	NATIONAL JUNIOR COLLEGE **SH2 PRELIMINARY EXAMINATION** Higher 1
CANDIDATE NAME	

SUBJECT CLASS		REGISTRATION NUMBER	

CHEMISTRY **8873/01**
Paper 1 Multiple Choice **23 September 2025**
1 hour

Additional Materials: Optical Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, subject class 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 booklet.
The use of an approved scientific calculator is expected, where appropriate.

Instructions on how to fill in the Optical Mark Sheet
Shade the index number in a 5 digit format on the optical mark sheet:
2nd digit and the last 4 digits of the Registration Number.

Example:

Student	Examples of Registration No.	Shade:
	2305648	**35648**

This document consists of **11** printed pages and **1** blank page.

Suggestion solution for P1 (MCQ)

1	A
2	D
3	C
4	C
5	B
6	C
7	C
8	A
9	D
10	B

11	C
12	D
13	C
14	D
15	A
16	B
17	C
18	D
19	D
20	C

21	B
22	B
23	B
24	D
25	B
26	C
27	D
28	B
29	B
30	C

1 ⟨ decay occurs when an atom's nucleus emits an alpha particle, which is a helium nucleus. The radioactive isotope, Radium 226, undergoes ⟨ decay.

$$88226Ra \rightarrow 24He + \boldsymbol{X}$$

Which row in the table correctly describes the nuclear make-up of **X**?

	number of protons	number of neutrons
A	86	136
B	88	136
C	86	138
D	88	138

Ans: A
No. of neutrons of Ra = 226 – 88 = 138

No of protons of X = 88 – 2 = 86
No. of neutrons of X = 138 – 2 = 136

2 Which of the elements have the most number of unpaired electrons?

A F

B O

C A*l*

D P

Ans: D

Electronic Configurations
F: $1s^2\ 2s^2\ 2p^5$
O: $1s^2\ 2s^2\ 2p^4$
A*l*: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
P: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

3 The successive ionisation energies of element **A** and **B** are shown below.

	ionisation energies / kJ mol^{-1}							
	1st	2nd	3rd	4th	5th	6th	7th	8th
A	1011	1907	2914	4964	6274	21267	25431	29872
B	1251	2298	3822	5159	6542	9362	11018	33604

What is the formula of the compound formed when **A** reacts with **B**?

A **AB** **B** **A_2B**

C **AB_3** **D** **AB_4**

Ans: C

For **A**, the largest increase in I.E is from the 5th to 6th I.E => Group 15

For **B**, the largest increase in I.E is from the 7th to 8th I.E=> Group 17

Hence, **AB_3** is the answer.

4 Metal chlorates can be prepared by adding chlorine to hot metal hydroxides like KOH:

$$3\ Cl_2 + 6\ KOH \rightarrow 5\ KCl + KClO_x + 3\ H_2O$$

From the above equation, determine the number x of the O in $KClO_x$.

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

Ans: C

From the equation, 5 Cl atoms are reduced from an oxidation number of 0 to −1. The last remaining Cl atom will hence oxidise from 0 to +5. Hence, there are 3 O on $KClO_x$ to balance the charge.

5 Boron Nitride (BN) has three main crystalline structures, of which the most common is the hexagonal type, featuring a layered structure similar to graphite.

Which of the sentences describing the structure is **incorrect**?

A A giant covalent structure with weak intermolecular forces of attraction between layers

B A simple covalent structure with weak intermolecular forces of attraction

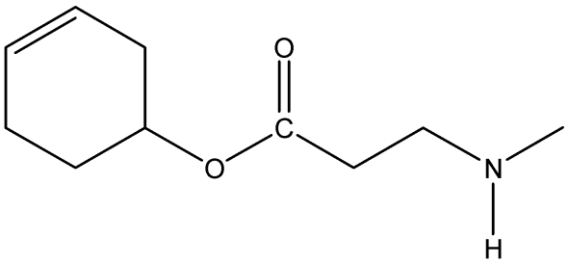
C The B is covalently bonded to 3 other N and vice versa.

