1. The chemical formula of ferric phosphate is
(1) $Fe(PO_4)_3$ (2) $FePO_4$. (3) $Fe(PO_3)_2$ (4) $Fe_2(PO_4)_3$ (5) $Fe_3(PO_4)_2$

2. The confusion that existed among chemists at the early stages of the study of Chemistry, regarding the concept of ' atomic weight' was dispelled by
(1) Dalton. (2) Avogadro. (3) Cannizzaro. (4) Moseley. (5) Rutherford.

3. When ammonia gas is passed over heated manganese dioxide,
(1) it is likely that MnN_3 is formed.
(2) it is likely that N_2O_4 is formed.
(3) it is likely that N_2 is formed.
(4) it is likely that N_2O is formed.
(5) it is unlikely that any of the above is formed.

4. Chromate ions are converted to dichromate ions by the reaction with ethanoic acid. In this reaction,
(1) the chromate ions undergo oxidation.
(2) the chromate ions undergo reduction.
(3) the chromate ions undergo both oxidation and reduction.
(4) the ethanoic acid oxidation.
(5) none of the above occurs.

5. Which one of the following statements concerning the system consisting of $C_6H_5-CH_3$ and CH_3-OH is likely to be true?
(1) This system obeys Raoult's Law
(2) This system shows positive deviations from Raoult's Law.
(3) This is not a binary system.
(4) This system shows negative deviations, only when the $C_6H_5CH_3$ mole fraction is high.
(5) This system shows negative deviations, only when the CH_3OH mole fraction is high.

6. Consider the following compounds:

$CH_3COOCOCH_3$ (P)

$CH_3CH_2COOCH_3$ (Q)

$ICH_2COCH_2CH_3$ (R)

$CH_3\underset{\underset{OH}{|}}{C}HCH_2CH_2CH_3$ (S)

Which of the above compounds / compound answer / answers the iodoform reaction ?
(1) P (2) Q (3) S (4) p and S (5) R and S

7. Which one of the following will give a precipitate readily with aqueous silver ethanoate ?
(1) $ClCH_2CH_2Cl$ (2) $C_6H_5CH_2Cl$ (3) $CH_2=CHBr$ (4) CH_3CCl_3 (5) $Br_2C=CBr_2$

8. The chemical formula of rutile is
(1) $Fe_2O_3.Tio_2$. (2) $FeO.TiO_2$. (3) TiO_3. (4) TiO_2. (5) TiO_4.

9. Which one of the following could be used to distinguish chemically between AgBr and AgI ?
(1) Dilute HNO_3 (2) Concentrated HNO_3 (3) Dilute HCl
(4) Concentrated Cl_3CCOOH (5) Dilute H_2SO_4

10. Which one of the following changes is most closely connected with the standard enthalpy of formation of magnesium fluoride?
(1) $Mg(s) + F_2(s) \rightarrow MgF_2(s)$
(2) $Mg^{2+}(g) + 2F^-(g) \rightarrow MgF_2(s)$
(3) $Mg(s) + 1/2\ F_2(g) \rightarrow MgF(s)$
(4) $Mg(s) + F_2(g) \rightarrow MgF_2(s)$
(5) $Mg(g) + 1/2\ F_2(g) \rightarrow MgF(s)$

11. How much of oxygen gas at s.t.p. is expected to be liberated by the passage of 1 Faraday of electricity through an aqueous solution of sulphuric acid ?
(1) 22.4 dm^3 (2) 11.2 dm^3 (3) 5.6 dm^3 (4) 88.8 dm^3 (5) 44.8 dm^3

12. When 1 mole of an organic compound, X was subjected to ozonolysis under oxidative conditions, 2 moles of ketone and 1 mole of dicarboxylic acid were obtained. The compound, X
(1) can be $(CH_3)_2C=CHCH_2CH_2CH_2CH=CHCOOH$.
(2) can be $C_6H_5CH=CHCH=C(CH_3)_2$.
(3) can be $CH_3CH=CHCH=CHCH_3$.
(4) can be $(CH_3)_2C=CHCH_2CH_2CH_2CH=\overset{\overset{CH_3}{|}}{C}C_6H_5$
(5) cannot be any of the above.

