SAMPLE QUESTION PAPER

CHEMISTRY

(313)

Time : 3 hrs. 
Maximum Marks : 80

Note: (i) All question in Section A are compulsory.
(ii) Attempt only one out of two options in section B, i.e., attempt either Part I or Part II or Part III in Section B.
(iii) Marks for each question is indicated against it.
(iv) Use log tables if necessary.

Section A

1. What is the molar mass of NH₃? (1)

2. A Sample of nitrogen gas consists of 4.63 × 10²² nitrogen atoms. How may moles of N atoms are there? (1)

3. What is the lowest possible temperature in Kelvin units? (1)

4. Derive SI units for
   (i) Force  (ii) Pressure (2)

5. Explain the geometry of the following:
   (i) NH₃  (ii) B F₃  (2)

6. A sample of nitrogen gas weighing 9.3 g at a pressure of 0.99 atm a accoutres a volume of 12.4 litres at 55K temperature. What do you expect its volume to be when the temperature is 220 k? Assume that pressure stays constant. (2)

7. What is the relationship between the standard free energy change and the equilibrium constant of the reaction? (2)

8. Calculate enthalpy for the following reaction:
   \( 2\text{H}_2 + \text{O}_2 \text{(g)} \rightarrow 2\text{H}_2\text{O(g)} \)
   Given Bond energy of H-H bond = 436 KJ mol⁻¹
   Bond energy of O – H bond = 423 KJ mol⁻¹
   Bond energy of O = O bond = 496.4 KJ mol⁻¹ (2)

9. Arrange the following oxides in the increasing order of acidic property. Justify your answer.
   Al₂O₃, CO₂, SO₂, B₂O₃ (2)
10. Draw the structure of the following:
   (i) $\text{H}_3\text{PO}_3$  (ii) $\text{P}_4\text{O}_{10}$
   (iii) $\text{H}_2\text{S}_2\text{O}_3$  (iv) $\text{ClO}_2$

11. Explain the following giving suitable reasons
   (i) $\text{BF}_3$ is weaker lewis acid as compared to $\text{BCl}_3$
   (ii) $\text{CCl}_4$ does not hydrolyse but $\text{SCl}_4$ does.
   (iii) $\text{N}_2$ is inert at room temperature.
   (iv) $\text{SF}_4$ is known but $\text{SCl}_6$ is not.

12. (i) What is le Chatelier’s principle?
   (ii) For the following reaction:
       $$\text{C}_2\text{H}_4 (g) + \text{I}_2 (g) \rightarrow \text{C}_2\text{H}_4\text{I}_2 (g)$$
       the rate of reaction is $\text{rate} = K \left[ \frac{\text{C}_2\text{H}_4(g)}{\text{I}_2(g)} \right]^{3/2}$
   (a) What is the order of the reaction with respect to each reactant?
   (b) What is the overall order of the reaction?
   (c) What is the unit of $K$, if the concentrations are measured in mol dm$^{-3}$ sec$^{-1}$?

13. A cell is set up between Cr and Cu electrodes
   (a) $\text{Cr(s)} | \text{Cr}^{3+} (\text{aq}) \ || \text{Cu}^{2+} (\text{aq}) | \text{Cu(s)}$
       If the two half cells work under standard conditions, calculate the e.m.f. of the cell.
       $$E^\circ \text{Cr}^{3+} | \text{Cr} = -0.74 \text{ V} ; E^\circ \text{Cu}^{2+} | \text{Cu} = +0.34 \text{ V}$$
   (b) Calculate $K_P$ for the reaction $\text{COCl}_2 \rightarrow \text{CO} + \text{Cl}_2$ in atm and Nm$^{-2}$, The equilibrium partial pressure of $\text{COCl}_2$, CO and Cl$_2$ are 0.20, 0.16 and 0.26 atm. respectively. (1 atm = 101300 Nm$^{-2}$)

14. (a) Write down ideal gas equation.
   (b) Give three different values of $R$ in the ideal gas equation.

15. (a) Write the IUPAC names of the following organic compounds:
   (i) $\text{CH}_3 - \text{C} - \text{CH}_3$
   (ii) $\text{CH}_3 - \text{CH} - \text{CH}_2 -\text{CH}_2 - \text{COOH}$
   (iii) $\text{Br}$
   (iv) $\text{Cl}$
(b) Define the following (any two only)

(i) Electrophiles 
(ii) Nucleophiles 
(iii) Catenation 
(iv) Isomerism 

16. (a) What is electrovalent bond? Explain the term lattice energy as applied to ionic crystal How is enthalpy of formation of NaCl calculated, using Born Habeis cycle?

