CAREERS 360

CBSE Class 12

Chemistry Item Bank

Chemistry (Class XII)

(I) Read the passage given below and answer the following questions:

In spite of the predictions of stable noble gas compounds since at least 1902, unsuccessful attempts at their synthesis gave rise to the widely held opinion that noble gases are not only noble but also inert. It was not until 1962 that this dogma was shattered when Bartlett in Canada published the first stable noble gas compound $XePtF_6$. This discovery triggered a worldwide frenzy in this area, and within a short time span many new xenon, radon, and krypton compounds were prepared and characterized. The recent discoveries show the ability of xenon to act as a ligand . The discovery by Seppelt's group that more than one xenon atom can attach itself to a metal center which in the case of gold leads to surprisingly stable Au- Xe bonds. The bonding in $[AuXe_4]^{2+}$ involves 4 Xe ligands attached by relatively strong bonds to a single Au(II) center in a square planar arrangement with a Xe-Au bond length of about 274 pm This discovery provides not only the first example of multiple xenon ligands but also represents the first strong metal - xenon bond.

(Source: Christe, K. O. (2001). A renaissance in noble gas chemistry. *Angewandte Chemie International Edition*, *40*(8), 1419-1421.)

1. In the complex ion $[AuXe_4]^{2+}$, Xe acts as :
   a. central atom
   b. ligand
   c. chelating agent
   d. electrophile
2. Hybridisation shown by Au in $[AuXe_4]^{2+}$ is :
   a. sp^3
   b. sp^3d
   c. sp^3d^2
   d. sp^2

3. Compounds of noble gases except _______ are known.
   a. Krypton
   b. Radon
   c. Helium
   d. Xenon
4. Xe is a ___________ ligand
   a. ambidentate
   b. bidantate
   c. unidentate
   d. hexadentate

ANSWERS : 1a, 2 b 3 c 4 c

(II) Read the passage given below and answer the following questions:

Boiling point or freezing point of liquid solution would be affected by the dissolved solids in the liquid phase. A soluble solid in solution has the effect of raising its boiling point and depressing its freezing point. The addition of non-volatile substances to a solvent decreases the vapor pressure and the added solute particles affect the formation of pure solvent crystals. According to many researches the decrease in freezing point directly correlated to the concentration of solutes dissolved in the solvent. This phenomenon is expressed as freezing point depression and it is useful for several applications such as freeze concentration of liquid food and to find the molar mass of an unknown solute in the solution. Freeze concentration is a high quality liquid food concentration method where water is removed by forming ice crystals. This is done by cooling the liquid food below the freezing point of the solution. The freezing point depression is referred as a colligative property and it is proportional to the molar concentration of the solution (m), along with vapor pressure lowering, boiling point elevation, and osmotic pressure. These are physical characteristics of solutions that depend only on the identity of the solvent and the concentration of the solute. The characters are not depending on the solute's identity. (Jayawardena, J. A. E. C., Vanniarachchi, M. P. G., & Wansapala, M. A. J. (2017). Freezing point depression of different Sucrose solutions and coconut water.)

1. When a non volatile solid is added to pure water it will:
   a. boil above 100^{o}C and freeze above 0^{o}C
   b. boil below 100^{o}C and freeze above 0^{o}C
   c. boil above 100^{o}C and freeze below 0^{o}C
   d. boil below 100^{o}C and freeze below 0^{o}C

2. Colligative properties are:
a. dependent only on the concentration of the solute and independent of the solvent's and solute's identity.
b. dependent only on the identity of the solute and the concentration of the solute and independent of the solvent's identity.
c. dependent on the identity of the solvent and solute and thus on the concentration of the solute.
d. dependent only on the identity of the solvent and the concentration of the solute and independent of the solute's identity.

3. Assume three samples of juices A, B and C have glucose as the only sugar present in them. The concentration of sample A, B and C are 0.1M, .5M and 0.2 M respectively. Freezing point will be highest for the fruit juice:
a. A
b. B
c. C
d. All have same freezing point

4. Identify which of the following is a colligative property :
a. freezing point
b. boiling point
c. osmotic pressure
d. all of the above

Ans 1 (b) 2 (d) 3 (a) 4(c)

(III) Read the passage given below and answer the following questions:

The rate of a reaction, which may also be called its velocity or speed, can be defined with relation to the concentration of any of the reacting substances, or to that of any product of the reaction. If the species chosen is a reactant which has a concentration c at time t the rate is -dc/dt, while the rate with reference to a product having a concentration x at time t is dx/dt. Any concentration units may be used for expressing the rate; thus, if moles per liter are employed for concentration and seconds for the time, the units for the rate are moles liter^{-1}sec^{-1}. For gas reactions pressure units are sometimes used in place of concentrations, so that legitimate units for the rate would be (mm. Hg) sec^{-1} and atm. sec^{-1}

The order of a reaction concerns the dependence of the rate upon the concentrations of reacting substances; thus, if the rate is found experimentally to be proportional to the α th power of the concentration of one of the reactants A, to the β th power of the concentration of a second reactant B, and so forth, via.,

rate = $k\,C_A^{\alpha}\,C_B^{\beta}$ (1)

the over-all order of the reaction is simply

$n = \alpha + \beta + \text{-----}$ (2)

Such a reaction is said to be of the α^{th} order with respect to the substance A, the β th order with respect to B and so on...

(Laidler, K. J., & Glasstone, S. (1948). Rate, order and molecularity in chemical kinetics. *Journal of Chemical Education*, *25*(7), 383.)

In the following questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices on the basis of the above passage.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.
B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.
C. Assertion is correct statement but reason is wrong statement.
D. Assertion is wrong statement but reason is correct statement.

1. **Assertion:** Rate of reaction is a measure of change in concentration of reactant with respect to time.

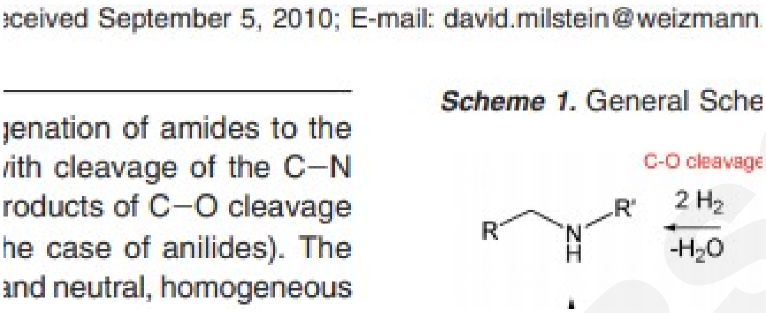
   Reason: Rate of reaction is a measure of change in concentration of product with respect to time.

