TAMPINES MERIDIAN JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION

H1 CHEMISTRY **8873/01**

Paper 1 Multiple Choice **25 September 2025**

1 hour

Additional materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

There are **thirty** questions in this section. Answer **all** questions. For each question, there are four possible answers labelled **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in soft pencil on the separate Answer Sheet.

Read very carefully the instructions on the use of Answer Sheet.

You are advised to fill in the Answer Sheet as you go along; no additional time will be given for the transfer of answers once the examination has ended.

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.

Use of Answer Sheet

Ensure you have written your name, class, date and subject on the Answer Sheet.

Shade the last four digits of your centre/index number on the Multiple Choice Answer Sheet. (e.g. if your centre/index number is 3054**1234**, shade 1234).

Use a **2B** pencil to shade your answers on the Answer Sheet; erase any mistakes cleanly. Multiple shaded answers to a question will not be accepted.

1 The relative atomic mass of antimony, which consist of the isotopes ^{121}Sb and ^{123}Sb, is 121.8. Calculate the percentage of ^{123}Sb in the isotopic mixture.

A	40%	**B**	45%	**C**	50%	**D**	60%

Answer: A

Let the percentage of ^{123}Sb in the isotopic mixture be x%

$$\frac{x}{100}123 + \frac{100-x}{100}121 = 121.8$$

$123x - 121x = 80$

$x = 40\%$

2 Atoms of elements from hydrogen to zinc have specific electronic arrangements.

Which statement is correct?

A	The shell with principal quantum number 3 can hold a maximum of 8 electrons.
B	The electrons always occupy the highest energy orbitals available.
C	The order of filling the orbitals is 1s, 2s, 2p, 3s, 3p, 3d, 4s.
D	In some atoms, electrons occupy the fourth shell even though the third shell is not full.

Answer: D

Transition elements to fill 4s subshell before 3d.
Examples include Sc: $[Ar]3d^14s^2$ Ti: $[Ar]3d^24s^2$

3 Elements **E** and **F** have the following successive ionisation energies in kJ mol^{-1}.

	1st	2nd	3rd	4th	5th	6th	7th
E	580	1800	2700	11600	14800	18400	23300
F	1310	3400	5300	7500	11000	13300	20300

What could be the formula of the compound formed by these two elements?

A	EF_3	**B**	E_2F_3	**C**	E_3F_2	**D**	E_4F_3

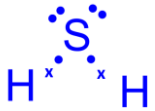
Answer: B

Element **E** is from Group 13: largest IE difference between 3rd and 4th IE
Element **F** is from Group 16: largest IE difference between 6rd and 7th IE
Compound formed: E_2F_3 eg: Al_2O_3

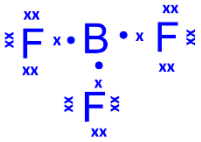
4 Which combination correctly represents the shape around the central atom in each of the species?

	SH_2	BF_3	NCl_3
A	linear	trigonal pyramidal	trigonal planar
B	linear	trigonal planar	trigonal pyramidal
C	bent	trigonal pyramidal	trigonal planar
D	bent	trigonal planar	trigonal pyramidal

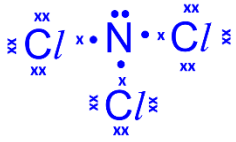
Answer: D



SH_2: bent



BF_3: Trigonal planar



NCl_3: Trigonal pyramidal

5 Gases can be liquefied under certain conditions.

Which statements about liquefaction of a non-polar gas are correct?

1	Some gases can be liquefied at room temperature by applying pressure.
2	The strength of the intermolecular forces is negligible at high pressure.
3	The strength of the intermolecular forces becomes more significant at low temperature.

