NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME			
SUBJECT CLASS		REGISTRATION NUMBER	

CHEMISTRY **8873/01**
Paper 1 Multiple Choice **19 September 2024**
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 **15** printed pages and **1** blank page.

Suggestion solution for P1 (MCQ)

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

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

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

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

A sample of 35.6 g of hydrated sodium carbonate contains 25.84% sodium ions by mass. When this sample is heated, anhydrous sodium carbonate and water vapour are formed.

What is the mass lost?

A 7.2 g **B** 10.6 g **C** 14.4 g **D** 21.2 g

Ans: C

$Na_2CO_3.xH_2O \rightarrow Na_2CO_3 + xH_2O$

$\frac{46}{106 + 18(x)} \times 100\% = 25.84$

x = 4

Mass of water given off = $\frac{35.6}{178} \times 18 \times 4 = 14.4g$

2 Diamond is an allotrope of carbon. The mass of a diamond can be measured in carats. One carat is 0.200 g of carbon.

Which expression gives the number of carats that contain 6.02×10^{23} carbon atoms?

A 0.200×12.0

B $\frac{12.0}{0.200}$

C $\frac{0.200}{12.0}$

D $\frac{0.200}{6.02 \times 10^{23}} \times 12.0$

Ans : B

1 mol of C contains 6.02×10^{23} C atoms

Mass of C = 12.0 g

Number of carat = $\frac{12.0}{0.200}$

3 One of the main chemicals in air bags in cars is the ionic compound sodium azide, NaN_3.

When the car is in a violent head-on impact, a sensor causes ignition of the sodium azide to form nitrogen gas explosively, rapidly filling the air bag.

I $2NaN_3 \rightarrow 2Na + 3N_2$

Fine particles of potassium nitrate and silicon dioxide are also present to react with the metallic sodium.

II $2KNO_3 + 10\ Na \rightarrow 5Na_2O + K_2O + N_2$

III $K_2O + SiO_2 \rightarrow K_2SiO_3$

IV $Na_2O + SiO_2 \rightarrow Na_2SiO_3$

Which statement is **not** correct?

A Equations III and IV represent acid-base reactions.

B In reaction I, sodium ions are reduced.

C In reaction II, both sodium atoms and potassium ions are oxidised.

D In reaction II, potassium nitrate is an oxidising agent.

Ans : C

Option A is correct. For reactions III and IV, basic oxide (metal oxide) reacts with acidic oxide (non-metal) oxide to produce salts.

Option B is correct. Oxidation state of Na decreases from +1 (in NaN_3) to 0 (in Na).

Option C is incorrect. K^+ ion is not oxidised, its oxidation state remains the same at +1.

Option D is correct. KNO_3 is an oxidising agent that oxidises Na to Na^+.

4 When iodine is oxidized by nitric acid, a white crystalline solid oxide can be isolated from the mixture.

1 mol of this iodine oxide reacts with 10 mol of acidified potassium iodide to give 6 mol of I_2.

What is the oxidation number of iodine in the oxide?

A +1 **B** +5 **C** +6 **D** +10

Ans: B
1 mol of iodine oxide reacts with 10 mol of I^- to gives 6 mol of I_2.
Balancing number of I atoms on both sides,
6 mol of I_2 contains 12 mol of I atoms.
Hence, 1 mol of iodine oxide contains 2 mol of iodine atoms.

2 mol I^{x+} reacts with 10 mol I^- to produce 6 mol I_2.

[O] $2I^- \longrightarrow I_2 + 2e^-$
10 mol I^- gives 10 mol of e^-

[R] $I^{x+} + ne^- \longrightarrow I_2$
2 mol of I^{x+} gains 10 mol of e^-
1 mol of I^{x+} gains 5 mol of e^- to give I_2

During **reduction**, oxidation state of I^{x+} **decreases** by **5** units from **+5** to **0**.

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

Sodium and fluorine are both reactive elements.

Which statements are correct?

1 One Na atom has two more protons than one F^- ion.

2 One Na atom has two more neutrons than one F atom.

3 One Na^+ ion has the same number of electrons as one F^- ion.

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

Ans: A

	F	→	F^-		Na	→	Na^+
p	9		9		11		11
n	10		10		12		12
e	9		10		11		10

6 Which pair of compounds meets the criteria below?

- The first compound has a larger bond angle than the second compound.
- The second compound is more polar than the first compound.

