

EUNOIA JUNIOR COLLEGE JC2 Preliminary Examination 2023 General Certificate of Education Advanced Level Higher 2

CHEMISTRY

Paper 1 Multiple Choice

9729/01

21 September 2023 1 hour

Additional Materials: Multiple Choice Answer Sheet Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, civics group and registration number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on 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 question paper.

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

1	D	11	С	21	С
2	С	12	D	22	С
3	А	13	В	23	А
4	В	14	А	24	D
5	В	15	В	25	D
6	D	16	В	26	D
7	С	17	В	27	А
8	A	18	В	28	А
9	A	19	D	29	D

1 A beam of particles contains D^- and ${}^{4}He^{2+}$. All particles approach an electric field at the same speed. (D is deuterium, ${}^{2}H$)



Which row describes the behaviour of the species?

	D-	⁴ He ²⁺	relative extent of deflection
Α	deflect towards (–) plate	deflect towards (+) plate	⁴ He ²⁺ deflected more than D ⁻
в	deflect towards (–) plate	deflect towards (+) plate	⁴ He ²⁺ deflected less than D ⁻
с	deflect towards (+) plate	deflect towards (–) plate	⁴ He ²⁺ deflected more than D ⁻
D	deflect towards (+) plate	deflect towards (–) plate	⁴ He ²⁺ deflected to the same extent as D ⁻

Answer: D

Angle of deflection $\propto \frac{charge}{mass}$

Angle of deflection of D⁻ $\propto \frac{-1}{2}$ Angle of deflection of He²⁺ $\propto \frac{+2}{4}$

Thus, He^{2+} and D^- are deflected to the same extent, but directed towards plate of opposite charge.

2 The melting point of calcium, 839 °C, is much higher than the melting point of sodium, 98 °C.

Which statement is most relevant in explaining this difference?

- Α The calcium atom is larger than the sodium atom.
- В The calcium atom is heavier than the sodium atom.
- С The calcium ion, Ca²⁺, has a higher charge than the sodium ion, Na⁺.
- D The calcium ion, Ca²⁺, contains more electrons than the sodium ion, Na⁺.

Answer: C

Calcium and sodium are metals. Their melting points depend on the strength of their metallic bonds.

Strength of metallic bonds depend on:

- •
- charge of metal ion size of metal ion

 \Rightarrow stronger attraction for delocalised electrons.)

- no. of valence electrons which can be delocalised (more delocalised electrons \Rightarrow greater attraction between metal cations and delocalised *electrons*)
- 3 For a fixed mass of an ideal gas, which of the following graphs does **not** have the same general shape as the rest?

(ρ = density of the gas; *M* = molar mass of gas; *T* = temperature in Kelvin)

A *pV* against $\frac{M}{T}$ **B** p against ρT **C** $\frac{p}{\rho}$ against *T* **D** $\frac{T}{p}$ against V

Since
$$n = \frac{m}{M}$$
,
Answer: A $pV = \frac{m}{M}RT$
 $pM = \frac{m}{V}RT = \rho RT$

Option A	Option B
Since $pM = \frac{m}{V}RT$,	Since $pM = \rho RT$, $R = \rho T T$,
$pV = R \frac{T}{M} \rightarrow pV = k \frac{T}{M}$	$\rho = \frac{1}{M} \rho T - \rho = \kappa \rho T (y = mx)$ Hence, $P \alpha \rho T$ (Graph is an increasing
hence, PV is inversely proportionate to $\frac{M}{T}$	straight line passing through origin)
(Graph of pV against $\frac{M}{T}$ will be a hyperbola	
graph, i.e., y = 1/x graph)	
Option C	Option D
Since $pM = \rho RT$,	Since $pM = {}^{M}PT$
P R - P	Since $pin = \frac{1}{V}RT$,
$\frac{1}{\rho} = \frac{1}{M} T \rightarrow \frac{1}{\rho} = kT (y = mx)$	$\frac{T}{p} = \frac{M}{mR} \lor \Rightarrow \frac{T}{p} = k \lor (y = mx)$
Hence, $\frac{P}{\rho} \propto T$ (Graph is an increasing	Hence, $\frac{T}{R} \propto V$ (Graph is an increasing
straight line passing through origin)	r straight line passing through origin)

4 The ammonia molecule can react in various ways: as an acid, as a base, as a nucleophile, as an oxidising agent and as a reducing agent.

