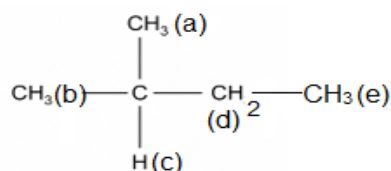


CHEMISTRY
PAPER I

For each question, there are **FOUR** responses: **A, B, C** and **D**. Choose the corresponding letter of your response and **CIRCLE** it. If you change your answer, cross out the previous response clearly and circle your new answer. **NO** score will be awarded if you circle more than **ONE** letter.

1. Compound X is analysed using proton (^1H) NMR spectroscopy.
Compound X



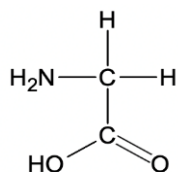
Which pair of hydrogen atoms would produce the same NMR signals?

- A a and b
B b and c
C c and d
D d and e
2. Four properties of distilled water are measured before and after dissolving sodium chloride. Which combination correctly describes the changes after dissolving sodium chloride?

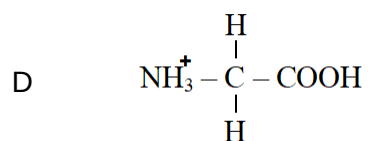
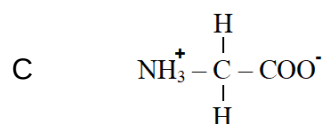
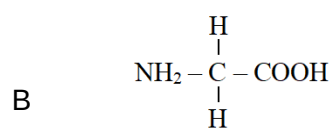
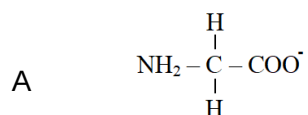
	Vapour pressure	Boiling point	Freezing point	Osmotic pressure
A	increases	decreases	increases	decreases
B	decreases	decreases	increases	increases
C	increases	increases	decreases	decreases
D	decreases	increases	decreases	increases

3. Identify the property of a molecule that produces a high R_f value in thin-layer chromatography.
- A It is weakly adsorbed by the stationary phase and is readily carried by the mobile phase.
B It remains at the initial spot because it is insoluble in the mobile phase.
C It is strongly adsorbed by the stationary phase and moves slowly.
D It has high polarity and hence always has a high R_f value.