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

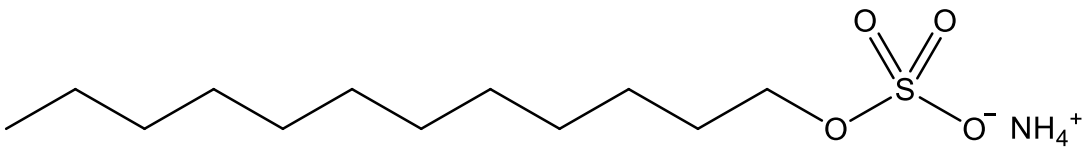
Answer: B

Applying pressure brings molecules closer and hence intermolecular forces becomes more significant for liquefaction to take place.

At low temperature, molecules have lower kinetic energy, move slower and hence intermolecular forces becomes more significant for liquefaction to take place.

[Note that the forces are not getting stronger, merely more significant in comparison to the decreased kinetic energy.]

6 Ammonium lauryl sulfate (ALS) is an anionic surfactant found primarily in shampoos and body–wash as a foaming agent. ALS is soluble in both water and oil. The structure of ALS is as follows.



Which statement is incorrect about ALS?

A	It is soluble in oil, due to the presence of compatible intermolecular instantaneous dipole–induced dipole interactions with oil molecules.
B	It is soluble in water, due to the presence of ion–dipole interactions with water molecules.
C	It has a high melting and boiling point due to the hydrogen bonding between the particles.
D	The pi bond in S=O is due to the side-on overlap of the orbitals.

Answer: C

A is correct.
The weak **instantaneous dipole-induced dipole attractions between the non-polar hydrocarbon** section of ALS is similar in strength / **compatible to the weak instantaneous dipole-induced dipole attractions between the non-polar oil molecules.**

B is correct.
The presence of **anions and cations in ALS allows for the formation of ion–dipole interactions**, which result in the release of sufficient energy to cause the detachment of ions from the giant ionic lattice structure for solvation.

C is incorrect. ALS **does not form intermolecular hydrogen bonding**. Instead it is the **ionic bonding** between the oppositely charged ions that brings about a high melting and boiling point.

D is correct as there is **pi bond is formed from side-on overlap**.

7 Consecutive elements **L**, **M** and **N** are in Period 3 of the Periodic Table. Element **M** has the lowest melting point and the highest first ionisation energy of these three elements.

What are the identities of **L**, **M** and **N**?

A	sodium, magnesium, aluminium
B	magnesium, aluminium, silicon
C	aluminium, silicon, phosphorus
D	silicon, phosphorus, sulfur

Answer: D
P has the lowest melting point as it consists of id-id attractions with smaller electron cloud. The 1st IE is the largest as it is from group 15 compared to group 14 (Si) and group 16 (S).

8 Which statement about Period 3 elements is true across the period?

A	The pH of the oxides in water decreases.
B	The solubility of the oxides in water increases.
C	The melting points of the elements decreases.
D	The electrical conductivity of the elements decreases.

Answer: A

Metallic oxides	Al_2O_3 and SiO_2	Non-metallic oxides
Basic	Not soluble in water	acidic
pH>7	pH = 7	pH<7

9 How do the following properties for Group 1 elements change down the group?

	reducing power	ionic radius	ionisation energy	
A	increases	increases	decreases	
B	increases	decreases	increases	
C	decreases	decreases	increases	
D	decreases	increases	decreases	

Answer: A

Reducing Power: As the atomic size increases down the group, the attraction of nucleus for electrons decreases and hence ease of losing electrons increases. Thus the reducing power increases as well.

Ionic Radius: Down the group, each element has 1 more principal quantum shell and hence bigger ionic radius.

Ionisation Energy: As the atomic size increases down the group, the attraction of nucleus for electrons decreases and hence ease of losing electrons increases. Thus the energy needed to remove electrons(ionisation energy) decreases.

10 Which statements are correct for all three halogens, chlorine, bromine and iodine?

1	The volatility decreases down the group.	
2	The electronegativity increases down the group.	
3	Their reactivity as oxidising agents decreases down the group.	
4	They form hydrides that are strong acids in aqueous solutions.	