In which of the following reactions is ammonia reacting as a Brønsted-Lowry acid?

- **A** $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$
- $\textbf{B} \quad NH_3 \ \textbf{+} \ NaH \ \rightarrow \ NaNH_2 \ \textbf{+} \ H_2$
- $\textbf{C} \quad NH_3 \ \textbf{+} \ HNO_2 \ \rightarrow \ N_2 \ \textbf{+} \ 2H_2O$
- $\textbf{D} \quad 2NH_3 \ + \ NaOCl \rightarrow \ N_2H_4 \ + \ NaCl \ + \ H_2O$

Answer: B

A: Brønsted-Lowry Base since NH₃ accepts H⁺ from H₂O to form NH₄⁺ and OH⁻.

B: Brønsted-Lowry Acid. NH_3 donates H^+ to H^- (in NaH) to form NH_2^- and H_2 .

C: Reducing agent. NH_3 is oxidised as oxidation number of N increases from -3 in NH_3 to 0 in N_2 .

D: Reducing agent. NH₃ is oxidised as oxidation number of N increases from -3 in NH₃ to -2 in N₂H₄.



6 Sulfur is converted to SF_6 by fluorine, to SCl_2 by chlorine and to S_2Br_2 by bromine.

Which trend does this information best provide evidence for?

- **A** electronegativity: F > Cl > Br
- **B** first ionisation energy: F > Cl > Br
- **C** bond energy: $Cl_2 > Br_2 > F_2$
- **D** oxidising ability: $F_2 > Cl_2 > Br_2$

Answer: D

Oxidation state of S in SF₆ is +6, SC l_2 is +2 and S₂Br₂ is +1, which correlates with the ability of the halogen to oxidise S.

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

Industrial welding commonly uses a mixture of gases. One such gas mixture composed of 25% argon and 75% of another gas by volume, has a density of 0.572 g dm⁻³ at standard temperature and pressure.

What is the identity of the other gas in the mixture?

- A oxygen, O₂
- **B** hydrogen, H₂
- **C** helium, He
- **D** carbon dioxide, CO₂

Answer: C

From density of the mixture, we can obtain the average molar mass of the mixture by multiplying the molar volume at s.t.p. $0.572 \times 22.7 = 12.984 \text{ g mol}^{-1}$ Let x be the unknown gas Average molar mass = $(0.25 \times A_r(Ar)) + (0.75 \times M_r(x))$ $Mr(x) = (12.984 - (0.25 \times 39.9)) / 0.75 = 4.012$ For M_r of 4.012, the identity is Helium. **8** Ethanal (CH₃CHO) is a colourless gas that is a toxic by-product of ethanol consumption. It undergoes complete combustion as follows:

$$CH_3CHO \ + \ \frac{5}{2}O_2 \ \rightarrow \ 2CO_2 \ + \ 2H_2O$$

A sample of 20 cm³ of ethanal was completely combusted with 100 cm³ of oxygen.

What will be the final volume of the resultant mixture of gases at 150 °C?

A 130 cm³ **B** 90 cm³ **C** 80 cm³ **D** 40 cm³

Answer: A

20 cm³ of ethanal requires 50 cm³ of oxygen for complete combustion. 50 cm³ of oxygen is left. Since boiling point of water = 100° C, both CO₂ and H₂O are gases, and since mole ratio = volume ratio for gases under same conditions of temperature and pressure, 40 cm³ of CO₂ and 40 cm³ of H₂O are formed. The final volume will therefore be 130 cm³.