A CO_2, BCl_3 **B** SF_6, H_2O **C** HCN, SO_3 **D** CO_2, NH_3

Ans: D

molecules	bp	lp	shape	angle	Polar?
CO_2	2	0	Linear	180º	Non polar
BCl_3	3	0	Trigonal planar	120 º	Non polar
SF_6	6	0	Octahedral	90º	Non-polar
H_2O	2	2	Bent	105º	Polar
HCN	2	0	Linear	180º	Polar
SO_3	3	0	Trigonal Planar	120º	Non polar
NH_3	3	1	Trigonal pyramidal	107.5º	Polar

7 Which statements about the structure of the $AlCl_3$ molecule are correct?

1 The aluminium atom has an unfilled octet.

2 The molecule is planar in shape.

3 In the molten state, it consists of Al^{3+} and Cl^- ions.

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

Ans : B

Statement 3 is wrong. $AlCl_3$ is a covalent molecule, it does not exist as ions in molten state.

Statements 1 and 2 are correct. Shape around Al is trigonal planar (3b.p, 0l.p) and also Al to have an unfilled octet (only 6 electrons after bonding).

8 Consider the following four compounds.

1 $(CH_3)_3CH$

2 $CH_3CH_2CH_2CH_3$

3 $CH_3CH_2CH_2OH$

4 CH_3CH_2Cl

What is the order of increasing boiling point of the compounds?

A 1 2 4 3

B 2 1 4 3

C 3 4 2 1

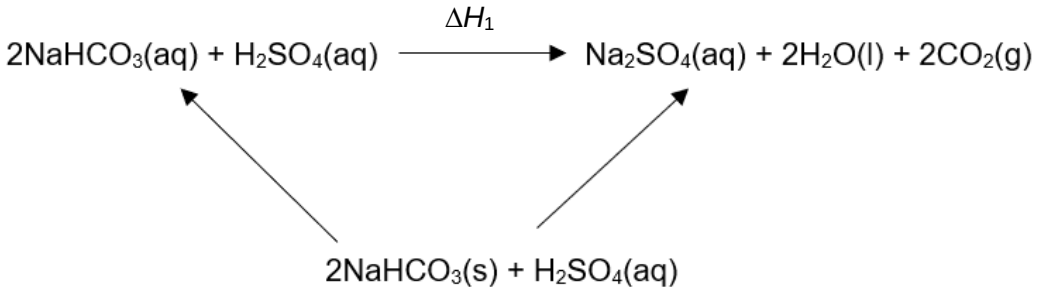
D 4 3 2 1

Ans : A

1. $(CH_3)_3CH$: branched(spherical) → weaker idid than 2 → **lowest b pt.**
2. $CH_3CH_2CH_2CH_3$: straight chain → stronger idid than 1.
3. $CH_3CH_2CH_2OH$: H–bonding → **highest b pt.**
4. CH_3CH_2Cl : pd–pd

9 The diagram below represents the energy changes associated with $NaHCO_3$ and H_2SO_4.

	ΔH / kJ mol^{-1}
$NaHCO_3(s) + aq \rightarrow NaHCO_3(aq)$	+ 15.0
$2NaHCO_3(s) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l) + 2CO_2(g)$	+ 37.0



Determine the value of ΔH_1.

A + 7.0 kJ mol^{-1} **B** + 22.0 kJ mol^{-1} **C** + 37.0 kJ mol^{-1} **D** +52.0 kJ mol^{-1}

Ans : A

$\Delta H_1 = -2 \times 15 + 37 = +7.0$ kJ mol^{-1}

10 In order to determine the enthalpy of neutralisation of a strong acid and a strong alkali, 25.0 cm^3 of 2.00 mol dm^{-3} sodium hydroxide is added to 25.0 cm^3 of 2.00 mol dm^{-3} hydrochloric acid. The increase in temperature is 12°C.

In a second experiment, the same method is used, but 50.0 cm^3 of 2.00 mol dm^{-3} sodium hydroxide is added to 50.0 cm^3 of 2.00 mol dm^{-3} hydrochloric acid.

What is the increase in temperature in the second experiment?

