1. In which one of the following is the first ionization energy lowest?
(1) Li (2) Be (3) B (4) K (5) Fr

2. Which one of the following changes is most closely related to the lattice energy of sodium chloride?
(1) $Na(s) + \frac{1}{2} Cl_2(g) \longrightarrow NaCl(g)$ (2) $Na(s) + \frac{1}{2} Cl_2(g) \longrightarrow Na^+Cl^-(s)$
(3) $Na(g) + Cl(g) \longrightarrow Na^+Cl^-(g)$ (4) $Na^+(g) + Cl^-(g) \longrightarrow Na^+Cl^-(s)$
(5) $Na^+(g) + Cl^-(g) \longrightarrow Na^+Cl^-(g)$

3. The chemical formula of potassium stannate is
(1) $KSnO_3$. (2) K_2SnO_3. (3) $KSnO_2$. (4) K_2SnO_2 (5) none of the above.

4. The concentration of a gas at pressure of 1 atm is 1.0 mol l^{-1}. If the gas behaves ideally, the condition that corresponds to this situation
(1) is 285.2 K. (2) is 12.2 °C. (3) is 12.2 K. (4) is 285.2°C. (5) cannot be definitely stated.

5. The number of primary alcohols with the molecular formula $C_4H_{10}O$ is
(1) 1. (2) 2. (3) 3. (4) 4. (5) none of the above.

6. Which one of the following statements concerning geometrical isomerism is correct?
(1) $H_2C=C(CH_3)_2$ exhibits geometrical isomerism.
(2) ClBrC=ClF exhibits geometrical isomerism.
(3) $ClFC=C(C_6H_5)_2$ exhibits geometrical isomerism.
(4) $Cl_2C = CBr_2$ exhibits geometrical isomerism.
(5) None of the above exhibits geometrical isomerism.

7. The inorganic compound P gives a gas, Q and a solution, R, on heating with concentrated HCl. A filter paper dipped in acidified $KMnO_4$ is decolorized by Q. When aqueous ammonia is added to R. a greenish precipitate is obtained. The precipitate reacts with air and turns brown. Which one of the following could be P?
(1) $HgSO_3$ (2) Bi_2S_3 (3) $CoSO_3$ (4) FeS (5) NiS

8. Rubies contain
(1) Al, Si and O. (2) Al, Cr, Fe and O. (3) Al, Ti, and O. (4) Al, Cr and O. (5) Al, Si. Cr and O.

9. Which one of the following statements concerning distinguishing between CH_3COCl and $ClCH_2COOH$ is true?
(1) Methyl orange indicator can be used for this purpose.
(2) Methyl red indicator can be used for this purpose.
(3) Phenolphthalein indicator can be used for this purpose.
(4) Aqueous sodium hydroxide can be used for this purpose.
(5) None of the above can be used for this purpose.

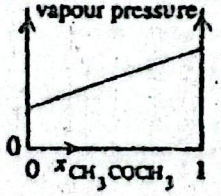
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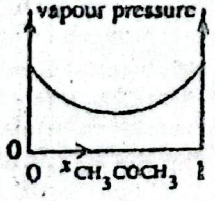
10. $CH_3-\underset{CH_3}{\overset{}{C}} = \overset{CH_3}{\overset{|}{C}}-\overset{CH_3}{\overset{|}{C}} = \underset{CH_3}{\overset{}{C}}-CH_3$ on ozonolysis gives
(1) 2 moles of propanone and 1 mole of butandione. (2) 2 moles of propanone and 2 moles of butandione.
(3) 4 moles of propanone and 1 mole of butanone. (4) 8 moles of ethanoic acid.
(5) 4 moles of ethanoic acid.