2. **Assertion:** For a reaction: P +2Q → Products, Rate = k $[P]^{1/2}[Q]^1$ so the order of reaction is 1.5
   Reason: Order of reaction is the sum of stoichiometric coefficients of the reactants.
3. **Assertion:** The unit of k is independent of order of reaction.
   Reason: The unit of k is moles $L^{-1}s^{-1}$.
4. **Assertion:** Reactions can occur at different speeds.
   Reason: Rate of reaction is also called speed of reaction.

Ans: 1B 2C 3D 4B

(IV) Read the passage given below and answer the following questions:

Reduction of carboxylic acids and their derivatives plays an important role in organic synthesis, in both laboratory and industrial processes. Traditionally, the reduction is performed using stochiometric amounts of hydride reagents, generating stochiometric amounts of waste. A much more attractive, atom-economical approach is a catalytic reaction using H2; however, hydrogenation of carboxylic acid derivatives under mild conditions is a very challenging task, with amides presenting the highest challenge among all classes of carbonyl compounds. Very few examples of the important hydrogenation of amides to amines, in which the C-O bond is cleaved with the liberation of water (Scheme 1), were reported. C-O cleavage of amides can also be affected with silanes as reducing agents.



ceived September 5, 2010; E-mail: david.milstein@weizmann

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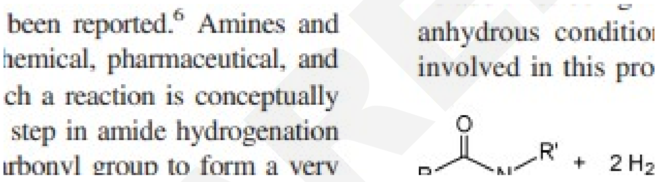
vith cleavage of the C—N
roducts of C—O cleavage
he case of anilides). The
and neutral, homogeneous

Scheme 1. General Sche

We have now prepared the new, dearomatized, bipyridine-based pincer complex 3, catalyst 3(Here refered as Cat. 3). Remarkably, it efficiently catalyzes the selective hydrogenation of amides to form amines and alcohols (eq 1). The reaction proceeds under mild pressure and neutral conditions, with no additives being required. Since the reaction proceeds well under anhydrous conditions, hydrolytic cleavage of the amide is not involved in this process.



been reported.[6] Amines and
hemical, pharmaceutical, and
ch a reaction is conceptually
step in amide hydrogenation
urbonyl group to form a very

anhydrous conditio
involved in this pro

(Balaraman, E., Gnanaprakasam, B., Shimon, L. J., & Milstein, D. (2010). Direct hydrogenation of amides to alcohols and amines under mild conditions. *Journal of the American Chemical Society*, *132*(47), 16756-16758.)

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A. Assertion and reason both are correct statements and reason is correct explanation for assertion.
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C. Assertion is correct statement but reason is wrong statement.
D. Assertion is wrong statement but reason is correct statement.

1. **Assertion:** The use of catalyst 3 is an efficient method of preparation of primary amines
   Reason: Use of catalyst 3 is a step down reaction.
2. **Assertion:** Use of hydride catalyst or hydrogen brings about cleavage of C-O bond in amides.
   Reason: Hydride catalyst or hydrogen cause to reduction of amides.
3. **Assertion:** N-methyl ethanamide on reaction with catalyst 3 will yield ethanol and methanamine**.**
   Reason: Use of Catalyst 3 brings about cleavage of C-N bond of amides
4. **Assertion:** Aniline can be prepared from suitable amide using catalyst 3
   Reason: The use of catalyst 3 is limited to aliphatic amides only.

Ans: 1B 2B 3 A 4C

(V) Read the passage given below and answer the following questions:

Nucleophilic substitution reaction of haloalkane can be conducted according to both $S_N{}^1$ and $S_N{}^2$ mechanisms. However, which mechanism it is based on is related to such factors as the structure of haloalkane, and properties of leaving group, nucleophilic reagent and solvent.

Influences of halogen : No matter which mechanism the nucleophilic substitution reaction is based on, the leaving group always leave the central carbon atom with electron pair. This is just the opposite of the situation that nucleophilic reagent attacks the central carbon atom with electron pair. Therefore, the weaker the alkalinity of leaving group is , the more stable the anion formed is and it will be more easier for the leaving group to leave the central carbon atom; that is to say, the reactant is more easier to be substituted. The alkalinity order of halogen ion is $I^- < Br^- < Cl^- < F^-$ and the order of their leaving tendency should be $I^- > Br^- > Cl^- > F^-$. Therefore, in four halides with the same alkyl and different halogens, the order of substitution reaction rate is RI> RBr > RCl > RF . In addition, if the leaving group is very easy to leave, many carbocation intermediates are generated in the reaction and the reaction is based on $S_N{}^1$ mechanism. If the leaving group is not easy to leave, the reaction is based on $S_N{}^2$ mechanism.

Influences of solvent polarity: In $S_N{}^1$ reaction, the polarity of the system increases from the reactant to the transition state, because polar solvent has a greater stabilizing effect on the transition state than the reactant, thereby reduce activation energy and accelerate the reaction. In $S_N{}^2$ reaction, the polarity of the system generally does not change from the reactant to the transition state and only charge dispersion occurs. At this time, polar solvent has a great stabilizing effect on Nu than the transition state, thereby increasing activation energy and slow down the reaction rate. For example, the decomposition rate ($S_N{}^1$) of tertiary chlorobutane in 25℃ water (dielectric constant 79) is 300000 times faster than in ethanol (dielectric constant 24). The reaction rate ($S_N{}^2$) of 2-bromopropane and NaOH in ethanol containing 40% water is twice slower than in absolute ethanol. In a word, the level of solvent polarity has influence on both $S_N{}^1$ and $S_N{}^2$reactions, but with different results. Generally speaking, weak polar solvent is favorable for $S_N{}^2$ reaction, while strong polar solvent is favorable for $S_N{}^1$ reaction, because only under the action of polar solvent can halogenated hydrocarbon dissociate into carbocation and halogen ion and solvents with a strong polarity is favorable for solvation of carbocation, increasing its stability. Generally speaking, the substitution reaction of tertiary haloalkane is based on $S_N{}^1$ mechanism in solvents with a strong polarity (for example, ethanol containing water).

