

**2016 Preliminary Examination
H2 Chemistry MCQ Solution**

1	2	3	4	5	6	7	8	9	10
A	B	B	D	A	D	D	C	B	B
11	12	13	14	15	16	17	18	19	20
D	B	D	C	C	A	C	C	D	A
21	22	23	24	25	26	27	28	29	30
A	D	A	C	C	B	B	A	A	D
31	32	33	34	35	36	37	38	39	40
B	C	A	B	D	B	A	B	D	C

<p>16. A</p> <p>Observation 1: $\text{H}_2\text{SO}_4 + \text{Cl}^- \longrightarrow \text{HCl} + \text{HSO}_4^-$</p> <p>HCl bubbled into Br^-, no visible reaction is observed and solution <u>remained colourless</u>.</p> <p>Observation 2: Addition of Ag^+ into solution containing Cl^- and $\text{NH}_3(\text{aq})$ gives a <u>colourless solution containing $[\text{Ag}(\text{NH}_3)_2]^+$</u> as AgCl is soluble in aq NH_3</p>	<p>17. C</p> <p>A: Charge of Group II metal ions is the same but the ionic radius increases down the group. Hence, with decreasing charge density, the magnitude of ΔH_{hyd} decreases down the group.</p> <p>B: Solubility of Group II sulfate decreases down the group.</p> <p>C: Down the group as the charge density of the metal ion decreases, its polarisation power decreases, thus there is less weakening of the C - O bond resulting in greater stability.</p> <p>D: Tendency to form complexes should be decreasing as the charge density of the metal ion decreases down the group.</p>
<p>18. C</p> <p>Blood red seen is due to the complex formed in the following reaction:</p> $[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + \text{SCN}^- \rightleftharpoons \text{H}_2\text{O} + [\text{Fe}(\text{H}_2\text{O})_5(\text{SCN})]^{2+} \text{ Blood red}$ <p>In the presence of an alkali, red- brown precipitate of iron(III) hydroxide is formed as well thus diluting the blood red colour making the letters appear orange brown.</p> $[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \rightleftharpoons 3\text{H}_2\text{O} + [\text{Fe}(\text{OH})_3(\text{H}_2\text{O})_3](\text{s}) \text{ red-brown ppt}$	<p>19. D</p> <p>Energy level diagram indicates in the single reaction step, the reactant(s) undergo bond breaking only ie reactant(s) absorb energy. There is no bond formation taking place. Hence, true for option D only. In options A and C, bond formation only occurs. In option B, there is bond breaking followed by bond formation in the reaction.</p>
<p>20. A</p> <p>Oxo reaction:</p> $\text{CH}_2=\text{CH}_2 + \text{CO} + \text{H}_2 \rightarrow \begin{array}{c} \text{CH}_2-\text{CH}_2 \\ \quad \\ \text{H} \quad \text{C}=\text{O} \\ \\ \text{H} \end{array}$ <p>Similarly for but-2-ene,</p> $\text{CH}_3\text{CH}=\text{CHCH}_3 + \text{CO} + \text{H}_2 \rightarrow \begin{array}{c} \text{CH}_3\text{CH}-\text{CHCH}_3 \\ \quad \\ \text{H} \quad \text{C}=\text{O} \\ \\ \text{H} \end{array}$	<p>21. A</p> <p>2,4-DNPH and $\text{I}_2/\text{NaOH}(\text{aq})$ doesn't react with X and Y. X is an ester, not a carbonyl compound. Y reacts with $\text{NaOH}(\text{aq})$, but it doesn't give observable result. Y reacts with Na to give effervescence of H_2.</p>
<p>22. D</p> $\begin{array}{c} \text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_2\text{OH} \\ \text{Cr}_2\text{O}_7^{2-}/\text{H}^+ \downarrow \\ \text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CO}_2\text{H} \end{array}$ <p>which goes through hydrogenation to form $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$.</p>	<p>23. A</p> <p>Nucleophilic substitution gives $\text{CH}_3\text{CH}_2\text{OD}$.</p> <p>B) oxidation to give CH_3CO_2^-</p> <p>C) Elimination to give $\text{CH}_2=\text{CH}_2$</p> <p>D) Condensation to give $\text{CH}_3\text{CO}_2\text{CH}_3$</p>

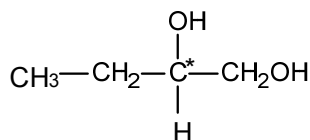
24. C

Z is an aldehyde and contains –OH group. Upon reduction by H_2 , **Z** forms a product that contains chiral carbon and no plane of symmetry.

A) Does not contain –OH

B) Is not an aldehyde

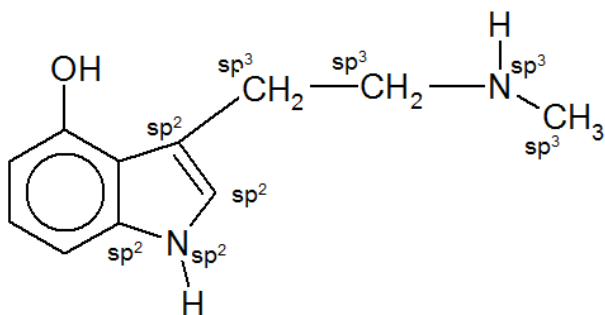
C) Contains –OH and aldehyde. Product of reduction reaction is a chiral compound.



