10573 comparative study of transition metals solved past papers pdf

Comparative Study of Transition Elements (Mount Kenya University)

COMPARATIVE STUDY OF TRANSITION ELEMENTS.

Containing the latest and most commonly asked COMPARATIVE STUDY OF TRANSITION ELEMENTS questions and answers to help you ace your final exams. Recommended for BEDS Students.

UNIVERSITY EXAMINATIONs 2016/2017

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL AND MATHEMATICAL SCIENCES

BACHELOR OF EDUCATION (SCIENCE)

SCHOOL BASED/DIBL

UNIT CODE: BCH4102 UNIT TITLE: COMPARATIVE STUDY OF TRANSITION ELEMENTS.

DATE: NOVEMBER 2017 MAIN EXAMS TIME 2HOURS

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.

QUESTION ONE 30 MARKS (Compulsory)

a. **Briefly explain why the zinc group of elements (group 12) is not classified as transition elements.**

I. This is because group 12 elements' last electron added is not a d-electron.

II. They have a completely filled (n-1) d subshells

IIII. Group 12 elements have fixed oxidation states.

IV. They form colorless ions

b. **Write down the oxidation state OF the metal in each of the following Ions.**

$I.\ [CU(NH_3)_4]2+$

X+ (0)4=+2

X=+2 Thus cu oxidation state is +2.

II. TaO_4^{3-}

X+-2(4) =-3

X+ (-8) =-3

X=-3+8=+5

Thus oxidation state of Ta is +5.

c. Explain the observations

I. Transition elements and their compounds are suitable industrial and biological catalysts.

This is because of;

-presence of vacant d-orbitals

-The tendency to exhibit variable oxidation states.

-presence of defects in their crystal lattices

II. All minerals of tantalum are contaminated with some niobium but not vanadium.

This is because tantalum and niobium are almost paired together in nature.

They are difficult to separate due to their similar physical and chemical properties.

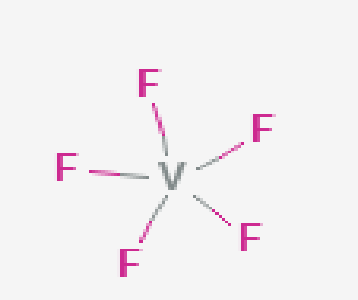
Vanadium however is not very similar and thus easy to separate.

IIII. vanadium v oxide is such a versatile catalyst.

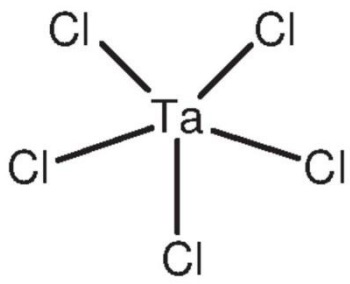
This is due to its narrow band gap energy of about 2.2e.

d. Draw the structures of the following species.

I. VF5



II. TaCl_5



c. Name three natural processes that utilize transition elements.

I. Nitrogen-fixing bacteria utilize enzymes that contain both molybdenum and iron.

II. Iron participates in two main processes, oxygen and electron transfer.

III. Human serum contains a glycoprotein called ceruloplasmin, the molecule of which contains eight copper atoms.

2a. Explain why TiO2 is preferred to PbCO3, Pb(OH)2 as White paint pigment.

- Because of its whiteness and opacity.

These properties are due to the refractive index of titanium oxide i.e. the ability to bend and scatter light which is greater than that of lead carbonate and lead hydroxide.

b. Describe the chloride process of producing pigment grade TiO2.

There are two stages;

-the dry ore is fed into a chlorinator with coke and chlorine gas.

Titanium chloride is formed

Once the reaction starts the heat produced during the reaction is enough to maintain the reaction.

-The titanium chloride is burnt in oxygen in the presence of carbon (ii) oxide to form Titanium dioxide. Seed crystals are added to help form TiO2 as a solid.

The products are cooled by mixing with chlorine gas.

The product is washed and dried

C. Name two other uses of titanium and give a reason for each use.

I. Titanium 6Al-4v alloy accounts for 50% of alloys used in Aircraft application. This is due to it's high tensile strength to density ratio.