(Ding, Y. (2013). A Brief Discussion on Nucleophilic Substitution Reaction on Saturated Carbon Atom. In *Applied Mechanics and Materials* (Vol. 312, pp. 433-437). Trans Tech Publications Ltd.)

1. $S_N{}^1$ mechanism is favoured in which of the following solvents:
   a. benzene
   b. carbon tetrachloride
   c. acetic acid
   d. carbon disulphide
2. Nucleophilic substitution will be fastest in case of:
   a. 1-Chloro-2,2-dimethyl propane

   b. 1-Iodo-2,2-dimethyl propane
   c. 1-Bromo-2,2-dimethyl propane
   d. 1-Fluoro-2,2-dimethyl propane
3. S_N^1 reaction will be fastest in which of the following solvents?
   a. Acetone (dielectric constant 21)
   b. Ethanol (dielectric constant 24)
   c. Methanol (dielectric constant 32)
   d. Chloroform (dielectric constant 5)
4. Polar solvents make the reaction faster as they:
   a. destabilize transition state and decrease the activation energy
   b. destabilize transition state and increase the activation energy
   c. stabilize transition state and increase the activation energy
   d. stabilize transition state and decrease the activation energy
5. S_N^1 reaction will be fastest in case of:
   a. 1-Chloro-2-methyl propane
   b. 1-Iodo-2-methyl propane
   c. 1-Chlorobutane
   d. 1-Iodobutane

Ans: 1 c, 2b, 3 c, 4c, 5 b

(VI) Read the passage given below and answer the following questions:

Within the 3d series, manganese exhibits oxidation states in aqueous solution from +2 to +7, ranging from Mn^{2+}(aq) to MnO^{-}_{4} (aq). Likewise, iron forms both Fe^{2+}(aq) and Fe^{3+}(aq) as well as the FeO^{2-}_{4} ion. Cr and Mn form oxyions CrO^{2-}_{4} , MnO^{-}_{4} , owing to their willingness to form multiple bonds . The pattern with the early transition metals—in the 3d series up to Mn, and for the 4d, 5d metals up to Ru and Os—is that the maximum oxidation state corresponds to the number of ''outer shell'' electrons. The highest oxidation states of the 3d metals may depend upon complex formation (e.g., the stabilization of Co^{3+} by ammonia) or upon the pH (thus MnO_4^{2-} (aq) is prone to disproportionation in acidic solution). Within the 3d series, there is considerable variation in relative stability of oxidation states, sometimes on moving from one metal to a neighbor; thus, for iron, Fe^{3+} is more stable than Fe^{2+}, especially in alkaline conditions, while the reverse is true for cobalt. The ability of transition metals to exhibit a wide range of oxidation states is marked with metals such as vanadium, where the standard potentials can be rather small, making a switch between states relatively easy.

(Cotton, S. A. (2011). Lanthanides: Comparison to 3d metals. *Encyclopedia of inorganic and Bioinorganic Chemistry*.)

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D. Assertion is wrong statement but reason is correct statement.

1.Assertion: Highest oxidation state is exhibited by transition metal lying in the middle of the series.

Reason: The highest oxidation state exhibited corresponds to number of (n-1)d electrons.

2. Assertion: Fe^{3+} is more stable than Fe^{2+}

Reason: Fe^{3+} has $3d^5$ configuration while Fe^{2+} has $3d^6$ configuration.

3. Assertion: Vanadium had the ability to exhibit a wide range of oxidation states.

Reason: The standard potentials Vanadium are rather small, making a switch between oxidation states relatively easy.

4. Assertion: Transition metals like Fe, Cr and Mn form oxyions

Reason: Oxygen is highly electronegative and has a tendency to form multiple bonds.

5.Assertion: The highest oxidation states of the 3d metals depends only on electronic configuration of the metal.

Reason: The number of electrons in the (n-1)d and ns subshells determine the oxidation states exhibited by the metal.

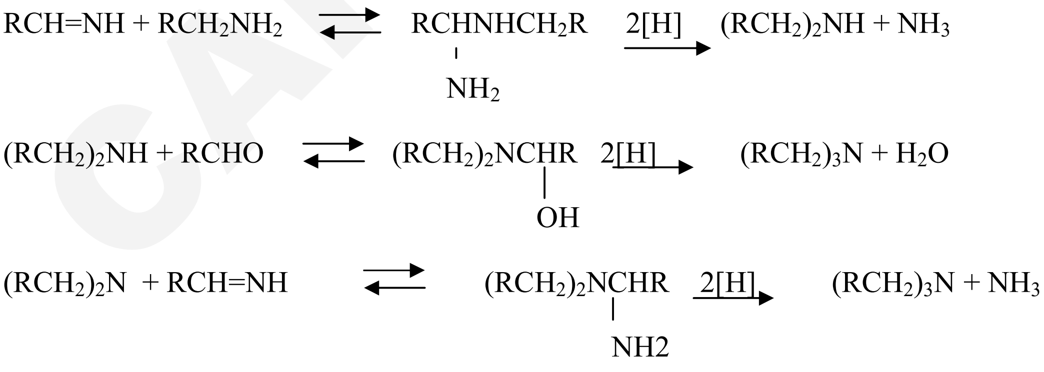
Ans: 1.c 2 a 3 a 4 b 5d

(VII) Read the passage given below and answer the following questions:

Reductive alkylation is the term applied to the process of introducing alkyl groups into ammonia or a primary or secondary amine by means of an aldehyde or ketone in the presence of a reducing agent. The present discussion is limited to those reductive alkylations in which the reducing agent is hydrogen and a catalyst or "nascent" hydrogen, usually from a metal-acid combination; most of these reductive alkylations have been carried out with hydrogen and a catalyst. The principal variation excluded is that in which the reducing agent is formic acid or one of its derivatives; this modification is known as the Leuckart reaction. The process of reductive alkylation of ammonia consists in the addition of ammonia to a carbonyl compound and reduction of the addition compound or its dehydration product. The reaction usually is carried out in ethanol solution when the reduction is to be effected catalytically

$$\begin{tikzcd}
RCHO + NH_3 \arrow[r, shift left] & RCHOHNH_2 \arrow[l, shift left] \arrow[r, "2[H]"] \arrow[d, shift right] & RCH_2NH_2 \\
 & RCH{=}NH \arrow[u, shift right] \arrow[ur, "2[H]"'] &
\end{tikzcd}$$

