

NANYANG JUNIOR COLLEGE  
JC 2 Preliminary Examination  
Higher 2

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## CHEMISTRY

**9729/01**

Paper 1 Multiple Choice

**16 Sep 2024**

**1 hour**

Additional Materials:            Multiple Choice Answer Sheet  
                                                 Data Booklet

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### READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, CT and NRIC / FIN on the Answer Sheet in the spaces provided.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

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This document consists of **19** printed pages.

**[Turn Over**

- 1 *Use of the Data Booklet is relevant to this question.*

Group 1, 2 and 3 metals form cations with +1, +2 and +3 oxidation states respectively.

Calcium and **V** are adjacent elements in Group 2 of the Periodic Table.

**V** and **W** are adjacent elements in the same period of the Periodic Table.

The table shows the angle of deflection of cations of these elements in an electric field.

element	calcium	<b>V</b>	<b>W</b>
angle of deflection	+12°	+5.5°	+8.1°

What is the proton number of **W**?

- A** 11                      **B** 13                      **C** 37                      **D** 39
- 2 *Use of the Data Booklet is relevant to this question.*

The successive ionisation energies, in  $\text{kJ mol}^{-1}$ , of elements **G** and **H** are given below.

<b>G</b>	580	1820	2740	11600	14800	18400	23300
<b>H</b>	940	2050	2970	4140	6590	7880	14900

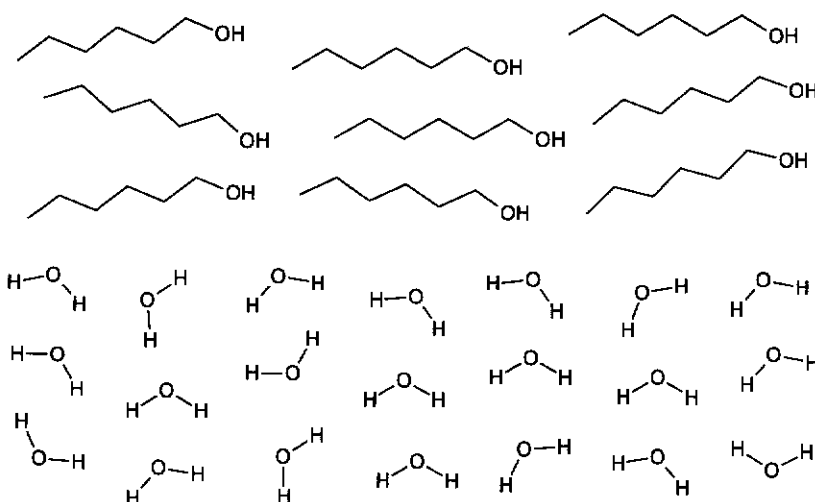
Which statements about elements **G** and **H** can be deduced from the data?

- There is inter-electron repulsion in only one valence p orbital of **H**.
  - The 3rd ionisation energy of **H** is greater than the 3rd ionisation energy of **G** because nuclear charge of **H** is larger.
  - The compound formed by **G** and **H** is  $\text{Al}_2\text{Te}_3$ .
- A** 1, 2 and 3              **B** 1 and 2              **C** 1 and 3              **D** 3
- 3 In which of the following pairs, is the bond angle in the first molecule larger than in the second?
- A**  $\text{NO}_3^-$ ,  $\text{BeCl}_2$
- B**  $\text{BrO}_3^-$ ,  $\text{PCl}_4^+$
- C**  $\text{AsF}_6^-$ ,  $\text{XeF}_4$
- D**  $\text{SO}_2$ ,  $\text{SO}_4^{2-}$

- 4 What is the trend in bond energy and in bond length of the carbon to hydrogen bond from  $C_2H_2$  to  $C_2H_4$  to  $C_2H_6$ ?

	bond length	bond energy
<b>A</b>	increase	decrease
<b>B</b>	increase	increase
<b>C</b>	decrease	increase
<b>D</b>	decrease	decrease

- 5 When hexanol is mixed with water, two distinct layers is observed.



Which two intermolecular forces of attraction are best used to explain this observation?

- instantaneous dipole - induced dipole interactions between hexanol molecules
- hydrogen bonding between hexanol molecules
- hydrogen bonding between water molecules
- instantaneous dipole - induced dipole interactions between hexanol and water molecules

**A** 1 and 3      **B** 1 and 4      **C** 2 and 3      **D** 3 and 4

- 6 Which oxide will **not** dissolve in dilute NaOH(aq) at room temperature?
- A Na<sub>2</sub>O  
B MgO  
C Al<sub>2</sub>O<sub>3</sub>  
D P<sub>4</sub>O<sub>10</sub>
- 7 Which statements explain the difference in thermal decomposition temperature between MgCO<sub>3</sub>(s) and BaCO<sub>3</sub>(s)?
- 1 Mg<sup>2+</sup> has a smaller ionic radius than Ba<sup>2+</sup>.
  - 2 CO<sub>3</sub><sup>2-</sup> electron cloud is less polarised in MgCO<sub>3</sub>.
  - 3 C–O bond is stronger in MgCO<sub>3</sub>.
- A 1, 2 and 3    B 1 and 2 only    C 2 and 3 only    D 1 only
- 8 2 cm<sup>3</sup> solution of Cl<sub>2</sub>(aq) is added to 2 cm<sup>3</sup> solution of I<sup>-</sup>(aq). The resulting mixture is added to 4 cm<sup>3</sup> of octane in a boiling tube. The contents of the boiling tube was shaken and left to stand to reach equilibrium.
- Which statement is correct?
- A Brown colour is seen in the octane layer.  
B Brown colour is seen in the aqueous layer.  
C The attraction of chlorine nucleus to an incoming electron is stronger than the attraction of iodine nucleus to an incoming electron, hence chlorine is a stronger oxidising agent than iodine.  
D The attraction of iodide nucleus for its valence electrons is weaker than the attraction of chloride nucleus to its valence electrons, hence iodide is a weaker reducing agent than chloride.

- 9 Use of the Data Booklet is relevant to this question.

A Jones reductor is a column containing zinc amalgam. When a solution containing a metal ion is passed through a Jones reductor, zinc metal is oxidised and the metal ion is reduced.

When 40.0 cm<sup>3</sup> of an acidified solution of 0.200 mol dm<sup>-3</sup> ReO<sub>4</sub><sup>-</sup>(aq) is added to a Jones reductor, 2.09 g of Zn metal was lost from the column.

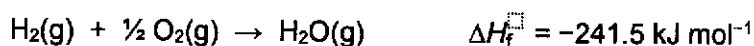
What is the final oxidation state of Re in this reaction?