13. The concentration of an aqueous solution of sodium hydroxide is 10^{-4} mol dm^{-3}. The pH value of this solution
(1) is 4 (2) is 10 (3) is approximately 5.
(4) is approximately 13. (5) cannot be definitely stated.

14. Which one of the following statements concerning ionization energies is true?
(1) The first ionization energy of Al is greater than the first ionization energy of Mg.
(2) The first ionization energy of Si is smaller than the first ionization energy of S.

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(3) The fourth ionization energy of B is smaller than the fourth ionization energy of Al.
(4) The first ionization energy of Cl is greater than the first ionization energy of Ne.
(5) All of the above statements are false.

15. A 1.0 mol dm^{-3} aqueous solution of a mono-basic acid is 25% dissociated. The K_a value of this acid is
(1) 6.25×10^{-2} mol dm^{-3} (2) 6.25×10^{-2} mol^2 dm^{-6}
(3) 8.33×10^{-2} mol^2 dm^{-6} (4) 8.33×10^{-2} mol dm^{-3}
(5) 6.25×10^{-4} mol dm^{-3}

16. The compound $C_2H_3BrCl_2$
(1) exists as 2 isomers. (2) exists as 3 isomers. (3) exists as 4 isomers.
(4) exists as 5 isomers. (5) exists as 6 isomers.

17. Which one of the following is most volatile ?
(1) CH_4 (2) NH_3 (3) H_2O (4) HF (5) Ne

18. Which one of the statements concerning an aqueous solution of hydrogen sulphide is most likely to be false ?
(1) It reacts with hydrofluoric acid (2) It reacts with iodic acid
(3) it reacts with HIO_4 (4) It reacts with H_3AsO_4
(5) It reacts with $HMnO_4$

19. Which one of the following could be the chloride of the element, M, of atomic number 40, containing the highest percentage of chlorine ?
(1) MCl_2 (2) MCl_3 (3) MCl_4 (4) MCl_5 (5) MCl_6

20. Which one of the following will undergo nitration most readily ?
(1) $C_6H_5COCH_3$ (2) C_6H_5Cl (3) 
(4) $C_6H_5OCH_3$ (5) $C_6H_5CH_2CH_3$

21. The K_a value of ethanoic acid is 1.75×10^{-5} mol dm^{-3} at 25 °C. The K_b value of ammonia is 1.80×10^{-5} mol dm^{-3} at 25°C. 4.0 cm^3 of a 1.0 mol dm^{-3} solution of ammonia is titrated at 25°C with a 0.10 mol dm^{-3} solution of ethanoic acid. In this titration the pH value at the equivalence point is
(1) approximately 10.5 (2) approximately 10. (3) approximately 9.
(4) approximately 7. (5) approximately 5.5.

22. Which one of the following equations could be most closely associated with the principle relevant to steam distillation ?
(1) $\frac{C_1}{C_2}$ = constant (2) $P_1 \times P_2$ = a constant (3) $\frac{P^\circ_A - P_A}{P^\circ_A} = X_B$
(4) $\frac{P^\circ_A - P_A}{P^\circ_A} = X_A$ (5) $P_1 + P_2 = P$

23. The shape of the species PF_4^+ is
(1) planar. (2) square planar. (3) tetrahedral.
(4) trigonal bipyramidal. (5) none of the above.

24. Which one of the following statements concerning K_p and K_c is true ?
(1) K_p changes with temperature.
(2) K_p increases with increase in pressure.
(3) K_c increases in the presence of positive catalysts.
(4) K_c increases in the presence of negative catalysts.
(5) None of the above statements is true.

25. Tin metal reacts with a concentrated solution of caesium hydroxide and gives
(1) $CsSnO_3$ and H_2. (2) $CsSnO_2$ and H_2. (3) Cs_2SnO_3 and H_2.
(4) Cs_2SnO_3 and O_2. (5) Cs_2SnO and O_2.