D The BN bond is polar

Ans : B

1. BN has a hexagonal structure similar to graphite and is giant covalent. Hence it has weak IMF between layers
2. As it is structurally similar to graphite, it cannot be simple covalent
3. In graphite, C is covalently bonded to 3 other C.
4. N is more electronegative than B and hence the bond is polar.

6 What is the total number of σ and π bonds in the structure below?



	σ	π
A	14	2
B	14	3
C	30	2
D	30	3

Ans: C

7 Which statement explains the trend of decreasing volatility from HC*l* to HI?

A The electronegativity between the bonded atoms increases.

B The molecules are polar and they have increasingly stronger permanent dipole-permanent dipoles.

C There are more electrons in iodine atom than in chlorine atom.

D The bond length decreases from H−C*l* to H−I, hence thermal stability increases.

Ans: C
Decreasing volatility means increasing boiling point / stronger intermolecular forces of attraction.
The difference in electronegativity between the H and the halogen decreases from HC*l* to HI, i.e. HI is the least polar and hence the pd-pd between HI is the weakest. This does not help to explain the trend.
Instead, the size of electron cloud increases from HC*l* to HI, resulting in stronger instantaneous dipole-induced dipole interactions (id-id) which help to explain the trend.
The covalent H-X bonds are not broken during boiling, so option D is irrelevant.

8 Which of the species contains the largest bond angle?

A ICl_2^-

B SO_2

C CH_4

D SF_6

Ans : A

A: 2 bond pair and 3 lone pairs. Hence linear in shape and 180°.
B: 2 bond pair and one lone pair. Hence, bent in shape and >120°.
C: 4 bond pairs. Hence tetrahedral in shape and 109.5°.
D: 6 bond pairs. Hence, octahedral in share and 90°.

9 Which of the following does the first compound have a higher melting point than the second compound.

1 Na_2O, HCl

2 $AlCl_3$, $CaCl_2$

3 CH_3CH_2OH, $CH_2(OH)CH_2(OH)$

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

Ans: D

1. Na_2O has a giant ionic lattice while HCl has a simple covalent structure.
2. $AlCl_3$ is simple covalent structure while is giant ionic lattice lattice.
3. $CH_2(OH)CH_2(OH)$ has more extensive hydrogen bonding than CH_3CH_2OH

10 Which of the reactions is the first reactant acting as a Bronsted-Lowry Acid?

1 $H_2O + NH_3 \rightleftharpoons OH^- + NH_4^+$

2 $HCl + CH_3NH_2 \rightarrow CH_3NH_3^+Cl^-$

3 $CH_3CHOOH + HCl \rightarrow CH_3CHOOH_2^+Cl^-$

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

Ans: B

1. H_2O donates a H^+ to NH_3 and behaves as a Bronsted-Lowry Acid
2. HCl donates a H^+ to CH_3NH_2 and behaves as a Bronsted-Lowry Acid
3. CH_3CHOOH accepts a H^+ from HCl and behaves as a Bronsted-Lowry Base

11 The ionic product of water is the product of the concentration of H^+ and OH^- from the dissociation of water, of which is represented by the equation below:

$$H_2O \rightleftharpoons H^+ + OH^- \qquad \otimes H=+ve$$

The K_w of water is 1.0×10^{-14} mol^2 dm^{-6} at 25°C.

Which of the statements correctly describes what happens when the temperature is raised?

1 pH of water decreases

2 $[H^+] > [OH^-]$

3 K_w value increases

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

Ans: C

1. $[H^+]$ increases as POE shifts right to produce more H^+ when temperature is raised.
2. $[H^+] = [OH^-]$ for pure water
3. As $K_w = [H^+][OH^-]$, the value increases as more H^+ and OH^- are dissociated.

