TARGET : JEE (ADVANCED) 2015

Course : VIJETA & VIJAY (ADP & ADR) **Date : 01-05-2015**

TEST INFORMATION

DATE : 03.05.2015 **OPEN TEST(OT) - 02 (Advanced)**

Syllabus : Full syllabus

This DPP is to be discussed (05-05-2015)
Open test (OT) to be discussed (05-05-2015)

DPP No. # 08

Total Total Marks : 141	**Max. Time : 106½ min.**
Single choice Objective (–1 negative marking) Q. 1 to 16	**(3 marks 2½ min.) [48, 40]**
Multiple choice objective (–1 negative marking) Q. 17 to 24	**(4 marks, 3 min.) [24, 18]**
Single Digit Subjective Questions (no negative marking) Q.25 to Q.35	**(4 marks 2½ min.) [44, 27½]**
Double Digits Subjective Questions (no negative marking) Q. 36	**(4 marks 2½ min.) [4, 2½]**
Comprehension (–1 negative marking) Q.37 to 41	**(3 marks 2½ min.) [15, 12½]**
Match Listing (–1 negative marking) Q.42 to Q.43	**(3 marks, 3 min.) [6, 6]**

1. A very large metal plate carries a charge of Q = –1 C. The work function for the metal is ϕ = 3 eV. The plate is illuminated by a 60 Watt light source with a wavelength λ of 330 nm. How long does it take to completely discharge the plate? (Assume that every efficient photon ejects electron which is instantly removed from the sheet surface. (All photons ejected from light source fall normally on the metal plate) (h= $6.6\times10^{-34}\, m^2kg/s$)

(A) 0.005 s (B) 0.025 s (C) 0.0625 s (D) 0.01

2. Consider the following statements :
(i) Nuclear fission is normally followed by emission of β^-–particles.
(ii) Emission of α–particle is normally followed by emission of γ–rays.
(iii) In carbon– carbon cycle of fusion reaction which powers the large stars, two carbon nuclei combine to form a magnesium nucleus :
The correct order of True / False in above statements is
(A) T T T (B) T T F (C) F T T (D) T F T

3. A particle of mass 'm' is projected from ground with velocity 'u' making angle 'θ' with the vertical. The de-Broglie wave length of the particle at the highest point is :

(A) ∞ (B) $\dfrac{h}{mu\sin\theta}$ (C) $\dfrac{h}{mu\cos\theta}$ (D) $\dfrac{h}{mu}$

4. Light of wavelength 400 nm is incident continuously on a Cesium ball. (work function 1.9 eV). The maximum potential to which the ball will be charged is
(A) 3.1 V (B) 1.2 V (C) zero (D) infinite

5. In a photoelectric experiment, with light of wavelength λ, the fastest electron has speed v. If the exciting wavelength is changed to $\frac{3\lambda}{4}$, the speed of the fastest emitted electron will become
(A) $v\sqrt{\frac{3}{4}}$ (B) $v\sqrt{\frac{4}{3}}$
(C) less than $v\sqrt{\frac{3}{4}}$ (D) greater than $v\sqrt{\frac{4}{3}}$

6. The radionuclide ^{238}U decays by emitting an alpha particle.
$$^{238}U \rightarrow {}^{234}Th + {}^{4}He$$
The atomic masses of the three isotopes are.
^{238}U 238.05079 amu
^{234}U 234.04363 amu
^{4}He 4.00260 amu
What is the maximum kinetic energy of the emitted alpha particle. Express your answer in Joule.
(1 amu = 1.67×10^{-27} kg)
(A) 6.8×10^{-14} J (B) 6.8×10^{-13} J (C) 4.3×10^{-14} J (D) 4.3×10^{-13} J

7. The energy that should be added to an electron, to reduce its de-Broglie wavelength from 2×10^{-9} m to 0.5×10^{-9} m will be :
(A) 1.1 MeV (B) 0.56 MeV (C) 0.56 KeV (D) 5.6 eV

8. X-rays of high penetrating power are called hard X-ray. Hard X-rays have energy of the order of 10^5 eV. The minimum potential difference through which the electrons should be accelerated in an X-ray tube to obtain X-ray of energy 10^5 eV is :
(A) 2×10^5 V (B) 50 kV (C) 40 kV (D) 10^5 V