- A -1                      B 0                      C +2                      D +3

- 10 Which of the following shows a correct enthalpy change?

A	$\Delta H_{\text{neut}}^{\ominus}$	$2\text{NaOH}(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$
B	$\Delta H_{\text{f}}^{\ominus}$	$2\text{Na}(\text{s}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{Na}_2\text{O}(\text{s})$
C	$\Delta H_{\text{hyd}}^{\ominus}$	$\text{NaCl}(\text{s}) \rightarrow \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
D	LE	$\text{NaOH}(\text{s}) \rightarrow \text{Na}^+(\text{g}) + \text{OH}^-(\text{g})$

- 11 The  $\Delta H_{\text{f}}^{\ominus}$  for steam is shown.



Which statement is correct?

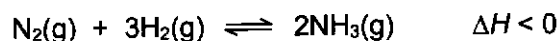
- A The reaction is always spontaneous.  
 B The reaction is more spontaneous at lower temperatures.  
 C The reaction is more spontaneous at higher temperatures.  
 D The reaction is never spontaneous.

- 12  $^{222}\text{Rn}$  is a radioactive isotope found naturally in soil. It can build up in indoor air from soil under foundations of buildings.  $^{222}\text{Rn}$  has a half-life of 3.82 days.

Radiation in air is measured in units of picocurie (pCi) per  $\text{dm}^3$  of air. Outdoor air generally contains  $0.4 \text{ pCi dm}^{-3}$  of  $^{222}\text{Rn}$ . The air in a sealed disused building contains  $15 \text{ pCi dm}^{-3}$  of  $^{222}\text{Rn}$ .

How many days does it take for  $^{222}\text{Rn}$  in the building to decompose to a safe level?

- A 0.04  
B 0.15  
C 5.23  
D 19.97
- 13 The Haber process is used in the industry for the synthesis of ammonia from nitrogen and hydrogen gas.



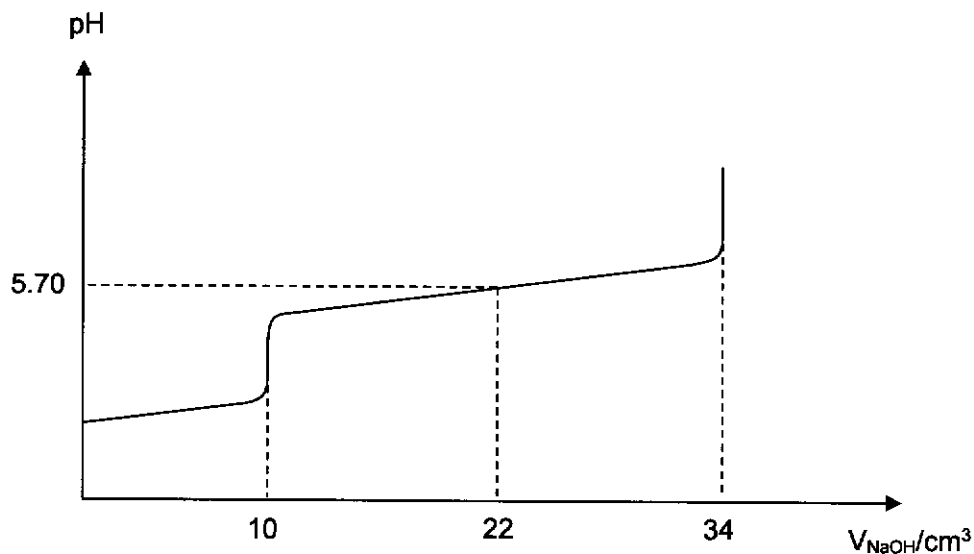
Which statements about the operating conditions of the Haber process are correct?

- 1 Perforated Pt mesh with a large surface area is used to ensure the rate of the forward reaction is greater than the rate of the backward reaction.
- 2 A temperature below 500 K is not used as the rate of reaction will be too slow.
- 3 A pressure of  $2.03 \times 10^7 \text{ Pa}$  is used to reduce the total number of gas particles in the reaction chamber.

- A 1, 2 and 3      B 1 and 2      C 2 and 3      D 3 only

14 Malonic acid has the structure  $\text{HO}_2\text{CCH}_2\text{CO}_2\text{H}$ .

A  $25.0 \text{ cm}^3$  solution contains a mixture of malonic acid and its conjugate base  $\text{HO}_2\text{CCH}_2\text{CO}_2^-$ . It is titrated against a  $0.100 \text{ mol dm}^{-3}$   $\text{NaOH}(\text{aq})$  to obtain the graph below.



Given:



What is the initial pH of the solution?

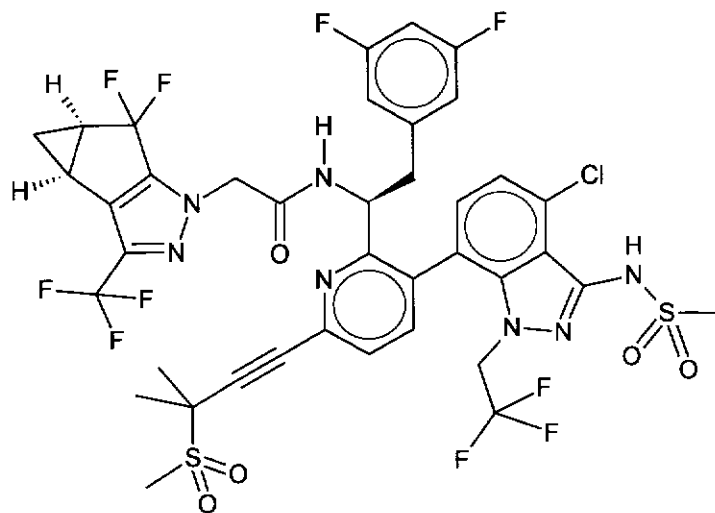
- A**    2.12                      **B**    2.70                      **C**    2.85                      **D**    3.00

15 Some metal hydroxides and carbonates are separately dissolved in distilled water to produce saturated solutions.

Given  $K_b$  of  $\text{CO}_3^{2-}$  is  $2.1 \times 10^{-4} \text{ mol dm}^{-3}$ , which compound will give a solution with the highest pH?

		magnitude of $K_{sp}$
<b>A</b>	$\text{MgCO}_3$	$3.5 \times 10^{-8}$
<b>B</b>	$\text{MnCO}_3$	$1.8 \times 10^{-11}$
<b>C</b>	$\text{Ni}(\text{OH})_2$	$2.0 \times 10^{-15}$
<b>D</b>	$\text{Sc}(\text{OH})_3$	$8.0 \times 10^{-31}$

- 16 Lenacapavir is an anti-retroviral medication used for the treatment of HIV.