- **9** Which of the following processes are always exothermic?
 - 1 Formation of an ionic compound from its gaseous constituent ions
 - 2 Formation of a covalent compound from its constituent elements
 - **3** Dissolving of an ionic compound in water
 - 4 Changing a covalent compound from liquid to solid state.
 - **A** 1 and 4 only **B** 2 and 4 only **C** 1, 2 and 3 only **D** 1, 2, 3 and 4

Answer: A

Option 1 is the lattice energy of an ionic compound. It is always exothermic as it involves the formation of ionic bonds.

Option 2 is the enthalpy change of formation of a covalent compound. It can either be exothermic or endothermic.

Option 3 is the enthalpy change of solution of an ionic compound. It can either be exothermic or endothermic.

Option 4 is the enthalpy change of solidification of a covalent compound. It is always exothermic as the phase change from liquid to solid involves the strengthening of intermolecular forces of attraction.

A sample of propan-1-ol was burnt under laboratory conditions in an apparatus that trapped y% of the heat evolved by heating a container of water. The burning of m g of propan-1-ol raised the temperature of 200 g of water by 30 °C.

Given that the enthalpy change of combustion of propan-1-ol is $-2020 \text{ kJ mol}^{-1}$, which of the following expressions gives the value of y?

- $\mathbf{A} \quad \frac{200 \times 4.18 \times 30 \times 100 \times 60.0}{m \times 2020 \times 1000}$
- $\mathbf{B} = \frac{200 \times 4.18 \times 30 \times 60.0}{m \times 2020 \times 1000 \times 100}$
- **c** $\frac{m \times 4.18 \times 30 \times 60.0}{200 \times 2020 \times 1000 \times 100}$
- $\mathbf{D} = \frac{200 \times 4.18 \times (30 + 273) \times 100 \times 60.0}{m \times 2020 \times 1000}$

Answer: A

$$\Delta H_{c}(\text{propan-1-ol}) = \frac{q}{n_{\text{propan-1-ol}}} = \frac{-mc\Delta T \div \frac{y}{100}}{n_{\text{propan-1-ol}}}$$
$$-2020 \times 1000 = \frac{-200 \times 4.18 \times 30}{m \div 60.0} \times \frac{100}{y}$$
$$y = \frac{200 \times 4.18 \times 30 \times 100 \times 60.0}{m \times 2020 \times 1000}$$

11 Nitrogen monoxide reacts with chlorine via the proposed mechanism to give nitrosyl chloride, NOC*l*.

Step 1:	$NO + Cl_2 \rightarrow NOCl + Cl$
Step 2:	$NO + Cl \rightarrow NOCl$

Which statement is correct?

- A NOC*l* is an intermediate.
- **B** The chlorine radical is acting as a catalyst.
- **C** Step 2 has a lower activation energy than step 1.
- **D** The rate equation derived from this mechanism is rate = k[NO][Cl].

Answer: C

A: Incorrect. Intermediates of the reaction are formed from reactants and subsequently consumed but NOC*l* is not consumed in step 2.

B: Incorrect. Cl not a catalyst as it is consumed without being regenerated.

C: Correct. Step 2 is the fast step as it involves only bond forming and there is no bonds broken, hence step 1 is the slow step, hence step 2 must have a lower E_a than step 1 (which is the slow step),

D: Incorrect. Since step 1 is the slow step, rate = $k[NO][Cl_2]$.

12 The values of the equilibrium constant, K_{p} , for the reaction

$$Ag_2CO_3(s) \rightleftharpoons Ag_2O(s) + CO_2(g)$$

are 3.98×10^{-4} atm and 1.41×10^{-2} atm at 77 °C and 127 °C respectively.

What deduction can be made from the information given?