9. The voltage applied to an X-ray tube is 18 kV. The maximum mass of photon emitted by the X-ray tube will be:
(A) 2×10^{-13} kg (B) 3.2×10^{-36} kg (C) 3.2×10^{-32} kg (D) 9.1×10^{-31} kg

10. **STATEMENT–1:** The frequency and intensity of a light source are both doubled then saturation photocurrent changes significantly.
STATEMENT–2: When frequency and intensity of a light source both are doubled then kinetic energy of emitted electrons is doubled.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is False, Statement-2 is True
(D) Statement-1 is False, Statement-2 is False

11. An isolated nucleus which was initially at rest, disintegrates into two nuclei due to internal nuclear forces and no γ rays are produced. If the ratio of their kinetic energy is found to be $\frac{64}{27}$ then :

(A) Ratio of their de–broglie wavelength is $\frac{\sqrt{64}}{\sqrt{27}}$ respectively

(B) Ratio of their speed is $\frac{64}{27}$ respectively

(C) Ratio of their nuclear radius is $\frac{5}{4}$ respectively

(D) None of these

12. In a sample of radioactive nuclide;
(A) a nucleus emits α,β radiations simultaneously.
(B) only α, β can be emitted simultaneously by a nucleus.
(C) α, β, γ may be obtained simultaneously from the sample.
(D) all the three α,β,γ one after the other will be obtained from a nucleus.

13. In a radioactive reactor, radionuclide *X* are being injected at a rate of *r* atoms/sec which decay to a stable daughter nuclide *Y* according to equation.

$$X \xrightarrow{\lambda} Y + \Delta E$$

The energy released in each decay process is transformed to electricity and used to light up a bulb. If the process starts at t = 0 then :(At t = 0 The number of radionuclide X = 0)
(A) Brightness of bulb increases with time in the beginning and then becomes constatnt
(B) Brightness of bulb decreases with time in the beginning and then becomes constatnt
(C) Brightness first increases then decreases later
(D) Brightness first decreases then increases later

14. Radius of a nucleus is given by the relation $R = R_0A^{1/3}$ where $R_0 = 1.3 \times 10^{-15}$ m and A is mass number. For a nucleon inside a nucleus, de-Broglie wavelength is given by diameter of the nucleus. Average kinetic energy of a nucleon in the Te^{128} nucleus based on above information will be :
(A) 4.7 MeV (B) 10 MeV (C) 2 MeV (D) 12 MeV

15. Three samples of a radioactive substance have activity in a ratio 2 : 5 : 7 , then after two half lives the ratio of their activities will be:
(A) 2 : 5 : 7 (B) 1 : 3 : 5 (C) 7 : 5 : 2 (D) data insufficient

16. The only source of energy in a particular star is the fusion reaction given by -
$3\,{}_2He^4 \longrightarrow {}_6C^{12}$ + energy
Masses of ${}_2He^4$ and ${}_6C^{12}$ are given
$m({}_2He^4) = 4.0025u$ $m({}_6C^{12}) = 12.0000u$
speed of light in vacuum is 3×10^8 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} kg/s (B) 4×10^{13} kg/s (C) 8×10^{13} kg/s (D) 6×10^{13} kg/s

17. The decay constant of a radioactive substance is 0.173 $(years)^{-1}$. Therefore:
(A) Nearly 63% of the radioactive substance will decay in (1/0.173) year.
(B) half life of the radio active substance is (1/0.173) year.
(C) one-fourth of the radioactive substance will be left after nearly 8 years.
(D) one-fourth of the radioactive substance will be left after nearly 6 years.

18. A fusion reaction consists of combining four protons into an α–particle. The mass of α–particle is 4.002603u and that of proton is 1.007825u, mass of electron is 0.00054466u.
(A) the equation $4p_1^1 \rightarrow He_2^4$ does not satisfy conservation of charge
(B) the correct reaction equation may be $4p_1^1 \rightarrow He_2^4 + 2\beta^+ + 2\upsilon$ where β^+ is positron and υ is the neutrino (zero rest mass and uncharged)
(C) loss of mass in the reaction is 0.027608 u
(D) the energy equivalent of the mass defect is 25.7 MeV

19. When a hydrogen atom is excited from ground state to first excited state then
(A) its kinetic energy increases by 10.2 eV.
(B) its kinetic energy decreases by 10.2 eV.
(C) its potential energy increases by 20.4 eV.
(D) its angular momentum increases by 1.05×10^{-34} J-s.

