

TEMASEK JUNIOR COLLEGE
2024 JC2 PRELIMINARY EXAMINATION
Higher 1



CHEMISTRY

8873/01

Paper 1 Multiple Choice

12 September 2024

1 hour

Additional Materials: Multiple Choice Answer Sheet (OMS)
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A, B, C, 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.

Write your name & Civics Group on the Answer sheet. Shade your index number in the appropriate boxes.

1. Enter your NAME (as in NRIC). _____
2. Enter the SUBJECT TITLE. _____
3. Enter the TEST NAME. _____
4. Enter the CLASS. _____

Write your **name**
and **Civics Group**

5. Enter your CLASS NUMBER or INDEX NUMBER.
6. Now SHADE the corresponding lozenge in the grid for EACH DIGIT or LETTER

WRITE		SHADE APPROPRIATE BOXES									
I N D E X		0	1	2	3	4	5	6	7	8	9
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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N U M B E R		0	1	2	3	4	5	6	7	8	9
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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		A	B	C	D	E	F	G	H	I	
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Index number
(refer to entry proof)

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.

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 (OMS).

1 Which statement about the electrons in a ground state nitrogen atom is correct?

- A** There are more electrons in s orbitals than there are in p orbitals.
- B** Electrons are present in two different energy levels.
- C** There is a pair of electrons in one of the p orbitals.
- D** The occupied orbital of highest energy is spherical.

Answer: **A**

The electronic configuration of N is $1s^2 2s^2 2p^3$.

A: Correct statement. There are 4 electrons in s orbitals and 3 electrons in p orbitals.

B: Electrons are present in three different energy levels (1s, 2s and 2p).

C: All the electrons in p orbitals are unpaired.

D: The occupied orbital of highest energy level is 2p, which has a dumb-bell shape.

2 In an experiment, protons are deflected by an angle of $+10^\circ$.

In another experiment under identical conditions, particle X is deflected by an angle of -2.5° .

What could be the composition of particle X?

	protons	neutrons	electrons
A	4	4	5
B	2	2	3
C	2	2	1
D	1	2	2

Answer: **B**

The angle of deflection is $\propto$ charge/ mass. Since X is deflection in the opposite direction as proton, it has a negative charge, with charge/mass = $\frac{1}{4}$.

	charge	mass	Charge/ mass
A	-1	8	-1/8
B	-1	4	-1/4
C	+1	4	+1/4
D	-1	3	-1/3

- 3 Which compound is composed of cation and anion that has the same number of electrons as each other?

1 Na_2O 2 NaN_3 3 NH_4F 4 NaCl

- A 1 and 3
B 1 and 4
C 2 and 3
D 2 and 4

Answer: A

	Cation	Number of e^-	Anion	Number of e^-
1	Na^+	$11 - 1 = 10$	O^{2-}	$8 + 2 = 10$
2	Na^+	10	N_3^-	$3(7) + 1 = 22$
3	NH_4^+	$7 + 4 - 1 = 10$	F^-	$9 + 1 = 10$
4	Na^+	10	Cl^-	$17 + 1 = 18$

- 4 Use of the Data Booklet is relevant to this question.

The **sixth** ionisation energies of four different elements are shown below. The elements are arsenic, selenium, antimony and tellurium (though not necessarily in that order) from Groups 15 and 16.

Which of the following shows the sixth ionisation energy of antimony?

A 12300 B 10400 C 7880 D 6820

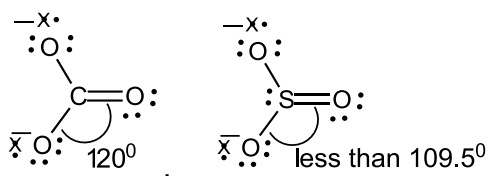
Answer: B

Arsenic (As) and Antimony (Sb) are in Group 15 and have 5 valence electrons in their valence shell. The sixth ionisation energies of As and Sb involve the removal of electron from an inner electron shell, hence the values are large → options A and B. Sb is in a Period below As, the electron to be removed from Sb is further from the nucleus and hence less strongly attracted. Hence, the sixth ionisation energy indicated in B is for Sb.

5 Which feature is present in each of the ions CO_3^{2-} and SO_3^{2-} ?

- A All bond angles are 120°
- B One dative covalent bond
- C Three sigma bonds
- D Eight lone pairs of electrons

Answer: C



6 Beryllium chloride, BeCl_2 , fully reacts with ammonia, NH_3 to form a compound. Which of the statements is **incorrect**?

- A The compound is formed from 1 mole of BeCl_2 and 2 moles of NH_3 .
- B The Be-N bond formed is chemically similar to a covalent bond.
- C The beryllium atom in beryllium chloride is electron deficient.
- D The compound is capable of forming only two hydrogen bonds per molecule.

Answer: D

A & C Only 4 e around Be on BeCl_2 , hence electron deficient. It can accommodate another 2 pairs of e from N to achieve octet.

B A dative bond is the same as a single covalent bond (strength and length)

D The compound formed has no more lone pairs of e on N available for hydrogen bonding.

7 In which of the following pairs of compounds would the first compound have a higher melting point than the second compound?

