Sample Question Paper- Chemistry

Time- 3 Hours **Max. Marks: 70**

General Instruction:

1. Question 1 is of 20 marks having four sub parts, all of which are compulsory.
2. Question numbers 2 to 8 carry 2 marks each, with two questions having internal choice.
3. Question numbers 9 to 15 carry 3 marks each, with two questions having internal choice.
4. Question numbers 16 to 18 carry 5 marks each, with an internal choice.
5. All working, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.
6. The intended marks for questions or parts of questions are given in brackets [].
7. Balanced equations must be given wherever possible and diagrams where they are helpful.
8. When solving numerical problems, all essential working must be shown.
9. In working our problems, use the following data:
   Gas constant R = 1.987 cal deg^{-1} mol^{-1} = 8.314 JK^{-1} mol^{-1} = 0.0821 dm^3 atm K^{-1} mol^{-1}
   1 l atm = 1 dm^3 atm = 101.3 J. 1 Faraday = 96500 Coulombs.
   Avogadro's number = 6.023×10^{23} mol^{-1}.

Question 1: (a) Fill in the blanks by choosing the appropriate word/ words from those given in the brackets: **[4]**

(Nitrolim, 68%, covalent bonding, 52.4%, 6, H-bonds, DDT)

(i) The packing fraction of a simple cubic unit cell is _____.
(ii) For 100% dissociation of $K_4[Fe(CN)_6]$, van't Hoff factor i = _____.
(iii) Calcium cyanamide is used as fertilizer under the name_____.
(iv) Solubility of alcohols and phenols in water is due to their ability to form_____ with water molecules.

(b) Complete the following statements by selecting the correct alternative from the choices given: **[4]**

(i) The role of a catalyst is to change_____
(a) Gibbs energy of reaction
(b) Enthalpy of reaction
(c) Activation energy of reaction
(d) Equilibrium constant

(ii) In the reaction
$C_6H_5CHO + (CH_3CO)_2 \xrightarrow{CH_3COONa} A$, Product A is
(a) Acetaldehyde
(b) Cinnamic acid

(c) β -naphthol
(d) Phenol

(iii) Amongst the following, the most basic compound is
(a) Benzylamine
(b) Aniline
(c) Acetanilide
(d) p – nitroaniline

(iv) The numbers of octahedral sitespes sphere in a fcc structure is
(a) 1
(b) 2
(c) 4
(d) 8

(c) Match the laws given in Column I with expressions given in Column II. [4]

Column I	Column II
A. Raoult's law	1. $\pi = CRT$
B. Henry's law	2. $\rho = x_1\rho_1^0 + x_2\rho_2^0$
C. Elevation in boiling point	3. $\Delta T_b = K_b m$
D. Osmotic pressure	4. $\rho = K_H \cdot x$

(d) Answer the following questions: [4×2]
(i) Find out the molar conductivity of an aqueous solution of $BaCl_2$ at infinite dilution when ionic conductances of Ba^{2+} and Cl^- ions are 127.30 S cm^2 mol^{-1} and 76.34 S cm^2 mol^{-1}, respectively.

(ii) The resistance of a conductivity cell containing 0.001M KCl solution at 298 K is 1500Ω. What is the cell constant, if the conductivity of 0.001 M KCL solution at 298K is 01.46×10^{-3} S cm^{-1}?

(iii) The rate of gaseous reaction is halved when the volume of the vessel is doubled. What is the order of the reaction?

(iv) A spontaneous reaction is not necessarily a fast reaction. Why?

Solution 1:
(a) (i) 52.4%
(ii) 5
(iii) Nitrolim
(iv) H- bonds

(b) (i) c (ii) b (iii) a (iv) a

(c) $A \rightarrow 3, B \rightarrow 5, C \rightarrow 4, D \rightarrow 1, E \rightarrow 2$

