CHEMISTRY STUDY MATERIALS FOR CLASS 12
(NCERT BASED QUESTIONS WITH ANSWERS)
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The d & f - Block Elements

Question 27: What are alloys? Name an important alloy which contains some of the lanthanoid metals. Mention its uses.

Solution 27: An alloy is a solid solution of two or more elements in a metallic matrix. It can either be a partial solid solution or a complete solid solution. Alloys are usually found to possess different physical properties than those of the component elements. An important alloy of lanthanoids is Mischmetal. It contains lanthanoids (94—95%), iron (5%), and traces of S, C, Si, Ca, and Al.

Uses:- (i) Mischmetal is used in cigarettes and gas lighters.

(ii) It is used in flame throwing tanks.

(iii)It is used in tracer bullets and shells.

Question 28: What are inner transition elements? Decide which of the following atomic numbers are the atomic numbers of the inner transition elements: 29, 59, 74, 95, 102, 104.

Solution 28: Inner transition metals are those elements in which the last electron enters the *f*-orbital. The elements in which the 4*f* and the 5*f* orbital's are progressively filled are called *f*-block elements. Among the given atomic nos, the atomic numbers of the inner transition elements are 59, 95, and 102.

Question 29: The chemistry of the actinoid elements is not so smooth as that of the Lanthanoids. Justify this statement by giving some examples from the oxidation state of these elements.

Solution 29: Lanthanoids primarily show three oxidation states (+2, +3, +4). Among these oxidation states, +3 state is the most common. Lanthanoids display a limited number of oxidation states because the energy difference between $4f$, $5d$, and $6s$ orbitals is quite large. On the other hand, the energy difference between $5f$, $6d$, and $7s$ orbitals is very less. Hence, actinoids display a large number of oxidation states. For example, uranium and plutonium display +3, +4, +5, and +6 oxidation states while neptunium displays +3, +4, +5, and +7. The most common oxidation state in case of actinoids is also +3.

Question 30: Which is the last element in the series of the actinoids? Write the electronic configuration of this element. Comment on the possible oxidation state of this element.

Solution 30: The last element in the actinoid series is lawrencium, Lr. Its atomic number is 103 and its electronic configuration is $[Rn]5f^{14}6d^{1}7s^{2}$ The most common oxidation state displayed by it is+3; because after losing 3 electrons it attains stable f^{14} configuration.

Question 31: Use Hund's rule to derive the electronic configuration of Ce^{3+} ion and calculate its magnetic moment on the basis of 'spin-only' formula.

Solution 31: $Ce: 1s^2\ 2s^2\ 2p^6 3s^2 3p^6 3d^{10}\ 4s^2\ 4p^6\ 4d^{10} 5s^2 5p^6\ 4f^1 5d^1 6s^2$

Magnetic moment can be calculated as: $\mu = \sqrt{n(n+2)}$ BM

Where, $n =$ number of unpaired electrons In Ce, $n = 2$

Therefore, $\mu = \sqrt{2(2+1)} = \sqrt{2\times 4} = \sqrt{8} = 2\sqrt{2} = 2.828$BM

Question 32: Name the members of the lanthanoid series which exhibit +4 oxidation state and those which exhibit +2 oxidation state. Try to correlate this type of behavior with the electronic configurations of these elements.

Solution 32: The lanthanides that exhibit +2 and +4 states are shown in the given table. The atomic numbers of the elements are given in the parenthesis.

+2	+4
Nd(60)	Ce(58)
Sm(62)	Pr(59)
Eu(63)	Nd(60)
Tm(69)	Tb(65)
Yb(70)	Dy(66)

Ce after forming Ce^{4+} attains a stable electronic configuration of [Xe]. Tb after forming Tb^{4+} attains a stable electronic configuration of $[Xe]4f^7$ Eu after forming Eu^{2+} attains a stable electronic configuration of $[Xe]4f^7$. Yb after forming Yb^{2+} attains a stable electronic configuration of $[Xe]4f^{14}$

Question 33: Compare the chemistry of the actinoids with that of lanthanoids with reference to: (i) electronic configuration (ii) oxidation states

and (iii) chemical reactivity.

Solution 33:

Electronic configuration:- The general electronic configuration for lanthanoids is $[Xe]^{54}\, 4f^{0-14} 5d^{0-1} 6s^2$ and that foractinoids is $[Rn]^{86}\, 5f^{1-14} 6d^{0-1} 7s^2$

Unlike $4f$ orbitals, $5f$ orbitals are not deeply buried and participate in bonding to a greater extent.

Oxidation states:- The principal oxidation state of lanthanoids is (+3). However, sometimes we also encounter oxidation states of + 2 and + 4. This is because of extra stability of fully-filled and half-filled orbitals. Actinoids exhibit a greater range of oxidation states. This is because the $5f$, $6d$, and $7s$ levels are of comparable energies. Again, (+3) is the principal oxidation state for actinoids. Actinoids such as lanthanoids have more compounds in +3 state than in +4 state.

Chemical reactivity:- In the lanthanide series, the earlier members of the series are more reactive. They have reactivity that is comparable to Ca. With an increase in the atomic number, the lanthanides start behaving similar to Al. Actinoids, on the other hand, are highly reactive metals, especially when they are finely divided. When they are added to boiling water, they give a mixture of oxide and hydride. Actinoids combine with most of the non-metals at moderate temperatures. Alkalies have no action on these actinoids. In case of acids, they are slightly affected by nitric acid (because of the formation of a protective oxide layer).

Question 34: Write the electronic configurations of the elements with the atomic numbers 61, 91, 101, and 109.

Solution 34:

Atomic number	Electronic configuration
61	$[Xe]^{54}4f^5 5d^0 6s^2$
91	$[Rn]^{86}5f^2 6d^1 7s^2$
101	$[Rn]^{86}5f^{13} 5d^0 7s^2$
109	$[Rn]^{86}5f^{14} 6d^7 7s^2$

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