p- block and d & f-Block elements

1. Given below are two statements :
   Statement I :
   $\alpha \; and \; \beta$ forms of sulphur can change reversibly between themselves with slow heating or slow cooling.
   Statement II :
   At room temperature the stable crystalline form of sulphur is monoclinic sulphur.
   In the light of the above statements. choose the correct answer from the options given below:

   A. Both Statement I and Statement II are true.

   B. Both Statement I and Statement II are false.

   C. Statement I is true but Statement II is false.

   D. Statement I is false but Statement II is true.

   Sulphur mainly exists in two allotropic forms: Rhombic and Monoclinic. The stable form at room temperature is rhombic sulphur(yellow in color), which transformed to monoclinic sulphur on heating at $369 \; K$.
   $\alpha \; and \; \beta$ form of sulphur can change reversibly between themselves with slow heating or slow cooling.

2. The correct order of electron gain enthalpy is :

   A. $O > S > Se > Te$

   B. $Te > Se > S > O$

   C. $S > O > Se > Te$

   D. $S > Se > Te > O$

   Electron affinity values for group 16 elements:
   $O = 141 \; kJ/mol$
   $S = 200 \; kJ/mol$
   $Se = 195 \; kJ/mol$
   $Te = 190 \; kJ/mol$
   $Po = 174 \; kJ/mol$
   Correct order of electron gain enthalpy is
   $S > Se > Te > O$

3. Match List - I with List -II

$List - I$	$List - II$
Name of oxo acid	Oxidation state of 'P'
(a) Hypophosphorous acid	$(i)\ +5$
(b) Orthophosphoric acid	$(ii)\ +4$
(c) Hypophosphoric acid	$(iii)\ +3$
(d) Orthophosphorous acid	$(iv)\ +2$
	$(v)\ +1$

Choose the correct answer from the options given below :

A. (a) -(iv), (b)-(v), (c)-(ii), (d)-(iii)

B. (a) -(v), (b)-(iv), (c)-(ii), (d)-(iii)

C. (a) -(v), (b)-(i), (c)-(ii), (d)-(iii)

D. (a) -(iv), (b)-(v), (c)-(ii), (d)-(iii)

Hypophosphorous acid (H_3PO_2)	$+1$
Orthophosphorous acid (H_3PO_3)	$+3$
Hypophosphoric acid $(H_4P_2O_6)$	$+4$
Orthophosphoric acid (H_3PO_4)	$+5$

Hence the correct option is (c).

4. A group 15 element which is a metal and forms a hydride with strongest reducing power among group 15 hydrides. The element is

A. As

B. P

C. Bi

D. Sb

The stability of hydrides decreases from NH_3 to BiH_3 which can be observed from their bond dissociation enthalpy. Consequently. the reducing character of the hydrides increases. Ammonia is only a mild reducing agent while BiH_3 is the strongest reducing agent amongst all the hydrides

5. Which of the following compound CANNOT act as a lewis base ?

A. NF_3

B. PCl_5

C. ClF_3

D. SF_4

Lewis base should have at least one lone pair of electrons in the valence shell of the central atom which is available for donation. PCl_5 cannot act as a Lewis base as the central atom P does not have lone pair of electrons.

6. Which one of the following group-5 hydride is the strongest reducing agent?

A. AsH_3

B. PH_3

C. SbH_3

D. BiH_3

Down the group the bond dissociation enthalpy of $M-H$ bond (where, $M=$ group 15 element) decresaes.
Order of bond dissociation enthalpy:
$N-H > P-H > As-H > Sb-H > Bi-H$

Therefore, BiH_3 can loose hydrogen very easily and hence has the highest reducing power.
Order of reducing power:
$NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$

7. The product obtained from electrolytic oxidation of acidified sulphate solutions, is

A. HO_3SOOSO_3H

B. HO_2SOSO_2H

C. HSO_4^-

D. HO_3SOSO_3H

Anode :
$2H_2SO_4 \longrightarrow H_2S_2O_8 + 2H^+ + 2e^-$
$2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$