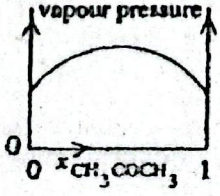
11. Which one of the following is the most suitable starting organic compound for the synthesis of $(CH_3)_2C=CHCOOH$?
(1) CH_3CH_2COOH (2) CH_3COCH_3 (3) $CH_3CH=CH_2$ (4) $CH_3\overset{OH}{\overset{|}{C}}HCH_3$ (5) $CH_3-\overset{CH_3}{\overset{|}{C}}-Br$ (CH_3)

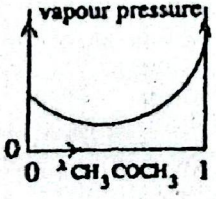
12. Which one of the following is likely to give CO_2 readily when heated?
(1) Li_2CO_3 (2) Na_2CO_3 (3) K_2CO_3 (4) Rb_2CO_3 (5) Cs_2CO_3

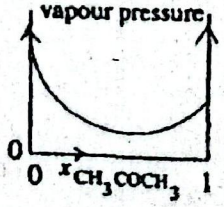
13. Which one of the following representations is most relevant to the variation of the vapour pressure of mixtures of CH_3COCH_3 and $CHCl_3$ at a given temperature?
(N.B. The boiling point of CH_3COCH_3=56.1°C; the boiling point of $CHCl_3$ = 61.7°C.)

(1)


(2)


(3)


(4)


(5)


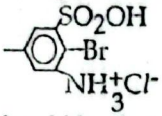
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14. The boiling point of aniline is 140°C. Under 1 atm pressure, a mixture of aniline and water boils
(1) at 100°C. (2) below 100°C (3) at 140°C. (4) above 140°C. (5) above 100°C.

15. Which one of the following indicators is most suitable for the titration between aqueous barium hydroxide and propanoic acid ?
(1) Methyl orange, $pK_I = 3.5$ (2) Methyl red, $pK_I = 5.0$ (3) Litmus, $pK_I = 6.8$
(4) Bromothymol blue, $pK_I = 7.0$ (5) Cresol red, $pK_I = 8.3$

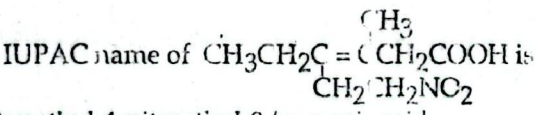
16. In which one of the following is the radius smallest?
(1) Cl^- (2) Na (3) K (4) Mg^{2+} (5) Na^+

17. For the process, $S(g) + 2e \rightarrow S^{2-}(g)$ $\Delta H^\circ = +95\ kJ\ mol^{-1}$
For the process, $S^-(g) + e \rightarrow S^{2-}(g)$ $\Delta H^\circ = +143\ kJ\ mol^{-1}$
According to the above data, what is the electron affinity of sulphur?
(1) $+48\ kJ\ mol^{-1}$ (2) $-48\ kJ\ mol^{-1}$ (3) $+96\ kJ\ mol^{-1}$ (4) $-96\ kJ\ mol^{-1}$ (5) $-238\ kJ\ molo^{-1}$

18. Which one of the following statements concerning the detection of elements in the compound, I  is not appropriate ?
(1) Lassaigne fusion should be done to show that N is present.
(2) Lassaigne fusion should be done to show that Cl^- is present.
(3) Lassaigne fusion should be done to show that I is present.
(4) Lassaigne fusion should be done to show that S is present.
(5) Lassaigne fusion should be done to show that Br is present.

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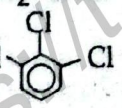
19. The shape of ClBrFPO is
(1) tetrahedral. (2) Planar. (3) trigonal bipyramidal. (4) octahedral. (5) none of the above.

20. The IUPAC name of  is
(1) 3-methyl-4-nitroethyl-3-hexenoic acid. (2) 4-ethyl-6-nitro -3-methyl-3-hexenoic acid.
(3) 4-ethyl-3- methyl-6-nitro-3-hexenoic acid. (4) 4-ethyl-3- methyl-4-nitroethyl-3 -butenoic acid.
(5) 3-methyl-4-ethyl-6-nitro-3-hexenoic acid.

