

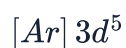
Chapter 8: The D-block and F-block Elements

NCERT Exemplar · Class 12 · Chemistry

Exercise

Question 1

Electronic configuration of a transition element X in +3 oxidation state is



. What is its atomic number?

(A) 25

(B) 26

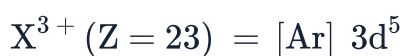
(D) 27

(D) 24

Solution

Ans: (B) 26

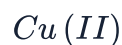
Positive oxidation states indicate the loss of electrons from the atom. If X is in +3 oxidation state, then three electrons have been removed from it. Find the atomic number of the parent atom, we will add three in the given electronic number. i.e.



$$X = 23 + 3 = 26$$

Question 2

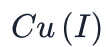
The electronic configuration of



is



whereas that of

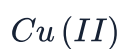


is



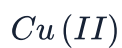
. Which of the following is correct?

(a)



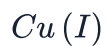
is more stable .

(b)

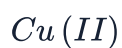


is less stable

(c)

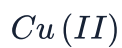


and

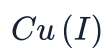


are equally stable

(d) Stability of



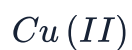
and



depends on the nature of copper salts.

Solution

Ans: (A)

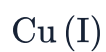


is more stable .

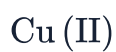
Electronic configuration of



is



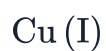
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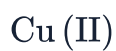
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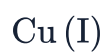
Despite the fact that



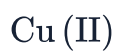
has fully filled 3d-orbital but



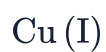
is more stable than



due to the greater effective nuclear charge of



as nucleus has to hold 17 electrons rather than 18 electrons like in



.

Question 3

Metallic radii of some transition elements are given below. Which of these elements will have the highest density?

Element	Fe	Co	Ni	Cu
Metallic radii/pm	126	125	125	128

(A) Fe

(B) Ni

(C) Co

(D) Cu

Solution

Ans: (D) Cu

Density is mass by volume. As we move from left to right for a long period, the atomic radii decrease. Hence, volume decreases. Also, an increase in atomic masses is observed.

So overall the density increases out of the above option from iron to copper, copper will have the highest density.

Question 4

Generally, transition elements form coloured salts due to the presence of unpaired electrons. Which of the following compounds will be coloured in solid-state?

(A) Ag_2SO_4

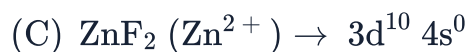
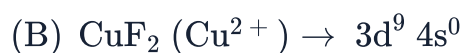
(B) CuF_2

(C) ZnF_2

(D) Cu_2Cl_2

Solution

Ans: (B) CuF_2



Unpaired electrons present in any compound impart colour to the salt of transition metal. Only



has unpaired electrons in its



orbital that's why it is white coloured in its solid-state while rest of the salts are colourless.

Question 5

In addition to a small amount of



to concentrate



, a green oily compound is obtained which is highly explosive in nature. Identify the compound from the following:



Solution

Ans: (A) Mn_2O_7



Manganese heptoxide is an acid anhydride of permanganic acid



. It is a dangerous oxidiser, volatile and highly reactive liquid.

Question 6

The magnetic nature of elements depends on the presence of unpaired electrons. Identify the configuration of the transition element, which shows the highest magnetic moment.

(A) $3d^7$

(B) $3d^5$

(C) $3d^8$

(D) $3d^2$

Solution

Ans: (B) $3d^5$

Magnetic moment of an electron/dipole moment is caused by its intrinsic properties of spin and electric charge. It depends upon the number of unpaired electrons in its valence shell. The more the number of unpaired electrons, the greater will be the value of magnetic moment.

$3d^7 = 3$ unpaired electrons

$3d^5 = 5$ unpaired electrons

$3d^8 = 2$ unpaired electrons

$3d^2 = 2$ unpaired electrons

Out of all,



has five unpaired electrons that is maximum and hence it has the highest magnetic moment.

Question 7

Which of the following oxidation states is common for all lanthanides?

- (A) +2
- (B) +3
- (C) +4
- (D) +5

Solution

Ans: (B) +3

Out of all +3 is the most common oxidation state for all the lanthanide elements.

Question 8

Which of the following reactions are disproportionation reactions?

- i. $Cu^+ \rightarrow Cu^{2+} + Cu$
- ii. $3MnO_4^{4-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$
- iii. $2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$
- iv. $2MnO_4^- + 3Mn^{2+} + 2H_2O \rightarrow 5MnO_2 + 4H^+$

- (A) i, ii
- (B) i, ii, iii
- (C) ii, iii, iv
- (D) i, iv

Solution

Ans: (A) i, ii

Disproportionation/redox reaction is a reaction in which one compound is oxidised as well as reduced at the same time.

- (A) $Cu^+ \rightarrow Cu^{2+} + Cu$

(+ 1) (+ 2) (0)



(+ 6) (+ 7) (+ 4)

Question 9

When



solution is added to oxalic acid solution, the decolourisation is slow in the beginning but becomes instantaneous after some time because

(A)



is formed as the product

(B) Reaction is exothermic

(C)



catalyses the reaction

(D)



acts as auto catalyst

Solution

Ans: (D)



acts as auto catalyst



formed in the reaction acts as an autocatalyst. Auto catalyst is a compound that is one of the products that are formed in the reaction itself catalyses the reaction.