Since the primary amine is formed in the presence of the aldehyde it may react in the same way as ammonia, yielding an addition compound, a Schiff's base ($RCH= NCH_2R$) and finally, a secondary amine. Similarly, the primary amine may react with the imine, forming an addition product which also is reduced to a secondary amine Finally, the secondary amine may react with either the aldehyde or the imine to give products which are reduced to tertiary amines.



$$RCH{=}NH + RCH_2NH_2 \rightleftarrows \underset{\displaystyle NH_2}{RCHNHCH_2R} \xrightarrow{2[H]} (RCH_2)_2NH + NH_3$$

$$(RCH_2)_2NH + RCHO \rightleftarrows \underset{\displaystyle OH}{(RCH_2)_2NCHR} \xrightarrow{2[H]} (RCH_2)_3N + H_2O$$

$$(RCH_2)_2N + RCH{=}NH \rightleftarrows \underset{\displaystyle NH2}{(RCH_2)_2NCHR} \xrightarrow{2[H]} (RCH_2)_3N + NH_3$$

Similar reactions may occur when the carbonyl compound employed is a ketone.

(source: Emerson, W. S. (2011). *The Preparation of Amines by Reductive Alkylation. Organic Reactions, 174–255.* doi:10.1002/0471264180.or004.03)

Q1. Ethanal on reaction with ammonia forms an imine (X) which on reaction with nascent hydrogen gives (Y). Identify ‘X’ and ‘Y’.

A. X is $CH_3CH=NH$ and Y is CH_3NH_2
B. X is $CH_3CHOHNH_2$ and Y is $CH_3CH_2NH_2$
C. X is $CH_3CHOHNH_2$ and Y is CH_3NH_2
D. X is $CH_3CH=NH$ and Y is $CH_3CH_2NH_2$

Q2. Acetaldehyde is reacted with ammonia followed by reduction in presence of hydrogen as a catalyst. The primary amine so formed further reacts with acetaldehyde. The Schiff’s base formed during the reaction is:

A. $CH_3CH=NHCH_3$
B. $CH_3CH=NHCH_2CH_3$
C. $CH_3=NHCH_2CH_3$
D. $CH_3CH_2CH=NHCH_3$

Q3. The reaction of ammonia and its derivatives with aldehydes is called:

A. Nucleophilic substitution reaction
B. Electrophilic substitution reaction
C. Nucleophilic addition reaction
D. Electrophilic addition reaction

Q4. $(CH_3CH_2CH_2)_2NH + CH_3CH_2CHO \longrightarrow P \xrightarrow{2[H]} Q$

The compound Q is:

A. $(CH_3CH_2CH_2)_3N$
B. $(CH_3CH_2CH_2)_2N(CH_2CH_3)$
C. $(CH_3CH_2)_3N$
D. $(CH_3CH_2)_2NH$

Q5. Reductive alkylation of ammonia by means of an aldehyde in presence of hydrogen as reducing agents results in formation of:

A. Primary amines
B. Secondary amines
C. Tertiary amines
D. Mixture of all three amines

(Ans: 1D,2B,3C,4 A,5D)

(VIII) Read the passage given below and answer the following questions:

Some colloids are stable by their nature, i.e., gels, alloys, and solid foams. Gelatin and jellies are two common examples of a gel. The solid and liquid phases in a gel are interdispersed with both phases being continuous. In most systems, the major factor influencing the stability is the charge on the colloidal particles. If a particular ion is preferentially adsorbed on the surface of the particles, the particles in suspension will repel each other, thereby preventing the formation of aggregates that are larger than colloidal dimensions. The ion can be either positive or negative depending on the particular colloidal system, i.e., air bubbles accumulate negative ions, sulphur particles have a net negative charge in a sulphur sol, and the particles in a metal hydroxide sol are positively charged. Accumulation of charge on a surface is not an unusual phenomenon-dust is attracted to furniture surfaces by electrostatic forces. When salts are added to lyophobic colloidal systems the colloidal particles begin to form larger aggregates and a sediment forms as they settle. This phenomenon is called flocculation, and the suspension can be referred to as flocculated, or colloidally unstable. If the salt is removed, the suspension can usually be restored to its original state; this process is called deflocculation or peptization. The original and restored colloidal systems are called deflocculated, peptized, or stable sols.

Why does a small amount of salt have such a dramatic effect on the stability of a lyophobic colloidal system? The answer lies in an understanding of the attractive and repulsive forces that exist between colloidal particles. Van der Waals forces are responsible for the attractions, while the repulsive forces are due to the surface charge on the particles. In a stable colloid, the repulsive forces are of greater magnitude than the attractive forces. The magnitude of the electrical repulsion is diminished by addition of ionized salt, which allows the dispersed particles to aggregate and flocculate. River deltas provide an example of this behaviour. A delta is formed at the mouth of a river because the colloidal clay particles are flocculated when the freshwater mixes with the salt water of the ocean

(source: Sarquis, J. (1980). *Colloidal systems. Journal of Chemical Education, 57(8), 602.* doi:10.1021/ed057p602)

Q1. Gelatin is a ________________ colloidal system.

A. Solid in solid
B. Solid in gas
C. Liquid in solid
D. Liquid in gas

Q2.Colloidal solutions are stable due to:

A. presence of charges on the colloidal particles
B. formation of aggregates by colloidal particles
C. preferential adsorption on the surface
D. preferential absorption on the surface

Q3. Settling down of colloidal particles to form a suspension is called:

A. flocculation
B. peptization
C. aggregation
D. deflocculation

Q4. When Van der Waals forces are greater than forces due to the surface charge on the particles,

A. flocculation occurs.
B. the colloid is stable.
C. peptization takes place.
D. deflocculation occurs.

Q5. The particles in suspension will repel each other, thereby preventing the formation of aggregates that are larger than colloidal dimensions. This statement explains:

A. formation of delta
B. river water is a colloidal of clay particles
C. effect of salt on lyphobic colloid
D. phenomenon of flocculation