- A More CO₂ is formed at equilibrium if a suitable catalyst is used.
- **B** More CO₂ is formed at equilibrium if the reaction is allowed to take place in another container of a smaller volume.
- **C** More CO₂ is formed at equilibrium if some Ag₂CO₃ is added to a system that is already in equilibrium.
- **D** The activation energy of the forward reaction is higher than that of the reverse reaction.

Answer: D

A: A <u>catalyst does NOT affect the equilibrium position</u> (since it <u>increases the rate of</u> <u>both the forward and backward reactions to the same extent</u>) and thus <u>does NOT</u> <u>affect the equilibrium composition</u>!

B: $K_p = (P_{CO2}) \rightarrow \text{Recall that } \text{solids are NOT included in } K_c \text{ or } K_p \text{ expressions as their concentration is constant (depends on its density)}.$

As long as there is some Ag₂CO₃ and Ag₂O solid to establish an equilibrium, adding or removing the solids will NOT affect equilibrium position.

C: $K_p = (P_{CO2}) \rightarrow \underline{Since total volume decreases but K_p remains constant}$, for the pressure of CO₂ gas to be kept constant, there must be less amount of CO₂ at equilibrium.

D: <u>when temperature increased</u>, the K_p <u>increased</u>. This means the <u>equilibrium</u> <u>position shifted right</u> towards the <u>endothermic reaction</u> to <u>absorb heat</u> hence the <u>forward reaction is endothermic</u> and thus the <u>*E*</u> <u>a of forward reaction is higher</u>.

13 The numerical values of K_a for two acids at 298 K are given.

acid	Ka
CH₃CO₂H	1.75 × 10 ^{–5}
$C_6H_5CO_2H$	$6.46 imes 10^{-5}$

Which statement is correct?

- **A** $C_6H_5CO_2^-$ is a stronger base than $CH_3CO_2^-$.
- **B** The K_a of CH_3O CO_2H is lower than that of $C_6H_5CO_2H$.
- **C** 1 mol dm⁻³ CH₃CO₂H(aq) has a lower pH than 1 mol dm⁻³ HOCH₂CO₂H(aq).
- **D** A smaller volume of HC*l* is required to neutralise 1 mol of $C_6H_5CO_2^-$ than 1 mol of $CH_3CO_2^-$.

Answer: B

Option A: $C_6H_5CO_2^-$ is the conjugate base of $C_6H_5CO_2H$, which is a stronger acid than CH_3CO_2H . The conjugate base $C_6H_5CO_2^-$ is thus a weaker base than $CH_3CO_2^-$.

Option B: $-OCH_3$ is an electron donating group on the benzene ring, thus making 4-methoxybenzoic acid a weaker acid than $C_6H_5CO_2H$ as the negative charge is less dispersed in 4-methoxybenzoate than $C_6H_5CO_2^-$.

Option C: -OH is an electron withdrawing group in CH₂(OH)CO₂H. CH₂(OH)CO₂H is thus a stronger acid than CH₃CO₂H. and dissociates to greater extent, giving a solution of lower pH for the same concentration of acid.

Option D: Since both $CH_3CO_2^-$ and $C_6H_5CO_2^-$ are monoacidic bases, the same volume of HCl should be used to neutralise the bases.

14 The pK_a values associated with aspartic acid are 1.88, 3.65, and 9.60.



The graph below shows the change in pH when aqueous sodium hydroxide is added to a solution containing 1 mole of aspartic acid.



Which statements about the reaction is correct?

- 1 At point W, the maximum concentration of the zwitterion is formed.
- 2 A solution of maximum buffering capacity is formed at both points X and Z.
- 3 Thymolphthalein (working range pH = 9.3-10.5) is a suitable indicator for equivalence point Y.

Δ	1 and 2	R	1 and 3	C 20	nlv D	3 only
~			i anu o	U 20		

Answer: A

Option 1 is correct as when 1 mole of NaOH has reacted with 1 mole of aspartic acid, only the zwitterion is present in the solution.



