 pm respectively. Use Moseley\'s law $\sqrt{v} = a(Z-b)$ to find the wavelength of the K_{α} X-ray of iron (Z = 26).

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31. Characteristic X-rays of frequency 4.2×10^{18} Hz are produced when transitions from L-shell to K-shell take place in a certain target material. Use Mosley's law to determine the atomic number of the target material. Given Rydberg constant $R = 1.1 \times 10^{7} m^{-1}$.

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32. The electric current in an X-ray tube (from the target to the filament) operating at $40kV$ is $10mA$. Assume that on an average, 1% of the total kinetic energy of the electrons hitting the target are converted into X-rays (a) what is the total power emitted as X-rays and (b) how much heat is produced in the target every second?

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33. The stopping potential for the photoelectrons emitted from a metal surface of work function 1.7 eV is 10.4 V. Find the wavelength of the radiaiton used. Also, identify the energy levels in hydrogen atom, which will emit this wavelength.

Watch Video Solution

34. What will be the maximum kinetic energy of the photoelectrons ejected from magnesium (for which the work -function W=3.7 eV) when irradiated by ultraviolet light of frequency $1.5 \times 10^{15} s^{-1}$.

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35. A metallic surface is irradiated with monochromatic light of variable wavelength. Above a wavelength of 5000Å no photoelectrons are emitted from the surface. With an unknown wavelength, stopping potential fo 3V is neceddsry ot eliminate the photocurrent. Find the unknown wavelenght.

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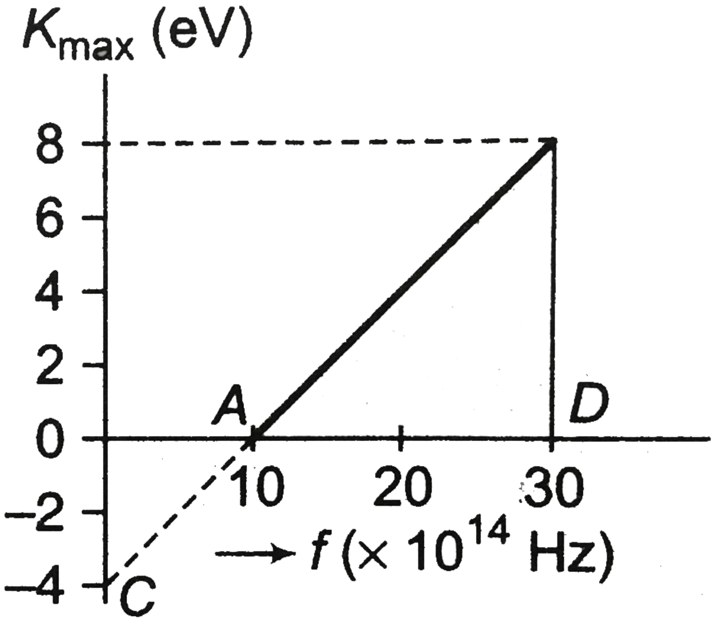
36. A graph regarding photoelectric effect is shown between the maximum kinetic energy of electrons and the frequency of the incident light. On the basis of data as shown in the graph, calculate (a) threshold frequency , (b) work- function, (c) planck constant



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37. A metallic surface is illuminated alternatively with light of wavelenghts $3000Å$ and $6000Å$. It is observed that the maximum speeds of the photoelectrons under these illuminations are in the ratio 3 : 1 . Calculate the work function of the metal and the maximum speed of the photoelectrons in two cases.

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38. Light of wavelength 180 nm ejects photoelectrons from a plate of metal whose work - function is 2 eV. If a uniform magnetic field of 5×10^{-5} T be applied parllel to the palte, what would be the radius of the path followed by electrons ejected normally from the plate with maximum energy.

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39. Light described at a palce by te equation $E = \left(100\frac{V}{m}\right)\left[\sin \times 10^{15}s^{-1}t + \sin\left(8 \times 10^{15}s^{-1}t\right]\right.$ falls on a metal surface having work function 2.0 eV. Calcualte the maximum kinetic energy of the photoelectrons.

Watch Video Solution

40. The electric field associated with a light wave is given by $E = E_0 \sin\left[\left(1.57x10^7 m^{-1}(x - ct)\right]\right.$. Find the stopping potential when this light is used in an experiment on photoelectric affect with a metal having work - function 1.9 eV.

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41. The disintegration rate of a certain radioactive sample at any instant is 4750 disintegrations per minute. Five minutes later the rate becomes 2700 per minute. Calculate

(a) decay constant and (b) half-life of the sample

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42. A radioactive sample contains 1.00×10^{15} atoms and has an activity of 6.00×10^{11} Bq. What is its half-life?

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43. Obtain the amount of $\hat{\ } 60Co$ necessary to provide a radioactive source of 8.0 Ci strength. The half-life of $\hat{\ } 60Co$ is 5.3 years?

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44. The half-life of $\_ 92^{238}U$ against alpha decay is 4.5×10^9 year. How much disintegration per second occurs in 1 g of $\_ 92^{238}U$?

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45. What is the probability that a radioactive atom having a mean life of 10 days decays during the fifth day?

Watch Video Solution

46. In an ore containing uranium, the ratio of ^238U $\rightarrow$ 206Pb $\nu c \leq iis3. Calcatethea \geq ofthe$ or $e, as \sum \in gt\hat{a}llthe \leq adpresent \in ti$ ^238U. $Takethehalf - l$ if eof^238U $\rightarrow be$4.5xx10^9` years.

Watch Video Solution

47. Complete the following reactions.

(a) $\_88^{226}Ra \rightarrow \alpha +$ (b) $\_8^{19}O \rightarrow_9^{19} F +$ (c) $\_13^{25}AI \rightarrow_{12}^{25} Mg +$

Watch Video Solution

48. Consider two decay reactions.

(a) $\_92^{236}U \rightarrow_{82}^{206} Pb + 10pro \rightarrow ns + 20 \neq utrons$ (b) $\_92^{238}U \rightarrow_{83}^{206} Pb + 8_2^4He + 6e \leq ctrons$

Are both the reactions possible?

Watch Video Solution

49. Obtain the binding energy of a nitrogen nucleus from the following data:

$m_H = 1.00783u$,m_N=1.00867u, m(_7^14N)=14.00307u

$Give your answer \in units of MeV. [Remember$1u=931.5MeV//c^2`]

Watch Video Solution

50. 8 protons and 8 lectures are separately at rest. How much energy will be released if we form $\_8^{16}O$ nucleus?

Given:

Mass of $\_8^{16}O$ atom = 15.994915u

Mass of neutron =1.008665u

Mass of hydrogen atom = 1.007825u

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51. Assuming the splitting of U^{235} nucleus liberates 200 MeV energy, find

(a) the energy liberated in the fission of 1 kg of U^{235} and

(b) the mass of the coal with calorific value of $30kJ/g$ which is equivalent to 1 kg of U^{235}.

Watch Video Solution

52. $_83^{212}Bi$ decays as per following equation.

$_83^{212}Bi \rightarrow_{82}^{208} Ti +_2^4 He$

The kinetic energy of α-particle emitted is 6.802 MeV. Calculate the kinetic energy of Ti recoil atoms.

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53. In a neutron induced fission of $_92U^{235}$ nucleus, usable energy of 185 MeV is released. If $_92U^{235}$ reactor is continuously operating it at a power level of 100 MW power, how long will it take for 1 kg of uranium to be consumed in this reactor?

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54. Calculate the Q-values of the following fusion reactions:

(a)$1^2H + 1^2H \rightarrow 1^3H + 1^1H.$

$1^2H + 1^2H \rightarrow 2^3(He) + n$

$1^2H + 1^3H \rightarrow 2^4(He) + n.$

Atomic masses are $m(1^2H) = 2.014102u$, $m(1^3H) = 3.016049u$, $m(2^3(He)) = 3.016029u, m(2^4(He)) = 4.002603u.$

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55. Calculate the Q-values of the fusion reaction

$He^4 + He^4 = Be^8$

In such a fusion energetically favourable? Atomic mass of Be^8 is 8.0053u and that of $He^4$is 4.0026 u.

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56. When fission occurs, several neutrons are released are released and the fission fragements are beta radioactive, why?

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Level 2 Single Correct

1. if we assume only gravitational attraction between proton and electron in hydrogen atom and the Bohr quantizaton rule to be followed, then the expression for the ground state energy of the atom will be (the mass of proton is M and that of electron is m.)

A. increases 4 times

B. decreases 4 times

C. increases 8 times

D. decreases 8 times

Answer: B

Watch Video Solution

2. An electron in a hydrogen atom makes a transiton from first excited state ot ground state. The magnetic moment due to circulating electron

A. 21

B. 10

C. 15

D. None of these

Answer: B

Watch Video Solution

3. The excitation energy of a hydrogen -like ion in its first excited state is $40.8eV$ Find the energy needed to remain the electron from the ion

A. will not pass through origin

B. will be a straight line with slope 4

C. will be a rectangular hyperbola

D. will be a parabola

Answer: A

Watch Video Solution

4. An electron in a hydrogen in a hydrogen atom makes a transition from first excited state to ground state. The equivelent current due to circulating electron

A. decreases 16 times

B. increases 4 times

C. decreases 4 times

D. increases 32 times

Answer: C

Watch Video Solution

5. In a sample of hydrogen like atoms all of which are in ground state, a photon beam containing photos of various energies is passed. In absorption spectrum, five dark line are observed. The number of bright lines in the emission spectrum will be (assume that all transitions take place)

A. 21

B. 10

C. 15

D. none of these

Answer: C

Watch Video Solution

6. Let A_0 be the area enclined by the orbit in a hydrogen atom .The graph of in (A_0 / A_1) against $\ln(n)$

A. Will not pass through origin

B. Will be a straight line with slope 4

C. will be rectangular hyperbola

D. Will be parabola

Answer: B

Watch Video Solution

7. In the hydrogen atom, an electron makes a transition from n=2 to n=1. The magnetic field produced by the circulating electron at the nucleus

A. Decreases 16 times

B. Increases 4 times

C. Decreases 4 times

D. Increases 32 times

Answer: D

Watch Video Solution

8. A stationary hydrogen atom emits photon corresponding to the first line of Lyman series. If R is the Rydberg constant and M is the mass of the atom, then the velocity acquired by the atom is

A. $\frac{3Rh}{4M}$

B. $\frac{4M}{3Rh}$

C. $\frac{Rh}{4M}$

D. $\frac{4M}{Rh}$

Answer: A

Watch Video Solution

9. Light wave described by the equation $200V/m \sin(1.5 \times 10^{15} s^{-1} t \cos(0.5 \times 10^{15} s^{-1} t$ falls metal surface having work function 2.0 eV. Then, the maximum kinetic energy photoelectrons is

A. $3.27 eV$

B. $2.2 eV$

C. $2.85 eV$

D. none of these

Answer: D

Watch Video Solution

10. A hydrogne like atom is excited using a radiation . Consequently, six spectral line are observed in the spectrum. The wavelegth of emission radiation is found to be equal or smaller than the radiation used for excitation. This concludes that the gas was initially at

A. Ground state

B. First excited state

C. Second excited state

D. Third excited state

Answer: C

Watch Video Solution

11. The time period of the electron in the ground state of hydrogen atom is two times the times period of the electon in the first excited state of a certain hydrongen like atom (Atomic number Z). The value of Z is

A. 2

B. 3

C. 4

D. None of these

Answer: C

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12. The wavelengths of K_{α} X-rays from lead isotopes Pb^{204}, Pb^{206} and Pb^{208} are λ_1, λ_2 and λ_3 respectively. Choose the correct alternative.

A. $\lambda_1 < \lambda_2 < \lambda_3$

B. $\lambda_1 > \lambda_2 > \lambda_3$

C. $\lambda_1 = \lambda_2 = \lambda_3$

D. None of these

Answer: C

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13. in cases of hydrogen atom, whenever a photon is emitted in the Balmer series, (a)there is a probability emitting another photon in the Lyman series

(b) there is a probability of emitting another photon of wavelength $1213Å$

(c) the wavelength of radiaton emitted in Lyman series is always shorter then the wavelength emitted in the Balmer series

(d) All of the above.

A. there is a probability emitting another photon in the Lyman series

B. there is a probability of emitting another photon of wavelength 1213 Å

C. the wavelength of radiation emitted in Lyman series is always shorter then the wavelength emitted in the Balmer series

D. All of the above.

Answer: D

Watch Video Solution

14. An electron of kinetic enregy K collides elastically with a stationary hydrogen atom is the ground state. Then,

A. $K > 13.6eV$

B. $K > 10.2eV$

C. $K < 10.2eV$

D. data insufficient

Answer: C

Watch Video Solution

15. In a stationary hydrogen atom, an electron jumps from n = 3 ot n =1. The recoil speed of the hydrogen atom is about

A. $4m/s$

B. $4cm/s$

C. $4mm/s$

D. $4 \times 10^{-4}m/s$

Answer: A

Watch Video Solution

16. An X-ray tube is operating at 150 kV and 10 mA. If only 1% of the electric power supplied is converted into X-rays, the rate at which the target is heated in calories per second is

A. 3.55

B. 35.5

C. 355

D. 3550

Answer: C

Watch Video Solution

17. An electron revolves round a nucleus of atomic number Z. if 32.4 eV of energy is required to excite an electron from the n=3 state to n=4 state, then the value of Z is

A. 5

B. 6

C. 4

D. 7

Answer: D

Watch Video Solution

18. If the de-Broglie wavelength of a proton is 10^{-13} m, the electric potentia through which it must have been accelerated is

A. $4.07 \times 10^4 V$

B. $8.15 \times 10^4 V$

C. $8.15 \times 10^3 V$

D. $4.07 \times 10^5 V$

Answer: B

Watch Video Solution

19. If E_n and L_n denote the total energy and the angular momentum of an electron in the nth orbit of Bohr atom, then

A. $E_n \propto L_n$

B. $E_n \propto \frac{1}{L_n}$

C. $E_n \propto L_n^2$

D. $E_n \propto \frac{1}{L_n^2}$

Answer: D

Watch Video Solution

20. An orbital electron is the ground state of hydrogen has the magnetic moment μ_1. This orbital electron is excited to 3rd excited state by some energy transfer to the hydrogen atom. The new magnetic moment fo the electron is μ_2 then

A. $\mu_1 = 4\mu_2$

B. $2\mu_1 = \mu_2$

C. $16\mu_1 = \mu_2$

D. $4\mu_1 = \mu_2$

Answer: D

Watch Video Solution

21. A moving hydrogen atom makes a head on collision with a stationary hydrogen atom. Before collision both atoms are in in ground state and after collision they move together. What is the minimum value of the kinetic energy of the moving hydrogen atom, such that one of the atoms reaches one of the excited state?