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

Answer: D

Down the group, M_r of the molecules increases. Electron cloud size increases and becomes more polarisable, giving rise to strong id-id interactions. More energy is needed to overcome the stronger id-id interactions and so volatility decreases

.

Electronegativity decreases down the group.

Oxidising strength of the halogens decreases down the group due to a decrease in electrostatic attraction between valence electron and nucleus. Hence it becomes more difficult to gain an electron down the group.

HX Acidity: HC*l*, HBr and HI are all strong acids.

11 Oxygen-17, ^{17}O, isotope is commonly used in Nuclear Magnetic Resonance Spectroscopy to study the chemical environment of oxygen atoms in molecules.

How many neutrons are present in 0.17 g of ^{17}O?
[L = Avogadro constant]

A	0.01L	**B**	0.08L	**C**	0.09L	**D**	0.17L

Answer: C

$$\text{Number of } {}^{17}O \text{ atoms} = \frac{0.17}{17} \times L = 0.01L$$

Each $^{17}_{8}O$ atom has 17-8 = 9 neutrons

Number of neutrons = 0.01L x 9 = 0.09L

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

Titanite is a mineral known to be a relatively soft gemstone. A particular sample of titanite has the following composition by mass:

Ca: 20.5% Ti: 24.4% Si: 14.3% O: 40.8%

The empirical formula of titanite is $Ca_wTi_xSi_yO_z$.

What is the value of z?

A	2	**B**	3	**C**	5	**D**	7

Answer: C

Ca	Ti	Si	O
20.5%	24.4%	14.3%	40.8%
(20.5/40.1) = 0.511	(24.4/47.9)=0.509	(14.3/28.1)=0.509	(40.8/16)=2.55
1	1	1	5

Calculated empirical formula is $CaTiSO_5$.

13 25.0 cm^3 of an aqueous solution of 0.200 mol dm^{-3} T^{2+} required 20.00 cm^3 of 0.100 mol dm^{-3} of acidified $KMnO_4(aq)$ for a complete reaction.

What is the final oxidation state of T?

A	0	**B**	+3	**C**	+4	**D**	+5

Answer: C

No of moles of T^{2+} = 0.200 x 0.025 = 0.005 mol
No of moles of $KMnO_4$ = 0.100 x 0.020 = 0.0020 mol

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$
1 mol of MnO_4^- gains 5 mol of e-

No of moles of electrons gained = 5 x 0.0020 mol = 0.0100 mol
No of moles of electrons per mol of T^{2+} lost= 0.0100 / 0.0050 = 2
Since the initial oxidation state of T is +2, the unknown oxidation number is +4.

14 Under acidic conditions, bromate(V) ions and bromide ions react as shown.

$$BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$$

The reaction is found to be first order with respect to both BrO_3^- and $Br^-$and second order with respect to H^+.

The initial concentration of BrO_3^- and Br^- is increased by a factor of 4 while concentration of H^+ decreased by half.

By which factor will the initial rate increase?

A	2	**B**	4	**C**	8	**D**	16

Answer: B

Rate = k $[BrO_3^-][Br^-][H^+]^2$
$y = (x)(x)(x)^2$
$y=x^4k$

New concentration
Rate = $k(4x)(4x)(1/2x)^2$
$y' = 4x^4k$

Thus rate = 4y

15 Caffeine is a drug that increases the activity of the brain and nervous system. Its elimination from the body follows a first-order kinetics with a half-life of 5.0 h.

How long will it take for someone who took 52 mg of caffeine, to have 6.5 mg of caffeine left in his system?