Lenacapavir

Given that

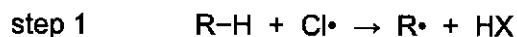
- all N atoms in Lenacapavir are  $sp^2$  hybridised,
- halogen atoms bonded to  $sp^2$  carbon atoms are  $sp^2$  hybridised.

What is the total number of  $\pi$  electrons in Lenacapavir?

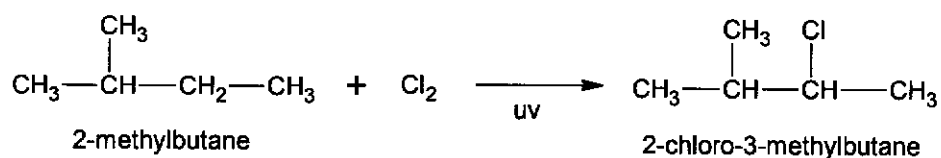
- A** 26                      **B** 44                      **C** 46                      **D** 52



- 17 Alkanes undergo free radical substitution (FRS) reaction with chlorine gas in sunlight. In FRS reactions, alkanes are converted to chloroalkanes in two steps.

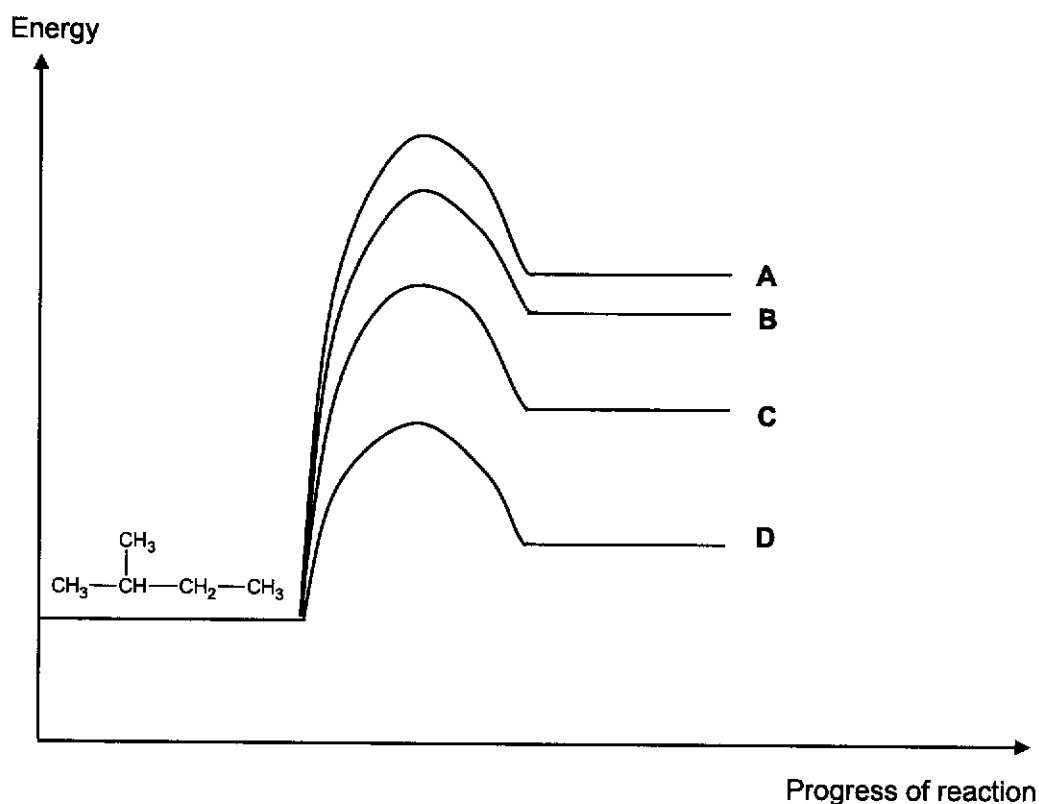


When 2-methylbutane is reacted with chlorine gas in sunlight, a total of four monochlorinated products are obtained. One of the products is 2-chloro-3-methylbutane.

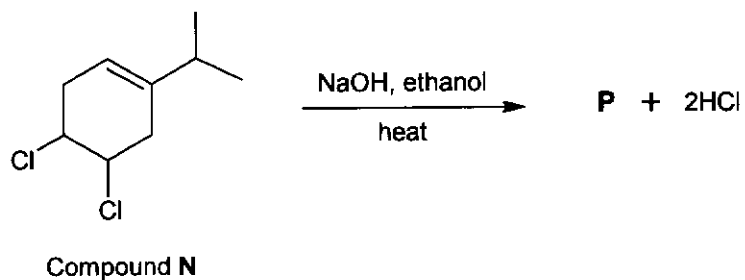


The energy profile for step 1 of FRS is shown, showing the energy changes when the intermediate of each of the four products is formed.

Which profile shows the energy change for the formation of 2-chloro-3-methylbutane?



- 18 Compound **N** undergoes the reaction as shown below to form the major product **P**.



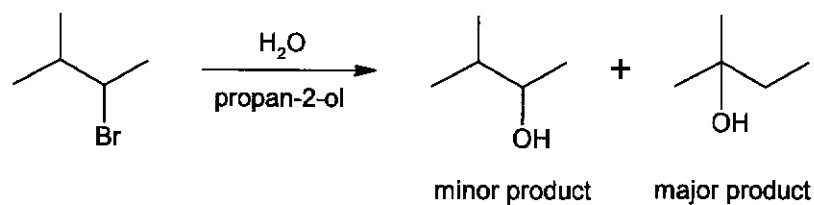
When  $\text{Br}_2(\text{aq})$  is added to **P**, an orange solution is observed.

Which statements about **P** are correct?