II. For automotive especially sports vehicles because of it's light metal with high strength and rigidity.

d. Write balanced chemical or ionic equations to represent the following reactions;

i. When concentrated solution of the green manganese ion MnO42- is diluted they change color to deep purple and precipitate a brown-black precipitate.

2 K2MnO4 + 2 $\longrightarrow$ 2KmnO4 + 2KOH + H

II. Pale green solution of Fe2+ turn rusty brown when exposed to air.

$$2Fe + O2 \longrightarrow 4Fe3+ + O$$

III. When yellow chromate solution is acidified, they change color to orange. The acidified solution is decolorized by aqueous potassium iodide.

$$Cr_2O_7^{2-} + 7H^+ + 6I \longrightarrow Cr^{2+} + 3I_2 + 7H_2O$$

3**. State and explain the general trends for each of the following properties down the group and across the first transition series of the periodic table.**

I. Density

II. Ionization energy

Density

Density increase across the period due to decrease in volume and increase in atomic mass

Increase down the group because the volume increases more slowly compared to atomic masses especially due to the lanthanide contraction.

II. Ionization energy

Increase across the period as the atomic radius decreases and the effective nuclear charge increases.

Within the first and second transition series ionisation energy decreases due to increase in atomic radius.

Between the second and third transition increases due to lanthanide contraction

4a. Name qualities that make titanium dioxide the base of most white paints used nowadays and explain why naturally occurring mineral rutile TiO2 cannot be used as mined but must be processed first.

Titanium dioxide pigment is a fine white powder. When used in paints, it provides for maximum whiteness and opacity.

It gives paint high hiding power, meaning the ability to mask or hide the substrate underneath. It does this more effectively than any other white pigment.

b. Assume that one is supplied with a sample of mineral illeminite $FeTiO_3$ and all reagents that may be required. Outline briefly how this mineral could be used to make.

I. A sample of pigment grade rutile

Illeminite is leached with dilute hydrochloric acid to remove phosphorus.

The illeminite is then reacted with excess concentrated (25%w/w) hydrochloric acid to generate titanium Ions.

Thermal hydrolysis is done by continuously adding the titanium solution in the presence of seed nuclei.

Titanium is cleaned and dried.

II. A sample of ferrocene $(C_5H_5)_2$

After the $FeCl_3$ is separated from $TiCl_4$ from the above process (I)

Ferrocene is obtained by treating fresh cyclopentadienyl magnesium bromide (grinard reagent) with ferric chloride in ethylene glycol ethers.

C. Metallic tantalum is used to repair badly damaged bones while metallic calcium cannot be used even though bones are a compound of calcium.

Tantalum is resistant to corrosion

Tantalum is almost immune to chemical attack (body liquids) below 150°c. While calcium may easily react

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BACHELOR OF EDUCATION (SCIENCE)

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UNIT CODE: BCH4102 UNIT TITLE: COMPARATIVE STUDY OF TRANSITION ELEMENTS.

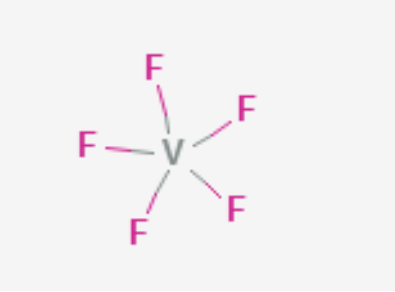
DATE: Fri 10th August, 2018 10:00AM MAIN EXAM TIME 2HOURS

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.

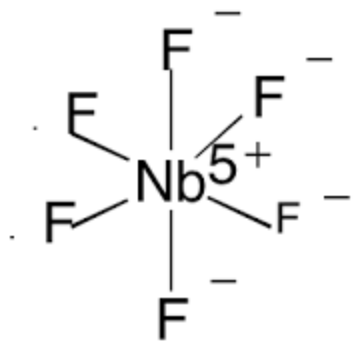
QUESTION ONE 30 MARKS (Compulsory)

a. Draw the structure of the following.