20. X-ray from a tube with a target A of atomic number Z shows strong K_α lines for target A and two weak K_α lines for impurities. The wavelength of K_α lines is λ_0 for target A and λ_1 and λ_2 for two impurities respectively. $\frac{\lambda_0}{\lambda_1} = 4$ and $\frac{\lambda_0}{\lambda_2} = \frac{1}{4}$. The screening constant of K_α lines is unity. Select the correct alternative(s) :
(A) The atomic number of first impurity is 2Z – 1
(B) The atomic number of first impurity is 2Z + 1
(C) The atomic number of second impurity is $\frac{Z+1}{2}$
(D) The atomic number of second impurity is $\frac{Z}{2} + 1$

21. The electron in hydrogen atom makes a transition $n_1 \rightarrow n_2$ where n_1 and n_2 are the principal quantum number of two states. Assuming 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 value of n_1 and n_2 are:
(A) $n_1 = 2$ And $n_2 = 1$
(B) $n_1 = 8$ and $n_2 = 2$
(C) $n_1 = 8$ And $n_2 = 1$
(D) $n_1 = 6$ and $n_2 = 3$

22. The correct statement is/are :
(A) Density of nucleus is independent of mass number (A).
(B) Radius of nucleus increases with mass number (A).
(C) Mass of nucleus is directly proportional to mass number (A).
(D) Density of nucleus is directly proportional to mass number.

23. The correct statements among the following are:(Consider only normal incidence)

(A) Pressure exerted by photons for perfectly reflecting surface is $\frac{2I}{C}$.

(B) Force exerted by photons on a perfectly reflecting surface is $\frac{2P}{C}$.

(C) Impulse applied by photon on a perfectly reflecting surface is $\frac{2E}{C}$.

(D) Force exerted by photons on a perfectly reflecting surface is $\frac{P}{C}$.

24. An electron revolves in first orbit in H atom, then :
(A) Current associated due to orbital motion of electron is 1.06 m A.
(B) Magnetic field at the centre of nucleus due to orbital motion of electron is 12.5 Tesla.
(C) First excitation energy of H atom is 10.2 eV.
(D) Current associated due to orbital motion of electron is 2.06 m A.

25. A parallel beam of uniform, monochromatic light of wavelength 6600 Å has an intensity of 900 Wm^{-2}. The number of photons in 1 mm^3 of this radiation are 1×10^X then find out value of X.

26. The voltage applied to an X-ray tube is 20 kV. The minimum wavelength of X-ray produced, is given by $\frac{31 \times n}{50}$ Å then n will be ($h = 6.62 \times 10^{-34}$ Js, $c = 3 \times 10^8$ m/s, $e = 1.6 \times 10^{-19}$ coulomb) :

27. If the frequency of k_α x-ray emitted from the element with atomic number 31 is f, if the frequency of k_α x-ray emitted from the element with atomic number 51 , is given by $\frac{25}{x}f$ then x is (assume that screening constant for K_α is 1)

28. The Ra^{226} nucleus undergoes α–decay according to equation $Ra_{88}^{226} \rightarrow Rn_{86}^{222} + He_2^4$. If the Q value of reaction is Q = X MeV then find [X]. Where [X] represents the greatest integer of X.
(Given : $m(Ra_{88}^{226}) = 226.025406u, m(Rn_{86}^{222}) = 222.017574u, m(He_2^4) = 4.002603\,u$]

29. A photon strikes a hydrogen atom in its ground state to eject the electron with kinetic energy 16.4 eV. If 25% of the photon energy is taken up by the electron, the energy of the incident photon is (24 × X) eV then 'X' is:

30. Two radioactive materials A and B have decay constants 5λ and λ respectively. Initially both A and B have the same number of nuclei. The ratio of the number of nuclei of A to that of B will be $\frac{1}{e}$, after the time $\frac{x}{8\lambda}$ then x is :

31. The difference between $(n + 2)^{th}$ Bohr radius and n^{th} Bohr radius is equal to the $(n - 2)^{th}$ Bohr radius. The value of n is ?

32. 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 light of wavelength 3λ, the stopping potential is V_0. If work function of the metallic surface is $\frac{hc}{\lambda x}$ then 'x' is :

33. A hydrogen atom is in its excited state with energy –1.51 eV. The angular momentum of the electron in this state is $\frac{xh}{2\pi}$ then write the value of 'x'.