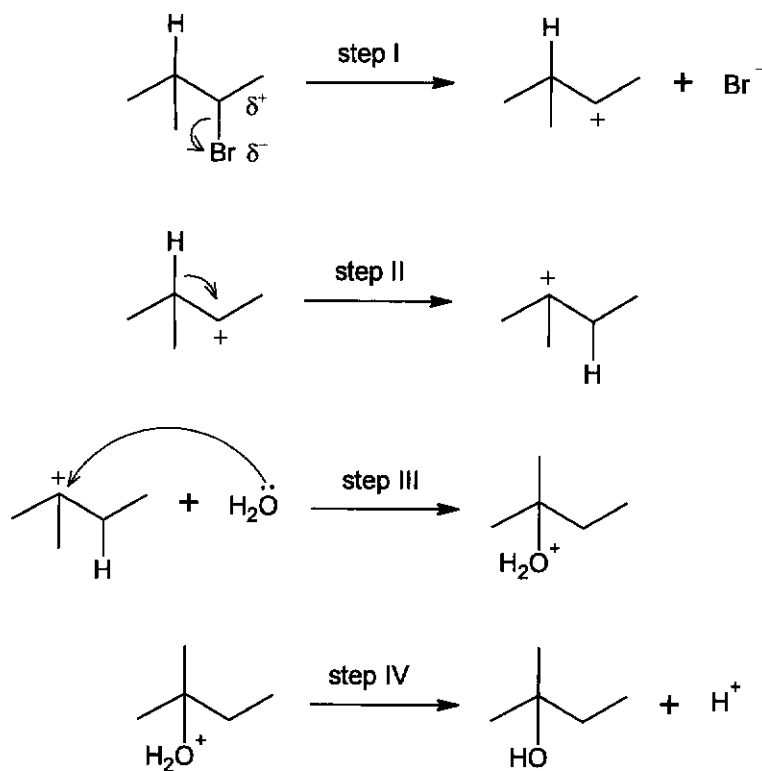
- 1 **P** reacts with  $\text{HBr}(\text{g})$  to form a compound with the formula  $\text{C}_9\text{H}_{15}\text{Br}_3$ .
- 2 **P** is resonance stabilised.
- 3 1 mol of **P** reacts with hot acidified  $\text{KMnO}_4$  to form two mol of  $\text{CO}_2(\text{g})$ .

- A** 1, 2 and 3      **B** 1 and 2 only      **C** 2 and 3 only      **D** 1 only

- 19 The hydrolysis of 2-bromo-3-methylbutane in propan-2-ol forms two products.



The following mechanism has been proposed for the formation of the major product.

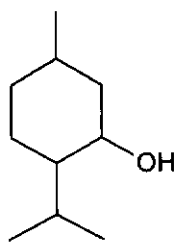


Which statements about the reaction are true?

- 1 The formation of the major product involves the movement of an H<sup>+</sup> ion.
- 2 Step II occurs because the product is more stable than the reactant.
- 3 Step II is faster than step III.

- A** 1, 2 and 3      **B** 1 and 2      **C** 2 and 3      **D** 1 only

- 20 Menthol is a compound found in mint leaves.

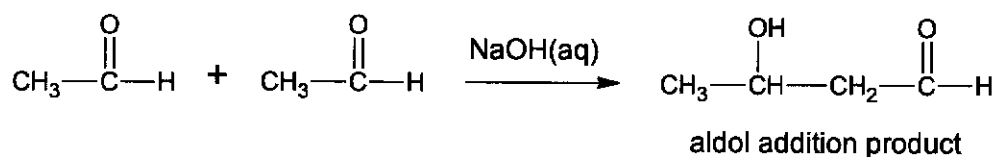


menthol

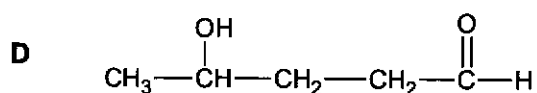
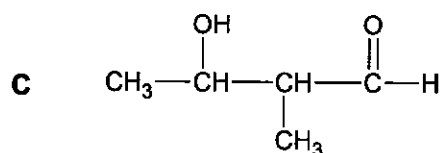
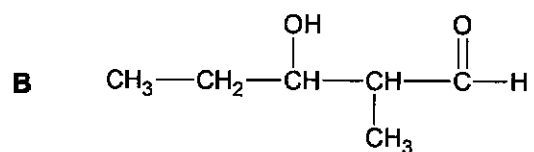
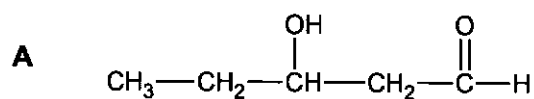
What is the IUPAC name of menthol?

- A 2-(propan-2-yl)-5-methylcyclohexan-1-ol
- B 5-methyl-2-(propan-2-yl)cyclohexan-1-ol
- C 1-(propan-2-yl)-4-methylcyclohexan-2-ol
- D 1-methyl-4-(propan-2-yl)cyclohexan-3-ol

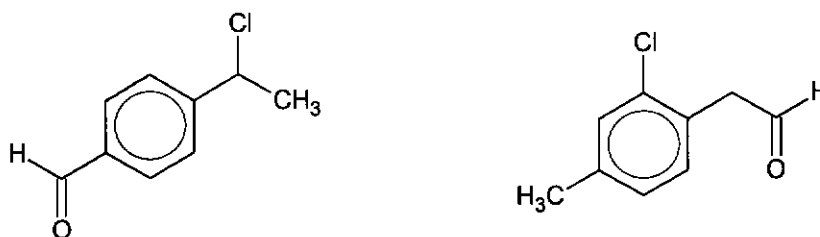
- 21 Aldol addition products are formed when a small amount of NaOH(aq) is added to an aldehyde at room temperature.



Which product is **not** formed when a small amount of NaOH(aq) is added to an equimolar mixture of ethanal and propanal?



22 Four simple tests are carried out on two organic compounds shown.



How many observations can be used to distinguish between them?

- 1 White precipitate formed.
- 2 Yellow precipitate formed.
- 3 Orange precipitate formed.
- 4 Brick-red precipitate formed.

**A** 0                      **B** 1                      **C** 3                      **D** 4

23 Which reaction involves an intermediate that has a planar carbon with three different groups?

- A**  $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3 + \text{HBr}$
- B**  $(\text{CH}_3)_2\text{CBrCH}_2\text{CH}_3 + \text{NH}_3$
- C**  $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}_3 + \text{NaBH}_4$
- D**  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3 + \text{CH}_3\text{COCl}$

24 The  $pK_a$  of some organic compounds are shown.

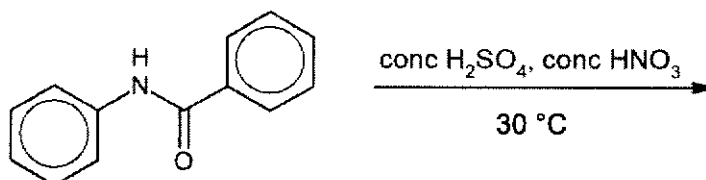
thioacetic acid	ethanoic acid	ethanethiol	ethanol
3.33	4.76	10.6	16.0

Which statement explains the trend in  $pK_a$ ?