Reaction:



Question 10

There are 14 elements in the actinide series. Which of the following elements does-not belong to this series?

- (A) U
- (B) Np
- (C) Tm
- (D) Fm

Solution

Ans: (C) Tm

In the periodic table, actinides lie from atomic number 90 to 103.

Thulium is not an actinide; it is a lanthanide.

Question 11



acts as an oxidizing agent in acidic medium. The number of moles of



that will be needed to react with one mole of sulphide ions in acidic solution is

(A)

$$\frac{2}{5}$$

(B)

$$\frac{3}{5}$$

(C)

$$\frac{4}{5}$$

(D)

$$\frac{1}{5}$$

Solution

Ans: (A)

$$\frac{2}{5}$$



From the reaction,

For 5 moles of

S

, two moles of



were required.

Therefore, for one mole of

S

, the number of moles of



required will be =

$$\frac{2}{5}$$

.

Question 12

Which of the following is amphoteric oxide?



(A) V_2O_5, Cr_2O_3

(B) Mn_2O_7, CrO_3

(C) CrO, V_2O_5

(D) V_2O_5, V_2O_4

Solution

Ans: (A) V_2O_5, Cr_2O_3

Oxides in the lower oxidation state are basic and in the higher oxidation state they are acidic. They are amphoteric in the intermediate oxidation state. Therefore,



are amphoteric in nature.

Question 13

Gadolinium belongs to the 4f series. Its atomic number is 64. Which of the following is the correct electronic configuration of gadolinium?

(A) $[Xe] 4f^7 5d^1 6s^2$

(B) $[Xe] 4f^6 5d^2 6s^2$

(C) $[Xe] 4f^8 6d^2$

(D) $[Xe] 4f^9 5s^1$

Solution

Ans: (A) $[Xe] 4f^7 5d^1 6s^2$

Gadolinium belongs to the 4f series; it has atomic no.= 64. It has extra stability due to a half-filled 4f subshell.



Question 14

Interstitial compounds are formed when small atoms are trapped inside the crystal lattice of metals. Which of the following is not the characteristic property of interstitial compounds?

- (A) They have high melting points in comparison to pure metals
- (B) They are very hard
- (C) They retain metallic conductivity
- (D) They are chemically very reactive.

Solution

Ans: (D) They are chemically very reactive.

Interstitial compounds/alloys are substances that are formed when a small atom like carbon, hydrogen, boron, nitrogen can occupy space in their lattices. All the properties mentioned above are true for interstitial compounds except (D), they are chemically inert.

Question 15

The magnetic moment is associated with its spin angular momentum and orbital angular momentum. Spin only magnetic moment value of

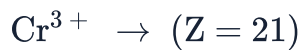


ion is

- (A) 2.87 B.M.
- (B) 3.87 B.M.
- (C) 3.47 B.M.
- (D) 3.57 B.M.

Solution

Ans: (B) 3.87 B.M.



$n = 3$ (3 unpaired electrons)

$$\mu = \sqrt{n(n + 2)}$$

$$\mu = \sqrt{3(3 + 2)}$$

$$\mu = \sqrt{3(5)}$$

$$\mu = \sqrt{15} = 3.87 \text{ B.M.}$$

Question 16

acts as an oxidizing agent in alkaline medium. When alkaline



is treated with



, iodide ion is oxidized to

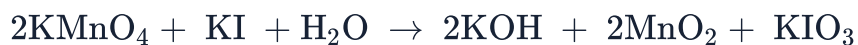


Solution

Ans: (C)



Iodide is oxidised to iodate.



iodide

iodate

Question 17

Which of the following statements is not correct?

(A) Copper liberates hydrogen from acids

(B) In its higher oxidation states, manganese forms stable compounds with oxygen and fluorine

(C)



and



are oxidizing agents in aqueous solution

(D)



and



are reducing agents in aqueous solution

Solution

Ans: (A) is incorrect.

Copper lies below hydrogen in electrochemical series and hence cannot liberate hydrogen from acids.



Question 18

When acidified



solution is added to



salts,



changes to

(A) Sn

(B) Sn^{3+}

(C) Sn^{4+}

(D) Sn^{+}

Solution

Ans: (C) Sn^{4+}



In the above redox reaction, oxidation of



is taking place. It gets converted to



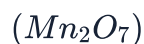
whereas, reduction of chromium is occurring from +6 oxidation state to +3.

Question 19

Highest oxidation state of manganese in fluoride is +4



but highest oxidation state in oxides is +7



because

(A) fluorine is more electronegative than oxygen

(B) fluorine does not possess d-orbitals

(C) fluorine stabilizes lower oxidation state

(D) in covalent compounds fluorine can form single bond only while oxygen forms double bond

Solution

Ans: (D) in covalent compounds fluorine can form single bond only while oxygen forms double bond

Oxygen has the capacity to form multiple bonds which enables it to form a variety of covalent compounds.

In



also, 6 oxygen are doubly bonded to two manganese atoms and one oxygen is forming bridge between two.

While in



, four fluorine atoms are singly bonded to manganese atom giving it a +4 oxidation state.

