SRJC Answer

| 1 | Th | The diagram below shows the structural formula of glucose. | | |
|-------------|---|--|--|--|
| | Wł wa | $\begin{array}{c} \begin{array}{c} CH_2OH\\ H\\ H$ | | |
| | Α | 4 | | |
| | В | 5 | | |
| | С | 6 | | |
| | D | 7 | | |
| Ans | Answer: B | | | |
| One Foui | One 1° alcohol converted to carboxylic acid: RCH ₂ OH + 2[O] \rightarrow RCOOH + H ₂ O Four 2° alcohols converted to ketones: RR'CHOH + [O] \rightarrow RR'C=O + H ₂ O | | | |
| 5 m | 5 mol of H_2O formed in total. | | | |

| 2 | Cluster decay is one rare instance of scientific phenomena predicted before experimental discovery, where a parent atomic nucleus emits a cluster of neutrons and protons that are heavier than an α -particle. One of the first predictions was the nuclear decay of radium-223. | | | |
|-------------------------|--|-------------------------------|---|----------------|
| | | | $^{223}_{88}$ Ra $\rightarrow {}^{14}_{6}$ C + A | |
| | Which rc | w in the table correctly desc | cribes the nuclear make-up | of element A ? |
| | | Number of protons | Number of neutrons |] |
| | Α | 74 | 119 | |
| | В | 82 | 127 | |
| | С | 74 | 209 | |
| | D | 82 | 217 | |
| Ans [.] Num | Answer: B Number of protons in A = $88 - 6 = 82$ | | | |

Number of neutrons in 14-carbon = 14 - 6 = 8Number of neutrons in **X** = 135 - 8 = 127

| 3 | A given mass of ideal gas occupies a volume V and exerts a pressure p at 30 °C. | | | | | |
|-------------------|--|--|--|--|--|--|
| | V | | | | | |
| | At which temperature will the same mass of the ideal gas occupy a volume $\frac{\nu}{3}$ and exert | | | | | |
| | a pressure 2 <i>p</i> ? | | | | | |
| | | | | | | |
| | A 20 °C | | | | | |
| | B 20 K | | | | | |
| | C 202 °C | | | | | |
| | D 202 K | | | | | |
| | | | | | | |
| Ans | wer: D | | | | | |
| | | | | | | |
| pV = | nRT | | | | | |
| (2p) | n(V) = nR(xT) | | | | | |
| $\frac{2}{2}$ | $(1_3) = 111((1))$ | | | | | |
| <u>-(</u> pv | /) = x(nRT) | | | | | |
| $x = \frac{2}{3}$ | 2 | | | | | |
| Orio | $_{3}^{3}$ | | | | | |
| N | T = 30 + 273 = 303 K | | | | | |
| INEW | $1 = \frac{1}{3} \times 303 = 202 \text{ K}$ | | | | | |
| | | | | | | |

| 4 | Th | The boiling point of water (100 $^{\circ}$ C) is greater than that of ammonia (–33 $^{\circ}$ C). | | | | |
|------|-----------------|---|--|--|--|--|
| | Wł | Which statement is a correct explanation of this? | | | | |
| | Α | Ammonia has intramolecular hydrogen bonds, which water does not have. | | | | |
| | В | The M_r of water is greater than that in ammonia, so van der Waals' forces are stronger in water. | | | | |
| | С | There are, on average, more hydrogen bonds between water molecules than there are between ammonia molecules. | | | | |
| | D | D The O–H bond requires 460 kJ mol ⁻¹ to overcome, while the N–H bond only requires 390 kJ mol ⁻¹ to overcome. | | | | |
| Ans۱ | nswer: C | | | | | |

5 The standard enthalpy change of formation of hydrazine, $N_2H_4(g)$, is *x* kJ mol⁻¹. The bond energy of the N=N bond is *y* kJ mol⁻¹. The bond energy of the H–H bond is *z* kJ mol⁻¹.

| | What is the standard enthalpy change of atomisation of hydrazine? | | | | |
|------|---|------------------------------------|--|--|--|
| | Α | (x + y + 2z) kJ mol ⁻¹ | | | |
| | В | (y + 2z - x) kJ mol ⁻¹ | | | |
| | С | (x + 2y + 4z) kJ mol ⁻¹ | | | |
| | D | (2y + 4z - x) kJ mol ⁻¹ | | | |
| Ansv | Answer: B $N_2H_4(g) \xrightarrow{\Delta H_a} 2N(g) + 4H(g)$ $\Delta H_f \sqrt{BE(N=N)} + 2BE(H-H)$ $N_2(g) + 2H_2(g)$ | | | | |