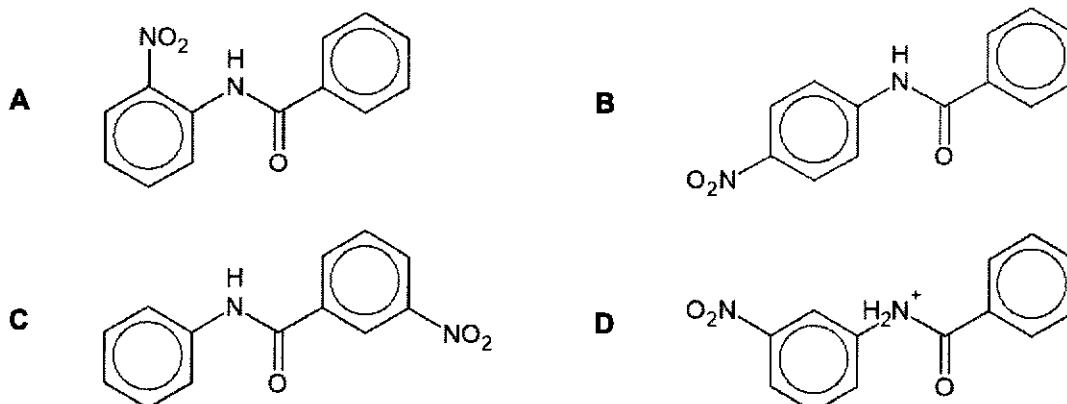
- ( $\text{CH}_3\text{CH}_2^-$ ) is an electron donating group.
- There are delocalised  $\pi$  electrons between the C-S bond in the conjugate base of thioacetic acid.
- The S-H bond is weaker than the O-H bond.

**A** 1, 2 and 3    **B** 1 and 2 only    **C** 2 and 3 only    **D** 1 only

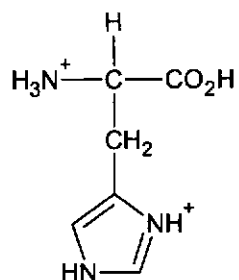
25 N-phenylbenzamide can react with concentrated nitric acid and concentrated sulfuric acid at  $30^\circ\text{C}$



What could be the structure of the main organic product?



- 26 Histidine, an  $\alpha$ -amino acid, exist as a triprotic acid in a strongly acidic solution. The three  $pK_a$  values of the different functional groups present on histidine are  $\alpha$ -carboxyl group = 1.82, side chain = 6.04 and  $\alpha$ -amino group = 9.18.



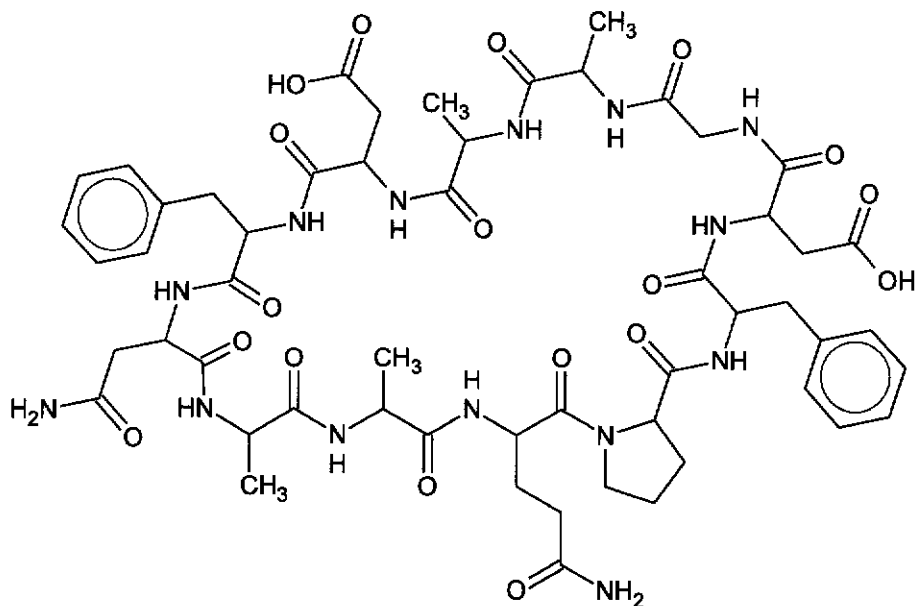
triprotic histidine

Which statement is true?

- A At pH 1.00, a solution of histidine will not rotate plane-polarised light.
- B At pH 5.20, there will be a sharp increase in pH when  $NaOH(aq)$  is added.
- C At pH 7.61, histidine will move neither to the anode nor the cathode in electrophoresis.
- D At pH 13.0, the compound containing histidine will have a low melting point.



- 27 The polypeptide shown below is heated with  $6 \text{ mol dm}^{-3} \text{ HCl(aq)}$  to ensure complete hydrolysis.

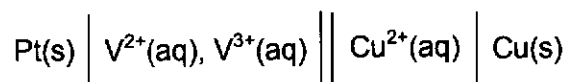


What is the total number of amino acids and the number of unique amino acids obtained from the hydrolysis?

	total number of amino acids	number of unique amino acids
<b>A</b>	11	6
<b>B</b>	11	5
<b>C</b>	12	7
<b>D</b>	12	6

28 *Use of the Data Booklet is relevant to this question.*

The cell notation for a galvanic cell at 25 °C is given.



The  $E^{\ominus}_{\text{cell}}$  for the reaction is +0.60 V.

Which of the step below will increase the  $E_{\text{cell}}$  for the reaction?

- A Increase  $[\text{V}^{3+}(\text{aq})]$
- B Decrease  $[\text{V}^{2+}(\text{aq})]$
- C Increase  $[\text{Cu}^{2+}(\text{aq})]$
- D Decrease the size of the Cu electrode

29 *Use of the Data Booklet is relevant to this question.*

An electrolytic cell is set up as follows

- Platinum cathode
- Platinum anode
- Electrolyte of  $2 \text{ mol dm}^{-3} \text{ Na}_2\text{SO}_4(\text{aq})$

A current of 0.8 A is passed through the cell for 81 minutes.

Which statements regarding the electrolytic cell are correct?

- 1 At room temperature pressure,  $242 \text{ cm}^3$  of gas is produced at the anode.
- 2 When a small sample of solution is collected at the cathode and universal indicator added, the colour turns blue.
- 3 A voltage larger than +2.06 V is required to run the electrolytic cell.