- 1 Na_2O , K_2O
- 2 AlF_3 , AlCl_3
- 3 MgO , MgCl_2

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

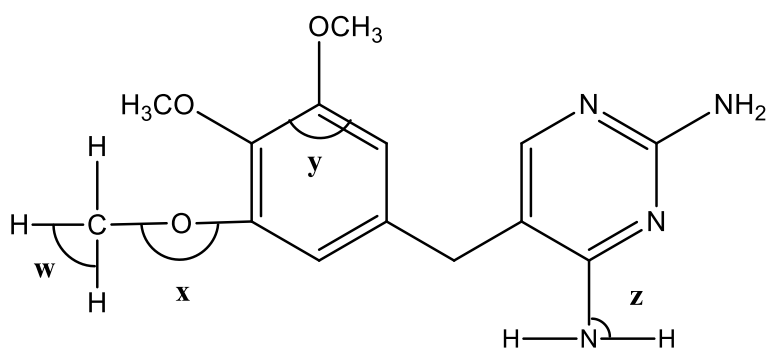
Answer: **A**

Option 1: Correct. $|LE| \propto \frac{q_{M^+} q_{O^{2-}}}{r_{M^+} + r_{O^{2-}}}$. As $r_{K^+} > r_{Na^+}$, Na_2O has a higher melting point.

Option 2: Correct: AlF_3 is ionic while $AlCl_3$ is simple covalent $\Rightarrow AlF_3$ has a higher melting point.

Option 3: Correct: $|LE| \propto \frac{q_{M^{2+}} q_{O^{2-}}}{r_{M^{2+}} + r_{O^{2-}}}$ & $|LE| \propto \frac{q_{M^{2+}} q_{Cl^-}}{r_{M^{2+}} + r_{Cl^-}}$. As $q_{O^{2-}} > q_{Cl^-}$ & $r_{Cl^-} > r_{O^{2-}}$, MgO has a higher melting point than $MgCl_2$.

- 8** Trimethoprim (TMP) is used for the treatment of urinary tract infections. It has the following structure:



Which are the correct bond angles **w**, **x**, **y** and **z**?

	w	x	y	z
A	90°	180°	120°	90°
B	90°	105°	118°	107°
C	109.5°	105°	120°	107°
D	109.5°	180°	118°	120°

Answer: **C**

w: 4 bond pairs 0 lone pair (tetrahedral)

x: 2 bond pairs 2 lone pairs (bent)

y: 3 bond pairs 0 lone pair (trigonal planar)

z: 3 bond pairs 1 lone pair (trigonal pyramidal)

- 9 Use of the Data Booklet is relevant to this question.

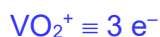
A solution containing 25 cm³ of 0.1 mol dm⁻³ VO₂⁺ reacts completely with 0.245 g of zinc. Which of the following can be the vanadium-containing species in the product?

- A VO₃⁻ B VO₂²⁺ C V³⁺ D V²⁺

Answer: D

$$\text{Number of moles of VO}_2^+ = \frac{25}{1000} \times 0.1 = 2.5 \times 10^{-3} \text{ mol}$$

$$\text{Number of moles of Zn} = \frac{0.245}{65.4} = 3.75 \times 10^{-3} \text{ mol}$$



Oxidation state of V in product = +2, hence V²⁺ is formed.

- 10 Which oxide does **not** react with dilute sodium hydroxide to produce a salt?

- A Al₂O₃ B P₄O₁₀ C SO₂ D SiO₂

Answer: D

oxide	nature of oxide	reacts with dil. NaOH	remarks
Al ₂ O ₃	amphoteric	yes	—
P ₄ O ₁₀	acidic	yes	—
SO ₂	acidic	yes	—
SiO ₂	acidic	no	only reacts with hot and concentrated strong alkalis to form silicates

- 11 When phosphoryl chloride, POCℓ₃, dissolves in water, it gives a mixture of phosphoric acid and hydrochloric acid. How many moles of sodium hydroxide would be needed to neutralise the solution formed by adding one mole of POCℓ₃ to excess water?

