CBSE 2016

Chemistry

General Instructions:

(i) *All questions are compulsory.*

(ii) *Questions number 1 to 5 are very short-answer questions and carry 1 mark each.*

(iii) *Questions number 6 to 10 are short-answer questions and carry 2 marks each.*

(iv) *Questions number 11 to 22 are also short-answer questions and carry 3 marks each.*

(v) *Questions number 23 is a value based question and carry 4 marks.*

(vi) *Questions number 24 to 26 are long-answer questions and carry 5 marks each.*

(vii) *Use log tables, if necessary. Use of calculators is* ***not*** *allowed.*

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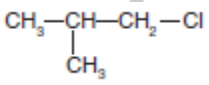
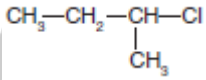
1. What type of magnetism is shown by a substance if magnetic moments of domains are arranged in same direction?

Solution: If magnetic moments of domains are oriented in same direction, substance exhibit ferromagnetism.

2. Out of

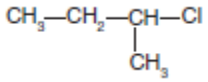


and



which is more reactive towards S_N1 reaction and why?

Solution:



being secondary alkyl halide is more reactive towards S_N1 reaction.

3. On adding NaOH to ammonium sulphate, a colorless gas with pungent odor is evolved which forms a blue coloured complex with Cu^{2+} ion. Identify the gas.

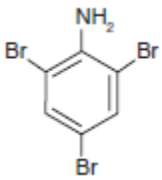
Solution: The gas is ammonia, NH_3 and the reaction is as follows:

$$Cu^{2}(aq) + 4NH_3(aq) \rightleftharpoons \underset{\text{(deep blue)}}{[Cu(NH_3)^2](aq)}$$

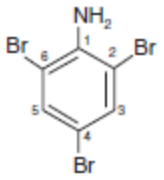
4. Write the main reason for the stability of colloidal sols.

Solution: Colloidal sols are stable because of solvation and charge present.

5. Write the IUPAC name of the given compound:



Solution: The IUPAC name of the compound is 2, 4, 6- tribromoaniline.



6. When a co-ordination compound $CrCl_3 \cdot 6H_2O$ is mixed with $AgNO_3$, 2 moles of AgCl are precipitated per mole of the compound. Write

(i) Structural formula of the complex.

(ii) IUPAC name of the complex.

Solution:

(i) $[Cr(H_2O)_5Cl]\ Cl_2.H_2O$

(ii) Pentaaquachloride chromium (III) chloride mono hydrate

7. From the given cells:

Lead storage cell, Mercury cell, Fuel cell and Dry cell

Answer the following:

(i) Which cell is used in hearing aids?

(ii) Which cell was used in Apollo Space Programme?

(iii) Which cell is used in automobiles and inverters?

(iv) Which cell does not have long life?

Solution:

(i) In hearing aids, mercury cell is used.

(ii) Fuel cell was used in Apollo Space Programme.

(iiI) Lead storage cell is sued in automobiles and inverters.

(iv) Dry cell doesn't have long life.

8. When chromite ore $FeCr_2O_4$ is fused with NaOH in presence of air, a yellow coloured compound (A) is obtained which on acidification with dilute sulphuric acid gives a compound (B). Compound (B) on reaction with KCl forms an orange colored crystalline compound (C).

(i) Write the formulae of the compounds (A), (B) and (C).

(ii) Write one use of compound (C).

Solution:

(i) $4FeCr_2O_4 + 8NaOH + 7O_2 \rightarrow 8Na_2CrO_4$ [A] $+ 2Fe_2O_3 + 8H_2O$

$2Na_2CrO_4$ [A] $+ H_2SO_4 \rightarrow Na_2Cr_2O_7$ [B] $+ Na_2SO_4 + H_2O$

$Na_2Cr_2O_7$ [B] $+ 2KCl \rightarrow K_2Cr_2O_7$ [C] $+ 2NaCl$

Compound A is Sodium chromate, Na_2CrO_4.

Compound B is Sodium dichromate $Na_2Cr_2O_7$.

Compound C is Potassium dichromate ($K_2Cr_2O_7$).

(ii) Compound C, $K_2Cr_2O_7$ Potassium dichromate is used a strong oxidizing agent.