A. $20.4eV$

B. $10.2eV$

C. $54.4eV$

D. $13.6eV$

Answer: A

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22. In an excited state of hydrogen like atom an electron has total energy of $-3.4eV$. If the kinetic energy of the electron is E and its de-Broglie wavelength is λ, then

A. $\lambda = 6.6\text{Å}$

B. $E = 3.4eV$

C. Both are correct

D. Both are wrong

Answer: C

Watch Video Solution

23. The count rate observed from a radioactive source at t second was N_0 and at 4t second it was $\frac{N_0}{16}$. The count rate observed at $\left(\frac{11}{2}\right)t$ second will be

A. $\frac{N_0}{128}$

B. $\frac{N_0}{64}$

C. $\frac{N_0}{32}$

D. None of these

Answer: B

Watch Video Solution

24. The half-lives of radioactive sample are 30 years and 60 years for two decay processes. If the sample decays by both the processes simultaneously. The time after which, only one-fourth of the sample will remain is

A. 10 years

B. 20 years

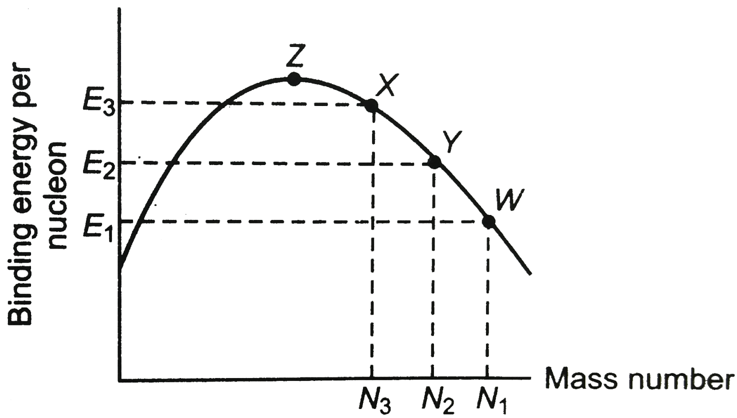
C. 40 years

D. 60 years

Answer: C

Watch Video Solution

25. Consider the nuclear fission reaction $W \rightarrow X + Y$. What is the Q-value (energy released) of the reaction?



A. $E_1N_1 - (E_2N_2 + E_3N_3)$

B. $(E_2N_2 + E_3N_3 - E_1N_1)$

C. $E_2N_2 + E_1N_1 - E_3N_3$

D. $E_1N_1 + E_3N_3 - E_2N_2$

Answer: B

Watch Video Solution

26. Consider the following nuclear reaction, $X^{200} \rightarrow A^{110} + B^{90} + Energy$

If the binding energy per nucleon for X, A and B are 7.4 MeV, 8.2 MeV and 8.2 MeV respectively, the energy released will be

A. 900 MeV

B. 110 MeV

C. 200 MeV

D. 160 MeV

Answer: D

Watch Video Solution

27. The energy released by the fission of a single uranium nucleus is 200 MeV. The number of fission of uranium nucleus per second required to produce 16 MW of power is (Assume efficiency of the reactor is 50%)

A. (a) 2×10^6

B. (b) 2.5×10^6

C. (c) 5×10^6

D. (d) None of these

Answer: D

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28. A radioactive isotope is being produced at a constant rate $dN/dt = R$ in an experiment. The isotope has a half-life $t_{1/2}$.Show that after a time $t >> t_{1/2}$,the number of active nuclei will become constant. Find the value of this constant.

A. RT

B. $\frac{R}{T}1n2$

C. $RT1n2$

D. $\frac{RT}{1n2}$

Answer: D

Watch Video Solution

29. A bone containing 200 g carbon-14 has β-decay rate of 375 decay/min. Calculate the time that has elapsed since the death of the living one. Given the rate of decay for the living organism is equal to 15 decay per min per gram of carbon and half-life of carbon-14 is 5730 years.

A. (a) 27190 years

B. (b) 1190 years

C. (c) 17190 years

D. (d) None of these

Answer: C

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30. Two identical samples (same material and same amount) P and Q of a radioactive substance having mean life T are observed to have activities A_P and A_Q respectively at the time of observation. If P is older than Q, then the difference in their age is

A. $T 1n\left(\frac{A_P}{A_Q}\right)$

B. $T 1n\left(\frac{A_Q}{A_P}\right)$

C. $T\left(\frac{A_P}{A_Q}\right)$

D. $T\left(\frac{A_Q}{A_P}\right)$

Answer: B

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31. A star initially has 10^{40} deuterons. It produces energy via the processes $\_1^2H +_1^2 H \rightarrow_1^3 H + p$ and $\_1^2H +_1^3 H \rightarrow_2^4 He + n.$ Where the masses of the nuclei are

$m($^2H)=2.014$a\mu$, m(p)=1.007$a\mu$, m(n)=1.008$a\mu$ and m($\hat{}$ $4He) = 4.001$ amu. If the average power radiated by the star is $10^{16} W$, the deuteron supply of the star is exhausted in a time of the order of

A. (a) $10^6 s$

B. (b) $10^8 s$

C. (c) $10^{12} s$

D. (d) $10^{16} s$

Answer: C

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32. Two radioactive samples of different elements (half-lives t_1 and t_2 respectively) have same number of nuclei at $t = 0$. The time after which their activities are same is

A. $\frac{t_1 t_2}{0.693(t_2 - t_1)} 1n \frac{t_2}{t_1}$

B. $\frac{t_1 t_2}{0.693} 1n \frac{t_2}{t_1}$

C. $\frac{t_1 t_2}{0.693(t_1 + t_2)} 1n \frac{t_2}{t_1}$

D. None of these

Answer: A

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33. A nucleus X initially at rest, undergoes alpha decay according to the equation

$_{-}Z^{232}X \rightarrow_{90}^{A} Y + \alpha$

What fraction of the total energy released in the decay will be the kinetic energy of the alpha particle?

A. (a) $\frac{90}{92}$

B. (b) $\frac{228}{232}$

C. (c) $\sqrt{\frac{228}{232}}$

D. (d) $\frac{1}{2}$

Answer: B

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34. A stationary nucleus of mass 24 amu emits a gamma photon. The energy of the emitted photon is 7 MeV. The recoil energy of the nucleus is

A. (a) $2.2keV$

B. (b) $1.1keV$

C. (c) $3.1keV$

D. (d) $2.2keV$

Answer: B

Watch Video Solution

35. A radioactive material of half-life T was kept in a nuclear reactor at two different instants. The quantity kept second time was twice of the kept first time. If now their present activities are A_1 and A_2 respectively, then their age difference equals

A. $\frac{T}{1n2}1n\frac{2A_1}{A_2}$

B. $T1n\frac{A_1}{A_2}$

C. $\frac{T}{1n2}1n\frac{A_2}{2A_1}$

D. $T1n\frac{A_2}{2A_1}$

Answer: C

Watch Video Solution

Level 2 More Than One Correct

1. If the potential difference of coolidge tube probucing X-ray is increased, then choose the corrent option (s).

Here, λ_0 is cut off wavelength and λ_{Ka} and $\lambda_{K\beta}$ are wavelengths of K_α and K_β characteristic X-rays.

A. the interval between $\lambda_{K\alpha}$ and $\lambda_{K\beta}$ increases

B. the interval between $\lambda_{K\alpha}$ and λ_0 increases

C. the interval between $\lambda_{K\beta}$ and λ_0 increases

D. λ_0 does not change

Answer: B::C

Watch Video Solution

2. In Bohr model of the hydrogen atom, let R,v and E represent the radius of the orbit, speed of the electron and the total energy respectively.

Which of the following quantities are directly proportional to the quantum number n?

A. vR

B. RE

C. v/E

D. R/E

Answer: A::C

Watch Video Solution

3. The magnitude of angular momentum, orbital radius and time period of revolution of an electron in a hydrogen atom corresponding to the quantum number n are L , r and T respectively. Which of the following statement (s) is/are correct?

A. $\frac{rL}{T}$ is independent of n

B. $\frac{L}{T} \propto \frac{1}{n^2}$

C. $\frac{T}{r} \propto n$

D. $Lr \propto \frac{1}{n^3}$

Answer: A::B::C

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4. In which of the following cases the havier of the two particles has a smaller de-Broglie wavelength ? The two particles

A. move with the same speed

B. move with the same linear momentum

C. move with the same kinetic energy

D. have the same change of potential energy in a conservative field

Answer: A::C

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5. Hydrogen atom absorbs radiations of wavelength λ_0 and consequently emit radiations of 6 different wavelengths, of which two wavelengths are longer than λ_0. Chosses the correct alternative(s).

A. The final excited staate of the atoms is n=4

B. The initial state of the atoms is n =2

C. The initial state of the atoms is n =3

D. There ae three transitions belonging to Lyman series

Answer: A::B::D

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6. In coolidge tube, if f and λ represent the frequency and wavelength of K_{α} -line for a metal of atomic number Z, then identify the statement which represents a straight line

A. $\sqrt{f} versus Z$

B. $\frac{1}{\sqrt{\lambda}} versus Z$

C. $f versus Z$

D. $\lambda versus Z$

Answer: A::B

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7. At $t=0$, number of radioactive nuclei of a radioactive substance are x and its radioactivity is y. Half-life of radioactive substance is T. Then,

A. (a) $\frac{x}{y}$ is constant throughout

B. (b) $\frac{x}{y} > T$

C. (c) value of xy remains half after one half-life

D. (d) value of xy remains one fourth after one half-life

Answer: A::B::D

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8. Choose the correct options.

A. (a) Isotopes have same number of atomic number

B. (b) Isobars have same atomic weight

C. (c) Isotones have same number of neutrons

D. (d) In neutral isotope atoms number of electrons are same

Answer: A::B::C::D

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9. Choose the correct options.

A. (a) By gamma radiations atomic number is not changed

B. (b) By gamma radiations mass number is not changed

C. (c) By the emission of one α and two β particles isotopes are produced

D. (d) By the emission of one α and four β particles isobars are produced

Answer: A::B::C

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10. Two radioactive substances have half-lives T and 2T. Initially, they have equal number of nuclei. After time $t = 4T$, the ratio of their number of nuclei is x and the ratio of their activity is y. Then,

A. (a) $x = 1/8$

B. (b) $x = 1/4$

C. (c) $y = 1/2$

D. (d) $y = 1/4$

Answer: B::C

Watch Video Solution

11. Regarding the nuclear forces, choose the correct options.

A. (a) They are short range forces

B. (b) They are charge independent forces

C. (c) They are not electromagnetic forces

D. (d) They are exchange forces

Answer: A::B::C::D

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12. Regarding a nucleus choose the correct options.

A. (a) Density of a nucleus is directly proportional to mass number A

B. (b) Density of all the nuclei is almost constant of the order of $10^{17} kg / m^3$

C. (c) Nucleus radius is of the order of $10^{-15} m$

D. (d) Nucleus radius $\propto$ A

Answer: B::C

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Level 2 Comprehension Based

1. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt.