Option 2 is correct as at these points, both the acid and its conjugate base are present in equal amounts.



Option 3 is incorrect as the equivalence point Y occurs at about pH = (3.65 + 9.60)/2 = 6.63. The working range of the indicator does not lie within the region of rapid pH change but near the maximum buffering region where $pH = pK_a = 9.60$.

15 Hydroxyapatite, Ca(OH)₂·3Ca₃(PO₄)₂, is the inorganic mineral found in bone. In older people, calcium ions can be lost from hydroxyapatite, weakening their bone structure.

In some cases, strontium salts are administered to strengthen the bone, where the strontium ions will replace the lost calcium ions in the hydroxyapatite. [K_{sp} values for Ca(OH)₂ is 5.0×10^{-6} and for Sr(OH)₂ is 3.2×10^{-4}]

Which statements are **not** correct?

- 1 There is ionic, covalent and metallic bonding in hydroxyapatite.
- 2 When strontium ions replace calcium ions, bone density increases.
- 3 Sr(OH)₂ is less soluble than Ca(OH)₂ and will precipitate more easily to replace Ca(OH)₂ when administered into the bone structure.

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

Answer: B

1: Incorrect. There is no metallic bonding in the salt.

2: Correct. Strontium ions have a larger mass than calcium ions. Since density is $\frac{m}{v}$, density of bone will increase due to replacement with strontium ions.

3: Incorrect. The K_{sp} value for Sr(OH)₂ is higher than that of Ca(OH)₂, making Sr(OH)₂ the **more** soluble salt.

16 Diazomethane (CH₂N₂) is a highly explosive yellow gas which is known to explode upon gentle impact or exposure to light.

Despite the risks associated with its use, it is well-known as an effective and efficient reagent in the preparation of methyl esters. The mechanism is shown below.



Which row best describes the type of reaction for the two steps?

	step 1	step 2
Α	acid-base reaction	elimination
в	acid-base reaction	nucleophilic substitution
С	nucleophilic substitution	elimination
D	nucleophilic substitution	nucleophilic substitution

Answer: B

Step 1 is acid base reaction as $: CH_2 - N = N$ is the base that accepts proton from RCOOH. Step 2 is nucleophilic substitution since RCOO⁻ is the nucleophile that replaces N₂.

17 Which structures represent the same stereoisomer?



Answer: B

2 and 3 are the same molecule while 1 and 4 are the same molecule.

18 When heated with bromine, hydrocarbon **X** undergoes free radical substitution. In a propagation step, the free radical **Y**• is formed by the loss of one hydrogen atom.

$$X + Br \bullet \rightarrow Y \bullet + HBr$$

What is a possible structure of hydrocarbon X if there are 3 possible forms of Y•?



Answer: B

The number of theoretical forms of $Y \bullet$ is equal to the number of different types of H atoms to be abstracted. In each case, all the H atoms bonded to each carbon with the same label (e.g. *a*, *b*, *c* etc) belong to the same type.



Only the alkane in B has 3 different types of H atoms giving rise to 3 theoretical forms of Y•

19 A hydrocarbon, which is a liquid at room temperature, decolourises aqueous bromine. What could be the molecular formula of the compound?

A C₂H₄ **B** C₆H₆O **C** C₇H₁₆ **D** C₁₀H₂₀

Answer: D

Option A is incorrect as ethene is gas, not liquid at room temperature.

Option B is incorrect as it is not a hydrocarbon.

Option C is incorrect as it is a saturated hydrocarbon that cannot undergo addition reaction.

Option D is correct as it has the same general formula of C_nH_{2n} and it is also a liquid at room temperature.

20 Which of the following will **not** be formed when benzene reacts with CHC l_3 in the presence of AlC l_3 ?



Answer: C

 $CHCb^+$ will be formed as $AlCb_3$ reacts with $CHCb_3$ in a Lewis acid-base reaction. Under these conditions, a series of Friedel-Crafts reactions can occur.



