

Full Syllabus Test 1

Subject: Chemistry

1. A gaseous mixture containing He , CH_4 and SO_2 was allowed to effuse through a fine hole. Find what molar ratio of gases comes out initially, if the mixture contains He , CH_4 and SO_2 in 1 : 2 : 3 mole ratio.

- ☒ A. 2 : 2 : 3
☒ B. 6 : 6 : 1
☒ C. $\sqrt{2} : \sqrt{2} : 3$
☒ D. 4 : 4 : 3

$$\text{Rate of effusion} \propto p \sqrt{\frac{1}{\text{molar mass}}}$$

Where p is the partial pressure of the gas in the container which is directly proportional to the number of moles present.

Hence,

$$\text{Rate of effusion} \propto \text{number of moles present initially} \times \sqrt{\frac{1}{\text{molar mass}}}$$

Hence, ratio of effusion rate of He , CH_4 and SO_2 =

$$\begin{aligned}
 &1 \times \sqrt{\frac{1}{4}} : 2 \times \sqrt{\frac{1}{16}} : 3 \times \sqrt{\frac{1}{64}} \\
 &= \frac{1}{2} : \frac{2}{4} : \frac{3}{8} = 4 : 4 : 3
 \end{aligned}$$

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2. For the dissociation reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, the degree of dissociation α in terms of K_p and total equilibrium pressure P is:

☐ A. $\alpha = \sqrt{\frac{4P + K_P}{K_P}}$

☒ B. $\alpha = \sqrt{\frac{K_P}{4P + K_P}}$

☐ C. $\alpha = \sqrt{\frac{K_P}{4P}}$

☐ D. None of these

$$\begin{array}{rcccl}
 & N_2O_4(g) & \rightleftharpoons & 2NO_2(g) & \\
 t = 0 & 1 \text{ mol} & & 0 & \\
 \text{at eq.} & 1 - \alpha & & 2\alpha & n_f = 1 + \alpha
 \end{array}$$

$$\begin{array}{rcc}
 \text{mole fraction} & \frac{1 - \alpha}{1 + \alpha} & \frac{2\alpha}{1 + \alpha} \\
 \text{Partial pressure} & \left(\frac{1 - \alpha}{1 + \alpha} \right) P & \left(\frac{2\alpha}{1 + \alpha} \right) P
 \end{array}$$

$$K_P = \frac{(P_{NO_2})^2}{P_{N_2O_4}} = \frac{\left(\frac{2\alpha}{1 + \alpha} \right)^2 P^2}{\left(\frac{1 - \alpha}{1 + \alpha} \right) P}$$

$$= \frac{4\alpha^2}{(1 + \alpha)(1 - \alpha)} P$$

on solving we will get,

$$\alpha^2 = \frac{K_P}{4P + K_P}$$

$$\alpha = \sqrt{\frac{K_P}{4P + K_P}}$$

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3. Which of the following is a buffer solution?

- ☒ A. 500 mL of 0.1 N CH_3COOH + 500 mL of 0.1 N NaOH
- ☒ B. 500 mL of 0.1 N CH_3COOH + 500 mL of 0.1 N HCl
- ☒ C. 500 mL of 0.1 N CH_3COOH + 500 mL of 0.2 N NaOH
- ☒ D. 500 mL of 0.2 N CH_3COOH + 500 mL of 0.1 N NaOH

a. $\text{CH}_3\text{COOH} + \text{NaOH} \rightleftharpoons \text{CH}_3\text{COONa} + \text{H}_2\text{O}$

0.1 N	0.1 N		
500 mL	500 mL		
50 meq.	50 meq.	0	0
at eqm. 0	0	50 meq.	

So, resultant solution is not a buffer solution.

b.

CH_3COOH	+	HCl
0.1 N		0.1 N
500 mL		500 mL
50 meq.		50 meq.

It is not a buffer solution.

CH_3COOH	+	NaOH	\rightleftharpoons	CH_3COONa	+	H_2O
0.1 N		0.2 N				
500 mL		500 mL				
50 meq.		100 meq.		0		0
at eqm. 0		50 meq.		50 meq.		
(meq. = milliequivalents)						

Resultant solution is not a buffer solution.

d. $\text{CH}_3\text{COOH} + \text{NaOH} \rightleftharpoons \text{CH}_3\text{COONa} + \text{H}_2\text{O}$

0.2 N	0.1 N		
500 mL	500 mL		
100 meq.	50 meq.	0	
at eqm. 50 meq.	0 meq.	50 meq.	

Resultant solution is a mixture of weak acid and its salt with strong base which is a buffer solution.