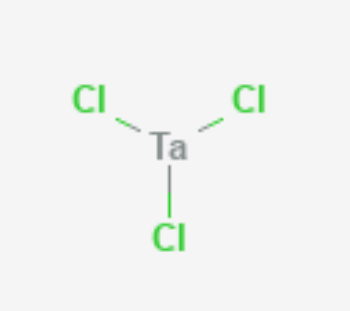
I. VF5



II. NbF5



III. TaCl3



b. Briefly describe how you can achieve separation of niobium and tantalum if you are supplied with an ore containing the two elements.

Niobium and tantalum can be separated by ion exchange.

- The ore sample is dissolved by fusion technique using ammonium biflouride as flux.
- Tantalum and niobium form stable anionic flouride complexes in flouride solutions.
- Tantalum is separated from the solution by solvent extraction using methyl isoamyl ketone.
- Niobium is subsequently separated by anion exchange using dowex marathon resin and hydrochloric solution as a mobile solvent.

C. Give four properties of transition elements

- magnetic properties

Paramagnetism: transition elements compounds are paramagnetic because they contain partially filled d-orbitals.

II. Catalytic properties

Most D-block elements act as good catalyst because of the presence of vacant d-orbitals and varying oxidation states.

III. Formation of colored metal salts

Iv. Varying oxidation states

d. Give the electronic configuration of the following species.(Nb=41,mn=25,

Fe=26, Fe=26, Zr=40)

I. Niobium (IV). [Ar]3d6

II. Manganese (II) [Ar]3d5

IV. Zirconium (II). [Kr]4d2

2a. Give reasons for the following observations

I. Generally transition metals have high electrical and thermal conductivities, tensile strength, density and melting points.

This is because of ability of the sd-orbital electrons to delocalize within the metal lattice.

II. Most industrial catalyst is either transition metal compounds or transition metals or alloys of the metals

This is because they can utilize both d and s electrons for the formation of bonds between reactant molecules and the surface catalyst atoms which increases concentration of the reactants at the catalyst surface and weakens the bonds in the reactants molecules with the result of the activation energy is lowered.

III. The third row of d block elements has only marginally larger atomic radii than the second row elements.

The second and third row of D-block elements has similar atomic radii due to lanthanide contraction

IV. Vanadium only forms pentafluoride while niobium and tantalum forms all pentahalides including penta iodide.

This is because stability of higher oxidation states in transition elements increases down the group.

Thus as you move down the group from Vanadium> Niobium

> Tantalum the ability to form compounds at higher oxidation state increases.

2a. briefly explain the following

I. Whereas Ni (CO) 4 is known, ca (CO)4 is not known

Positive charges destabilize the carbonyl. Thus carbonyls with high positive charges are less stable.

This is because the bond order between metal and carbon decreases with increasing positive charge.

Thus ca(CO)4 is very unstable.

b. Briefly explain why zinc group of elements is not classified among transition elements.

I. Fixed oxidation state

II. No colored salts

III. No catalytic properties

IV. Have completely filled (n-1)d subshells

V. The last election added is not a d-electron.

C. Write down the oxidation state and electron configuration arrangement of the metal in each of the Ions.

I. $Cu(NH_3)_4^{2+}$

X+ (0)4=+2

x=2

Cu [Ar]3d10s1-2= Cu[Ar]3d9

Cu[Ar]3d9

II. TaO4,^3-

X+(-2)4=-3

X=-3+8

X=+5

[Xe]4f145d36s2-5=[Xe]4f14

III. OSO4

x+(-2)4=0

X=+8

[Xe]4f145d66s2-8=[Xe]4f14

3a.write a balanced and net ionic equation for each of the following reactions.

I. A solution of Na2Cr2O7 turns from orange to yellow on addition of an alkali.

Cr2O7- + OH-. >>. 2Cr3+. + H2O

II. Both acidic and alkaline MnO4- solutions are decolorised by potassium iodide.

$MnO_4^- + 2I^- + 8H^+ >>> Mn^{2+} + I_2 + 4H_2O$

b. Explain why metallic tantalum is used to repair badly damaged bones while metallic calcium cannot be used even though bone is a compound of calcium.

This is because tantalum is immune to chemical attack (human liquids) below 150°c.

Tantalum is also almost resistant to corrosion, while calcium is reactive.

4a. Explain why TiO_2 is preferred to $PbCO_3$, $Pb(OH)_2$ as white pigment.