D) Product from reduction

$CH_2(OH)CH(CH_3)CH_2OH$ does not have chiral carbon.

25. C

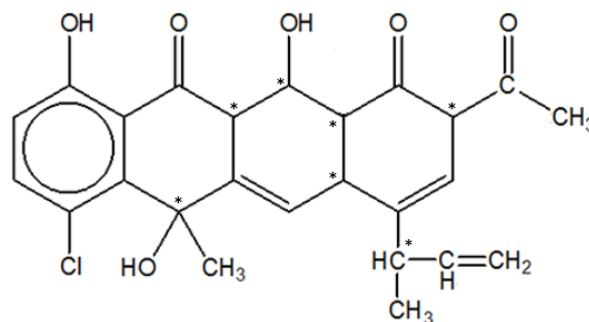


As shown in the diagram above, there is no sp^3 C atom overlapping with sp^2 N atom.

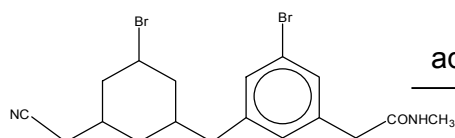
26. B

Maximum number of stereoisomers = $2^{n+m} = 2^{7+0}$

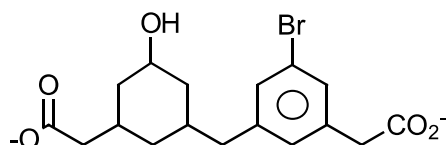
There are 7 chiral carbons in compound. There isn't any C=C that can display cis-trans isomerism.



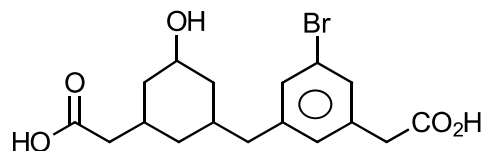
27. B



aq NaOH, heat

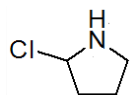


acidification



28. A

The lower the pK_b , the stronger the base. Hence, molecules should be arranged from weakest base to the strongest base.



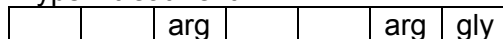
is the least basic due to the close proximity of the electron withdrawing Cl atom, which decreases the electron density on the N atom.



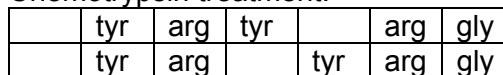
is the most basic due to the presence of two electron release groups, and the absence of any electron withdrawing groups.

29. A

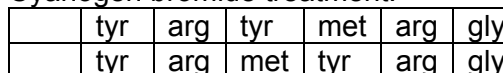
Trypsin treatment:



Chemotrypsin treatment:



Cyanogen bromide treatment:



x

Primary structure:

pro–tyr–arg–met–tyr–arg–gly

Note: A much faster way would be to analyse the options given, instead of solving in the forward direction.

30. D

General rules

Taking the neutral form of the dipeptide into account,

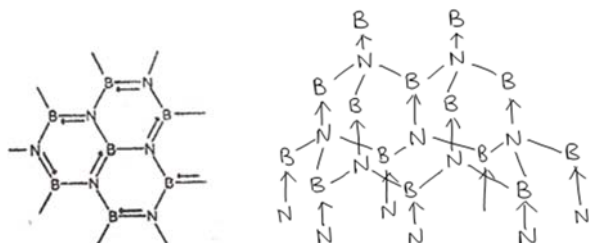
If $\text{pH} > \text{pI}$, $-\text{COOH}$ will be deprotonated, resulting in a negatively charged dipeptide

If $\text{pH} < \text{pI}$, $-\text{NH}_2$ will be protonated, resulting in a positively charged dipeptide

If $\text{pH} = \text{pI}$, the dipeptide is electrically neutral

$\text{pH } 7.4 > \text{pI of carnosine (pI} = 6.83) \rightarrow \text{deprotonation}$

31. B

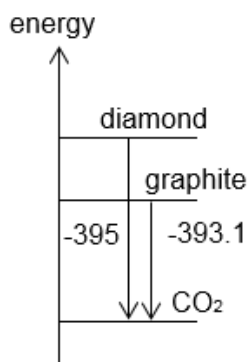


In the cubic structure, each B atom is bonded covalently to 4 N atoms in a tetrahedral manner, where one of the bonds is a dative bond (where N lone pair of electron is donated to B atom).

Like graphite, there are extensive van der Waals forces of attraction between the layers in hexagonal boron nitride.

Option 3 is incorrect. The boron-nitrogen bond in hexagonal boron nitride is shorter and stronger than that in cubic boron nitride, due to the pi bond present. Each B atom uses all its three valence electrons to form covalent bonds with three neighbouring nitrogen atoms. Each nitrogen atom still has a lone pair of electrons which it uses to form a dative pi-bond with an adjacent boron atom.