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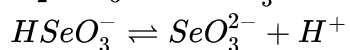
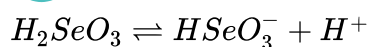
4. Selenious acid (H_2SeO_3), a diprotic acid has $K_{a1} = 3.0 \times 10^{-3}$ and $K_{a2} = 5.0 \times 10^{-8}$. What is the $[OH^-]$ of a 0.30 M solution of a selenious acid?

☐ A. 2.85×10^{-3}

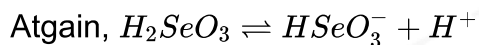
☐ B. 5.0×10^{-6}

☐ C. 3.5×10^{-12}

☒ D. 3.5×10^{-13}



Since K_{a1} has a very high value compared to K_{a2} , thus $[H^+]_{total} = [H^+]$



$$\begin{array}{l} t = 0 \quad C \quad 0 \quad 0 \\ t = t_{eq} \quad C - C\alpha \quad C\alpha \quad C\alpha \end{array}$$

$$\therefore K_{a1} = \frac{Ca^2}{(1 - \alpha)}$$

α is not negligible with respect to 1. So, after solving quadratic equation,

$$\alpha = 0.095$$

$$[H^+] = C\alpha = 0.095 \times 0.3$$

$$[OH^-] = \frac{k_w}{[H^+]}$$

$$\begin{aligned} [OH^-] &= \frac{10^{-14}}{0.095 \times 0.3} \\ &= 3.5 \times 10^{-13}. \end{aligned}$$

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5. Which of the following statements for crystals having Schottky defect is not correct?

- ☒ A. Schottky defect arises when some of the lattice points are unoccupied called vacancies or holes and the number of missing positive and negative ions is same so that the crystal remains neutral in all
- ☒ B. Schottky defect are more common in ionic compounds with high co-ordination number
- ☒ C. The density of the crystals having schottky defect is larger than that of the perfect crystal
- ☒ D. The crystal having schottky defect is electrically neutral as a whole

After removing cation and anion in Schottky defect, density of crystal will decrease. In Schottky defect, amount of positive charge removed = amount of negative charge removed.

6. What size of particles does a colloidal system has?

- ☒ A. $10^{-4} \text{ m to } 10^{-10} \text{ m}$
- ☒ B. $10^{-5} \text{ m to } 10^{-7} \text{ m}$
- ☒ C. $10^{-9} \text{ m to } 10^{-12} \text{ m}$
- ☒ D. $10^{-6} \text{ m to } 10^{-9} \text{ m}$

The size of colloidal particle is in the range of $10^{-6} \text{ m to } 10^{-9} \text{ m}$. Hence, (d) is the correct option.

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7. The d -electronic configuration of Cr^{2+} , Mn^{2+} , Fe^{2+} and Ni^{2+} are $3d^4$, $3d^5$, $3d^6$ and $3d^8$ respectively, which one of the following aqua-complex will exhibit the minimum paramagnetic behaviour?

- ☐ A. $[Cr(H_2O)_6]^{2+}$
- ☐ B. $[Mn(H_2O)_6]^{2+}$
- ☐ C. $[Fe(H_2O)_6]^{2+}$
- ☒ D. $[Ni(H_2O)_6]^{2+}$

As H_2O is weak ligand, pairing of electrons will not take place until each orbital is singly occupied.

a. $[Cr(H_2O)_6]^{2+} = 3d^4 = t_{2g}^3 e_g^1$

Number of unpaired electrons = 4

b. $[Mn(H_2O)_6]^{2+} = 3d^5 = t_{2g}^3 e_g^2$

Number of unpaired electrons = 5

c. $[Fe(H_2O)_6]^{2+} = 3d^6 = t_{2g}^4 e_g^2$

Number of unpaired electrons = 4

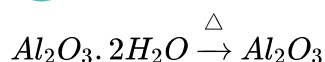
d. $[Ni(H_2O)_6]^{2+} \rightarrow Ni^{2+} = 3d^8 \rightarrow [Ni(H_2O)_6]^{2+}$

has $t_{2g}^6 e_g^2$ configuration in which only two unpaired electrons are present which is minimum in all.

More the number of unpaired electrons, more will be the paramagnetic behaviour.

8. The process of converting hydrated alumina into anhydrous alumina is called

- ☐ A. Roasting
- ☐ B. Smelting
- ☐ C. Dressing
- ☒ D. Calcination



This is called calcination.

Calcination is the process in which the ore of the metal is heated to high temperature in the absence or limited supply of air or oxygen.