Because of its whiteness and opacity

These properties are due to the refractive index of titanium oxide i.e. the ability to bend and scatter light which is greater than that of lead carbonate and lead hydroxide.

b. Describe the chloride processes of producing pigment grade TiO_2.

The dry ore is fed into a chlorinator with coke and chlorine gas.

Titanium chloride is formed

Once the reaction starts the heat produced during the reaction is enough to maintain the reaction.

-The titanium chloride is burnt in oxygen in the presence of carbon(ii) oxide to form Titanium dioxide.

Seed crystals are added to help form TiO_2 as a solid.

The products are cooled by mixing with chlorine gas.

The product is washed and dried

C. Name four other industrial uses of titanium

I. Titanium 6Al-4v alloy accounts for 50% of alloys used in Aircraft application. This is due to its high tensile strength to density ratio.
II. For automotive especially sports vehicles because of it is a light metal with high strength and rigidity.
III. Surgical applications such as in joint replacements (especially hip joints) and tooth implants.
IV. In making jewelry, surgical tools, mobile phones and other high-performance products.

d. Briefly explain how you would prepare a sample of titanocene.

Prepared by synthesis by Wilkinson and Birmingham by reacting Titanium tetrachloride and sodium cyclopentadiene

$2NaC2H. + TiCl4 \longrightarrow (C5H5)2TiCl2 + 2NaCl$

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BACHELOR OF EDUCATION (SCIENCE)

SCHOOL BASED/DIBL

UNIT CODE: BCH4102 UNIT TITLE: COMPARATIVE STUDY OF TRANSITION ELEMENTS.

DATE: MON 15th APRIL, 2019 MAIN EXAM 2:00 PM TIME 2HOURS

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.

QUESTION ONE 30 MARKS (Compulsory)

1a. Give a plausible explanation for each of the following observations:

I. Explain why Cr3+ (aq) is violet in color while Y3+ is colorless.

Yttilium forms a predominantly +3 oxidation state due to loss of 3 Valence electrons giving it a well-defined aqueous cation chemistry. Thus does not form variable oxidation states and do not form colored compounds.

II. Transition metals form compounds in which they show variable oxidation states.

Transition elements exhibit a wide range of oxidation states differing usually by one.

This is due to the fact that (n-1) d electrons may get involved a long with ns electrons in bonding, as electrons in (n-1)d orbitals are in an energy state comparable to ns electrons.

III. Most transition metal ions and compounds are paramagnetic.

Paramagnetism in transition metals and their compounds occur due to the presence of partially filled d-orbitals.

IV. The physical and chemical properties of Zr are similar to those of Hf but differ significantly from those of Ti.

Zr and Hf have similar chemistry due to their almost identical atomic and ionic radius. (Zr, 160, HF, 159).

While that of Ti is different (Ti, 147).

V. VF5 is viscous liquid while VCl5 is either very unstable or does not form.

This is because fluorine is more electronegative than chlorine and is able to oxidize vanadium to its highest oxidation state.

Chlorine being less electronegative forms a very unstable compound with vanadium.

Vi. The permanganate ion MnO4- is deep purple in color but TeO4- and ReO4- are colorless.

This is because in MnO4- there's transition of electrons from one d-orbital to another which corresponds to a fairly energy difference, therefore light is absorbed in purple region of the spectrum.

While in TeO4- and ReO4- there is no possibility of the electronic transitions within the d-orbitals.

Vii. In extraction of tungsten metal, WO3 is reduced with H2 gas. Why is it not advisable to use carbon for the reduction?

This is because tungsten reacts with carbon to form tungsten carbide

b. Name two natural processes that utilize transition metals

-Iron atoms are importantly involved in hemoglobin of blood and in the ferredoxins of photosynthesis process.

-Mollybdenum and iron are contained in nitrogen fixing enzymes.

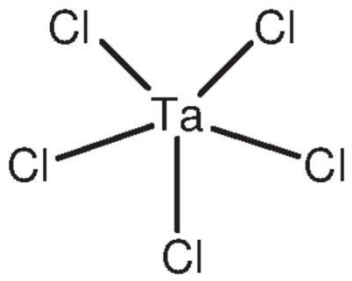
C. State the characteristics of rutile which make it a suitable paint pigment.