Therefore, due to capability of oxygen to have multiple bonds in covalent compounds, manganese is having higher oxidation state of +7 in



.

Question 20

Although zirconium belongs to 4d transition series and hafnium to 5d

transition series even then they show similar physical and chemical properties because

- (A) both belong to d-block
- (B) both have same number of electrons
- (C) both have similar atomic radius
- (D) both belong to the same group of the periodic table

Solution

Ans: (C) both have similar atomic radius

As an effect of lanthanide contraction, zirconium and hafnium have similar radii of 160pm and 159 pm respectively. Due to this similarity in their size, they show similar physical and chemical properties.

Lanthanide contraction: Because the elements in Row 3 have 4f electrons. These electrons do not shield well, causing a greater nuclear charge. This greater nuclear charge has a greater pull on the electrons and results in the decrease in their size and atomic radii.

Question 21

Why is



not used to make the medium acidic in oxidation reactions of



in acidic medium?

- (A) Both



and



act as oxidizing agents.

(B)



oxidises



into



which is also an oxidizing agent.

(C)



is a weaker oxidizing agent than



.

(D)



acts as a reducing agent in the presence of



.

Solution

Ans: (B)



oxidises



into



which is also an oxidizing agent.



is not used in titrations involving



as it produces unsatisfactory results. When



is added to



, it itself acts as reducing agent and converts



to



.

Multiple Choice Questions (Type-II)

Question 22

Generally, transition elements and their salts are coloured due to the presence of unpaired electrons in metal ions. Which of the following compounds are coloured?

(A) KMnO_4

(B) $\text{Ce}(\text{SO}_4)_2$

(C) TiCl_4

(D) Cu_2Cl_2

Solution

Ans: (A) & (B)

Due to charge transfer phenomenon, which can be understood, for an instant, an electron is transferred from oxygen to the central metal atom, where oxidation state of metal is reduced by one and oxygen gets converted from



to



This transfer imparts Colour to the compound.

Question 23

Transition elements show magnetic moments due to spin and orbital motion of electrons. Which of the following metallic ions have almost the same spin only magnetic moment?



Solution

Ans: (A) & (D)

The magnetic moment of an electron/dipole moment is caused by its intrinsic properties of spin and electric charge. It depends upon the number of unpaired electrons in its valence shell. The more the number of unpaired electrons, the greater will be the value of the magnetic moment.



and



have same unpaired electrons i.e. 3 unpaired electrons. Hence they have the same spin only magnetic moment.

Question 24

In the form of dichromate, Cr(VI) is a strong oxidizing agent in acidic medium

but



(VI) in



and



(VI) in



are not because

(A)



(VI) is more stable than



(VI) and



(VI)

(B)



(VI) and



(VI) are more stable than



(VI)

(C) higher oxidation states of heavier members of group-6 of transition series are more stable

(D) lower oxidation states of heavier members of group-6 of transition series are more stable.

Solution

Ans: (B) and (C)

For the heavier metals of d-block, higher oxidation state is more favourably stable than the lower oxidation state. For example:

Mo

(VI) and

W

(VI) are more stable than

Cr

(VI). For lighter d-block elements like chromium, +3 oxidation state is more stable. So,

Cr

(VI) in dichromate act as a strong oxidising agent by reducing itself from +6 to +3 oxidation states While

Mo

(VI) and

W

(VI) does not.

Question 25

Which of the following actinoids show oxidation states up to +7?

(A) *Am*

(B) *Pu*

(C) *U*

(D) *Np*

Solution

Ans: (B) & (D)

Actinides show a variety of oxidation states like +3, +5, +6 and +7.

From the given option, plutonium and neptunium show all oxidation states up to +7.

Question 26

General electronic configuration of actinides is

$$(n-2)f^{1-14}(n-1)d^{0-2}ns^2$$

. Which of the following actinoids have one electron in 6d orbital?

- (A) U (Atomic no. 92)
- (B) Np (Atomic no. 93)
- (C) Pu (Atomic no. 94)
- (D) Am (Atomic no. 95)

Solution

Ans: (A) and (B)

Electronic configuration:

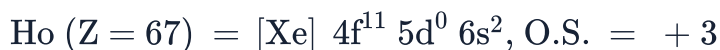
**Question 27**

Which of the following lanthanoids show +2 oxidation state besides the characteristic oxidation state +3 of lanthanides?

- (A) *Ce*
- (B) *Eu*
- (C) *Yb*
- (D) *Ho*

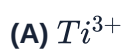
Solution

Ans: (B) and (C)



Question 28

Which of the following ions show higher spin only magnetic moment value?



Solution

Ans: (B) and (C)

Magnetic moment of an electron/dipole moment is caused by its intrinsic properties of spin and electric charge. It depends upon the number of unpaired electrons in its valence shell. The more the number of unpaired electrons, the greater will be the value of magnetic moment.

Electronic configuration:



Out of all given options,



and



have unpaired electrons in number of five and four respectively. Hence, have higher spin only magnetic moment.

Question 29

Transition elements form binary compounds with halogens. Which of the following elements will form



type compounds?

- (A) Cr
- (B) Co
- (C) Cu
- (D) Ni

Solution

Ans: (A) and (B)

Cr

and

Co

form tri halide compounds.

Question 30

Which of the following will not act as oxidizing agents?