A 6°C **B** 12°C **C** 24°C **D** 48°C

Ans: B

$H^+ + OH^- \rightarrow H_2O$
0.05 0.05 0.05
$q = mc\Delta T$
$= (25+25) \times 4.18 \times 12$
$= 2508$ J

$H^+ + OH^- \rightarrow H_2O$
0.1 0.1 0.1
Since 0.1 mol of H_2O is produced, heat released would be double of that of expt 1.
$q = mc\Delta T$
$2508 \times 2 = (50+50) \times 4.18 \times \Delta T$
$\Delta T = 12$°C

11 What is meant by the term *dynamic equilibrium?*

A An equilibrium that is constantly changing its position

B An equilibrium where the forward and reverse reactions are taking place at different rate

C An equilibrium where the forward and reverse reactions are taking place at the same rate

D An equilibrium which has not yet settled to a constant state

Ans : C

12 X and Y react together to form Z in a reversible reaction.

The equilibrium yield of Z at different conditions are shown in the following table.

Conditions	Equilibrium yield of Z
High Temperature	Decreased
High Pressure	Increased

Which equation could represent this reaction?

A $X(g) + Y(g) \rightleftharpoons Z(g)$ $\quad \Delta H = -100 \text{ kJ mol}^{-1}$

B $X(g) + Y(g) \rightleftharpoons Z(g)$ $\quad \Delta H = +100 \text{ kJ mol}^{-1}$

C $X(s) + Y(g) \rightleftharpoons 2Z(g)$ $\quad \Delta H = -100 \text{ kJ mol}^{-1}$

D $X(s) + Y(g) \rightleftharpoons 2Z(g)$ $\quad \Delta H = +100 \text{ kJ mol}^{-1}$

Ans: A

Higher temperature, equilibrium shifts left which favour endothermic reaction. Therefore, the forward reaction is an exothermic reaction.

Lower pressure, equilibrium shifts left since L.H.S has greater number of moles of gases.

13 PCl_5 decomposes as shown.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

1.0 mol of $PCl_5(g)$, 1.0 mol of $PCl_3(g)$ and 1.0 mol of $Cl_2(g)$ are placed in a container of volume 2 dm^3 at 250 °C and allowed to reach equilibrium.

At this temperature, the equilibrium mixture contains 1.8 mol of PCl_3.

What is the value of K_c at 250 °C?

A 0.12 **B** 1.8 **C** 8.1 **D** 16.2

Ans: C

	$PCl_5(g)$	$\rightleftharpoons$	$PCl_3(g)$ +	$Cl_2(g)$
I / mol dm^{-3}	0.5		0.5	0.5
C / mol dm^{-3}	-0.4		+0.4	+0.4
E / mol dm^{-3}	0.1		0.9	0.9

$$\mathbf{K_c = \frac{(0.9)(0.9)}{0.1} = 8.1}$$

14 Ammonium carbonate is a crystalline solid. On gentle warming a reaction occurs, forming ammonia as one product.

How are the carbonate ions behaving during this reaction?

A Brønsted-Lowry acid

B Brønsted-Lowry base

C oxidising agent

D reducing agent

Ans: B

$(NH_4)_2CO_3 \rightarrow 2NH_3 + H_2O + CO_2$

CO_3^{2-} gained H^+ to form H_2CO_3 which spontaneously forms $H_2O + CO_2$ on warming.

Therefore it is a Brønsted-Lowry base.

15 The dissociation constant, K_w, for the ionisation of water, $H_2O \rightleftharpoons H^+ + OH^-$, at different temperatures is given below.

Temperature / °C	K_w / mol^2 dm^{-6}
0	1.15×10^{-15}
25	1.00×10^{-14}
50	5.50×10^{-14}

Which statement is correct?

A Only at 25 °C are $[H^+]$ and $[OH^-]$ equal.

B The equilibrium lies furthest to the right at 0 °C.

C The forward reaction is exothermic.

D The pH of water decreases with temperature.

Ans: D

Option **A** is incorrect as the $[H^+]$ and $[OH^-]$ of water are equal at all temperatures.

Option **B** is incorrect as the value of K_w is the smallest (across the three temperatures) at 0 ^{o}C. Hence, equilibrium lies most to the left.

