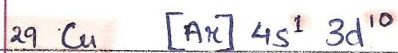
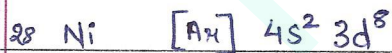
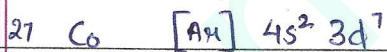
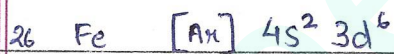
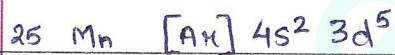
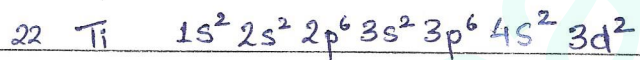


## 23 - Transition Elements

Q-1) What is a transition element?

> A transition element is a d-block element which forms one or more stable ions with an incomplete d sub-shell.

[Ti → Cu :- Zn and Sc are not ; no incomplete d orbital]



ions are formed by removing  $e^-$  from the 4s-sub-shell.



Q-2) Properties of transition elements.

1. Atomic & ionic radii

• decrease v. slightly across the period

↳ great force of attraction between 3d-orbital & nucleus

\* Ca has greater atomic radii / ionic radii

2. Melting point.

• high

↳ strong metallic bonding ; 3d e<sup>-</sup> are involved

↳ smaller radii ∴ larger attractive forces.

\* Ca has lower melting point

3. Density

• high

↳ small atomic radii

\* Ca has lower density

4. Hard and rigid.

↳ used as construction material.

5. IE1

• high ; v. small decrease across period.

↳ small atomic size and great charge [high density]

\* Ca has lower IE1

6. Electrical conductivity

• good conductors (3d e<sup>-</sup>) [except Cu]

\* Ca has higher electrical conductivity

Q-3) Oxidation states

- Transition elements have variable oxidation states.
- The resulting ions are often different colours.

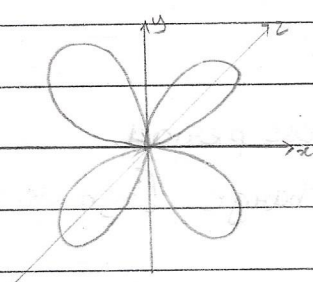
The maximum oxidation state is the  $e^-$  in 4s orbital plus the unpaired  $e^-$  in 3d orbital.

Highest oxidation state is shown in compounds with F or O.

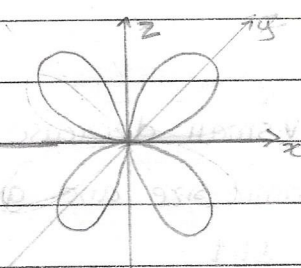
eg:  $MnO_4^-$ ,  $Cr_2O_7^{2-}$ ,  $V_2O_5$  ; form complex ions.

Ti	V	Cr	Mn	Fe	Co	Ni	Cu
			+7				
		+6	+6	+6			
	+5	+5	+5	+5	+5		
+4	+4	+4	+4	+4	+4	+4	
+3	+3	+3	+3	+3	+3	+3	
+2	+2	+2	+2	+2	+2	+2	+2
							+1

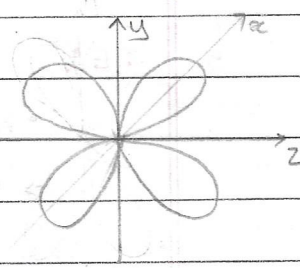
Q-4) Shapes of the d-orbitals.



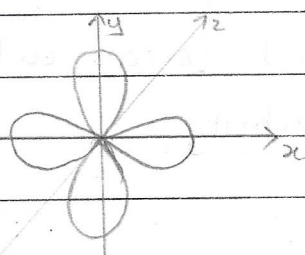
$d_{xy}$



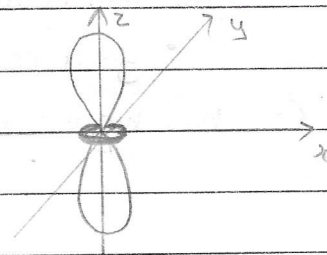
$d_{xz}$



$d_{yz}$



$d_{x^2-y^2}$



$d_{z^2}$



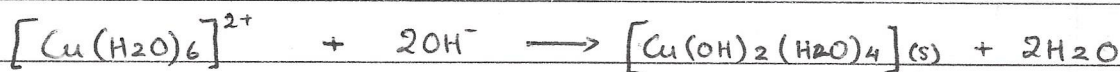
Q-5) What are ligands?