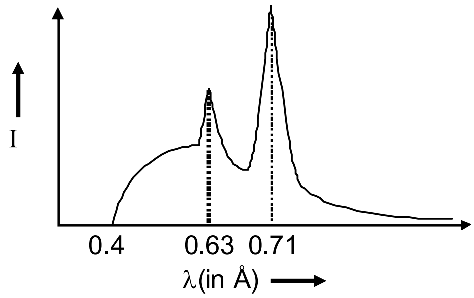
34. The energy required to excite an electron from n = 2 to n = 3 energy level is 47.2 eV. The charge of Nucleus around which the electron is revolving is ne, find n. (in terms of no. of protons)

35. A nucleus $^{229}_{90}X$ under goes α-decay and β-decay and the resultant nucleus is $^{181}_{73}Y$. Find number of β-decay.

36. Initially two radioactive nucleus have same no of active nucleus their half life are 3 years and 4 years respectively after how many years, number of nucleus of one of the radioactive element is half the number of active nucleus of other radioactive element.

COMPREHENSION # 1

Figure shows intensity versus wavelength graph of X-rays coming from coolidge-tube with molybdenum as target element :



The two peaks shown in graph correspond to K_α & K_β X-rays

37. Wavelength of L_α X-rays from Coolidge tube will be (approximately)
(A) 5.60 Å (B) 4.26 Å (C) 0.33 Å (D) 1.34 Å

38. Voltage applied across Coolidge tube is (approximately)
(A) 20 kV (B) 16 kV (C) 31 kV (D) 18 kV

COMPREHENSION # 2

When light of sufficiently high frequency is incident on metallic surface, electrons are emitted from the metallic surface. This phenomenon is called photoelectric emission. Kinetic energy of emitted photoelectron depends on the wavelength of incident light and is independent of the intensity of the incident light. Number of emitted photoelectrons depends on intensity and $(h\nu - \phi)$ is the maximum kinetic energy of emitted photoelectrons (where ϕ is work function of metallic surface). Reverse effect of photo emission produces X - ray , X ray is not deflected by electric and magnetic field, Wavelength of continuous X ray depends on potential difference across the tube. Wavelength of characteristic X ray depends on atomic number of the target.

39. If frequency ($\nu > \nu_0$) of incident light becomes n times the initial frequency (ν) then maximum kinetic energy of emitted photoelectrons becomes (ν_0 threshold frequency) :

(A) n times the initial maximum kinetic energy
(B) more than n times the initial maximum kinetic energy
(C) less than n times of initial maximum kinetic energy
(D) maximum kinetic energy of emitted photoelecrons remain unchanged.

40. A light beam containing a number of wavelengths is used in an photoelectric experiment. The stopping potential :

(A) is related to mean wavelength.
(B) is related to maximum wavelength.
(C) is related to the maximum K.E of emitted photoelectrons
(D) is related to intensity of incident light.

41. If potential difference across Coolidge tube is increased then :

(A) λ_{min} will decrease.
(B) characteristic wavelength will increase.
(C) λ_{min} will increase.
(D) none of these.

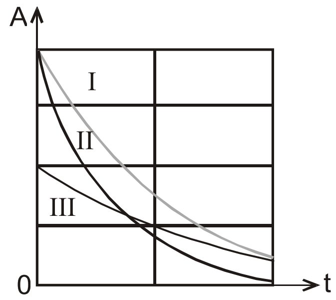
42. Match the statements given in column-I with their corresponding possible results in column-II.

	Column-I		**Column-II**
(P)	If photons of ultraviolet light of energy 12 eV are incident on a metal surface of work function of 4 eV, then the stopping potential (in eV) will be	(1)	8
(Q)	The ratio of wavelengths of K_α lines of two elements is $\left(\frac{85}{81}\right)^2$ Number of elements having atomic numbers between these elements will be	(2)	3
(R)	If 20 gm of a radioactive substance due to radioactive decay reduces to 10 gm in 4 minutes, then in what time (in minutes) 80 gm of the same substance will reduce to 20 gm	(3)	1
(S)	The mass defect for the nucleus of helium is 0.0302a.m.u. The binding energy per nucleon for helium in MeV is approximately (1amu = 930 MeV/c^2)	(4)	7