12 Which of the following mixtures will form a buffer solution? All the reagents have the same concentration.

A 20 cm^3 of HNO_3 mixed with 20 cm^3 of NH_3

B 10 cm^3 of CH_3COOH mixed with 20 cm^3 of NaOH

C 20 cm^3 of HCl mixed with 20 cm^3 of NH_3

D 5 cm^3 of H_2SO_4 mixed with 15 cm^3 of NH_3

Ans : D

A. Only the salt of NH_4^+ NO_3^- is present.
2. There will be excess NaOH left
3. Only the salt of $NH_4^+Cl^-$ will be present
4. There is the weak base NH_3 and its conjugate acid NH_4^+ present. Hence it is a buffer.

13 10.0 cm^3 of a gaseous hydrocarbon, CxHy, was burnt in 100 cm^3 of oxygen. The total volume after the reaction was 85.0 cm^3, which decreased to 55.0 cm^3 on shaking with excess sodium hydroxide solution. All volumes were measured at r.t.p.

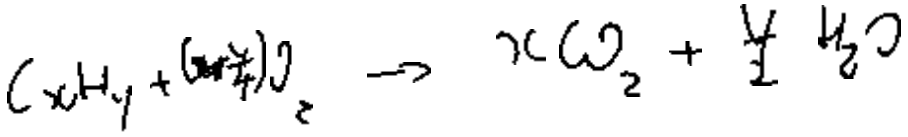
Determine the molecular formula of CxHy.

A C_2H_4

B C_2H_6

C C_3H_6

D C_3H_8



Ans: C

	$C_xH_y(g)$	+	$(x + \frac{y}{4})O_2(g)$	↓□	$x\ CO_2(g)$	+	$\frac{y}{2}H_2O(l)$
Initial vol /cm^3	10		100		0		
Change in vol / cm^3	10		45		30		
Final vol / cm^3	0		55		30		
Reacting vol / cm^3	10		45		30		
Mole ratio	$\frac{10}{10} = 1$		$\frac{45}{10} = 4.5$		$\frac{30}{10} = 3$		

4 $x = 3$, $x + \frac{y}{4} = 4.5$ ® hence y = 6, hence molecular formula is C_3H_6.

14 Which of the following ionic compounds releases the most energy when they are formed from their gaseous ions?

A LiCl **B** AlF_3 **C** FeS **D** Fe_2O_3

Ans: D

$|L.E| \propto |\frac{q_+ \times q_-}{r_+ + r_-}|$

Since Fe_2O_3 has the largest product of the charges, it will have the largest lattice energy.

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

The reaction of methanol (M_r = 32.0) with oxygen is shown in the following equation.

$$CH_3OH(g) + 3/2\ O_2(g) \rightarrow CO_2(g) + 2H_2O(l) \quad \otimes H = -315\ kJ\ mol^{-1}$$

Methanol was burnt to heat up 300 cm^3 of water from 30°C to 50°C,

Given that the heat transfer was 90% efficient, what is the mass of methanol used for the reaction?

A 2.83 g **B** 4.25 g **C** 7.08 g **D** 41.5 g

Ans: A

q = 300 x 4.18 x 20 = 25080J

100 % of heat transferred = 25080 x $\frac{100}{90}$ = 27866 ≈ 27870 J

Amount of methanol burnt = $\frac{27870}{315000}$ = 0.08848 mol

Mass of methanol burnt = 0.08848 x 32 = 2.83g

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

In the free radical chlorination of methane, 1 mol of methane reacts with 1 mol Cl_2 to give an acidic gas and chloromethane as the product.

What is the enthalpy change for this reaction?

A – 791 kJ mol^{-1}

B – 117 kJ mol^{-1}

C + 117 kJ mol^{-1}

D + 750 kJ mol^{-1}

Ans: B

ΔH of reaction = BE (C – H) + BE (Cl – Cl) – BE (C – Cl) – BE (H – Cl)

= 410 + 244 – 360 – 431
= – 117kJ mol^{-1}

17 The equilibrium below describes one step in the Contact Process of making SO_3.

$$SO_2 + ½\ O_2 \rightleftharpoons SO_3 \quad \Delta H < 0$$

Which conditions will increase the yield of SO_3?