The work- function of the emitting surface is i

A. $2.2eV$

B. $1.5eV$

C. $1.9eV$

D. $1.1eV$

Answer: C

Watch Video Solution

2. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt. The wavelength of the second source is

A. 6150Å

B. 5150Å

C. 4150Å

D. 4500Å

Answer: C

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3. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt.

if the photoelectrons (after emission form the source) are subjected to a magnetic field of 10 tesla, the two retarding potentials would

A. Uniformly increase

B. Uniformly decrease

C. remain the same

D. none of these

Answer: C

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4. The atomic masses of the hydrogen isotopes are

Hydrogen $m_1H^1 = 1.007825$ amu

Deuterium $m_1H^2 = 2.014102$ amu

Tritium $m_1H^3 = 3.016049$ amu

The energy released in the reaction,

$_1H^2 +_1 H^2 \rightarrow_1 H^3 +_1 H^1$ is nearly

A. (a) 1MeV

B. (b) 2MeV

C. (c) 4MeV

D. (d) 8 MeV

Answer: C

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5. The atomic masses of the hydrogen isotopes are

Hydrogen $m_1H^1 = 1.007825$ amu

Deuterium $m_1H^2 = 2.014102$ amu

Tritium $m_1H^3 = 3.016049$ amu

The number of fusion reactions required to generate 1kWh is nearly

A. (a) 10^8

B. (b) 10^{18}

C. (c) 10^{28}

D. (d) 10^{38}

Answer: B

Watch Video Solution

6. The atomic masses of the hydrogen isotopes are

Hydrogen $m_1H^1 = 1.007825$ amu

Deuterium $m_1H^2 = 2.014102$ amu

Tritium $m_1H^3 = 3.016049$ amu

The mass of deuterium, $\_1H^2$ that would be needed to generate 1 kWh

A. (a) $3.7kg$

B. (b) $3.7g$

C. (c) $3.7 \times 10^{-5}kg$

D. (d) $3.7 \times 10^{-8} kg$

Answer: D

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Level 2Passage 2

1. in an experimental set up to study the photoelectric effect a point soure fo light of power 3.2×10^{-3} W was taken. The source can emit monoenergetic photons of energy 5eV and is located at a distance of 0.8 m from the centre of a stationary metallic sphere of work-function 3.0 eV. The radius of the sphere is $r = 8. .10^{-3}$ m. The efficiency of photoelectric emission is one for every 10^{6} incident photons. Based on the information given above answer the questions given below. (Assume that the sphere is isolated and photoelectrons are instantly swepts away after the emission).

de-Broglie wavelength of the fastest moving photoelectron is

A. 6.63Å

B. 8.69Å

C. 2Å

D. 5.26Å

Answer: B

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Level 2 Passage 3

1. in an experimental set up to study the photoelectric effect a point soure fo light of power 3.2×10^{-3} W was taken. The source can emit monoenergetic photons of energy 5eV and is located at a distance of 0.8 m from the centre of a stationary metallic sphere of work-function 3.0 eV. The radius of the sphere is $r = 8. .10^{-3}$ m. The efficiency of photoelectric emission is one for every 10^6 incident photons. Based on the information given above answer the questions given below. (Assume that the sphere is isolated and photoelectrons are instantly swepts away after the emission).

It was observed that after some time emission of photoelectrons from the sphere stopped. Charge on the sphere when the photon emission stops is

A. $16\pi\varepsilon_0^r$ coulomb

B. $8\pi\varepsilon_0^r$ coulomb

C. $15\pi\varepsilon_0^r$ coulomb

D. $20\pi\varepsilon_0^r$ coulomb

Answer: B

Watch Video Solution

Level 2 Passage 4

1. in an experimental set up to study the photoelectric effect a point soure fo light of power 3.2×10^{-3} W was taken. The source can emit monoenergetic photons of energy 5eV and is located at a distance of 0.8 m from the centre of a stationary metallic sphere of work-function 3.0 eV. The radius of the sphere is $r = 8..10^{-3}$ m. The efficiency of photoelectric emission is one for every 10^6 incident photons. Based on the information given above answer the questions given below. (Assume that the sphere is isolated and photoelectrons are instantly swepts away after the emission).

Time after which photoelectric emission stops is

A. 100s

B. 121s

C. 111s

D. 141s

Answer: C

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Level 2 Subjective

1. The wavelength for n=3 to n=2 transition of the hydrogen atom is 656.3 nm. What are the wavelength for this same transition in (a) positronium, which consists of an electron and a positron (b) singly ionized helium

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2. (a) Find the frequencies of revolution of electrons in n = 1 and n=2 Bohr orbits.

(b)What is the frequency of the photon emitted when an electron in an n=2 orbit drops to an n=1 hydrogen orbit?

(c)An electron typically spends about $10^{-8} s \in anexcitedstatebef$ or $eitdrops \to alowerstatebyemie \in gapho$

100xx10^(-8)` s?.

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3. A muan is an unstable elementary partical whose mass (μ^{-}) can be captured by a hydrogen nucleus (or proton) to from a muonic atom.

a Find the redius of the first Bohr orbit of this atom.

b Find the ionization energy of the atom.

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4. (a) A gas of hydrogen atoms is their ground state is bombarded by electrons with kinetic energy 12.5 ev. What emitted wavelengths would you expect to see?

(b) What if the electrons were replaced by photons of same anergy?.

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5. A source emits monochromatic light of frequency 5.5×10^{14} Hzat a rate of 0.1 W. Of the photons given out, 0.15% fall on the cathode of a photocell which gives a current of $6\mu A$ in an extrnal circuit.

(a) Find the enrgy of a photon.

(b) Find the number of photons leaving the source per second.

(C) Find the percentage of the photons falling on the cathode which produce photoelectrons.

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6. The hydrogen atom in its ground state is excited by means of monochromatic radiation. Its resulting spectrum has six different lines. These radiations are incident on a metal plate. It is observed that only two of them are responsible for photoelectric effect. if the ratio of maximum kinetic energy of photoelectrons is the two cases is 5 then find the work function of the metal.

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7. Electrons in hydrogen like atom $(Z = 3)$ make transition from the fifth to the fourth orbit and from the third orbit. The resulting radiation are incident normally on a metal plate and eject photoelectrons. The stopping potential for the photoelectrons ejected by the shorter wavelength is 3.95 volts. Calculate the work function of the metal and the stopping potential for the photoelectron ejected by longer wavelength

(Rydberg constant $= 1.094 \times 10^7 m^{-1}$

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8. Find an expression fot the magneitc dipole moment and magnetic field induction at the centre of Bohr'r hypothetical hydrogen atom in the n th orbit of the electron in terms of universal constant.

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9. An electron and a proton are seperated by a large distance and the electorn approaches the proton with a kinectic energy of 2 eV. If the electron is captured by the proton to form a hydrogen atom in the ground state, what wavelength photon would be given off?

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10. Hydrogen gas in the atomic state is excited to an energy level such tht the electrostatic potential energy of H-atom becomes $-1.7eV$. Now, a photoelectric plate having work function w=2.3 eV is exposed to the emission spectra of this gas. Assuming all the transitions to be possible, find the minimum de-Broglie wavelength of the ejected photoelectrons.

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11. A gas of hydrogen - like atoms can absorb radiations of $698eV$. Consequently , the atoms emit radiation of only three different wavelengths . All the wavelengthsare equal to or smaller than that of the absorbed photon.

a Determine the initial state of the gas atoms.

b Identify the gas atoms

c Find the minimum wavelength of the emitted radiation ,

d Find the ionization energy and the respective wavelength for the gas atoms.

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12. A photon with energy of 4.9 eV ejects photoelectrons from tungsten. When the ejcect phototelectrons from tungsten. When the ejected electron enters a cnstant magnetic field of strength B=2.5 mT at an angle of 60° with the field direction, the maximum pitch fo the helix described by the electron is found to be 2.7 mm. Find the work function of the metal in electron volt. Given that specific charge of electron is `1.76xx10^11 C/kg.

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13. For a certain hypothetical one electron atom, the wavelength $(\in \text{Å})$ for the spectral lines for transitions originating at n=p and terminating at n=1 are given by $\lambda = \frac{1500p^2}{p^2 - 1}, where p = 2, 3, 4$

(a)Find the wavelength of the least energetic and the most energetic photons in this series.

(b) Construct an energy level diagram for this element showing the energies of the lowest three levels.

(c) What is the ionization potential fo this elelment?

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14. A photocell is operating in saturation mode with a photocurrent 4.8 mA when a monochromatic radiation of wavelength $3000\text{Å}$and power of 1wM is incident. When another monochromatic radiation of wavelength 1650Å and power 5wM is indcident, it is observed that maximum velocity of photoelectron increases to two times. Assuming efficiency of photoelectron generation per incident photon to be same for both the cases, calculate.

(a) the threshold wavelength for the cell

(b) the saturation current in second case

(c) the efficiency of photoelectron generation per incident photon.

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15. The photons from the Balmer series in Hydrogen spectrum having wavelength between $450nm$ to $700nm$ are incident on a metal surface of work function $2eV$ Find the maximum kinetic energy of ejected electron (Given hc = 1242 eV nm)`

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16. Assume that the de Broglie wave associated with an electron can from a standing wave between the atom arrange in a one dimensional array with nodes at each of the atomic sites. It is found that one such standing wave if the distance d between the atoms of the array is $2A^0$ A similar standing wave is again formed if d is increased to 2.5Å . Find the energy of the electrons in electron volts and the least value of d for which the standing wave type described above can from .

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17. The nagative muon has charge equal to that of an electron but a mass that is 207 times as great. Consider hydrogen like atom consisting of a proton and a muon.

(a) What is the reduced mass of the atom?

(b) What is the ground-level energy (in eV)?

(c) What is the wavelength of the radiation emitted in the transiton from the n=2 level to the n=1 level?

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18. Assume a hypothetica hydrogen atom in which the potential energy between electron and proton at separation r is given by $U=\left[k \in r-\left(\frac{k}{2}\right)\right]$, where k is a constant. For such a hypothetical hydrogen atom, calcualete the radius of nth Bohr orbit and energy levels.

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19. An electron is orbiting is a circular orbit of radius r under the influence of a constant magnetic field of strength B. Assuming that Bohr postulate regarding the quantisation of angular momentum holds good for this elerctron, find

(a) the allowed values of te radius r of the orbit.

(b) the kinetic energy of the electron in orbit

(c) the potential energy of insteraction between the magnetic moment of the orbital current due to the electron moving in its orbit and the magnetic field B.

(d) the total energy of the allowed energy levels.

(e) the total magnetic flux due to the magnetic field B passing through the nth orbit. (Assume that the charge on the electronis -e and the mass of the electron is m).

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20. A mixture of hydrogen atoms (in their ground state) and hydrogen like ions (in their first excited state) are being excited by electrons which have been accelerated by same potential of emitted light are found in the ratio 5:1. Then, find

(a) the minimum value of V for which both the atoms get excited after collision with electrons.

(b) atomic number of other ion.

(c) the energy of emitted light.

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21. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt.

if the photoelectrons (after emission form the source) are subjected to a magnetic field of 10 tesla, the two retarding potentials would

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22. In an experiment on photoelectric effect light fo wavelength 400 nm is incident on a metal plate at rate of 5W. The potential of the collector plate is made sufficiently positive with respect to emitter so that the current reaches the saturation value. Assuming that on the average one out of every 10^6 photons is able to eject a photoelectron, find the photocurrent in the cirucuit.

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23. A light beam of wavelength 400 nm is incident on a metal of work-function 2.2 eV. A particular electron absorbs a photon and makes 2 collisions before coming out of the metal

(a) Assuming that 10% of existing energy is lost to the metal in each collision find the final kinetic energy of this electron as it comes out of the metal.

(b) Under the same assumptions find the maximum number of collisions, the electron should suffer before it becomes unable to come out of the metal.

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24. A F^{32} radio nuclide with half-life $T = 14.3$ days is produced in a reactor at a constant rate $q = 2 \times 10^9$ nuclei per second. How soon after the beginning of production of that radio nuclide will its activity be equal to $R = 10^9$ disintegration per second?

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25. Consider a radioactive disintegration according to the equation $A \rightarrow B \rightarrow C$. Decay constant of A and B is same and equal to λ. Number of nuclei of A, B and C are N_0 , 0, 0 respectively at $t = 0$. Find

(a) number of nuclei of B as function of time t.

(b) time t at which the activity of B is maximum and the value of maximum activity of B.

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26. Nuclei of a radioactive element A are being produced at a constant rate α. The element has a decay constant λ. At time $t = 0$, there are N_0 nuclei of the element.

(a) Calculate the number N of nuclei of A at time t.

(b) If $\alpha = 2N_0\lambda$, calculate the number of nuclei of A after one half-life of A, and also the limiting value of N as $t \rightarrow \infty$.

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27. A solution contains a mixture of two isotopes A (half-life=10days) and B (half-life=5days). Total activity of the mixture is 10^{10} disintegration per second at time $t = 0$. The activity reduces to 20% in 20 days. Find (a) the initial activities of A and B, (b) the ratio of initial number of their nuclei.

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28. A radio nuclide with disintegration constant λ is produced in a reactor at a constant rate α nuclei per second. During each decay energy E_0 is released. 20% of this energy is utilized in increasing the temperature of water. Find the increase in temperature of m mass of water in time t. Specific heat of water is s. Assume that there is no loss of energy through water surface.

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29. A stable nuclei C is formed from two radioactive nuclei A and B with decay constant of λ_1 and λ_2 respectively. Initially, the number of nuclei of

A is N_0 and that of B is zero. Nuclei B are produced at a constant rate of P. Find the number of the nuclei of C after time t.

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30. Polonium $(_ 84^{210}$Po$)emits_$2^4He $partic \leq s$ and $isconverted \int o \leq ad($_82^206Pb $). Thisreactionisusedf$ or $\prod uc \in ge \leq ctricpower \in aspacemission.$ Po^210 $hashalf - l$ if $eof138.6days. As \sum \in ganefficiencyof10\% f$ or $theth$ ^210Po$isrequired \rightarrow \prod uce$1.2xx10^7J $ofe \leq ctrice \neq rgyperdayattheendof693days. Alsof \in dthe \in itialactivi$ ^210Po=209.98264$a\mu$, ^206Pb=205.97440$a\mu$, _2^4He=4.00260$a\mu$, 1 am u=931 MeV//c^2 and $Avogadro' s\nu mber$ = 6xx10^23//mol`

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31. A radio nuclide consists of two isotopes. One of the isotopes decays by α-emission and other by β-emission with half-lives $T_1 = 405s$ and $T_2 = 1620s$, respectively. At $t = 0$, probabilities of getting α and β-particles from the radio nuclide are equal . Calculate their respective probabilities at $t = 1620s$. If at $t = 0$, total number of nuclei in the radio nuclide are N_0. Calculate the time t when total number of nuclei remained undecayed becomes equal to $N_0 / 2$.