Option **C** is incorrect as K_w increases with temperature, the forward reaction is favoured. By LCP, the position of equilibrium would shift to favour endothermic reaction.

Option **D**:
$K_w = [H^+] [OH^-]$
$K_w = [H^+]^2$
pH = – log $\sqrt{}$ (K_w)
as K_w increases with temperature, pH will decrease.

16 The indicator bromophenol blue, HIn, changes colour from yellow to blue over a pH range of 3.0 to 4.6.

Which statements are correct?

1 When bromophenol blue is added to water at 25 °C, [HIn] < [In^-].

2 Bromophenol blue would be a suitable indicator for the titration of a strong base and a weak acid.

3 The In^- ions are yellow.

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

Ans: C

Water has a pH of 7, so the indicator would show blue colour, which means

[HIn] < [In^-].Hence statement 1 is correct.

Statement 2 is incorrect: The end point of the titration between a strong base and weak acid > pH 7, the sharp change in pH at the equivalence point does not overlap with the working range of bromophenol blue. Hence it will change colour only after the equivalence point when a weak acid is added from burette.

Statement 3 is incorrect: Since bromophenol blue changes colour from yellow to blue over a pH range of 3.0 to 4.6, this implies that the colour of the solution will be yellow and blue for pH < 3.0 and pH > 4.6 respectively. (HIn molecule is yellow while In^- ion is blue.)

17 Which statement about catalysts is correct?

A Catalysts alter the reaction pathway by increasing the activation energy.

B Catalysts increase the rate of reaction of only the forward reaction of an equilibrium reaction.

C Catalysts ensure reactants have the correct orientation for reaction.

D Catalysts alter the yield of an equilibrium reaction.

Ans : C

18 Potassium – Argon dating is the most widely used technique for determining the absolute ages of crustal geologic events and processes. ^{40}K decays to form ^{40}Ar with a half-life of 1.25×10^9 years.

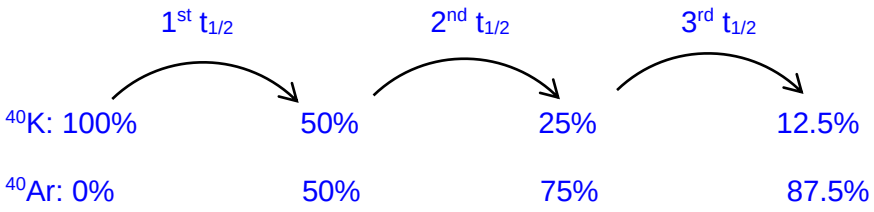
A rock sample was tested and found to have the ratio of ^{40}K: ^{40}Ar to be 1:7

Determine the age of the rock in years.

A 1.25×10^9 **B** 2.50×10^9 **C** 3.75×10^9 **D** 6.00×10^9

Ans : C

To have the ratio of ^{40}K: ^{40}Ar to be 1:7, ^{40}K must have gone through 3 half-lives:



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

What are the identities of the two oxides?

A Al_2O_3 and MgO

B Na_2O and MgO

C SiO_2 and Al_2O_3

D Na_2O and P_4O_{10}

Ans: D

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

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

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

D. Na_2O (pH > 7, ionic oxide➔ basic) and P_4O_{10} (pH < 7, covalent oxide➔ acidic)

$Na_2O(s) + H_2O(l) \rightarrow 2\ NaOH(aq)$
$P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$

$3NaOH + H_3PO_4\ (aq) \rightarrow 4Na_3PO_4$

NaOH is the limiting reagent, hence excess H_3PO_4 is present, so the **pH Will be below 7**

20 **X**, **Y** and **Z** are elements all found within Groups 13, 14 and 15 of the Periodic Table.

X is in the same group in the Periodic Table as **Y**.

Y and **Z** are in Period 3.

The first ionisation energy of **X** is greater than the first ionisation energy of **Y**.
The melting point of **Z** is less than the melting point of **Y**.

Y and **Z** both form chlorides which are white solids. These white solids react with water to produce solutions with a pH of less than 4.

Which row of the table shows the possible identities of **X** and **Y**?