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9. Glycerol boils at 290°C with slight decomposition. Impure glycerin can be purified by:

- ☐ A. Steam distillation
- ☒ B. Vacuum distillation
- ☐ C. Simple distillation
- ☐ D. Extraction by solvent

It can be purified by vacuum distillation as the liquids which decompose at its boiling point can be purified by vacuum distillation. Glycerol which decomposes at its boiling point can be distilled without decomposition by vacuum distillation.

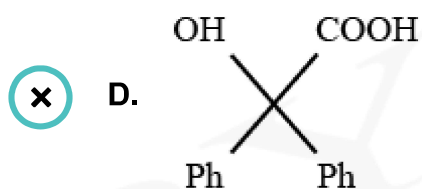
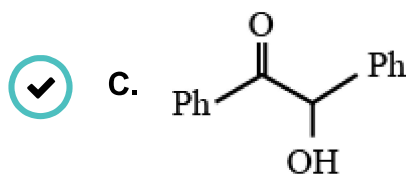
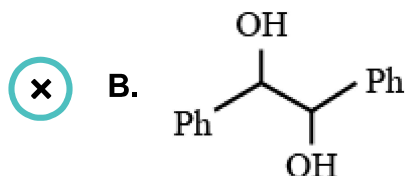
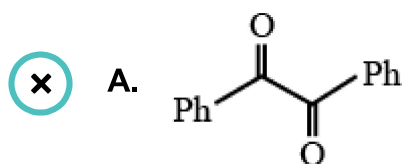
10. The carbon-based reduction method is used for the extraction of:

- ☐ A. Sn from SnO_2
- ☐ B. Fe from Fe_2O_3
- ☐ C. Zn from ZnO
- ☒ D. All of the above

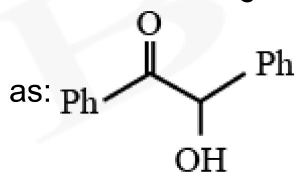
Carbon can be used as a reducing agent to extract metal from metal oxide. Less electropositive elements like tin, iron and Zn can be extracted using carbon reduction method.

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11. Which structure is related to benzoin?



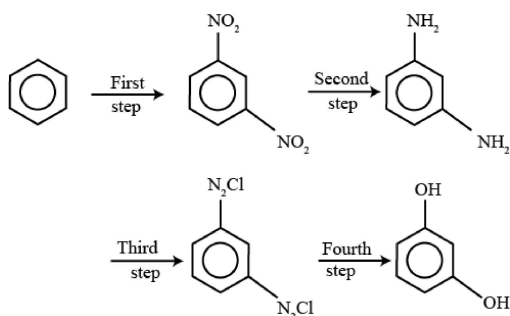
Benzoin is an organic molecule with molecular formula $C_{14}H_{12}O_2$ and structure



It is parent product formed in benzoin condensation reaction.

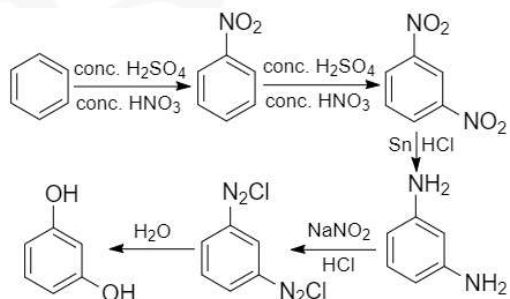
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12. Benzene can be converted in to 1,3-dihydroxy benzene in four steps as follows:



The correct sequence of reagents for this conversion is:

- ☒ A. $\text{Cu}_2/\text{H}_2\text{O}$; dil. HNO_3 ; NaNO_2/HCl ; Sn/HCl
- ☒ B. $\text{Conc. HNO}_3/\text{H}_2\text{SO}_4$; $\text{NaNO}_2/\text{Conc. HCl}$; Sn/HCl ; $\text{Cu}_2\text{O}/\text{H}_2\text{O}$
- ☒ C. $\text{Conc. HNO}_3/\text{H}_2\text{SO}_4$; Sn/HCl ; $\text{NaNO}_2/\text{Conc. HCl}$; H_2O
- ☒ D. $\text{Conc. HNO}_3/\text{H}_2\text{SO}_4$; $(\text{NH}_4)_2\text{S}$; $\text{NaNO}_2/\text{Conc. HCl}$; H_2O



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13.

List I	List II
(A) Sucrose	(i) β - D-glucose $C_1 - C_4$ glycosidic linkage
(B) Lactose	(ii) α - D-glucose, β - D-fructose $C_1 - C_2$ glycosidic linkage
(C) Cellulose	(iii) β - D-glucose, β - D-galactose $C_1 - C_4$ glycosidic linkage

List-I contains saccharides and List-II contains the monosaccharide units as well as glycosidic bonds.