A Increase the temperature of the reaction

B Using a catalyst

C Reducing the temperature of the reaction

D Removing SO_2

Ans: C
A: Increasing the temperature of the reaction will favour the backward endothermic reaction, reducing the yield
B: A catalyst speeds up the rate of reaction, but does not increase the yield
C: The forward exothermic reaction will be favoured, thus increasing the yield.
D: The POE will shift left, reducing the yield.

18 1.4 mol of N_2 and 3 mol of H_2 were mixed into 2 dm^3 closed vessel at 100°C in the following reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Given that the 0.8 mol of NH_3 was produced, calculate the Kc for the process.

A 0.0169 **B** 0.0677 **C** 0.156 **D** 0.625

Ans: D

	$N_2(g)$	+ $3H_2(g)$	$\rightleftharpoons 2NH_3(g)$
Initial amt/ mol	1.4	3	0
Change amt/ mol	-0.4	-1.2	+0.8
Equilibrium amt / mol	1.0	1.8	0.8

$K_c = \frac{(0.8\div2)^2}{(1.0\div2)(1.8\div2)^3}$ = 0.625 $mol^{-2}dm^6$ (units not needed)

19 Radioactive decay is a first order reaction.

Carbon-14 is a radioactive element with a half-life of 5700 years and gives off a count number per minute as a measure of its radioactivity. A tiny sample of clay, containing carbon-14 from an ancient statue gives 30 counts per minute, while carbon-14 obtained from new clay gives 7.5 counts per minute.

What is the age of the statue (in years)?

A 2850 **B** 5700 **C** 8550 **D** 11400

Ans: D

The count is at 2 half-lives. Hence, without calculation, the age of the statue is 11400

20 Two substances, A and B, react according to the following equation:

$$2A + 2B \rightarrow C$$

To determine the order of reaction with respect to each substance, four experiments were performed and the results are shown below:

Expt	Vol of A / cm^3	Vol of B / cm^3	Vol of H_2O / cm^3	Time taken for B to decolourise / s
1	10	10	10	30
2	20	10	0	15
3	10	20	0	30

Which is the correct rate equation?

A Rate = k [A]

B Rate = k [B]

C Rate = k [A][B]

D Rate = k $[A]^2[B]^2$

Ans: C

Rate α $\frac{vol\ of\ B}{time\ take\ for\ B\ to\ decolourise}$

Expt 1: 1/3, Expt 2: 2/3, Expt 3: 2/3

Compare Expt 1 and 2, where vol of B is the same and vol of A doubles, rate doubles.
Hence, reaction is 1st order with respect to A.

Compare Expt 1 and 3, where vol of A is the same and vol of B doubles., rate doubles.
Hence reaction is 1st order with respect to B.

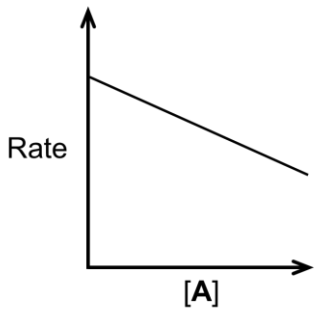
Rate = k [A][B]

21 The rate equation for the reaction between species **A** and **B** at stoichiometric ratio has been found to be rate = k[A].

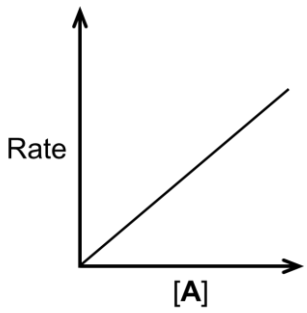
A + **B** ⟶ **C**

Which graph(s) may be observed for the reaction?