4. A student analyses the behaviour of the amino acid glycine using electrophoresis.



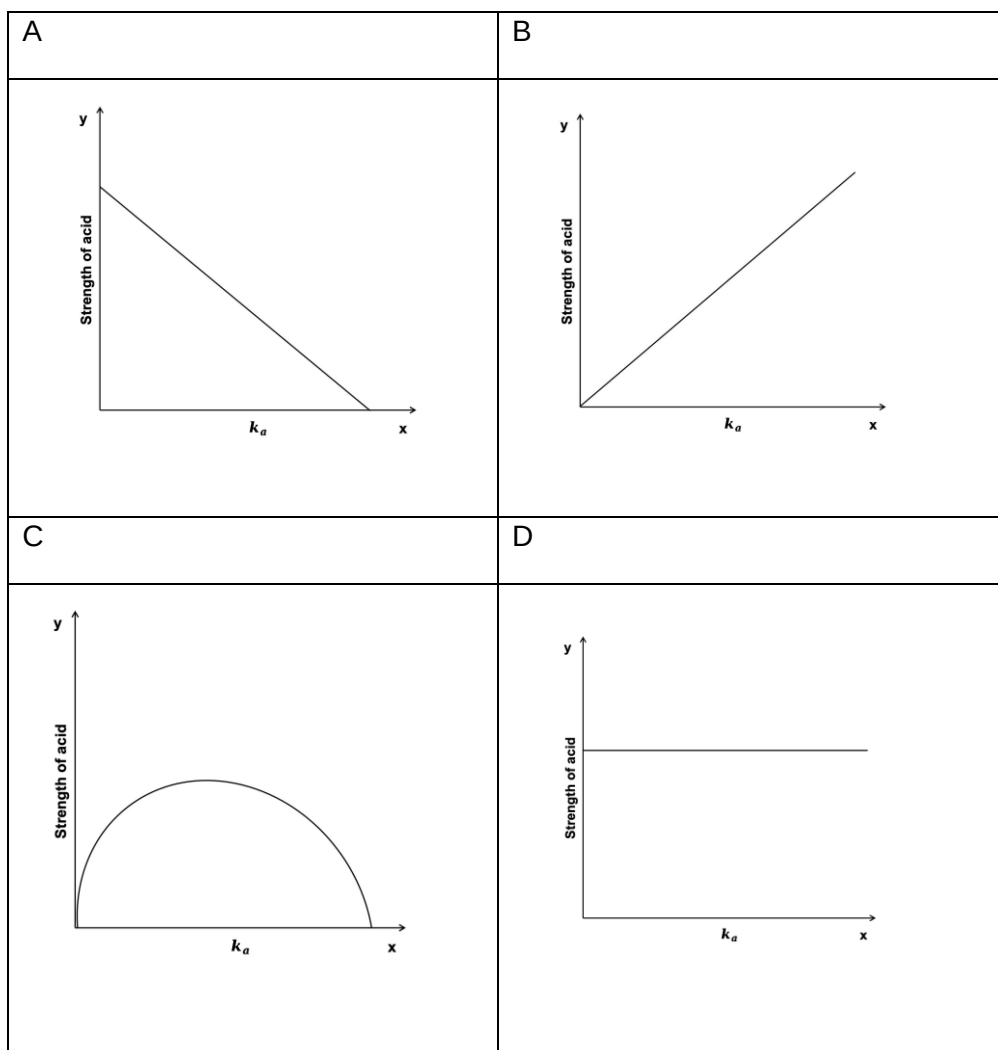
Determine the charge on glycine when the pH of its solution is greater than its isoelectric point.



5. Calculate the oxidation number of Mn in KMnO_4 .

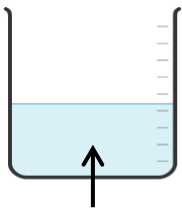
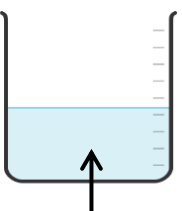
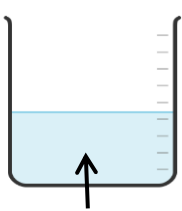
- A +3
B +5
C +7
D +9

6. Which graph best represents the qualitative relationship between K_a and acid strength.



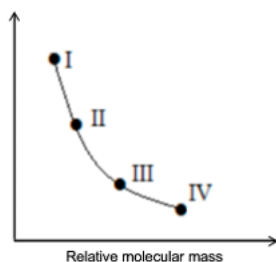
7. According to collision theory, which statement best explains why increasing pressure increases the rate of a reaction between gases?
- A Increasing pressure reduces the volume the gas particles occupy, so particles are packed closer together, increasing the frequency of collisions between reactant particles.
 - B Increasing pressure gives gas particles more kinetic energy, so collisions become less frequent but more energetic.
 - C Increasing pressure lowers the activation energy of the reaction, so a greater proportion of collisions result in a reaction.
 - D Increasing pressure decreases the size of individual gas particles, allowing more collisions to occur per second.

8. Figure shows the preparation of three different solutions that are at same temperature and behave ideally.

Solution X	Solution Y	Solution Z
 0.01 mol dm⁻³ of glucose	 0.01 mol dm⁻³ of sodium chloride	 0.01 mol dm⁻³ of calcium chloride

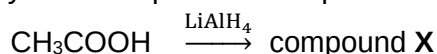
Which arrangement shows the increasing order of osmotic pressure?

- A (smallest) Y < X < Z (largest)
 B (smallest) Z < Y < X (largest)
 C (smallest) X < Y < Z (largest)
 D (smallest) X < Z < Y (largest)
9. Figure shows how a physical property of four carboxylic acids (I-IV) varies with relative molecular mass, at constant temperature.



- A Solubility
 B Boiling point
 C Melting point
 D Strength of van der Waals forces

10. Ethanoic acid is reduced by LiAlH_4 to produce compound X



What is the name of compound X?