Choose the correct option considering List-I and List-II.

- ☐ A. A - (iii), B - (i), (C) - (ii)
- ☒ B. A - (ii), B - (iii), (C) - (i)
- ☐ C. A - (i), B - (ii), (C) - (iii)
- ☐ D. A - (iii), B - (ii), (C) - (i)

(A) In sucrose, α - D-glucose and β - D-fructose are held together by $C_1 - C_2$ glycosidic linkage where C_1 is on the glucosyl subunit and C_2 is on the fructosyl unit.

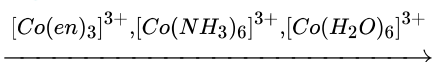
(B) In lactose, β - D-galactose and β - D-glucose are held together by $C_1 - C_4$ glycosidic linkage where C_1 is on the galactosyl subunit and C_4 is on the glucosyl unit.

(C) Cellulose is polysaccharide containing linear chain of several β - D-glucose units through $C_1 - C_4$ glycosidic linkage.

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14. Correct increasing order for the wavelength of absorption in the visible region for the complexes of Co^{3+} is:

- ☒ A. $[Co(en)_3]^{3+}, [Co(NH_3)_6]^{3+}, [Co(H_2O)_6]^{3+}$
☐ B. $[Co(H_2O)_6]^{3+}, [Co(en)_3]^{3+}, [Co(NH_3)_6]^{3+}$
☐ C. $[Co(H_2O)_6]^{3+}, [Co(NH_3)_6]^{3+}, [Co(en)_3]^{3+}$
☐ D. $[Co(NH_3)_6]^{3+}, [Co(en)_3]^{3+}, [Co(H_2O)_6]^{3+}$



According to spectrochemical series, strength of ligand decreases on moving from left to right in the given complexes, as the strength of ligand decreases splitting energy decreases and also energy between t_{2g} and e_g decreases. Hence, the correct order for increasing wavelength of absorption in the visible region is $[Co(en)_3]^{3+}, [Co(NH_3)_6]^{3+}, [Co(H_2O)_6]^{3+}$

15. For the ideal gaseous reaction, the rate is generally expressed in terms of $\frac{dP}{dt}$ instead of $\frac{dC}{dt}$ or $\frac{dn}{dt}$ (where $C = n/v$ is concentration and n is the number of moles). What is the relation among these three expressions if T and V are constant?

- ☐ A. $\frac{dC}{dt} = \frac{dn}{dt} = \frac{dP}{dt}$
☒ B. $\frac{dC}{dt} = \frac{1}{V} \frac{dn}{dt} = \frac{1}{RT} \left(\frac{dP}{dt} \right)$
☐ C. $RT \frac{dC}{dt} = \frac{dn}{dt} = \frac{dP}{dt}$
☐ D. None of these