$\log_{10} 2 = 0.3010, \log_{10} 5.94 = 0.7742$ and $x^4 + 4x - 2.5 = 0$, x=0.594`

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32. Find the amount of heat generated by 1 mg of Po^{210} preparation during the mean life period of these nuclei if the emitted alpha particles are known to possess kinetic energy 5.3 MeV and practically all daughter nuclei are formed directly in the ground state.

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33. In an agriculture experiment, a solution containing 1 mole of a radioactive meterial $(t_{1/2} = 14.3 days)$was injected into the roots of a plants.the plant was allowed 70 hours to settle down and then activity eas measured in its fruit. If the activity measured was $1\mu Ci$ what per cent of activity is transmitted from the root to the fruit in steady state?

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Exercise 34.1

1. The decay constant of a radioactive sample is λ. The half-life and the average-life of the sample are respectively

A. (a) $1/\lambda$ and $(In2)/\lambda$

B. (b) $(In2)/\lambda$ and $1/\lambda$

C. (c) $\lambda(In2)$ and $1/\lambda$

D. $\lambda/(In2)$ and $1/\lambda$

Answer: B

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2. Consider a particle , β particle and $\gamma - rays$, each having an energy of $0.5 MeV$. In increase order of panetrating power , the radiation are .

A. (a) α, β, γ

B. (b) α, γ, β

C. (c) β, γ, α

D. (d) γ, β, α

Answer: A

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3. Which of the following is a correct statement?

A. (a) Beta rays are same as cathode rays

B. (b) Gamma rays are high energy neutrons

C. (c) Alpha particles are singly ionized helium atoms

D. (d) Protons and neutrons have exactly the same mass

Answer: A

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4. The electron emitted in beta radiation originates from

A. (a) inner orbits of atom

B. (b) free electrons existing in nuclei

C. (c) decay of a neutron in a nucleus

D. (d) photon escaping from the nucleus

Answer: C

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5. During a negative beta decay,

A. (a) an atomic electron is ejected

B. (b) an electron which is already present within the nucleus is ejected

C. (c) a neutron in the nucleus decays emitting an electron

D. (d) a part of the binding energy of the nucleus is converted into a electron

Answer: C

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6. A freshly prepared radioactive source of half-life $2h$ emits radiation of intensity which is 64 times the permissible safe level. The minimum time after which it would be possible to work safely with this source is

A. 6h

B. 12h

C. 24h

D. 128 h

Answer: B

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7. A radioactive sample S_1 having an activity of $5\mu Ci$ has twice the number of nuclei as another sample S_2 which has an activity of $10\mu Ci$. The half-lives of S_1 and S_2 can be

A. (a) 20 yr and 5 yr, respectively

B. (b) 20 yr and 10 yr, respectively

C. (c) 10 yr each

D. (d) 5 yr each

Answer: A

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8. Half-life of a radioactive substance A is 4 days. The probability that a nuclear will decay in two half-lives is

A. (a) 1/4

B. (b) 3/4

C. (c) 1/2

D. (d) 1

Answer: B

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9. After 280 days, the activity of a radioactive sample is 6000 dps. The activity reduces to 3000 dps after another 140 days. The initial activity of the sample in dps is

A. (a) 6000

B. (b) 9000

C. (c) 3000

D. (d) 24000

Answer: D

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10. The half-life of $\hat{} 215 At$ is $100 \mu s$. The time taken for the activity of a sample of $\hat{} 215 At$ to decay to $\frac{1}{16} th$ of its initial value is

A. $400 \mu s$

B. $63 \mu s$

C. $40 \mu s$

D. $300 \mu s$

Answer: A

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11. The half life of radioactive Radon is $3.8 days$. The time at the end of which $\frac{1}{20}th$ of the radon sample will remain undecayed is $(given \log e = 0.4343)$

A. (a) 3.8 days

B. (b) 16.5 days

C. (c) 33 days

D. (d) 76 days

Answer: B

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12. Activity of a radioactive substance decreases from 8000 Bq to 1000 Bq in 9 days. What is the half-life and average life of the radioactive substance?

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13. A radioactive substance has a half-life of 64.8 h. A sample containing this isotope has an initial activity $(t = 0)$ of $40 \mu Ci$. Calculate the number of nuclei that decay in the time interval between $t_1 = 10.0h$ and $t_2 = 12.0h$.

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14. A freshly prepared sample of a certain radioactive isotope has an activity of 10mCi. Afte 4.0h its activity is 8.00 mCi.

(a) Find the decay constant and half-life

How many atoms of the isotope were contained in the freshly preapared sample?

(c) What is the sample's activity 30.0 h after it is prepared?

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15. A radioactive substance contains 10^{15} atoms and has an activity of 6.0×10^{11} Bq. What is its half-life?

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16. Two radioactive elements X and Y have half-life periods of 50 minutes and 100 minutes, respectively. Initially, both of them contain equal number of atoms. Find the ratio of atoms left $N_X I N_Y$ after 200 minutes.

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Exercise 34.2

1. If a star can convert all the He nuclei completely into oxygen nuclei. The energy released per oxygen nuclei is (Mass of the helium nucleus is 4.0026 amu and mass of oxygen nucleus is 15.9994 amu)

A. (a) 7.6 MeV

B. (b) 56.12 MeV

C. (c) 10.24 MeV

D. (d) 23.4 MeV

Answer: C

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2. Fast neutrons can easily be slowed down by

A. (a) the use of lead shielding

B. (b) passing them through heavy wate

C. (c) elastic collisions with heavy nuclei

D. (d) applying a strong electric field

Answer: B

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3. During a nuclear fusion reaction,

A. (a) a heavy nucleus breaks into two fragements by itself

B. (b) a light nucleus bombarded by thermal neutrons breaks up

C. (c) a heavy nucleus bombarded by thermal neutrons breaks up

D. (d) two light nuclei combine to give a heavier nucleus and possibly other products

Answer: D

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4. The equation

$4H^{+} \rightarrow_{2}^{4} He^{2+} + 2e \overline{+} 26MeV represents$

A. (a) β-decay

B. (b) γ-decay

C. (c) fusion

D. (d) fission

Answer: C

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5. (a) How much mass is lost per day by a nuclear reactor operated at a 10^{9} watt power level?

(b) If each fission releases 200 MeV, how many fissions occur per second to yield this power level?

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6. Find energy released in the alpha decay,

Given $\_92^{238}U \rightarrow_{90}^{234} Th +_2^4 He$

$M($_92^238U)=238.050784uM($_90^{234}Th) = 234.043593u$

$M($_2^4He)=4.002602u`

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7. Complete the nuclear reactions.

(a) $\_3^6 Li + ? \rightarrow_4^7 Be +_0^1 n$ (b) $\_17^{35} CI + ? \rightarrow_{16}^{32} S +$ _2^4He(c)

_4^9Be+_2^4Herarr3($\_2^4 He) + ?$ (d) $_35^{79} Br +_2^1 H \rightarrow ? + 2($_0^1n)`

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8. Consider the reaction $\_1^2 H +_1^2 H =_2^4 He + Q$. Mass of the deuterium atom $= 2.0141u$. Mass of helium atom $= 4.0024u$. This is a nuclear.........reaction in which the energy Q released is............MeV.

Watch Video Solution

9. The binding energies per nucleon for deuteron ($_1H^2$) and helium ($_2He^4$)are1.1MeV and 7.0MeVrespectively.Thee≠rgyre≤asedwhe

_2He^4`) is........

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Assertion And Reason

1. Assertion : Rate of radioactivity cannot be increased or decreased by increasing or decreasing pressure or temperature.

Reason : Rate depends on the number of nuclei present in the radioactive sample.

A. If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: B

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2. Assertion : Only those nuclei which are heavier than lead are radioactive.

Reason : Nuclei of elements heavier than lead are unstable.

A. (a) If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: D

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3. Assertion : After emission of one α-particle and two β-particles, atomic number remains unchanged.

Reason : Mass number changes by four.

A. (a) If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: B

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4. Assertion : γ-rays are produced by the transition of a nucleus from some higher energy state to some lower energy state.

Reason : Electromagnetic waves are always produced by the transition process.

A. If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: C

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5. Assertion : During β-decay a proton converts into a neutron and an electron. No other particle is emitted.

Reason: During β-decay linear momentum of system should remain constant.

A. (a) If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: D

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6. Assertion : If we compare the stability of two nuclei, then that nucleus is more stable whose total binding energy is more.

Reason: More the mass defect during formation of a nucleus more will be the binding energy.

A. If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

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7. Assertion : In a nuclear process energy is released if total binding energy of daughter nuclei is more than the total binding energy of parent nuclei.

Reason: If energy is released then total mass of daughter nuclei is less than the total mass of parent nuclei.

A. (a) If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: A::B

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8. Assertion : Binding energy per nucleon is of the order of MeV.

Reason: $1MeV = 1.6 \times 10^{-13}J$.

A. (a) If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: B

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9. Assertion : 1 amu is equal to 931.48 MeV.

Reason: 1 amu is equal to 1/12th the mass of C^{12} atom.

A. (a) If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: D

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10. Assertion: Between α, β and γ radiations, penetrating power of γ-rays is maximum.

Reason : Ionising power of γ-rays is least.

A. (a) If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: B

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11. Assertion: The nuclear energy can be obtained by the nuclear fission of heavier nuclei as well as by fusion of lighter nuclei.

Reason: As the mass number increases, the binding energy per nucleon, first increases and then decreases.

A. (a) If both Assertion and Reason are true and Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: A::B

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Level 1 Subjective Questions

1. The half-lives of radioisotopes P^{32} and P^{33} are 14 days and 25 days respectively. These radioisotopes are mixed in the ratio of 4:1 of their atoms. It the initial activity of the mixed sample is 3.0 mCi, find the activity of the mixed isotopes after 60 years.

View Text Solution

for JEE MAIN

1. When a metalic surface is illuminated with light of wavelength λ, the stopping potential is V. the same surface is illuminated by light of wavelength 2λ the stopping potential is $\frac{V}{3}$ The thershold waelength for the surface is

A. $\frac{4\lambda}{3}$

B. 4λ

C. 6λ

D. $\frac{8\lambda}{3}$

Answer: B

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2. The de Broglie wavelength of an electron moving with a velocity of $1.5 \times 10^{8} ms^{-1}$ is equal to that of a photon find the ratio of the kinetic energy of the photon to that of the electron.

A. 2

B. 4

C. $\frac{1}{2}$

D. $\frac{1}{4}$

Answer: D

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3. Let p and E denote the linear momentum and energy of a photon. If the wavelength is decreased,

A. both p and E increase

B. p increase and E decreases

C. p decrease and E increases

D. both p and E decrreases

Answer: A

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4. The de Broglie wavelength of an neutron corresponding to root mean square speed at 927° is λ. What will be the de Broglie wavelength of the neutron corresponding to root mean square speed at $27^{\circ}C$?

A. $\frac{\lambda}{2}$

B. λ

C. 2λ

D. 4λ

Answer: C

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5. If an orbital electron of the hydrogen atom jumps from the ground state to a higher energy state, its orbital value where its velocity is reduced to half its initial value.. If the radius of the electron orbit in the ground state is r, then the radius of the new orbit would be:

A. 2r

B. 4r

C. 8r

D. 16r

Answer: B

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6. If a hydrogen atom at rest, emits a photon of wavelength λ, the recoil speed of the atom of mass m is given by :

A. $\frac{h}{\lambda}$

B. $\frac{mh}{\lambda}$

C. $mh\lambda$

D. $\frac{h\lambda}{m}$

Answer: A

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7. Two particles of masses m and $2m$ have equal kinetic energies. Their de Broglie wavelengths area in the ratio of:

A. $1:1$

B. $1:2$

C. $1:\sqrt{2}$

D. $\sqrt{2}:1$

Answer: D

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8. The binding energy of nucei X and Y are E_1 and E_2, respectively. Two atoms of X fuse to give one atom of Y and an energy Q is released. Then,

A. $Q = 2E_1 - E_2$

B. $Q = E_2 - 2E_1$

C. $Q < 2E_1 - E_2$

D. $Q > E_2 - 2E_1$

Answer: B

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9. $A \xrightarrow{\lambda} B \xrightarrow{2\lambda} C$

$T = 0, N_0, 0,$

$TN_1N_2N_3$

The ratio of $N_1 \text{ to } N_2$ is maximum I s

A. $\frac{2}{\ln 2}$

B. 2

C. 0.5

D. $\frac{\ln 2}{2}$

Answer: B

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10. The graph of $1n\left(\frac{R}{R_0}\right)$ versus $1nA(R = radius$ of a nucleus and $A =$ its mass number) is

A. a straight line

B. a parabola

C. and ellipse

D. a circle

Answer: A

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11. When a β^- particle is emitted from a nucleus, the neutrons-proton ratio:

A. os decreased

B. is increased

C. remains the same

D. may in increases or decreases

Answer: A

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12. Radiation two photons having energies twice and five times the work function of a metal are incident successively on the metal surface. The ratio of the maximum velocity of photoelectrons emitted in the two cases will be

A. $1:2$

B. $2:1$

C. $1:4$

D. $4:1$

Answer: A

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13. Cut off potential for a metal in photoelectric effect for light of wavelength λ_1, λ_2 and λ_3 is found to be V_1, V_2 and V_3 volts , If V_1, V_2 and V_3 are in Arithmetic progression then λ_1, λ_2 and λ_3 will be in

A. Arithmetic progression

B. Geometric progression

C. Harmonic progression

D. None of these

Answer: C

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14. Photons with energy $5eV$ are incident on a cathode C in a photoelectric cell . The maximum energy of emitted photoelectrons is $2eV$. When photons of energy $6eV$ are incident on C , no photoelectrons will reach the anode A , if the stopping potential of A relative to C is

A. 5

B. 3 V

C. 1 V

D. 4 V

Answer: B

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15. Consider the following nuclear reaction,

$X^{200} \rightarrow A^{110} + B^{90} + Energy$

If the binding energy per nucleon for X, A and B are $7.4 MeV$, $8.2 MeV$ and $8.2 MeV$ respectively, the energy released will be

A. 200 MeV

B. 160 MeV

C. 110 MeV

D. 90 MeV

Answer: B

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16. The activity of a sample reduces from A_0 to $\frac{A_0}{\sqrt{3}}$ in one hour. The activity after 3 hours more will be

A. $\frac{A_0}{3\sqrt{3}}$

B. $\frac{A_0}{9}$

C. $\frac{A_0}{9\sqrt{3}}$

D. $\frac{A_0}{27}$

Answer: B

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17. The number of α and β- emitted during the radioactive decay chain starting from $._{226}^{88} Ra$ and ending at $._{206}^{82} Pb$ is

A. 3α and $6\beta^-$

B. 4α and $5\beta^-$

C. 5α and $4\beta^-$

D. 6α and $6\beta^-$

Answer: C

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18. The wavelength of the K_{α} line for an element of atomic number 57 is λ . What is the wavelength of the K_{α} line for the element of atomic number29 ?

