NEW

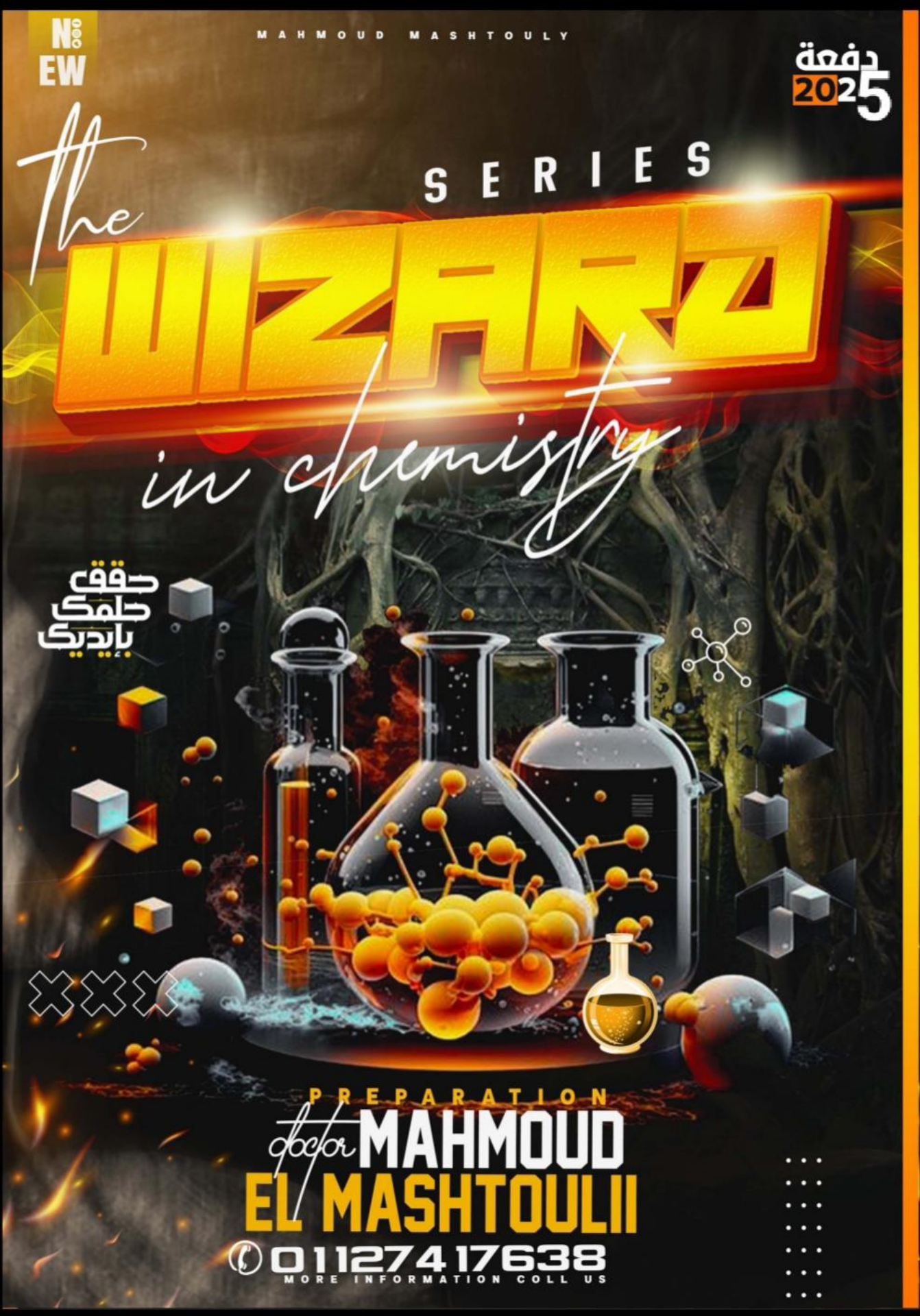
MAHMOUD MASHTOULY

دفعة 2025

SERIES

the WIZARD in chemistry

حقق حلمك بايدك



PREPARATION

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MORE INFORMATION COLL US

General properties for 1st transition series

Atomic mass	Density	Metallic bond	Magnetic property
Atomic radius	Chemical activity	Catalytic activity	Colors