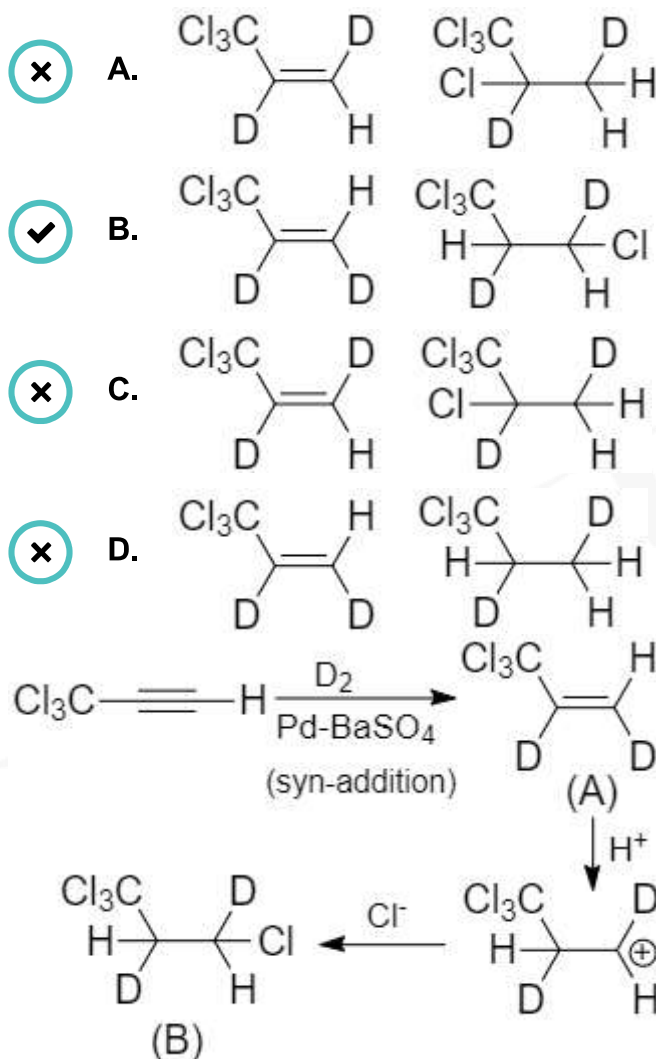
$$C = \frac{n}{V} = \frac{P}{RT}$$

$$\therefore \frac{dC}{dt} = \frac{1}{V} \frac{dn}{dt} = \frac{1}{RT} \left(\frac{dP}{dt} \right)$$

Since T and V are constants.

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16. $CCl_3 - C \equiv C - H \xrightarrow{D_2/Pd-HaSO_4} A \xrightarrow{HCl} B$
Compound A and B respectively are:



Secondary carbocation will be highly destabilized by electron withdrawing power of CCl_3- hence here it forms primary carbocation and result in antimarkovnikov product.

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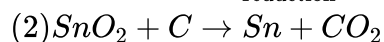
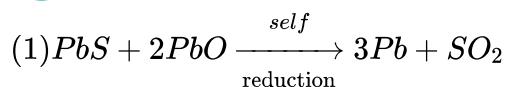
17. Which of the following salts will not give positive brown ring test?

- ☒ A. $Cu(NO_3)_2$
- ☐ B. $Pb(NO_3)_2$
- ☒ C. $Zn(NO_3)_2$
- ☒ D. $Mg(NO_3)_2$

$Pb(NO_3)_2$ does not give brown ring test because Pb^{2+} forms insoluble sulphate ($PbSO_4$) with H_2SO_4 and hinders formation of brown ring.

18. The methods chiefly used for the reduction of ores of lead and tin are respectively.

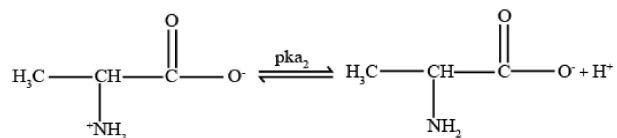
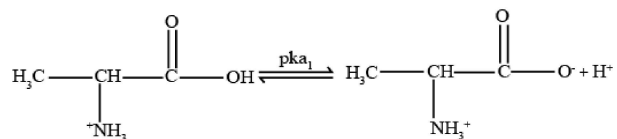
- ☒ A. Self reduction and carbon reduction
- ☒ B. Self reduction and electrolytic reduction
- ☒ C. Carbon reduction and self reduction
- ☒ D. Cyanide process and carbon reduction



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19. Consider the following ionic equilibrium

Given $pK_{a1} = 2.3$ and $pK_{a2} = 9.7$



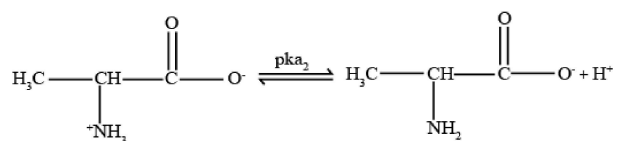
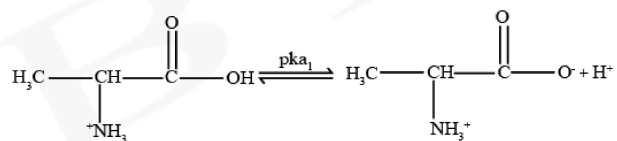
Then what is the isoelectric point of alanine?

☒ A. 8

☒ B. 6

☒ C. 4

☒ D. 5



$$PI = \frac{pK_{a1} + pK_{a2}}{2} = \frac{2.3 + 9.7}{2} = 6$$

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20. The sum of p orbitals involved in the hybridisation of NH_3 and BF_3 molecules are:

☒ A. 6

☒ B. 5

☒ C. 4

☒ D. 3

In NH_3 , N is bonded to three H atoms and also has a lone pair. Thus, it is sp^3 hybridised.

In BF_3 , B is bonded to three F atoms and has no lone pair. Thus, it is sp^2 hybridised.

The hybridisation of NH_3 and BF_3 are sp^3 and sp^2 respectively.

Hence, a total of 5 p orbitals are involved in the hybridisation of both the molecules.