- A methanal
 - B methanol
 - C propanal
 - D ethanol
11. why is propanone widely used in the cosmetic industry?
- A It is used to strengthen glass container.
 - B It is a good solvent that evaporates easily.
 - C It acts as a fertilizer for plant extracts.
 - D It reacts with oils to produce soap.
12. An unknown organic compound Y with molecular formula $\text{C}_4\text{H}_{10}\text{O}$ on investigation gave the following observations.

Test	Observation
Tollens' reagent	No visible change
Iodoform test	Yellow precipitate formed
Acidified potassium dichromate(VI)	Orange solution turned green

- A butanal
 - B butan-1-ol
 - C butan-2-one
 - D butan-2-ol
13. A transition metal ion M^{3+} reacts with excess ethanedioate ions, $\text{C}_2\text{O}_4^{2-}$, to form a complex with coordination number 6. The transition metal is not oxidized or reduced in this reaction.

Which ion represents the complex ion formed?

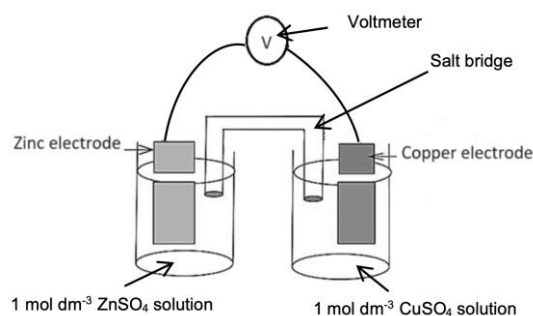
- A $[\text{M}(\text{C}_2\text{O}_4)_2]^-$
- B $[\text{M}(\text{C}_2\text{O}_4)_3]^{3-}$
- C $[\text{M}(\text{C}_2\text{O}_4)_3]^{3+}$
- D $[\text{M}(\text{C}_2\text{O}_4)_6]^{9-}$

14. A solution is prepared by dissolving 3.5 g of a non-volatile solute in 125 g of pure water. The boiling point of pure water is 100° C. The solution boils at 373.52 K.

K_b for water = 0.512 K Kg mol⁻¹

What is the relative molecular mass of the solute?

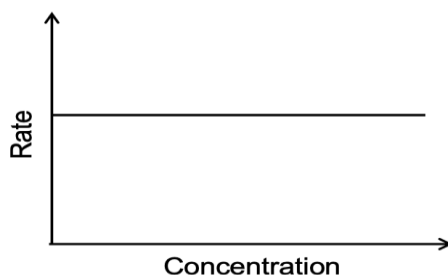
- A 18
B 28
C 46
D 64
15. Why is the carbon atom in the carbonyl group of an aldehyde susceptible to attack by nucleophiles?
- A The carbon atom has a partial negative charge (δ^-).
B The oxygen atom has a partial positive charge (δ^+).
C The carbon atom has a partial positive charge (δ^+).
D The oxygen atom is electron deficient.
16. A galvanic cell is set up as shown in Figure.



Which statement is correct?

- A The salt bridge contains solutions of ZnSO₄ and CuSO₄.
B Both zinc and copper electrodes gain mass during the reaction
C Electric current in the external circuit is generated by the flow of ions.
D Electric current in the external circuit is generated by the flow of electrons.
17. Which pair of reactants is required to prepare propyl ethanoate?
- A propanoic acid and ethanol
B methanoic acid and propanol
C ethanoic acid and propanol
D ethanol and propanol

18. Two separate experiments are run to determine the rate for the reaction $2R + 2Q \rightarrow P$. In the first, $[R]$ is varied while $[Q]$ is held constant. In the second, $[Q]$ is varied while $[R]$ is held constant. The rate is unaffected by either change, as shown below.



What is the rate for this reaction?