26. When dilute HCl was added to the inorganic compound, Q a gas and a light blue solution were obtained. This gas did not change the colour of acidified $KMnO_4$. When an excess of aqueous ammonia was added to a portion of the light blue solution, a dark blue solution was obtained. When H_2S gas was passed through another portion of the light blue solution, a precipitate was not obtained. Which one of the following could be Q ?
(1) $CuSO_3$ (2) $NiCO_3$ (3) $Ni(NO_2)_2$ (4) $NiSO_3$ (5) $CuCO_3$

27. When we consider equi-molar aqueous solutions, which one of the following will be most acidic ?
(1) Cl_2 (2) SO_3 (3) Cl_2O_7 (4) Br_2 (5) Br_2O

28. Which one of the following statements concerning the electrode, Mg(s) / Mg^{2+}(aq) is true ?
(1) As the Mg^{2+} concentration is decreased, the potential of the electrode becomes more and more negative.
(2) As the Mg^{2+} concentration is increased, the potential of the electrode becomes more and more negative.
(3) As the surface area of Mg(s) is increased, the potential of the electrode becomes more and more positive.

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(4) As the surface area of Mg (s) is decreased, the potential of the electrode becomes more and more positive.
(5) None of the above is true.

29. Which one of the following statements concerning atomic spectra is true ?
(1) As the frequencies of the lines of the spectrum of hydrogen increase, the lines rapidly come close together.
(2) As the frequencies of the lines of the spectrum of hydrogen increase, the lines rapidly separate from each other.
(3) The frequency difference between successive lines in the spectrum of hydrogen remains constant.
(4) Hydrogen gives only an emission spectrum.
(5) Hydrogen gives only an absorption spectrum.

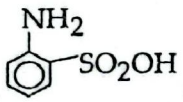
30. Which one of the following statements concerning the manufacture of bleaching powder is true ?
(1) Bleaching powder is manufactured by passing Cl_2 gas over heated $CaCO_3$.
(2) Bleaching powder is manufactured by passing Cl_2 gas over heated CaO.
(3) Bleaching powder is manufactured by passing Cl_2 gas through a cold solution of $Ca(OH)_2$.
(4) Bleaching powder is manufactured by passing Cl_2 gas through a hot solution of $Ca(OH)_2$.
(5) None of the above statements is true.

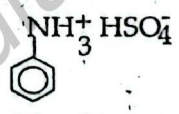
31. Which of the following shows/show buffer action?
(a) Potassium bicarbonate
(b) Trisodium orthophosphate
(c) Rubidium carbonate
(d) Proteins

32. Which of the following reacts/react with 2,4-dinitrophenol ?
(a) Aqueous hydroiodic acid
(b) Aqueous sodium bicarbonate.
(c) Ethanolic sodium ethoxide
(d) Aqueous hydrobromic acid.

33. Which of the following statements? statement are/is true ?
(1) The solubility of $Sn(OH)_2$ in water is less than that in aqueous NaOH.
(b) The solubility of $Zn(OH)_2$ in water is less than that in aqueous KOH.
(c) The solubility of $Ca(OH)_2$ in water is less than that in aqueous KOH.
(d) The solubility of $Fe(OH)_3$ in water is less than that in aqueous NaOH.

34. Which of the following statements/statement concerning distinguishing between.
are/is true ?



and


(a) An aqueous solution of sodium hydroxide can be used for this purpose.
(b) An aqueous solution of sodium carbonate can be used for this purpose.
(c) An aqueous solution of hydrochloric acid can be used for this purpose.
(d) None of the above solutions can be used for this purpose.

35. Which of the following are/is present in the main constituents of the three types of oil obtained from the cinnamon plant ?
(a) Amide group
(b) Ketone group
(c) Aldehyde group
(d) Hydroxy group

36. Which of the following statements/statement concerning gamma rays are/is true ?
(a) Gamma rays travel with a velocity of 95% of the velocity of light.
(b) The ionizing power of gamma rays is very high.
(c) The penetrating power of gamma rays is very high.
(d) The path of gama rays is not altered by magnetic fields.

37. Which of the following statements/statement concerning the Periodic Table are/is true?
(a) Certain elements of Group 4 form divalent compounds.
(b) Certain non-transition elements of group 3 exhibit the +4 oxidation state.
(c) Certain elements of Group 4 exhibit the +7 oxidation state.
(d) Certain non-transition elements of group 7 exhibit the +1 oxidation state.