By Hess' Law, $\Delta H_a = -\Delta H_f + BE(N=N) + 2BE(H-H) = (y + 2z - x) kJ mol^{-1}$

| 6 | Th res | The $\Delta G_{solution}^{\Theta}$ and $\Delta S_{solution}^{\Theta}$ for silver chloride are +55.6 kJ mol ⁻¹ and +33.2 J mol ⁻¹ K ⁻¹ respectively. | | | | |
|---|--|--|--|--|--|--|
| | What is the enthalpy change when 287 g of silver chloride is precipitated under the same conditions? | | | | | |
| | Α | +65.5 kJ | | | | |
| | В | –65.5 kJ | | | | |
| | С | +131 kJ | | | | |
| | D | –131 kJ | | | | |
| | | | | | | |

Answer: D

 $\Delta G = \Delta H - T\Delta S$ $55.6 = \Delta H_{solution}^{\Theta} - (298)(0.0332)$ $\Delta H_{solution}^{\Theta} = +65.49 \text{ kJ mol}^{-1}$ $\Delta H_{ppt}^{\Theta} = -65.49 \text{ kJ mol}^{-1}$

For 2 mol of AgCl precipitated, enthalpy change is –131 kJ.

| 7 | Th rea | e diagram shows t action. | the reaction pathway diagram | for an uncatalysed reversible | |
|------|--------------------------------------|--|--------------------------------------|----------------------------------|--|
| | Th Wi pa | energy (arbitrary units) The reaction was then catalysed. What are the changes in the rate constant, equilibrium constant and the reaction pathway diagram? | | | |
| | | Rate constant, k | Equilibrium constant, K _c | Energy profile | |
| | A | Unchanged | Increase | 10 5 0 reaction pathway | |
| | В | Increase | Unchanged | 10 5 0 reaction pathway | |
| | С | Increase | Increase | 10 5 0 reaction pathway | |
| | D | Increase | Unchanged | 10 5 0 reaction pathway | |
| Ansv | ver: | D | ted and rate constant | | |
| K h | however, is not affected by catalyst | | | | |

 K_c however, is not affected by catalyst. Graph is correct as catalyst merely lower the E_a and does not change the ΔH .

| 8 | Steam dissociates at an initial pressure of 1 atm at T K to form hydrogen gas and oxygen gas. | | | | | | | |
|--|--|--|-------------------|--------|-------------|---------------------------------------|-------|--|
| | | | 2H ₂ (| D(g) 🔫 | ⇒ 2H | ₂ (g) + O ₂ (g) | | |
| | lf eq | If the total pressure at equilibrium is 1.3 atm, what is the numerical value of the equilibrium constant, K_p , of the reaction at $T K$? | | | | | | |
| | Α | 0.028 | | | | | | |
| | В | 0.135 | | | | | | |
| | С | 0.450 | | | | | | |
| | D | 0.675 | | | | | | |
| Ans | Answer: D $2H_2O(g) \longrightarrow 2H_2(g) + O_2(g)$ | | | | | | | |
| Init | ial p | ressure | 1 | | | 0 | 0 | |
| Ch | ang | e | -x | | | +x | + x/2 | |
| Eqm pressure | | | 1-x | | | Х | x/2 | |
| 1.3 : 0.3 : x = (K _p = = | 1.3 = 1 - x + x + (x/2) 0.3 = x/2 x = 0.6 $K_{p} = [(0.6)^{2}(0.3)]/(0.4)^{2}$ = 0.675 | | | | | | | |



| 10 | A solution contains 1 x 10^{-3} mol dm ⁻³ of bromide, fluoride, iodide and sulfate ions. Which lead (II) compound will be precipitated first when 0.01 mol dm ⁻³ of lead (II) nitrate is added dropwise to the solution at 25° C? | | | |
|----|--|-------------------|----------------------------|--|
| | | Compound | Solubility product at 25°C | |
| | Α | Lead(II) bromide | 4.0 x 10 ⁻⁵ | |
| | В | Lead(II) sulphate | 1.6×10^{-8} | |
| | С | Lead(II) fluoride | 2.7×10^{-8} | |
| | D | Lead(II) iodide | 7.1 x 10 ⁻⁹ | |

Answer: B

For lead halide: $IP = [Pb^{2+}][X^{-}]^2$ = (0.01)(1x10⁻³)² = 1 x 10⁻⁸ mol³ dm⁻⁹ IP of Lead (II) bromide < K_{sp} (no ppt) IP of Lead(II) fluoride < K_{sp} (no ppt) IP of Lead(II) iodide > K_{sp} (ppt)

For lead sulfate: IP = $[Pb^{2+}][SO_4^{2-}]$ = (0.01)(1x10⁻³) = 1 x 10⁻⁵ mol² dm⁻⁶ IP >> than the K_{sp}, precipitation will occur readily

To determine the critical concentration of Pb²⁺ to bring about precipitation for lead(II) iodide and lead(II) sulfate.