- A $\text{Rate} = k$
 - B $\text{Rate} = k[R][Q]$
 - C $\text{Rate} = k[R]^2[Q]$
 - D $\text{Rate} = k[R][Q]^2$
19. Which statement explains why amides are less basic than amines?
- A The C=O bond in amides is highly polar, which repels incoming protons.
 - B Amides have a large molecular mass, which reduces their solubility in water.
 - C Amides contain a carbonyl oxygen that ionises in water to release hydroxide ions.
 - D Lone pair of electrons on nitrogen in amides is delocalised into the carbonyl group, making it less available to accept a proton.
20. For a reaction to occur, reacting particles must collide. Which statement best describes the collision between reacting particles?
- A A collision is effective if colliding particles have energy equal to or greater than activation energy.
 - B Collisions at lower temperatures are more likely to cause a reaction than those at higher temperature. The reaction rate is independent of the energy of the colliding molecules.
 - C The reaction rate is independent of the energy of the colliding molecules.
 - D All collisions between reactant molecules result in a chemical reaction.

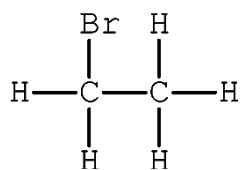
21. The standard electrode potentials for four half-equations are as shown.

half-equation	$E^\ominus / \text{V}$
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$	+0.80
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.34
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.44
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$	-0.76

Using these $E^\ominus$ values, which overall reaction is feasible under standard conditions?

- A $\text{Fe}^{2+}(\text{aq}) + \text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + \text{Fe}(\text{s})$
- B $\text{Cu}^{2+}(\text{aq}) + 2\text{Ag}(\text{s}) \rightarrow 2\text{Ag}^+(\text{aq}) + \text{Cu}(\text{s})$
- C $2\text{Ag}^+(\text{aq}) + \text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{Ag}(\text{s})$
- D $\text{Zn}^{2+}(\text{aq}) + 2\text{Ag}(\text{s}) \rightarrow 2\text{Ag}^+(\text{aq}) + \text{Zn}(\text{s})$
22. Why are transition elements commonly used as catalysts?
- A They have high melting points, giving them the thermal stability needed at high reaction temperatures.
- B They have large atomic radii, which provide a large surface area for reactant molecules to adsorb onto.
- C They form very stable complexes with reactant molecules, which prevents the reactants from breaking apart.
- D They can exist in variable oxidation states, allowing them to form intermediate compounds with reactants and provide a reaction pathway of lower activation energy.
23. Which measure of concentration is independent of temperature, provided no solute or solvent is lost?
- A Normality.
- B Molarity.
- C Molality.
- D Strength.
24. Which statement is the Brønsted-Lowry definition of an acid?
- A An acid is a proton acceptor.
- B An acid is a proton donor.
- C An acid is an electron pair acceptor.
- D An acid is a substance that produces hydrogen ions in solution.

25. Which row describes the splitting pattern of the protons in this molecule?



	Splitting pattern of protons attached to C of $-\text{CH}_2\text{Br}$	Splitting pattern of protons attached to C of $-\text{CH}_3$
A	Quartet	Triplet
B	Triplet	Quartet
C	Doublet	Triplet
D	Triplet	Doublet

26. Table shows standard reduction electrode potential of three metals.

Metal	$E^\ominus/\text{V}$
X	-2.38 V
Y	-1.05 V
Z	+0.34 V

Deduce the increasing order of their reducing power.

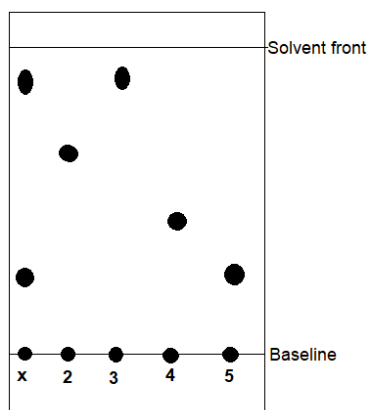
- A (smallest) $\text{Y} < \text{Z} < \text{X}$ (largest)
 B (smallest) $\text{X} < \text{Y} < \text{Z}$ (largest)
 C (smallest) $\text{Z} < \text{X} < \text{Y}$ (largest)
 D (smallest) $\text{Z} < \text{Y} < \text{X}$ (largest)
27. The experimental record for a reaction $2\text{X} \rightarrow \text{Y}$ is given below.