(d) (i) By applying Kohlrausch's law,

$\Lambda_m^o(BACl_2) = \lambda_{Ba^{2+}}^o + 2\lambda_{Cl^{2-}}^o$

$\Lambda_m^o(BACl_2) = \lambda_{Ba^{2+}}^o + 2\lambda_{Cl^{2-}}^o$

Given , $\lambda_{Ba^{2+}}^o = 127.30 Scm^2mol^{-1}$

$\lambda_{Cl^-}^o = 76.34 Scm^2mol^{-1}$

Thus,

$\Lambda_m^o(BACl_2) = 127.30 Scm^2mol^{-1} + 2 \times 76.34 Scm^2mol^{-1}$

$= 127.30 Scm^2mol^{-1} + 152.68 Scm^2mol^{-1}$

$= 279.98 Scm^2mol^{-1}$

(ii) Given that, conductivity,

$\kappa = 0.146 \times 10^{-3} Scm^{-1}$

Resistance, R = 1500Ω

Therefore, cell constant =

$\kappa \times R$

$= 0.146 \times 10^{-3} \times 1500$

$= 0.219 cm^{-1}$

(iii) Let the reaction be,

$A \rightarrow$ products

$Rate = k[A]^n$ or $r = k[a]^n$ ----------(i)

When volume of the vessel is double, molar concentration becomes half. SI=ince, rate becomes half, therefore,

$\frac{r}{2} = k\left[\frac{a}{2}\right]^n$ ----------(ii)

Dividing (i) by (ii), we get,

$2 = 2^n$ or $n = 1$

order = 1

(iv) A spontaneous reaction means that it has tendency to occur at its own. But this reaction may take very small time or extremely large time.

Question 2: Account for the following: **[2]**

(i) N-N single bond is weaker than P-P bond.
(ii) PCl5 is more covalent than PCl3.

OR

Write the balanced chemical equations for the following:
(i) Reaction of gold with aqua – regia.
(ii) Reaction of chlorine with dry slaked lime.

Solution 2:

(i) N-N bond is weaker than the single P-P bond due to high interelectronic repulsion of the non-bonding electrons in N_2 owing to small bond length. This makes the N-N bond weaker than P-P bond. Therefore, the catenation property is weaker in nitrogen as compared to phosphorus.

(ii) Higher the positive oxidation state of central atom, more will be its polarizing power, which increases the covalent character of the bond formed between the central atom and the halogen atom. In pentahalides, the central atom is in +5 oxidation state while in trihalides, it is in +3 oxidation state. Therefore, pentahalides are more covalent than trihalides.

OR

(i) When gold reacts with aqua-regia

$$Au + 4H^+ + NO_3^- + 4Cl^- \rightarrow AuCl_4^- + NO + 2H_20$$

(ii) When dry slaked line reacts with chlorine, it give bleaching powder.

$$2Ca(OH)_2 + 2CL_2 \rightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O$$

Question 3: **[2]**

(i) Why would tranquilizer not be taken regularly for long period?
(ii) Why medicines should not be taken without consulting doctors?

Solution 3:

(i) It is because body becomes habitual of these drugs.
(ii) It does taken higher than recommended then it may cause harmful effect and act as poison. Thus, a doctor should always be consulted before taking medicine.

Question 4: **[2]**

(i) If a is the edge length of a body centered cubic structure and r is the radius of the atom, then how are these two related?
(ii) How many atoms are present per unit cell in a primtire unit cell?

Solution 4:

(i) For abody centred cubic structure, edge length and radius are related as:

$r = \frac{\sqrt{3}}{4} a$

(ii) 1 atom per unit cell.

Question 5: KF has ccp structure, calculate the radius of the unit cell if the side of the cube or edge length is 400pm. How many F^- ions and octahedral voids are there in the unit cell? **[2]**

Solution 5: For ccp lattice, $r = \frac{a}{2\sqrt{2}} = \frac{400}{2 \times 1.414} = 141.4pm$

Theses are four F^- ions and four octahedral voids.

Question 6: What is oxidation state of the halogen in the following:
(i) Cl_2O (ii) ClO_2 (iii) $KBrO_3$ (iv) $NaClO_4$ **[2]**

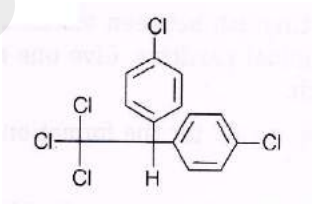
Solution 6: Oxidation state of hydrogen
(i) $\underline{Cl}_2O : +2$ (ii) $\underline{Cl}O_2 : +4$ (iii) $K\underline{Br}O_3 : +5$ (iv) $Na\underline{Cl}O_4 : +7$

Question 7: Write the formula of DDT and its uses.