Cathode :
$e^- + H^+ \longrightarrow \frac{1}{2}H_2$

Main product of electrolysis of conc. H_2SO_4 is HO_3SOOSO_3H $(H_2S_2O_8)$

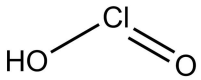
8. Number of $Cl = O$ bonds chlorous acid, chloric acid and perchloric acid respectively are

A. $1, 2$ and 3

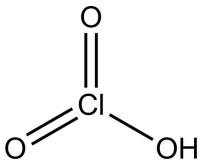
B. $4, 1$ and 0

C. $1, 1$ and 3

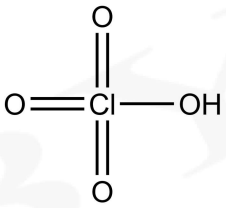
D. $3, 1$ and 1



chlorous acid



chloric acid

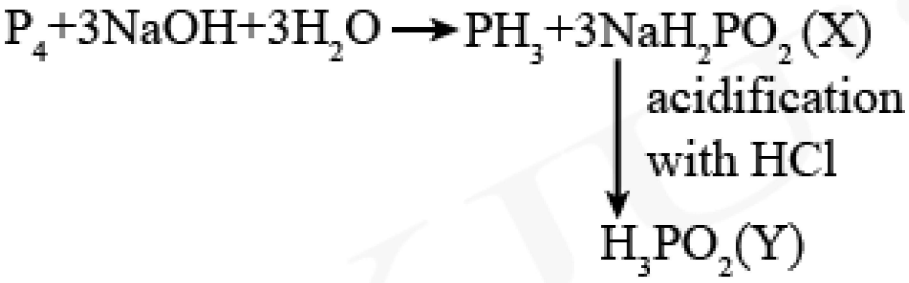


perchloric acid

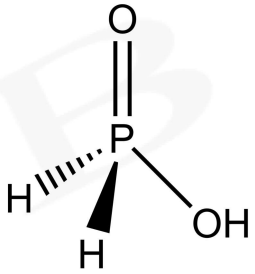
So option (a) is correct

9. White phosphorus on reaction with concentrated $NaOH$ solution in an inert atmosphere of CO_2 gives phosphine and compound (X). (X) on acidification with HCl gives compound (Y). The basicity of compound (Y) is

- A. 3
- B. 2
- C. 4
- D. 1



$$P_4 + 3NaOH + 3H_2O \rightarrow 3NaH_2PO_2\ (X) \xrightarrow{\text{Acidification with } HCl} H_3PO_2(Y)$$



Basicity of $H_3PO_2 = 1$ because only one ionisable hydrogen

10. Reaction of ammonia with excess Cl_2 gives

- A. NH_4Cl and HCl
- B. NCl_3 and HCl
- C. NCl_3 and NH_4Cl
- D. NH_4Cl and N_2

$$NH_3 + \underset{(\text{excess})}{3Cl_2} \longrightarrow \underset{(\text{explosive})}{NCl_3} + 3HCl$$

Option (b) is correct

11. Chemical nature of the nitrogen oxide compound obtained from a reaction of concentrated nitric acid and $P_4O_{10}(in\ 4:1\ ratio)$ is :

- ✔ **A.** acidic
- ✘ **B.** basic
- ✘ **C.** neutral
- ✘ **D.** amphoteric

$4HNO_3 + P_4O_{10} \rightarrow (HPO_3)_4 + 2N_2O_5$
N_2O_5 is acidic in nature

12. What is the correct order of the following elements with respect to their density ?

- ✘ **A.** $Cr < Zn < Co < Cu < Fe$
- ✘ **B.** $Cr < Fe < Co < Cu < Zn$
- ✘ **C.** $Zn < Cu < Co < Fe < Cr$
- ✔ **D.** $Zn < Cr < Fe < Co < Cu$

Elements	density in g/cm^3
Zn	7.1
Cr	7.19
Fe	7.8
Co	8.7
Cu	8.9

Option (d) is correct

13. Given below are two statements :

Statement - I : CeO_2 can be used for oxidation of aldehyde and ketones.