21. Which one of the following molecules is most polar?
(1) NH_3 (2) H_2O (3) H_2S (4) H_2Te (5) CF_4

22. Which one of the following will not give NO_2 on heating?
(1) $Ca(NO_3)_2$ (2) $CsNO_3$ (3) $Cd(NO_3)_2$ (4) $Al(NO_3)_3$ (5) $Pb(NO_3)_2$

23. Which one of the following statements concerning SO_2 is not true ?
(1) SO_2 reacts with acidified $KMnO_4$. (2) SO_2 reacts with acidified CrO_3
(3) SO_2 reacts with concentrated HNO_3 (4) SO_2 reacts with aqueous H_2S.
(5) SO_2 reacts with aqueous HF.

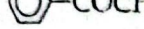
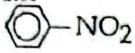
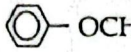
24. Which one of the following will undergo hydrolysis most readily?
(1) $CH_2=CHCl$ (2) $CH_3CH = CHCl$ (3) $(C_6H_5)_3CCl$
(4)  (5) Cl_3CCH_3

25. Which one of the following statements concerning alpha rays is not true?
(1) The penetrating power of alpha rays is low.
(2) The ionizing power of alpha rays is high.
(3) Alpha rays travel with a velocity which is almost equal to that of light.
(4) The path of alpha rays is changed by electric fields.
(5) The path of alpha rays is changed by magnetic fields.

26. As a catalyst for the reaction, $4NH_3(g) + 5O_2(g) \rightarrow 4\ NO\ (g) + 6H_2O$
(1) calcium may be used. (2) sulphur may be used. (3) aluminium may be used.
(4) lithium may be used. (5) none of the above can be used.

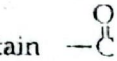
27. Aluminium reacts with aqueons sodium hydroxide and liberates hydrogen gas (Al= ;27 H=1). The amount of hydrogen given by 1.8 g aluminium
(1) is 0.200 g. (2) is 0.067 g (3) is 0.033 g (4) is 0.400 g
(5) cannot be calculated from the data supplied here.

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28. Bromine water reacts with
(1)  (2)  (3)  (4)  (5) all of the above.

29. In the 5th period of the Periodic Table there are
(1) 18 elements (2) 32 elements. (3) 36 elements. (4) 50 elements. (5) 54 elements.

30. For the purpose of chemically distinguishing between C_6H_5CHO and I_3CCHO
(1) phenylhydrazine can be used.
(2) 2,4–dinitrophenylhydrazine can be used.
(3) aqueous sodium hydroxide can be used.
(4) aqueous hydrgen iodide can be used.
(5) none of the above can be used.

31. Which of the following statements/statement concerning proteins and amino acids are/is true?
(a) Proteins contain  links.
(b) All amino acids are optically active.
(c) Naturally-occurring amino acids are β- amino acids.
(d) The relative molecular masses of proteins are high.

32. Which of the following react/reacts with aqueous KOH?
(a) Zn (b) Sn (c) Fe (d) C

33. $(CH_3)_2\,{}^{14}CHOD$ (D= deuterium)
(a) does not undergo dehydrogenation.
(b) undergoes oxidation/
(c) can be converted to $CH_3{}^{14}CH_2CH_3$.
(d) does not undergo iodination.

34. Which of the following statements/statement concerning the manufacture of ammonia by the 'Haber Process' are/is true?
(a) In this manufacturing process copper is used as the catalyst.
(b) In this manufacturing process nickel is used as the catalyst.
(b) In connection with this manufacturing process, water is necessary at some stage or the other.
(d) Air is necessary for this manufacturing process.

35. Which of the following statements/statement concerning environmental pollution are/is true?
(a) The environment may be harmed by CO_2.
(b) The environment is polluted by NO_2.
(c) The environment is polluted by CO.
(d) All of the above statements are true.