OR

Complete the following chemical equations:

(i) $8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow$

(ii) $Cr_2O_7^{2-} + 3Sn^{2+} + 14H^+ \rightarrow$

Solution:

(i) $8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$

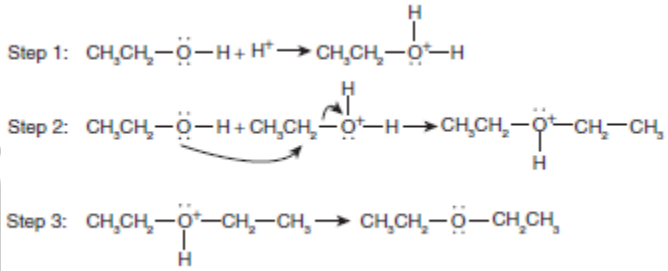
(ii) $Cr_2O_7^{2-} + 3Sn^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O + 3Sn^{4+}$

9. Write the mechanism of the following reaction:

$$2CH_3CH_2OH \xrightarrow[413\,K]{\text{conc. } H_2SO_4} CH_3CH_2 - O - CH_2 - CH_3$$

Solution:

The mechanism of the reaction is as follows:



10. For a reaction: $2NH_3(g) \xrightarrow{Pt} N_2(g) + 3H_2(g)$; Rate = k

(i) Write the order and molecularity of this reaction.

(ii) Write the unit of k.

Solution:

(i) For the reaction, the order is zero and molecularity is two.

(ii) Since the order is zero, the unit of k is mol $L^{-1}s^{-1}$.

11. The rate constant for the first order decomposition of H_2O_2 is given by the following equation:

$$\log k = 14.2 - \frac{1.0 \times 10^4}{T} K$$

Calculate E_a for this reaction and rate constant k if its half-life period be 200 minutes.

(Given: R = 8.314 J K^{-1} mol^{-1})

Solution: Given,

$$\log k = 14.2 - \frac{1.0 \times 10^4}{T}$$

On comparing it with $\log k = \log A - \frac{E_a}{2.303RT}$

We get, $\frac{E_a}{2.303R} = 1 \times 10^4$

$\therefore\ E_a = 2.303 \times R \times 10^4 = 2.303 \times 8.314 \times 10^4 = 19.14 \times 10^4\ \text{J} = 191\ \text{kJ}$

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{200} = 0.0034 = 3.4 \times 10^{-3}\ \text{min}^{-1}$$

12. (i) Differentiate between adsorption and absorption.

(ii) Out of $MgCl_2$ and $AlCl_3$, which one is more effective in causing coagulation of negatively charged sol and why?

(iii) Out of sulphur sol and proteins, which one forms multimolecular colloids?

Solution:

(i) Adsorption occurs only at surface of absorbent whereas absorption occurs throughout the bulk.

(ii) According to Hardy Schulze rule, $AlCl_3$ with high positive charged cation (Al^{3+}) will coagulate more effectively.

(iii) Sulphur sol.

13. Give reasons:

(i) C–Cl bond length in chlorobenzene is shorter than C–Cl bond length in CH_3–Cl.

(ii) The dipole moment of chlorobenzene is lower than that of cyclohexyl chloride.

(iii) S_N1 reactions are accompanied by racemization in optically active alkyl halides.

Solution:

(i) In chlorobenzene, due to resonance the partial double bond character develops, thus bond length is shorter than C–Cl of CH_3–Cl.

(ii) The dipole moment of chlorobenzene is lower than cyclohexyl chloride, because of its shorter bond length ($\mu = q \times d$) due to resonance and sp^2 hybridized carbon.

(iii) Because S_N1 reactions occur via formation of carbocation that lead to formation of *d*– & *l*-products, hence racemization takes place.

14. An element crystallizes in a f.c.c. lattice with cell edge of 250 pm. Calculate the density if 300 g of this element contain 2×10^{24} atoms.

Solution:

$a = 250$ pm

$Z = 4$

$$\rho = \frac{Z \times M}{(a)^3 \times N_A \times 10^{-30}} = \frac{4 \times 90.33}{(250)^3 \times 6.022 \times 10^{23} \times 10^{-30}} = 38.4\ \text{g/cm}^3$$

15. Give reasons:

(i) Mn shows the highest oxidation state of +7 with oxygen but with fluorine it shows the highest oxidation state of +4.

(ii) Transition metals show variable oxidation states.

(iii) Actinoids show irregularities in their electronic configurations.