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21. $p \times 10^{-q}$ is the molarity of SO_4^{2-} ion in an aqueous solution that contains 34.2 ppm of $Al_2(SO_4)_3$. Calculate $(p + q)$?
(Assume complete dissociation and density of solution 1 g L^{-1})

Accepted Answers

7 7.0 7.00

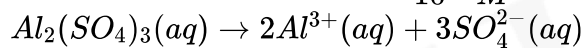
Solution:

We know, 34.2 ppm of $Al_2(SO_4)_3$ is actually equal to 34.2 mg of $Al_2(SO_4)_3$ in 1 L solution.

Again, molar mass of $Al_2(SO_4)_3 = 342 \text{ g/mol}$

$$\therefore \text{Molarity of } Al_2(SO_4)_3 = \frac{34.2 \times 10^{-3}}{342} M$$

$$= 10^{-4} M$$



$$10^{-4} M \quad \quad \quad 2 \times 10^{-4} M \quad \quad \quad 3 \times 10^{-4} M$$

$$[SO_4^{2-}] = 3 \times 10^{-4} M$$

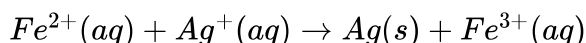
According to the question,

$$p = 3 \text{ and } q = 4$$

$$\therefore p + q = 3 + 4 = 7$$

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22. Consider an electrochemical cell in which the following reaction occurs :



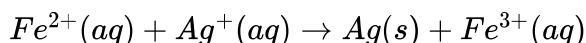
Then how many of following changes will decrease the cell voltage:

- (i) Decrease the $[Ag^+]$
- (ii) Increase in $[Fe^{3+}]$
- (iii) Increase the amount of Ag

Accepted Answers

2 2.0 2.00

Solution:



$$E_{cell} = E_{cell}^o - \frac{0.0591}{1} \log \frac{[Fe^{3+}]}{[Fe^{2+}][Ag^+]}$$

- (i) By decreasing $[Ag^+] \rightarrow E_{cell} \downarrow$
- (ii) By increasing $[Fe^{3+}] \rightarrow E_{cell} \downarrow$
- (iii) By increasing amount of $Ag \rightarrow$ no effect on E_{cell} .

23. Number of oxygen shared in neosilicates is a, in sorosilicate is b, cyclosilicates is c, phyllosilicate is d and tectosilicates is e. Then $a + b + c + d + e$ is

Accepted Answers

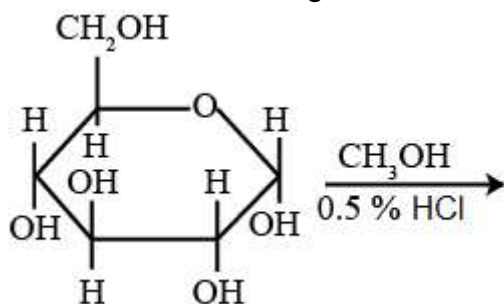
11 11.0 11.00

Solution:

- a) unit composition of neosilicate is SiO_4^{4-} and no oxygen is shared.
 - b) unit composition of pyrosilicate is $Si_2O_7^{6-}$ and number of oxygen shared is 2
 - c) unit composition of cyclosilicate is $Si_6O_{18}^{6-}$ and number of oxygen shared is 2
 - d) unit composition of phyllosilicate is $Si_2O_6^{2-}$ and number of oxygen shared is 3
 - e) unit composition of tectosilicate is SiO_2 and number of oxygen shared is 4
- Hence $a + b + c + d + e$ is 11

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24. Consider the following reaction.

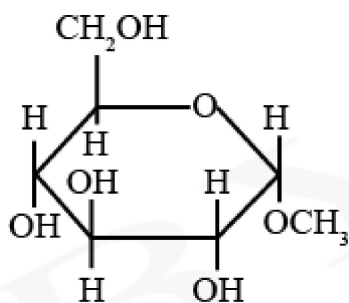


How many methoxy group is/are present in the final product?

Accepted Answers

1 1.0 1.00

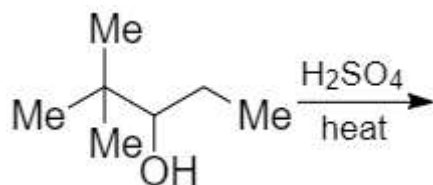
Solution:



Acid catalysed methylation of glucose with methanol leads to methylation of anomeric OH and thus forms methyl glucoside.

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25.