- (A) CrO_3
- (B) MoO_3
- (C) WO_3
- (D) CrO_4^{2-}

Solution

Ans: (B) and (C)

A compound act as oxidising agent when it's central atom is reduced to its lower oxidation state. This occurs only when the lower oxidation state of metal is more stable than the higher oxidation states.

In metal



and



, both



and



are stable in their higher oxidation state and won't get reduced to their lower oxidation state. Therefore, will not act as oxidising agents.

Question 31

Although +3 is the characteristic oxidation state for lanthanide but cerium

also shows +4 oxidation state because

(A) it has variable ionization enthalpy

(B) it has a tendency to attain noble gas configuration

(C) it has a tendency to attain



configuration

(D) it resembles



Solution

Ans: (B) and (C)

Electronic configuration of cerium:



Lead has the tendency to lose its four outer electrons to attain Noble gas configuration and this removal of electrons corresponds to the



configuration and cause it to be stable in +4 oxidation state.

Short Answer Questions

Question 32

Why does copper not replace hydrogen from acids?

Solution

Ans: Copper lies below hydrogen in electrochemical series which means it has positive standard reduction potential i.e.

$$+ 0.34 \text{ V}$$

. and hence cannot liberate hydrogen from acids.

Question 33

Why



value for



,

 Ni

and

 Zn

are more negative than expected?

Solution

Ans:

 Mn has half-filled $3d^5$ electrons and Zn

has fully-filled $3d^{10}$ electrons which give them extra stability and they both resist to lose electrons and get reduced.

The

 E°

value also depends on the hydration enthalpy. More negative is the enthalpy of hydration, high is the

 E°

value. This is the reason behind $[\text{Ni}^{2+}]$ having higher

 E°

value than expected.

Question 34

Why is the first ionization enthalpy of

 Cr

lower than that of

 Zn

?

Solution

Ans: Cr(24)= [Ar]3d⁵4s²

Zn (30) = [Ar] 3d¹⁰4s²

The stability of orbitals according to the electrons filled is in order:

Fully filled > half-filled > partially filled

As

3d¹⁰

is completely filled orbital of

Zn

is more stable than the

3d⁵

half-filled orbital of

Cr

. It is comparatively easy to remove electron from

3d⁵

than from

3d¹⁰

.

Therefore, the first ionization enthalpy of

Cr

is lower than that of

Zn

.

Question 35

Transition elements show high melting points. Why?

Solution

Ans: Transition elements have the ability to involve their d-electrons along with their s-electrons in the process of bond formation. This results in formation of strong metal-metal bonds which makes their melting point high.

Question 36

When



ion is treated with



, a white precipitate is formed. Explain the reaction with the help of a chemical equation.

Solution

When



reacts with potassium iodide white precipitate of



is formed.

Question 37

Out of



and



, which is more stable and why?

Solution

Ans: Higher enthalpy of hydration provides extra stability to



oxidation state than +1 oxidation state.

Enthalpy of hydration is described as the amount of energy released on dilution of one mole of gaseous ions.

Question 38

When a brown compound of manganese (A) is treated with



, it gives a gas

(B) The gas taken in excess, reacts with



to give an explosive compound

(C). Identify compounds A, B and C.

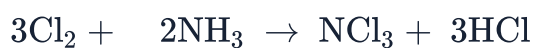
Solution

Ans: The reactions are explained as:



(A)

(B)



(excess)

(C)

Question 39

Although fluorine is more electronegative than oxygen, the ability of oxygen to stabilize higher oxidation states exceeds that of fluorine. Why?

Solution

Ans: Fluorine - $1s^2 2s^2 2p^5$

Oxygen - $1s^2 2s^2 2p^6 3s^2 3p^6$

As we can infer from the electronic configuration, fluorine only has one unpaired electron in its 2p-orbital which can be involved in formation of only one bond and fluorine lacks d-orbital.

While oxygen has d-orbitals in its configuration which allow the oxygen to form multiple bonds. Therefore, oxygen has greater stability to stabilise its oxidation states than fluorine.

Question 40

Although



and



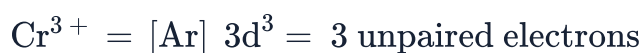
ions have same number of unpaired electrons but the magnetic moment of Cr^{3+} is 3.87 BM and that of

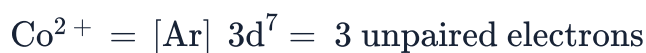


is 4.87 BM. Why?

Solution

Ans: Magnetic moment of an electron/dipole moment is caused by its intrinsic properties of spin and electric charge. It depends upon the number of unpaired electrons in its valence shell. The more the number of unpaired electrons, the greater will be the value of magnetic moment.





But as both the ions have the same no. of unpaired electrons, there's one other factor called orbital contribution which also influences the magnetic moment. As, the three unpaired electronic configuration is symmetrical in



this contributes zero orbital contribution but this is quite appreciable in case of



and hence it has larger value of Magnetic moment than



Question 41

Ionisation enthalpies of Ce, Pr and Nd are higher than Th, Pa and U. Why?

Solution

Ans:

Ce, Pr and Nd

belong to the lanthanide series whereas

Th, Pa and U

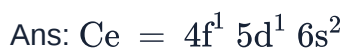
belong to the actinides family.