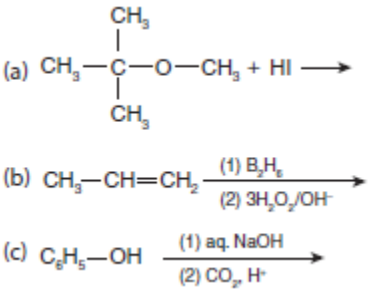
Solution:

(i) Mn shows +7 oxidation state with oxygen because it can form multiple bond, but fluorine cannot.

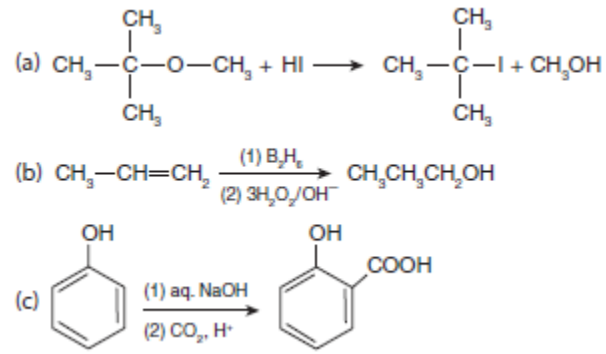
(ii) Transition metals show variable oxidation states, it is because the energy of *ns* and $(n-1)$ *d* orbitals are approximately same, thus they can lose different number of electrons depending on the requirement.

(iii) Actinoids show irregularities in electronic configuration, because of less energy difference between 5*f*, 6*d* and 7*s* orbitals. Hence, electrons can re-arrange for stable configuration.

16. Write the main product(s) in each of the following reactions:



Solution:



17. (i) Name the method of refining of metals such as Germanium.

(ii) In the extraction of Al, impure Al_2O_3 is dissolved in conc. NaOH to form sodium aluminate and leaving impurities behind. What is the name of this process?

(iii) What is the role of coke in the extraction of iron from its oxides?

Solution:

(i) For metals like germanium, zone refining method is used.

(ii) The process is known as leaching.

(iii) Coke acts as a reducing agent.

18. Calculate E.M.F of the following cell at 298 K:

$2Cr(s) + 3Fe^{2+}(0.1M) \rightarrow 2Cr^{3+}(0.01M) + 3Fe(s)$

Given: $E°(Cr^{3+} \mid Cr) = -0.74$ V and $E°\ (Fe^{2+} \mid Fe) = -0.44$ V

Solution:

$$E = E° - \frac{0.0591}{n}\log\frac{\text{Product}}{\text{Reactant}}$$

$$Cr\,|\,Cr^{3+}\,||\,Fe^{2+}\,|\,Fe$$

$Cr \rightarrow Cr^{3+} + 3e^-$ …(i)

$Fe^{2+} + 2e^- \rightarrow Fe$ …(ii)

On multiplying (i) by 2 and (ii) by 3 and adding these equations we get:

$2Cr\,(s) + 3Fe^{2+} \rightarrow 3Fe(s) + 2Cr^{3+}$

$$E = [0.44 - 0.74] - \frac{0.0591}{6}\log\frac{(0.01)^2}{(0.1)^3}$$

$$E = 0.30 - \frac{0.0591}{6}\log\frac{1}{10} = 0.30 - \frac{0.0591}{6}(-1) = 0.31\text{V}$$

19. (i) Write the name of two monosaccharides obtained on hydrolysis of lactose sugar.

(ii) Why Vitamin C cannot be stored in our body?

(iii) What is the difference between a nucleoside and nucleotide?

Solution:

(i) On hydrolysis of lactose two sugars obtained: β–D–Glucose and β–D–Galactose.

(ii) It is water soluble, hence it is excreted through urine.

(iii) Nucleoside: It is formed when pentose sugar combines with nitrogen base.

Nucleotide: When nucleoside bonds with phosphate group.

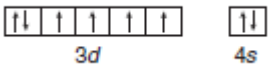
20. (a) For the complex $[Fe(CN)_6]^{3-}$, write the hybridization type, magnetic character and spin nature of the complex. (At. number: Fe = 26).

(b) Draw one of the geometrical isomers of the complex $[Pt(en)_2Cl_2]^{2+}$ which is optically active.