Codes :

	P	Q	R	S
(A)	2	1	3	4
(B)	1	2	1	4
(C)	2	4	3	1
(D)	1	2	4	3

43. Figure shows activities A of three different radioactive material samples (labelled as I, II and III) versus time. Using the given information, correctly match the requisite parameter in the left column with the options given in right column. Consider only their natural decay as the cause of rate of change of number of parent nuclei



Column-I	Column-II
(P) Disintegration constant (λ) has maximum value for the material of sample	(1) I
(Q) Half life is maximum for the material of the sample	(2) II
(R) Initially if samples of all three materials have same number of atoms then number of parent atoms of which of the sample will be maximum at any later time	(3) III
(S) Suppose all the materials decay by emitting α-particles of same energy and initially all three samples contain same amount (in gm) of the materials. Till the end of time span equal to their respective half lives, maximum energy is radiated by the sample	(4) it is not possible to compare with the help of data available

Codes :

	P	Q	R	S
(A)	4	2	3	4
(B)	2	4	1	3
(C)	2	3	3	4
(D)	2	1	4	3

ANSWER KEY OF DPP No. # 07

1.	(B)	**2.**	(D)	**3.**	(B)	**4.**	(C)	**5.**	(B)	**6.**	(C)	**7.**	(D)
8.	(D)	**9.**	(A)	**10.**	(B)	**11.**	(C)	**12.**	(B)	**13.**	(C)	**14.**	(B)
15.	(D)	**16.**	(A,B,D)	**17.**	(A,B,C,D)	**18.**	(A,B,C,D)	**19.**	(B,C)	**20.**	(A,D)		
21.	(B,D)	**22.**	8	**23.**	8	**24.**	5	**25.**	5	**26.**	6	**27.**	5
28.	3	**29.**	1	**30.**	6	**31.**	(A)	**32.**	(B)	**33.**	(C)	**34.**	(B)
35.	(B)	**36.**	(B)	**37.**	(B)	**38.**	(A)	**39.**	(C)	**40.**	(A)	**41.**	(C)
42.	(B)	**43.**	(A)	**44.**	(B)	**45.**	(A)						

1. The energy per photon is

$$E_\lambda = \frac{hc}{\lambda} = \frac{6.6\times10^{-34} m^2kg/s \times 3\times10^8 m/s}{3.3\times10^{-7} m} = 6 \times 10^{-19}\ \text{J}.$$

The time to discharge the plate is given by total number of electrons divided by the rate of photons:

$$t = Q/e \times \frac{E_\lambda}{P} = \frac{6\times10^{-19} J}{1.6\times10^{-19}\times 60\, J/s} = 0.0625\ \text{s}$$

2. (i) Nuclear fission results in fragments whose neutron/proton ratio is higher than the required value (N/P ratios is greater for heavier nuclei). To reduce the N/P ratio these fragments undergo β^- decays in which a neutron is converted into a proton.
(ii) Some of the energy generated in α–emission goes into nuclear excitation. The excited nucleus returns to ground state by γ–emission.
(iii) In carbon–carbon cycle, ^{12}C nucleus acts just as a catalyst. The net result is fusion of four protons into a helium nucleus.

3. (C) Velocity at highest point = u sinθ

$\therefore$ $\lambda_D = \dfrac{h}{mu\sin\theta}$ (Since θ is angle between velocity and verticle)

4. (B) $eV_s = \dfrac{hc}{\lambda} - \phi = \dfrac{1240(nm)eV}{400(nm)} - 1.9\ eV = 1.2\ eV$

$\Rightarrow$ $V_s = 1.2$ V

$\therefore$ The cesium ball can be charged to a maximum potential of 1.2 V.