Atomic mass

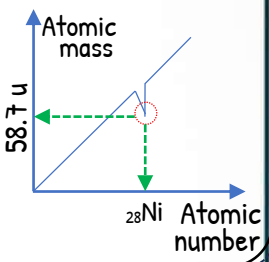
From **Sc** to **Cu** (left to right)

As **Atomic Number** ↑ **Atomic Mass** ↑

Atomic mass of **Nickel** is abnormal

As it has 5 isotopes and most of them have small atomic masses so average mass is 58.7 a.m.u

Graph



Atomic radius

From **Sc** to **Cu** (left to right)

Atomic radius decreases by very small amounts (So the atomic volume is relatively constant)

Explain Atomic volume is relatively constant from **Chromium** to **Copper** ?

For 2 opposite reasons :

1st factor (اول سبب)

As atomic no. increase (no. of protons increases = effective nuclear charge "Z_{eff}") & no. of electrons also increases so attraction force between them increases

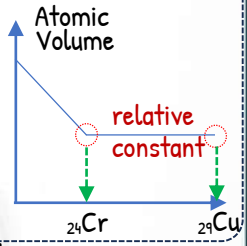
so atomic radius Decreases

2nd factor (تانى سبب)

Number of electrons (-ve charge) in d-sublevel increases which leads to increase repulsion force between electrons

so atomic radius increase

Graph



Explain These elements is used to make substitutional alloys ?

as there atomic radius is relatively constant

Density

$$\text{Density} = \frac{mass \uparrow}{Volume \text{ ثابت}}$$

As **Atomic Number** ↑ **Density** ↑

Chemical activity

From **Sc** to **Cu** (left to right)

As

Atomic Number ↑ **Activity** ↓

Examples

Scandium (Sc)

- High chemical activity

(React vigorously with H_2O)

$3Sc + 6HOH \longrightarrow 3\ Sc(OH)_3 + 3H_2$

Iron (Fe)

- Medium chemical activity
- Iron rust if exposed to air

Copper (Cu)

Limited chemical activity

Metallic property

- All of them are solids .. with metallic luster (لمعان) and good conductor of heat and electricity
- As **Valence electrons** ↑ **Metallic bond** (Strength) ↑ **Melting Point** ↑

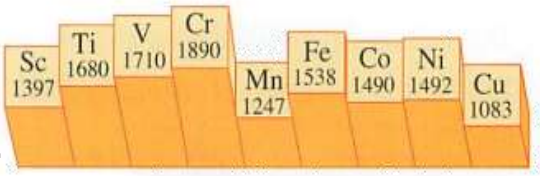
• كل ما يخرج عيال (الكترونات) كتير من ال atom يبقى ال metallic bond اقوى

• والسبب ان يخرج الكترونات كتيره .. ان ال transition elements بيخرج الالكترونس من 4s و ال 3d

---

بالرغم ان ال Mn عنده 5 unpaired electron فى ال d يعنى المفروض يبقى عنده metallic bond عاليه بس لقوا العكس ..

دا بسبب ان ال electrons دى فيه بينها و بين النيوكلس strong attraction force صعب يخرج الالكترونات .. ف البوند ضعيفه و كذلك ال melting



Melting point of 1st transition series

Magnetic property

لو لقيت فيها unpaired electrons يبقى كده الماده بتتشد لل magnet

Paramagnetic Property

↑

Unpaired electron

الالكترون بيلف حوالين نفسه (زى المروحه) فبيعمل magnetic field .. ف بيلزق فى المغناطيس

Substance that is attracted to external magnetic field is paramagnetic substance

Example : $d^1 : d^9$

Diamagnetic Property

↑↓

Paired electron

الالكترونين بيلفوا بس عكس بعض كل واحد بيطلع magnetic field عكس التانى .. فميش هيطلع magnetic field

Substance that isn't attracted to external magnetic field is Diamagnetic substance