OR

Write the physical property of tetrachloromethane and its uses. **[2]**

Solution 7:
Formula of DDT



Uses (i) DDT is a cheap but powerful insecticide.
(ii) It is popularly very effective against anopheles, mosquitoes and lice that carry typhus.

OR

Carbon tetrachloride, CCl_4
It is colorless oily liquid with sickly smell. Its boiling point 350K.
Uses
It is used
(i) in large quantities, in the manufacturing of refrigerators and propellants for aerosol cans.
(ii) as a feed stock in the synthesis of chlorofluorocarbons (freons) and other chemicals.
(iii) as a cleaning fluid, as a degreasing agent, as a sport remover.

(iv) as fire extinguisher.

Question 8: Explain Finkelstein reaction with example. **[2]**

Solution 8: Alkyl iodides are often prepared by the reaction of alkyl chlorides/bromides with Nal in dry acetone. This reaction is known as Finkelstein reaction.

e.g. $CH_3CH_2Br + NAI \xrightarrow[\Delta]{\text{Acetone}} \underset{\text{Iodoethane}}{CH_3CH_2I} + NaBr$

$CH_3CH_2Cl + NAI \xrightarrow[\text{Reflux}]{\text{Acetone}} \underset{\text{Iodoethane}}{CH_3CH_2I} + NaCl$

Question 9: **[3]**

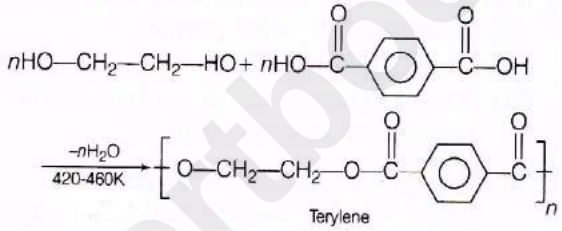
(i) Give an example of polyester used as a synthetic fibre.

(ii) Name the compounds from which polyester is prepared.

(iii) What type of polymerization takes place during the formation of the polyester from these compounds?

Solution 9: (i) Terylene is a polyester which is used as synthetic fibre.

(ii) It is a condensation polymer of ethylene glycol and terephthalic acid.



(iii) Condensation polymerization takes place during the formation of the polyester from terephthalic acid and ethylene glycol.

OR

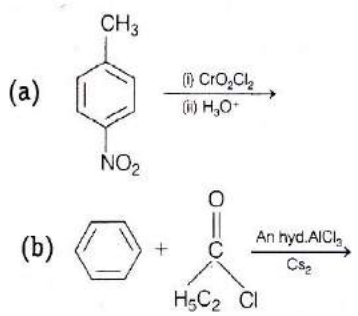
Difference between Chain Growth and Step Growth Polymerisation

S.No.	Chain Growth Polymerisation	Step Growth Polymerisation
1.	Only one repeating unit is added at a time.	Any two species present can react.
2.	Reaction mixture contains only monomer, polymer and growing chain.	All molecular species are present at any stage.
3.	Concentration of monomers disappear early in the reaction.	Concentration of monomers decreases steadily throughout the reaction.
4.	With increase in reaction time, the yield increase but molecular weight is affected a little.	Long reaction time is essentially required to get high molecular mass polymer.
5.	Reaction is fast and polymer is formed at once.	The polymer is formed in gradual steps.
6.	There is very little change in the molecular mass throughout the reaction.	The molecular mass of polymer increases throughout the reaction.

Question 10: Explain denaturation of proteins. **[3]**

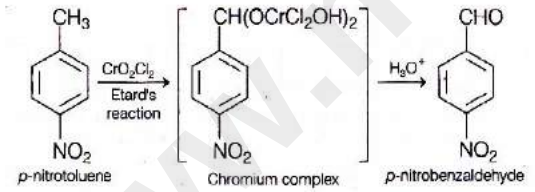
Solution 10: Denaturation of Proteins:
Protein is found in a biological system with a unique three- dimensional structure and biological activity is called native protein. When there is a physical change like change in temperature or chemical change like change in pH in the native form, the hydrogen bonds gets disturbed. As a result, globules unfold and helix get uncoiled and protein losses its biological activity. This is known as denaturation of protein. During denaturation, 2^o and 3^o structure destroyed but 1^o structure remains intact e.g. Coagulation of egg while on boiling and curding of milk which is caused due to the formation of laction acid by the bacteria present in milk.