36. The Kp value for a given gaseous equilibrium
(a) depends on the partial pressures of the products.
(b) depends on the mole fractions of the reactants.
(c) depends on the temperature.
(d) does not depend on the presence or absence of catalysts.

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37. Which of the following statements/statement concerning a real gas are/is true?
(a) There are forces among the molecules.
(b) The volume of the molecules is not negligible.
(c) For a given mass of gas, the value of PV does not change with the pressure.
(d) The value of $\frac{PV}{nRT}$ does not change with the temperature.

38. Which of the following statements/statement are/is true?
(a) The pH value of an aqueous solution cannot be negative.
(b) When the pH value of an aqueous solution decreases by 2 units, the H_3O^+ concentration increases 100 times.
(c) The pH value of pure water decreases with increase in temperature.
(d) The pOH value of pure water increases with increase in temperature.

39. Which of the following statements/statement concerning K_2O_2 are/is true?
(a) In this compound the valency of potassium is 2.
(b) In this compound the oxidation number of potassium is + 4.
(c) In this compound the oxidation number of oxygen is - 1.
(d) An aqueous solution of this compound is strongly basic.

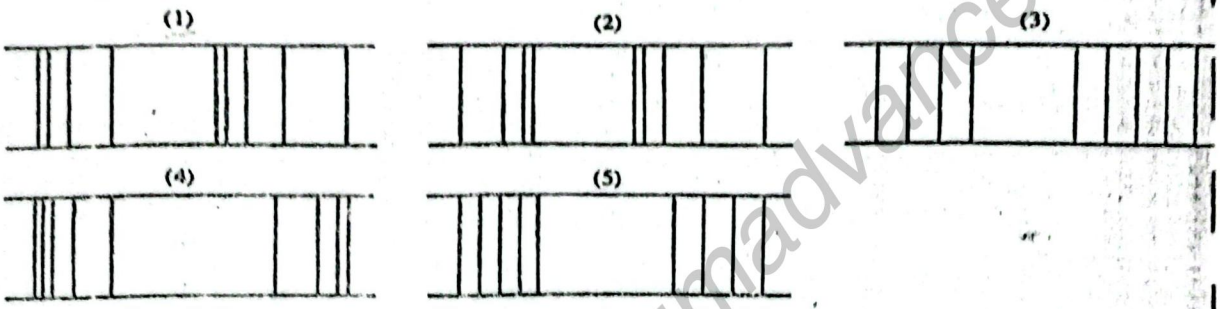
40. Which of the following statements/statement concerning certain isotopes are / is true?
(a) O-18 is radioactive. (b) F-19 is radioactive. (c) P-32 is radioactive. (d) Co-60 is radioactive.

	First Statement	Second Statement
41	Gaseous H_2S cannot act as an oxidizing agent.	In H_2S, sulphur is in its lowest oxidation state.
42.	The relative molecular mass of terylene is not very high.	Terylene is formed from benzene-1,4–dicarboxylic acid and ethylene.

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43.	At ordinary temperature, the reaction between gaseous H_2 and gaseous F_2 does not require catalysts.	This reaction is highly exothermic.
44.	HNO_3 cannot act as a base.	HNO_3 is a strong proton donor.
45.	Oxygen can exist in the oxidized state.	There are substances more electronegati than oxygen.
46.	$C_6H_5N^+(CH_3)_3Cl^-$ undergoes nitration readily.	In $N(CH_3)_3$ there is a pair of electrons v donor properties.
47.	SiO_2 can react with Rb_2CO_3.	Silicic acid is a strong acid.
48.	Barium does not react rapidly with water.	Barium is not an alkali metal.
49.	The boiling point of graphite is very high.	Graphite contains covalent bonds.
50.	SnS and SnS_2 are two compounds suitable for the experimental demonstration of the Law of Multiple Proportions.	SnS and SnS_2 can be prepared quantitati starting with tin metal.

51. Which one of the following patterns corresponds most closely with the pattern of lines of the spectru atomic hydrogen?