- A 1, 2 and 3    B 1 and 2 only    C 2 and 3 only    D 1 only

- 30 Two chromium(III) complexes, **J** and **K**, both with the formula,  $\text{CrH}_{15}\text{N}_5\text{SClO}_4$ , are dissolved separately in deionised water. Neither has water ligands present in their complex.

The table shows some similarities and differences between **J(aq)** and **K(aq)**.

	<b>J(aq)</b>	<b>K(aq)</b>
number of different types of ligand in complex ion	2	2
observation on addition of nitric acid followed by aqueous silver nitrate	white precipitate is seen	no observable change
observation on addition of nitric acid followed by aqueous barium nitrate	no observable change	white precipitate is seen

Which statements are correct?

- 1 The complex ion in **J(aq)** is  $[\text{Cr}(\text{NH}_3)_5(\text{SO}_4)]^+$ .
- 2 The complex ion in **K(aq)** is  $[\text{Cr}(\text{NH}_3)_5\text{Cl}]^+$ .
- A** both 1 and 2    **B** 1 only    **C** 2 only    **D** neither 1 nor 2



**Nanyang JC J2 Preliminary Examinations 2024**  
**H2 Chemistry 9729/01**  
**Paper 1 MCQ Answers and Comments**

Ans	Ans	Ans	Ans	Ans
D	B	D	D	C
B	D	C	C	D
D	C	C	A	C
A	A	D	A	A
D	B	B	B	B

A: 7  
 B: 7  
 C: 7  
 D: 9

1 D mod N22P1Q6

4. of deflection,  $\theta = k \times \frac{\text{charge}}{\text{mass}}$

(NB: Elements V and W are not their usual symbol in the Periodic Table.)  
 Both Ca and V form cations with +2 charge. Hence, since  $\theta(\text{Ca}^{2+}) > \theta(\text{V}^{2+})$ ,  $\Rightarrow A_1(\text{Ca}) < A_1(\text{V})$ , V must be below Ca in Group 2.

Therefore element V is Sr and W is either Rb or Y.

From  $\text{Ca}^{2+}$ , we can determine a value for k.  
 $k = 240$  (or 240.6 using  $A_1$ )

Using k, we can calculate the  $\frac{\text{charge}}{\text{mass}}$  ratio for W,  $\frac{\text{charge}}{\text{mass}}(\text{W}) = 0.0337$

Lastly, compare the  $\frac{\text{charge}}{\text{mass}}$  ratio calculated against those of  $\text{Rb}^+$  and  $\text{Y}^{3+}$ ,  
 $\frac{\text{charge}}{\text{mass}}(\text{Rb}^+) = 0.0117$  and  $\frac{\text{charge}}{\text{mass}}(\text{Y}^{3+}) = 0.0337$ ,  
 we can deduce the identity of element W as Yttrium (proton number 39).

2 B mod NY20 Promo P1Q3

Deduce the group number of elements G and H by looking at the largest jump in IEs.

G: largest jump at 4th IE; 4th electron is removed from inner shell, 3 valence electrons, G is Group 3.

H: largest jump at 7th IE; 7th electron is removed from inner shell, 6 valence electrons, H is Group 16.

From the Data Booklet, we can conclude

- G is likely to be Al
- H is an element below S in Group 16. (1st IE of H < 1st IE of S. Down the group, 1st IE decrease.)

H: [noble gas]  $ns^2 np_x^2 np_y^1 np_z^1$   
 Statement 1 is correct. There is only one p orbital with paired electrons in H.

G is Period 3, H is at least Period 4.  
 Statement 2 is correct. H has a larger nuclear charge than G.

The factors that affect IE are  
 i) nuclear charge (IE increase with increasing nuclear charge)  
 ii) shielding effect (IE decrease with increasing shielding effect)  
 iii) distance from nucleus (IE decrease with increasing distance from nucleus)

Hence the only factor that can explain why the 3rd IE of H is larger than 3rd IE of G is the nuclear charge.

H is below S in Group 16 as the 1st IE of H (940) is smaller than the 1st IE of S (1000). However, as we do not have the IEs of Group 16 elements below S, we cannot positively identify which of Se, Te or Po is H. Hence statement 3 cannot be deduced from the data. (FYI, H is Se)

(For H, we can eliminate Group 6 as 1st IE of Cr is < 940 kJ mol<sup>-1</sup>. Elements below Cr in Group 6 will also have 1st IE < 940.)

3 D

To deduce bond angles fast in MCQs, use the following shortcut.

The number of bond pairs around the central atom is given by the number of non-central atoms in the formula

- To determine the number of lone pairs, give the charge to the central atom. Hence if charge is -, give one electron to central atom. If charge is +, take one electron away from central atom. Next, subtract the valence electrons of the central atom that are used to bond to each non-central O (need 2 electrons each) or X (need 1 electron each). Lastly pair the remaining electrons around the central atom to obtain the number of lone pairs.

A)	BP-LP	NO <sub>3</sub> <sup>-</sup>	BeCl <sub>2</sub>
	bond angle	3 - 0	2 - 0
		120°	< 180°
B)	BP-LP	BrO <sub>3</sub> <sup>-</sup>	PCl <sub>4</sub> <sup>+</sup>
	bond angle	3 - 1	4 - 0
		107°	< 109°
C)	BP-LP	AsF <sub>6</sub> <sup>-</sup>	XeF <sub>4</sub>
	bond angle	6 - 0	4 - 2
		90°	= 90°
D)	BP-LP	SO <sub>2</sub>	SO <sub>4</sub> <sup>2-</sup>
	bond angle	2 - 1	4 - 0
		118°	> 109°

4 A mod N21P1Q5

Shapes of hybrid orbitals

sp	sp <sup>2</sup>	sp <sup>3</sup>
50% s character, more spherical	75% p character, more elongated	75% p character, more elongated
shortest bond length	longest bond length	weakest bond
strongest bond		

5 D

In explaining solubility, we compare

- Energy required to break bonds between solute particles and bonds between solvent particles
- Energy evolved when bonds are formed between solute and solvent particles

The strongest bond required to be broken is the hydrogen-bonding between water molecules.

The most extensive/dominant bonds formed between water and hexanol molecules (due to the long alkyl chain of hexanol) is the instantaneous dipole - induced dipole interactions between hexanol alkyl chains and water molecules.

Therefore, water and hexanol do not mixed because the energy evolved when hydrogen bonds formed between water and hexanol is not sufficient to compensate for the energy required to break hydrogen bonding in water molecules.

6 B

A. Na<sub>2</sub>O(s) dissolve in water to form NaOH(aq). Since dilute NaOH(aq) is not saturated, Na<sub>2</sub>O can still dissolve.