Example : $d^0 : d^{10}$

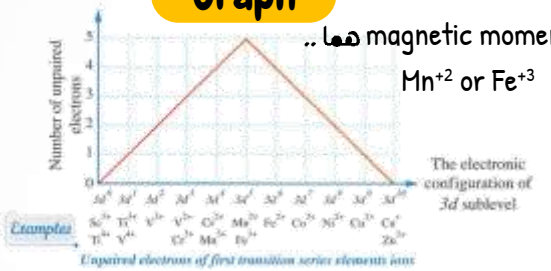
Paramagnetic Property — Diamagnetic Property

Magnetic moment

ساعات بيسأل عن ال magnetic moment (عزم المغناطيس) .. هى هى عدد ال unpaired electrons

Magnetic moment > 0 — Magnetic moment = 0

Graph



اعلى magnetic moment هما ..
Mn^{+2} or Fe^{+3}

الخلاصه

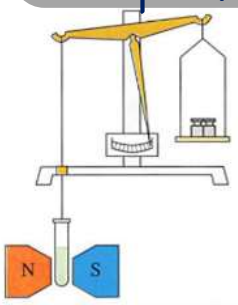
As unpaired electrons ↑ Magnetic moment ↑ Attraction force of magnet ↑

خلى بالك

ال unpaired electron بيبقى فى

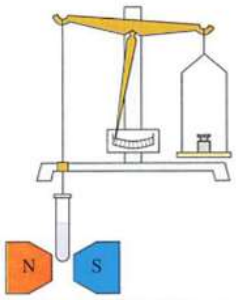
S or d

Example (1)



paramagnetic المادة الهنا دى
علشان مشدودة لل magnet

Example (2)



Diamagnetic المادة الهنا دى
علشان الوزن بتاع الثقل اتقل من المادة

Exercise (1)

Classify the following substances to paramagnetic & diamagnetic :

(Zn=30 Cu=29 Ni=28 Fe=26)

- Zinc (Zn)
- Nickel (II) (Ni^{+2})
- Copper (II) chloride (Cu^{+2})
- Iron (II) chloride (Fe^{+2})

Solution

Zn : [Ar] $4s^2$ $3d^{10}$ — Diamagnetic

Ni^{+2} : [Ar] $3d^8$ — Paramagnetic

Cu^{+2} : [Ar] $3d^9$ — Paramagnetic

Fe^{+2} : [Ar] $3d^6$ — Paramagnetic

Exercise (2)

Arrange the following cations ascendingly according to their magnetic moment:

- Titanium (III) oxide Ti_2O_3
- Chromium (III) oxide Cr_2O_3
- Copper (I) chloride $CuCl$
- Iron (III) chloride $FeCl_3$

Ti = 22
Cr = 24
Cu = 29
Fe = 26

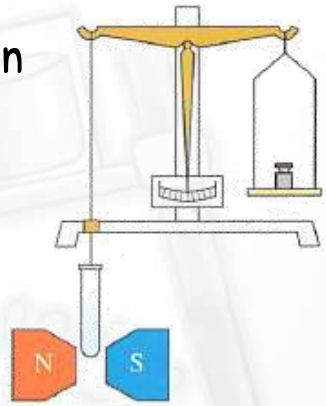
Solution

Ti_2O_3	Ti^{+3} : [Ar] $3d^1$	↑ □ □ □ □	1 unpaired electron
Cr_2O_3	Cr^{+3} : [Ar] $3d^3$	↑ ↑ ↑ □ □	3 unpaired electron
$CuCl$	Cu^{+} : [Ar] $3d^{10}$	↑↓ ↑↓ ↑↓ ↑↓ ↑↓	0 unpaired electron
$FeCl_3$	Fe^{+3} : [Ar] $3d^5$	↑ ↑ ↑ ↑ ↑	5 unpaired electron

Arrangement : $Cu^{+} < Ti^{+3} < Cr^{+3} < Fe^{+3}$

Exercise (3)

In the opposite figure, which of the following ions. when its compound is placed in a test tube, would make the balance pointer more deviated ? Explain.