A. λ

B. 2λ

C. 4λ

D. 8λ

Answer: C

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19. There are two radioactive substance A and B. Decay consant of B is two times that of A. Initially, both have equal number of nuceli. After n half-lives of A,rates of disintegaration of both are equal. The value of n is

.

A. 1

B. 2

C. 4

D. None of these

Answer: A

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20. A radioactive ncleus A finaly transforms into a stable nucleus. B Then A and B can be

A. isobars

B. isotones

C. isotopes

D. None of these

Answer: C

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21. If $._{92}U^{238}$ changes to $._{85}At^{210}$ by a series of α-and β -decays, the number of α and β-decays undergone is .

A. 7 and 5

B. 7 and 7

C. 5 and 7

D. 7 and 9

Answer: B

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22. Number of nuclei of a radioactive substance are 1000 and 900 at times $t = 0$ and time $t = 2s$. Then, number of nuclei at time $t = 4s$ will be

A. 8000

B. 810

C. 790

D. 700

Answer: B

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23. In a sample of a radioactive substance, what fraction of the initial nuceli will remain undecayed after a time $t = T/2$, where T=half -life of radioactive substance?

A. $\frac{1}{\sqrt{2}})$

B. $\frac{1}{2\sqrt{2}})$

C. $\frac{1}{4}$

D. $\frac{1}{\sqrt{2-1}}$

Answer: A

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24. Magnetic moment due to the motion of the electron in nth energy of hydrogen atom is proportional to

A. n

B. n^0

C. n^5

D. n^3

Answer: A

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25. An electron in nth excited state in a hydrogen atom comes down to first excited state by emitting ten different wavelength. Find value of n (an integer).

A. 6

B. 7

C. 8

D. 9

Answer: A

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26. The angular momentum of an electron in an orbit is quantized because irt is a necessary condition for the compatibility with

A. the wave nature of electron

B. particle nature of electron

C. Paullis exclusion behaviour

D. None of these

Answer: A

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27. Find the maximum angular speed of the electron of a hydrogen atoms in a statoonary orbit

A. $6.2 \times 10^{5} rad/s$

B. $4.1 \times 10^{16} rad/s$

C. $2.4 \times 10^{10} rad/s$

D. $9.2 \times 10^{10} rad/s$

Answer: B

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28. In hydrogen and hydrogen-like atom , the ratio of $E_{4n} - E_{2n}$ and $E_{2n} - E_n$ varies with atomic nimber z and principal quantum number$n$ as

A. $\frac{Z^2}{N^2}$

B. $\frac{Z^4}{n^4}$

C. $\frac{Z}{n}$

D. None of these

Answer: D

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29. The ratio of the maximum wavlength of the Lyman series in hydrogen specturm to the maximum wavelength in the Panchen series is

A. $\frac{3}{105}$

B. $(6)(15)$

C. $\frac{52}{7}$

D. $\frac{7}{108}$

Answer: D

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30. When an electron in the hydrogen atom in ground state absorb a photon of energy $12.1 eV$, its angular momentum

A. decreases by $2.11 \times 10^{-34} J - s$

B. decreases by $1.055 \times 10^{-34} J - s$

C. increases by $2.11 \times 10^{-34} J - s$

D. increases by $1.055 \times 10^{-34} J - s$

Answer: C

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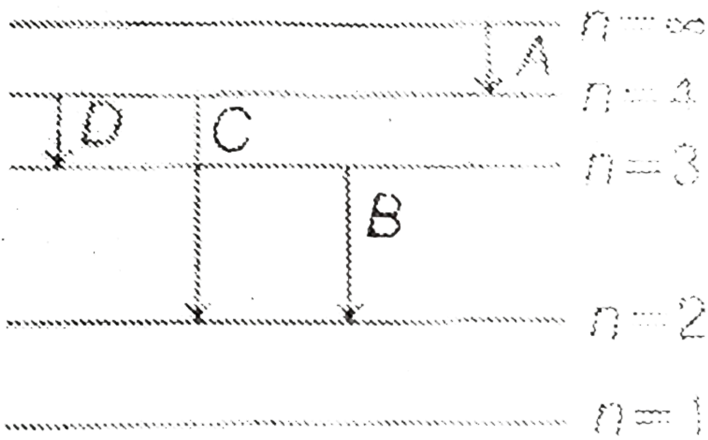
31. Consider the electron energy level diagram of H-atom Photons associated with shortest and longest wavelength would be emitted from the atom by the transitions labeled



A. D and C respcitively

B. C and A respectively

C. C and D respectivley

D. A and C respectively

Answer: C

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32. In a characteristic X-ray spectra of some atom superimposed on continuous X-ray spectra :

A. P represents K_{α} line

B. Q represents K_{β} line

C. Q and P represent K_{α} and K_{β} lines respectively

D. Q and P represent K_{α} and K_{β} lines respectivley

Answer: C

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33. What is the probability of a radioactive nucleus to survive one mean life?

A. $\frac{1}{e}$

B. $1 - \frac{1}{e}$

C. $\frac{\ln 2}{e}$

D. $1 - \frac{\ln 2}{e}$

Answer: A

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34. The activity of a radioactive substance is R_1 at time t_1 and R_2 at time $t_2(> t_1)$. Its decay cosntant is λ. Then .

A. $R_1 t_1 = R_2 t_2$

B. $R_1 = R_1 e^{-(\lambda^{t_1 - t_2})}$

C. $\frac{R_1 - R_2}{t_2 - t_1}$=constant

D. $R_2 = R_1 e^{\lambda(t_2 - t_1)}$

Answer: B

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35. In problem43, number of atoms decayed between time interval t_1 and t_2 are

A. $\frac{\ln(2)}{\lambda}(R_1 - R_2)$

B. $R_1 e^{-\lambda t_1} - R_2 e^{-\lambda t_2}$

C. $\lambda(R_1 - R_2)$

D. $\left(\frac{R_1 - R_2}{\lambda}\right)$

Answer: D

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36. N_1 atoms of a radioactive element emit N_2 beta partilces per second. The decay cosntant of the element is (in s^{-1})

A. $\frac{N_1}{N_2}$

B. $\frac{N_2}{N_1}$

C. $N_1 \ln(2)$

D. $N_2 \ln(2)$

Answer: B

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37. Magnetic field at the center (at nucleus) of the hydrogen like atom $(\text{atomic number} = z)$ due to the motion of electron in nth orbit is proporional to

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38. The binding energy of the electron in the ground state of He atom is equal to $E_0 = 24.6eV$. Find the energy required to remove both the electrons from the atom.

A. $24.6eV$

B. $49.2eV$

C. $79eV$

D. $38.2eV$

Answer: C

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39. A y-ray photon is emitted

A. after ionization of an atom

B. due to conversion of a neutron nto a neutorn in the nucleus

C. after de-excitaion of a nucleus

D. due to conversion of a proton into a neutron in the nucleus

Answer: C

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40. Angular momentum (L) and radius (r) of a hydrogen atom are related as

A. Lr=constant

B. Lr^2=constant

C. L^4 =constant

D. None of these

Answer: D

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41. $92^{U^{235}}$ mucleus absorbs a slow neutron and undergoes fission into $54^{X^{139}}$ and $38^{sr^{94}}$ nuclie The other particies produced in this fission process are

A. 1β and 1α

B. 2β and 1 neutron

C. 2 neutrons

D. 3 neutrons

Answer: B

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42. The ratio of de-Broglie wavelengths of molecules of hydrogen and helium gas moving at rms speed in two gas jars kept separately at temperature 37° C and 127° C respectively is :

A. $\frac{2}{\sqrt{3}}$

B. $\sqrt{\frac{2}{3}}$

C. $\frac{\sqrt{3}}{2}$

D. $\sqrt{\frac{8}{3}}$

Answer: D

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43. The rest mass of a deuteron is equivalent to an energy of $1876 MeV$, that of a proton to $939 MeV$, and that of a neutron to` 940 MeV. A deutron may disintegrate to a proton and neutron if

A. emits a y-ray photon of energy 2 MeV

B. captures a y-ray photon of energy 2MeV

C. emits a y-ray photon of energy o3 MeV

D. captures a y-ray photon energy 3 MeV

Answer: D

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44. Consider a hydrogen-like atom whose energy in nth excited state is given by

$$E_n = \frac{13.6Z^2}{n^2}$$

When this excited makes a transition from excited state to ground state , most energetic photons have energy

$E_{\max} = 52.224 eV$. and least energetic photons have energy

$E_{\max} = 1.224 eV$

Find the atomic number of atom and the intial state or excitation.

A. 2

B. 5

C. 4

D. 3

Answer: A

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45. An electron in a Bohr orbit of hydrogen atom with quantum number n has ans angular momentum $4.2176 \times 10^{-24} kg - m^2 / \sec$

A. $5.86 Å$

B. $3.26 Å$

C. 4.66Å

D. 4.77Å

Answer: D

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46. Two identical photocathode receive light of frequencies f_1 and f_2. If the maximum velocities of the photoelectrons (of mass m) coming out are respectively v_1 and v_2 then:

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

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

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

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

Answer: B

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47. Assuming that about $20MeV$ of energy is released per fusion reaction $._1 H^2 + ._1 H^3 \rightarrow ._0 n^1 + ._2 He^4$, the mass of $._1 H^2$ consumed per day in a future fusion reactor of powder $1MW$ would be approximately

A. $0.001g$

B. $0.2g$

C. $10.0g$

D. $2g$

Answer: B

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48. In a Coolidge tube, the potential difference used to accelerate the electrons is increased from $12.4kV$ to $24.8kV$. As a result, the difference between the wavelengths of K_{α}-line and minimum wavelength becomes thrice. The wavelength of the K_{α} line is $0.25 \times KA^{\circ}$. Find the value of K.

$$\frac{hc}{e} = (12.4KVA^{\circ})$$

A. 1Å

B. 0.5Å

C. 1.5Å

D. 1.25Å

Answer: D

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49. The half life of $._{92}U^{238}$ against α -decay is 4.5×10^{9} years. What is the activity of 1g sample of $._{92}U^{238}$?

A. $3.89 \times 10^{11} Bq$

B. $3.89 \times 10^{8} Bq$

C. $1.23 \times 10^{4} Bq$

D. $1.23 \times 10^5 Bq$

Answer: C

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50. Positron is the antiparticle of an electron .It has the same mass as an electron but the opposite charge An electron and a positron moving towards each other with equal and opposite velocities.

A. can annihilate into one photon. Conserving both energy and momentum

B. cannot annihilate into one photon because energy cannot be conserved

C. cannot annihilate into one photon because momentum cannot be conserved

D. cannot annihilate into one photon because charge cannot be conserved

Answer: C

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51. Ratio of the de Broglie wavelenght of molecules of helium and hydrogen at temperatur 27° C and 327° C respectively is

A. 2

B. 1

C. 3

D. 4

Answer: B

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52. An element A decays into element C by a two-step process :

$A \rightarrow B + ._2 He^4$

$B \rightarrow C + 2e^-$

Then.

A. A and C are isotopes

B. A and C ae isobars

C. B and C are isotopes

D. A and B are isobars

Answer: A

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53. Consider the following energies

(1) The minimum energy needed to excite a hydrogen atom from its ground state $- E_1$

(2) Energy needed to ionze a hydrogen atom from ground state $= E_2$

(3) Energy released in $^{235}_{\cdot}U - \text{fission} \quad = E_3$

(4) Energy needed to remove a neutron from a $^{12}_{\cdot}C_{\text{cucleus}} = E_4$

A. $E_1 < E_2 < E_3 < E_4$

B. $E_1 < E_3 < E_2 < E_4$

C. $E_1 < E_2 < E_4 < E_3$

D. $E_2 < E_1 < E_4 < E_3$

Answer: C

Watch Video Solution

54. Supose the potential energy between electron and porton a distance r is given by $U = -\frac{Ke^2}{3r^3}$ Assuming Bohar's Model to be valid for this atom if the speed of elctron in n^{th} orbit depends on the prinicpal quantum number n as v $\propto n^x$ then find the vlaue of x.