32. C



33. A

$E^\ominus_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V}$ & $E^\ominus_{\text{Cu}^{2+}/\text{Cu}} = +0.34 \text{ V}$

For anode, oxidation: select E^\ominus that is more negative. Hence, Zn is preferentially discharged. 1 is correct.

For cathode, reduction: select E^\ominus that is more positive.

$E^\ominus_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V}$ & $E^\ominus_{\text{H}^+/\text{H}_2} = +0.00 \text{ V}$

Hence, H_2 evolved.

$\text{H}^+ (\text{aq}) + \text{e}^- \rightarrow \frac{1}{2}\text{H}_2(\text{g})$, effervescence observed. 2 is correct

$[\text{H}^+]$ decreases, pH of solution increases. 3 is correct.

34. B

Statement 1 is correct. Increasing the temperature favours the endothermic (forward) reaction, and by Le Chatelier's principle, the position of equilibrium will shift to the right.

Statement 2 is correct. Since $\text{Fe}_3\text{O}_4(\text{s})$ and $\text{FeO}(\text{s})$ are both in solid states, they are not part of the K_C expression. $K_C = [\text{CO}_2(\text{g})] / [\text{CO}(\text{g})]$ Therefore K_C has no units.

Statement 3 is not correct. Adding a solid reactant or product does not affect the position of equilibrium.

35. D

1. pH of aqueous solution of chlorides decreases from 6.5 (MgCl_2) to 1 (PCl_5).
2. maximum oxidation states of the elements in the chlorides increases from MgCl_2 to PCl_5 .
3. All are insulators in the solid state from MgCl_2 to PCl_5 .

36. B

Option 1: Due to its greater nuclear charge, Cu has a higher atomic mass and smaller atomic volume. Hence, its density is higher than Ca.

Option 2: Metallic bond for Cu is stronger since both 3d and 4s electrons are delocalised compared to the 4s electrons only for Ca. Hence, more

	<p>energy is needed during melting accounting for its higher m pt.</p> <p>Option 3: Electrical conductivity for Cu should be higher since it has a greater number of delocalised electrons (both 3d and 4s) to conduct electricity compared to the 4s electrons only for Ca.</p>
<p>37. A</p> <p>Statement 1 is correct. The magnitude of the equilibrium constant is large ($\gg 100$), which implies the position of equilibrium lies far to the right.</p> <p>Statement 2 is correct. Since K_2 is larger in magnitude than K_1, it implies that en has a higher tendency to replace the water ligands than ammonia.</p> <p>Statement 3 is correct.</p>	$K_{\text{stab}} = \frac{[\text{Ni}(\text{NH}_3)_6]^{2+}}{[\text{Ni}(\text{H}_2\text{O})_6]^{2+}[\text{NH}_3]^6}$ $K'_{\text{stab}} = \frac{[\text{Ni}(\text{en})_3]^{2+}}{[\text{Ni}(\text{H}_2\text{O})_6]^{2+}[\text{en}]^3}$ $K''_{\text{stab}} = \frac{[\text{Ni}(\text{en})_3]^{2+}[\text{NH}_3]^6}{[\text{Ni}(\text{NH}_3)_6]^{2+}[\text{en}]^3}$ $= \frac{[\text{Ni}(\text{en})_3]^{2+}}{[\text{Ni}(\text{H}_2\text{O})_6]^{2+}[\text{en}]^3} \times \frac{[\text{Ni}(\text{H}_2\text{O})_6]^{2+}[\text{NH}_3]^6}{[\text{Ni}(\text{NH}_3)_6]^{2+}}$ $= K'_{\text{stab}} / K_{\text{stab}}$
<p>38. B</p> <p>Statements 1 and 2 are correct.</p> <p>Reactant in stage III is saturated, it cannot undergo addition reaction. Stage III is elimination.</p>	
<p>39. D</p> <p>Option 1 is correct. Protonation of R-groups of the residues in the tertiary structure disrupts existing ionic interactions and hydrogen bonds between them, which results in denaturation.</p> <p>Option 2 is incorrect. The amide functional group in the peptide linkages are neutral, and will not react with H^+</p> <p>Option 3 is incorrect. Primary structure is only affected during hydrolysis. Complete hydrolysis will only occur when ovalbumin is heated for a prolonged period of time under highly acidic conditions, e.g. $6 \text{ mol dm}^{-3} \text{ HCl(aq)}$, heat for a few hours.</p>	<p>40. C</p> <p>Option 1 is incorrect. Both compounds react with aqueous bromine to give a white ppt.</p> <p>Option 2 is correct. The alkyl side chain on the benzene ring will undergo oxidation as long as there is a H atom present at the benzylic position. Purple acidified KMnO_4 will be decolourised.</p> <p>Option 3 is correct. The $-\text{NH}_2$ of the phenylamine will undergo nucleophilic substitution with CH_3Br. The Br^- leaving group will form a cream ppt with AgNO_3.</p>