52. When the temperature increases by 10°C, the rate of a reaction.
(1) increases approximately by 10%.
(2) increases approximately by 50%.
(3) is approximately doubled.
(4) goes up about ten-fold.
(5) remains almost constant.

53. In connection with the reaction between $CH_3\overset{\overset{O}{\|}}{C}{}^{18}OH$ and C_2H_5OH occurring in the presence of concentra H_2SO_4, which one of the following statements is most appropriate?
(1) ^{18}O may be present in the water molecules formed.
(2) The --OH of $CH_3-\overset{\overset{^{18}O}{\|}}{C}-OH$ undergoes protontion and attacks the C_2H_5OH molecules.
(3) The C_2H_5OH molecule undergoes protonation and attacks the $CH_3-\overset{\overset{^{18}O}{\|}}{C}-OH$
(4) All the ester molecules formed contain ^{18}O.
(5) All of the above statements are incorrect.

54. Consider the electrochemical cell,

$Zn(s) \mid Zn^{2+}(aq, 1 \text{ mol dm}^{-3}) \parallel Ag^{+}(aq, 1 \text{ mol dm}^{-3}) \mid Ag(s)$

$E^{\ominus}$ value for the standard zinc electrode is - 0.76 V.
$E^{\ominus}$ value for the standard silver electrode is + 0.80 V.
Which one of the following statements concerning the above cell is not true?
(1) $E^{\ominus}$ of the cell = +.1.56 V
(2) In the external circuit, electron flow from the zinc electrode to the silver electrode.
(3) When the cell operates, oxidation takes place at the zinc electrode.
(4) When the cell operates, reduction takes place at the silver electrode.
(5) When the cell operates, the mass of the silver electrode decreases.

55. It has become necessary to synthesise $(C_6H_5)_3COH$ starting with benzene. Which one of the following initial step is most appropriate for this synthesis?
(1) C_6H_6+ conc. HNO_3/ conc. H_2SO_4.
(2) C_6H_6+ Br_2/Fe
(3) C_6H_6+CH_3COCl/ anhydrous $AlCl_3$
(4) C_6H_6+CH_3Cl/anhydrous $AlCl_3$
(5) C_6H_6+Cl_2 in the presence of strong sun light.

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56. The organic compound X does not directly answer the carbylamine test. However, the product Y obtained by boiling X with aqueous sodium hydroxide answers the carbylamine test. Y does not undergo diazotization. On Oxidation under vigorous conditions, Y gives Z. When heated with soda-lime, Z gives benzene, When Z is heated it loses a molecule of water. Which one of the following could be X?

(1) CH_3CONH–C$_6$H$_4$–CH_3 (ortho) (2) CH_3CONH–C$_6$H$_4$–CH_3 (para) (3) $CH_3CONHCH_2$–C$_6$H$_4$–CH_3 (ortho)

(4) $CH_3CONHCH_2$–C$_6$H$_4$–CH_3 (meta) (5) $CH_3CONHCH_2$–C$_6$H$_4$–CH_3 (para)

57. Which one of the following statements concerning distinguishing between aqueous HBr and aqueous HI is not true?

(1) Aqueous $HClO_4/CCl_4$ can be used for this purpose.
(2) Aqueous $HClO_3/CCl_4$ can be used for this purpose.
(3) Acidified $KMnO_4/CHCl_3$ can be used for this purpose.
(4) Aqueous Br_2/C_6H_6 can be used for this purpose.
(5) None of the above can be used for this purpose.

58. With which one of the following could you start to perform a chemical test to distinguish between $C_6H_5CH_2NH_2$ and $C_6H_5NH_2$?

(1) CH_3COCl (2) C_6H_5COCl (3) $CHCl_3$ (4) KNO_3 (5) NH_4NO_3

59. Naturally-occurring carbon contains 98.89% of the $^{12}_{6}C$ isotope and 1.11% of the $^{13}_{6}C$ isotope. The relative atomic mass of $^{13}_{6}C$ is 13.003. The relative atomic mass of naturally-occuring carbon

(1) is 12.501. (2) is 12.101. (3) is 12.031 (4) is 12.011 (5) is 12.003.