A. 1

B. 2

C. 3

D. 4

Answer: C

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55. Half lives of two isotopes X and Y of a material are known to be 2×10^9 years and 4×10^9 years respectively if a planet was formed with equal number of these isotopes, then the current age of planet, given that currently the material has 20% of X and 80% of Y by number, will be:

A. 8×10^9 years

B. 6×10^9 years

C. 4×10^9 years

D. 2×10^9 years

Answer: A

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1. A radioactive substance is being consumed at a constant of $1s^{-1}$. After what time will the number of radioactive nuclei becoem 100. Initially, there were 200 nuceli present.

A. 1 s

B. $\frac{1}{\ln(2)}s$

C. $\ln(2)s$

D. 2 s

Answer: C

Watch Video Solution

2. A radiaocatice isotope is being produced at a constant rate X. Half-life of the radioactive substance is Y. After some time, the number of radioactive nuceli become constant. The value of this constant is .

A. $\dfrac{XY}{\ln(2)}$

B. XY

C. (XY) ln (2)

D. $\dfrac{X}{Y}$

Answer: A

Watch Video Solution

3. A radioactive substance X decys into another radioactive substance Y. Initially, only X was present . λ_x and λ_y are the disintegration constant of X and Y. N_y will be maximum when.

A. $\dfrac{N_y}{N_x - N_y} = \dfrac{\lambda_y}{\lambda_x - \lambda_y}$

B. $\dfrac{N_x}{N_x - N_y} = \dfrac{\lambda_x}{\lambda_x - \lambda_y}$

C. $\lambda_y N_y = \lambda_x \lambda_x$

D. $\lambda_y N_x = \lambda_y \lambda_x$

Answer: C

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4. Half-life of a radioactive substance A is two times the half-life of another radioactive substance B. Initially, the number of A and B are N_A and N_B, respectively . After three half-lives of A, number of nuclei of both are equal. Then, the ratio N_A / N_B is .

A. $1/4$

B. $1/8$

C. $1/3$

D. $1/6$

Answer: B

Watch Video Solution

5. The kinetic energy of an electron is E when the incident wavelength is λ

To increase ti KE of the electron to 2E, the incident wavelength must be

A. 2λ

B. $\lambda / 2$

C. $\dfrac{(hc\lambda)}{(E\lambda + hc)}$

D. $\dfrac{(hc\lambda)}{(E\lambda - hc)}$

Answer: C

Watch Video Solution

6. The ratio between total acceleration of the electron in singly ionized helium atom and hydrogen atom (both in ground state) is

A. 1

B. 8

C. 4

D. 16

Answer: B

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7. The shortest wavelength of the Brackett series of a hydrogen-like atom (atomic number of Z) is the same as the shortest wavelength of the Balmer series of hydrogen atom. The value of z is

A. 2

B. 3

C. 4

D. 6

Answer: A

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8. According to Bohr's theory of hydrogen atom , the product of the binding energy of the electron in the nth orbit and its radius in the nth orbit

A. is proportional to n^2

B. is inversely proportional to n^3n

C. has a constant value of 10.2 eV-Å`

D. has a constant value of $7.2 eV - \text{Å}$

Answer: D

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9. An electtron and a photon have same wavelength . If p is the moment of electron and E the energy of photons, the magnitude of p/E in S I unit is

A. 3.0×10^8

B. 3.33×10^{-9}

C. 9.1×10^{-31}

D. 6.64×10^{-34}

Answer: B

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10. In X-ray tube , when the accelerating voltage V is halved, the difference between the wavelength of K_{α} line and minimum wavelength of continuous X-ray spectrum

A. remains constant

B. becomes more than two times

C. becomes half

D. becomes less than two times

Answer: D

Watch Video Solution

11. If K_1 and K_2 are maximum kinetic energies of photoelectrons emitted when light of wavelength λ_1 and λ_2 respectively are incident on a metallic surface. If $\lambda_1 = 3\lambda_2$ then

A. $2K_1 = K_2$

B. $K_1 = 2K_2$

C. $K_1 < \frac{K_2}{2}$

D. $K_1 < 2K_2$

Answer: C

Watch Video Solution

12. The binding energy per nucleon number for deutron $H_1^2$and helium He_2^4 are $1.1 MeV$ and $7.0 MeV$ respectively . The energy released when two deuterons fase to form a belium nucleus He_2^4 is ....

A. $20.8 MeV$

B. $16.6 MeV$

C. $25.2 MeV$

D. $23.6 MeV$

Answer: D

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13. A particle of mass 3m at rest decays into two particles of masses m and 2m having non-zero velocities. The ratio of the de Broglie wavelengths of the particles $\left(\frac{\lambda_1}{\lambda_2}\right)$ is

A. $\frac{1}{2}$

B. $\frac{1}{4}$

C. 2

D. None of these

Answer: D

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14. A potential difference of 10^3 V is applied across an X-ray tube. The ratio of the de-Broglie wavelength of X-rays produced is

A. $\frac{1}{20}$

B. $1/100$

C. 1

D. $1/10^4$

Answer: C

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15. de-Broglie wavelength of an electron in the nth Bohr orbit is λ_n and the angular momentum is J_n then

A. $J_n \propto \lambda_n$

B. $\lambda_n \propto \frac{1}{J_n}$

C. $\lambda_n \propto J_n^2$

D. None of these

Answer: A

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16. The angular momentum of an electron in the hydrogen atom is $\frac{3h}{2\pi}$

Here. h is Planck's constant. The kinetic energy of this electron is

A. $4.35eV$

B. $1.51eV$

C. $3.4eV$

D. $6.8eV$

Answer: B

Watch Video Solution

17. In a hydrogen atom, the binding energy of the electron in the ground state is E_1 then the frequency of revolution of the electron in the nth orbit is

A. $2E_1 / nh$

B. $2E_1 n / h$

C. E_1 / nh

D. $E_1 n / h$

Answer: A

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18. Two electrons are moving with the same speed, v One electron enters at different instants , the quantity produced second time was twic of that produced first time. If now their present acitivies are A_1 and A_2 respectively then their age difference equals

A. $\lambda_1 = \lambda_2$

B. $\lambda_1 > \lambda_2$

C. $\lambda_1 < \lambda_2$

D. $\lambda_1 > \lambda_2$ or $\lambda_1 < \lambda_2$

Answer: D

View Text Solution

19. A radioactive material of half-life T was kept in a nuclear reactor at two different instants. The quantity kept second time was twice of the kept first time. If now their present activities are A_1 and A_2 respectively, then their age difference equals

A. $\frac{T}{\ln 2}\left|\ln.\frac{2A_1}{A_2}\right|$

B. $T\left|\ln.\frac{2A_1}{A_2}\right|$

C. $\frac{T}{\ln 2}\left|\ln.\frac{A_1}{2A_2}\right|$

D. $T\left|\ln.\frac{A_2}{2A_1}\right|$

Answer: C

Watch Video Solution

20. One of the lines in the emission spectrum of Li^{2+} has the same wavelength as that of the second line of Balmer series in hydrogen spectrum. The electronic transition corresponding to this line is.

A. $12 \rightarrow 9$

B. $12 \rightarrow 6$

C. $4 \rightarrow 3$

D. $6 \rightarrow 3$

Answer: B

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21. different between nth and $(n+1)th$ Bohr's radius of hydrogen atom is equal to $(n=1)th$ Bohr's radius. The value of n is

A. 1

B. 2

C. 3

D. 4

Answer: D

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22. When a hydrogen atom emits a photon in going from n=5 to n=1, its recoil speed is almost

A. 4 m/s

B. 800 m/s

C. 3mm/s

D. $01. mm / s$

Answer: A

Watch Video Solution

23. A radioactive isotope A decays into another isotope B which has a half-life equal to 1/2 of that of A. Both isotopes emit α-particles during their decay into a stable nucleus. If a sample consists initially of atoms of A. only then the net activity of the sample initially

A. increases with time

B. decreases with time

C. remains constant

D. any of the above may be true

Answer: B

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24. There are two radio nuceli A and B. A is an α emitter and B a β emitter. Their disintegration constant are in the ratio of $1:2$ What should be the ratio of number of atoms of A and B at any time t so that probabilities of getting alpha and beta particles are same at that instant?

A. $2:1$

B. $1:2$

C. e

D. e^{-1}

Answer: A

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25. A radioactive element$X$ converts into another stable elemnet Y. Half-life of X is $2h$. Initally, only X is present. After time t, the ratio of atoms of X and Y is found to be $1:4$ Then t in hours is .

A. 2

B. 4

C. between 4 and 6

D. 4

Answer: C

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26. A radioacitve nucleus is being produced at a constant rate α per second. Its decay constant is λ. If N_0 are the number of nuclei at time $t = 0$, then maximum number of nuceli possible are .

A. $\frac{\alpha}{\lambda}$

B. $N_0 + \frac{\alpha}{\lambda}$

C. N_0

D. $\frac{\lambda}{\alpha} + N_0$

Answer: A

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27. The ratio of molecular mass of two radioactive substances is $3/2$ and the ratio of their decay cosntatnt is $4/3$. Then. The ratio of their initial activity per mole will be

A. 2

B. $\frac{8}{9}$

C. $\frac{4}{3}$

D. $\frac{9}{8}$

Answer: C

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28. A radioactive source in the form of a metal sphere of diameter 3.2×10^ −3 m emits β-particle at a constant rate of 6.25×10^ 10 particle/sec. The source is electrically insulated and all the β-particle are emitted from the surface. The potential of the sphere will rise to 1 V in time

A. $180\mu s$

B. $90\mu s$

C. $18\mu s$

D. $9\mu s$

Answer: C

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29. A hydrogen atom ia in excited state of principal quantum number n . It emits a photon of wavelength λ when it returnesto the ground state. The value of n is

A. $\sqrt{\lambda R(\lambda R - 1)}$

B. $\sqrt{\frac{\lambda R - 1}{\lambda}}$

C. $\sqrt{\frac{\lambda}{\lambda R - 1}}$

D. $\sqrt{\lambda(R - 1)}$

Answer: C

Watch Video Solution

30. A neutron moving with a speed v makes a head-on collision with a hydrogen in ground state kept at rest which inelastic collision will be take place is (assume that mass of photon is nearly equal to the mass of neutron)

A. $10.2eV$

B. $20.4eV$

C. $12.1eV$

D. $16.8eV$

Answer: B

Watch Video Solution

31. At t=O, light of intensity 10^{12} photons/$s - m^2$ of energy 6eV per photon starts falling on a plate with work founction $2.5eV$ If area of the plate is $2 \times 10^{-4} m^2$ and for every 10^5 photons one photoelectron is emitted, charge on the plate at t=25 s is

A. $8 \times 10^{-15} C$

B. $4 \times 10^{-14} C$

C. $12 \times 10^{-10} C$

D. $16 \times 10^{-12} C$

Answer: A

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32. The radius of the second orbit of an electron in hydrogen atom is $2.116 A$. The de Broglie wavelength associated with this electron in this orbit would be

A. 6.64Å

B. 1.058Å

C. 2.116Å

D. 13.28Å

Answer: A

Watch Video Solution

33. The de-Broglie wavelength of electron in gound state of an hydrogen atom is

A. 1.06Å

B. 1.52Å

C. $0.53 Å$

D. $3.33 Å$

Answer: D

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34. Radius of an electron moving in a circle in constant magnetic field is two times that of an α particle in the same field. Then de-Broglie wavelength of electrons is x-times of the α-particle Here x is

A. 2

B. $\frac{1}{2}$

C. 1

D. 4

Answer: C

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35. An electrons of a stationary hydrogen aton passes form the fifth enegry level to the ground level. The velocity that the atom acquired as a result of photon emission will be

(m is the mass of the electron, R, Rydberg constanrt and h, Planck's constant)

A. $\frac{25m}{24hR}$

B. $\frac{24}{25hR}$

C. $\frac{24hR}{25m}$

D. $\frac{25hR}{24m}$

Answer: C

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36. An electron and a proton are separated by a large distance and the electron approaches the proton with a kinetic energy of 2 eV. If the electron is captured by the proton to form a hydrogen atom in the ground state, what wavelength photon would be given off?

A. 1262.2Å

B. 793.3Å

C. 1204.6Å

D. 942.6Å

Answer: B

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37. Two separate monochromatic light beams A and B of the same intensity (energy per unit area per unit time) are falling normally on a unit area of a metallic surface. Their wavelength are λ_A and λ_B respectively. Assuming that all the the incident light is used in ejecting the photoelectrons, the ratio of the number of photoelectrons from beam A to that from B is

A. $\left(\frac{\lambda_A}{\lambda_B}\right)$

B. $\left(\frac{\lambda_B}{\lambda_A}\right)$

C. $\left(\frac{\lambda_B}{\lambda_A}\right)^2$

D. $\left(\frac{\lambda_A}{\lambda_B}\right)^2$

Answer: A

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38. In the Bohr model of a hydrogen atom, the centripetal force is furnished by the Coulomb attraction between the proton and the electrons. If a_0 is the radius of the ground state orbit, m is the mass and e is the charge on the electron and e_0 is the vacuum permittivity, the speed of the electron is

A. zero

B. $\frac{e}{\sqrt{\varepsilon_0 a_0 m}}$

C. $\frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$

D. $\frac{\sqrt{4\pi\varepsilon_0 a_0 m}}{e}$

Answer: C

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39. Average life ofa radioactive sample is 4 ms Initially the total number of nuclie is N_0 A charged capacitor of capacity $20\mu f$ is connected across a resistor R. The value of R such that ratio of number of nuclei remaining to the charge on capacitor remains constant with time is

A. 100Ω

B. 200Ω

C. 300Ω

D. 400Ω

Answer: B

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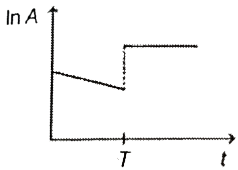
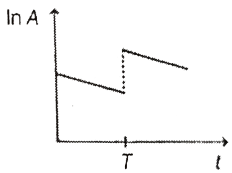
40. At time $t = 0$, some radioactive gas is injected into a sealed vessel. At time T, some more of the same gas is injected into the same vessel. Which one of the following graphs best represents the variation of the logarithm of the activity A of the gas with time t?