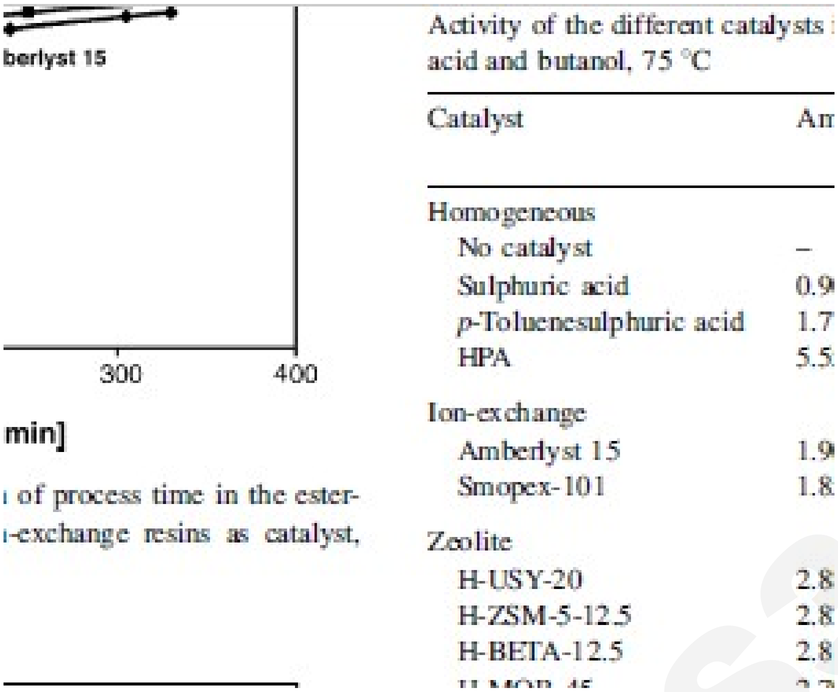
(Ans: 1C, 2C, 3A,4A,5B)

(IX) Read the passage given below and answer the following questions:

Industrially widely applied esterification reactions are commonly catalysed using mineral liquid acids, such as sulphuric acid and p-toluenesulphonic acid. The catalytic activity of homogeneous catalysts is high. They suffer, however, from several drawbacks, such as their corrosive nature, the existence of side reactions, and the fact that the catalyst cannot be easily separated from the reaction mixture. The use of solid acid catalysts offers an alternative and has received a lot of attention in the past years. Solid acid catalysts are not corrosive and, coated onto a support, they can be easily reused. Examples of solid acid catalysts used in esterification reactions include ion-exchange resins , zeolites and superacids like sulphated zirconia and niobium acid. Ion-exchange resins are the most common heterogeneous catalysts used and have proven to be effective in liquid phase esterification and etherification reactions. Because of their selective adsorption of reactants and swelling nature, these resins not only catalyse the esterification reaction but also affect the equilibrium conversion. Shortcomings include insufficient thermal resistance, which limits the reaction temperature to 120 ^{o}C, preventing widespread use in industry. Zeolites, like Y, X, BEA, ZSM-5 and MCM-41 offer an interesting alternative and have proven to be efficient catalysts for esterification reactions. Zeolites have found wide application in oil refining, petrochemistry and in the production of fine chemicals. Their success is based on the possibility to prepare zeolites with strong Brønsted acidity that can be controlled within a certain range, combined with a good resistance to high reaction temperatures.

In this study, the activity of various commercial available solid acid catalysts is assessed with respect to the esterification of acetic acid with butanol. The ion-exchange resins Amberlyst 15 and Smopex-101, the acid zeolites H-ZSM-5, H-MOR, H-BETA and H-USY, and the solid superacids sulphated zirconia and niobium acid are selected. Comparative esterification experiments have been carried out using the homogeneous catalysts sulphuric acid, p-toluenesulphuric acid and a heteropolyacid (HPA).

The weight-based activity of the heterogeneous catalysts tested is maximum for Smopex101. The following table gives the activity of different catalysts in the esterification reaction between acetic acid and butanol at 75^{0}C.



of process time in the ester-
-exchange resins as catalyst,

Activity of the different catalysts
acid and butanol, 75 °C

Catalyst	Am
Homogeneous	
No catalyst	–
Sulphuric acid	0.9
p-Toluenesulphuric acid	1.7
HPA	5.5
Ion-exchange	
Amberlyst 15	1.9
Smopex-101	1.8
Zeolite	
H-USY-20	2.8
H-ZSM-5-12.5	2.8
H-BETA-12.5	2.8

Here: k_{obs}: observed reaction rate constant ($m^3mol^{-1}s^{-1}$)
kc catalysed reaction rate constant ($m^3mol^{-1}g_{cat}^{-1}s^{-1}$)
Please note: k c = k obs/ amount (in g)

(source: PETERS, T., BENES, N., HOLMEN, A., & KEURENTJES, J. (2006). *Comparison of commercial solid acid catalysts for the esterification of acetic acid with butanol. Applied Catalysis A: General, 297(2), 182–188.* doi:10.1016/j.apcata.2005.09.00)

Q1. Which of the following are heterogeneous catalysts for esterifctaion reaction:

A. sulphuric acid and p-toluenesulphonic acid
B. sulphuric acid and niobium acid
C. p-toluenesulphonic acid and niobium acid
D. niobium acid and sulphated zirconia

Q2. Unit for observed rate constant for esterification reaction is $m^3mol^{-1}s^{-1}$, so the reaction is:

A. zero order
B. first order
C. second order
D. third order

Q3. The catalytic activity of homogeneous catalysts is high. The weight based activity of HPA is less than which of the following heterogenous catalysts?