38. Which of the following were / was sufficient to provide the initial basis for Dalton's Atomic Theory ?
(a) Law of Multiple Proportions.
(b) Law of Definite Proportions.
(c) Law of Conservation of Mass.
(d) Gay Lussacc's Law.

39. Which of the following are/is required to calculate the lattice energy of $AlCl_3$?
(a) Seond ionization energy of Al.
(b) First ionization energy of Al.
(c) Sublimation energy of Cl_2.
(d) First ionization energy of Cl.

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40. Which of the following groups/ group are/is present in polymeric materials useful to man?

(a) —OH (b) $-NH_2$

(c) —CO— NH — (d) $-CH_2-\underset{\displaystyle CH_3}{\overset{|}{C}}=CH-CH_2-$

	First Statement	Second Statement
41.	The nitration of $C_6H_5NHCOCH_3$ gives the 3-netro derivative	The $-COCH_3$ group is meta-directing.
42.	Graphite anodes are used in the manufacture of caustic soda.	Graphite has a layer structure.
43.	Liquid HF conducts electricity very well.	The electronegativity difference between H and F is high.
44.	C_6H_5MgBr reacts very readily with $H-\overset{\displaystyle O}{\overset{\|}{C}}-OH$	Grignard reagents add across the $>C=O$ groups of aldehdes and ketones.
45.	There are only 18 elements in the 4th period of the periodic table.	Only 18 electrons can be accommodated in the 4s, 3*d* and 4*p* sub-levels.
46.	In obtaining SO_3 on the large scale from the reaction $2SO_2 + O_2 \rightarrow 2SO_3$, very high pressures are used to increase the efficiency.	In the reaction $2SO_2 + O_2 \rightarrow 2SO_3$, there is reduction in number the of gaseous molecules.
47.	The van der Waals Equation breaks down. at s.t.p.	At s.t.p. all gases behave in accordance with the equation $PV = nRT$.
48.	CO_2 does not cause any damage to our environment	The CO_2 in the environment is utilized in photosynthesis.
49.	The atomic mass unit is accepted as 1.66×10^{-24} g	While exactly 1/12 of the mass of a carbon atom is taken as the atomic mass unit, there are 6.022×10^{23} carbon atoms in exactly 12 g of carbon.
50.	Ethyne does not show any acidic properties.	Ethyne consists of only hydrogen and carbon.

51. The isotope $^{214}_{84}Po$ emits two beta particles and two alpha particles. The final product of this nuclear change is

(1) $^{206}_{84}Po$ (2) $^{206}_{84}Pb$ (3) $^{206}_{82}Pb$ (4) $^{210}_{82}Rn$ (5) none of the above

52. It has become necessary to synthesise $C_6H_5CH=CH_2$ starting from benzene. Which one of the following is the most appropriate starting step for this purpose ?

(1) $C_6H_6 + CH_3Cl$ + anhydrous $AlCl_3$
(2) C_6H_6 + concentrated HNO_3 / Concentrated H_2SO_4
(3) $C_6H_6 + CH_3COCl$ + anhydrous $AlCl_3$
(4) C_6H_6 + concentrated HNO_3/ concentrated HCl / CH_3CH_2OH
(5) $C_6H_6 + ClCH_2CH_2OH$ in the presence of ultra-violet radiation

53. Which one of the following steps is most likely to occur in the mechanism of the addition of bromine to propene?

(1) $CH_2=\underset{\displaystyle CH_3}{CH}$ $Br-Br$ (2) $CH_2=\underset{\displaystyle CH_3}{CH}$ Br^+ (3) $\underset{\displaystyle CH_3}{CH}=CH_2$ Br

(4) $:Br^-$ $\underset{\displaystyle CH_3}{CH}=CH_2$ (5) $\underset{\displaystyle CH_3}{CH}=CH_2$ $Br-Br$

54. The half-life of a radioactive isotope A is 4 days. After 6 days, the radioactivity of a sample of A is

(1) 0.49 of the initial value. (2) 0.48 of the initial value.
(3) 0.27 of the initial value. (4) 0.26 of the initial value
(5) none of the above.

55. Which one of the following groups of chemicals could be used for the purpose of distinguishing between methanal and ethanal ?