A	6.5 h	**B**	15.0 h	**C**	20.0 h	**D**	40.0 h

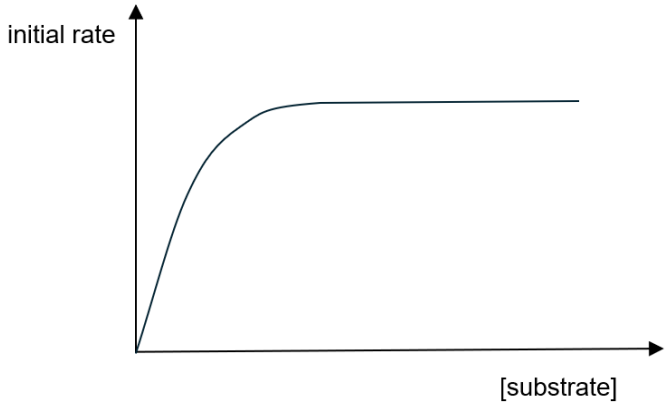
Answer: B

$(\frac{6.5}{52}) = (\frac{1}{2})^n$

n = 3

Time taken = 3 x 5h = 15 h

16 The Michaelis-Menten graph shows how the initial rate of reaction varies for an enzyme catalysed reaction as the concentration of the substrate changes.



Which statement explains the shape of the graph?

A	The enzyme is acting as a limiting reagent and is being used up in the reaction.
B	Substrate molecules inhibit the enzyme at high concentrations which resulted in a constant rate.
C	At high substrate concentration, the order of reaction with respect to substrate is 1.
D	The reaction will reach a constant rate when all active sites of the enzyme are occupied.

Answer: D

Option A (incorrect): Enzyme is a catalyst so it is not been used up in the reaction.

Option B (incorrect): substrate inhibition does occur in some systems, but that's not the usual explanation for a plateau in Michaelis-Menten kinetics.

Option C (incorrect): Order of reaction at high substrate concentration is 0.

Option D (correct): when all active sites are occupied, the enzyme is saturated, and increasing [S] further does not increase the rate

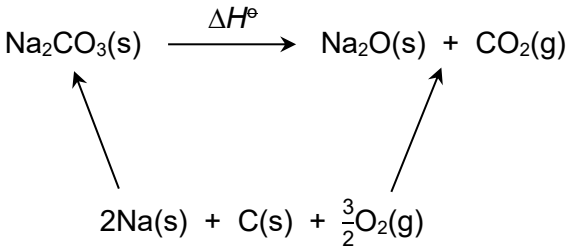
17 Which equation defines standard enthalpy change of formation correctly?

A	$Na(s) + C\mathit{l}(g) \rightarrow NaC\mathit{l}(s)$
B	$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$
C	$Mg^{2+}(g) + O^{2-}(g) \rightarrow MgO(s)$
D	$H_2(g) + S(s) + 2O_2(g) \rightarrow H_2SO_4(l)$

Answer: D

Standard enthalpy change of formation of a substance is the energy change when 1 mole of the substance is formed from its elements under standard conditions of 298K and 1bar.

18 The diagram below illustrates the energy changes of a set of reactions occurring at standard conditions.



Given that:

$\Delta H_f^{\ominus}(Na_2CO_3) = -x$ kJ mol^{-1}
$\Delta H_c^{\ominus}(Na) = -y$ kJ mol^{-1}
$\Delta H_c^{\ominus}(C) = -z$ kJ mol^{-1}

What is the unknown enthalpy change, $\Delta H^{\ominus}$, in kJ mol^{-1}?