For lead (II) sulfate: $1.6 \times 10^{-8} = [Pb^{2+}](1 \times 10^{-3})$ Min [Pb²⁺] = 1.6 x 10⁻⁵ mol dm⁻³

For lead (II) iodide: $7.1 \times 10^{-9} = [Pb^{2+}](1 \times 10^{-3})^2$ Min [Pb²⁺] = 7.1 x 10⁻³ mol dm⁻³

Thus **lead (II) sulfate** requires lesser Pb²⁺ to bring about precipitation.

11
 Use of the Data Booklet is relevant to this question.

 The diagram represents an experiment to determine the value of the E0 (Sn**(aq)/Sn(s)), the standard electrode potential of tin

$$det (Sn**(aq)/Sn(s))$$
, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of tin

 $det (Sn**(aq)/Sn(s))$, the standard electrode potential of the suggestions could be correct?

 $det (Sn**(aq)/Sn(s))$
 $det (Sn**(Sn)) = -0.14 V (oxd)$
 $(Sn**(Sn)) = -0.14 V (oxd)$
 $(Sn**(Sn)) = -0.14 V (oxd)$
 $(Sn**(Sn)) = -0.14 V (oxd) = (Sn**(Sn) = Sn**(Sn) = Sn**(Sn) = Sn**(Sn) = (Sn**(Sn) = Sn**(Sn) = (S$

INORGANIC CHEMISTRY





| 14 | Us | lse of the Data Booklet is relevant to this question. | | | | |
|----|------------|--|--|--|--|--|
| | Zin use | Zinc and magnesium are metals that are widely used in alloys such as Mazak which is used to make die-cast toys. Each metal forms many compounds containing a M^{2+} ion. | | | | |
| | Wł ma | Which statement about the electron arrangements in the atoms and ions of zinc and magnesium is correct? | | | | |
| | Α | A A zinc atom has fewer electrons than a magnesium atom. | | | | |
| | В | A Zn ²⁺ ion has one more occupied electron shell than a Mg atom. | | | | |
| | С | A Zn atom has two more occupied electron shells than a Mg ²⁺ ion. | | | | |

| | D | A Zn ²⁺ ion electronic | A Zn ²⁺ ion has an outer electronic configuration of 4s ² , while a Mg ²⁺ ion has an outer electronic configuration of 3s ² . | | |
|-----|--|-----------------------------------|---|--|--|
| Ans | Answer : C | | | | |
| | | | | | |
| Zn: | [Ar]3 | d ¹⁰ 4s ² | Zn ²⁺ : [Ar] 3d ¹⁰ | | |
| Ma: | Mg: [Ne] 3s ² Mg ²⁺ : [Ne] | | | | |

| 15 | How would the magnitude of the following vary down Group II? | | | | | | | |
|----|---|-----------------------------------|---------------------------|----------------------------|--|--|--|--|
| | (i) the lattice energy of the sulfate, ΔH^{θ}_{latt} , (ii) the standard enthalpy change of hydration of M ²⁺ (g), ΔH^{θ}_{hyd} , (iii) the standard enthalpy change of solution of the sulfates, ΔH^{θ}_{soln} . | | | | | | | |
| | | $\Delta H^{\theta}_{\text{latt}}$ | ΔH^{θ}_{hyd} | ΔH^{θ}_{soln} | | | | |
| | Α | decreases | decreases | increases | | | | |
| | В | decreases | increases | increases | | | | |
| | С | increases | decreases | decreases | | | | |
| | D | increases | increases | decreases | | | | |

Answer : A

In all Group II sulfates, M^{2+} and SO_4^{2-} : **q⁺, q⁻ and r⁻ are the same**.

$$\left|\Delta H_{int}\right| \propto \frac{\bar{q}q}{r+r}$$

• cation size, **r** * **increases**

$$\left|\Delta H_{hyd}(\mathbf{M}^{2+})\right| \alpha \frac{q^+}{r^+}$$

Down the group,

- cationic size, **r**⁺**increases**
- $|\Delta H^{\theta}_{hyd}|$ decreases <u>significantly</u>

Overall effect, going down the group:

 $|\Delta H^{\theta}_{latt}|$ decreases less significantly than $|\Delta H^{\theta}_{hyd}|$ $|\Delta H^{\theta}_{soln}|$ of Group II sulfates becomes more positive / endothermic.

| 16 | Which statement is most likely to be true for astatine, the element below iodine in Group | | | | | | |
|------|---|---|--|--|--|--|--|
| | VI | I of the Periodic Table? | | | | | |
| | Α | Astatine reacts with aqueous sodium bromide to given aqueous sodium astatide and bromine. | | | | | |
| | В | Astatine reacts with aqueous iron (II) ions to give iron (III) ions. | | | | | |
| | С | Hydrogen iodide is more acidic than hydrogen astatide. | | | | | |
| | D | Silver astatide has a lower K_{sp} value than silver iodide. | | | | | |
| Ans | wer | : D | | | | | |
| Opti | on / | A : Wrong. | | | | | |
| | = | \Rightarrow At cannot displace Br ⁻ as it is less reactive than Br. | | | | | |
| Opti | on l | 3: Wrong. | | | | | |
| | = | \Rightarrow At is a weaker oxidizing agent therefore, may not oxidize Fe ²⁺ to Fe ³⁺ . | | | | | |
| Opti | on (| C: Wrong. | | | | | |
| | = | ⇒ H-At is more acidic because H-At bond is weaker than HI thus it is easier for H-At to dissociate into its H ⁺ ions. | | | | | |
| Onti | 0 n | D: Correct | | | | | |
| Opti | = | ⇒ Down the group, K _{sp} decreases as ΔH _{hyd} ^θ (At ⁻) is proportional to q / r since ionic radius increases. | | | | | |
| | | | | | | | |



| | С | The bonds in fluorine are more polar than those in the other halogens. | |
|-------------------|-----|--|--|
| | D | The bonds in fluorine have some π -character. | |
| Answer : B | | | |
| F-F I | bon | ds in fluorine are non-polar. | |

| 18 | Ar ox | element J has the electronic configuration [Ar] $3d^3 4s^2$ and forms a series of ohalides. | | | | | |
|-------|--|--|--|--|--|--|--|
| | Wł | nich oxohalide of J is not likely to be formed? | | | | | |
| | Α | J O ₃ | | | | | |
| | В | JO_2^+ | | | | | |
| | С | | | | | | |
| | D | JCl ₃ | | | | | |
| Ans | Answer : A | | | | | | |
| [Ar]: | [Ar] 3d ³ 4s ² : <u>Group V</u> (Element : Vanadium) | | | | | | |
| Max | imu | m oxidation no. of Vanadium : <u>+5</u> | | | | | |
| Α | ١ | $O_3 \rightarrow +6$ (impossible to form a compound higher than its own O.S.) | | | | | |
| В | \ | $(O_2^+ \rightarrow +5)$ | | | | | |
| C | | $(O_3 \rightarrow +5)$ | | | | | |
| ט | \ | $(\cup_{l_3} \rightarrow +3)$ | | | | | |

| 19 | Pla co ca Wł | atinum(IV) chloride combines with ammonia to form compounds in which the ordination number of platinum is 6. A formula unit of one of the compounds contains a tion and only one chloride ion. That is the formula of this compound? | | | |
|------|--|---|--|--|--|
| | Α | $Pt(NH_3)_6Cl_4$ | | | |
| | В | $Pt(NH_3)_5Cl_4$ | | | |
| | С | $Pt(NH_3)_4Cl_4$ | | | |
| | D | $Pt(NH_3)_3Cl_4$ | | | |
| Ans | nswer: D | | | | |
| Cati | ation in complex has a <u>charge of 1+</u> (only <u>one corresponding C/ anion</u>), hence there must | | | | |

.

be <u>3 chloride ligands dative bonded to the Pt(IV) atom</u> to give an <u>overall charge of 1+</u>. As Pt has a <u>coordination number of 6</u>, there are <u>3 more ammonia ligands</u> bonded to it. Formula of complex is $[Pt(NH_3)_3(Cl)_3]^+ Cl^-$