5. (D) $\dfrac{1}{2}mv^2 = \dfrac{hc}{\lambda} - \phi$

$$\frac{1}{2}mv'^2 = \frac{hc}{(3\lambda/4)} - \phi = \frac{4hc}{3\lambda} - \phi$$

Clearly $v' > \sqrt{\dfrac{4}{3}}\, v$

6. Mass defect = (238.05079 – 234.04363 – 4.00260) u = 4.56×10^{-3} u
= $4.56 \times 10^{-3} \times 1.66 \times 10^{-27} = 7.57 \times 10^{-30}$ kg
$mc^2 = 7.57 \times 10^{-30} \times 9 \times 10^{16} = 6.8 \times 10^{-13}$ J

7. $\lambda = \dfrac{h}{p} = \dfrac{h}{\sqrt{2mE}}$

$\therefore$ $E = \dfrac{h^2}{2m\lambda^2}$

$$\Delta E = \frac{h^2}{2m}\left(\frac{1}{\lambda_1^2} - \frac{1}{\lambda_2^2}\right)$$

Put $\lambda_1 = 0.5 \times 10^{-9}$ m
& $\lambda_2 = 2 \times 10^{-9}$ m and solve.

8. If electrons are accelereted through a potential difference V, the maximum energy of emitted photon could be

E_{max} = eV. $\therefore$ 10^5 eV = eV

$\Rightarrow$ V = 10^5 V.

9. Energy of photon is given by mc^2 now the maximum energy of photon is equal to the maximum energy of electron = eV

hence, $mc^2 = ev$ $\Rightarrow$ $m = \dfrac{eV}{c^2} = \dfrac{1.6\times10^{-19}\times18\times10^3}{(3\times10^8)^2} = 3.2 \times 10^{-32}$ kg

10. The number of photons incident per unit time remains same hence saturation photo current remains same.

If frequency is doubled then kinetic energy of photo electrons is more than doubled.

11. $P_1 = P_2 = P$

$m_1v_1 = m_2v_2$

$$\left(\frac{P^2}{2m_1}\right)\Big/\left(\frac{P^2}{2m_2}\right) = \frac{64}{27}$$

$$\frac{m_2}{m_1} = \frac{64}{27} = \frac{v_1}{v_2}$$

$$\frac{\lambda_1}{\lambda_2} = \frac{h/P_1}{h/P_2} = 1:1$$

$$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{27}{64}\right)^{1/3} = \frac{3}{4}$$

12. Type of particle emittion cannot be generalised for all reaction.

Hence α, β, γ particles may be emitted simultaneously.

13. The rate of accumulation of nuclei of X in the reactor can be given as

$$\frac{dN_X}{dt} = r - \lambda N_x$$

$$\Rightarrow \quad N_x = \frac{r}{\lambda}(1 - e^{-\lambda t})$$

Thus amount of N_x continuously increases with time hence brightness of bulb will continuously increase.

14. $\lambda = 2R = 2R_0A^{1/3}$

$$P = \frac{h}{\lambda} \quad \Rightarrow \quad E = \frac{P^2}{2m} = \frac{h^2}{2m(4R_0^2A^{2/3})}$$

$$E = \frac{(6.62\times10^{-34})^2}{2\times1.67\times10^{-27}\times4(1.3\times10^{-15})^2(128)^{2/3}} \text{ Joule}$$

= 4.72 MeV.

15. Activity after time t

$A = \lambda N_0 e^{-\lambda t}$

$A = \lambda A_i$

$A = \lambda$(initial activity)

$A \propto$ initial activity

16. Fraction of mass converted in energy

$$\frac{3\times4.0025-12.0000}{3\times4.0025}=\frac{0.0075}{12}=\frac{\text{Rate of loss of mass}}{\text{Rate of burning}}$$

Rate of burning $= \frac{12}{75\times10^{-4}}$ Rate of loss of mass.

Rate of burning $= \frac{12}{75\times10^{-4}}\times\frac{\text{Power output}}{C^2}$

$= \frac{12}{75\times10^{-4}}\times\frac{4.5\times10^{27}}{(3\times10^{8})^2}$

$= \frac{12\times4.5\times10^{27}}{75\times9\times10^{12}} = \frac{54}{9\times75}\times10^{15} = \frac{2}{25}\times10^{15} = 8\times10^{13}$ kg/s

17. Given, $\lambda = 0.173$

$T_{1/2} = \frac{\ln 2}{\lambda} = \frac{0.693}{0.173} \cong 4$

Also for $t = \frac{1}{0.173}$ year

Remaining nuclei $N = N_0e^{-1} = 0.37\ N_0$

Decay nuclei $= N_0 - N = 0.63\ N_0$.