60. Which one of the following set of products is likely to be formed from the reaction between silver and hot concentrated nitric acid?

(1) $AgNO_2$, NO_2 and H_2O. (2) $AgNO_2$, N_2O_5 and H_2O. (3) $AgNO_3$, N_2O and H_2O.
(4) $AgNO_3$, NH_4NO_3 and H_2O. (5) $AgNO_3$, NO_2 and H_2O.

PART A - STRACTURED ESSAY

1. (a) Write the chemical formula of the compounds given below, at the appropriate places in the Table provided to you.

Table

Compound	Chemical Formula
ammonium chromate	
aluminium carbonate	
stannic phosphate	

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(b) Give the arrangement of the electrons in the valence shells of the atoms of the $COCl_2$ molecule, in the usual form as a 'dot-and cross diagram'

(c) The specific heat of the metal, M is 0.4 J g^{-1} K^{-1}. This metal forms the two chlorides, MCl and MCl_2. MCl is a white solid insoluble in water. MCl_2 is soluble in water.

(i) Calculate the relative atomic mass of M, and identify M. The molar heat capacity of solid elements is approximately 26 J mol^{-1} K^{-1}.

(iii) Write the electronic configuration of M in the usual form, $1s^2 2s^2$.....

(d) You are supplied with a pure sample of NH_3 and a pure sample of ND_3 (D=deuterium). Describe sufficiently clearly how you would distinguish between these two samples.
N.B. You are provided with facilities available in an ordinary laboratory.

2. (a) Assume that the tri-valent metal, X reacts with sulphuric acid and forms the sulphate of the metal, hydrogen sulphide and water only. Write the balanced chemical equation for this reaction.

(b) An alloy contains nickel and silver only. 0.258g of this alloy was reacted completely by heating with excess of sulphur. The excess of unreacted sulphur was then removed completely by heating the reaction mixture very strongly. The mass of the sulphide mixture so obtained was 0.366g. Calculate the molar fraction of nickel in the alloy. (Ni=59; Ag = 108; S=32)

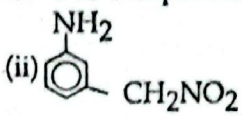
(c) You are supplied with unlabelled aqueous solutions of $MgBr_2$, $Sr(OH)_2$ and BaI_2. You are also supplied separately with an aqueous solution of $(NH_4)_2CO_3$. You are provided with test tubes. Explain briefly how you would, under these conditions identify chemically the three unlabelled solutions provided to you, using only the above four chemicals.
N.B. You are not permitted to perform the flame test or the touch the solutions with the fingers.

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3. (a) The organic compound, *A* contains C,H and O only, *A* molecule of *A* contains two carboxylic groups, and contains no other functional groups. On combustion, *A* gives carbon dioxide and water in the mole ratio of 2:1. The relative molecular mass of *A* is approximately 115. Determine the molecular formula of *A*. (C=12; H=1; O=16)

(b) Indicate how you would chemically distinguish between the two compounds in each of the following pairs.

(i) $H_2C=C(CH_3)_2$ and $H_2C=CHCH_3$

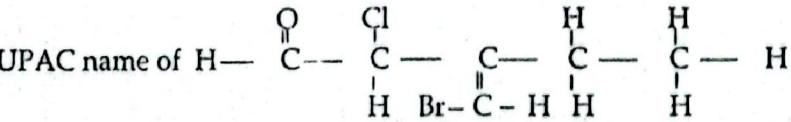
(ii)  and 

(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 synthesis suggested by you is unnecessarily long, you will not be awarded full marks.

(i) Synthesis of $CH_3CONHCH_2CH_3$ using ethylamine as the only starting organic compound.