B. MgO is an ionic oxide that is basic. It will not react with alkaline NaOH(aq). MgO is also insoluble, giving only a weakly alkaline solution of pH 9 with water.

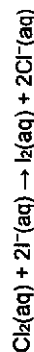
C. Al<sub>2</sub>O<sub>3</sub> is an ionic oxide with high covalent character. It is amphoteric and will dissolve in NaOH(aq) to form a soluble complex NaAl(OH)<sub>4</sub>.

D. P<sub>4</sub>O<sub>10</sub> is a covalent oxide that is acidic. It reacts with NaOH(aq) to form a soluble salt Na<sub>3</sub>PO<sub>4</sub>(aq).

7 D

Down Group 2, cationic radius increase while cationic charge is constant. Charge density increases, polarising power becomes stronger. CO<sub>3</sub><sup>2-</sup> electron cloud is less polarised. C-O bond in CO<sub>3</sub><sup>2-</sup> is weakened to a smaller extent, more energy is required to break the C-O bond. Thermal decomposition temperature increase.

8 C



Cl<sub>2</sub>, stronger oxidising agent, will oxidise I<sup>-</sup> to iodine.

l<sub>2</sub>(aq) T l<sub>2</sub>(aq) (2)

brown purple

A. False. I<sub>2</sub> is purple in non-polar organic hexane solvent.

B. False. I<sub>2</sub> is a non-polar molecule with very low solubility in water. The equilibrium(2) lies almost completely to the product side.

C. Correct. Down Group 17, incoming electron added to valence shell further away from nucleus. Hence attraction of Cl nucleus to incoming electron is stronger.

D. False. I<sup>-</sup> is a stronger reducing agent since its valence electrons are less readily attracted to the nucleus.

9 A

amt/(mol)	0.008	0.0319
OA:RA ratio	1	4
Zn : e <sup>-</sup>	2	1
LCM Zn	1	8
		4

Change in OS = Final OS - Initial OS

-8 = Final OS - (+7)

Final OS = -1

10 C

A is wrong. 2 mol of water is formed in the equation.

B is correct. Both Na(s) and O<sub>2</sub>(g) are in their elemental states.

C is wrong. ΔH<sub>hyd</sub> is for gas ion to aq ion.

D is wrong. Equation given is -LE. LE is defined for ionic solid formed from constituent ions.

11 B mod N21P1Q11

ΔS < 0 as there are less number of gas particles in the product. Less ways of arranging gas particles in system. Entropy of product decrease.

Using ΔG = ΔH - TΔS, as T↓, |TΔS| < |ΔH| such that ΔG becomes more negative. Hence reaction is more spontaneous when temperature decrease.

12 D

2024 NYJC H2 Chem P1 (Ans)

Use the equation,

$$[Rn]_t = [Rn]_0 \times (\frac{1}{2})^{nt}$$

[Rn]<sub>0</sub> = initial conc, [Rn]<sub>t</sub> = conc at any point in time, n = number of half-lives.

$$0.4 = 15 \times (\frac{1}{2})^n$$

$$n = 5.228$$

$$\text{time taken} = 5.228 \times 3.82$$

$$= 19.97 \text{ days}$$

13 C

1 is wrong. Use of a catalyst does not affect relative rates of forward and backward reactions. Both rates increase to the same extent. No change in position of equilibrium.

2 is correct. A medium high temperature of 500 °C (774 K) is used. Low temperature of 227 °C (500 K), although favouring the forward exothermic reaction to produce heat, results in a low rate of reaction, hence are not used.

3 is correct. A high pressure of 2.03 x 10<sup>7</sup> Pa (200 atm) is used to shift the eqm position to the right by reducing total number of gas particles.

14 D

Analysis of the graph shows:

- V<sub>NaOH</sub> required to reached second equivalence volume is larger than V<sub>NaOH</sub> required for first equivalence volume.

⇒ Initial solution is already a buffer solution containing both HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub>H and HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub><sup>-</sup>.

If initial solution contains only HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub>H V<sub>NaOH</sub> required for each step of the neutralisation would be the same.

- V<sub>NaOH</sub> required for 1st neutralisation (HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub>H + OH<sup>-</sup> → HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub><sup>-</sup> + H<sub>2</sub>O) = 10 cm<sup>3</sup>

V<sub>NaOH</sub> required for 2nd neutralisation (HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub><sup>-</sup> + OH<sup>-</sup> → O<sup>2-</sup>CCH<sub>2</sub>CO<sub>2</sub><sup>2-</sup> + H<sub>2</sub>O) = 34 - 10 = 24 cm<sup>3</sup>

Hence, V<sub>NaOH</sub> required for neutralising only the original HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub><sup>-</sup> = 24 - 10 = 14 cm<sup>3</sup> (>10 cm<sup>3</sup>)

⇒ In the initial solution, [HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub><sup>-</sup>] < [HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub>H]. When [HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub>H] = [HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub><sup>-</sup>], solution is at maximum buffer capacity.

pH = pK<sub>a1</sub> = 2.85.

Therefore, when [HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub><sup>-</sup>] > [HO<sub>2</sub>CCH<sub>2</sub>CO<sub>2</sub>H], pH > pK<sub>a1</sub>. (i.e. we have more of the weak base component, solution is more alkaline than the mid-point) The only answer with pH > 2.85 is 3.00.

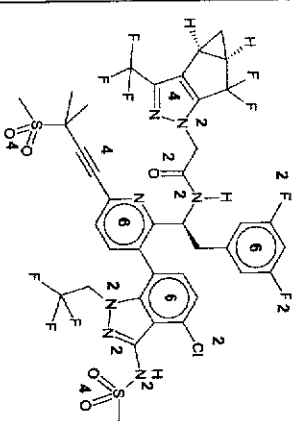
15 A

Let x mol dm<sup>-3</sup> be the solubility of the salt.