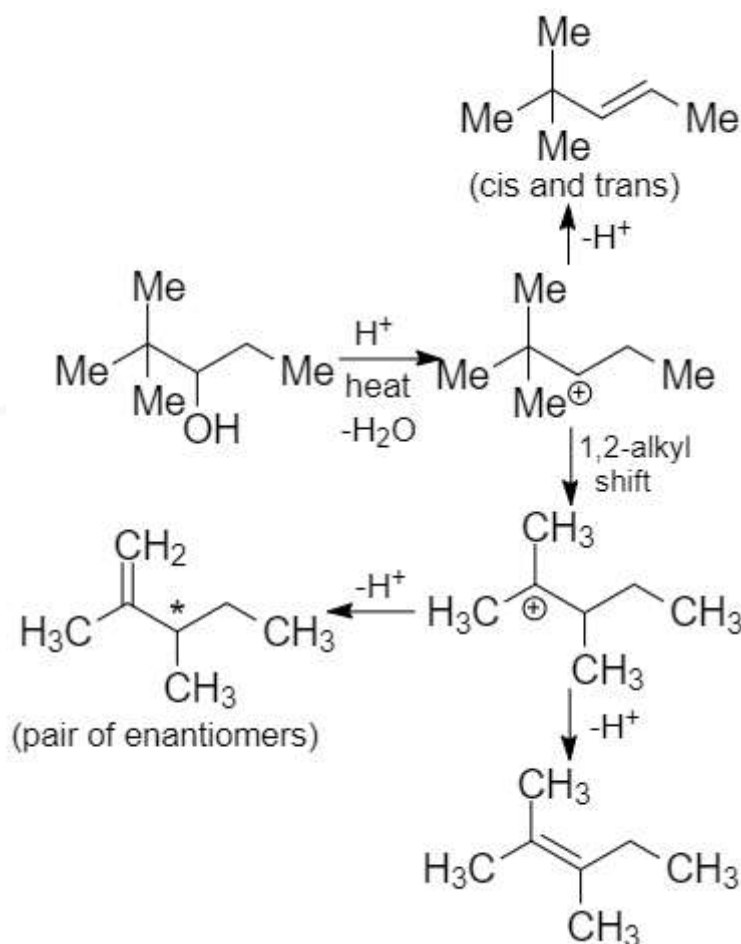


In the given reaction, the total number of alkenes formed (including stereoisomers) is:

Accepted Answers

5 5.0 5.00

Solution:



So, a total 5 alkenes can be formed including stereoisomers.

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26. An organic compound was analysed by Duma's method, 0.40 g of compound on combustion gave 50 mL of nitrogen at 27°C and 756 mm of pressure. Calculate percentage of nitrogen in the compound.

Accepted Answers

14.14 14.1 14

Solution:

By using formula,

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

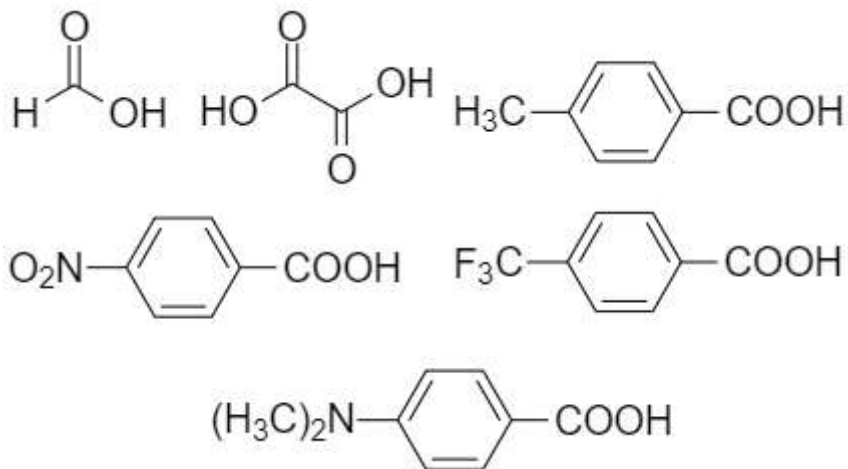
$$\text{Volume of } N_2 \text{ at STP} = \frac{P_1 V_1}{T_1} \times \frac{T_2}{P_2} = \frac{756}{300} \times 50 \times \frac{273}{760} = 45.26 \text{ mL}$$

Mass of organic compound (W) = 0.40 g

$$\% \text{ of } N_2 = \frac{28}{22400} \times \frac{V_2}{W} \times 100 = \frac{28}{22400} \times \frac{45.26}{0.40} \times 100 = 14.14\%$$