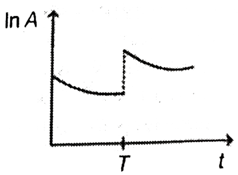
A. (a)



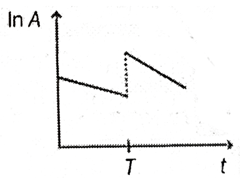
B. (b)



C. (c)



D. (d)



Answer: B

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41. A sample of radioactive material has mass m, decay constant λ, and molecular weight M. Avogadro constant $= N_A$. The initial activity of the sample is:

A. λm

B. $\frac{\lambda m}{M}$

C. $\frac{\lambda m N_A}{M}$

D. $\frac{\lambda m}{M N_A}$

Answer: C

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42. Binding energy per nucleon for C^{12} is $7.68 MeV$ and for C^{13} is $7.74 MeV$. The energy required to remove a neutron from C^{13} is .

A. $5.34 MeV$

B. $5.5 MeV$

C. $9.5 MeV$

D. $9.34 MeV$

Answer: A

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43. Light coming from a discharge tube filled with hydrogen falls on the cathode of the photoelectric cell. The work function of the surface of cathode is 4eV Which one of the following values of the anode voltage (in volts) with respect to the cathode willl likely to make the photoo current zero.

A. -4

B. -4

C. -8

D. -10

Answer: D

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44. In a hypothetical system , a partical of mass m and charge $-3q$ is moving around a very heavy partical chaRGE q. Assume that Bohr's model is applicable to this system , then velocuity of mass m in the first orbit is

A. $\frac{3q^2}{2\varepsilon_0 h}$

B. $\frac{3q^2}{4\varepsilon_0 h}$

C. $\frac{3q}{2\varepsilon_0 h}$

D. $\frac{3q}{4\varepsilon_0 h}$

Answer: A

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45. In a certain nuclear reactor, a radioactive nucleus is bieng produced at a constant rate =1000/s The mean life of the radionuclide is 40 minutes. At steady state, the number of radionuclide will be

A. 4×10^4

B. 24×10^4

C. 24×10^5

D. 24×10^6

Answer: C

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46. In a hypothetical atom, potential energy between electron and proton at distance r is given by $\left(\frac{-ke^2}{4r^2}\right)$ where k is a constant Suppose Bohr theory of atomic structures is valid and n is principle quantum number, then total energy E is proportional to

A. n^5

B. n^2

C. n^6

D. n^4

Answer: C

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47. A freshly prepared smaple contains 16×10^{20} raadioactive nuclei, whose mean life is 10^{10} seconds The acitiivity of the sample just after 4 ahlr lives time is

A. $\frac{\ln 2}{16} \times 10^{10} dps$

B. $1 \times 10^{10} dps$

C. $\frac{1}{\ln 2} \times 10^{10} dps$

D. $\ln 2 \times 10^{10} dps$

Answer: B

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48. Consider a nuclear reaction :

$A \xrightarrow{\lambda_1} B + C$

and $B \xrightarrow{\lambda_2} C$

A converts into B and to C with decay with decay constant λ_1 B is alos stable nucleus which futher decays into stable nucleus C with decay constant λ_2. Mark the correct statement(s)

A. $\dfrac{dN_C}{dt} = -(\lambda_1 N_A + \lambda_2 N_B)$

B. $\dfrac{dN_A}{dt} = -\lambda_1 N_A$

C. $\dfrac{dN_A}{dt} = (\lambda_1 N_A + \lambda_2 N_B)$

D. $\dfrac{dN_B}{dt} = \lambda_1 N_A + \lambda_2 N_B$

Answer: B

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49. Two particles A and B have de-Broglie's wavelength 30Å combined to from a single particle. C Momentum is conserved in this processs. The possible de-Broglile's wavelength of C is (the motion in one dimensional)

A. 10Å

B. 20Å

C. 60Å

D. 80Å

Answer: C

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50. The only source of energy in a particular star is the fusion reaction given by -

$3._2He^4 \rightarrow ._6C^{12}$+energy

Masses of $._2He^4$ and $._6C^{12}$ are given

$\left(m._{2}\,He^{4}\right) = 4.0025u, m\left(._{6}\,C^{12}\right) = 12.0000u$

Speed of light in vaccume is $3 \times 10^{8} m/s$. power output of star is 4.5×10^{27} watt. The rate at which the star burns helium is

A. 8×10^{12}

B. 4×10^{12}

C. 12×10^{13}

D. 9×10^{13}

Answer: A

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51. The de-Broglie wavlength of an electron emitted fromt the ground state of an H-atom after the absoprtion of a photon quals $\frac{1}{2}$ of the de-Broglie wavelength when it was in orbit. The energy of the photon abserobed is

A. $66eV$

B. $13.6eV$

C. $20.4eV$

D. $136eV$

Answer: A

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52. An electron and a proton are separated by a large distance and the electron approaches the proton with a kinetic energy of 2 eV. If the electron is captured by the proton to form a hydrogen atom in the ground state, what wavelength photon would be given off?

A. $2.4eV$

B. $2.7eV$

C. $2.9eV$

D. $5.4eV$

Answer: B

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53. If light of wavelength of maximum intensity emitted from surface at temperature T_1 Is used to cause photoelectric emission from a metallic surface, the maximum kinetic energy of the emitted electron is 6 ev, which is 3 time the work function of the metallic surface. If light of wavelength of maximum intensity emitted from a surface at temperature $T_2(T_2 = 2T_1)$ is used, the maximum kinetic energy of the photo electrons emitted is

A. 10eV

B. 8eV

C. 14eV

D. 12eV

Answer: C

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54. When photon of wavelength λ_1 are incident on an isolated sphere suspended by an insulated thread, the corresponding stopping potential is found to be V. When photon of wavelength λ_2 are used, the corresponding stopping potential was thrice the above value. If light of wavelength λ_3 is used, calculate the stopping potential for this case.

A. $\frac{hc}{e}\left(\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{1}{\lambda_1}\right)$

B. $\frac{hc}{e}\left(\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{1}{2\lambda_1}\right)$

C. $\frac{hc}{e}\left(\frac{1}{\lambda_3}+\frac{1}{\lambda_2}+\frac{1}{\lambda_1}\right)$

D. $\frac{hc}{e}\left(\frac{1}{\lambda_3}-\frac{1}{\lambda_2}-\frac{1}{\lambda_1}\right)$

Answer: B

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55. The ground state and first excited state energies of hydrogen atom are $-13.6eV$ and $-3.4eV$ respectively. If potential energy in ground state is taken to be zero. Then:

A. potential energy in the first excited state would be $20.4ev$

B. total energy in the first excited state would be $23.8eV$

C. kinetic energy in the first excited state would be $3.4eV$

D. total energy in the ground state would be $13.\ 6eV$

Answer: A::B::C::D

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56. An electron is excited from a lower energy state to a higher energy state in a hydrogen atom. Which of the following quantity/quantities decreases/decrease in the excitation ?

A. potential energy

B. Angular speed

C. Kinetic energy

D. Angularn momentum

Answer: B::C

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57. The electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$, where n_1 and n_2 are the principle quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. the possible values of n_1 and n_2 are

A. $n_1 = 4, n_2 = 2$

B. $n_1 = 8, n_2 = 2$

C. $n_1 = 8, n_2 = 1$

D. $n_1 = 6, n_2 = 3$

Answer: A::D

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58. An electron in hydrogen atom first jumps from second excited state to first excited state and then from first excited state to ground state. Let the ratio of wavelength, momentum and energy of photons emitted in these two cases be a, b and c respectively, Then

A. c=1/a

B. a=9/4

C. b=5/27

D. c=5/27

Answer: A::C::D

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59. The magnitude of energy, the magnitude of linear momentum and orbital radius of an electron in a hydrogen atom corresponding to the quantum number n are E, P and r respectively. Then according to Bohr's theory of hydrogen atom:

A. Epr is proportinal to $\frac{1}{n}$

B. P/E is proportional to n

C. Er is constant for all orbits

D. Pr is proportional to n

Answer: A::B::C::D

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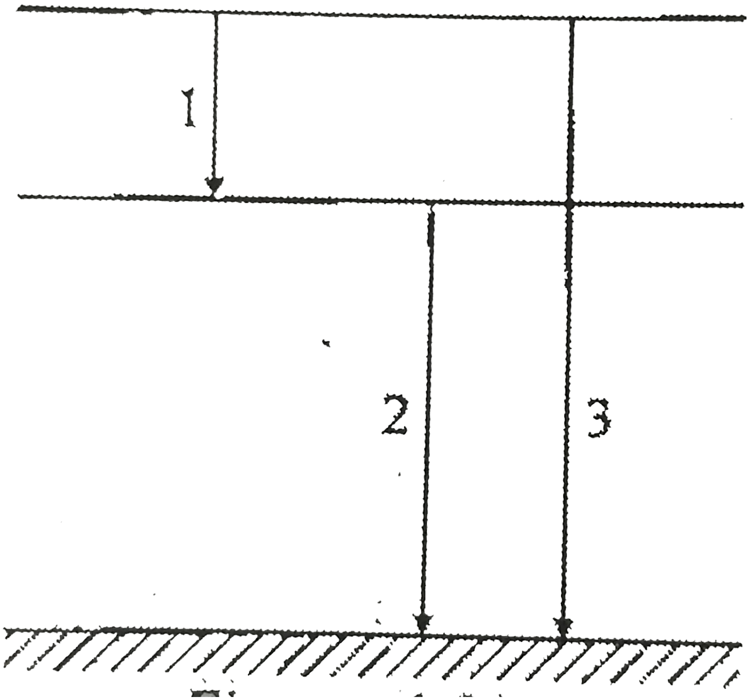
60. The wavelengths and frequencies of photons in transition 1,2 and 3 for hydrogen like atom are λ_1, λ_2, λ_3, v_1, v_2 and v_3 respectively. Then:



A. $v_3 = v_1 + v_2$

B. $v_3 = \frac{v_1 v_2}{v_1 + v_2}$

C. $\lambda_3 = \lambda_1 + \lambda_2$

D. $\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

Answer: A::D

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61. Which of the following transition in He^{+} ion will give rise to a spectral line which has the same wavelength as some spectral line in the hydrogen atom ?

A. n=4 to n=2

B. n=6 to n=2

C. n=6 to n=3

D. n=8 to n=4

Answer: A::D

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62. Suppose the potential energy between an electron and a proton at a distance r is given by $Ke^2/3r^3$. Application of Bohr's theory tohydrogen atom in this case showns that

A. kinetic energy in the nth atom in this orbit is proportional to n^6

B. kinetic energy is proportional to m^{-3} (m=mass of electron)

C. kinetic energy in the nht orbit is proportional to n^{-2}

D. kinetic energy is proportional to m^3 (m=mass of electron)

Answer: A::B

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63. Let A_n be the area enclosed by the n^{th} orbit in a hydrogen atom. The graph of $ln(A_n / A_t)$ against In (n)

A. will pass through origin

B. will be a straight line with slpe 4

C. will be a parabola

D. will be a circle

Answer: A::B

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64. Hydrogen atom absorbs radiations of wavelength λ_0 and consequently emit radiations of 6 different wavelengths, of which two wavelengths are longer than λ_0. Chosses the correct alternative(s).

A. The final excited state of atoms is n=4

B. The fina state of the atoms is n=4

C. The initial state of the atoms is n=3

D. There are three transitions belonging to Lyman serires

Answer: A::B::D

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65. The threshold wavelength for photoelectric emission for a material is $5200A^\circ$. Will the photoelectrons be emitted when this material is illuminated with monochromatic radiation from 1 watt ultra violet lamp?

A. 50 watt infrared lamp

B. 1 watt infrared lamp

C. 50 watt ultraviolent lamp

D. 1 watt ultraviolent lamp

Answer: C::D

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66. From the following equation pick out the possible nuclear fusion reactions

A. $6^{C^{13}} + 1^{H^1} \rightarrow 6^{C^{14}} + 4.3MeV$

B. $6^{C^{12}} + 1^{H^1} \rightarrow 7^{N^{13}} + 2MeV$

C. $7^{C^{14}} + 1^{H^1} \rightarrow 8^{O^{15}} + 7.3MeV$

D. $92^{U^{235}} + 0^{n^1} \rightarrow 54^{Xe^{140}} + 36Sr^{94} + 0^{n^1} + 0^{n^1} + y + 200MeV$

Answer: B::C

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67. In the Bohr model of the hydrogen atgom

A. the radius of the nth orbit is proportiona to n_2

B. the total energy of the electron in the nth orbit is inversely proportional to n

C. the angular momentum of the electron in an the orbit is an integral miltiple of $h / 2\pi$

D. the magnitude of the potentital energy of the electron in any orbit is greater han its kinetic energy

Answer: A::C::D

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68. The mass number of a nucleus is.

A. always less then it atomic number

B. always more than its atomic number

C. sometimes equal to its atomic number

D. sometimes more than its atomic number

Answer: C::D

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69. Photoelectric effect supports quantum nature of light because

A. there is minimum frequency of light below which no photoelectrons are emitted

B. the maximum kinetic energy of photoelectrons depends only on the frequency of light and not on its intensity

C. even when the metal surface is faintly illuminated (with frequency more than the threshold frequency) the photoelectrons leave the surface immediately

D. electric charge of the photoelectrons is quantized

Answer: A

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70. If a nucleus $._{Z}^{A}x$ emits one α-particle and one β (negative β) particle in succession, then the daughter nucleus will have which of the following configurations?

