

d and f Block Elements

Question1

Identify the correct statements about lanthanoids

- I. Ce^{4+} and Tb^{4+} act as oxidising agents.
- II. Eu^{2+} and Yb^{2+} act as oxidising agents.
- III. Misch metal is an alloy of 95% iron and 5% lanthanoid metal.
- IV. La^{3+} and Ce^{4+} are diamagnetic in nature.

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Options:

A.

I and II only

B.

I and IV only

C.

II, III and IV only

D.

I, II and IV only

Answer: B

Solution:



Statements I and IV are correct, while II and III are incorrect. Their correct form is,

II Eu^{2+} and Yb^{2+} acts as reducing agent.

IV Misch metal is primarily composed of lanthanoids metal ($\sim 95\%$) and iron ($\sim 5\%$) and traces of S, C, Ca and Al.

Question2

Match the following

List I (Industrial process)	List II (Catalyst used)
A Ostwald's process	I CuCl_2
B Haber's process	II Zeolites
C Deacon's process	III Pt gauge
D Cracking of hydrocarbons	IV Fe

The correct answer is

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Options:

- A. $A - \text{II}, B - \text{I}, C - \text{IV}, D - \text{III}$
- B. $A - \text{IV}, B - \text{I}, C - \text{II}, D - \text{III}$
- C. $A - \text{III}, B - \text{IV}, C - \text{II}, D - \text{I}$
- D. $A - \text{III}, B - \text{IV}, C - \text{I}, D - \text{II}$

Answer: D

Solution:

The correct match is A-III, B-IV, C-I, D-II.

A. Ostwald's process is an industrial process to make nitric acid. Catalyst used is Pt gauge.

B. Haber's process is industrial process to make ammonia. Iron is used as catalyst in the process.



C. Deacon's process is used to make chlorine. CuCl_2 is used as catalyst.

D. Cracking of hydrocarbon is done in presence of zeolite catalyst.

Question3

Observe the following *f*-block elements

$\text{Eu}(Z = 63)$; $\text{Pu}(Z = 94)$; $\text{Cf}(Z = 98)$;

$\text{Sm}(Z = 62)$; $\text{Gd}(Z = 64)$; $\text{Cm}(Z = 96)$

How many of the above have half-filled *f*-orbitals in their ground state?

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Options:

A. 3

B. 4

C. 2

D. 5

Answer: A

Solution:

Element	Atomic Number	Electronic configuration
Eu	63	$[\text{Xe}]4f^76s^2$
Pu	94	$[\text{Rn}]5f^67s^2$
Cf	98	$[\text{Rn}]5f^{10}7s^2$
Sm	62	$[\text{Xe}]4f^66s^2$



Gd	64	$[\text{Xe}]4f^75d^16s^2$
Cm	96	$[\text{Rn}]5f^76d^17s^2$

Total 3 elements, Cu, Gd and Cm have half filled f -orbitals.

Question4

The alloy formed by beryllium with ' X ' is used in the preparation of high strength springs. ' X ' is

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Options:

- A. Al
- B. Zn
- C. Cu
- D. Cr

Answer: C

Solution:

The alloy formed by beryllium with copper ($X = \text{Cu}$) is commonly used in the preparation of high-strength springs. This alloy is known as beryllium copper and is prized for its excellent combination of strength, electrical conductivity, and resistance to fatigue and corrosion, making it ideal for various applications including spring manufacturing.

Therefore, the correct option is:

Option C: Cu

Question5

Which of the following orders is correct for the property given?

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Options:

- A. $\text{Cr} < \text{Mn} < \text{Fe}$ - standard electrode potential value for $\text{M}^{3+}/\text{M}^{2+}$
- B. $\text{Cr}^{2+} < \text{Mn}^{2+} < \text{Fe}^{2+}$ - magnetic moments
- C. $\text{VO}_2^+ < \text{Cr}_2\text{O}_7^{2-} < \text{MnO}_4^-$ - oxidising power
- D. $\text{Ti} < \text{V} < \text{Cr}$ - first ionisation enthalpy

Answer: C

Solution:

In the given options, statement (c) is correct, while the others contain inaccuracies. Here are the correct versions for the incorrect options:

For option (a), the correct order of standard electrode potential for the reaction $\text{M}^{3+}/\text{M}^{2+}$ in volts is:
 $\text{Cr} < \text{Fe} < \text{Mn}$ ($-0.41 \text{ V}, +0.77 \text{ V}, +1.57 \text{ V}$)

For option (b), the correct order of magnetic moments is: $\text{Cr}^{2+}(d^4) = \text{Fe}^{2+}(d^6) < \text{Mn}^{2+}(d^5)$

For option (d), the correct order of the first ionization enthalpy in kJ/mol is:
 $\text{V} < \text{Cr} < \text{Ti}$ ($650 < 653 < 656$)

Question 6

The set of elements which obey the general electronic configuration $(n-1)d^{1-10}ns^2$ is?