When electrons start accommodating the 4f and 5f orbitals, the 5f electrons penetrate less into the inner core. They are more effectively shielded nuclei in comparison to 4f-electrons in lanthanides. This leads to the fact that 5f-electrons experience reduced nuclear force of attraction and hence they have Lower ionisation enthalpies than lanthanoids.

Question 42**Although****belongs to 4d and****belongs to the 5d transition series but it is quite difficult to separate them. Why?****Solution**

Ans: As an effect of lanthanoid contraction, zirconium and hafnium have similar radius of 160pm and 159 pm respectively. Due to this similarity in their size, they show similar physical and chemical properties.

Lanthanoid contraction: Because the elements in Row 3 have 4f electrons. These electrons do not shield good, causing a greater nuclear charge. This greater nuclear charge has a greater pull on the electrons and result in the decrease in their size and atomic radii.

Question 43**Although +3 oxidation state is the characteristic oxidation state of lanthanoids but cerium shows +4 oxidation state also. Why?****Solution**

As in



,

4f has only single electron. Cerium holds the capacity to lose this electron also and attain



configuration which is more stable.



Hence it shows 4+ oxidation states.

Question 44

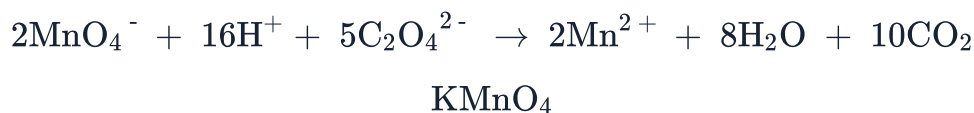
Explain why does colour of



disappear when oxalic acid is added to its solution in acidic medium?

Solution

Ans:



oxidises the oxalic acid to CO₂ and reduces itself to



state.



is colourless that's why it seems that



has been disappeared.

Question 45

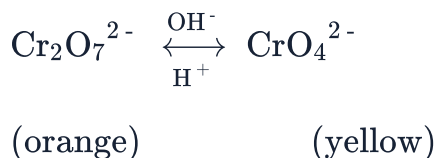
When orange solution containing



ion is treated with an alkali, a yellow solution is formed and when H⁺ ions are added to yellow solution, an orange solution is obtained. Explain why this happens?

Solution

Ans: This is due to the inter conversion of dichromate (orange) to chromate ion (yellow).



Question 46

A solution of



on reduction yields either a colourless solution or a brown precipitate or a green solution depending on pH of the solution. What different stages of the reduction do these represent and how are they carried out?

Solution

Ans:



act as an oxidising agent however it's activity as oxidising agent is influenced by the pH of the solution i.e. acidic, basic or neutral solution.



(Orange) (yellow)



(yellow) (orange)

Question 47

The second and third rows of transition elements resemble each other much more than they resemble the first row. Explain why?

Solution

Ans: As an effect of lanthanide contraction, the second and third rows of transition elements resemble each other. For example, zirconium and hafnium have similar radius i.e. 160pm and 159pm respectively. Due to this similarity in their size, they show similar physical and chemical properties.

Lanthanoid contraction: Because the elements in Row 3 have 4f electrons. These electrons do not shield good, causing a greater nuclear charge. This greater nuclear charge has a greater pull on the electrons and result in the decrease in their size and atomic radii.

Question 48

of E
is Cu
while that of $+0.34V$
is Zn
 $-0.76V$
. Explain.

Solution

Ans: The sum of sublimation energy and ionisation enthalpy to oxidise



is so highly that it is not compensated by the hydration enthalpy of



. Due to this, the



of



is positive.

While in case if



, the



value is negative or more negative than the expected value because when the electrons are removed from the 4s-orbital.



acquires a stable



configuration state.

Question 49

The halides of transition elements become more covalent with increasing oxidation state of the metal. Why?

Solution

Ans: As the positive charge of the ion increases or we can say that oxidation state of a transition element increases, its size decreases and as per Fajan's rule, more the charge on the metal ion, more is its tendency to form covalent compounds because positively charged cation attracts the electron cloud strongly towards itself.

Question 50

While filling up of electrons in the atomic orbitals, the 4s-orbital is filled before the 3d-orbital but reverse happens during the ionization of the atom. Explain why?

Solution

Ans: As per

$$(n + l)$$

rule, 4s has lower energy than 3d-orbital.

$$3d - n + l = 3 + 2 = 5$$

$$4s - n + l = 4 + 0 = 4$$

So, 4s are filled first.

After filling of electrons, 4s-orbital moves beyond 3d-orbital and 4s electrons are loosely held by the nucleus. Hence, electrons are removed first during the process of ionisation.

Question 51

Reactivity of transition elements decreases almost regularly from

Sc to Cu

. Explain.

Solution

Ans: Ionisation enthalpies are the main factor that influence the reactivity of transition elements. Higher the ionisation enthalpy, lesser is the reactivity of the transition element.

When we move along the period from

Sc to Cu

, a regular increase in the ionisation enthalpy is observed which results in the almost regular decrease in the reactivity of elements.

MATCHING TYPE:

Question 52

Match the catalysts given in Column I with the processes given in Column II.