Solution:

(a) $[Fe(CN)_6]^{3-}$

Fe in ground state



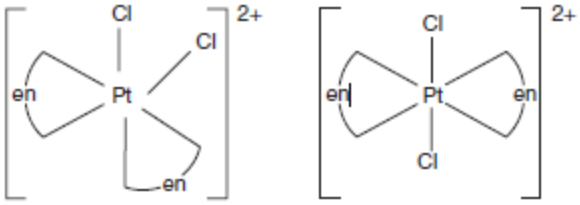
Since CN^- is a strong field ligand, thus pairing takes place.

Hybridization: d^2sp^3 (octahedral)

Magnetic character – Paramagnetic

Spin nature – Low spin complex

(b)



21. (i) $C_6H_5-CONH_2 \xrightarrow{Br_2/aq.KOH} A \xrightarrow[0-5°C]{NaNO_2+HCl} B \xrightarrow{KI} C$

(ii) $CH_3-Cl \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[\Delta]{CHCl_3+alc.\,KOH} C$

Solution:

(i) $C_6H_5-CONH_2 \xrightarrow{Br_2/KOH} \underset{(A)}{C_6H_5NH_2} \xrightarrow[0-5°C]{NaNO_2+HCl} C_6H_5N_2^+Cl^- \xrightarrow{KI} C_6H_5I$

(ii) $CH_3Cl \xrightarrow{KCN} \underset{(A)}{CH_3CN} \xrightarrow{LiAlH_4} \underset{(B)}{CH_3CH_2NH_2} \xrightarrow[\Delta]{CHCl_3+alc.KOH} \underset{(C)}{CH_3CH_2NC}$

22. (i) What is the role of *t*-butyl peroxide the polymerization of ethene?

(ii) Identify the monomers in the following polymer:

$[NH-(CH_2)_6-NH-CO-(CH_2)_4-CO]_n$

(iii) Arrange the following polymers in the increasing order of their intermolecular forces:

Polystyrene, Terylene, Buna-S

Solution:

(i) *t*-butyl peroxide acts as radial initiator in the polymerization of ethene.

(ii) The two monomers are $NH_2-(CH_2)_6-NH_2$ (Hexamethylene diamine) and $HOOC-(CH_2)_4-COOH$ (Adipic acid).

(iii) Buna – S < Polystyrene < Terylene

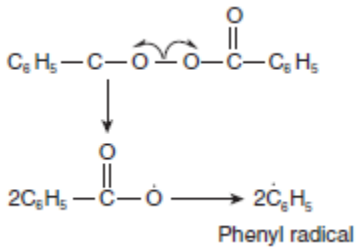
OR

Write the mechanism of free radical polymerization of ethene.

Solution:

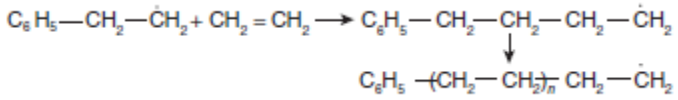
Steps involved in the free radical polymerization of ethene are:

(a) Chain initiation step:

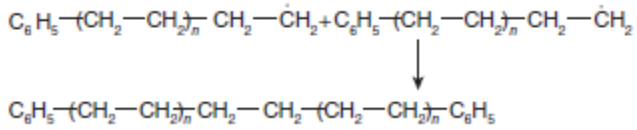


$$C_6H_5^{\bullet} + CH_2 = CH_2 \rightarrow C_6H_5 - CH_2 - CH_2^{\bullet}$$

(b) Chain propagating step:



(c) Chain terminating step:



23. Due to hectic and busy schedule, Mr. Angad made his life full of tensions and anxiety. He started taking sleeping pills to overcome the depression without consulting the doctor. Mr. Deepak, a close friend of Mr. Angad, advised him to stop taking sleeping pills and suggested to change his lifestyle by doing Yoga, meditation and some physical exercise. Mr. Angad followed his friend's advice and after few days he started feeling better.

After reading the above passage, answer the following:

(i) What are the values (at least two) displayed by Mr. Deepak?

(ii) Why is it not advisable to take sleeping pills without consulting doctor?

(iii) What are tanquilizers? Give two examples.

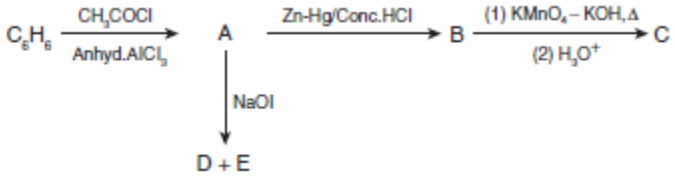
Solution:

(i) Mr. Deepak is a caring person. He is also very well aware of the harmful effects caused by the overdose of sleeping pills.