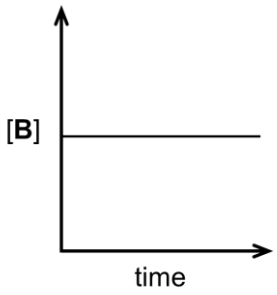
1



2



3



A 1 only

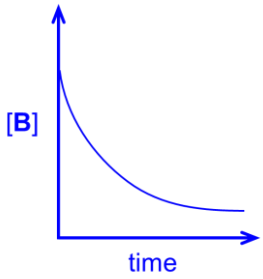
B 2 only

C 1 and 3 only

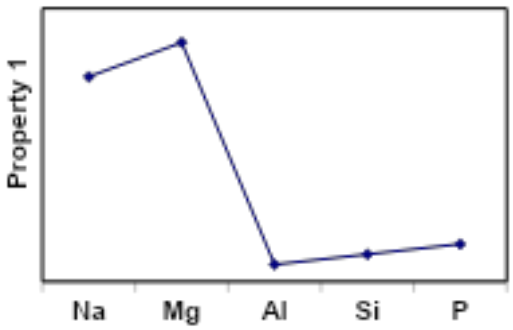
D 2 and 3 only

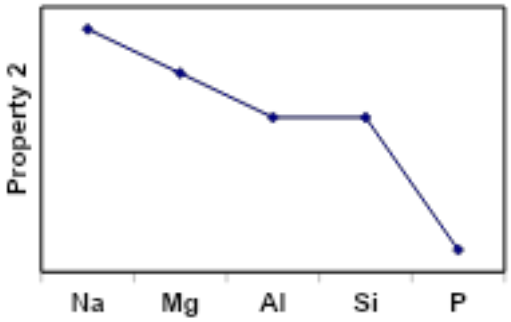
Ans:B
Rate increases when [**A**] increases. Graph 2 should be correct instead of 1.

Despite being zero order, B is being consumed significantly during the reaction and the [**B**] will decrease at the same rate as [**A**], following a first order trend.



22 The graphs below show the variation of two properties of some period 3 elements and/or their compounds.





Which correctly describes properties 1 and 2?

	Property 1	Property 2
A	atomic radius of the elements	electrical conductivity of the elements
B	boiling point of the chlorides at the highest oxidation states	pH of the oxides when added to water
C	melting point of the oxides	first ionisation energies of the elements
D	electrical conductivity of elements	pH of the chlorides at the highest oxidation states when added to water

Ans: B

For option A

Property 1 **cannot be atomic radii** as it should be a **continuous decrease across the period** due to increase in nuclear attraction for the outermost electron. This is because of increase in nuclear charge but constant shielding caused by the same number of inner electrons.

Property 2: **Electrical conductivity should increase from Mg to Al** due to increase in number of mobile charged carriers (more electrons in the sea of delocalised electrons). Electrical conductivity should be very low for Si while P exhibit zero electrical conductivity. Hence graph shows a wrong trend for electrical conductivity.

For option B

Boiling point of chloride compounds decreases from NaCl

Property 2: **acid base property of oxide** depends on the **nature of**

to $AlCl_3$ as $AlCl_3$ is a simple covalent molecule therefore easier to overcome the intermolecular temporary dipole induced dipole than ionic bonds in giant ionic lattice of NaCl and $MgCl_2$.
From $AlCl_3$ to PCl_5, they have the structure of simple covalent molecules with Mr of $AlCl_3$ (133.5) < $SiCl_4$ (170.1) < PCl_5 (208.5). B.pt increases with increasing ease of distortion of the electron cloud of the chloride compound.

Hence property1 shows the correct trend in the b.pt of chlorides across period 3 element.

bonds present in the oxide compound. While ionic oxide tends to be basic and covalent oxide is acidic; ionic oxides with significant covalent character will be amphoteric, this is usually observed when cation has high charge/size ratio.

pH of oxides in aqueous medium not only depends on the nature of the bonds, **solubility** also matters.