18. Mass defect $\Delta m = 4m_H - m_{He} - 2m_e$

$Q = 0.027608\ u \times 932\frac{MeV}{u} = 25.7$ MeV

19. In ground state n = 1 and for first excited state n = 2

$KE = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{2r}(z=1) = \frac{14.4\times10^{-10}}{2r}$ eV $\quad (\because r = 0.53\ n^2\ A^o\ (z=1))$

$(KE)_1 = \frac{14.4\times10^{-10}}{2\times0.53\times10^{-10}}$ eV = 13.58 eV and $(KE)_2 = \frac{14.4\times10^{-10}}{2\times0.53\times10^{-10}\times4}$ ev = 3.39 ev

$\therefore$ KE decreases by = 10.2 ev

$\therefore$ PE increases by = Excitation energy + Loss in kinetic energy = 10.2 + 10.2 = 20.4 ev

Now Angular momentum ; $L = mvr = \frac{nh}{2\pi}$

$\Rightarrow L_2 - L_1 = \frac{h}{2\pi} = \frac{6.6\times10^{-34}}{6.28} = 1.05\times10^{-34}$ J–sec.

20. $\frac{\lambda_0}{\lambda_1} = 4 \quad\Rightarrow\quad \frac{(Z_1-1)^2}{(Z-1)^2} = 4 \quad\Rightarrow\quad Z_1 = 2Z-1$

$\frac{\lambda_0}{\lambda_2} = \frac{1}{4} \quad\Rightarrow\quad \frac{(Z_2-1)^2}{(Z-1)^2} = \frac{1}{4} \quad\Rightarrow\quad Z_2 = \frac{Z+1}{2}$.

21. Time period $T_n = \frac{2\pi r_n}{V_n}$

$$T \propto \frac{n^2}{1/n}$$

i.e., $T \propto n^3$

$$T_{n_1} = 8T_{n_2}$$

$$n_1 = 2n_2$$

Hence, $n_1 = 2n_2$
Choice (b) and (c) are wrong.

22. $R = R_0 A^{1/3}$
Radius of nucleus $R \propto A^{1/3}$
So, choice (b) is correct.

Density = $\frac{\text{mass}}{\text{volume}} = \frac{A \times 1.67 \times 10^{-27}}{\frac{4}{3}\pi R_0{}^3 A}$

Density $\propto A^{\circ}$
i.e., Density is indenpendent of mass number.
So, choices (a), (b) and (c) are correct and choice (d) is worng.

23. Pressure = $\frac{I}{C}$ (1 + r) where I is the Intensity

F = $\frac{P}{C}$ (1 + r) where P is the power

Impulse $I = \frac{E}{C}$ (1 + r)

where E is the Energy
r is the reflection coefficient.
and r = 1 for perfectly reflecting surface.
Choice (d) is wrong.

24. $I = \frac{1.06 z^2}{n^3}$ mA
For H atom z = 1 and first orbit n = 1
I = 1.06 mA. So, choice (a) is correct.

Magnetic field $B = \frac{12.5 z^3}{n^5}$ Tesla
B = 12.5 Tesla. So, choice (b) is correct.

$$\Delta E = 13.6\, z^2 \left[1 - \frac{1}{4}\right]$$

$= 13.6 \times \frac{3}{4}$ = 10.2 eV. So, choice (c) is correct.

25. Energy incident in 1 m^2 in 1 sec.
E = 900 J

$$\frac{hc}{\lambda} n \times 1 \times 3 \times 10^8 = 900$$

n = 10^{13} photons/m^3
n = 10^4 photons/mm^3.

26. $$\lambda_{min} = \frac{hc}{eV} = \frac{6.62\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}\times20\times10^{3}} = \frac{12375}{20\times10^{-3}}\text{ Å} = 0.62\text{ Å}$$

27. $\sqrt{f} = a(Z-1)$

$\sqrt{f} = a(31-1)$

$\sqrt{\frac{25f}{x}} = a(51-1)$

x = 9

28. Q = [M (Ra^{226}) – M(Rn^{222}) – M(He^4)] × 931
= (226.025406 – 222.017574 – 4.002603) u × 931

= 0.005229 u × 931 $\frac{MeV}{u}$

Q = 4.87 MeV

29. Energy required to just remove the electron = 13.6 eV
∴ Energy required = 13.6 + 16.4 = 30 eV
If E be the photon energy 25%
E = 30 eV, E = 120eV = 24 × 5 eV.
X = 5 **Ans**

30. Using the law of radioactive decay, one can write $\frac{N_A(t)}{N_B(t)} = \frac{N_0\exp(-5\lambda t)}{N_0\exp(-\lambda t)} = \frac{1}{e}$.