Question 11: **[3]**
(i) Write the structure of the main products of the following reactions: **[2]**

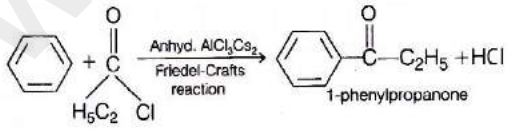


(ii) How is phenyl amino methane obtained from phenyl nitrile? **[1]**

Solution 11: (A)



(B)



Question 12: **[4]**

(i) Which of the following ores can be concentrated by forth floating method and why? **[1]**
(ii) How does sodium cyanide act as depressant in preventing zinc sulphide (ZnS) from forming the forth? **[3]**

Solution 12:

(i) Froth floating method is used to concentrate only sulphide ores (ZnS) because of their preferential wettability by pine oil.

(ii) Sodium cyanide combines with ZnS to form a complex $NA_2[Zn(CN)_4]$ on the surface of ZnS and therefore, it selectively prevents ZnS from forming the froth.

$$ZnS + 4NaCN \rightarrow \underset{\text{Sodium tetracyanozincate(II)}}{Na_2[Zn(CN)_4]} + Na_2S$$

Question 13: **[3]**

(i) What is the role of a stabilizer in froth floating process? Give examples.

(ii) What is cupellation?

OR

Explain zone refining method of metal with diagram.

Solution 13:

(i) In forth floatation process stabilizer stabilizes the froth. For example aniline, cresol, etc.

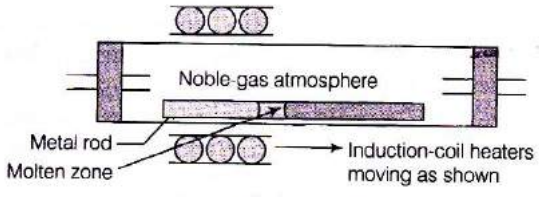
(ii) Cupellation is a method used for refining of those metals which contain impurities of other metals which form volatile oxides. The process was used to obtain silver from melted teadores.

OR

Zone Refining: This method is based on the principle that the impurities are more soluble in the melt than in the solid state of the metal.

A moveable circular heater is fixed at one end of the rod of impure metal. The molten zone moves along with the heater which is moved forward. As the heater moves forward, the pure metal crystallises while the impurities pass on to the molten zone and finally fall down.

This process is repeated several times. It gives metals of high purity e.g. Si, Ge, Ga, B and In, etc.



Zone refining process

Question 14: **[4]**

(i) Explain the following reactions:

(a) Stephen reaction (b) Etard reaction

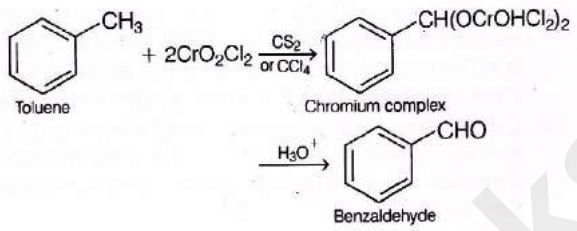
(ii) Arrange the following compounds in the increasing order of their acidic strength.

$(CH_3)_2CHCOOH$, $CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$.

Solution 14: (i) (a) Stephen reaction: In this reaction, nitriles are reduced to corresponding imine with stannous chloride, in the presence of hydrochloric acid, which on hydrolysis gives corresponding aldehyde.

$$\underset{\text{Alkyl cyanide}}{RCN} + SnCl_2 + HCl \rightarrow \underset{\text{Imine}}{RCH{=}{=}NH} \xrightarrow{H_3O^+} \underset{\text{Aldehyde}}{RCHO}$$

(b) Etard reaction: in this reaction chromyl chloride oxidises methyl group of toluene to a chromium complex, which on hydrolysis gives corresponding benzaldehyde.