- It is white

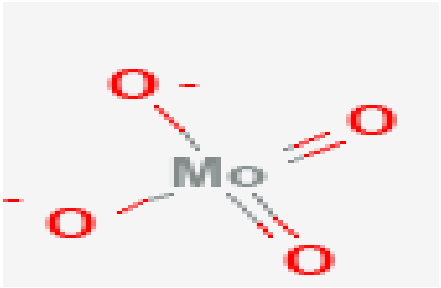
- Opacity i.e. its ability to bend and scatter light.

2a. Draw the structures of the following species.

II.TaCl5



III. MoO4



b. Describe the extraction of chromium from chromites FeCrO_4^{2-}

- Crushed ore is concentrated by gravity separation method.

- The concentrated ore is mixed with excess Na2CO3 and a small amount of lime and roasted in a reverberatory furnace at 900-1000°c in presence of free supply of air.
- The chromite ore is converted into soluble sodium chromite.
- Chromic oxide mixed with powdered aluminum (3:1 ratio) is placed in a fire clay crucible.
- A mixture of Barium peroxide and magnesium powder is placed over this.
- Sand surrounds the crucible to prevent loss of heat by radiation.
- During this process Cr2O3 is reduced to chromium.

C. State two uses of chromium.

I. Chromium is used to harden steel.

II. Used in many dyes and paints.

d. Write balanced net ionic equation for each of the reaction involved

I. when a solution of Na2Cr2O7 turns from orange to yellow on addition of an alkali.

Cr_2O_7- + OH^+ ⟶ 2 Cr^{3+} + H2O

3a. Assume that one is supplied with Illeminite and all reagents that may be required. Outline briefly how this mineral could be used to make

I. A sample pigment of grade rutile

The Illeminite is concentrated magnetically.

Mix with coke and heat in chlorine steam at 900-1200°c temperature to form tetrachloride.

Condense the tetrachloride and reduce with magnesium in presence of argon gas in a steel reactor.

2FeTiO_3 + 6c + 7 cl_2 ⟶ 2Fecl_3 + 2TiCl_4 + 6Co

Fecl_3 and TiCl_4 are separated by fractional distillation due to their different melting points.

The Ticl4 is burnt with oxygen in the presence of carbon ii oxide to form titanium dioxide. Seed crystals are added to help form TiO2 as a solid.

The products are cooled by mixing with chlorine gas.

The product is washed and dried.

C. Describe briefly how a sample of niobium v bromide can be prepared if one is supplied with a sampleof columbite and all the necessary reagents.

- Columbite concentrate and tin slags (with high tantalum content) are dressed by wet chemical process.
- The tantalum rich ore is then crushed ground and decomposed in hydrochloric acid.
- This is followed by a liquid- liquid extraction process in which methyl isobutyl ketone is mixed.
- The tantalum is extracted as a fluoride in the organic solution.
- Niobium remains in the aqueous residue.
- The niobium is then precipitated from the solution as a fluoride by addition of ammonium hydroxide.
- The filter cake is dried (900-1000°c) to obtain Niobium pentoxide.
- The oxide is reduced aluminothermically to produce Niobium reguli.
- The reguli are further purified through hydriding and dehydring process.
- The pure Niobium is then reacted with bromine at 230°-250°c in a tube furnace to Niobium V bromide.

4a. State and explain the general trends for each of the following properties down the group and across the periodic table.

I. Density

II. ionisation energy

Density

Density increase across the period due to decrease in volume and increase in atomic mass

Increase down the group because the volume increases more slowly compared to atomic masses especially due to the lanthanide contraction.

II. Ionization energy

Increase across the period as the atomic radius decreases and the effective nuclear charge increases.

Within the first and second transition series ionisation energy decreases due to increase in atomic radius.

Between the second and third transition increases due to lanthanide contraction

b. Explain briefly the reasons for the following observations supporting your discussion, wherever possible by means of balanced chemical or ionic equations or structure.

When mno2 is mixed with NaCO3 and melted in presence of air sodium manganate which is green is formed.

When dissolved in water, MnO2 reacts with NaCO3 to form sodium permanganate which is purple in color.