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Options:

- A. Bh, Eu, Po
- B. Ho, Er, Lu
- C. Hs, Hg, W
- D. K, Bi, Ba

Answer: C

Solution:



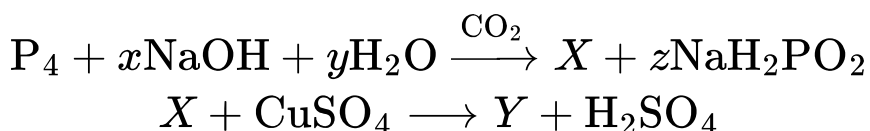
Hs, Hg, W elements obey $(n - 1)d^{1-10}ns^2$ electronic configuration. Hs - 108 - $[\text{Rn}]5f^{14}6d^67s^2$

Hg - 80 - $[\text{Xe}]4f^{14}5d^{10}6s^2$

W - 74 - $[\text{Xe}]4f^{14}5d^46s^2$

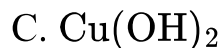
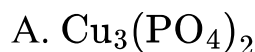
Question 7

Y in the given sequence of reactions is



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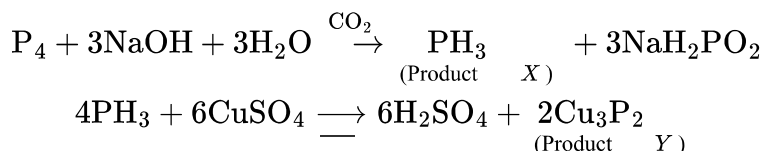
Options:



Answer: B

Solution:

The complete reaction is as follows,



Hence, product Y is Cu_3P_2 .



Question8

Identify the element for which +1 oxidation state is more stable than +3 oxidation state.

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Options:

A. Ga

B. Sn

C. Tl

D. Ge

Answer: C

Solution:

Due to inert pair effect, Tl(+1) is more stable than Tl(+3). The valence 's' electrons acts as inner core electrons due to poor shielding of 'd' and 'f' electrons.

This is the reason Tl is more stable in +1 oxidation state.

Question9

Identify the correct statements from the following.

(i) Ti (IV) is more stable than Ti (III) and Ti (II).

(ii) Among 3d-series elements (From $Z = 22$ to 29). Only copper has positive reduction potential (M^{2+}/M).

(iii) Both Sc and Zn exhibit +1 oxidation state.

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Options:

A. i, ii only



B. ii, iii only

C. i, iii only

D. i, ii, iii

Answer: A

Solution:

Let's examine each statement carefully:

(i) "Ti(IV) is more stable than Ti(III) and Ti(II)."

True. Among titanium's common oxidation states (+2, +3, +4), the +4 state is generally the most stable due to the high lattice or coordination stabilization and the noble-gas-like configuration of Ti^{4+} ($3d^0$).

(ii) "Among 3d-series elements (Z = 22 to 29), only copper has a positive reduction potential (M^{2+}/M)."

True. Standard reduction potentials for most 3d metals (like Ti, V, Cr, Mn, Fe, Co, Ni, Zn) are **negative**. Copper is unique with a standard reduction potential of about +0.34 V, making it the only one in that range with a **positive** reduction potential for the M^{2+}/M couple.

(iii) "Both Sc and Zn exhibit +1 oxidation state."

False.

Sc typically shows +3 oxidation state (it is isoelectronic with Ar when Sc^{3+}). Instances of Sc in +1 or +2 are either extremely rare or not well-established.

Zn commonly shows +2. While there are organometallic complexes where Zn can appear in unusual oxidation states, Zn^{+1} is **not** a stable or typical oxidation state in standard inorganic chemistry contexts.

Conclusion

(i) is correct

(ii) is correct

(iii) is incorrect

Hence, the correct statements are **(i) and (ii) only**, matching **Option A**.

Question10

The order of melting points of Cr, Mo and W is

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Options:

A. $\text{Cr} > \text{Mo} > \text{W}$

B. $\text{Mo} > \text{Cr} > \text{W}$

C. $\text{W} > \text{Mo} > \text{Cr}$

D. $\text{W} > \text{Cr} > \text{Mo}$

Answer: C

Solution:

The melting points of given elements are as follows :

Element	Melting point
W	3422°C
Cr	1907°C
Mo	2623°C

Hence, correct order of melting point is $\text{W} > \text{Mo} > \text{Cr}$.

Question11

The number *f*-electrons in +3 oxidation state of gadolinium ($Z = 64$) is *x* and in +2 oxidation state of ytterbium ($Z = 70$) is *y*.
The sum of *x* and *y* is

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Options:

A. 13

B. 20

C. 18

D. 21

Answer: D

Solution:

To determine the number of f -electrons in the +3 oxidation state of gadolinium (Gd) and +2 oxidation state of ytterbium (Yb), we can examine their electronic configurations:

Gadolinium (Gd):

Atomic number: 64

Electronic configuration: $[\text{Xe}] 4f^7 5d^1 6s^2$

In the +3 oxidation state (Gd^{3+}), gadolinium loses three electrons. These electrons are typically removed from the outermost orbitals, i.e., $6s$ and $5d$, leaving the f -orbital unchanged.

Configuration of Gd^{3+} : $[\text{Xe}] 4f^7$

Number of f -electrons (x): 7

Ytterbium (Yb):

Atomic number: 70

Electronic configuration: $[\text{Xe}] 4f^{14} 6s^2$

In the +2 oxidation state (Yb^{2+}), ytterbium loses two electrons, typically from the $6s$ orbital, leaving the f -orbital full.

Configuration of Yb^{2+} : $[\text{Xe}] 4f^{14}$

Number of f -electrons (y): 14

Finally, the sum of x and y is:

$$x + y = 7 + 14 = 21$$