	X	**Y**
A	B	A*l*
B	Ge	Si
C	As	P
D	N	P

Ans: A

X is in the same group in the Periodic Table as **Y**. The first ionisation energy of **X** is greater than the first ionisation energy of **Y**.
➔**X** must be in an earlier period than **Y**.
➔Option B & C wrong

Y and **Z** are in Period 3. **Y** and **Z** both form chlorides which are **white solids.** These white solids react with water to produce solutions with a pH of less than 4.
➔$AlCl_3$, PCl_5 are solid that give pH less than 4
➔$SiCl_4$ is a liquid that gives pH less than 4
➔Option B is wrong

Y and **Z** are in Period 3. The melting point of **Z** is less than the melting point of **Y**.
➔Melting point of Si > A*l* > P
➔ Y cannot be P
➔Option D is wrong

21 Which factor helps to explain why the reducing power of the Group 1 elements increases from lithium to rubidium?

A The repulsion between paired electrons increases.

B The outer electron is in an ‘s’ subshell.

C The nuclear charge of the elements increases.

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

22 The solids sodium bromide and sodium iodide both react with concentrated sulfuric acid at room temperature.

With NaBr, the products formed are S and Br_2.

With NaI, the products formed are H_2S and I_2.

Which statement can be deduced from the above information?

A Iodine will displace the bromide ions from the solution.

B Sodium bromide is more volatile than sodium iodide.

C Iodide ions are stronger reducing agents than bromide ions.

D Sulfuric acid act as a dehydrating agent with NaI.

Ans: C

A. **Wrong** – Iodine is a weaker oxidising agent than bromine.

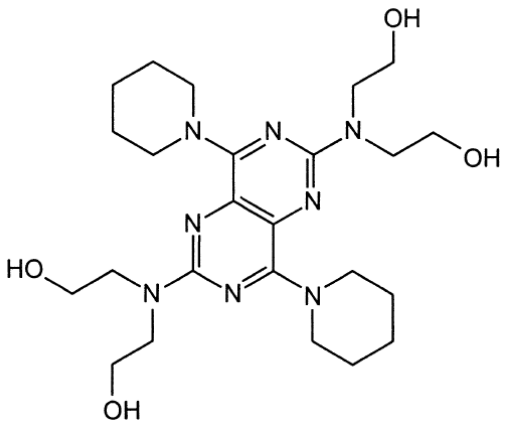
B. **Wrong** – Reaction did not show their boiling point.

C. **True** - The 2 reaction shows how the halide reacted with H_2SO_4. I^- acted as a reducing with H_2SO_4 but not with Br^-.

There is no change in oxidation state change for S when reacted with Br^- but when reacted with I^-, S in H_2SO_4 (+6) oxidation is being reduced to -2 in H_2S.

D. **Wrong** - There is an oxidation state change for I^- to become I_2. So H_2SO_4 is an oxidizing agent

23 Dipyridamole is a drug that is used to treat recovering stroke patients.



Dipyridamole

What is the empirical formula of this drug?

A $C_6H_9N_2O$

B $C_6H_{10}N_2O$

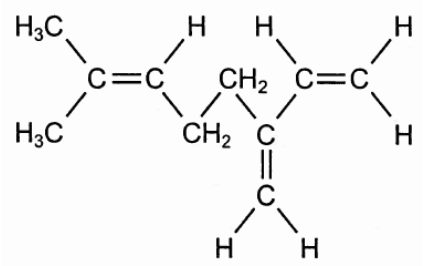
C $C_{11}H_{20}N_4O_2$

D $C_{24}H_{40}N_8O_4$

Ans: B

Molecular Formula = $C_{24}H_{40}N_8O_4$
Empirical Formula = $C_6H_{10}N_2O$

24 The following unsaturated hydrocarbon is found in the secretion of a termite.



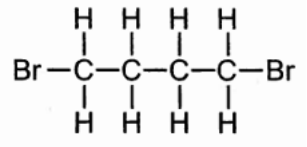
How many pairs of cis-trans isomers of this molecule exist?