Pyrolusite which is brown in color is also formed. It is visible when the melt is cooled

$3NaMnO_4 + 2H_4O \longrightarrow 2NaMnO_4 + MnO_2 + NaOH$

Grey Purple

II. When molybdenum (ii) bromide is dissolved in water and lead nitrate added, only one third of the halogens are precipitated.

This is because of the formation an insoluble coating of lead chloride over molybdenum chloride which hinders further reaction.

III. A solution of Na2Cr2O7 turns from orange to yellow on addition of an alkali.

In this reaction the chromium (ii) ions which are orange are reduced to Chromium (ii) ions which are yellow in color

UNIVERSITY EXAMINATIONs 2018/2019

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UNIT CODE: BCH4102 UNIT TITLE: COMPARATIVE STUDY OF TRANSITION ELEMENTS.

DATE: WED 10th APRIL, 2019 7:00AM TIME 2HOURS

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.

QUESTION ONE 30 MARKS

a. Give four properties of transition elements.

I. magnetic properties

Paramagnetism: transition elements compounds are paramagnetic because they contain partially filled d-orbitals.

II. Catalytic properties

Most D-block elements act as good catalyst because of the presence of vacant d-orbitals and varying oxidation states.

III. Formation of colored metal salts

Iv. Varying oxidation states

b. Give possible reasons for the following observations;

I. Generally transition metals have high electrical and thermal conductivities, tensile strength, density and melting points.

This is because of ability of the sd-orbital electrons to delocalize within the metal lattice.

II. Most industrial catalyst is either transition metal compounds or transition metals or alloys of the metals

This is because they can utilize both d and s electrons for the formation of bonds between reactant molecules and the surface catalyst atoms which increases concentration of the reactants at the catalyst surface and weakens the bonds in the reactants molecules as a result, the activation energy is lowered.

III. The third row of d block elements has only marginally larger atomic radii than the second row elements.

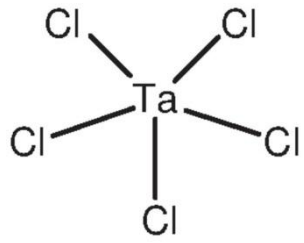
The second and third row of D-block elements has almost similar atomic radii due to lanthanide contraction

IV. The third ionisation potential of 26Fe is lower than that of 25 Mn.

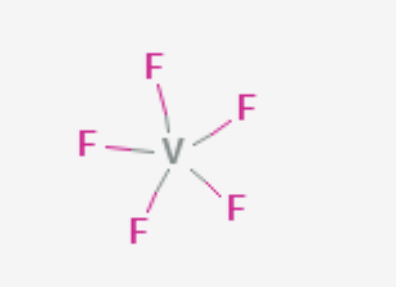
Along the period, ionisation energy increases because the effective nuclear charge experienced by ns2 electrons increases along the period, causing the shells to shrink in size and thus making it difficult to remove the electrons.

C. Draw the structure of the following species.

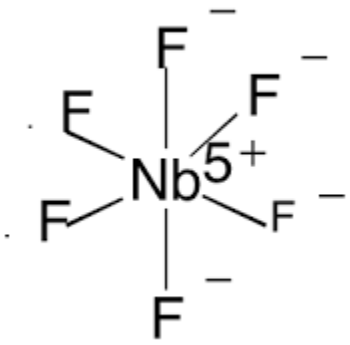
I. TaCl5



II. VF5



III.NbF6



d. Give the electronic configuration of the following species.

I. Niobium (IV)

II. Manganese (II)

IV. Zirconium (II)

Niobium (IV). : [Ar]3d6

Manganese (II) : [Ar]3d5

Zirconium (ii) : [Kr]4d2

2a state and explain the general trend down the group for each of the following properties in transition elements.

I. Density

II. Ionisation energy

III. Oxidising ability of the group oxidation state.

Density

Increases down the group because the volume increases more slowly compared to atomic masses especially due to lanthanide contraction.

Ionisation energy

Between the First and second row ionisation energy decreases due to increase in atomic radius.

Between the second and third transition series Ionisation energy increases due to lanthanide contraction

The oxidation ability of the group oxidation state.

The first row elements are unstable in higher oxidation states while the second and third rows are more stable in the high oxidation states.

bi. Briefly explain the extraction of vanadium from the ore of your choice.