- **21** Which compound, when shaken with aqueous silver nitrate, will give a white precipitate in the shortest time?
 - A 2-chlorobut-1-ene
 - B chlorobenzene
 - **C** propanoyl chloride
 - **D** tetrachloromethane

Answer: C

White ppt of AgC*l* is observed when the C-C*l* bond breaks to release C*l*, which will form a white ppt with Ag⁺(aq). The ease of hydrolysis increases in the following order: chlorobenzene, chloroalkene < chloroalkane < acyl chloride. Thus, propanoyl chloride will hydrolyse most readily to produce white ppt.

- 22 Chlorofluorocarbons, CFCs, are chemicals that were commonly used in refrigeration and air conditioning. They are harmful to the ozone layer and many manufacturing companies are substituting CFCs with other compounds. Which of the following can be used as a substitute for CFCs?
 - 1 butane
 - 2 trichlorofluoromethane
 - 3 1,1,1,2-tetrafluoroethane
 - **A** 2 and 3 only **B** 1 and 2 only **C** 1 and 3 only **D** 1, 2 and 3

Answer: C

CFCs are harmful to the ozone layer due to the generation of Cl radicals when the C-Cl bond in the CFC molecules break. 1,1,1,2-tetrafluoroethane and butane do not contain any Cl atom and thus will be suitable substitutes.

- 1 mol of **X** reacts completely with excess Na(s) to produce 1.0 mol of H₂(g).
- 1 mol of **X** reacts completely with 1 mol of PCl₅(s).
- 1 mol of **X** reacts completely with 1 mol of Br₂(aq).

Which of the following is compound **X**?



Answer: A

Upon redox reaction with excess Na(s), each mol of the aliphatic alcohol, phenol and carboxylic acid groups will form 0.5 mol of $H_2(g)$.

Upon nucleophilic substition with $PCl_5(s)$, each mol of the aliphatic alcohol and carboxylic acid groups will react with 1 mol of $PCl_5(s)$.

Upon electrophilic substitution with $Br_2(aq)$, only each of position 2 (and/or 4) relative to the phenol group reacts with 1 mol of $Br_2(aq)$ (where 1 mol of Br_2 works out to be 1 mol Br is substituted while the other 1 mol is released as HBr by-product).

Option A is correct since its phenol and carboxylic acid undergoes redox reaction with Na(s) to give 1 mol of $H_2(g)$. Its carboxylic acid group undergoes nucleophilic substitution with 1 mol of PC $l_5(s)$ and its position 2 relative to the phenol is available for electrophilic substitution with 1 mol of Br₂.

Option B is incorrect since its phenol, aliphatic alcohol and carboxylic acid undergoes redox reaction with Na(s) to give 1.5 mol of H₂(g), not 1.0 mol of H₂(g). Its carboxylic acid group and aliphatic alcohol undergoes nucleophilic substitution with 2 mol of PC $l_5(s)$., not 1 mol of PC $l_5(s)$.

Option C is incorrect since its position 2 and 4 relative to the phenol are available for electrophilic substitution with 2 mol of Br_2 , not 1 mol of Br_2 .

Option D is incorrect since its phenol undergoes redox reaction with Na(s) to give 0.5 mol of $H_2(g)$, not 1.0 mol of $H_2(g)$. Also, none of Its functional groups undergoes nucleophilic substitution with PC $l_5(s)$.

- X CH₃CH₂CH₂CH=CHCHO, an aroma of tomatoes
- Y CH₃CH₂CH₂CH₂CH=CHCOCH₃, a flavour of mushrooms
- Z CH₃CH₂CH₂CH₂CH=CHCH=CHCHO, an aroma of cucumbers

If these compounds are all present in the ratio X: Y: Z = 1:2:2, and all are reduced by excess hydrogen, how many hydrogen atoms would be incorporated on average per molecule?