Statement - II : Aqueous solution of $EuSO_4$ is a strong reducing agent.

In the light of the above statements , choose the correct answer from the options given below :

A. Both Statement I and Statement II are false

B. Both Statement I and Statement II are true

C. Statement I is true but Statement II is false

D. Statement I is false but Statement II is true

Ce and Eu have stable oxidation state of +3.
The +3 oxidation state of lanthanide is most stable and therefore lanthanide in +4 oxidation state has strong tendence to gain electron and converted into +3 and therefore act as strong oxidizing agent. CeO_2 is used to oxidized alcohol aldehyde and ketones. Lanthanide in +2 oxidation state has strong tendency to loss electron and convert into +3 oxidation state therefore act as strong reducing agent.
So $Ce^{+4}O_2$ acts as oxidizing agent to get reduced to +3 and $Eu^{+2}O_4$ acts as reducing agent to get oxidized to +3 .

14. Fex_2 and Fey_3 are known when x and y are

A. $x = F, Cl, Br, I$ and $y = F, Cl, Br$

B. $x = Cl, Br, I$ and $y = F, Cl, Br, I$

C. $x = F, Cl, Br$ and $y = F, Cl, Br, I$

D. $x = F, Cl, Br, I$ and $y = F, Cl, Br, I$

FeI_3 does not exist as I^- reduces Fe^{3+} to Fe^{2+}.
$\underset{\text{Unstable}}{2FeI_3} \rightarrow \underset{\text{Stable}}{2FeI_2} + I_2$
Due to strong reducing nature of I^-
$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

FeF_2 , $FeCl_2$, $FeBr_2$, FeI_2 all exist

15. What is the spin-only magnetic moment value $(B.M)$ of a divalent metal ion with atomic number 25, in it's aqueous solution ?

A. 5.92

B. 5.26

C. Zero

D. 5.0

The element having atomic number 25 is manganese. The electronic configuration of Mn^{2+} is :
Mn^{2+} : $[Ar]\ 3d^5$

In aqueous solution it exists as $\left[Mn(H_2O)_6\right]^{2+}$. Since H_2O is a weak field ligand, it does not cause pairing of unpaired electrons .

So , its spin only magnetic moment is

$$\mu = \sqrt{n(n+2)} = \sqrt{5 \times 7} = 5.92\ B.M$$

16. Given below are two statements :
Statements I: Potassium permanganate on heating at 573 K forms potassium manganate.

Statement II : Both potassium permanganate and potassium manganate are tetrahedral and paramagnetic in nature.

In the light of the above statements, choose the most appropriate answer from the options given below :

A. Statement I is false but statement II is true

B. Both statement I and statement II are false

C. Both statement I and statement II are true

D. Statement I is true but statement II is false

$KMnO_4$ on heating dissociates as

$$\underset{\text{Permanganate}}{2\overset{+7}{K}MnO_4} \xrightarrow{\Delta} \underset{\text{Manganate}}{K_2\overset{+6}{M}nO_6} + MnO_2 + O_2$$

Both permanganate and manganate are trtrahdral but only manganate is paramagnetic.

$\overset{+7}{Mn} : 3d^0 4s^0$ Diamagnetic

$\overset{+6}{Mn} : 3d^1 4s^0$ Paramagnetic

$\therefore$ Statement I is true but statement II is false.

17. The correct order of following $3d$ metal oxides, according to their oxidation number is

$(a)\ CrO_3$
$(b)\ Fe_2O_3$
$(c)\ MnO_2$
$(d)\ V_2O_5$
$(e)\ Cu_2O$

A. (a) > (d) >(c)>(b)>(e)

B. (d) >(a)>(b)>(c)>(e)

C. (a)>(c)>(d)>(b)>(e)

D. (c)>(a)>(d)>(e)>(b)

Oxidation state of oxygen is -2.