- > Ligands are a species that contains a lone pair of electrons that forms a co-ordinate/dative bond to a central metal atom/ion.
- > A complex is a molecule or ion formed by a central metal atom/ion surrounded by one or more ligands.
- > Co-ordination number is the number of co-ordinate/dative bonds that a ligand forms with the central metal ion.  
eg:  $\text{Fe}(\text{CN})_6$

Q-6) Shape of ligands.

Co-ordination no.	Shape	Example
2	Linear ( $180^\circ$ )	$\text{CuCl}_2^-$ , $[\text{Ag}(\text{NH}_3)_2]^+$
4	Tetrahedral ( $109.5^\circ$ )	$\text{CoCl}_4^{2-}$ , $[\text{Zn}(\text{NH}_3)_4]^{2+}$
4	Square planar ( $90^\circ$ )	$\text{Pt}(\text{NH}_3)_2\text{Cl}_2$
6	Octahedral ( $90^\circ$ )	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$

Q-7) Ligand exchange reactions.



Same reaction

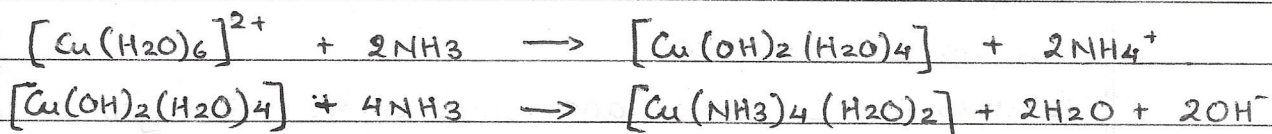
blue solution

pale blue ppt.

but with Cobalt:

pink

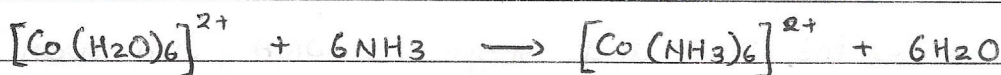
blue



excess  $\text{NH}_3$

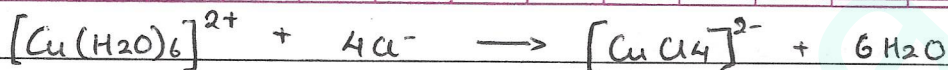
blue

dark blue



pink

black



blue

yellow

Same with Co:

pink

blue

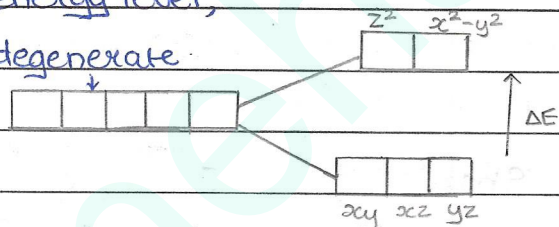
Q-8) Splitting of the d-orbital

Octahedral

non-degenerate

same energy level;

degenerate



\* Reverse  $xy, xz, yz$  and  $z^2, x^2-y^2$  for tetrahedral.

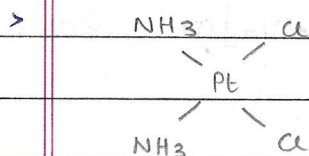
The electrons absorb photons of certain wavelengths/frequencies to 'jump' to a higher energy level.

$\Delta E$  corresponds to the energy absorbed.

High energy = high frequency or low wavelength.

Orbitals split into higher energy levels near ligands due to repulsion from the ligand lone pairs.

Q-9) Cisplatin in cancer treatment.



~~cis-pl~~

Cisplatin enters the cell.

It loses the Cl atoms and binds to the nitrogen atoms on the DNA

This kinks the DNA and stops the DNA from working properly  $\therefore$  the cell dies.



Q-10) Stability constant in complex ions.

$$K_{stab} = \frac{[\text{products}]}{[\text{reactants}]} \rightarrow \text{water is not included.}$$

Higher  $K_{stab}$  = more stable product.

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