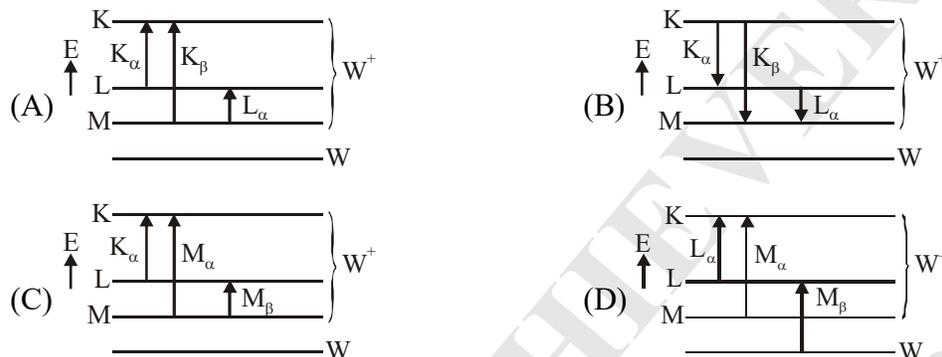| CLASS : CC (ADVANCED)	MODERN PHYSICS	M/M. 73	TEST NO. 8

[SINGLE CORRECT CHOICE TYPE]

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(A) 1876 MeV (B) 938 MeV (C) 200 MeV (D) 8 MeV

Q.2 When 1 cm thick surface is illuminated with light of wavelength λ, the stopping potential is v. When the same surface is illuminated by light of wavelength 2λ, the stopping potential is v/3. Threshold wavelength for metallic surface is **[3]**

(A) $4\lambda/3$ (B) 4λ (C) $8\lambda/3$ (D) 6λ

Q.3 A nucleus of nuclear density ρ disintegrates into two daughter nuclei with masses in the ratio 8 : 27. Density of the smaller nucleus is **[3]**

(A) $\frac{2}{3}\rho$ (B) $\frac{2}{5}\rho$ (C) $\frac{8}{27}\rho$ (D) ρ

Q.4 The electron in a H - atom makes a transition from $n_2 \to n_1$ where n_1 and n_2 are the principal quantum number of the states. Assume Bohr's model to be valid. The time period of the electron in initial state is 27 times than that in final state. Find the possible value of n_1 and n_2, if only just first 10 states are in the observable range of instrument. **[3]**

(A) 1-2, 2-4, 3-6, 4-8, 5-10 (B) 1-3, 2-6, 3-9
(C) 14, 28 (D) none

Q.5 A small mirror of mass m is suspended by a light thread of length ℓ. The angle through which the thread will be deflected when a short pulse of laser of energy E falls normally on the mirror is **[3]**

(A) $\dfrac{2E}{mc\sqrt{2gl}}$ (B) $\dfrac{mc\sqrt{gl}}{2E}$ (C) $\dfrac{mc\sqrt{2gl}}{2E}$ (D) $\dfrac{2E}{mc\sqrt{gl}}$

Q.6 In the nuclear reaction $_1H^2 + {}_1H^2 \to {}_2He^3 + {}_0n^1$, Mass of deuterium atom = 2.014741 amu, Mass of $_2He^3$ atom = 3.016977 amu, and Mass of neutron = 1.008987 amu. The Q-value of the reaction will be

(A) 0.00352 MeV (B) 3.27 MeV (C) 0.82 MeV (D) 2.45 MeV **[3]**

Q.7 The k_α wavelength of an element with atomic number Z is λ_1. The k_α wavelength of an element with atomic number 2Z is λ_2. How are λ_1 and λ_2 related? **[3]**

(A) $\lambda_1 > 4\lambda_2$ (B) $\lambda_2 = 4\lambda_2$ (C) $\lambda_1 < 4\lambda_2$
(D) Depending on z, λ_1 could be greater than or less than $4\lambda_2$

Q.8 What is the minimum kinetic energy needed by a hydrogen atom in ground state to produce a photon after collision with another identical hydrogen atom at rest? **[3]**