Metal oxide	Oxidation number
CrO_3	$+6$
Fe_2O_3	$+3$
MnO_2	$+4$
V_2O_5	$+5$
Cu_2O	$+1$

$a > d > c > b > e$

Hence, option (a) is correct.

18. The spin only magnetic moments (in BM) for free Ti^{3+}, V^{2+} and Sc^{3+} ions respectively are

$(At.No-\ Sc:21,\ Ti:22,\ V:23)$

A. $1.73,\ 3.87,\ 0$

B. $0,\ 3,87,\ 1.73$

C. $3.87,\ 1.73,\ 0$

D. $1.73,\ 0,\ 3.87$

Magnetic moment, $\mu = \sqrt{n(n+2)}\ BM$
where, n is number of unpaired electrons.
The electronic configuration and magnetic moment of the given species are

$Ti^{3+}: 3d^1$ (1 unpaired electron) $\mu = 1.73\ BM$

$V^{2+}: 3d^3$ (3 unpaired electron) $\mu = 3.87\ BM$

$Sc^{3+}: 3d^0$ (no unpaired electron) $\mu = 0$

Hence, option (a) is correct.

19. Which one of the following lanthanides exhibits $+2$ oxidation state with diamagnetic nature ? (Given Z for $Nd = 60,\ Yb = 70,\ La = 57, Ce = 58$)

A. Nd

B. Yb

C. La

D. Ce

$Yb\ (70) = 4f^{14}\ 6s^2$

$Yb^{2+} = 4f^{14}\ 6s^0$

$\because$ All the electrons are paired hence Yb^{+2} is diamagnetic.

$La = 4f^0\ 5d^1\ 6s^2$
$La^{2+} = 5d^1$
La^{2+} is paramagnetic.

Ce and Nd does not form stable +2 oxidation state.

Hence, option (b) is correct.

20. Identify the element for which electronic configuration in $+3$ oxidation state is $[Ar]3d^5$:

A. Mn

B. Ru

C. Co

D. Fe

$Mn(25) = [Ar]3d^5 4s^2$

$Mn^{+3} = [Ar]3d^4 4s^0$

$Ru -$ belongs to 4d transition series

$Co(27) = [Ar]3d^7 4s^2$

$Co^{+3} = [Ar]3d^6 4s^0$

$Fe(26) = [Ar]3d^6 4s^2$

$Fe^{+3} = [Ar]3d^5 4s^0$

Hence, option (d) is correct.

21. Among the following allotropic forms of sulphur, the number of allotropic forms, which will show paramagnetism is _____

(A) $\alpha - sulphur$
(B) $\beta - sulphur$
(C) $S_2 - form$

Accepted Answers

1 1.0 1.00

Solution:

α-sulphur (Rhombic sulphur) and β-sulphur (Monoclinic sulphur) are the two allotropes of sulphur which are diamagnetic. But the S_2-form which exists at high temperature and has structure similar to O_2 is paramagnetic.
So, 1 is the correct answer

22. Among the following, the number of halide(s) which is/are inert to hydrolysis is/are

(A) BF_3
(B) $SiCl_4$
(C) PCI_5
(D) SF_6

Accepted Answers

1 1.0 1.00

Solution:

BF_3- shows Partial hydrolysis
$4BF_3 + 3H_2O \rightarrow H_3BO_3 + 3HBF_4$
$SiCl_4-$ Undergoes hydrolysis readily.
$SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$
PCl_5- Undergoes hydrolysis by addition-elimination mechanism.
$PCl_5 + H_2O \rightarrow POCl_3 + 2HCl$
SF_6- Inert towards hydrolysis.
So correct answer is 1

23. The reaction of white phosphorus on boiling with alkali in inert atmosphere resulted in the formation of product $'A'$. The reaction of $1\ mol\ of\ 'A'$ with excess of $AgNO_3$ in aqueous medium gives _____ mol(s) of Ag

(Round off the Nearest integer).