(ii) The increasing order of acidic strength is

$$(CH_3)_2CHCOOH < CH_3CH(Br)CH_2COOH < CH_3CH_2Ch(Br)COOH$$

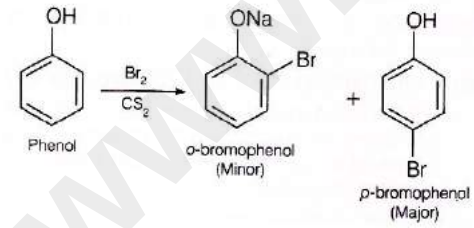
This is because presence of electron withdrawing group (EWG) makes an acid more acidic. (As the distance between EWG and –COOH group increases, acidity decreases.)

Question 15: Give equations for the following reactions: **[3]**

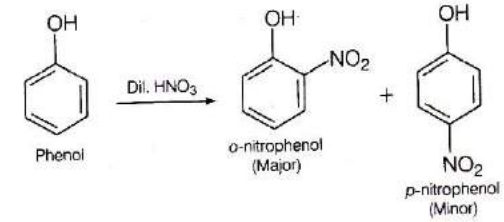
(i) Bromine in CS_2 with phenol.
(ii) Dilute HNO_3 with phenol.
(iii) Treating phenol with chlorofoam in the presence of aqueous NaOH.

Solution 15:

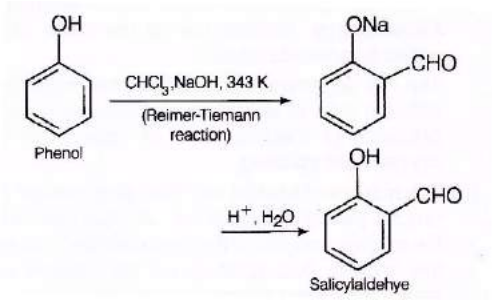
(i)



(ii)



(iii)



Question 16: **[5]**

(i) A violet compound of manganese, W decomposes on heating to liberate oxygen and compounds X and Y of manganese are also formed. Compound Y reacts with KOH in the presence of oxygen to give compound X.

On heating compound Y with conc. H_2SO_4 and NaCl, chlorine gas is liberated and a compound Z of manganese along with other products is formed. Identify compounds W to Z and also explain the reactions involved.

OR

Give reasons for the following:

(i) Iron is a transition metal while sodium is not.

(ii) Cd^{2+} salts are white.

(iii) Zn, Cd and Hg are quite soft and have low melting points.

(iv) $La(OH)_3$ is more basic than $Lu(OH)_3$.

(v) Third ionization enthalpy of manganese is exceptionally high.

Solution 16:

(i) Since, compound Y on reacting with conc. H_2SO_4 and NaCl gives Cl_2 gas, so it is manganese dioxide (MnO_2). It is obtained along with MnO_4^{2-} when $KMnO_4$ (violet) is heated.

Thus, W = $KMnO_4$, X = K_2MnO_4, Y = MnO_2, Z = $MnCl_2$.

$$\underset{W}{2KMNO_4} \xrightarrow{\Delta} \underset{X}{K_2MnO_4} + \underset{Y}{MnO_2} + O_2$$

$$\underset{Y}{2MnO_2} + \underset{W}{4KOH} + O_2 \rightarrow \underset{X}{2K_2MnO_4} + H_2O$$

$$\underset{Y}{MnO_2} + 4NACl + 4H_2SO_4 \xrightarrow{\Delta} \underset{Z}{MnCl_2} + 4NaHSO_4 + 2H_2O + Cl_2$$

OR

(i) Transition metals have incompletely filled d – orbitals. As a result, they exbit variable oxidation states. Thus, iron has unpaired electrons in the d- subshell while sodium does not have.

(ii) Cd^{2+} salts are white because Cd^{2+} ion has completely filled d- orbitals ($4d^{10}$). Hence, in the absence of d-d transition, they show only white colour.

(iii) Zn, Cd, Hg metals have completely filled d- orbitals (d10). It means that d- electrons are not readily available for metallic bond formation. Since, the metallic bonds are weak. Therefore, these metals are quit soft and also have low melting points.

(iv) $Lu(OH)_3$ has greater covalent character than $La(OH)_3$ on account of lanthanoid contraction. Thus the liberation of hydroxide ions from $La(OH)_3$ is easy and it is more basic than $Lu(OH)_3$.

(v) Mn^{2+} has the configuration, $[Ar]3d^5$ which is highly symmetrical configuration. Hence, the removal of third electron is very difficult. Therefore, third ionization enthalpy of the metal Mn is exceptionally high.