Initial concentration of X (mol dm^{-3})	Final concentration of X (mol dm^{-3})	Time taken
0.50 M	0.38 M	10 minutes

What is the average rate of reaction, taking into account the stoichiometric coefficient of X, during this interval?

- A $1 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}$
 B $2 \times 10^{-4} \text{ mol dm}^{-3} \text{ s}^{-1}$
 C $1 \times 10^{-2} \text{ mol dm}^{-3} \text{ s}^{-1}$
 D $2 \times 10^{-2} \text{ mol dm}^{-3} \text{ s}^{-1}$

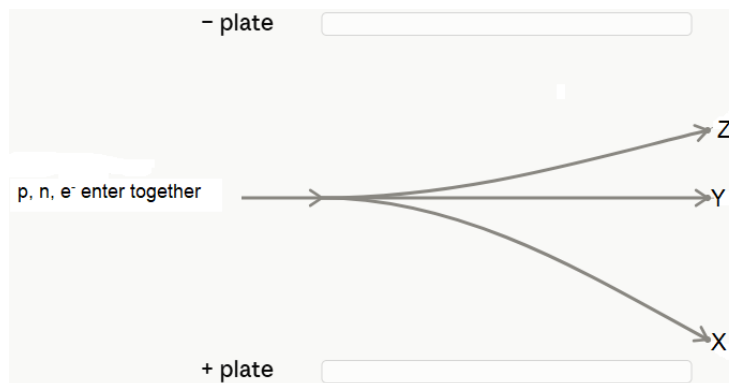
28. A student adds 50 cm³ of pure water to 200 cm³ of an aqueous ethanoic acid solution. Which change occurs as the solution is diluted?
- A The strength of acid decreases.
B The pH of the solution increases.
C The concentration of acid increases.
D The concentration of hydrogen ions increases.
29. Mixture **X** consisting of food colorants was analysed against four colours marked as 2, 3, 4 and 5 on a thin layer chromatography (TLC) plate. The following chromatogram was obtained after the analysis as shown in the Figure.



- Which food colorants are present in mixture **X**?
- A 2 only
B 4 only
C 2 and 4
D 3 and 5
30. Ethyl ethanamide is prepared by reacting ethylamine with ethanoyl chloride as shown
$$\text{CH}_3\text{CH}_2\text{NH}_2 + \text{CH}_3\text{COCl} \rightarrow \text{CH}_3\text{CONHCH}_2\text{CH}_3 + \text{HCl}$$

What are the roles of using excess ethylamine in this reaction?
- I. Prevents protonation of ethylamine.
II. Prevents hydrolysis of ethanoyl chloride.
III. Removes hydrogen chloride formed in the reaction.
IV. Maintains the reaction temperature.
- A I and II
B I and III
C II and IV
D III and V

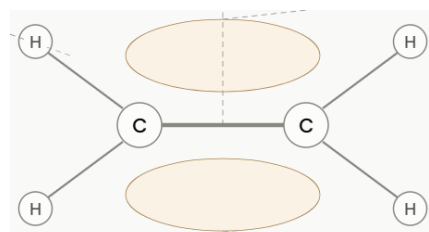
31. A proton, a neutron and an electron enter a uniform electric field together, travelling at right angles to the field, as shown in the figure. Each particle follows one of the paths X, Y or Z.



Which row correctly matches each particle to its path?

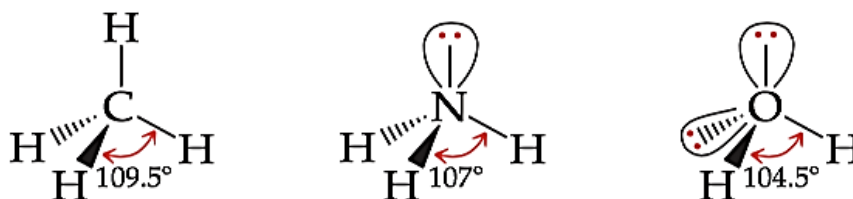
	Proton	Neutron	Electron
A	X	Y	Z
B	Z	Y	X
C	Y	Z	X
D	Y	X	Z

32. X^{2+} and Y^{-} are ions formed from elements with atomic numbers 20 and 17 respectively. Which statement about these ions is correct?
- A X^{2+} has more electrons than Y^{-} .
- B Y^{-} has more protons than X^{2+} .
- C Both ions have the same number of protons.
- D Both ions have the same number of electrons.
33. The figure shows the bonding in ethene. Which statement correctly describes the hybridisation of carbon atoms and bonding present in ethene, C_2H_4 ?