- Co^{2+}
- Mn^{2+}
- Cr^{3+}
- V^{3+}

[V=23 , Cr=24 , Mn=25 , Co=27]

Solution

- Co^{2+} : [Ar] $3d^7$ ↑↓ ↑↓ ↑ ↑ ↑
- Cr^{3+} : [Ar] $3d^3$ ↑ ↑ ↑ □ □
- Mn^{2+} : [Ar] $3d^5$ ↑ ↑ ↑ ↑ ↑
- V^{3+} : [Ar] $3d^2$ ↑ ↑ □ □ □
- Mn^{2+} as it has 5 unpaired electron so it has highest magnetic moment

Colors

When visible light falls(Photons) on the substance , it absorbs some of the light and reflects the other colors to our eyes and that called

Complementary colors

It is sum of the colors that aren't absorbed by the elements , so elements will appears with reflected colors

Black color
[the substance absorbs all White light]

White color
[substance doesn't absorb any light]

Absorbed color		Complementary color
Blue	⇌	Orange
Red	⇌	Green
Violet	⇌	yellow

Chromium III (Cr^{3+}) appears in green color explain as it absorbs the red color so it appears the complementary

خلى بالك
الحاجه بيبقى ليها لوون لما يكون فى unpaired electron فى ال atomاو ال ion

In the transition metals if

- There is unpaired electrons in d -sublevel
  Colored substance (d^1 --> d^9)
- There isn't unpaired electrons in d -sublevel
  Colorless substance (d^0 - d^{10})

- Colorless
  [d^0 (Sc^{3+}) , d^{10} (Zn^{2+}) &
  S -block and p-block metals]

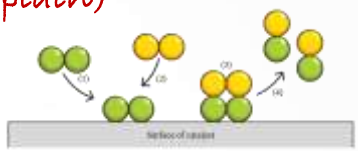
	Configuration	No. of unpaired	Magnetic moment	Color
Iron (III) Fe^{+3}	[Ar] $4s^0 3d^5$	5	Paramagnetic	colored
Copper (II) Cu^{+2}	[Ar] $4s^0 3d^9$	1	Paramagnetic	colored
Nickel (II) Ni^{+2}	[Ar] $4s^0 3d^8$	2	Paramagnetic	colored
Zinc (Zn)	[Ar] $4s^0 3d^{10}$	0	Diamagnetic	colorless

Catalytic activity

عموما ال catalyst هى اى ماده بتسرع التفاعل (ومابتتفاعلش "يعنى زى مادخلت زى ماهتخرج")

- Transition element are considered as **Ideal catalyst** (Explain)

Due to the presence of electrons in 4s & 3d Which :



(1) Form bonds between reactant & surface of catalyst

(2) So the concentration of reactant Increases at surface of catalyst

(3) which lead to decreasing the activation energy of the reaction So the rate of the reaction increases

هفهمك اصبر .. هنفترض رايح مدرستك .. قدامك حلين ..
ياتاخد صحابك وتتنطلطوا فى الميكروباصات و هتنزلوا فى اخر الخط مش زى ما ركبتوا ..
يا تركبوا ال metro (مواصله واحد) وهتنجزك .. وفى الاخر هتوصل لنفس الحته الانت عايزها .. بس
وفرتلك مجهود و وقت كمان علشان توصل للمدرسه .. ال catalyst هو ال metro

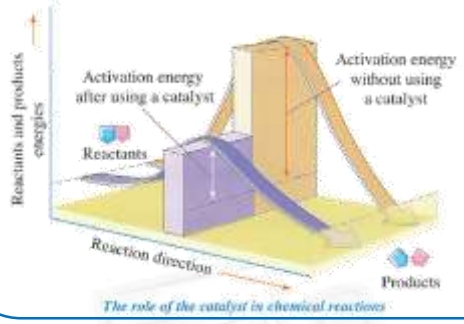
Role of catalyst

Catalyst decrease the activation energy of the reaction

activation energy ومعنى

دى الطاقه البتحتجها ال reactant علشان تتحول ل product

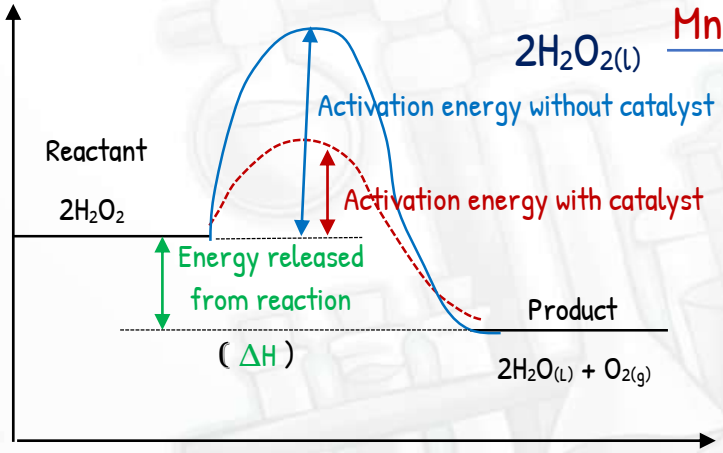
Role of catalyst



Example (1)