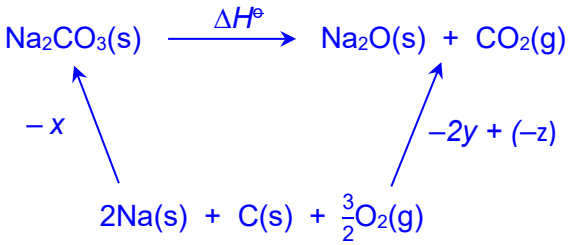
A	$x - y - z$
B	$-x + y - z$
C	$-x - y - z$
D	$x - 2y - z$

Answer: D

$2Na(s) + C(s) + \frac{3}{2}O_2(g) \rightarrow Na_2CO_3(s)$ $\quad \Delta H_f^{\ominus}(Na_2CO_3)$

$Na(s) + \frac{1}{4}O_2(g) \rightarrow \frac{1}{2}Na_2O(s)$ $\quad \Delta H_c^{\ominus}(Na)$

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\quad \Delta H_c^{\ominus}(C)$



$\Delta H^{\ominus} = \underline{\boldsymbol{x - 2y - z}}$

19 The decomposition of iron(III) hydroxide, $Fe(OH)_3$, produces water and iron(III) oxide, Fe_2O_3, as shown in the equation below.

$$2Fe(OH)_3(s) \rightarrow Fe_2O_3(s) + 3H_2O(g) \qquad \Delta H_r = +96.4 \text{ kJ mol}^{-1}$$

Given that the values of the enthalpy change of formation of $Fe_2O_3(s)$ and $H_2O(g)$ are –824 kJ mol^{-1} and –242 kJ mol^{-1} respectively, what is the enthalpy change of the formation of $Fe(OH)_3(s)$?

	A	– 727 kJ mol^{-1}
	B	– 823 kJ mol^{-1}
	C	– 1454 kJ mol^{-1}
	D	– 1646 kJ mol^{-1}

Answer: B

$\Delta H_r = \Sigma\Delta H_f$ (products) – $\Sigma\Delta H_f$ (reactants)

$+96.4 = (–824 + 3(–242)) – 2\Delta H_f(Fe(OH)_3)$

$2\Delta H_f(Fe(OH)_3) = –1646$

$\Delta H_f(Fe(OH)_3) =$ **–823 kJ mol^{-1}** (to 3 s.f.)

20 In a 2.0 dm^3 vessel, 1.6 mol of nitrosyl chloride gas, NO*Cl*, was heated at 320°C. At equilibrium, 40% of the NO*Cl* gas dissociated according to the equation below.

$$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$$

What is the numerical value of the equilibrium constant, K_c?

	A	0.071
	B	0.107
	C	0.137
	D	0.142

Answer: A

	2NO*Cl* (g)	⇌	2NO (g)	+ Cl_2 (g)
Initial/ mol	1.6		0	0
Change/ mol	$-\left(\frac{40}{100} \times 1.6\right)$ = – 0.64		+ 0.64	$+\left(\frac{1}{2} \times 0.64\right)$ = + 0.32
Equilibrium/ mol	0.96		0.64	0.32
Equilibrium/ mol dm^{-3}	$\frac{0.96}{2}$ = 0.48		$\frac{0.64}{2}$ = 0.32	$\frac{0.32}{2}$ = 0.16

	$K_c = \frac{[NO]^2[Cl_2]}{[NOCl]^2} = \frac{(0.32)^2(0.16)}{(0.48)^2} =$ **0.071 mol dm^{-3}**

21	The Haber Process is an industrial method used to synthesise ammonia from nitrogen and hydrogen gases. $N_2(g) + H_2(g) \rightleftharpoons NH_3(g) \qquad \Delta H_r < 0$ Which statements about Haber Process are correct?		
		1	Iron catalyst is added to increase the yield of ammonia.
		2	An adequately high pressure of 250 atm is used to increase the yield of ammonia while keeping cost of reaction low.
		3	A moderate temperature of 450 °C is used to increase yield of ammonia while ensuring high rate of reaction.
	A	1 and 2 only	
	B	1 and 3 only	
	C	2 and 3 only	
	D	1, 2 and 3	
	Answer: C Use of catalyst does not increase the yield of ammonia. It increases the rate of reaction. (Option 1 is incorrect) High pressure favours the formation of ammonia. However, too high a pressure would be expensive to maintain as thicker pipes need to be built to withstand the high pressure. ⇒ an adequately high pressure of 250 atm is used instead (Option 2 is correct) Low temperature favours the formation of ammonia. However, too low a temperature would decrease the rate of reaction, making it not feasible industrially. ⇒ a moderate temperature of 450 °C is used instead (Option 3 is correct)		