- A Each carbon atom is sp hybridised and forms two sigma bonds and two pi bonds.
- B Each carbon atom is sp^2 hybridised and forms three sigma bonds and one pi bond.
- C Each carbon is sp^2 hybridised and forms two sigma bonds and one pi bond.
- D Each carbon atom is sp^3 hybridised and forms four sigma bonds only.

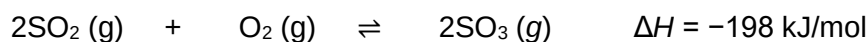
34. What conclusion can be drawn from Figure about the effect of lone pairs on bond angles?



- A Lone pairs and bonding pairs have the same effect on bond angles.
 B Lone pairs increase bond angles compared with expected value.
 C Increasing the number of lone pairs causes greater distortion of bond angles.
 D Lone pairs have no effect on the bond angles of the molecules.
35. At 298 K, which process is spontaneous under the conditions given?

	Process	$\Delta H/\text{kJ mol}^{-1}$	$\Delta S/\text{J K}^{-1} \text{mol}^{-1}$
A	Dissolution of NaCl(s) in H_2O	+ 3.9	+ 10.0
B	Compression of a gas	+ 2.0	- 15.0
C	Free expansion of a gas	0	+ 25.0
D	Melting of ice	+ 6.0	+ 22.0

36. Consider the following equilibrium system



Which change will increase the yield of SO_3 ?

- A Increasing the temperature
 B Increasing the concentration of O_2
 C Decreasing the pressure
 D Adding a catalyst
37. An unknown alkene X with molecular formula, C_6H_{12} , is subjected to oxidation with hot, concentrated acidified KMnO_4 , resulting in the formation of the following products:
- Butan-2-one
 - Ethanoic acid
- Which structure represents the original alkene?

- A $\text{CH}_3\text{--CH=CH--CH}_3\text{--CH}_2\text{--CH}_3$
 B $\text{CH}_3\text{--C(CH}_3\text{)=CH--CH}_2\text{--CH}_3$
 C $\text{CH}_3\text{--CH}_2\text{--C(CH}_3\text{)=CH--CH}_3$
 D $\text{CH}_3\text{--CH}_2\text{--CH=CH--CH}_2\text{--CH}_3$

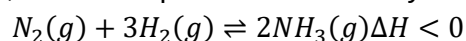
38. Chloroethane can be prepared from ethene or from ethanol. Which row identifies the reagents and conditions for these reactions?

	Preparation from ethene	Preparation from ethanol
A	$Cl_2(g)$, ultraviolet light	$HCl(g)$, heating under reflux
B	$Cl_2(g)$, room temperature	$PCl_3(l)$, room temperature
C	$HCl(g)$, room temperature	$SOCl_2(l)$, room temperature
D	$HCl(g)$, room temperature	$NaCl(aq)$, heating under reflux

39. For a reversible reaction at equilibrium, which change will alter the value of the equilibrium constant?

- A Changing the concentration of reactants
- B Changing the pressure of the system
- C Changing the temperature
- D Adding a catalyst

40. The Haber process for the manufacture of ammonia is carried out at high pressure, moderate temperature, and in the presence of a catalyst:



Which option correctly explains the choice of these conditions?

- A High pressure increases yield; moderate temperature gives a reasonable rate; the catalyst increases rate without changing yield.
- B High pressure increases rate; moderate temperature increases yield; the catalyst shifts equilibrium towards ammonia.
- C Low pressure increases yield; moderate temperature gives a reasonable rate; the catalyst increases yield.
- D High pressure increases yield; high temperature increases yield; the catalyst increases yield.

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