Manganese dioxide [MnO_2] Used in decomposition تفكك hydrogen peroxide [H_2O_2] to prepare oxygen gas & water

$$2H_2O_{2(l)} \xrightarrow{MnO_2} 2H_2O_{(L)} + O_{2(g)}$$



خلى بالاك

(ΔH)=-ve
نازل
exothermic
سخن

(ΔH)=+ve
طالع
endothermic
بارد

Example (2)

Divided iron [Fe] used in preparation of **Ammonia** gas by **haber-Bosh** Method

$$N_{2(g)} + 3\ H_{2(g)} \xrightarrow[500°c\ /\ 200\ atm]{Fe} 2\ NH_{3(g)}$$

Ammonia gas

Example (3)

Vanadium pent oxide (V_2O_5): Used in preparation of Sulphuric acid (H_2SO_4) by **contact method**

(1) $SO_{2(g)} + ½\ O_2 \xrightarrow[450°c]{V_2O_5} SO_{3(g)}$

Sulphur dioxide — Sulphur Trioxide

(2) $SO_{3(g)} + H_2O \longrightarrow H_2SO_{4\ (aq)}$

Sulphuric acid

Questions

Q (1)

Which of the following ions is paramagnetic ?

a) Co^{3+} b) Ag^{+} c) Cd^{2+} d) Sc^{3+}

Q (2)

The following table shows the atomic masses estimated in (u) of eight of the first transition series elements:

Element	(W)	(X)					(Y)	(Z)
Atomic mass (u)	47.86	50.942	51.996	54.938	55.845	58.933	58.69	63.54

Which of these elements is nickel?

a) (W) b) (X) c) (Y) d) (Z)

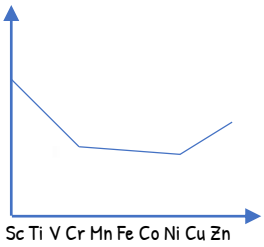
Q (3)

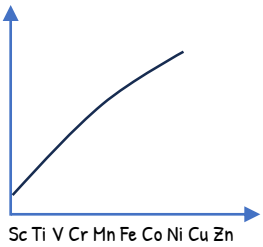
Which of the following represents the properties of a transition metal ?

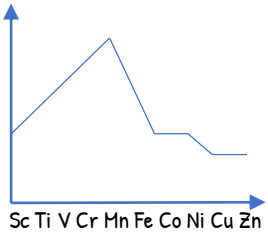
Choices	Density (g/cm^3)	Melting point (°C)	Boiling point (°C)
a)	0.97	98	883
b)	2.64	69	382
c)	3.1	-7	59
d)	8.96	108.5	2562

Q (4)

The following graphical figures represent the graduation in three properties of the elements of the first transition series :







Which of the following states the property whose graduation is represented by each of the three graphical figures ?

Choices	Graduation of the atomic radius property	Graduation of the effective nuclear charge property	Graduation of the highest common oxidation state property
a)	(1)	(2)	(3)
b)	(3)	(2)	(1)
C)	(1)	(3)	(2)
d)	(2)	(1)	(3)

Q (5)

Which of these ions has the greatest magnetic moment ?

a) Fe^{2+} b) Fe^{3+} c) Cr^{3+} d) Mn^{3+}

Q (6)

Which of these substances its weight decreases when placed in a magnetic field ?

a) VCl_3 b) $ScCl_3$ c) $TiCl_3$ d) $FeCl_3$

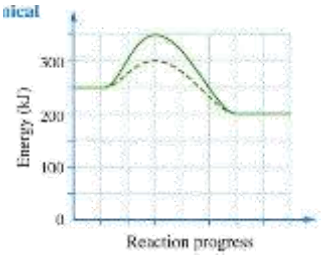
Q (7)

The spin-only magnetic moment μ of the atom or the ion of the element is calculated from the relation $\mu = \sqrt{n(n+2)}$, where (n) is the number of the unpaired electrons in the atom or the ion, and its value is estimated in (BM). What is the oxidation number of manganese when its μ value is 3.87 BM ?

a) +2 b) +3 c) +4 d) +5

Q (8)

The opposite graph represents a certain chemical reaction,



Calculate :

(1) The value of ΔH of reaction.