(b) Why is sigma bond stronger than π bond?

17. (a) 0.0663 g of an organic compound on combustion gave 0.621 g of CO₂ and 0.0381 g of H₂O. st also

(b) What is the ratio of the mass of oxygen that combines with 1.0 g Carbon in carbon monoxide and carbon dioxide?

18. (a) Write de Broglic expression.

(b) Write down Balmer formula and explain the terms imrowed, what is the wavelength of the light emitted when the electron in a hydrogen atom jumps from N₂ = 4 to N₁ = 1 levels?

(Rydberg Constant R = 109677 cm⁻¹)

19. Define ‘Entropy. what are its SI units?

Predict giving reasons, the sign of entropy change, Δ S for the following reaction:

2SO₂(g) → 2SO₃(g) + O₂(g)

What is the significance of the term T Δ S in Δ G = Δ H − T Δ S ?

(b) The heat evolved in the combustion of glucose is shown in the following equation:

C₆H₁₂O₆(s) + 6O₂(g) → 6CO₂(g) + 6H₂O(l) Δ H = −2840 KJ

How much energy will be required for production of 1.08 g of glucose?

(Molar mass of glucose = 180 g mol⁻¹)

20. (a) Explain with the help of the relevant structural changes, the stronger acidic character of Phenol than alcohols

(b) Identify the products A, B, and C the following reaction :

CH₃CHO NaOH → A → NaOH(CaO) B → Cl₂ hv → C
Section - B

PART-I (ENVIRONMENTAL CHEMISTRY)

1. (a) Define any Two of the following terms
   (i) Pollutant  (ii) Biosphere
   (iii) Eutrophication  (iv) Biological oxygen Demand (BOD) (2)
   (b) List four effects of acid rain (2)
2. Describe with the help of diagram the three stages of treatment of waste water (6)
3. How does carbon get into the environment from dead organic mater. (1)
4. Show diagrammatically how heavy metals enter into the eco system. (2)
5. The increase in concentration of accumulated toxic chemicals as one goes higher in the food chain is termed as Bio magnification. Draw an appropriate food chain consisting of Mosquito, Marshy plant, Bird and fish and also label these components as producer, Primary consumer, Secondary consumer and tertiary consumer, showing in increase in concentration of toxic chemicals. (2)

PART-II (CHEMISTRY AND INDUSTRY)

1. Define any Four of the following:
   Dyes, Drugs medicines, paints, mother glass
   Petrochemicals, Polymerisation, (4)
2. (a) Distinguish between thermoplastic and thermosetting polymers (4)
   (b) Differentiate between analgesics and antipyretics
   (c) Differentiate between antiseptics and disinfectants (2)
3. What do you understand by Reinforced concrete Construction (RCC). (1)
4. Each of the following monomer polymerises to give different product. Show the formation of the polymer products by using the 3 monomer units each. (2)
   (i) \( \text{CH} = \text{CH}_2 \)  (ii) \( \text{CH}_2 = \text{C} - \text{COOCH}_3 \)
5. Justify the superiority of Allopathic system of medicine over the alternative systems of medicine by giving at least two advantages. (2)
MARKING SCHEME
CHEMISTRY

Question No. Expected value points
Distribution of Marks

1. The molar mass of NH$_3$ is 17
   \[14 + 3 = 17\] 1 mark

2. \[\frac{4.63 \times 10^{27} \text{ atom}}{6.02 \times 10^{23} \text{ atoms/mol}}\]
   
   0.0769 mol 1/2 mark

   If units are not given deduct 1/2 mark

3. Zero Kelvin 1 mark

4. (i) Force Mass × Acceleration 1/2 mark
   (ii) Pressure Force / Area 1/2 mark
   (iii) Kg m$^{-1}$ S$^{-2}$ 1/2 mark