A. Smopex-101
B. Amberlyst 15
C. sulphated ZrO2

D. H-USY-20

Q4. The weight-based activity of the heterogeneous catalysts tested decreases in the following order:

A. Smopex-101 > Amberlyst 15 > sulphated ZrO2 > H-USY-20 >H-BETA-12.5 > H-MOR-45 > Nb2O5 > H-ZSM-5-12
B. Smopex-101 > Amberlyst 15 > sulphated ZrO2 > H-USY-20 >H-BETA-12.5 > H-MOR-45 > H-ZSM-5-12> Nb2O5
C. Smopex-101 > Amberlyst 15 > sulphated ZrO2 > H-USY-20 >H-BETA-12.5 > Nb2O5> H-MOR-45 > H-ZSM-5-12
D. Smopex-101 > sulphated ZrO2 > Amberlyst 15 > H-USY-20 >H-BETA-12.5 > H-MOR-45 > H-ZSM-5-12> Nb2O5

Q5. Catalysts used in oil refining industry are:

A. ion exchange resins
B. superacids
C. zeolites
D. mineral liquid acids

(ANS: 1D, 2C, 3A, 4A, 5C)

(X) Read the passage given below and answer the following questions:

Biopolymers are polymers that are generated from renewable natural sources, are often biodegradable and nontoxic. They can be produced by biological systems (i.e. microorganisms, plants and animals), or chemically synthesized from biological materials (e.g., sugars, starch, natural fats or oils, etc.). Two strategies are applied in converting these raw materials into biodegradable polymers: extraction of the native polymer from a plant or animal tissue, and a chemical or biotechnological route of monomer polymerization. Biodegradable biopolymers (BDP) are an alternative to petroleum-based polymers (traditional plastics). Some BDP degrade in only a few weeks, while the degradation of others takes several months. In principle the properties relevant for application as well as biodegradability are determined by the molecular structure. According to the American Society for Testing and Materials, biopolymers are degradable polymers in which degradation results from the action of naturally occurring microorganisms such as bacteria, fungi and algae .

Polylactic acid (PLA) is an example of biopolymer. It is a thermoplastic polyester. Generally, there are two major routes to produce polylactic acid from the lactic acid ($CH_3CH(OH)$-$COOH$)monomer. The first route involves condensation–water removal by the use of solvent under high vacuum and temperature. This approach produces a low to intermediate molar mass polymer. An alternative method is to remove water under milder conditions, without solvent, to produce a cyclic intermediate dimer, referred to as lactide. This intermediate is readily purified by vacuum distillation. Ring opening polymerization of the dimer is accomplished under heat, again without the need for solvent. By controlling the purity of the dimer it is possible to produce a wide range of molar masses .PLA is a good material for production of clothing, carpet tiles, interior and outdoor furnishing, geotextiles, bags, filtration systems, etc.

The primary biodegradability of PLA was tested using hydrolysis tests at various composting temperatures and pH. It was demonstrated that composting is a useful method for PLA biodegradation. The degradation rate is very slow in ambient temperatures. A 2017 study found that at 25 °C in sea water, PLA showed no degradation over a year. As a result, it is poorly degraded in landfills and household composts, but is effectively digested in hotter industrial composts.

(source: Flieger, M., Kantorová, M., Prell, A., Řezanka, T., & Votruba, J. (2003). *Biodegradable plastics from renewable sources. Folia Microbiologica, 48(1), 27–44.* doi:10.1007/bf02931273)

In the following questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices on the basis of the above passage.

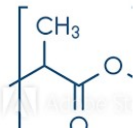
A. Assertion and reason both are correct statements and reason is correct explanation for assertion.
B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.
D. Assertion is wrong statement but reason is correct statement.

Q1.Assertion: Biodegradable polymers degrade in few weeks.

Reason: Microorganisms bring about degradation of biopolymers.

Q2. Assertion: Lactic acid on polymerisation forms



Reason: PLA is used in producing geotextiles.

Q3. Assertion: Lactic acid undergoes condensation polymerisation

Reason: Lactic acid is a bifunctional monomeric unit.

Q4. Assertion: . The degradation of PLA is very slow in ambient temperature.

Reason: PLA is a thermoplastic.

Q5.Assertion: PLA is poorly degraded in landfills.

Reason: The degradation rate of PLA is very slow in ambient temperatures.

(ANS: 1D, 2B, 3A,4B,5A)

(XI) Read the passage given below and answer the following questions:

In the last 10 years much has been learned about the molecular structure of elemental sulfur. lt is now known that many different types of rings are sufficiently metastable to exist at room temperature for several days. It is known that at high temperature, the equilibrium composition allows for a variety of rings and chains to exist in comparable concentration, and it is known that at the boiling point and above, the vapor as well as the liquid contains small species with three, four, and five atoms.

The sulfur atom has the same number of valence electrons as oxygen. Thus, sulfur atoms S_2 and S_3 have physical and chemical properties analogous to those of oxygen and ozone. S_2 has a ground state of 38 $\sigma3s^2\sigma^{\star}3s^2\sigma3pz^2\pi3px^{2} = \pi3py^2\pi^*3px^1 = \pi^*3py^1$. S3 , thiozone has a well-known uv spectrum, and has a bent structure, analogous to its isovalent molecules 0_3, SO_2, and S_20. The chemistry of the two elements, sulphur and oxygen, differs because sulfur has a pronounced tendency for catenation. The most frequently quoted explanation is based on the electron structure of the atom. Sulfur has low-lying unoccupied 3d orbitals, and it is widely believed that the 4s and 3d orbitals of sulfur participate in bonding in a manner similar to the participation of 2s and 2p orbitals in carbon.

(source: Meyer, B. (1976). *Elemental sulfur. Chemical Reviews, 76(3), 367–388.* doi:10.1021/cr60301a003)

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D. Assertion is wrong statement but reason is correct statement.

Q1 Assertion: Sulphur belongs to same group in the periodic table as oxygen.

Reason: S2 has properties analogous to O2.

Q2. Assertion: Thiozone has bent structure like ozone.

Reason: Ozone has a lone pair which makes the molecule bent.

Q3. Assertion: S2 is paramagnetic in nature

Reason: The electrons in π^*3px and π^*3py orbitals in S_2 are unpaired.

Q4.Assertion: Sulphur has a greater tendency for catenation than oxygen.

Reason: 3d and 4s orbitals of Sulphur have same energy.

(ANS: 1B,2B, 3A,4C)

(XII) Read the passage given below and answer the following questions:

Adenosine triphosphate (ATP) is the energy-carrying molecule found in the cells of all living things. ATP captures chemical energy obtained from the breakdown of food molecules and releases it to fuel other cellular processes. ATP is a nucleotide that consists of three main structures: the nitrogenous base, adenine; the sugar, ribose; and a chain of three phosphate groups bound to ribose. The phosphate tail of ATP is the actual power source which the cell taps. Available energy is contained in the bonds between the phosphates and is released when they are broken, which occurs through the addition of a water molecule (a process called hydrolysis). Usually only the outer phosphate is removed from ATP to yield energy; when this occurs ATP is converted to adenosine diphosphate (ADP), the form of the nucleotide having only two phosphates.