Column I	Column II
(i) Ni in the presence of hydrogen	(a) Ziegler Natta catalyst
(ii) Cu_2Cl_2	(b) Contact process
(iii) V_2O_5	(c) Vegetable oil to ghee
(iv) Finely divided iron	(d) Sandmeyer reaction
(v) $TiCl_4 + Al(CH_3)_3$	(e) Haber's Process
	(f) Decomposition of $KClO_3$

Solution

Ans:

Column I	Column II
(i) Ni in the presence of hydrogen	(c) Vegetable oil to ghee
(ii) Cu_2Cl_2	(d) Sandmeyer reaction
(iii) V_2O_5	(b) Contact process
(iv) Finely divided iron	(e) Haber's Process

(v) $\text{TiCl}_4 + \text{Al}(\text{CH}_3)_3$	(a) Ziegler Natta catalyst
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Question 53

Match the compounds/elements given in Column I with uses given in Column II.

Column I (Compound/element)	Column II (Use)
(i) Lanthanoid oxide	(a) Production of iron alloy
(ii) Lanthanoid	(b) Television screen
(iii) Misch metal	(c) Petroleum cracking
(iv) Magnesium based alloy is constituent of	(d) Lanthanoid metal + iron
(v) Mixed oxides of lanthanides are employed	(e) Bullets
	(f) In X-ray screen

Solution

Ans:

Column I (Compound/element)	Column II (Use)
(i) Lanthanide oxide	(b) Television screen
(ii) Lanthanoid	(a) Production of iron alloy
(iii) Misch metal	(d) Lanthanoid metal + iron
(iv) Magnesium based alloy is constituent of	(e) Bullets

(v) Mixed oxides of lanthanoids are employed	(c) Petroleum cracking
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Question 54

Match the properties given in Column I with the metals given in Column II.

Column I (Property)	Column II (Metal)
(i) An element which can show +8 oxidation state	(a) Mn
(ii) 3d block element that can show upto +7 oxidation state	(b) Cr
(iii) 3d block element with highest melting point	(c) Os
	(d) Fe

Solution

Ans:

Column I (Property)	Column II (Metal)
(i) An element which can show +8 oxidation state	(c) Os
(ii) 3d block element that can show upto +7 oxidation state	(a) Mn
(iii) 3d block element with highest melting point	(b) Cr

Question 55

Match the statements given in Column I with the oxidation states given in Column II.

Column I	Column II
----------	-----------

(i) Oxidation state of Mn in MnO_2 is	(a) + 2
(ii) Most stable oxidation state of Mn is	(b) + 3
(iii) Most stable oxidation state of Mn in oxides is	(c) + 4
(iv) Characteristic oxidation state of lanthanoids is	(d) + 5
	(e) + 7

Solution

Ans:

Column I	Column II
(i) Oxidation state of Mn in MnO_2 is	(c) + 4
(ii) Most stable oxidation state of Mn is	(a) + 2
(iii) Most stable oxidation state of Mn in oxides is	(e) + 7
(iv) Characteristic oxidation state of lanthanoids is	(b) + 3

Question 56

Match the solutions given in Column I and the colours given in Column II.

Column I (Aqueous solution of salt)	Column II (Colour)
-------------------------------------	--------------------

(i) $FeSO_4 \cdot 7H_2O$	(a) Green
(ii) $NiCl_2 \cdot 4H_2O$	(b) Light pink
(iii) $MnCl_2 \cdot 4H_2O$	(c) Blue
(iv) $CoCl_2 \cdot 6H_2O$	(d) Pale green
(v) Cu_2Cl_2	(e) Pink
	(f) Colourless

Solution

Ans:

Column I (Aqueous solution of salt)	Column II (Colour)
(i) $FeSO_4 \cdot 7H_2O$	(d) Pale green
(ii) $NiCl_2 \cdot 4H_2O$	(a) Green
(iii) $MnCl_2 \cdot 4H_2O$	(b) Light pink

(iv) $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$	(e) Pink
(v) Cu_2Cl_2	(f) Colourless

Question 57

Match the property given in Column I with the element given in Column II.

Column I (Property)	Column II (Elements)
(i) Lanthanoid which shows +4 oxidation state	(a) Pm
(ii) Lanthanoid which can show +2 oxidation state	(b) Ce
(iii) Radioactive lanthanoid	(c) Lu
(iv) Lanthanoid which has $4f^7$ electronic configuration in +3 oxidation state	(d) Eu
(v) Lanthanoid which has $4f^{14}$ electronic configuration in +3 oxidation state	(e) Gd
	(f) Dy

Solution

Ans:

Column I (Property)	Column II (Elements)
(i) Lanthanoid which shows +4 oxidation state	(b) Ce
(ii) Lanthanoid which can show +2 oxidation state	(d) Eu
(iii) Radioactive lanthanoid	(a) Pm
(iv) Lanthanoid which has $4f^7$ electronic configuration in +3 oxidation state	(e) Gd
(v) Lanthanoid which has $4f^{14}$ electronic configuration in +3 oxidation state	(c) Lu

Question 58

Match the properties given in Column I with the metals given in Column II.