(ii) Synthesis of $CH_3\,{}^{14}\underset{\underset{OH}{|}}{C}H\,{}^{14}CH_2CH_3$ using $CH_3{}^{14}CH_2OH$ as the only starting organic compound.

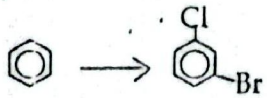
4. (a) Write the IUPAC name of 

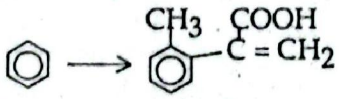
N.B. Disregard optical isomerism and geometrical isomerism.

(b) When benzoic acid is reacted with a mixture of conc. HNO_3/ conc. H_2SO_4, 3- nitrobenzoic acid is formed. Considering the mechanism relevant to this reaction, explain the above fact.

(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 proposes by you is unnecessarily long, you will not be awarded full marks.

(i) 

(ii) 

PART B - ESSAY

5. (a) (i) Derive the equation PV=nRT for an ideal gas, assuming the equation $PV = 1/3\ mN\ \bar{c}^2$ as applied for an ideal gas in the kinetic Molecular theory.

(ii) The density of a gas at 25 °C under 10 atm is 0.0131 g ml^{-1}. Calculate the molar mass of the gas, assuming ideal behaviour.

(b) (i) Explain how you would determine the distribution coefficient of dimethylamine between water and tetrachloromethane in the laboratory.

(ii) The organic compound, Y is more soluble in diethyl ether than in water. The distribution coefficient of Y between diethyl ether and water is 4. 160 ml of an aqueous solution of Y contains 7.2g of Y. This initial aqueous solution is extracted with 80 ml of diethyl ether. The second aqueous solution so formed is separated and then it is extracted with another 80 ml of diethyl ether. Calculate the mass of Y present in this second diethyl ether extract.

6. (a) You are supplied with a sample of lead iodide. Explain briefly how you would attempt to determine the K_{sp} of lead iodide at 25 °C in the laboratory.

(b) The K_{sp} of silver chloride at a certain temperature is $1.44\times10^{-10}\ mol^2\ l^{-2}$

(i) Calculate the mass of silver chloride that dissolves in 500 ml of 0.005 mol l^{-1} calcium chloride at the same temperature. (Ag=108;Cl=35.5)

(ii) Calculate how many moles of silver chloride would dissolve in 10 l of an aqueous solution of 0.01 mol l^{-1} sodium dichloroethanoate at the same temperature.
N.B. Assume that silver dichloroethanoate is soluble in water.

(c) (i) You are supplied with a 0.001 mol l^{-1} aqueous solution of an acid-base indicator, Hln. Giving the relevant theoretical treatment, explain briefly how you would attempt to determine the pK_1 value of Hln in the laboratory.
N.B. You are provided with an instrument with which the pH of a solution can be measured.

(ii) The dissociation constant of a weak mono-basic acid at 25°C is 9.0×10^{-5} mol l^{-1}. Calculate the degree of dissociation and the pOH value of a 10 mol l^{-1} aqueous solution of this acid at 25° C.
K_w at 25 °C=$1.0\times10^{-14}\ mol^2\ l^{-2}$

7. (a) (i) Consider the following equilibrium. $aA(g) + bB(g) \rightleftharpoons cC(g) + dD(g)$
Derive the relationship between K_p and k_c for this equilibrium.

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(ii) 3 mol of ethanoic acid and 1.3 mol of methanol are allowed to reach equilibrium at a certain temperature in the presence of concentrated sulphuric acid. This reaction gave 2.8 mol of the ester. Calculate the K_c for this esterification reaction.

(b) (i) Explain the following observation:
The standard enthalpy change that occurs in the reaction between aqueous potassium hydroxide and aqueous hydrochloric acid is equal to the standard enthalpy change that occur in the reaction between aqueous sodium hydroxide and aqueous hydrobromic acid. However, the standard enthalpy change that occurs in the reaction between aqueous ammonia and aqueous hydrochloric acid is numerically less than the two standard enthalpy changes mentioned previously.