(A) 6.8eV (B) 3.4eV (C) 20.4eV (D) 2.04eV

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(A) $\dfrac{n^3h^3}{8\pi^3km^2e^2}$ 　　　(B) $\dfrac{n^2h^3}{8\pi^3km^3e^2}$ 　　　(C) $\dfrac{n^3h^3}{8\pi^2km^2e^2}$ 　　　(D) $\dfrac{n^2h^2}{8\pi^2km^2e^2}$

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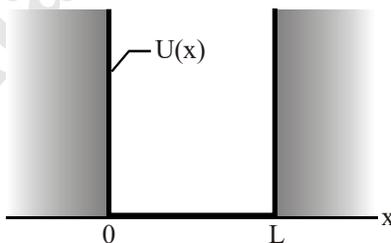

[PARAGRAPH TYPE]
Paragraph for question nos. 11 to 13

Figure shows the potential energy of the electron as a function of its position along the x-axis of the idealized trap. When the electron is in the central cylinder, its potential energy U (in eV) is zero because there the potential V is zero. If the electron could get outside this region, its potential energy would be positive and of infinite magnitude because there $V \to -\infty$. We call the potential energy pattern of figure an infinitely deep potential energy well or, for short, an infinite potential well.

Just like the standing wave in a length of stretched string, the matter wave describing the confined electron must have nodes at x = 0 and x = L. By using de-Broglie's hypothesis,

We get the energy E. We find that E depends on n according to

$$E_n = \left(\frac{h^2}{8m_eL^2}\right)n^2, \qquad \text{for } n = 1, 2, 3, \ldots\ldots$$

Perhaps the most direct way to construct a potential energy well in the laboratory is to prepare a sample of a semiconducting material in the form of a powder whose granules are small and of uniform size. Each such granule - each crystallite - acts as a potential well for the electrons trapped within it.

Equation shows that we can increase the energy level values of an electron trapped in an infinite well by reducing the width L of the well. This would also shift the photon energies that the well can absorb to higher values and thus shift the corresponding wavelengths to shorter values. A given crystallite can absorb photons with an energy above a certain threshold energy E_t ($= hf_t$) and thus wavelengths below a corresponding threshold wavelength

$$\lambda_t = \frac{c}{f_t} = \frac{hc}{E_t}$$

Light with any wavelength longer than λ_t is scattered by the crystallite instead of being abosrbed. The color we attribute to the crystallite is then determined by the wavelength composition of the scattered light we intercept.

The photograph here shows Semiconductor cadmium selenide, each consisting of a powder of crystal-lites of uniform size. The lower sample scatters light at the red end of the spectrum. The upper sample differs from the lower sample only in that the upper sample is composed of smaller crystallites.

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(A) $\dfrac{h^2}{8mL^2}$ (B) $\dfrac{h^2}{2mL^2}$ (C) $\dfrac{h^2}{mL^2}$ (D) $\dfrac{3h^2}{8mL^2}$

Q.12 If we use crystallites of cadmium selenide which are bigger than the lower sample, it could **[3]**
(A) Absorb red light and scatter infrared light
(B) Absorb yellow light and scatter red light.
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Q.13 Assume that the lower sample has a threshold wavelength of 620 nm. Estimate the order of size of the crystallite. **[3]**
(A) 10^{-10} m (B) 10^{-9} m (C) 10^{-11} m (D) 10^{-8} m

[REASONING TYPE]

Q.14 **Statement-1:** Cut off wavelength of X-ray coming from a Coolidge tube depends on the target material.
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(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

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[MATRIX TYPE]

Q.15 If Q is energy released in the decay , m_x is atomic mass of parent nucleus, m_y is atomic mass of daughter nucleus and m_e is mass of electron, then match the following : **[6]**

Column-I		Column-II	
(A)	k electron capture	(P)	$Q = (m_x - m_y)c^2$
(B)	β^- decay	(Q)	$Q = (m_x - m_y - m_e)c^2$
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		(S)	$Q = (m_x - m_y + 2m_e)c^2$