Ore: Carnotite

Vanadium is extracted from carnotite as a coproduct with uranium by leaching the ore concentrate for 24 hours with sulphuric acid and an oxidant such as sodium chlorate

The leachate is fed into a solvent extraction circuit where uranium is extracted in an organic solvent consisting of 2.5% amine, 2.5% isodelanol and 95% kerosene

Vanadium remains in the raffinate, which is fed into a second solvent extraction circuit where the vanadium is extracted with ammonium sulphate

The ammonium metavanadate is filtered, dried and calcined to V_2O_5

II. State two uses of vanadium.

i. Vanadium alloys are used in nuclear reactors because of vanadium low neutron-absorbing properties.
ii. In manufacture of ceramics

3a. Name the qualities that make titanium dioxide the base of most white paints and explain why naturally occurring mineral rutile cannot be used as mined but has to processed first.

Titanium dioxide is preferred as base for paints because of its whiteness and opacity due to its ability to bend and scatter light.

Mineral rutile cannot be used as it contains impurities.

b. Assume that one is supplied with a sample of mineral FeTiO2 and all reagents that may be required.

Outline how this mineral could be used to make.

I. A sample of pigment rutile grade

The Illeminite is concentrated magnetically. Mix with coke and heat in chlorine steam at 900-1200°c temperature to form tetrachloride.

Condense the tetrachloride and reduce with magnesium in presence of argon gas in a steel reactor.

$2FeTiO_3 + 6c + 7\ cl_2 \longrightarrow 2Fecl_3 + 2TiCl_4 + 6Co$

Fecl3 and Ticl4 are separated by fractional distillation due to their different melting points.

The Ticl4 is burnt with oxygen in the presence of carbon ii oxide to form titanium dioxide.

Seed crystals are added to help form TiO2 as a solid.

The products are cooled by mixing with chlorine gas.

The product is washed and dried.

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After the FeCl3 is separated from TiCl4 from the above process (I)

Ferrocene is obtained by treating fresh cyclopentadienyl magnesium bromide (Grignard reagent) with ferric chloride in ethylene glycol ethers.

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QUESTION ONE 30 MARKS (Compulsory)

a. Briefly explain why the zinc group of elements is not classified among transition elements.

I. This is because their last added electron added is not a d-electron.

While transition elements last element added is d-electron.

II. They have completely filled (n-1) d subshells unlike those of transition elements which are partially filled.

III. They have fixed oxidation states while transition elements have varying oxidation states.

IV. They form colorless salts while transition elements form colored salts.

2. Briefly describe how you would achieve separation of tantalum and niobium if you are supplied with an ore containing the two elements.

- The ore concentrate and tin slags (with high tantalum content) are dressed by wet chemical process.
- The tantalum rich ore is then crushed ground and decomposed in hydrochloric acid.
- This is followed by a liquid- liquid extraction process in which methyl isobutyl ketone is mixed.
- The tantalum is extracted as a fluoride in the organic solution. Niobium remains in the aqueous residue
- The Niobium is then precipitated from solution as a flouride by addition of ammonium hydroxide.
- The filter cake is dried (900-1000°c) to obtain Niobium pentoxide.
- The oxide is reduced aluminothermically to produce Niobium reguli.
- The reguli are further purified through hydriding and dehydring process.

3. Explain why TiO_2 is preferred to PbCO_3, Pb( )OH_2 as white paint pigment.

This is because of its whiteness and opacity due to its refractive index which is the ability to bend and scatter light.

bi) Describe the processes of producing pigment grade TiO2 from Illemite.

The Illeminite is concentrated magnetically. Mixed with coke and heat in chlorine steam at 900-1200°c temperature to form tetrachloride

Condense the tetrachloride and reduce with magnesium in presence of argon gas in a steel reactor.

$2FeTiO_3 + 6c + 7\ cl_2 \longrightarrow 2Fecl_3 + 2TiCl_4 + 6Co$

Fecl3 and Ticl4 are separated by fractional distillation due to their different melting points.

The Ticl4 is burnt with oxygen in the presence of carbon ii oxide to form titanium dioxide.

Seed crystals are added to help form TiO2 as a solid.