(1) $K_2Cr_2O_7$, aqueous H_2SO_4 and KBr
(2) $KMnO_4$ and aqueous HCl
(3) K_2CrO_4, aqueous HI and aqueous NaOH
(4) Br_2 and aqueous KI
(5) None of the above groups of materials can be used for the purpose of distinguishing between methanal and ethanal.

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56. NO_2, SO_2 and water react together and form
(1) H_2SO_4 and NO.
(2) H_2SO_4 and N_2O.
(3) H_2SO_3 and H_2SO_4.
(4) H_2SO_3 and HNO_3.
(5) H_2SO_4 and N_2

57. Which one of the following statements concerning a catalyst is most appropriate?
(1) A catalyst decreases the enthalpy change of a reaction.
(2) A catalyst decreases the enthalpy change of the forward reaction.
(3) A catalyst decreases the activation energy of the forward reaction.
(4) A catalyst increases the activation energy of the reverse reaction.
(5) A catalyst changes the activation energy of a reaction.

58. An organic compound is more soluble in CCl_4 than in water, and the relevant distribution coefficient is 4. A sample of volume 100 cm^3 of an aqueous solution of this organic compound contains 3.00 g of the organic compound. This sample was extracted successively with two 25 cm^3 portions of CCl_4. How much of the organic compound is present in the 100 cm^3 of the aqueous solution that is obtained finally ?
(1) 1.50g (2) 1.25 g 3) 1.00 g (4) 0.75 g (5) 0.33 g

59. Consider the following conversion:
$(CH_3)_2CHCH_2OH \rightarrow (CH_3)_2 CHCHO$
Which one of the following is most suitable for this purpose ?
(1) Reacting with K_2CrO_4 and concentrated sulphuric acid.
(2) Refluxing with $K_2Cr_2O_7$ and sulphuric acid
(3) Reacting with $KMnO_4$ and concentrated nitric acid.
(4) Passing the vapour of the alcohol over heated copper
(5) Passing the vapour of the alcohol over heated alumina.

60. Which one of the following will give a precipitate with aqueous $BaCl_2$?
(1) Aqueous NH_4I
(2) Aqueous ammonia
(3) Aqueous SO_2
(4) Aqueous CO_2
(5) Aqueous $K_2Cr_2O_7$

PART A STRUCTURED ESSAY

1. (a) The element X forms compounds of chemical formulae, XH_2 and XS. XH_2 reacts with water, XS dissolves in water. This solution imparts a colour to the bunsen flame.

(i) Indicate in the cage below, which one of the following could be X.
Na, Mg, Al, K, Ca, Fe, Co, Ni, Cu, Zn.

X =

(ii) Write the electron configuration of X in the usual manner, as $1s^2$, $2s^2$, ...

(b) The compound of molecular formula $H_2S_2O_7$, gives a white precipitate with aqueous $BaCl_2$. In this reaction, a considerable amount of heat is also liberated. The two sulphur atoms of $H_2S_2O_7$ are identical, while four of the oxygen atoms are also identical. Suggest a structural formula for $H_2S_2O_7$.

(c) Write chemical formulae of the following compound in the appropriate cages.

	Compound	Chemical formula
(i)	beryllium dichromate	
(ii)	chromic oxalate	

2. (a) When iodine reacts with an excess of chlorine water, HIO_3 and HCl are formed. Write a balanced, chemical equation for this reaction.

(b) 0.305 g of a mixture consisting of solid anhydrous sodium bicarbonate and solid anhydrous sodium carbonate was heated strongly. The residue so obtained was dissolved in water and an excess of calcium chloride was added. The precipitate of calcium carbonate so formed was filtered, separated, dried and weighed. The mass of this calcium carbonate was 0.200 g. Calculate the mole ratio of sodium bicarbonate : sodium carbonate in the above mixture.
(H=1 ; Na = 23 ; Ca = 40 ; O= 16 ; C= 12)

(c) Assume that you are supplied with an aqueous solution of potassium chloride as the only starting chemical substance. You are also provided with the facilities commonly found in a laboratory. Indicate clearly how you would, under these conditions, attempt to distinguish between an aqueous solution of magnesium sulphate and an aqueous solution of zinc sulphate provided to you.