Na_2O is **basic and fully soluble** in water, therefore pH very high (highly alkaline).
Solubility of MgO less than Na_2O but more than Al_2O_3, hence pH of MgO > Al_2O_3.
pH of Al_2O_3 and SiO_2 are both equal to 7 because both are insoluble in water but Al_2O_3 is an amphoteric oxide while SiO_2 is an acidic oxide.
Oxides of P dissolves in water to give phosphoric acid therefore pH is very low.

Hence property 2 shows the correct trend for pH of aqueous oxides across period 3.

For option C
Melting points of oxides across the period should peak at SiO_2 since it has a very strong giant covalent lattice.
Phosphoric oxide is a simple covalent molecule, therefore there should be a drastic drop of m.pt from SiO_2 to P_4O_{10}.
Hence property 1 cannot be m.pt of oxides across period 3 elements.

First ionisation energy of elements across period should exhibit a general increasing trend due to increasing nuclear attraction for the most loosely held electron. This is due to increase in nuclear charge but constant shielding effect by the same number of inner shell electrons.

Hence property 2 cannot be first ionisation energy.

For option D
Electrical conductivity should increase from Na to Mg to Al due to increase in number of mobile charged carriers (more electrons in the sea of delocalised electrons). Electrical conductivity should be

For chlorides across period 3 element, they are all soluble in aqueous medium. For chlorides that dissociates into ions in aq medium, cation hydrolysis gives rise to acidic solution. Extent of cation hydrolysis

very low for Si while P exhibit zero electrical conductivity. Hence graph shows a wrong trend for electrical conductivity.

increases with charge/size ratio of the cation. Hence $AlCl_3$ (aq) more acidic than $MgCl_2$(aq) while NaCl is neutral (pH =7)

On the other hand, covalent chlorides react with water to form HCl therefore the pH value should be low for both $SiCl_4$ and PCl_5.

Hence graph of property 2 do not agree with the pH trend of aqueous chlorides across the period.

23 A solution of $Al(NO_3)_3$ react with Na_2CO_3 to give off a strong effervescence of an acidic gas.

Which of the following solutions will have the same reaction with Na_2CO_3?

A KOH **B** $FeCl_3$ **C** $MgSO_4$ **D** $Ca(NO_3)_2$

Ans: B

Fe^{3+} has the highest charge density among all the metal ions and is thus able to ionise water sufficiently to produce enough H^+ that will react with the Na_2CO_3 to produce CO2 like Al^{3+}.

24 Which factor helps to explain why the oxidising power of the Group 17 elements decreases down the group?

A The repulsion between paired electrons increases.

B The outer electron is in a 'p' subshell.

C The nuclear charge of the elements increases.

D The distance between the nucleus and the valence electron increases.

Ans : D

Oxidising power can be inferred from the I.E. The best answer would be D as down the group, the distance between the nucleus and valence electron increases which is one of the factors why nuclear attraction decreases down the group leading to a decrease in I.E and hence oxidizing power.

25 Equal amount of two Period 3 oxides were added to water. The resultant solution has a pH above 7.

What are the identities of the two oxides?

1 Al_2O_3 and MgO

2 Na_2O and MgO

3 SiO_2 and Al_2O_3

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

Ans: B

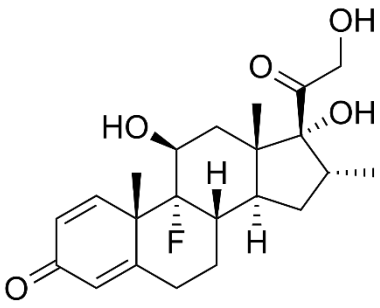
1. Al_2O_3 (pH=7, insoluble in water) and MgO (pH > 7, ionic oxide basic)
   Overall = pH > 7

2. Na_2O (pH > 7, ionic oxide basic) and MgO (pH > 7, ionic oxide basic)
   Overall = pH > 7

3. SiO_2 (pH=7, insoluble in water) and Al_2O_3 (pH=7, insoluble in water)
   Overall = pH = 7

26 Dexamethasone is a corticosteroid medcine that helps to relieve swelling, tiching and allergic reactions.

The structure is given below:



Which of the follow reagents can react with dexamethasone?