A 2.0 **B** 2.8 **C** 4.0 **D** 4.8

Answer: D

H₂ reduces the ketones, aldehydes and alkenes in X, Y, and Z.

Reducing each of these groups incorporates 2 H atoms into the molecule.

Since *X*, *Y*, *Z* are in the ratio 1:2:2, 1 molecule of X would incorporate $1 \times 4 = 4$ H atoms, 2 molecules of Y would incorporate $2 \times 4 = 8$ H atoms, 2 molecules of Z would incorporate $2 \times 6 = 12$ H atoms.

A <u>total of 24 H atoms are incorporated into 2 + 2 + 1 = 5 molecules</u> hence on average Therefore, 24 H atoms divided by 5 molecules resulted in average of 4.8 H atoms are incorporated per molecule. **25** Deuterium, D, is the ²H isotope of hydrogen.

Which reactions will give an organic product containing deuterium?

1			
I	heat		
2			
2	heat		
0	NaOD in D ₂ O		
3	heat		
4 10		-	• •
1 and 2	B 1 and 3 C 1 only	D	3 only

Answer: D

Α



Only option 3 will give organic products that contain deuterium.

26 Pravastatin is used for prevention of cardiovascular diseases and treatment of abnormal lipid levels in the blood.



pravastatin

Which statement about pravastatin is correct?

- A It has a total of 2¹⁰ stereoisomers.
- **B** 1 mol of pravastatin reacts with 3 mol of HC*l*(g).
- **C** It gives an orange precipitate with 2,4-dinitrophenylhydrazine.
- **D** It reacts with cold alkaline KMnO₄ to give a compound with 6 secondary alcohol groups.

Answer: D

Option A: There are 8 chiral centres in pravastatin.



The 2 C=C bonds in the ring are not able to exhibit cis-trans isomerism due to the cyclic ring.

Option B: The 3 alcohol -OH groups can undergo nucleophilic substitution with HC*l*, and the 2 C=C can undergo electrophilic addition with HC*l*.

Option C: No ketone or aldehyde present in pravastatin.

Option D: Pravastatin undergoes mild oxidation on the C=C to give a compound with 6 2° alcohol groups (3 of the 2° alcohol groups were pre-existing in the original

compounds while 3 of the 2° alcohol groups were resulted from the mild oxidation of C=C giving two 2° alcohol groups per C=C).





A 1>2>3 B 1>3>2 C 2>1>3 D 3>2>1 Answer: A

Answer: A

 N^1 is an 3° aliphatic amine with its lone pair of electrons on N readily available for donation to a H⁺.

 N^2 is phenylamine with the lone pair of electrons on N delocalised into the pi electron cloud of the benzene ring, making it less available for donation to a H⁺.

N³ is a nitrile with one lone pair of electron on N atom. Nitriles do not react with acids via proton transfer. Hence it usually considered to be neutral.

FYI: The lone pair electrons on the N^3 are contained in a *sp* hybrid orbital which makes them much less basic and an amine. The 50% character of an *sp* hybrid orbital close to the nucleus and therefore less basic compared to other nitrogen containing compounds such as amines.

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

The $E^{\Theta_{cell}}$ of a galvanic cell is found to be +0.19 V. One of the half-cells contains 1 mol dm⁻³ each of K₂S₂O₈(aq) and K₂SO₄(aq). Which of the following reactions occurs in the other half-cell?