Solving this one gets the results.

31. $r_n \,\alpha\, n^2$

$r_{n+2} = k(n+2)^2 \Rightarrow r_n = kn^2$

$r_{n-2} = k(n-2)^2$

$(n+2)^2 - n^2 = (n-2)^2 \Rightarrow$ n = 8

32. $\frac{hc}{\lambda} = 5\, eV_0 + \phi$

$\frac{hc}{3\lambda} = eV_0 + \phi \Rightarrow \frac{2hc}{3\lambda} = 4eV_0$

$\Rightarrow \phi = \frac{hc}{6\lambda}$

33. $E_n = -\frac{13.6\,eV}{n^2} = -1.51\ eV \qquad \Rightarrow n = 3$

$\therefore L = 3\left(\frac{h}{2\pi}\right)$

34. $E = -13.6\ Z^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$47.2 = -13.6\ Z^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$

$Z = 5$

35. ${}^{229}_{90}X \rightarrow {}^{181}_{73}Y + a\,{}^{4}_{2}\alpha + b\,{}^{0}_{-1}\beta$

a =12

b = 7

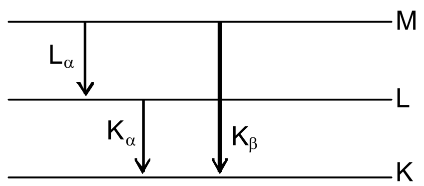
36. Let $\lambda_1 = \frac{\ln 2}{3}$ and $\lambda_2 = \frac{\ln 2}{4}$

$\frac{N/2}{N} = \frac{N_0 e^{-\lambda_1 t}}{N_0 e^{-\lambda_2 t}}$

t = 12

38 $\frac{1}{\lambda_{K\beta}} = \frac{1}{\lambda_{K\alpha}} + \frac{1}{\lambda_{L\alpha}}$

$\frac{1}{\lambda_{L\alpha}}$ = 5.6Å



$eV = \frac{hc}{\lambda}$

$V = \frac{hc}{e\lambda} = 31 \times 10^3$ volts

39. From Einstein photoelectic equation.

$K = h\nu - \phi$

$K' = h\nu - \phi = n(h\nu - \phi) + (n-1)\phi$

$K' = nk + (n-1)\phi$

From above expression K' > nK because ϕ can never be zero

40. Stopping potential is the measurment of maximum kinetic energy of emitted photoelectrons and kinetic energy of emitted photoelectrons is linearly with the frequency of incident light correponding (i,e corresponding to shortest wavelength, K.E is maximum).
Stopping potential is independent of intensity.

41. $\lambda_{min} = \frac{hc}{eV}$

$\lambda_{min} \propto \frac{1}{V}$

As λ_{min} decrease, V increases. So choice (a) is correct and the rest are wrong.

42. (A) Stopping potential in electron volts = $h\nu - \phi$= 12–4 = 8.

(B)) $\left(\frac{Z_1 - 1}{Z_2 - 1}\right)^2 = \frac{\lambda_2}{\lambda_1} = \left(\frac{85}{81}\right)^2$. Therefore Z_1= 86 and Z_2 =82

(C) Half life time of radioactive material is 4 min. For 80 gm to reduce to 20gm, two half life times are required.

(D) The binding energy per nucleon for helium in MeV is approximately $\frac{0.0302 \times 930}{4} \approx 7$

43. (P) Activity of the sample II becomes half in minimum time. Hence it has maximum disintegration constant.
(Q) Activity of the sample III takes maximum life to become half therefore it has maximum half - life.
(R)
(S) It can not be compared without information about atomic weight as energy radiated will depend upon no. of atoms, not upon amount of substance.

$A_0 = N_0\lambda_1 = N_0\,\lambda_2$

$\frac{A_0}{2} N_0\,\lambda_3 \Rightarrow \lambda_1 = \lambda_2 = 2\lambda_3$

$N = \frac{N_0}{2^n} = \frac{N_0}{2^{\frac{t\lambda}{\mu 2}}}$

$\frac{N_3}{N_1} = 2^{\frac{t}{\mu 2}(\lambda_1 - \lambda_3)} > 1$

$N_3 > N_1$