(ii) Consider the reaction, $AgCl(s) + KBr(aq) \longrightarrow AgBr(s) + KCl(aq)$.
This reaction occurs only slowly and when the reaction mixture is stirred vigorously. Therefore, the standard enthalpy change for this reaction cannot be determined directly. Explain how you would attempt to determine the standard enthalpy change relevant to the occurrence of the above reaction in the direction indicated.

8. (a) (i) Consider the following reaction: $H_2O_2(aq) + 2KI(aq) + HCl(aq) \longrightarrow I_2(aq) + 2H_2O(l) + 2KCl(aq)$
The rate, R, of this reaction with respect to H_2O_2 can be expressed as, $R=k\,[H_2O_2]^n$
present briefly a convenient experimental method for the determination of n in the above expression.

(ii) The compund, AX_2Y decomposes in aqueous solution as follows: $AX_2Y(aq) \longrightarrow X_2(g) + AY(aq)$
The following data were obtained by studying the rate of this reaction at constant temperature and pressure.

AX_2Y (aq) concentration, mol dm^{-3}	Time taken for the liberation of 10 cm^3 $X_2(g)$, s
0.6	62.5
0.5	108.0

Calculate the time taken for the liberation of 10 cm^3 X_2 (g) under the same temperature and pressure as employed above, when the AX_2Y (aq) concentration is 0.4 mol dm^{-3}

(b) Explain the basis of **'Radio-carbon Dating'.**

(c) Assume that hydrogen chloride gas is decomposed to a very small extent by the catalytic action of a certain noble metal under ordinary temperature and pressure. Assume also that this dissociation cannot be demonstrated by a change in colour of the gas or by a change in odour of the gas. Explain briefly how you would attempt to show, by a chemical method, that the above catalytic decomposition actually occurs.

9. (a) Consider the elements, nitrogen, phosphorus and bismuth. Demonstrate how the metal-nonmetal nature of these elements varies taking into consideration the physical properties of the elements and the chemical properties of the oxides, N_2O_3, P_2O_3 and Bi_2O_3.

(b) Indicate how the following conversions could be effected.
N.B. The necessary reagents and reaction conditions should be stated at the appropriate places. It is not necessary here to write the balanced chemical equations.
(i) Obtaining pure calcium starting with dolomite.
(ii) Obtaining pure nitric oxide starting with nitric acid, **without using reducing agents.**

(c) You are supplied with a mixture consisting of copper powder, zinc powder and magnesium powder. Explain how you would attempt to determine the percentages of the elements present in this mixture.

10. (a) Discuss the physio-chemical principles involved in the manufacture of sodium carbonate by the **'Ammonia-Soda Process'**

(b) Discuss the environmental pollution that could occur by the use of the above manufacturing process.
N.B. It is sufficient to consider five important aspects.

(c) you are supplied with a mixture of sodium carbonate, potassium carbonate and ammonium carbonate. Propose a method to determine the percentage composition of the mixture.
N.B. You are provided with facilities available in an ordinary chemistry laboratory.

11. (a) Name the allotropic forms of sulphur and indicate how each of those allotropic forms can be prepared.

(b) (i) How does hydrogen sulphide react with acidified potassium dichromate?
Write the relevant balanced chemical equation.
(ii) How does hydrogen sulphide react with acidified ferric chloride?
Write the relevant balanced chemical equation.

(c) Show graphically, in the usual way, how the boiling point of HF,HCl,HBr and HI vary. Give reasons for the observed characteristic variation.

12. (a) (i) Explain how the hardness of water arises.
(ii) Give three methods used in the removal of hardness of water. Explain the processes that take place in these methods.

(b) Write a brief description of the various steps involved in the manufacturer of cement by the "Dry Process".

(c) Explain the theory associated with the extraction of citronella oil.

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