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(a) The organic compound, A contains only C, H and N. When a certain mass of the compound A was subjected to appropriate combustion, carbon dioxide and water were obtained in the mole ratio of 4:3. Nitrogen was also obtained in this combustion. The accurate relative molecular mass of A is exactly 164. Determine the molecular formula of A. (C =12; H = 1; N=14)

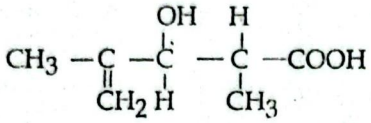
(b) The molecular formula of the organic compound, B is C_7H_9N. Draw all the structures possible for B.

(c) Indicate how the following syntheses could be effected. The essential reagents and reaction conditions should be clearly stated at the appropriate places.
N.B. If the method of synthesis proposed by you is unnecessarily long, you will not be awarded full marks.

(i) The syntheses of $CH_3C{\equiv}CCOOH$, using $HC{\equiv}CH$ as the only starting organic compound.

(ii) The synthesis of $(CH_3CH_2)_2\overset{CH_3}{\underset{|}{C}}—OH$, using CH_3CH_2OH as the only starting organic compound.

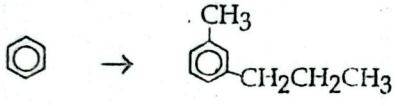
4. (a) Name the compound with the following structure in accordance with IUPAC nomenclature.
N.B. Disregard stereoisomerism

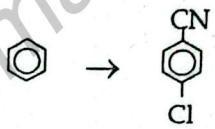


(b) Give the mechanism relevant to the following addition reaction.

$$C_2H_4 + Br_2 \rightarrow BrCH_2CH_2Br$$

(c) Indicate how the following conversions could be effected. The necessary reagents and reaction conditions should be clearly stated at the appropriate places.
N.B. If the method of conversion proposed by you is unnecessarily long, you will not be awarded full marks.

(i) 

(ii) 

5. (a) Derive Avogadro's Law using the equation, $PV = 1/3\ mNc^2$

(b) **This part of the question is connected with the experimental determination of molar volumes of gases by G.C.E Advanced Level students.**

(i) A sample of calcium carbonate of mass 1.50 g was heated, and 360 ml of CO_2 gas at 27 °C and under an atmospheric pressure of 750 mm Hg was collected.
Calculate the molar volume of CO_2 at s.t.p. according to the above data. (Ca = 40; O=16 ; C= 12 : 1 atm = 760 mm Hg)

(ii) Give five reasons, clearly and separately, for there being a difference between the answer you obtain and the expected standard value.

(c) A vessel having a certain definite volume contains H_2 gas and He gas. At 0 °C ,the pressure inside the vessel was 0.89 atm. 0.03 mol of CH_4 was introduced into this vessel, and it was heated until the temperature was 107 °C Then the pressure inside the vessel rose to 1.65 atm. If at the begining of this experiment, the partial pressure of H_2 was twice the partial pressure of He, calculate the mole fraction of He at the end of the experiment.
N.B. Assume that, under these conditions, all three gases behave ideally, and that the volume of the vessel remains unchanged.

6. (a) (i) Consider the following equilibrium existing in a volume, V dm^3

$$RCOOH\ (l) + R'OH\ (l) \rightleftharpoons RCOOR'(l) + H_2O\ (l)$$

Assume that x mol ester is formed when 1 mol of RCOOH and 1 mol of R'OH reach the state of equilibrium at a certain temperature. Show that, for this equilibrium at the above temperature,

$$K_c = \frac{X^2}{(1-X)^2}$$

(ii) The reaction between ethanol and ethanoic acid is catalyzed by concentrated sulphuric acid. Describe clearly and briefly how you would determine the K_c for this reaction at room temperature.

(b) 25.0 cm^3 of a solution of NaOH required 50.0 cm^3 of a 0.05 mol dm^{-3} solution of HCl for neutralization. This NaOH solution was saturated with $Ca(OH)_2$ at a certain temperature. 25.0 cm^3 of this saturated solution required 65.0 cm^3 of the above HCl solution for neutralization. Calculate the solubility product of $Ca(OH)_2$ at the above temperature.