Question 17: **[5]**
Explain crystal field theory in detail.

OR

Explain on the basis of valence bond theory that $[Ni(CN)_2]^{2-}$ ion with square planar structure in diamagnetic and the $[NiCl_4]^{2-}$ ion with tetrahedral geometry is paramagnetic.
Solution 17:
Crystal Field Theory(CFT) is an electrostatic model which considers the metal- ligand bond to be ionic arising purely from electrostatic interactions between the metal ion and the ligand.

Main characteristics of CFT are as follows:
(i) The transition metal ion is surrounded by the ligands with lone pairs of electrons and the complex is a combination of central ion surrounded by other ions or molecules or dipoles, i.e. ligands.

(ii) All types of ligands are regarded as point charges.

(iii) The interactions between the metal ion and the negative ends of anion (or ion dipoles) is purely electrostatic, i.e., the bond between the metal and ligand is considered 100% ionic.

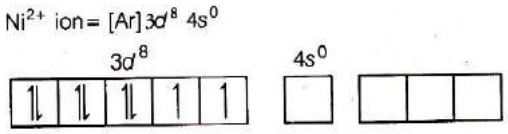
(iv) The ligands surrounding the metal ion produce electrical field and this electrical field influences the energies of the orbitals of central metal ions, particularly d – orbits.

(v) In the case of free metal ion, all the five d-orbitals have the same energy. Orbitals having the same energies are called degenerate orbitals.

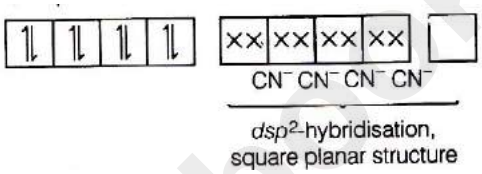
The five degenerate d- orbitals of the metal ion split into different sets of orbital having different energies in the presence of electrical field of ligands. This is called crystal field splitting.

OR

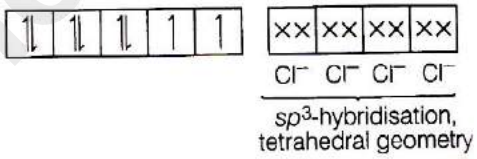
Outer configuration of $_{28}Ni$ atom = $[Ar]3d^8 4s^2$
Ni^{2+} ion = $[Ar]3d^8 4s^0$



(CN^- being strong field ligand pair up the d- electrons metal atom.)
$[Ni(CN)_4]^{2-}$ ion =



The complex is diamagnetic in nature as it has no unpaired electrons.
In the complex ion$[NiCl_4]^{2-}$, nickel is in +2 oxidation state and has the electronic configuration $3d^8$ also. But Cl^- being weak field ligand, does not cause pairing.
$[NiCl_4]^{2-}$ ion =



$[NiCl_4]^{2-}$ ion is paramagnetic in nature as it has two unpaired electrons.

Question 18: **[5]**
(i) What is demulsification? Name two demulsifiers **[2]**
(ii) What are micelles? Give an example of micelles system. **[3]**

OR

(i) Distinguish between micelles and colloidal particles. Give one example of each. **[3]**
(ii) Give reason for the formation of deltas. **[2]**

Solution 18:
(i) The process of separation the constituents of an emulsion is called demulsification.

Heating and centrifugation are the two techniques used to destroy an emulsion. So, act as demulsifiers.

(ii) The aggregates of colloidal particles which have both hydrophilic and hydrophobic parts are called micelles. These are formed above certain concentration called CMC. These, molecules are arranged readily with the hydrocarbon or non-polar part towards the centre and the polar part towards the periphery, e.g. soap solution in water is an example of micelle system.

OR

(i) Micelles: Small ions of an electrolyte molecule form the aggregate particles which behave like colloidal particles, are known as micelles, e.g. soap and detergent.

Colloidal particles: Colloidal particles have an enormous surface area per unit mass as a result of their small size. Its size ranges between 1-100m.

(ii) River water is a colloidal solution of clay. Sea water contains a number of electrolytes. When river water meets sea water, the electrolytes present in sea water coagulate the colloidal solution of clay resulting in the deposition with the formation of deltas.