| 21 | Со | Consider the following reactions. | | | | | |
|-------|-------------------|-----------------------------------|------------------------------|--|---------|-------------------------|-------------|
| | | | Reaction | Reactants | | Conditions | 7 |
| | | | Ι | CH ₄ , Br ₂ | | uv light | |
| | | | II | CH ₂ =CH ₂ , Br ₂ | | CCl ₄ | |
| | Wh the | nich of the two reaction | following is cor ons? | rect about the c | arbon- | containing intermediate | s formed in |
| | | Carbon | -containing int | ermediate in | Ca | bon-containing interm | nediate in |
| | | | Reaction 1 | [| | Reaction II | |
| | Α | | pyramidal | | | electron deficient | |
| | В | | pyramidal | | | planar | |
| | С | | planar | | | electron rich | |
| | D | | planar | | | pyramidal | |
| Ansv | Answer : A | | | | | | |
| Inter | mec | liate of rea | ction I is $\bullet CH_3$ | (pyramidal in s | shape) | | |
| Inter | mec | liate of read | ction II is H ₂ C | – CH ₃ (electron | deficie | ent and not planar) | |

| 22 | An KM Wh | organic compound, on heating wi nO₄(aq), produces CH₃COCH₂COCH₂(at could the organic compound be? | th ar CH₂C0 | excess of hot concentrated acidic DCH_2COOH and CH_3COCH_3 . |
|----|----------------|--|----------------|---|
| | A | $CH_3 \\ C(CH_3)_2 \\ CH_3$ | В | (H ₃ C) ₂ C (H ₃ C) ₂ C (H ₃ |
| | С | | D | |



Only structure **C** produces the two compounds given, on strong oxidation with hot acidified $KMnO_4$.

| 23 | Three halogeno compounds can be synthesised from an organic compound ${\bf K}$ by the following routes: | | | | | | |
|----|--|-----------------|------------------------------|-----------------|-----------------|--|--|
| | $\begin{array}{c c} & & & \\ & & & \\ & & \\ & & & \\ & & \\ & & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ &$ | | | | | | |
| | | \downarrow | CH ₂ COC <i>i</i> | СНВгСООН | | | |
| | | | Μ | N | | | |
| | When compounds K, L, M and N (not necessarily in that order) are added to separate portions of water, solutions are formed with pH values of 0.5, 2.5, 3.0 and 3.5. | | | | | | |
| | Which pH value is associated with K, L, M and N? | | | | | | |
| | | <u>pH = 0.5</u> | <u>pH = 2.5</u> | <u>pH = 3.0</u> | <u>pH = 3.5</u> | | |
| | Α | L | N | к | Μ | | |
| | В | к | N | L | М | | |
| | С | Μ | К | N | L | | |
| | D | Μ | L | Ν | К | | |
| | | | | | | | |

Answer : **D**

pH measures the acidity of the compound, if the conjugate salt is being stabilized by the substitutent attached to it, it will be more acidic.

M will has the lowest pH (it is the most acidic) as it will react with water to form RCOOH and HCI. For L and N, it has electron withdrawing substituent group (CI and Br) which will help to stabilize the conjugate ion. CI, being the stronger electron withdrawing groups will help to stabilize more as compared to CI thus L has a lower pH than N. K has the highest pH.

| 24 | Nit | Nitrile Q undergoes the two reactions as shown below. | | | | | |
|--|--|---|--|--|--|--|--|
| | Wł | Product \leftarrow Nitrile Q \rightarrow Product : Ethanoic acid hydrolysis Product : Ethanoic acid \rightarrow hydrolysis Product : Ethanoic acid hydrolysis \rightarrow | | | | | |
| | Α | CH ₃ CONHCH ₂ CH ₃ | | | | | |
| | | | | | | | |
| | в | CH ₃ CH ₂ CONHCH ₂ CH ₃ | | | | | |
| | С | [CH ₃ CH ₂ NH ₃ ⁺][CH ₃ COO ⁻] | | | | | |
| | D | $[CH_{3}CH_{2}CH_{2}NH_{3}^{+}][CH_{3}CH_{2}COO^{-}]$ | | | | | |
| Ans | wer | : C | | | | | |
| Nitril CH ₃ (CH₃ (| Nitrile Q is CH ₃ CN CH ₃ CN reduces to form CH ₃ CH ₂ NH ₂ (product of a step-up reaction) CH ₃ CH ₂ NH ₂ undergoes neutralisation with CH ₃ COOH to form an amide salt, [CH ₃ CH ₂ NH ₃ ⁺][CH ₃ COO ⁻] | | | | | | |