A 0 **B** 1 **C** 2 **D** 3

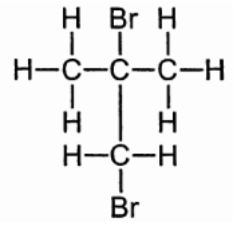
Ans : A
No cis-trans C=C

25 Which compound could be formed by the action of bromine on an alkene of formula C_4H_8?

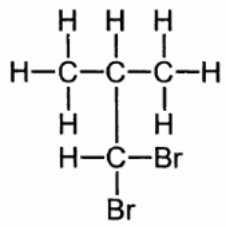
A



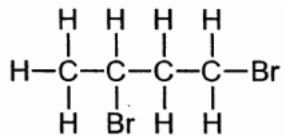
B



C



D



Ans: **B**

Br_2 react with alkenes via electrophilic addition where 2 Br atoms are added across the C=C. Hence, the 2 Br atoms will be on adjacent C atoms. The only compound that fulfils this criteria is compound **B**.

26 Lactic acid accumulates in muscles when oxygen is in short supply. It can cause muscular pain. Part of the reaction sequence is shown.

$$\underset{\text{glyceraldehyde}}{HOCH_2CH(OH)CHO} \rightarrow \underset{\text{pyruvic acid}}{CH_3COCO_2H} \rightarrow \underset{\text{lactic acid}}{CH_3CH(OH)CO_2H}$$

Which statements about the reaction sequence are correct?

1 An aldehyde is oxidised to a carboxylic acid.

2 A ketone is reduced to a secondary alcohol.

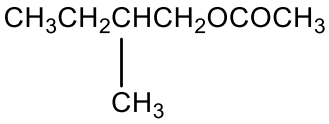
3 A secondary alcohol is oxidised to a ketone.

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

Ans: A

1 The aldehyde on glyceraldehyde is oxidised to a carboxylic acid on pyruvic acid
2 The ketone on pyruvic acid is reduced to a 2^o alcohol on lactic acid.
3 The 2^o alcohol on glyceraldehyde is oxidised to a ketone on pyruvic acid

27 An ester with a smell of banana has the following formula.



Which pair of reactants, under suitable conditions, will produce this ester?

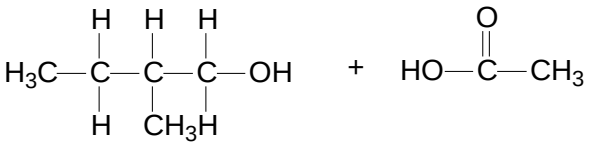
A 2-methylbutan-1-ol and ethanoic acid

B 2-methylpentan-1-ol and methanoic acid

C 2-methylbutanoic acid and ethanol

D 2-methylpentanoic acid and methanol

Ans : A



28 Polymers are used extensively in our daily lives. Various polymers have found their way into products such as eye drops and wrinkle free shirts.

Which row best describes the most suitable polymer to use for each type of product?

	Eye drops	wrinkle free shirts
A	poly(vinyl alcohol)	polyamide
B	poly(vinyl chloride)	polyester
C	poly(vinyl chloride)	polyamide
D	poly(vinyl alcohol)	polyester

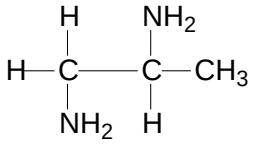
Ans : D

Poly(vinyl alcohol) can form hydrogen bonding with water, it is soluble in the eye drops.

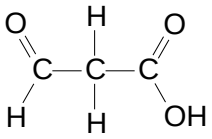
Polyester forms weaker pd-pd and id-id between polymer chains, less prone to wrinkle.
Polyamide forms stronger H-bonding between polymer chains, more likely to create crease on shirt.

29 Which molecule cannot be used to carry out polymerisation?

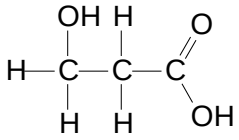
A



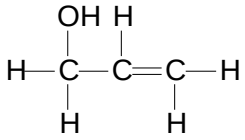
B



C



D



Ans : B

Molecule B can only form ONE ester group on the −COOH end, it is unable to form polymer.

30 Which statements related to nanoparticles and nano-structures are true?

1 Graphene is a nanoparticle.

2 There are permanent dipole-permanent dipole forces of attraction between the wall surface and nano-structures of the gecko's feet.

3 Nanoparticles of smaller diameter allows more sites available for heterogeneous catalysis to take place.

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

Ans : D

Statement 1 is incorrect. Graphene is a nanomaterial as only 1 of its dimensions are in the nanoscale.

Statement 2 is incorrect. It should be weak id-id interactions.

Statement 3 is correct. Smaller particle size increases the surface area of contact with reactants.