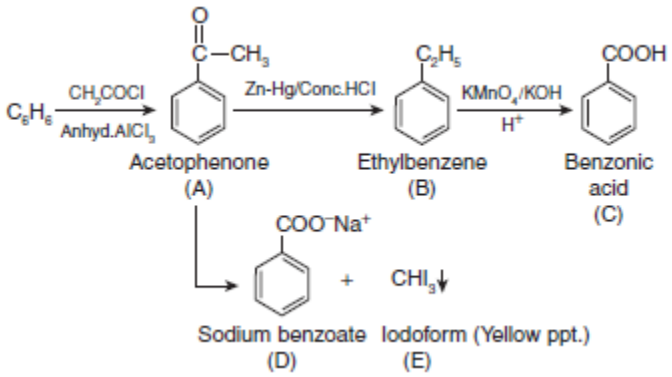
(ii) It is not advisable to take sleeping pills without consulting doctor, because it can be dangerous and life threating.

(iii) Medicines which are used to curve anxiety and depression are called tranquilizers eg. Equanil, phenelzine.

24. (a) Write the structures of A, B, C, D and E in the following reactions:



Solution:



OR

(a) Write the chemical equation for the reaction involved in Cannizzaro reaction.

(b) Draw the structure of the semicarbazone of ethanol.

(c) Why p*K*a of F–CH_2–COOH is lower than that of Cl–CH_2–COOH?

(d) Write the product in the following reaction:

$$CH_3 - CH = CH - CH_2CN \xrightarrow[(ii)\ H_2O]{(i)\ DIBAL-H}$$

(e) How can you distinguish between propanal and propanone?

Solution:

(a) Reaction involved in Cannizzaro reaction:

$$2HCHO \xrightarrow{50\%\ NaOH} CH_3OH + HCOONa$$

(b) CH_3–CH=N–NH–CO–NH_2

(c) In F–CH_2–COOH, fluorine is more electron withdrawing than chlorine in $ClCH_2$–COOH so FCH_2COOH is more acidic than $ClCH_2COOH$, thus its pK_a value is lesser than $ClCH_2COOH$.

(d) $\underset{\text{Pent-3-ene nitrile}}{CH_3 - CH = CH - CH_2 - CH} \xrightarrow[(ii)\ H_2O]{(i)\ DIBAL-H} \underset{\text{Pent-3-en-1-al}}{CH_3 - CH = CH - CH_2 - CHO}$

(v) Propanal and propanone can be differentiated

$$CH_3 - CH_2 - CHO + 2\left[Ag(NH_3)_2\right]^+ \rightarrow CH_3 - CH_2 - COO^- + 2\underset{\text{Silver mirror}}{Ag} + H_2O + 3NH_3$$

25. (a) Calculate the freezing point of solution when 1.9 g of $MgCl_2$(M = 95 g mol^{-1}) was dissolved in 50 g of water, assuming $MgCl_2$ undergoes complete ionization. (K_f for water = 1.86 K kg mol^{-1})

(b) (i) Out of 1 M glucose and 2 M glucose, which one has a higher boiling point and why?

(ii) What happens when the external pressure applied becomes more than the osmotic pressure of solution?

Solution:

(a) W_B (solute) = 1.9 g $\qquad W_{H_2O}$ = 50g

M_{MgCl_2} = 95 g/mol $\qquad i$ = 3 (for Mg Cl_2)

$$\Delta T_f = iK_f m$$

$$\Delta T_f = 3 \times 1.86 \times \frac{1.9}{95} \times \frac{1000}{50}(\text{kg})$$

ΔT_f = 2.232 K

Also, $\Delta T_f = T_i - T_f$

$$T_f = T_i - \Delta T_f$$
$$= 273.15 - 2.232$$
$$= 270.918\ \text{K}$$

(b) (i) 2M glucose has a higher boiling point. It is because more is the concentration; more is elevation in boiling point. $\Delta T_b \propto m$

(ii) Reverse osmosis takes place when the external pressure applied becomes more than the osmotic pressure of solution.

OR

(a) When 2.56 g of sulphur was dissolved in 100 g of CS_2, the freezing point lowered by 0.383 K. Calculate the formula of sulphur (S_x).

(b) Blood cells are isotonic with 0.9% sodium chloride solution. What happens if we place blood cells in a solution containing

(i) 1.2% sodium chloride solution?