……

(2) The activation energy before using a catalyst.

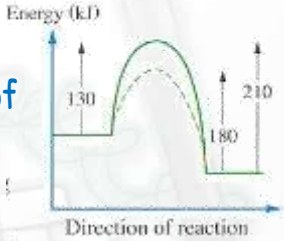
……

(3) The activation energy after using a catalyst.

……

Q (9)

The opposite graph represents the activation energy of a reaction before and after using a catalyst, Calculate the activation energy of the catalyzed reaction



Solution :

……

……

Q (10)

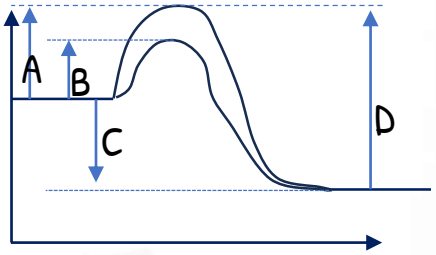
The two ions which form ammonium sulphate molecule are derived from the products of Haber-Bosch process and contact process, each of these two processes involves a catalyst. Which of the following represents one of these two processes ?

Choices	ion	Derived from	Process	Catalyst
a)	Ammonium	Ammonia	Contact	Iron
b)	Ammonium	Ammonia	Haber-Bosch	Vanadium pentoxide
c)	Sulphate	Sulphuric acid	Contact	Vanadium pentoxide
d)	Sulphate	Sulphuric acid	Haber-Bosch	Iron

Q (11)

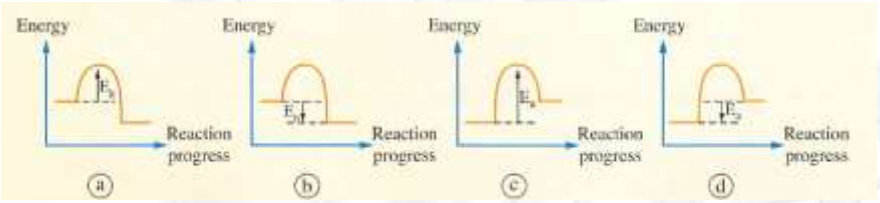
The opposite figure shows the energy diagram of a chemical reaction. What is the letter which indicates the activation energy when a catalyst is used ?

a) A b) B c) C d) D



Q (12)

Which of the following graphical figures represents an endothermic reaction whose activation energy equals E_a ?



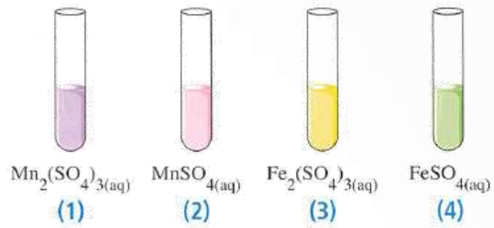
Q (13)

All the following aqueous solutions of vanadium compounds are colored, except

a) VCl_3 b) $VOSO_4$ c) Na_2VO_4 d) VSO_4

Q (14)

Study the opposite figures then describe the change in the color of each solution, (with explanation), after:



(1) Leaving the 4 test tubes exposed to atmospheric air.

……………………………………………………………………………………

……………………………………………………………………………………

(2) Passing hydrogen gas through them.

……………………………………………………………………………………

……………………………………………………………………………………

Q (15)

Which of the following compounds is used in providing the glass with the green color ?

a) Cu_2O b) TiO_2 c) MnO_2 d) Cr_2O_3

Q (16)

Which of the following hydrated ions is violet ?

a) Cr^{3+} b) Zn^{2+} c) Cu^{+} d) V^{2+}