| 26 | Compound T can be made from phenol. Which are the correct reagents and conditions for steps I. II and III of this synthesis? | | | | | |
|-----|---|---|---|---|--|--|
| | | | $\stackrel{\text{OH}}{\longrightarrow} \stackrel{\text{OH}}{\longrightarrow} \stackrel{\text{NH}_2}{\longrightarrow}$ | $\underset{NO_2}{OH} NH_2$ | | |
| | | | | Т | | |
| | | Ι | II | III | | |
| | Α | concentrated HNO ₃ , r.t.p. | LiA/H_4 in dry ether, r.t.p. | Aqueous NH ₃ , heat | | |
| | В | concentrated HNO ₃ , r.t.p. | Sn, excess concentrated HC <i>l</i> , reflux followed by NaOH(aq) | dilute HNO ₃ , r.t.p. | | |
| | С | dilute HNO ₃ , r.t.p. | LiA/H₄ in dry ether, r.t.p. | Ethanolic NH ₃ , heat in a sealed tube | | |
| | D | dilute HNO ₃ , r.t.p. | Sn, excess concentrated HC <i>l</i> , reflux followed by NaOH(aq) | dilute HNO ₃ , r.t.p. | | |
| Ans | ver | : D | | | | |
| Con | cent | rated HNO ₃ will give multiple | substitution of phenol. | | | |

Reduction of nitrobenzene requires Sn+excess concentrated HC*l*, reflux followed by NaOH(aq).

Dilute HNO_3 is used to substitute a nitro group at position 4.

- 27 Which sequence shows the correct order of increasing pK_b in an aqueous solution of equal concentration? A $C_2H_5CONH_2 < C_2H_5NH_2 < C_2H_5NH_3^+CI < C_2H_5COCI$ B $C_2H_5NH_2 < C_2H_5COOCH_3 < C_2H_5COOH < C_2H_5COCI$ C $C_2H_5NH_2 < C_2H_5CONH_2 < CH_3CH(CI)COOH < C_2H_5COOH$ D $C_2H_5NH_3^+CI < C_2H_5COOCH_3 < C_2H_5COOH < CH_3CH(CI)COOH$ Answer : B Lower pK_b = Higher K_b = Higher basicity
- **A** : $C_2H_5NH_2$ contains an amine $-NH_2$. Hence, it is **basic** with the highest pH
- **B** : $C_2H_5COOCH_3$ is an ester. Esters are **neutral** hence pH is 7.
- C : C₂H₅COOH is a carboxylic acid. It is resonance stabilised as the negative charge is delocalised across the 2 oxygen atoms. Hence, carboxylic acids are **acidic** hence pH < 7.</p>
- D: C₂H₅COC/ is an acyl chloride. It dissociates in water readily to form CH₃CH₂COOH and HC/. HC/ is completely dissociated into H⁺ and Cl⁻ ions hence the H⁺ ions in solution accounts for the high acidity. pH <<< 7</p>

| 28 | Phenylethanoate undergoes acid hydrolysis in the presence of water labelled with the ¹⁸ O isotope. | | | | | | |
|------|---|---|--|--|--|--|--|
| | Which product is formed? | | | | | | |
| | Α | C ₆ H ₅ ¹⁸ OH | | | | | |
| | В | C ₂ H ₅ ¹⁸ OH | | | | | |
| | С | C ₆ H ₅ CO ¹⁸ OH | | | | | |
| | D | CH ₃ CO ¹⁸ OH | | | | | |
| Ansv | ver | : D | | | | | |



| 30 | A٢ | nexapeptide, U , is hydrolysed to the following dipeptides: | | | | | | |
|-----|---|--|--|--|--|--|--|--|
| | | Ileu–Val Ala–Pro Lys–Leu | | | | | | |
| | Ca res wit Wł | rboxypeptidase, an enzyme which hydrolyses the peptide bond of an amino acid sidue at the C-terminus, acts on U to liberate valine. 2,4-dinitrofluorobenzene reacts h an amino acid residue at the N-terminus of U to form 2,4-dinitrophenylalanine. hich is the amino acid sequence of polypeptide U ? | | | | | | |
| | Α | Ala-Pro-Lys-Leu-Ileu-Val | | | | | | |
| | В | Val-Ileu-Lys-Leu-Pro-Ala | | | | | | |
| | С | Ileu-Val-Ala-Pro-Lys-Leu | | | | | | |
| | D | Lys-Leu-Ala-Pro-Ileu-Val | | | | | | |
| Ans | Answer : A | | | | | | | |
| Ami | Amino acid residue at N terminus: alanine (Ala) | | | | | | | |
| Ami | no a | cid residue at C terminus: valine (Val) | | | | | | |
| Thu | s U i | s (N) Ala-Pro-Lys-Leu-Ileu-Val (C). | | | | | | |

Thus **U** is (N) Ala-Pro-Lys-Leu-Ileu-Val (C).