1 CH_3NH_2 in the presence of dicyclohexylcarbodiimide

2 H_2, Ni catalyst

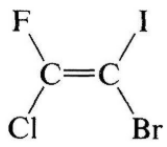
3 Acidified $K_2Cr_2O_7$

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

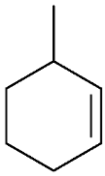
Ans: C

1. No COOH group present
2. Reduction of C=C
3. Oxidation of 2° OH group

27 Which of the following structures exhibit cis-trans isomerism?

1 

2 

3 

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

Ans: D

1. 2 different groups on the adjacent carbons
2. 2 H on one of the C
3. C=C is in a ring, so cannot exhibit cis-trans isomerism

28 An ester has the molecular formula of $(CH_3)_2CHCO_2CH_2CH_2CH_3$.

Which carboxylic acid and alcohol are used to make this ester?

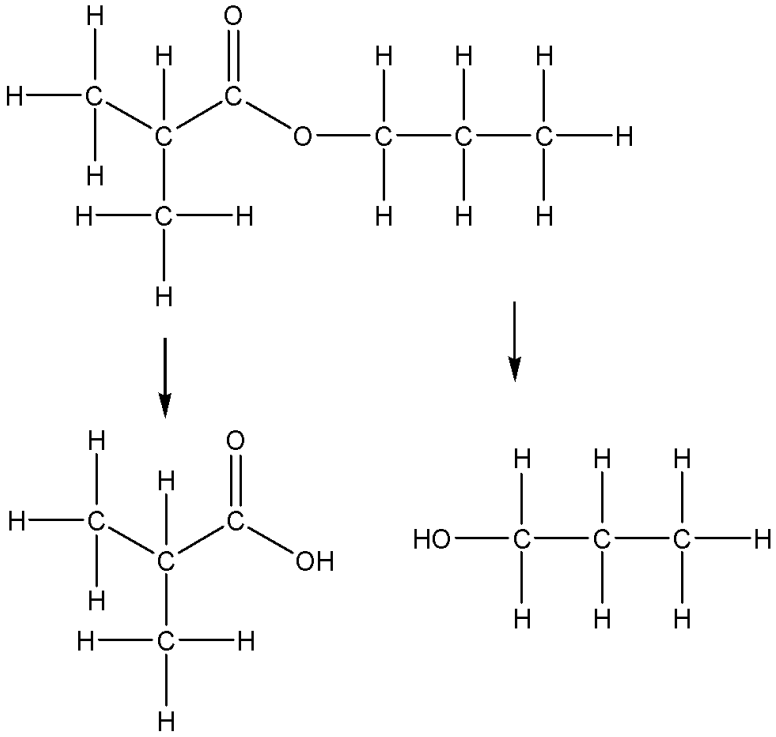
A Ethanoic acid and butan-1-ol

B 2-methylpropanoic acid and propan-1-ol

C Propanoic acid and propan-1-ol

D Butanoic acid and butan-1-ol

Ans: B



2-methylpropanoic acid

propan-1-ol

29 Which statements about addition polymers is correct?

A Monomers of the addition polymers are usually saturated

B The molecular formula of the polymer is a repeat unit of the monomer

C Addition polymer have different empirical formula as the monomer

D Addition polymerisation adds monomers together with loss of portions of the monomer.

Ans: B

30 In which of the contexts will hydrogen bonding be important to the properties mentioned?

1 Water resistance of poly(vinyl chloride) (PVC)

2 The creasing of nylon material fabric

3 Making water soluble polymer in eye drops with poly(vinyl alcohol) (PVA)

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

Ans: C

1. PVC has water resistance properties, so it cannot have hydrogen bonding properties.
2. The hydrogen bonds hold the nylon chains together, causing creasing.
3. Can form hydrogen bonds with water due to OH side chain