- **A** $\operatorname{Co}^{2+} \rightarrow \operatorname{Co}^{3+} + e^{-}$
- **B** $Fe^{2+} \rightarrow Fe^{3+} + e^{-}$
- **C** Co^{3+} + $e^{-} \rightarrow \operatorname{Co}^{2+}$
- **D** $Fe^{3+} + e^{-} \rightarrow Fe^{2+}$

Answer: A

From the Data Booklet, $S_2O_8^{2^-} + 2e^- \rightleftharpoons 2SO_4^{2^-} E^\circ = +2.01 \text{ V}$ $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$ $+0.19 \text{ V} = +2.01 \text{ V} - E^\circ_{\text{anode}}$ $E^\circ_{\text{anode}} = +1.82 \text{ V}$ From the Data Booklet, the half equation that has $E^\circ = +1.82 \text{ V}$ is the Co³⁺/Co²⁺ half-cell. Reduction: $S_2O_8^{2^-} + 2e^- \rightarrow 2SO_4^{2^-}$ Oxidation: $Co^{2^+} \rightarrow Co^{3^+} + e^-$ **29** The standard cell potentials for the redox equilibria of aqueous vanadium-containing ions and the colours of these ions are given below.

 $VO_2^+ + 2H^+ + e^- \rightleftharpoons H_2O + VO^{2+}$ $E^{\Theta} = +1.00 \text{ V}$ yellowblue $VO^{2+} + 2H^+ + e^- \rightleftharpoons H_2O + V^{3+}$ $E^{\Theta} = +0.34 \text{ V}$ bluegreen $V^{3+} + e^- \rightleftharpoons V^{2+}$ $E^{\Theta} = -0.26 \text{ V}$ greenpurple

What is likely to be the final colour when metallic zinc is added to a solution containing VO^{2+} ?

 $Zn^{2+} + 2e^{-} \rightleftharpoons Zn$ $E^{\Theta} = -0.76 \text{ V}$ colourless

A yellow B blue C green D purple

Answer: D

 $\begin{array}{ll} 2VO_2^+(aq) + Zn(s) + 4H^+(aq) \longrightarrow 2VO^{2+}(aq) + Zn^{2+}(aq) + 2H_2O(I) \\ yellow & blue & E^\theta_{cell} = 1.00 - (-0.76) = +1.76 \text{ V} \\ \text{Since } E^\theta_{cell} > 0 \text{ V}, \text{ the reaction is energetically feasible under standard conditions.} \end{array}$

 $\begin{array}{ll} 2\text{VO}^{2+}(aq) + \text{Zn}(s) + 4\text{H}^{+}(aq) & \longrightarrow 2\text{V}^{3+}(aq) + \text{Zn}^{2+}(aq) + 2\text{H}_2\text{O}(\text{I}) \\ blue & green & \text{E}^{\theta}_{\text{cell}} = 0.34 - (-0.76) = +1.10 \text{ V} \\ \text{Since } \text{E}^{\theta}_{\text{cell}} > 0 \text{ V}, \text{ the reaction is energetically feasible under standard conditions.} \end{array}$

 $\begin{array}{ll} 2V^{3+}(aq) + Zn(s) \longrightarrow 2V^{2+}(aq) + Zn^{2+}(aq) & E^{\theta}_{cell} = -0.26 - (-0.76) = +0.50 \ V \\ green & purple & colourless \\ \end{array}$ Since $E^{\theta}_{cell} > 0 \ V$, the reaction is energetically feasible under standard conditions.

From the above, Zn will reduce VO_2^+ to V^{2+} . Hence the resultant solution will be purple in colour.

30 Aqueous copper(II) sulfate forms a deep blue solution when aqueous ammonia is added. The colour intensity of the mixture can be analysed by measuring its absorbance using a colorimeter.

Given that the total volume of solution used is 1.0 cm^3 , which graph, **A**, **B**, **C** or **D**, correctly represents the absorbance against volume of solutions used when $0.2 \text{ mol dm}^{-3} \text{ CuSO}_4(\text{aq})$ is mixed with $0.4 \text{ mol dm}^{-3} \text{ NH}_3(\text{aq})$ in the given proportions?



Answer: B

When $CuSO_4(aq)$ and $NH_3(aq)$ are mixed, the deep blue complex ion $[Cu(NH_3)_4(H_2O)_2]^{2+}$ is formed.