5. (i) correct Geometry 1/2 mark
   Pyramid Shape 1/2 mark

6. \[V_1 = 12.42, V = ? \quad \frac{V_1}{T_1} = \frac{V_2}{T_2}\] 1 mark

   \[T_1 = 55 \text{ k}, T_2 = 220 \text{ k}\]

   \[\frac{12.42}{55 \text{ k}} = \frac{V_2}{220 \text{ k}}\]

   \[V_2 = 4.92\] 1 mark

7. Correct relation 2 mark

8. \[2\text{H} \rightarrow \text{H}_2, \text{O} \rightarrow \text{O}_2 \quad \text{2H} - \text{O}\]

   \[2 \times 436 \quad 496.4 \quad \frac{1}{4} \times 463\] 1 mark

   \[\Delta H = 1852 - 1368.4 = 483.6 \text{ K J}\] 1 mark

9. B$_2$O$_3$ > Al$_2$O$_3$ > CO$_2$ > SO$_2$ 1 mark

   Justification 1 mark

   Large the Size of cation less acidic will be the oxide.
10. Correct Structure

\[ \text{HO} - \text{S} - \text{S} - \text{OH} \]

11. (i) Due to back bonding
(ii) Due to absence of d-orbital in C
(iii) Dissociation energy is very high
(iv) Due to larger size of Cl Six Cl can not be accommodated around S

12. (a) It states that when a system at equilibrium is disturbed by a change in concentration, Pressure or temperature, a net charge occurs in it in a direction that tends to decrease the disturbing factor.
(b) (i) First order with respect is C\textsubscript{2}H\textsubscript{4} and 1.5 w. r. t. I\textsubscript{2}
(ii) The overall order of reaction is 2 – 5
(iii) \[ x = \frac{\text{sec}^{-1}}{(\text{mol} \cdot \text{dm}^{-3})^{3/2}} = \text{mol}^{-3/2} \text{dm}^{9/2} \text{sec}^{-1} \]

13. (a) Anode reaction = Cr (S) \rightarrow Cr^{3+} + 3e^- 
Cathode = Cu^{2+} (aq) + 2 e^- \rightarrow Cu 
E\text{ Cell} = E^{\circ} \text{ Cell} = 0.34 - (-0.74) = 1.08 \text{ V}
K\text{p}, in atmosphere 
COCl\textsubscript{2} (g) \rightarrow CO (g) + Cl\textsubscript{2} (g) 
K\text{p} = \frac{P \text{ CO} \times P\text{Cl}_2}{P \text{ COCl}_2} = \frac{(0.16 \text{ atm})(0.26 \text{ atm})}{(0.20 \text{ atm})} = 0.16 \times \frac{0.26}{0.20} = 0.21 \text{ atm}
(b) $K_p$ in N m$^{-2}$

$K_p = 0.21 \text{ atm}$ and $1 \text{ atm} = 101300 \text{ N m}^{-2}$

$\therefore K_p = (0.21 \text{ atm}) (101300 \text{ N m}^{-2} \text{ atm}^{-1}) = 21273 \text{ N m}^{-2}$ 1 mark

14. (a) $V \alpha \frac{1}{P}$ at Constant temp. (Boyle’s Law)

$V \alpha T$ at Constant Pressure (Charles Law)

$V \alpha n$ at Constant temp and pressure (Avogadro’s Law)

$V \alpha nT/P$ or $PV \alpha nT$

or $PV = \text{Constant} \times nT$

$PV = nR\frac{T}{P}$ 1/2 mark

(b) $R = 0.082057 \text{ atm mol}^{-1} \text{ k}^{-1}$

$R = 8.314 \times 10^7 \text{ erg mol}^{-1} \text{ k}^{-1}$

$R = 1.987 \times 10^7 \text{ Cal mol}^{-1} \text{ k}^{-1}$ 1/2 mark

$\frac{1}{2} \times 3 = 1\frac{1}{2}$ marks

15. (a) (i) 2–methyl propane–2 ol

(ii) Cyclohexene

(iii) An electrophile is positively charged species. It is election setting. It attacks at position of high density.

Examples $\text{H}^+$, $2\text{NO}_2^+$, $\text{Ag}^+$

(iv) Nucleophile is a negatively charged species. It is nucleus seeking. It attacks a position of low election density examples $\text{OH}^-$, $2\text{NO}^-_2$, etc.

(iii) The property of linking of atoms of the same element with ano there to form chains or signs is known as catenation.

(iv) The substance which have the same molecular formula but differ in their physical and chemical properties are called isomers. This general phenomenon is known as isomerism. 1 x 2 = 2 marks

16. (a) An electrovalent bond is formed when one or more electron from one atom gets completely transferred to another atom or atoms and each atom acquires a nearest noble gas Configuration.

Lattice energy is the amount of energy released when one mole of the substance is formed from its ions e.g.

