PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 16

Total Marks : 37

Max. Time : 43 min.

Topic : Atomic Structure

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Multiple choice objective ('–1' negative marking) Q.4	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.5,6,8,9	(4 marks, 5 min.)	[16, 20]
Match the Following (no negative marking) (2 × 4) Q.7	(8 marks, 10 min.)	[8, 10]

1. If numerical value of mass and velocity are equal for a particle, then its de-Broglie wavelength in terms of K.E. is :

(A) $\frac{mh}{2K.E.}$ (B) $\frac{h}{2mK.E.}$ (C) both are correct (D) none is correct.

2. A wavelength of 400 nm of electromagnetic radiation corresponds to :

(A) frequency (ν) = 7.5 × 10^{14} Hz (B) wave number($\bar{\nu}$) = 2.5 × 10^6 m^{-1}.

(C) momentum of photon = 1.66 × 10^{-27} kg ms^{-1} (D) all are correct values.

3. In one experiment, a proton having initial kinetic energy of 1 eV is accelerated through a potential difference of 3 V. In another experiment, an α-particle having initial kinetic energy 20 eV is retarded by a potential difference of 2 V. The ratio of de-Broglie wavelengths of proton and α-particle is :

(A) $2\sqrt{6}$: 1 (B) 8 : 1 (C) 4 : 1 (D) $2\sqrt{2}$: 1

4.* When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy $(K.E)_A$ and de-Broglie wavelength is λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.7 eV is $(KE)_B$, where $(KE)_B = (KE)_A$ –1.5 eV. If the de-Broglie wavelength of these photoelectrons is λ_B (= $2\lambda_A$), then :

(A) The work function of metal A is 2.25 eV (B) The work function of metal B is 4.20 eV

(C) $(KE)_A$ = 2 eV (D) $(KE)_B$ = 2.75 eV

5. Average life time of an electron in hydrogen atom excited to n = 2 state is 10^{-8} s. Find the number of revolutions made by the electron on the average, before it jumps to the ground state.

6. The ionisation energy of He^+ ion is 19.6 × 10^{-18} J per ion. Calculate the energy of the first stationary state of Li^{2+} ion.

7. **Match the following :**

Column (I)	Column (II)
(A) Binding energy of 5^{th} excited state of Li^{2+} sample	(p) 10.2 V
(B) I^{st} excitation potential of H-atom	(q) 3.4 eV
(C) 2^{nd} excitation potential of He^+ ion	(r) 13.6 eV
(D) I.E. of H-atom	(s) 48.4 V

8. The IP of H-atom is 13.6 V. It is exposed to electromagnetic waves of wavelength 1026 Å and then, it gives out induced radiations. Find the wavelength of all possible induced radiations.

9. The ionization energy of a Hydrogen like species is 4 Rydberg. What is the radius of the first orbit of this atom ? (Given : Bohr radius of hydrogen = 5.3 × 10^{-11} m; 1 Rydberg = 2.2 × 10^{-18} J)

Answer Key

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1.	(A)	**2.**	(D)	**3.**	(C)	**4.***	(A,B,C)
5.	8.2×10^6	**6.**	-4.41×10^{-17} J.	**7.**	[A – q] ; [B – p] ; [C – s] ; [D – r].		

8. I induced = 1026 Å , II induced = 1216 Å, III induced = 6568 Å **9.** 2.65×10^{-11} m.

Hints & Solutions

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1. $\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{v^2}$

but $v^2 = \frac{2KE}{m}$ therefore $\lambda = \frac{hm}{2KE}$

2. Use $C = \upsilon\lambda$ $\Rightarrow$ $\bar{u} = \frac{1}{\lambda}$

3. $K.E._{proton} = 1 + (1)(3) = 4$ eV $\therefore \lambda_p = \frac{h}{\sqrt{2m_p(KE)_p}}$ & $KE_{\alpha\text{-particle}} = 20 - (2)(2) = 16$ eV $\therefore \lambda_\alpha = \frac{h}{\sqrt{2m_\alpha(KE)_\alpha}}$

$\therefore \frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha(KE)_\alpha}{m_p(KE)_p}} = \sqrt{\frac{4 \times 16}{1 \times 4}} = \frac{4}{1}$

4.* $4.25 = (W_0)_A + (K.E.)_A$

$4.70 = (W_0)_B + (K.E.)_A - 1.5$

So $(W_0)_B - (W_0)_A = 0.45 + 1.5$

$= 1.95$

Now , $\lambda_B = 2\lambda_A$

$$\frac{h}{\sqrt{2m(K.E)_B}} = \frac{2h}{\sqrt{2m(K.E)_A}}$$

So $(K.E)_A = 4\,(K.E)_B$

$4.25 - (W_0)_A = 4\,[\,4.7 - (W_0)_B]$

$4(W_0)_B - (W_0)_A = 14.55$

So $(W_0)_B = 4.2$eV

So $(W_0)_A = 2.25$ eV

$(K.E.)_A = 2$eV

$(K.E)_B = 0.5$eV

5. number of revolutions per second

$$= \frac{V}{2\pi r} = \frac{2.18 \times 10^6 \left(\frac{Z}{n}\right)}{2 \times 3.14 \times 0.529 \times \left(\frac{n^2}{Z}\right) \times 10^{-10}} = \frac{2.18 \times 10^6 \left(\frac{1}{2}\right)}{2 \times 3.14 \times 0.529 \times \left(\frac{2^2}{1}\right) \times 10^{-10}}$$

Number of revolution in 10^{-8} second = $\frac{2.18 \times 10^6 \left(\frac{1}{2}\right)}{2 \times 3.14 \times 0.529 \times \left(\frac{2^2}{1}\right) \times 10^{-10}} \times 10^{-8} = 8.2 \times 10^6$.

6. The ionisation energy of He^+ is 19.6×10^{-18} J.

$\therefore$ Energy of the first orbit of He^+ (Z = 2) = 19.6×10^{-18} J.

$\therefore$ Energy of the first orbit of H^+ (Z = 1) = $\frac{19.6 \times 10^{-18}}{4}$ J

$\therefore$ Energy of the first orbit of Li^{2+} (Z = 3) = $\frac{19.6 \times 10^{-18}}{4} \times 9 = 4.41 \times 10^{-17}$ J.

7. **(A)** Transition n ® 6 to n ® ∞ For Li^{2+} sample

(B) Transition $n \rightarrow 1$ to $n \rightarrow 2$ For H-atom sample

(C) Transition $n \rightarrow 1$ to $n \rightarrow 3$ For He^+ sample

(D) Transition $n \rightarrow 1$ to $n \rightarrow \infty$ For H-atom sample

8. $\Delta E = \frac{12400}{1026} = 12.09$ eV.

So, $\Delta E = E_3 - E_1$.

Hence, induced radiations will be correspond to following energy transition

$E_3 \rightarrow E_1$, $E_3 \rightarrow E_2$ and $E_2 \rightarrow E_1$.

9. $-13.6 \frac{Z^2}{n^2} = 4R = 4 \times 2.2 \times 10^{-18}$ J.

$Z^2 = \frac{4 \times 2.2 \times 10^{-18} \text{ J}}{13.6 \times 1.6 \times 10^{-19}} = 4$; Z = 2.

$r = 0.529 \frac{n^2}{Z} \times 10^{-10}$ m. $r = 0.529 \times 10^{-10} \times \frac{1}{2} = 2.645 \times 10^{-11}$ m.