The products are cooled by mixing with chlorine gas.

The product is washed and dried.

4. Briefly explain why, whereas Vcl5 is not known VOCl2 is known.

This is because VCl5 is thermally unstable at room temperature. While $VOCl_2$ is stable at room temperature

5. When tantalum ii chloride is dissolved in water and lead nitrate added, only a third of the halogens are precipitated briefly explain.

This is because of the formation of insoluble coating of lead chloride over TaCl2 which prevents further reaction.

6. Explain why

I. gold and silver is used for making ornaments.

This is because of their inert nature, which makes them not react with the body.

II. Mercury is a liquid.

Mercury has no metallic bond

8. Arrange the following elements according to increasing atomic size

a. Iron, Osmium, Ruthenium

- Fe<Ru<Os

b. Molybdenum, strontium, Zirconium

- Mo<Zr<Dr

C. Scandium, lanthanum, Yttrium

- SC<Y<La

9. Which of the following pairs is more stable?

a. CrO30, WO3. WO3

b. MnO4-, ReO4-. ReO4-

C. Cr2+,Cr3+. Cr3+

d. Mn2+,MnO4-. Mn2+

e.CrO42-, MoO2-. MoO2-

f.Mn2OO7, Re2O7. Re2O7

10. Indicate whether the species below are oxidizing or reducing agents.

a. TiO2+. : Reducing agent

b. CrO2-. : Oxidizing agent

c. Cu+. : Reducing agent

d. MnO-. : Oxidizing agent

Briefly describe the following processes in metallurgy of transition elements.

Pryometallugy-

It is the extraction and purification of metals by processes involving only the application of heat.

The most important operations are roasting, smelting, and refining. Eg decomposition of hydrates such as ferric hydroxide.

Ii. Hydrometallurgy

Involves the use of aqueous solution in the extraction of metals from their ores. eg extraction of silver from it's ore.

III. Eletrometallurgy

This method uses electric energy to produce metals by ectrolysis. Eg extraction of aluminium from aluminium oxide.

B. 5 stages involved in metallurgy

I. Mining of the ore

II.seperation

III. Concentration of the metal or metal compound.

IV. Reduction of the ore

C. I.describe three major differences between the first row and the second and third rows

I. Atomic radius.

The second and third series tend to have similar atomic radii due to lanthanide contraction as a result they have similar chemistry compared to the first row elements.

II. Oxidation state

For the second and third row elements are more stable in the high oxidation states while the first row elements are more stable in the lower oxidation states.

Cii.Why the second and third row elements show alot of similarities in their chemistry.

This is due to lanthanide contraction, the difference between the radius of second and third group of elements is negligible.

As a result they have similar lattice energies, ionisation energies, and other properties.

D. Describe the d-block elements in the following respects.

I. Electron configuration

Generally the electron configuration of d-block elements is (n-1)d1-10ns1-2.

These elements can find stability in half-filled orbitals and completely filled orbitals.

An example is the electron configuration of copper.3d104s1.

Magnetic properties

Most of these elements compounds are paramagnetic because they contain partially filled d-orbitals.

paramagnetism and diamagnetism

Paramagnetism arises as a result of unpaired electrons an atom.

Diamagnetism

Unpaired electrons results in paramagnetism and aligned together unpaired electrons produce ferromagnetism.

D-block elements and their ions exhibit this behaviour depending on the unpaired electrons.

Complex compound formation

Complex compounds are compounds wherein a number neutral molecules or anions are bound to a metal.

Transition metals and their ions with the larger nuclear charge and smaller atomic size can attract electrons and receive lone pair of electrons from anions and neutral molecules into their empty d-orbitals forming coordinate bonding.

Catalytic properties

Most transition elements act as good catalyst because of the following:

I. The presence of vacant d-orbitals.

II. The tendency to to exhibit variable oxidation states.

III. The presence of defects in their crystal lattices

These elements take a reaction through a path of low activation energy by:

I. Providing a large surface area for the absorption and allowing sufficient time to react.

II.may interact with the reactants through their empty orbitals.

III. May actively interact by redox reaction through their multiple oxidation states.

Examples include, iron in the Haber process, vanadium v oxide in the manufacture of sulphuric acid.