$\text{Na}^+(g) + \text{Cl}(g) \rightarrow \text{Na}^+ \text{ Cl}(s) – \Delta H$

$\Delta H = – 788.5 \text{ K J mol}^{-1}$ 1/2 mark

Born Haber Cycle

$\Delta H_f = \Delta H_g + 1 \text{ E} + \Delta H_{\text{dis}} – E A + \Delta H$ Latter energy

$\Delta H_f = \text{Heat of formation}$ 1½ marks

1 E $\rightarrow$ 1 ionization enthalpy

$\Delta H_{\text{dis}} \rightarrow \text{Heat of dissociation}$

$E A \rightarrow \text{Electron gain enthalpy}$

$\Delta H_{\text{lattice}} \rightarrow \text{Lattice energy}$

(b) $\alpha$-bond is formed due end overlap

$\pi$-bond is formed due of Side ways overlapping 1 mark

17. (a) % $C = \frac{0.621 \times 12}{44 \times 0.0663} \times 100 = 25.54 \quad \frac{25.54}{12} = 2.128 \quad C = 1$
%\ H = \frac{0.6381 \times 2}{18 \times 0.0663} = 6.38 \quad \frac{6.38}{1} = 6.38 \quad H = 3

\frac{68.1}{32} = 2.128 \quad S = 1 

(b) \quad CO = 4 : 3
\quad CO_2 = 8 : 3

18. (a) \ E = h\nu \quad \nu = \frac{c}{\lambda}
\lambda = \frac{h}{mc} \quad or \quad \lambda = \frac{h}{p}

(b) \quad \nu = \frac{1}{\lambda} = \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)

= 109677 \left(\frac{1}{(1)^2} - \frac{1}{(2)^2}\right)

= 109677 \times \frac{15}{16} = 102 \text{,}822 \text{ Cm}^{-1}

\lambda = \frac{1}{\nu} = \frac{1}{102822} = 9.7 \times 10^{-6} \text{cm} = 97 \text{ nm}

19. (a) \quad The entropy is measure of disorder or randomness in a system. the greater the disorder in a system, the greater is the entropy of the system
\quad SI unit = J \text{ mol}^{-1} \text{ K}^{-1}
\quad entropy decrease
\quad It \Delta S total is positive then section will be spontaneous
\quad \Delta G \text{ Syst} = -T \Delta S \text{ univ}

(b) \quad 1 \text{ mol} = -2840 \text{ K J}
\quad 180 = -2840 \text{ K J}

1.08 = \frac{-2840}{180} \times 1.08 = \text{ K J} = \Delta H
\Delta E = \Delta H - \Delta V_{2p} \text{RT}
\Delta H - O. R \text{ T} = \Delta H
\quad = 17.04 \text{ K J}

20. (a) \quad (I) \leftrightarrow (II) \leftrightarrow (III) \leftrightarrow (IV) \leftrightarrow (V)

(b) \quad A = \text{CH}_3\text{ COO Na}
\quad B = \text{CH}_4
\quad C = \text{CH}_3\text{ Cl}

4 \times \frac{1}{2} \text{ markw}
SECTION B

PART-I ENVIRONMENTAL CHEMISTRY

1. (a) 1 Mark for each of the two correct definitions 2 marks
   (b) 1/2 Mark for each of four correct effects 2 marks
2. Correct explanation and diagram of stages for primary treatment 2 marks
   Correct explanation and diagram of stages for Secondary treatment 2 marks
   Correct explanation and diagram of stages for Tertiary treatment 2 marks
3. Through Decay and decomposition due to micro-organisms 1 mark
4. For indicating correct sources 1 mark
   For showing correct pathways 1 mark
5. Marshy Plant → Mosquito → Fish → Bird
   Producer Pri-consumer Sec-consumer Ter-consumer
   Correct food chain 1 mark
   Correct labelling 1 mark

PART-II CHEMISTRY AND INDUSTRY

1. 1 Mark for each of the Four correct definition 4 marks
2. (a) 1 Mark for each definition 4 marks
3. correct description 4 marks
4. (i) N CH = CH₂ → \[\text{Cl} \quad \text{CH} - \text{CH} - \text{CH} - \text{CH} - \text{Cl} \]
   (ii) N CH₂ = C - COOCH₃ → \[\text{CH}_3 \quad \text{CH}_3 \quad \text{CH}_3 \quad \text{COOCH}_3 \quad \text{COOCH}_3 \quad \text{COOCH}_3 \]
5. Correct Advantages
   1 mark for each 2 marks