A. A-4 nucleons

B. A-3 nucleons

C. A-Z-3 neutrons

D. A-Z protons

Answer: A::C

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71. Find the half life of U^{238}, if one gram of it emits 1.24×10^4 α-particle per second. Avogadro's Number $= 6.023 \times 10^{23}$.

A. The half life of this nuclide is 4.5×10^9 years

B. The half-life of this nuclide is 9×10^9 years

C. The activity of the prepared smaple is 2.48×10^4 particles/sec

D. The acitivty of the prpared sample is 1.24×10^4 particles/sec

Answer: A::D

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72. A nitrogen nucleus $7^{N^{14}}$ absorbs a neutron and can transfrom into lithium nucleus 3^{Li^7} under suitable conditions, after emitting :

A. 4 protons and 5 neutrons

B. 1 alpha particles and 2 gamma particles

C. 1 alpha particle 3 protons and 1 negative beta particle

D. 4 protons and 4 neutrons

Answer: C::D

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73. Nucleus A decays to B with decay constant λ_1 and B decays to C with decay constant λ_2. Initially at $t = 0$ number of nuclei of A and B are $2N_0$ and N_0 respectively. At $t = t_o$, no. of nuclei of B is $\frac{3N_0}{2}$ and nuclei of B stop changing. Find t_0?

A. the value of $t_0$is$\frac{1}{\lambda_1}\ln.\ \frac{4}{3}\frac{\lambda_1}{\lambda_2}$

B. the value of $t_0$is$\frac{1}{\lambda_2}\ln.\ \frac{4}{3}\frac{\lambda_1}{\lambda_2}$

C. the value of N_A at $t_0$is$\frac{3N_0}{2}\frac{\lambda_2}{\lambda_1}$

D. the value of N_A at $t_0$is$\frac{2N_0}{3}\frac{\lambda_2}{\lambda_1}$

Answer: A::C

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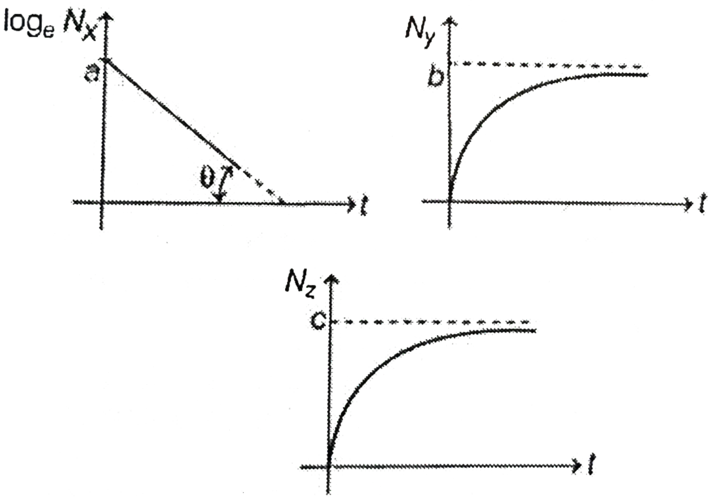
74. An unstable nucleus X can decay into two stable nuclie Y and Z A sample containing only X is taken at t=0 Three graphs $\log_e(N_x$ vs t,N_x, vs t and N_z vs t are drawn as shown below Here N_x, N_y and N_z represent number of nuclei of X,Y and Z repectively at any instant. t



Choose the correct choice (s) from the following :

A. Decay constant for decay of X into Y is $\frac{b\tan\theta}{e^a}$

B. ecay constant for decay of X into Z is $\frac{c\tan\theta}{e^a}$

C. Number of nuclei of X at t=0-is e^a

D. Half-life of nuclei X is $\frac{1}{\tan\theta}$

Answer: A::B::C

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75. An electron , initiallty at rest is released from a large distance from a proton (fixed in space). The de-broglie wavelength of the electron when it is at distance r from proton is λ the ratio of its kinetic energy at this distance with the kinetic energy of the electron is ground stae of hydrogen atom (Bohr model) with the radius of its orbit being r, is α Pick the correct options (s)

A. $\lambda \propto \sqrt{r}$

B. $\lambda \propto \frac{1}{r}$

C. $\alpha = \frac{1}{2}$

D. $\alpha = 2$

Answer: A::D

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76. A nucleus X of mass M. initially at rest undergoes alpha decay according to the equation

$_(Z)^A X \to ._{Z-2}^{A-4} Y + ._2^4 He$

The alpha particle emitted in the above process is found to move in a circular track of radius r in a uniform magnetic field B. Then (mass and charge of α particle are m and q respectively)

A. The ratio of kinetic energies of the alpha particle and (doughether nucleus Y approximately equals $\frac{M-m}{m}$

B. the ratio of kinetic energies of the alpha particle and the doughter nucleus Y apporximately $\frac{m}{M}$

C. The enetgy relased in the process approximately equals $\frac{M}{M-m}\frac{r^2q^2B^2}{2m}$

D. The energy released in the process apporximately equals $\frac{M}{M-m}\left(\frac{r^2q^2B^2}{2m}\right)$

Answer: A::C

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77. Consider an atom made up of a protons and a hypothetical particle of triple the mass of electron but having same charge as electron. Apply bohr model and consider all possible transition of this hypothetical from second excited state to lower states.The possible wavelengths emitted is (are) (given in term of the Rydberg constant R for the hydrogen atom)

A. $\dfrac{8}{5R}$

B. $\dfrac{3}{8R}$

C. $\dfrac{4}{9R}$

D. $\dfrac{12}{5R}$

Answer: B::C::D

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for JEE Advanced (More than One Options is Correct)

1. The wavelengths of K_{α} X-rays from lead isotopes Pb^{204}, Pb^{206} and Pb^{208} are λ_1, λ_2 and λ_3 respectively. Choose the correct alternative.

A. $\lambda_1 = \lambda_2 = \lambda_3$

B. $\lambda_1 > \lambda_2 > \lambda_3$

C. $\lambda_1 < \lambda_2 < \lambda_3$

D. $\lambda_2 = \sqrt{\lambda_1 \lambda_3}$

Answer: A::D

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Metch the column

1. $\sqrt{v}$ versus Z graph for dcharacteristic X-rays is as shown in figure. Mathc the following

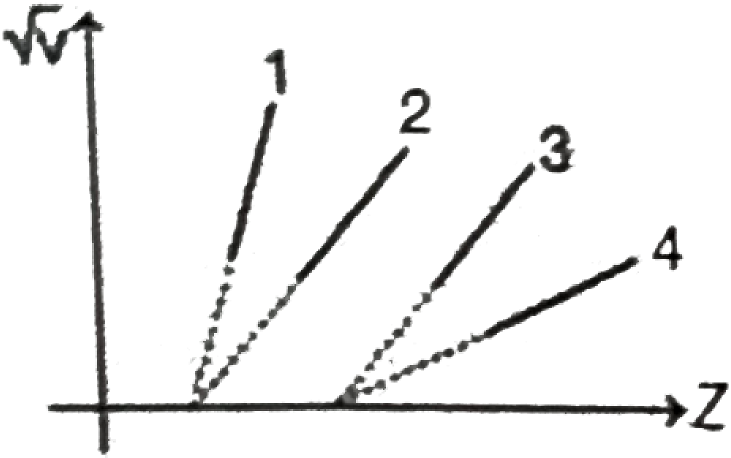

Table-1	Table-2
(A) Line-1	(P) L_α
(B) Line-2	(Q) L_β
(C) Line-3	(R) K_α
(D) Line-4	(S) K_β

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2. Regarding trasnsition of electrons match the following table

Table-1	Table-2
(A) $n = 5$ to $n = 2$	(P) Lyman series
(B) $n = 8$ to $n = 4$	(Q) Brackett series
(C) $n = 3$ to $n = 1$	(R) Paschen series
(D) $n = 4$ to $n = 3$	(S) Balmer series

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3. Match the following table.

Table-1	Table-2
(A) Sun	(P) Nuclear fission
(B) Nuclear reactors	(Q) Nuclear fusion
(C) Total binding energy in a process is increased	(R) Energy is released
(D) Total binding energy in a process is decreased	(S) Energy is absorbed

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4. Excitions energy of hydrogen atom is $13.6 eV$ mathc the following

Table-1	Table-2
(A) Energy of second excited state of hydrogen	(P) -3.4 eV
(B) Energy of fourth state of He^{+}	(Q) -13.6 eV
(C) Energy of first excited state of Li^{+2}	(R) -1.5 eV
	(S) None

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5. In a nuclear reactor mathc the following .

Table-1	Table-2
(A) Cadmium rods	(P) Moderator
(B) Boron rods	(Q) Control rods
(C) Graphite core	(R) Neutron absorbing rods
(D) Carbon rods	

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6. In each situationof Table-1 a physicial quantity relate to orbiting electron in a hydrogen like atoms is given The. Terms Z and n given in Table-2 have usual meaning in Bohr's therory .Match the quantities in Table-1 with the terms those dpend on quantity given in Table-2

Table-1	Table-2
(A) Frequency of orbiting electron	(P) is directly proportional to Z^2
(B) Angular momentum of orbiting electron	(Q) is directly proportional to n
(C) Magnetic moment of orbiting electron	(R) is inversely proportional to n^3
(D) The average current due to orbiting of electron	(S) is independent of Z

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Integer Type Questions

1. The ratio between acceleration of the electron in singley ionized helium atom and duby ionized lithium aomt (both in ground state) is (x/27). Find value of n.

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2. If the radius of firs Bohr's orbit is x, then de-Broglie wavelenght of electron in 3rd orbit is nearly $(n\pi x)$ Find value of n

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3. A H-atom moving with speed v makes a head on collisioon with a H-atom at rest . Both atoms are in ground state. The minimum value of velocity v for which one of the atom may excite is $(1.25n \times 10^{4})$ m/s Find value of x.

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4. The magnetic fieold at the centre of a hydrogen atom due to the motion of the electron in the first Bohr orbit is B . The magnetic field at

the centre due to the motion of the electron in the second Bohr orbit will be $\frac{B}{2^x}$ Find value of x.

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5. when the voltage applied to an X-ray tube increases from $V_1 = 10kV$ to $V_2 = 20kV$, the wavelenght interval between K_α line and cut-off wavelenght of continuous spectrum increases by a factor of 3. Atomic number of the metallic target is

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6. Light of wavelength $330nm$ falling on a piece of metal ejects electrons with sufficient energy with required voltage V_0 to prevent them reaching a collector. In the same set up, light of wavelength $220nm$ ejects electrons which require twice the voltage V_0 to stop them in reaching a collector. the numerical value of voltage V_0 is

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7. Light of wavelength $0.6 \mu m$ from a sodium lamp falls on a photocell and causes the emission of photoelectrons for which the stopping potential is 0.5V. With light of wavelength $0.4 \mu m$ from a murcury vapor lamp, the stopping potential is $1.5 V$. Then, the work function [in electron volts] of the photocell surface is

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8. An α-particle accelerated through V volt is fired towards a nucleus . Its distance of closest approach is r. If a proton acceleration throught the same potential is fired towards the same nucleus, the distance of closest approach of proton will be xr. Find value of x.

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9. The kinetic energies of the photoelectrons ejected from a metal surface by light of wavelength 2000Å range from zero to 3.2×10^{-19} Joule. Then find the stopping potential (in V).

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10. In a hydrogen atom following the Bohr's psotulates the product of linear momentum and angular momentum is proportional ot $(n)^x$ where 'n' is the orbit number. Find the valur of x.

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11. A target element A is bombarded with electrons and the wavelengths of the characterstic spectrum are measured. A second characteristic spectrum is also obtained , because of an impurity in the target. The wavelengths of the K_α lines are 196 pm (element A) and 169 pm (impurity). If the atomic number of impurity is $z = (10\lambda - 1)$. Find the value of λ . (atomic number of element A is 27).

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12. A moving hydrogen atom makes a head on collision with a stationary hydrogen atom. Before collision both atoms are in in ground state and after collision they move together. What is the minimum value of the kinetic energy of the moving hydrogen atom, such that one of the atoms reaches one of the excited state?

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13. A radioactive sample contains two different types of radioactive nuclei. A-with half-time 5 days and B-type nuclei is 64 times that of B type of nuclei . Their decay rates will be equal when time a 9n days. Find the value of n.

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14. $A \xrightarrow{\lambda} B \xrightarrow{2\lambda} C$

$T = 0, N_0, 0,$

$TN_1N_2N_3$

The ratio of N_1 to N_2 is maximum I s

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15. In a photeclectric experiment , when electromegnetic wave given by $E = E_0 \sin \omega t$ is incident , electron just ejects. When $E = E_0 \sin 2\omega t$ is incident $K_{\max} = K_1$ and when E $= E_0 \sin 6\omega t$ is incident $K_{\text{amx}} = k_2$. When k_2 / k_1

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16. Nuclei X and Y convert into a stable nucleus Z. At t=0 , the number of nuclei of X is 8 times that of Y. Half life of X is 1 hour and half life of y=2 hour. Find the time (in hour) at which rate of disintegration of X and Y are equal.

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17. Single electron is orbiting in n^{th} orbit of hydrogen atom. The magnetic field prodruced by the electron at the nucleus will be proportional to n^{-k}. Find the value of k.

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