[SUBJECTIVE TYPE]

Q.16 A gas containing hydrogen like ions with atomic number Z, emits photons in transition $n + 2 \rightarrow n$, where $n = Z$. These photons fall on a metallic plate and eject electrons having minimum de-Broglie wavelength λ of 5Å. Find the value of Z if the work function of metal is 4.2eV. **[5]**

Q.17 There are two bodies A & B with temperatures 1500 K and 3600 K respectively. Photons having wavelength equal to the wavelength corresponding to maximum spectral radiancy of A & B (say λ_A and λ_B respectively) are incident on a metal sphere of radius 12 cm having work-function 1.2 eV. The maximum kinetic energies of the electrons emitted by these photons are in the ratio 1 : 3.

(a) Find the wavelengths λ_A and λ_B.

(b) If 10^{12} photons of wavelength λ_B are incident per second and photo electric efficiency is one electron per 10^6 photons, find the time after which emission of photo-electrons will stop. In this case assume that λ_A is not present. **[5]**

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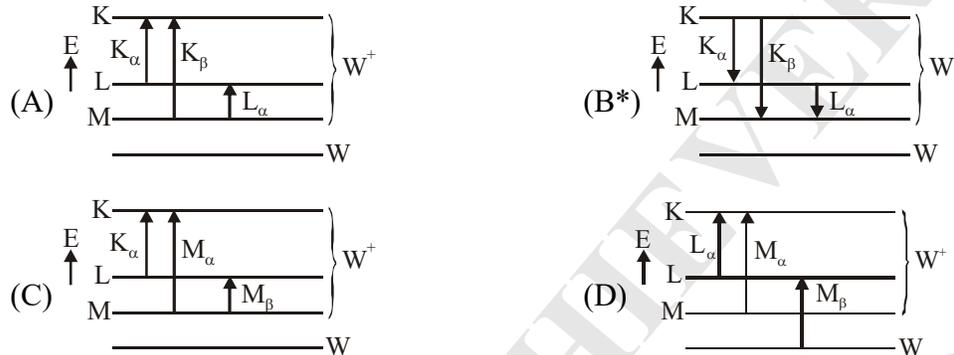| CLASS : CC (ADVANCED)	MODERN PHYSICS	M/M. 73	TEST NO. 8

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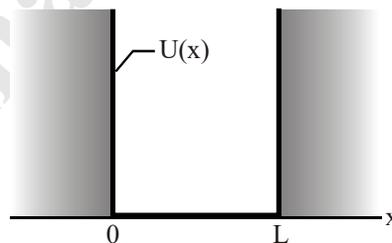

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		(S)	$Q = (m_x - m_y + 2m_e)c^2$

[Ans. (A)-P (B)-P (C)-R]

[SUBJECTIVE   TYPE]

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[Ans.   Z = 2]

Q.17 There are two bodies A & B with temperatures 1500 K and 3600 K respectively. Photons having wavelength equal to the wavelength corresponding to maximum spectral radiancy of A & B (say λ_A and λ_B respectively) are incident on a metal sphere of radius 12 cm having work-function 1.2 eV. The maximum kinetic energies of the electrons emitted by these photons are in the ratio 1 : 3.
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Ans.   30940 Å, 1289 Å, 7000 S

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Ans.   15.7 eV, 7 km/s

Q.19 A perfectly absorbing surface intercepts a parallel beam of monochromatic light of λ = 500 nm, incident on it normally. If the power through any cross-section of beam is 10 W.
(i) Find the number of photons absorbed per second by the surface.
(ii) Find the force exerted by light beam on the surface. **[5]**

Ans. 2.52×10^{19} eV, 3.3×10^{-8} N

Q.20 A solution contains a mixture of isotopes X^A of half life 14 days and X^B of half life 25 days. Total activity is 1 curie at time t = 0. The activity reduces by 50% in 20 days. **[5]**
(a) Find the initial activities of X^A & X^B.
(b) Find the ratio of their initial numbers of nuclei.

[Ans. (a) 0.367 curie (b) 0.633 curie]