For **questions 31 – 40**, one or more of the numbered statements **1** to **3** may be correct. Decide whether each of the statements is or is not correct. The responses **A** to **D** should be selected on the basis of

| A | В | C | D |
|-------------|--------------|--------------|------------|
| 1, 2 and 3 | 1 and 2 only | 2 and 3 only | 1 only |
| are correct | are correct | are correct | is correct |

No other combination of statements is to be used as correct response.

| 31 | Oxygen dissolved in the sea is critical for the survival of ocean life. It was found in a study that the solubility of oxygen is higher in water of lower salinity than in water of higher salinity. Oxygen is also more soluble in the colder, deeper parts of the ocean. Which are possible explanations for the above observations? | | | |
|----|---|--|--|--|
| | 1 | The dissolving of oxygen in water is an exothermic process. | | |
| | 2 | Oxygen is soluble in water due to intermolecular hydrogen bonding. | | |
| | 3 | Oxygen is less soluble in water of higher salinity due to interference from ion- dipole interactions. | | |
| | Answer : A (1, 2 and 3) | | | |
| | 1 | . Oxygen is more soluble in colder water, ie. when temperature is lowered. Hence, the dissolving of oxygen must be a process that releases heat. | | |
| | 2 | The H atom bonded to an O atom in H_2O can form hydrogen bonds with the lone pair of electrons on the oxygen atom in an O_2 molecule. | | |
| | 3 | When salt content in water increases, there are more extensive ion-dipole interactions that involve H_2O molecules. Hence, H_2O molecules are not as available to interact with the O_2 molecules. | | |

32 Alcohol dehydrogenases (ADH) are a group of dehydrogenase enzymes that occur in many organism and facilitate the interconverison between alcohols and aldehydes or ketone. In humans, they serve to break down alcohol which is toxic. It is also used in fermentation in the production of ethanol. $CH_3CHO + 2[H] \rightarrow CH_3CH_2OH$ The graph shows how the rate of the enzyme-catalysed reaction varies with the concentration of ethanal. rate [ethanal] Which statement best explains the reason for the flattening of the curve? 1 At high ethanal concentrations all the active sites in the enzyme molecules are occupied by ethanal molecules. 2 As the ethanol product builds up the reaction slows down. All ethanal has been used up and the reaction is completed. 3 Answer : D (1 only) 1. At high ethanal concentrations all the active sites in the enzyme molecules are occupied by ethanal molecules. Rate remains constant thereafter. \rightarrow TRUE 2. build-up of ethanol product should not cause the rate to slow down. \rightarrow FALSE 3. For statement 3: Should all ethanal be used up, rate will decrease and drop to zero since reaction has ceased. \rightarrow FALSE

| 33 | In which processes will ΔS be positive? | | |
|----|---|---|--|
| | 1 | Evaporation of a solvent from a solution. | |
| | 2 | Adding a polar solute to a non-polar solvent. | |
| | 3 | Spreading out a solution on a clean surface. | |
| | Answer : D (1 only) | | |

 As the solvent evaporates, there is a phase change from liquid to gas, which results in an increase in disorderliness.

- 2. No mixing will occur, hence no change in disorderliness.
- No changes occur to the particles in the solution, hence no change in disorderliness.

| 34 | In a car engine, non-metallic element V forms a pollutant oxide W. Further oxidation of W to X occurs spontaneously in the atmosphere. In this further oxidation, 2 mol of W reacts with 1 mol of gaseous oxygen. X can dimerise at specific conditions. Which statements about V, W and X are correct ? | | | |
|----|---|---------------------------|--|--|
| | 1 V forms a basic hydride. | | | |
| | 2 | W is a diatomic molecule. | | |
| | 3 | X is a polar molecule. | | |
| | Answer : A (1, 2 and 3) | | | |
| | V is Nitrogen, W is nitrogen monoxide (NO), X is nitrogen dioxide (NO ₂) | | | |
| | 1. Hydride NH₃ is basic | | | |
| | 2. NO is a diatomic molecule | | | |
| | 3. 2NO + O ₂ \rightarrow 2NO ₂ NO ₂ is a polar molecule and dimerises to form N ₂ O ₄ | | | |

| 35 | Use of the Data Booklet is relevant to this question. | | |
|----|--|---|--|
| | The unbalanced equation below involves manganese species in acid medium. | | |
| | $MnO_4^{2-} \longrightarrow Mn^{2+} + MnO_4^{-}$ | | |
| | Which statements are true? | | |
| | 1 | This is a disproportionation reaction. | |
| | 2 | Unequal amounts of Mn^{2+} and MnO_4^- ions are formed. | |
| | 3 | The 3d electrons in Mn ²⁺ ions are unpaired. | |
| | Answer : A (1, 2 and 3) | | |