Full Syllabus Test 1

27. Find out the number of compounds which are more acidic than benzoic acid among the following.

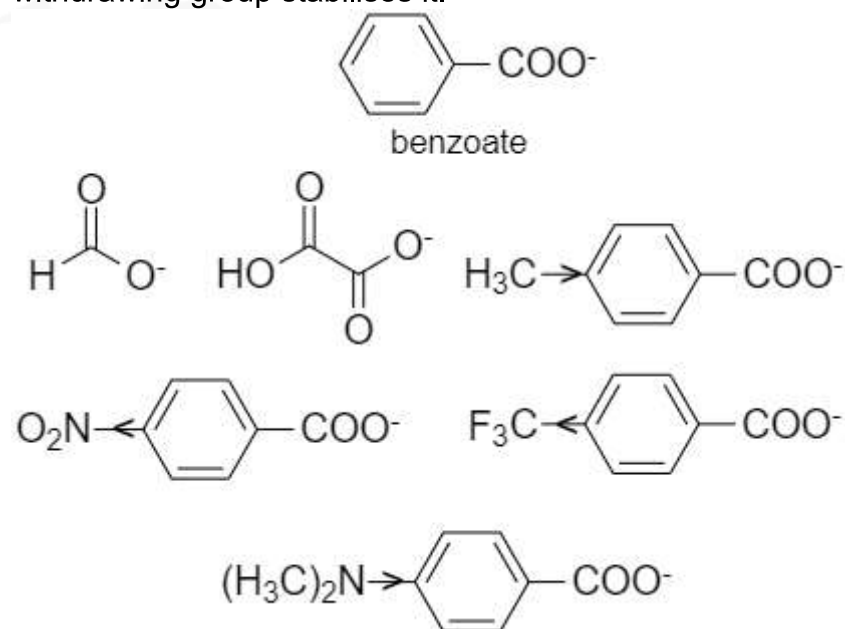


Accepted Answers

4 4.00 4.00

Solution:

Acidic strength can be attributed to the stability of the conjugate base. Electron donating species destabilise the conjugate base, whereas electron withdrawing group stabilises it.



Formic acid and oxalic acid are stronger acids than benzoic acid. Thus, a total of 4 acids are stronger than benzoic acid among the given compounds.

Full Syllabus Test 1

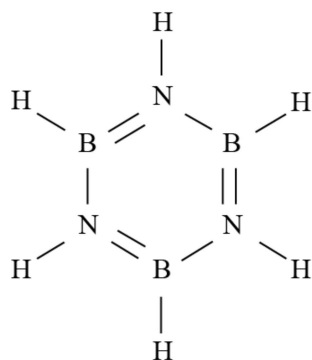
28. If the number of bonds present in borazole are x σ and y π , then find the value of $x \times y$.

Accepted Answers

36 36.0 36.00

Solution:

Structure of inorganic benzene is:



Hence,

Number of σ bonds = 12

Number of π bonds = 3

$\therefore x \times y = 12 \times 3 = 36$

Full Syllabus Test 1

29. 29.2% (w/w) HCl stock solution has a density of 1.25 g mL^{-1} . The molecular weight of HCl is 36.5 g mol^{-1} . The volume (mL) of stock solution required to prepare a 200 mL solution of 0.4 M HCl is :

Accepted Answers

8.0 8 8.00

Solution:

Given,

density = 1.25 g mL^{-1}

Mass of 1000 mL solution = 1250 g

According to the question,

100 g of the solution contains 29.2 g HCl

So, 1250 g of the solution contains $(29.2 \times 12.5) \text{ g } HCl$

So, Molarity of the solution = $\frac{9.2 \times 12.5}{36.5} = 10 \text{ M}$

Let, the volume of stock solution required be $V_1 \text{ mL}$.

$$\therefore V_1 = \frac{200 \times 0.4}{10} = 8 \text{ mL}$$

30. A decapeptide (Mol. wt. 796) on complete hydrolysis gives glycine (Mol. wt. 75), alanine and phenylalanine. Glycine contributes 47.0% to the total weight of the hydrolysed products. The number of glycine units present in the decapeptide is

Accepted Answers

6 6.00 6.0

Solution:

Molecular weight of decapeptide = 796 g/mol

Total bonds to be hydrolysed ($10-1$) = 9 per molecule

Total weight of H_2O added = $9 \times 18 = 162 \text{ g/mol}$

Total weight of hydrolysis products = $796 + 162 = 958 \text{ g}$

Total weight % of glycine (given) = 47%

$$\text{Total weight of glycine in product} = \frac{958 \times 47}{100} = 450 \text{ g}$$

Molecular weight of glycine = 75 g/mol

$$\text{Number of glycine molecules} = \frac{450}{75} = 6$$