Column I (Property)	Column II (Metal)
(i) Element with highest second ionisation enthalpy	(a) Co
(ii) Element with highest third ionisation Enthalpy	(b) Cr
(iii) M in $M(CO)_6$ is	(c) Cu
(iv) Element with highest heat of atomisation	(d) Zn

	(e) Ni
--	--------

Solution

Ans:

Column I (Property)	Column II (Metal)
(i) Element with highest second ionisation enthalpy	(c) Cu
(ii) Element with highest third ionisation Enthalpy	(d) Zn
(iii) M in $M(CO)_6$ is	(b) Cr
(iv) Element with highest heat of atomisation	(e) Ni

ASSERTION AND REASON TYPE:

Question 59

Assertion (A):



iodide is not known.

Reason (R):



oxidises I to iodine.

Solution

Ans: All halogens combine with copper to form copper halides except iodine. The reason behind this is that



oxidises iodide (-1) to iodine (0). Therefore,



iodide does not exist. Both the statements assertion and reason are correct and reason is the correct explanation of assertion.

Question 60

Assertion (A): Separation of



and



is difficult.

Reason (R): Because



and



lie in the same group of the periodic table.

Solution

Ans: Although



and



lie in same group but As an effect of lanthanide contraction, zirconium and hafnium have similar radius of 160pm and 159 pm respectively. Due to this similarity in their size, they show similar physical and chemical properties. As a result,



and

Hf

are difficult to separate. Both the statements assertion and reason are correct but reason is not the correct explanation of assertion.

Question 61

Assertion (A): Actinoids form relatively less stable complexes as compared to lanthanoids.

Reason (R): Actinoids can utilize their 5d orbitals along with 6d orbitals in bonding but lanthanoids do not use their 4f orbital for bonding.

Solution

Ans: Actinoids are more reactive than lanthanoids as they involve their 5d-orbital in the bond formation process while due to effectively shielded and greater nuclear charge 4f-orbitals are not available for bonding. Thus, lanthanoids comparatively form less complexes than actinoids.

Assertion is not true but reason is true.

Question 62

Assertion (A):

Cu

cannot liberate hydrogen from acids .

Reason (R): because it has positive electrode potential.

Solution

Ans:

Cu

lies below hydrogen in electrochemical series and has positive electrode potential. hence cannot liberate hydrogen from acids.

Both the statements assertion and reason are correct and reason is the correct explanation of assertion.

Question 63

Assertion (A): The highest oxidation state of osmium is +8.

Reason (R): Osmium is a 5d-block element.

Solution

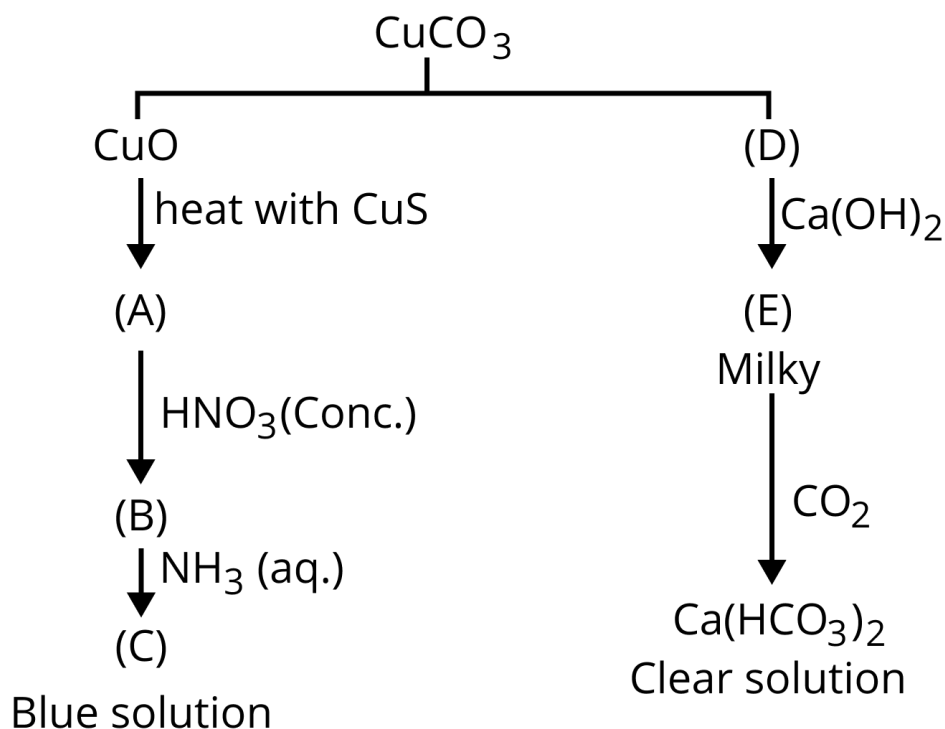
Ans: Osmium has the capacity to expand its octet by utilising all the electrons from its 6s and 5d orbitals this results in it attaining an oxidation state of +8.

Both the statements assertion and reason are correct but reason is not the correct explanation of assertion. The correct option is B.

Long Answer Questions

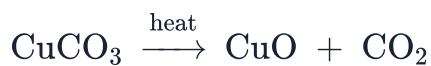
Question 64

Identify A to E and explain reaction involves:



Solution

Ans:



(D)



(E)



clear sol.