(c) (i) Will you be able to determine the solubility product of $Mg(OH)_2$ by a method similar to that given in (b) above ? Give reasons for your response. K_{sp} of $Mg(OH)_2 = 10^{-12}$ mol^3 dm^{-9} , at the relevant temperature.

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(ii) Will you be able to determine the solubility product of $Al(OH)_3$ by a method similar to that given in (b) above ? Give reasons for your response.

7. (a) Describe clearly how the occurrence of metals and the general methods of their extraction could be related to the position of the metals in the electrochemical series.

(b) (i) Name the factors, other than concentration, pressure and catalysts, which influence the rate of a chemical reaction.

(ii) Describe briefly an experiment that you have performed in the laboratory for the determination of the relationship between the rate of the thiosulphate / acid reaction and the concentration of thiosulphate.

(c) You are supplied with a substance that catalyses the reaction between $H_2(g)$ and $I_2(g)$. Indicate briefly a simple experiment for the purpose of demonstrating definitely and clearly that the above catalyst is actually effective in bringing the above reaction towards a state of equilibrium at ordinary temperature.

8. (a) Write brief descriptions of two methods available for the measurement of radioactivity.

(b) Explain how the standard enthalpy of formation of $C_2H_4(g)$ can be determined experimentally.

(c) At 25 °C, a certain aqueous solution is 1.00 mol dm^{-3} with respect to HCl, and 0.01 mol dm^{-3} with respect to the carboxylic acid RCOOH. At 25 °C, K_a of RCOOH = 2.0×10^{-5} mol dm^{-3}; $K_w = 10^{-14}$ mol^2 dm^{-6}.

(i) Calculate the degree of dissociation of RCOOH in the above solution at 25°C.

(ii) Calculate the pOH of the above solution at 25°C.

(iii) What is the relationship between the pOH of a 1.00 mol dm^{-3} solution of pure aqueous HCl at 25°C and the answer that you obtain in (ii) above ? Explain why that relationship arises.

9. (a) **State clearly and separately** the various courses of action taken for the purpose of increasing the yield in the manufacture of ammonia.
Explain as fully as you can, **appropriately and separately,** how each of these courses of action increase the efficiency of the manufacturing process.
N.B. It is sufficient to consider only four such courses of action

(b) Describe briefly how you would demonstrate in the laboratory that ammonia gas can be readily converted into oxidized species of nitrogen, under certain conditions.
N.B. You should write balanced chemical equations for the relevant reactions.

(c) Explain how nitrogen gas present in the atmosphere is converted to water-soluble species by simple chemical reactions in the Nitrogen Cycle.

10. (a) How and under what conditions does sulphuric acid react with the following substances?
(i) carbon
(ii) sulphur
(iii) hydrobromic acid.

(b) Propose a method to obtain pure sulphur starting with $CuFeS_2$.

(c) You are supplied with a sample of an amalgam containing zinc, and tin. Indicate briefly and clearly how you would attempt to determine the percentages of zinc, tin and mercury present in this sample.

11. (a) Consider the hydrides of potassium, calcium, sulphur and chlorine.
(i) State clearly and separately the nature of the bonding in these hydrides.
(ii) State clearly and separately the reactions shown by these hydrides with water.

(b) **"Hydrogen bonds are very important in connection with living systems."**
demonstrate clearly that the above statement is true by considering five relevant facts.

(c) You have been informed that a sample of soap supplied to you contains a certian amount of unreacted caustic soda. As chemical reagents, you are suplied with only a solution of calcium nitrate and solution of magnesium nitrate. Apart from these, you are also provided with facilities in an ordinary laboratory. Under these conditions. Propose a method to determine the percentage of caustic soda present in the sample of soap provided to you.

12. (a) (i) Name the four types of oxide that you have studied. Give one example for each of these types of oxide.
(ii) Write a brief description of the uses of oxygen.

(b) Write a brief description of how the large-scale combustion of petroleum fuels and crude oil could adversely affect the environment.

(c) solid iodine is dissolved in aqueous potassium iodide. Explain briefly how you would attempt to determine the total iodine concentration (i.e, I_2 and I^-) present in this solution.

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