22	Which equation shows the first reactant acting as a Brønsted–Lowry acid?	
	A	$NH_3 + NaH \rightarrow NaNH_2 + H_2$
	B	$O^{2-} + H_2O \rightarrow 2OH^-$
	C	$HPO_4^{2-} + H_3O^+ \rightarrow H_2PO_4^- + H_2O$
	D	$HNO_3 + H_2SO_4 \rightarrow H_2NO_3^+ + HSO_4^-$
	Answer: A Option A: NH_3 loses a proton to form NH_2^-. Option B: Oxide anion is a proton acceptor, hence a Bronsted–Lowry base. Option C: HPO_4^{2-} is a proton acceptor, hence a Bronsted–Lowry base. Option D: HNO_3 is a proton acceptor, hence a Bronsted–Lowry base.	

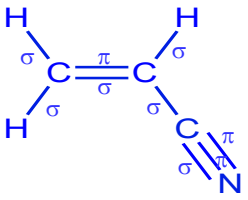
23	Water dissociates into ions according to the following equilibrium. $H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$ $\quad \Delta H^\ominus = +57\ kJ\ mol^{-1}$ at 25°C Which statements are correct as temperature is increased to 50°C?							
		1	The dissociation constant of water, K_w, increases					
		2	$[H^+] = [OH^-]$					
		3	pH of water remains at 7					
	A	1 and 2 only	**B**	1 and 3 only	**C**	2 and 3 only	**D**	1 only
	Answer: A When temperature increases, based on Le Chatelier's principle, equilibrium position will shift right towards the endothermic reaction to absorb heat. Since $K_w = [H^+]\,[OH^-]$, K_w increases in magnitude. $[H^+] = [OH^-]$ as 1 mol of water molecule dissociates to form 1 mol of H^+ and 1 mol of OH^-. pH will decrease to a value below 7, as $[H^+]$ increases. (pH = – log $[H^+]$)							

24 The molecule $H_2C{=}CHC{\equiv}N$ is planar.

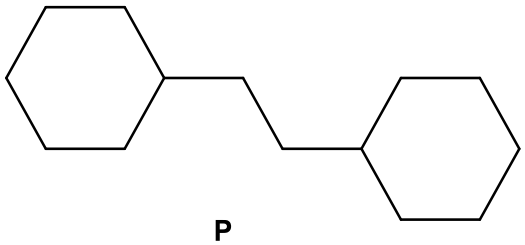
State the number of σ and π bonds present in the molecule.

	σ	π
A	4	2
B	4	5
C	6	3
D	6	5

Answer: C



25 How many mono-brominated isomers, could be produced when compound **P** reacts with bromine in the presence of sunlight?

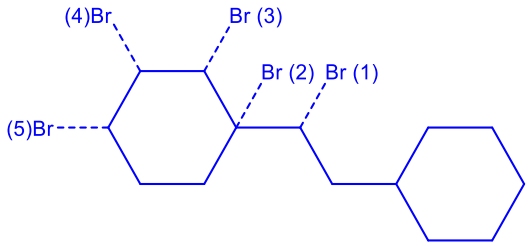


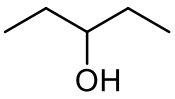
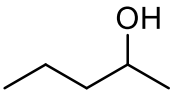
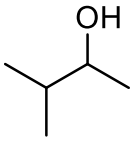
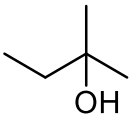
P

A	5	**B**	6	**C**	7	**D**	8

Answer: A

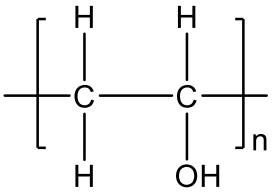
There are **5** isomers based on mono-substitution.