(A)



(conc.) (B)



(C) blue solution

Question 65

When a chromite ore (A) is fused with sodium carbonate in free excess of air and the product is dissolved in water, a yellow solution of compound (B) is obtained. After treatment of this yellow solution with sulphuric acid, compound (C) can be crystallized from the solution. When compound (C) is treated with



, orange crystals of compound (D) crystallise out. Identify A to D and also explain the reactions.

Solution**Question 66**

When an oxide of manganese (A) is fused with KOH in the presence of an oxidizing agent and dissolved in water, it gives a dark green solution of compound (B). Compound (B) disproportionate in neutral or acidic solution to give purple compound (C). An alkaline solution of compound (C) oxidises potassium iodide solution to a compound (D) and compound (A) is also formed. Identify compounds A to D and also explain the reactions involved.

Solution

Ans: (A) = MnO_2

(B) = K_2MnO_4

(C) = KMnO_4

(D) = KIO_3



(A) (B)



(C)



(A) (D)

Question 67

On the basis of lanthanoid contraction, explain the following:

(a) Nature of bonding in



and



.

(b) Trends in the stability of oxo-salts of lanthanoids from



.

(c) Stability of the complexes of lanthanides.

(d) Radii of 4d- and 5d-block elements.

Solution

Ans: As per Fajan's rule, smaller the size of ion, greater is its tendency to make covalent bonds as the positively charged cation strongly attracts the negatively charged electron cloud.

On moving from

La to Lu

in the lanthanoid series, the atomic size decreases so the covalent character increases. Hence,



is ionic and



is covalent.

Ans: The stability of oxo salts is directly proportional to the size of atom, as we move from

La to Lu

, the size of the atom decreases and hence the stability of oxo salts also decreases.

Ans: As we move along the lanthanide series, the atomic size decreases. As a result, the charge/size ratio increases and the stability of the complexes also increases.

Ans: As an effect of lanthanide contraction, zirconium and hafnium have similar radius of 160 pm and 159 pm respectively. Due to this similarity in their size, they show similar physical and chemical properties. Lanthanoid contraction: Because the elements in Row 3 have 4f electrons. These electrons do not shield good, causing a greater nuclear charge. This greater nuclear charge has a greater pull on the electrons and results in the decrease in their size and atomic radii.

(e) Trends in acidic character of lanthanide oxides.

Ans: Acidic or basic character of oxides is related to the nature of oxides. As we move along the lanthanide series from La to Lu, the covalent character increases.

Therefore, their basic character decreases or acidic character increases.

Question 68

(A) Answer the following questions:

(i) Which element of the first transition series has the highest second ionization enthalpy?

(ii) Which element of the first transition series has highest third ionization enthalpy?

(iii) Which element of the first transition series has lowest enthalpy of atomization?

Solution

Ans: Out of all the elements of the first transition series copper has the highest second ionisation enthalpy.

Electronic configuration of Copper is:



After the Loss of first electron from the 4s copper acquires



configuration which is stable. Therefore, removal of second electron from the field 3-D orbital is very difficult and requires high amount of energy.

Ans: Among the elements of first transition series zinc has the highest third ionisation enthalpy.

Electronic configuration of zinc is:



After the loss of two electrons from 4s orbital, Z and +2 Ion acquires

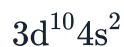


fully filled configuration which is highly stable therefore removal of third electron from



orbital will be more difficult and requires a large amount of energy.

Ans: Zinc is the element of the first transition series that has the lowest enthalpy of atomisation. The electronic configuration of zinc is:



.This is because it has filled 3d-subshell and filled 4s-subshell so no unpaired electron is available for metallic bonding.

(b) Identify the metal and justify your answer:



Ans:



as per EAN Rule.

EAN Rule: Effective atomic number (EAN), number that represents the total number of electrons surrounding the nucleus of a metal atom in a metal complex.



Ans: The M in the given complex is in +7 O.S.

Manganese is the only element in the first transition series that shows +7 oxidation state, therefore this compound is



.

Question 69

Mention the type of compounds formed when small atoms like



get trapped inside the crystal lattice of transition metals. Also give physical and chemical characteristics of these compounds.

Solution

Ans: Interstitial compounds are formed when small atoms like



get trapped inside the crystal lattice of transition metals.

Characteristics:

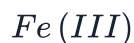
They are hard and rigid in nature having high melting points.

Like pure metals only, they are conductors. They can gain chemical inertness.

Question 70

(A) Transition metals can act as catalysts because these can change their oxidation state.

How does



catalyse the reaction between iodide and persulphate ions?

(B) Mention any three processes where transition metals act as catalysts.

Solution



role of Fe ions:



Ans: 1. Fine powdered state of Nickel is used in the hydrogenation of oils into fats.

2. Iron is used in the formation of ammonia in Haber's process.

3. In contact process in manufacture of



, vanadium is used in its oxide form-



Question 71

A violet compound of manganese (A) decomposes on heating to liberate oxygen and compounds (B) and (C) of manganese are formed. Compound (C) reacts with



in the presence of potassium nitrate to give compound (B). On heating compound (C) with conc.



and



, chlorine gas is liberated and a compound (D) of manganese along with other products is formed. Identify compounds A to D and also explain the reactions involved.

Solution



(A) (B) (C)



(D)