Accepted Answers

6

Solution:

$P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$

$PH_3 + 6AgNO_3 \rightarrow [Ag_3P.3AgNO_3] + 3HNO_3$

$Ag_3P.3AgNO_3 + 3H_2O \rightarrow 6Ag + 3HNO_3 + H_3PO_3$

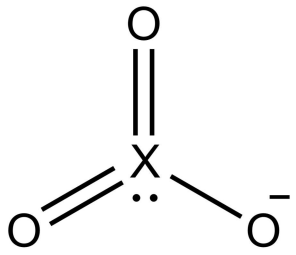
So, 1 mol of $PH_3(A)$ On reaction with excess of aq. $AgNO_3$ gives 6 moles of Ag.

24. The number of halogen(s) forming halic (V) acid is/are

Accepted Answers

3 3.0 3.00

Solution:



XO_3^- can be formed by all the halides that have vacant d orbitals. Here X is halogen
Except F all other halogens (which are not radioactive) have vacant d orbitals.
So answer is 3 i.e. Cl, Br, I

25. The spin only magnetic moment of a divalent ion in aqueous solution (atomic number 29) is (nearest integer)

Accepted Answers

2 2.0 2.00

Solution:

The element having atomic no. 29 is copper
The electronic configuration of Cu^{2+} is
Cu^{2+} : $[Ar]\ 3d^9$

It has 1 unpaired electron

$$\mu = \sqrt{(n(n+2)} = \sqrt{3} = 1.73\ BM = 2(nearestinteger)$$

26. In mildly alkaline medium, thiosulphate ion is oxidized by MnO_4^- to "A" . The oxidation state of sulphur in "A" is

Accepted Answers

6 6.0 6.00

Solution:

In neutral or faintly alkaline medium

$$8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow 8MnO_2 + \underset{A()}{6SO_4^{2-}} + 2OH^-$$

A is SO_4^{2-} .
The oxidation state of sulphur in A is :
$x - 8 = -2$
$x = +6$

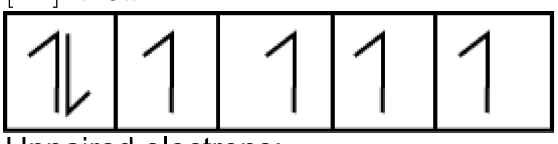
27. In the ground state of atomic $Fe(Z = 26)$, the spin-only magnetic moment is $x \times 10^{-1} BM$.
(Round off to the Nearest Integer).

Accepted Answers

49 49.0 49.00

Solution:

$Fe(Z = 26)$
Electrons configuration :
$[Ar]4s^2 3d^6$



Unpaired electrons:
$n = 4$

$\therefore \mu = \sqrt{4(4+2)} = \sqrt{24} BM$

$\mu = 4.89$

$\mu = 49 \times 10^{-1} B.M$
$x = 49$

28. Number of electrons present in 4f-orbital of Ho^{3+} ion is _____. (Given: Atomic no. of $Ho = 67$)

Accepted Answers

10 10.0 10.00

Solution:

Electronic configurations of $Ho \; and \; Ho^{3+}$ are

$Ho : 4f^{11}\ 6s^2$

$Ho^{3+} : 4f^{10}$

$\therefore$ Number of electrons present in $4f$ orbital of $Ho^{3+} \; is \; 10$.

29. The number of 4f electrons in the ground state electronic configuration of Gd^{2+} is _____.
[Atomic number of Gd $= 64$]

Accepted Answers

7 7.0 7.00

Solution:

Atomic number of Gd is 64

Electronic configuration of Gd is $[Xe]4f^7 5d^1 6s^2$

$Gd^{2+} = [Xe]4f^7 5d^1$

30. The number of 'f' electrons in the ground state electronic configuration of $Np\ (Z = 93)$ is _____.

Accepted Answers

4 4.0 4.00

Solution:

The electronic configuration of neptunium in ground state is $[Rn]\ 5f^4\ 6d^1\ 7s^2$

$\therefore$ It has 4 electrons in the f subshell of the anti penultimate shell.