The importance of ATP (adenosine triphosphate) as the main source of chemical energy in living matter and its involvement in cellular processes has long been recognized. The primary mechanism whereby higher organisms, including humans, generate ATP is through mitochondrial oxidative phosphorylation. For the majority of organs, the main metabolic fuel is glucose, which in the presence of oxygen undergoes complete combustion to CO_2 and H_2O:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6O_2 + 6H_2O + \text{energy}$

The free energy (ΔG) liberated in this exergonic (ΔG is negative) reaction is partially trapped as ATP in two consecutive processes: glycolysis (cytosol) and oxidative phosphorylation (mitochondria). The first produces 2 mol of ATP per mol of glucose, and the second 36 mol of ATP per mol of glucose. Thus, oxidative phosphorylation yields 17-18 times as much useful energy in the form of ATP as can be obtained from the same amount of glucose by glycolysis alone.

The efficiency of glucose metabolism is the ratio of amount of energy produced when 1 mol of glucose oxidised in cell to the enthalpy of combustion of glucose. The energy lost in the process is in the form of heat. This heat is responsible for keeping us warm.

(source: Ercińska, M., & Silver, I. A. (1989). ATP and Brain Function. *Journal of Cerebral Blood Flow & Metabolism*, *9*(1), 2–19. https://doi.org/10.1038/jcbfm.1989.2 and https://www.britannica.com/science/adenosine-triphosphate)

Q1. Cellular oxidation of glucose is a:

A. spontaneous and endothermic process
B. non spontaneous and exothermic process
C. non spontaneous and endothermic process
D. spontaneous and exothermic process

Q2. What is the efficiency of glucose metabolism if 1 mole of glucose gives 38ATP energy?(Given: The enthalpy of combustion of glucose is 686 kcal, 1ATP= 7.3kcal)

A. 100%
B. 38%
C. 62%
D. 80%

Q3.Which of the following statement is true?

A. ATP is a nucleoside made up of nitrogenous base adenine and ribose sugar .
B. ATP consists the nitrogenous base, adenine and the sugar, deoxyribose.
C. ATP is a nucleotide which contains a chain of three phosphate groups bound to ribose sugar.
D. The nitrogenous base of ATP is the actual power source.

Q4. Nearly 95% of the energy released during cellular respiration is due to:

A. glycolysis occurring in cytosol
B. oxidative phosphorylation occurring in cytosol
C. glycolysis in occurring mitochondria
D. oxidative phosphorylation occurring in mitochondria

Q5. Which of the following statements is correct:

A. ATP is a nucleotide which has three phosphate groups while ADP is a nucleoside which three phosphate groups.
B. ADP contains a nitrogenous bases adenine, ribose sugar and two phosphate groups bound to ribose.
C. ADP is the main source of chemical energy in living matter.
D. ATP and ADP are nucleosides which differ in number of phosphate groups.

(ANS: 1D,2B(Glucose catabolism yields a TOTAL of 38 ATP. 38 ATP x 7.3 kcal/mol ATP = 262 kcal. Glucose has 686 kcal. Thus the efficiency of glucose metabolism is 262/686 x 100 = 38%.) ,3C,4D,5B)

(XIII) Read the passage given below and answer the following questions:

The transition metals when exposed to oxygen at low and intermediate temperatures form thin, protective oxide films of up to some thousands of Angstroms in thickness. Transition metal oxides lie between the extremes of ionic and covalent binary compounds formed by elements from the left or right side of the periodic table. They range from metallic to semiconducting and deviate by both large and small degrees from stoichiometry. Since d-electron bonding levels are involved, the cations exist in various valence states and hence give rise to a large number of oxides. The crystal structures are often classified by considering a cubic or hexagonal close-packed lattice of one set of ions with the other set of ions filling the octahedral or tetrahedral interstices. The actual oxide structures, however, generally show departures from such regular arrays due in part to distortions caused by packing of ions of different size and to ligand field effects. These distortions depend not only on the number of d-electrons but also on the valence and the position of the transition metal in a period or group. (source: Smeltzer, W. W., & Young, D. J. (1975). Oxidation properties of transition metals. *Progress in Solid State Chemistry*, *10*, 17-54.)

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A. Assertion and reason both are correct statements and reason is correct explanation for assertion.
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C. Assertion is correct statement but reason is wrong statement.
D. Assertion is wrong statement but reason is correct statement.

1.Assertion: Cations of transition elements occur in various valence states

Reason: Large number of oxides of transition elements are possible.

2.Assertion: Crystal structure of oxides of transition metals often show defects.

Reason: Ligand field effect cause distortions in crystal structures.

3.Assertion : Transition metals form protective oxide films.

Reason: Oxides of transition metals are always stoichiometric.

4.Assertion: CrO crystallises in a hexagonal close-packed array of oxide ions with two out of every three octahedral holes occupied by chromium ions.

Reason: Transition metal oxide may be hexagonal close-packed lattice of oxide ions with metal ions filling the octahedral voids.

(ANS: 1 B , 2 A, 3C , 4D)

(XIV) Read the passage given below and answer the following questions:

The d block elements are the 40 elements contained in the four rows of ten columns (3-12) in the periodic table. As all the d block elements are metallic, the term d-block metals is synonymous. This set of d-block elements is also often identified as the transition metals, but sometimes the group 12 elements (zinc, cadmium, mercury) are excluded from the transition metals as the transition elements are defined as those with partly filled d or f shells in their compounds. Inclusion of the elements zinc, cadmium and mercury is necessary as some properties of the group 12 elements are appropriate logically to include with a discussion of transition metal chemistry.

The term transition element or transition metal appeared to derive from early studies of periodicity such as the Mendeleev periodic table of the elements. His horizontal table of the elements was an attempt to group the elements together so that the chemistry of elements might be explained and predicted. In this table there are eight groups labeled I-VIII with each subdivided into A and B subgroups. Mendeleev recognized that certain properties of elements in Group VIII are related to those of some of the elements in Group VII and those at the start of the next row Group I. In that sense, these elements might be described as possessing properties transitional from one row of the table to the next. (source: Winter, M. J. (2015). *D-block Chemistry* (Vol. 27). Oxford University Press, USA.)

In the following questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices on the basis of the above passage.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.
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C. Assertion is correct statement but reason is wrong statement.
D. Assertion is wrong statement but reason is correct statement.

1.Assertion: Group 12 elements are not considered as transition metals.

Reason: Transition metals are those which have incompletely filled d shell in their compounds.