1. Mn undergoes both oxidation and reduction simultaneously (oxidation number of Mn changes from +6 in MnO_4^{2-} to +2 in Mn^{2+} and +7 in MnO_4^{-})

2. Overall equation: $5MnO_4^{2^-} + 8H^+ \rightarrow 4MnO_4^- + Mn^{2+} + 4H_2O$

3. Electronic configuration of Mn²⁺ is [Ar] 3d⁵

| 36 | Which statements are true? | | |
|----|--|---|--|
| | 1 | Pentan-1-ol is less soluble in polar solvent than ethanol. | |
| | 2 | The melting point of aminoethanoic acid is higher than that of ethanamide due to the presence of stronger hydrogen bonding present. | |
| | 3 | The boiling point of 2,2,3,3-tetramethylbutane is higher than 2,3,3-trimethylpentane due to the longer parent carbon chain which allow more extensive intermolecular van der Waals' forces of attraction. | |
| | Answer : D (1 only) | | |
| | Statement 2 is wrong as aminoethanoic acid exists as zwitterion and hence they have strong ionic bond not hydrogen bond. | | |
| | Statement 3 is wrong as 2,2,3,3-tetramethylbutane boiling point is lower than 2,3,3-trimethylpentane due to branding. | | |

37 Bacteria have been suggested as a possible means of cleaning up spillages. Some bacteria contain enzymes that can insert one or more oxygen atoms into any carbon-hydrogen bond in an alkane. This converts a water-insoluble alkane into a water-soluble alcohol, for example,

 CH_3CH_3 \longrightarrow CH_3CH_2OH

Which alcohols could be obtained by this process from $(CH_3)_2CHCH_2CH_3$?

| 1 | (CH ₃) ₂ CHCH ₂ CH ₂ OH | | |
|------|---|--|--|
| 2 | CH ₃ CH(OH)CH(CH ₃) ₂ | | |
| 3 | (CH ₃) ₂ C(OH)CH(OH)CH ₃ | | |
| Ansv | nswer : A (1, 2 and 3) | | |
| 1 | (CH ₃) ₂ CHCH ₂ CH ₂ OH | | |
| | $(CH_3)_2CHCH_2CH_3$ (CH ₃) ₂ CHCH ₂ CH ₂ OH | | |
| 2 | CH ₃ CH(OH)CH(CH ₃) ₂ | | |





- Nucleophilic Substitution Nucleophilic Substitution CH_3 CH_3 HC OH OH CH_3 CH_3 HCl is removed CH_3 CH₃ CH_3 Н OHH 1 and 2 are correct. 3 is wrong as it has no phenol group to give a purple complex with neutral iron (III) chloride solution.
- Penicillin is widely used to kill bacteria. The general structure of a penicillin molecule is 39 given below. റ CO₂H R = an aryl group R S Ĥ Which products are formed when penicillin is boiled with excess aqueous sodium hydroxide? 1 CO2⁻ Na⁺ Na^{+ -}O₂C 0 HN and O⁻Na⁺ R H₂N S 2 CO₂ Na⁺ Na^{+ -}O₂C О H_2N and O⁻Na⁺ R $H_{3}N_{+}$ 3 0 CO₂ Na⁺ 0 and O⁻Na⁺ R H₂N S Answer : D (1 only)



"boiled with NaOH(aq)" => amide bonds will be hydrolysed to form $-CO_2^-Na^+$ and $-NH_2$. "Neutralisation of acidic carboxylic group" => carboxylic acid group will form carboxylate salt

| 40 | Thyroxine is a hormone which controls the metabolic rate. It has the following structure: | | |
|----|---|--------------------------------|--|
| | HO $ -$ | | |
| | Which properties of <i>thyroxine</i> are correct? | | |
| | 1 | lt ca | n decolourise dilute chlorine at all temperatures. |
| | 2 | lt ca | n form a tripeptide with cysteine and proline. |
| | 3 | 3 It can exist as zwitterions. | |
| | Answer : C (2 and 3 only) | | |
| | | 1 | It can decolourise dilute chlorine at all temperatures. \rightarrow False |
| | | | All 2, 4, 6 positions of the phenol are occupied, hence easy electrophlic substitution will not occur. |
| | | 2 | It can form a tripeptide with cysteine and proline. \Rightarrow True |
| | | | Cysteine and Proline can each form a peptide bond with the amine and carboxyl group present |
| | | 3 | It can exist as zwitterions. |
| | | | Amine and carboxyl group present can form zwitterions in aqueous solution |

END OF PAPER 1