PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 14

Total Marks : 37

Max. Time : 41 min.

Topic : Atomic Structure

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.3 to Q.9	(3 marks, 3 min.)	[21, 21]
Subjective Questions ('–1' negative marking) Q.1 to Q.2	(4 marks, 5 min.)	[8, 10]
Match the Following (no negative marking) (2 × 4) Q.10	(8 marks, 10 min.)	[8, 10]

1. In I experiment, electromagnetic radiations of a certain frequency are irradiated on a metal surface ejecting photoelectrons having a certain value of maximum kinetic energy. However, in II experiment,on doubling the frequency of incident electromagnetic radiations, the maximum kinetic energy of ejected photoelectrons becomes three times. What percentage of incident energy is converted into maximum kinetic energy of photoelectrons in II experiment ?

2. The potential difference applied on the metal surface to reduce the velocity of photoelectron to zero is known as Stopping Potential. When a beam of photons of wavelength 40 nm was incident on a surface of a particular pure metal, some emitted photoelectrons had stopping potential equal to 18.6 V, some had 12 V and rest had lower values. Calculate the threshold wavelength (λ_0) of the metal (in Å) assuming that at least one photoelectron is ejected with maximum possible kinetic energy. (hc = 12400 eVÅ)

3. For which of the following species, Bohr model is not valid :
(A) He^+ (B) H (C) Li^{2+} (D) H^+

4. Wavelength of radiations emitted when an electron in a H-like atom jumps from a state A to C is 2000 Å and it is 6000 Å, when the electron jumps from state B to state C. Wavelength of the radiations emitted when an electron jumps from state A to B will be :
(A) 2000 Å (B) 3000 Å (C) 4000 Å (D) 6000 Å

5. If the radius of the first Bohr orbit of the H atom is r, then for Li^{2+} ion, it will be :
(A) 3r (B) 9r (C) r/3 (D) r/9

6. In a certain electronic transition in the Hydrogen atom from an initial state i to a final state f, the difference in the orbit radius ($r_i - r_f$) is seven times the first Bohr radius. Identify the transition :
(A) $4 \rightarrow 1$ (B) $4 \rightarrow 2$ (C) $4 \rightarrow 3$ (D) $3 \rightarrow 1$

7. The velocity of electron in the ground state of H atom is 2.184×10^8 cm/sec. The velocity of electron in the second orbit of Li^{2+} ion in cm/sec would be :
(A) 3.276×10^8 (B) 2.185×10^8 (C) 4.91×10^8 (D) 1.638×10^8

8. The potential energy of the electron present in the ground state of Li^{2+} ion is represented by :
(A) $+\frac{3e^2}{4\pi \epsilon_0 r}$ (B) $-\frac{3e}{4\pi \epsilon_0 r}$ (C) $-\frac{3e^2}{4\pi \epsilon_0 r^2}$ (D) $-\frac{3e^2}{4\pi \epsilon_0 r}$

9. If the angular momentum of an electron in a Bohr orbit is $\frac{2h}{\pi}$, then the value of potential energy of this electron present in He^+ ion is :
(A) – 13.6 eV (B) – 3.4 eV (C) – 6.8 eV (D) – 27.2 eV.

10. **Match the following :**

E_n = total energy, ℓ_n = angular momentum, K_n = K.E. , V_n = P.E., T_n = time period, r_n = radius of nth orbit

Column (I)	**Column (II)**
(A) $E_n^{-y} \propto r_n/Z$, then y is	(p) 1/2
(B) $\ell_n \propto n^x$,then x is	(q) – 2
(C) Value of $\frac{E_n}{V_n}$ is	(r) – 3
(D) $T_n \propto \frac{Z^t}{n^m}$, t & m are respectively	(s) 1

Answer Key

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1.	75%	**2.**	1000 Å	**3.**	(D)	**4.**	(B)	**5.**	(C)
6.	(C)	**7.**	(A)	**8.**	(D)	**9.**	(C)		
10.	(A – s) ; (B – s) ; (C – p) ; (D – q, r).								

Hints & Solutions

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1. For I experiment, $h\nu_1 = W + KE_{max1}$ .... (1)

For II experiment, $h\nu_2 = W + KE_{max2}$ .... (2)

here, $\nu_2 = 2\nu_1$ and $KE_{max2} = 3\,KE_{max1}$

$\therefore$ $2h\nu_1 = W + 3\,KE_{max1}$ .... (3)

From (1) and (3) : $h\nu_1 = 2KE_{max1}$ or $h\left(\frac{\nu_2}{2}\right) = 2\left(\frac{KE_{max\,2}}{3}\right)$

$\therefore$ % of incident energy converted into max KE in II experiment

$$= \frac{KE_{max\,2}}{h\nu_2} \times 100 = \frac{3}{4} \times 100 = 75\%.$$

2. The maximum KE of potoelectron is corresponding to maximum stopping = 18.6 eV

$\therefore$ $E_{incident} = W + KE_{max}$

$$\frac{12400}{400}\text{ eV} = W + 18.6\text{ eV}$$

$$W = 12.4\text{ eV}$$

$$\therefore \quad \lambda_0 = \frac{12400}{12.4}\text{ Å} = 1000\text{ Å}$$

3. Only for Single electron species.

4. $$\frac{1}{\lambda_1} = RZ^2\left[\frac{1}{n_C} - \frac{1}{n_A}\right] \quad \text{....... (1)}$$

$$\frac{1}{\lambda_1} = RZ^2\left[\frac{1}{n_C} - \frac{1}{n_B}\right] \quad \text{....... (ii)}$$

$$\frac{1}{\lambda_3} = RZ^2\left[\frac{1}{n_B} - \frac{1}{n_A}\right]$$

$$\frac{1}{\lambda_3} = \frac{1}{\lambda_1} - \frac{1}{\lambda_2} = \frac{\lambda_2 - \lambda_1}{\lambda_1\lambda_2} = \frac{1}{3000}$$

$\lambda_3 = 3000$ Å.

5. For $r = 0.52\ \text{Å} \times \frac{12}{1}$

For $L^{2+}\ r_1 = 0.529 \times \frac{12}{3}$

$\frac{r}{r_1} = 3 \quad \Rightarrow \quad r_1 = \frac{r}{3}$

6. $r_4 - r_3 = 7 \times r_1$

7. Use $V_n = 2.185 \times 10^8 \left(\frac{z}{n}\right)$ cm/sec.

8. $PE = -\frac{KZe^2}{r}$.

9. $\frac{nh}{2\pi} = \frac{2h}{\pi} \quad \Rightarrow n = 4,$

$P.E. = 2(T.E.) = 2\left(-13.6 \times \frac{2^2}{4^2}\right) = -6.8\ \text{eV}.$

10. (A) $E_n^{-y} \propto r_n / Z$

$$\left(\frac{Z^2}{n^2} \times 13.6\ \text{eV}\right)^{-y} \propto \frac{1}{z}\left(\frac{n^2}{Z} \times 0.529\ \text{Å}\right)$$

$y = 1$

(B) $\ell_n \propto n^x \Rightarrow \frac{nh}{2\pi} \propto n^x \Rightarrow \quad x = 1$

(C) Potential energy = 2 (total energy)

(D) $T_n \propto \frac{n^3}{z^2} \quad \Rightarrow \quad t = -2 \quad \Rightarrow \quad m = -3.$