(ii) 0.4% sodium chloride solution?

Solution:

(a) $\Delta T_f = K_f m$

$$\Delta T_f = K_f \times \frac{W_B}{M_B} \times \frac{1}{W_A}(\text{kg})$$

$$M_B = \frac{K_f \times W_B}{\Delta T_f \times W_A(\text{kg})} = \frac{3.83 \times 2.56 \times 1000}{0.383 \times 100\,(\text{kg})} = 256 \text{ g/mol}$$

Molar mass = n × Atomic mass

$$n = \frac{\text{Molar mass}}{\text{Atomic mass}} = \frac{256}{32} = 8$$

(b)

(i) On placing blood cells in 1.2% sodium chloride solution which is a hypertonic solution, water will move out from blood cells, hence cells will shrink.

(ii) On placing blood cells in 0.4 % sodium chloride solution which is a hypotonic solution, water will enter into the blood cells, hence cells will swell.

26. (a) Account for the following:

(i) Ozone is thermodynamically unstable.

(ii) Solid PCl_5 is ionic in nature.

(iii) Fluorine forms only one oxoacid HOF.

(b) Draw the structure of

(i) BrF_5

(ii) XeF_4

Solution:

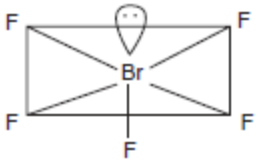
(i) $O_3 \rightleftharpoons O_2 + O;\ \Delta H = -\text{ve}$

Ozone is thermodynamically unstable, on decomposition it releases energy and the reaction is exothermic. Its ΔS is positive and thus, ΔG is always negative.

(ii) In solid state, PCl_5 exist as $[PCl_4]^+$ $[PCl_6]^+$ because of unequal P–Cl bond lengths.

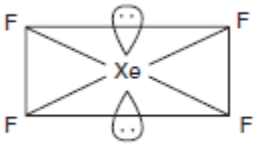
(iii) 'F' can exhibit only one oxidation state i.e. –1 and in HOF it exhibits –1 oxidation state so it can form only HOF. In F, absence of *d*-orbital is another reason for exhibiting only one oxidation state.

(b) (i) BrF_s



Square pyramidal

(ii) XeF_4



Square planar

OR

(a) Compare the oxidizing action of F_2 and Cl_2 by considering parameters such as bond dissociation enthalpy, electron gain enthalpy and hydration enthalpy.

(b) Write the conditions to maximize the yield of H_2SO_4 by contact process.

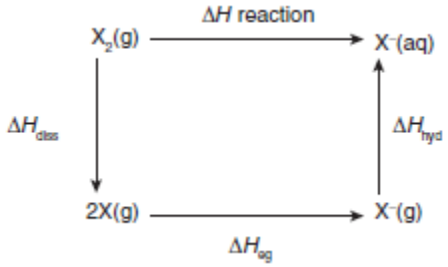
(c) Arrange the following in the increasing order of property mentioned:

(i) H_3PO_3, H_3PO_4, H_3PO_2 (Reducing character)

(ii) NH_3, PH_3, AsH_3, SbH_3, BiH_3 (Base strength)

Solution:

(a)



$\Delta H_{\text{reaction}} = \Delta H_{\text{dissociation}} + \Delta H_{e^- \text{ gain}} - \Delta H_{\text{hydration}}$.

The dissociation enthalpy ($\Delta H_{\text{dissociation}}$) of F_2 is less positive than that of Cl_2 but the ΔH_{eg} for F_2 is positive and for Cl_2 it is negative. However, since F^- is a smaller anion, it is more strongly hydrated and hence $\Delta H_{\text{hydration}}$ for F^- is more –ve than Cl^-.

$\Delta H_{\text{reaction}}$ for F_2 is more negative than Cl_2, hence F_2 is stronger oxidizing agent than Cl_2.

(b) The main reaction in the contact process is:

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \uparrow$$

This reaction is reversible. In order to increase the yield of SO_3 following conditions are required:

(i) High pressure (according to LCP) should be maintained.

(ii) High temperature should be maintained and

(iii) V_2O_5 catalyst

(c)

(i) $H_3PO_4 < H_3PO_3 < H_3PO_2$ (Reducing character)

(ii) $BiH_3 < SbH_3 < A_5H_3 < PH_3 < NH_3$ (Base strength)