2.Assertion: All d block elements are metallic in nature.

Reason: The d –block elements belong to Group3 -12 of the periodic table.

3.Assertion : Group VII elements of Mendeleev periodic table are transition elements.

Reason: Group I –VIII in Mendleev periodic table is divided into two subgroups, A and B.

4.Assertion: Nickel is a transition element that belongs to group 10 and period 4 of the modern periodic table.

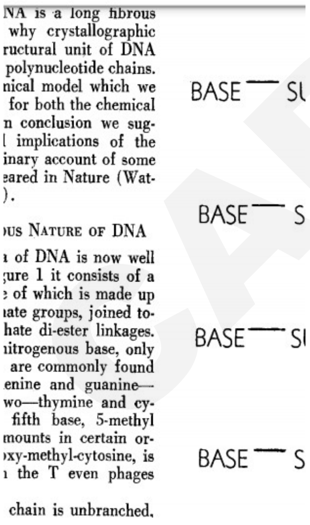
Reason: Electronic configuration of Nickel is $[Ar]_{18}3d^{8}4s^{2}$

(ANS: 1A, 2B, 3D,4A)

(XV) Read the passage given below and answer the following questions:

EVIDENCE FOR THE FIBROUS NATURE OF DNA

The basic chemical formula of DNA is now well established. As shown in Figure 1 it consists of a very long chain, the backbone of which is made up of alternate sugar and phosphate groups, joined together in regular 3' 5' phosphate di-ester linkages. To each sugar is attached a nitrogenous base, only four different kinds of which are commonly found in DNA. Two of these---adenine and guanine--- are purines, and the other two thymine and cytosine-are pyrimidines. A fifth base, 5-methyl cytosine, occurs in smaller amounts in certain organisms, and a sixth, 5-hydroxy-methyl-cytosine, is found instead of cytosine in the T even phages. It should be noted that the chain is unbranched, a consequence of the regular internucleotide linkage. On the other hand the sequence of the different nucleotides is, as far as can be ascertained, completely irregular. Thus, DNA has some features which are regular, and some which are irregular. A similar conception of the DNA molecule as a long thin fiber is obtained from physicochemical analysis involving sedimentation, diffusion, light scattering, and viscosity measurements. These techniques indicate that DNA is a very asymmetrical structure approximately 20 A wide and many thousands of angstroms long. Estimates of its molecular weight currently center between 5 X 10^6 and 10^7 (approximately 3 x10^4 nucleotides). Surprisingly each of these measurements tend to suggest that the DNA is relatively rigid, a puzzling finding in view of the large number of single bonds (5 per nucleotide) in the phosphate-sugar back bone. Recently these indirect inferences have been confirmed by electron microscopy.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ate groups, joined to-
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nitrogenous base, only
are commonly found
enine and guanine—
wo—thymine and cy-
fifth base, 5-methyl
mounts in certain or-
xy-methyl-cytosine, is
ı the T even phages

chain is unbranched.

Figure 1

(source: Watson, J. D., & Crick, F. H. (1953, January). The structure of DNA. In *Cold Spring Harbor symposia on quantitative biology* (Vol. 18, pp. 123-131). Cold Spring Harbor Laboratory Press.)

1.Purines present in DNA are:

A. adenine and thymine
B. guanine and thymine
C. cytosine and thymine
D. adenine and guanine

2. DNA molecule has ___________ internucleotide linkage and __________ sequence of the different nucleotides

A. regular , regular
B. regular , irregular
C. irregular , regular
D. irregular , irregular

3.DNA has a ___________ backbone

A. phosphate -purine
B. pyrimidines- sugar
C. phosphate- sugar
D. purine- pyrimidine

4. Out of the four different kinds of nitrogenous bases which are commonly found in DNA, ___________ has been replaced in some organisms.

A. adenine
B. guanine
C. cytosine
D. thymine

(ANS 1D, 2 B, 3 C, 4 C)

(XVI) Read the passage given below and answer the following questions:

Polysaccharides may be very large molecules. Starch, glycogen, cellulose, and chitin are examples of polysaccharides.

Starch is the stored form of sugars in plants and is made up of amylose and amylopectin (both polymers of glucose). Amylose is soluble in water and can be hydrolyzed into glucose units breaking glycocidic bonds, by the enzymes α- amylase and β-amylase. It is straight chain polymer. Amylopectin is a branched chain polymer of several D-glucose molecules. 80% of amylopectin is present in starch. Plants are able to synthesize glucose, and the excess glucose is stored as starch in different plant parts, including roots and seeds. The starch that is consumed by animals is broken down into smaller molecules, such as glucose. The cells can then absorb the glucose.

Glycogen is the storage form of glucose in humans and other vertebrates, and is made up of monomers of glucose. It is structurally quite similar to amylopectin . Glycogen is the animal equivalent of starch. It is stored in liver and skeletal muscles.

Cellulose is one of the most abundant natural biopolymers. The cell walls of plants are mostly made of cellulose, which provides structural support to the cell. Wood and paper are mostly cellulosic in nature.

Like amylose, cellulose is a linear polymer of glucose. Cellulose is made up of glucose monomers that are linked by bonds between particular carbon atoms in the glucose molecule.Every other glucose monomer in cellulose is flipped over and packed tightly as extended long chains. This gives cellulose its rigidity and high tensile strength—which is so important to plant cells. Cellulose passing through our digestive system is called dietary fiber. (Source: https://chem.libretexts.org)

1. In animals , Glycogen is stored in :

    A. Liver
    B. Spleen
    C. Lungs
    D. Small Intestine

2. Amylose is :

    A. straight chain , water insoluble component of starch ,which constitutes 20 % of it .
    B. straight chain , water soluble component of starch ,which constitutes 20 % of it.
    C. branched chain , water insoluble component of starch ,which constitutes 80 % of it .
    D. branched chain , water soluble component of starch ,which constitutes 80 % of it .

3. Which biopolymer breaks down to release glucose , whenever glucose levels drop in Our body :

    A.starch
    B. cellulose
    C. chitin

D. glycogen

4. The linkages which join monosaccharides to form long chain polysaccharides :

A. Peptide linkage

B. Disulphide bonds

C. Hydrogen bonds

D. Glycosidic linkage

5. Cellulose on complete hydrolysis yields:

A. amylose

B. amylopectin

C. glucose

D. amylose and amylopectin

(ANS 1 A,2B,3D, 4D,5C)