26	Which alcohol gives the greatest number of different alkenes on elimination?				
	A		**B**		
	C		**D**		
	Answer: B Option A: 2 isomers – cis-pent-2-ene & trans-pent-2-ene Option B: 3 isomers – pent-1-ene, cis-pent-2-ene & trans-pent-2-ene Option C: 2 isomers – 3-methylbut-1-ene, 2-methylbut-2-ene Option D: 2 isomers – 2-methylbut-2-ene, 2-mtheylbut-1-ene				

27	The diagram shows the products of two reactions of ethanol, C_2H_5OH. C_2H_4 ←**Q**— C_2H_5OH —**R**→ $C_2H_4O_2$ Which reagents and conditions are used in reactions **Q** and **R**?			
		Q	**R**	
	A	alcoholic KOH, heat	$LiAlH_4$ in dry ether	
	B	excess concentrated H_2SO_4, heat	$LiAlH_4$ in dry ether	
	C	alcoholic KOH, heat	acidic $KMnO_4$, heat	
	D	excess concentrated H_2SO_4, heat	acidic $KMnO_4$, heat	
	Answer: D Reaction X involves elimination of H_2O (Option A and C wrong) Reaction Y involves oxidation reaction. (Option B wrong)			

28 The structure below is that of a polymer based on vinyl alcohol.



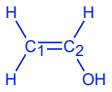
Which statements correctly describe the above polymer?

1	It is water-resistant.
2	The polymer can react with hot aqueous base.
3	The polymer is formed via addition polymerisation.
4	The monomer cannot exhibit cis trans isomerism.

A	1 and 2 only
B	3 and 4 only
C	2, 3 and 4 only
D	1, 2 and 4 only

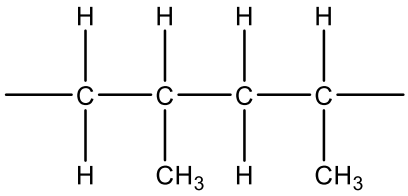
Answer: B

Option 1: The alcohol can form hydrogen bonds with the water. (incorrect)
Option 2: The alcohol cannot undergo neutralisation with hot aqueous base. (incorrect)
Option 3: presence of the C=C in the monomer allows formation of polymer via addition reaction. (correct)

Option 4: The monomer  cannot form cis-trans as there are 2 similar group attached on C_1.

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

A short section of the chain in the addition polymer polypropylene is shown.

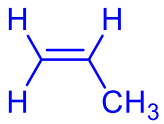


The relative molecular mass of a sample of the polypropylene is approximately 150 000.

How many monomers are joined together to make this typical polymer molecule?

A	1790	**B**	1830	**C**	3570	**D**	3750

Answer: C



monomer

$M_r = 42$

No of monomers = 150 000/ 42 = 3570

30 Which statement about nanomaterials is correct?

A	Nanomaterials could lead to environment hazard if not disposed properly.
B	Nanomaterials are good catalysts due to their high surface area to mass ratio.
C	Nanomaterials are classified as particles with all dimensions between 1–100 nm on the nanoscale.
D	Nanomaterials could be used in cosmetic products because it has no potential harmful effects on human health.

Answer: A

Option A : Due to their tiny size, nanomaterials may enter the water bodies and affect aquatic life etc and ;lead to environment hazards if not disposed properly. (correct)
Option B: Nanomaterials are good catalysts due to high surface area to VOLUME ratio, not to mass ratio. (incorrect)
Option C : Nanomaterials are defined as a material containing particles where there is **at least one** dimension between 1–100 nm on the nanoscale. (incorrect)
Option D: Nanomaterials are used in cosmetic products due to their efficiency due to their tiny size, not because they have no harmful effects on human health.