PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 21

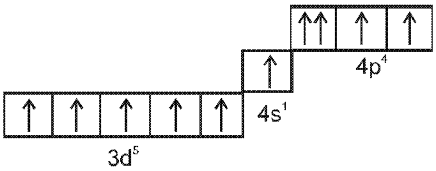
Total Marks : 28

Max. Time : 32 min.

Topic : Atomic Structure

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.5 to Q.8	(4 marks, 5 min.)	[16, 20]

1. In the following electronic configuration, some rules have been violated :



I : Hund   II : Pauli's exclusion   III : Aufbau

(A) I and II   (B) I and III   (C) II and III   (D) I, II and III

2. What is the potential difference through which an electron, with a de Broglie wavelength of 1.5 Å should be accelerated, if its de Broglie wavelength has to be reduced to 1 Å :

(A) 110 volts   (B) 70 volts   (C) 83 volts   (D) 55 volts

3. X^{2+} is isoelectronic with sulphur and has (Z + 2) neutrons (Z is atomic no. of element X). Hence, mass number of X^{2+} is :

(A) 34   (B) 36   (C) 38   (D) 40

4. Which of the following compounds is isoelectronic with $[NH_3 \rightarrow BH_3]$:

(A) B_2H_6 (B) C_2H_6 (C) C_2H_4 (D) C_3H_6

5. A neutral atom of an element has 2K, 8L, 9M and 2N electrons. Find out the following :

(a) Atomic number of element   (b) Total number of s electrons

(c) Total number of p electrons   (d) Total number of d electrons

(e) Number of unpaired electrons in element

6. Calculate :

(a) the value of spin only magnetic moment of Co^{3+} ion (in BM).

(b) the number of radial nodes in a 3p-orbital.

(c) the number of electrons with (m = 0) in Mn^{2+} ion.

(d) the orbital angular momentum for the unpaired electron in V^{4+}.

7. An element undergoes a reaction as shown :

$X + e^- \rightarrow X^-$ Energy released = 30.876 eV

The energy released, is used to dissociate 8 g of H_2 molecules equally into H^+ and H*, where H* is in an excited state, in which the electron travels a path length equal to four times its debroglie wavelength.

(a) Determine the least amount (moles) of 'X' that would be required.

Given: I.E. of H = 13.6 eV/atom

Bond energy of H_2 = 4.526 eV/molecule.

(b) Why is the amount of X calculated in the above question 'least'?

8. A compound of Vanadium has a spin magentic moment 1.73 BM. Work out the electronic configuration of the Vanadium ion in the compound.

Answer Key

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1. (C) 2. (C) 3. (C) 4. (B)

5. (a) 21 (b) 8 (c) 12 (d) 1 (e) 1. 6. (a) $\sqrt{24}$ or 4.9 BM (b) 1 (c) 11 (d) $\frac{\sqrt{6}\,h}{2\pi}$

7. (a) a = 4 moles. 8. $_{23}V^{4+}$: $1s^2$, $2s^2\ 2p^6$, $3s^2\ 3p^6\ 3d^1$

Hints & Solutions

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1. Definition

2. $\lambda = \frac{12.3}{\sqrt{V}}$.

3. $_{16}S^{32}$ = $e^- = 16$

x^{+2} = $e^- = 16$

$(\because A = Z + N)$

4. (B) has same number of electrons i.e., 18.

$[NH_3 \rightarrow BH_3] = 10 + 8 = 18$.

5. E.C. $\rightarrow$ $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^1, 4s^2$

6. (a) Co^{3+} : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$ $\therefore$ 4 unpaired electrons $\therefore \mu = \sqrt{4(4+2)} = \sqrt{24}$ = 4.9 BM

(b) Number of radial nodes = $n - \ell - 1$

Number of radial nodes in 3p orbital = 3 – 1 – 1 = 1

(c) Number of electrons with (m = 0) in Mn^{2+} ($1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$) ion = 1s (2) + 2s (2) + 2p (2) + 3s (2) + 3p (2) + 3d (1) = 11

(d) Orbital angular momentum for the unpaired electron in V^{4+} lies in 3d orbital. $\therefore \ell = 2$

$$\therefore \text{Orbital angular momentum} = \sqrt{\ell(\ell+1)}\ \frac{h}{2\pi} = \frac{\sqrt{6}\,h}{2\pi}$$

7. (a) $x + e^- \rightarrow x^-$

energy released = $E.A_1$ = 30.87 eV/atom

Let no. of moles of X be a

$\therefore$ $a \times N_A \times 30.87 = 4 \times N_A \times 4.526 + 4 \times N_A \times 13.6 + 4 \times N_A \times 12.75$ $\Rightarrow$ a = 4 moles.

8. Number of unpiared electron are given by

$$\text{Magnetic moment} = \sqrt{[n(n+2)]} \text{ B.M.}$$

where n is number of unpaired electrons

or $1.73 = \sqrt{[n(n+2)]}$ or $1.73 \times 1.73 = n^2 + 2n$ $\therefore$ n = 1

Now Vanadium atom must have one unpaired electron and thus its configuration is

$${}_{23}V^{4+} : 1s^2 , 2s^2 2p^6, 3s^2 3p^6 3d^1$$