A	[CO <sub>3</sub> <sup>2-</sup> ]	$x = \sqrt{3.5 \times 10^{-8}}$ $= 1.87 \times 10^{-4}$
	pH	$14 + \lg \sqrt{2.1 \times 10^{-4} \times 1.87 \times 10^{-4}}$ $= 10.3$
B	[CO <sub>3</sub> <sup>2-</sup> ]	$x = \sqrt{1.8 \times 10^{-11}}$ $= 4.24 \times 10^{-6}$
	pH	$14 + \lg \sqrt{2.1 \times 10^{-4} \times 4.24 \times 10^{-6}}$ $= 9.47$
C	[OH <sup>-</sup> ]	$x = \sqrt{\frac{2.0 \times 10^{-15}}{4}}$ $2x = 1.58 \times 10^{-8}$
	pH	$14 + \lg 1.59 \times 10^{-8}$ $= 9.20$
D	[OH <sup>-</sup> ]	$x = \sqrt{\frac{8.0 \times 10^{-31}}{27}}$ $3x = 3.94 \times 10^{-9}$
	pH	$14 + \lg (1 \times 10^{-7} + 3.94 \times 10^{-9})$ $= 7.14$

16 D

All N and X atoms bonded to sp<sup>2</sup> carbon have a lone pair in a p orbital that overlaps with p orbitals of the sp<sup>2</sup> carbon. The lone pair will be delocalised to form π electrons.



17 C

Stability of alkyl radicals: 3° > 2° > 1°  
More electron donating alkyl groups will increase electron density on the electron deficient C radical.

The four possible product radicals of 2-methylbutane

<chem>CC(C)C(C)C</chem>	1°
<chem>CC(C)C(C)C</chem>	3°
<chem>CC(C)C(C)C</chem>	2°
<chem>CC(C)C(C)C</chem>	1°

18 C



N undergoes elimination with NaOH, ethanol, heat to form a benzene ring in P that does not decolourise Br<sub>2</sub>(aq).

Statement 1 is wrong as benzene ring in P does not undergo electrophilic addition in order to maintain the resonance stabilization energy of the conjugated  $6\pi$  electrons system.

Statement 2 is correct.

Statement 3 is correct. P undergoes aryl sidechain oxidation to produce 2 mol of  $\text{CO}_2$ .



19 A

Statement 1 is correct. An H with its bond pair constitute a  $\text{H}^-$  ion.

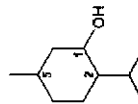
Statement 2 is correct. The product is a  $3^\circ$  carbocation that is more stable than the  $2^\circ$  carbocation reactant. More electron donating alkyl groups bonded to the  $\text{C}^+$  will increase electron density and disperse the positive charge.

Statement 3 is correct. Step 2 must be faster than step 3. If step 2 is slower, the  $2^\circ$  carbocation product of step 1 will react with water in a reaction similar to step 3 to form the minor product. However, the major product in this reaction was formed from the reaction of step 2, implying that the carbocation product of step 1 immediately undergo  $\text{H}^-$  rearrangement (step 2) before water can react with the carbocation (step 3).

20 B

There are two IUPAC rules tested for.

- The parent functional group is always assigned the smallest number in the carbon chain.
- Alkyl substituents are written in alphabetical order.

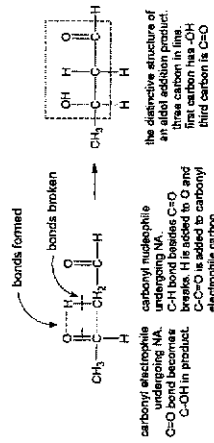


Carbon with  $-\text{OH}$  is assigned as carbon 1. 5-methyl is written before 2-(propan-2-yl).

21 D mod N22P2Q5civ

In nucleophilic addition (NA) reactions, a neutral nucleophile  $\text{H}-\text{Nu}$  is added across the  $\text{C}=\text{O}$  double bond.

The diagram below shows how to identify the product of an aldol addition (NA).



A	
B	
C	
D	

22 C

<p><math>\text{AgNO}_3</math>, ethanol, heat</p>		<p>white ppt</p>
		<p>no white ppt</p>

Hence  $\text{CH}_3\text{CH}_2\text{SH}$  is a stronger acid than  $\text{CH}_3\text{CH}_2\text{OH}$ .

25 B

From Data Booklet,

<p>G</p> <p>Reactivity of rings (compared to benzene)</p> <p>Position of E (relative to position of G)</p>	<p><math>-\text{OH}</math>, <math>-\text{OR}</math>, <math>-\text{NH}_2</math>, <math>-\text{NHR}</math> or <math>-\text{NR}_2</math>, <math>-\text{NHCOOR}</math></p>	<p><math>-\text{Cl}</math>, <math>-\text{Br}</math>, <math>-\text{I}</math></p>
	<p>Activated</p>	<p>Deactivated</p>
	<p>2- and/or 4-</p>	<p>2- and/or 4-</p>

$-\text{COO}^-$  is an electron donating group that is 2,4-directing. The four isomer, B, is formed at higher yield. An attacking electrophile at the 2-position faces stronger steric hindrance, hence electrophile attacking at 4-position forms the major product.

C is wrong as  $-\text{ONH}_2$  is an electron withdrawing group that will deactivate the ring towards electrophilic attack. D is wrong as an amide functional group is not basic.

26 C

Dominant forms of histidine at respective pH is shown.

<p>A</p> <p>pH 1.00</p>	<p>B</p> <p>pH 5.20</p>
<p>The <math>\alpha</math>-carbon bonded to <math>\text{COOH}</math> is bonded to four different group, hence it is chiral.</p>	<p>When <math>\text{OH}^-</math> is added, it will react with and be removed by the structure shown above. pH will remain relatively constant</p>

<p><math>\text{NaOH(aq)}</math>, heat</p>		<p>no yellow ppt</p>
<p><math>\text{I}_2(\text{aq})</math>, heat</p>		<p>yellow ppt</p>
<p>2,4-DNPH</p>		<p>orange ppt</p>
<p>Fehlings solution, heat</p>		<p>no brick-red ppt</p>
		<p>orange ppt</p>
		<p>brick-red ppt</p>

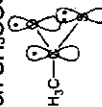
23 A

A		<p>trigonal planar</p>
B		<p>trigonal planar</p>
C		<p>tetrahedral</p>
D		<p>tetrahedral</p>

24 A mod N22P1Q3

Statement 1 is correct.  $\text{CH}_3\text{CH}_2\text{O}^-$  is an electron donating group that increase the electron density on the  $-\text{O}^-$ , intensifying the negative, hence  $\text{CH}_3\text{CH}_2\text{O}^-$  is not stable. Hence  $\text{CH}_3\text{CH}_2\text{OH}$  is not acidic.

Statement 2 is correct. In  $\text{CH}_3\text{COS}^-$ , S is  $\text{sp}^2$  hybridised with a lone pair in p orbital overlapping with p orbitals of  $\text{C}=\text{O}$ . Hence, negative charge on  $\text{CH}_3\text{COS}^-$  is dispersed.



Statement 3 is correct.  $\text{S}-\text{H}$  bond is weaker than  $\text{O}-\text{H}$ , less energy required to break.