- A 3 B 4 C 5 D 6

Answer: **D**

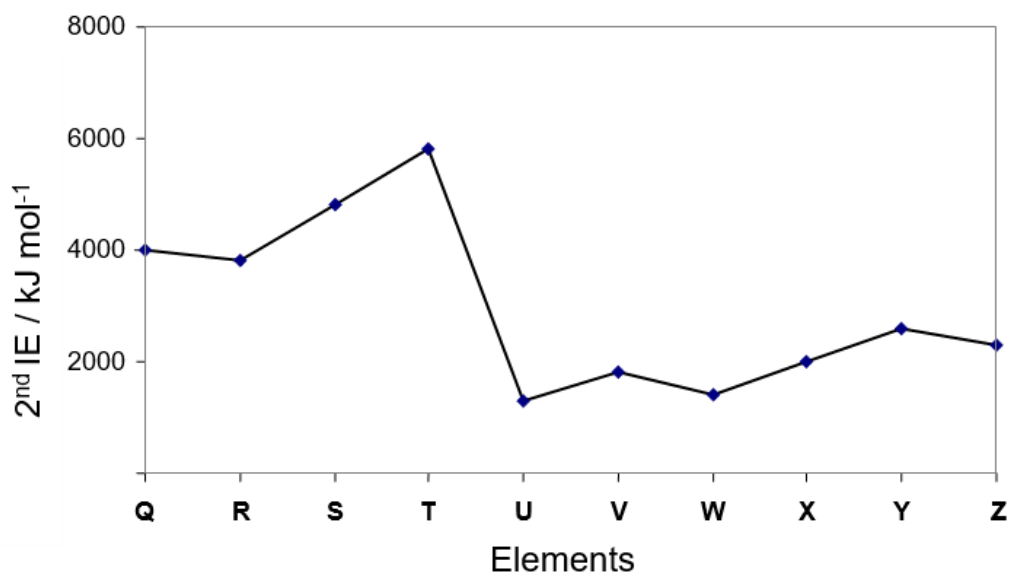


H_3PO_4 is a tribasic acid and 3 mol of NaOH is needed to neutralise 1 mol of H_3PO_4 .

1 mol of NaOH is needed to neutralise 1 mol of HCl.

Hence, in total, 6 mol of NaOH is needed.

- 12 The graph below shows the variation in the **second** ionisation energies for the consecutive elements **Q** to **Z** in the Periodic Table, all with proton number below 20



What can be deduced from the above?

- 1 T has a smaller atomic radius than U.
 - 2 Effervescence is observed when a magnesium strip is dipped into the aqueous solution containing the chloride of element W.
 - 3 When the oxide of U is mixed with water, an alkaline solution is formed.
- A** 1, 2 and 3 **B** 1 and 2 **C** 2 and 3 **D** 3 only

Answer: **C**

2nd I.E. means that the 2nd electron is removed. The big drop in 2nd I.E. from **T** to **U** means that 2nd electron in **T** is removed from an inner electron shell. **T** has 1 valence electrons and is in Group 1. Hence **U** is in Group 2 and is Mg.

Option 1: Incorrect. Atomic radius decreases across the period.

Option 2: Correct. The chloride of **W** is SiCl_4 , which undergoes hydrolysis in water to form an acidic solution. The acid reacts with the Mg strip to form H_2 gas which is observed as effervescence.

Option 2: Correct. The oxide of **U** is MgO , which forms a solution of pH 9.

- 13** Which sample contains the same number of the named species as the number of molecules in 1 g of hydrogen?
- A** Electrons in 1 g of helium
- B** Atoms in 23.0 g of sodium
- C** Ions in 26.5 g of sodium carbonate
- D** Molecules in 44 g of carbon dioxide

Answer: **A**

Amount of $\text{H}_2 = 0.5 \text{ mol}$

A: amount of He = $1/4 = 0.25 \text{ mol}$; amount of electrons = $0.25 \times 2 = 0.5 \text{ mol}$

B: amount of Na = $23.0/23.0 = 1 \text{ mol}$

C: amount of $\text{Na}_2\text{CO}_3 = 26.5/106 = 0.25 \text{ mol}$; amount of ions = $0.25 \times 3 = 0.75 \text{ mol}$

D: amount of $\text{CO}_2 = 1 \text{ mol}$; amount of molecules = 1 mol

- 14** Use of the Data Booklet is relevant to this question.
A sample of glass is composed of 50% SiO_2 , 38% CaO and 12% Al_2O_3 by mass.
What is the Si / Al molar ratio in the glass sample?

A 0.28 **B** 2.08 **C** 3.54 **D** 7.08

Answer: **C**

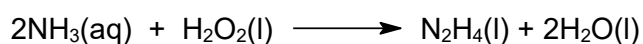
In 100g, mass of $\text{SiO}_2 = 50 \text{ g}$, Amount = $\frac{50}{28.1+2(16.0)} = 0.832 \text{ mol}$

Mass of $\text{Al}_2\text{O}_3 = 12 \text{ g}$,

Amount of Al = $2 \times \left[\frac{12}{2(27.0)+3(16.0)} \right] = 0.235 \text{ mol}$

$\frac{\text{Si}}{\text{Al}} = \frac{0.832}{0.235} = 3.54$

- 15** Hydrazine, N_2H_4 , was used as fuel for the Apollo space mission, and it can be synthesised in an environmentally friendly manner according to the following reaction.



substance	$\Delta H_f^\circ / \text{kJ mol}^{-1}$
$\text{H}_2\text{O}(\text{l})$	-286
$\text{N}_2\text{H}_4(\text{l})$	+51
$\text{NH}_3(\text{aq})$	-80
$\text{H}_2\text{O}_2(\text{l})$	-174

Given the above enthalpy changes of formation, what is the enthalpy change of the above reaction in kJ mol^{-1} ?

- A** -187 **B** -19 **C** +19 **D** +187

Answer: **A**

$$\Delta H_r^\circ = \sum \Delta H_f^\circ(\text{products}) - \sum \Delta H_f^\circ(\text{reactants})$$

$$= [+51 + 2(-286)] - [2(-80) + (-174)] = \underline{-187 \text{ kJ mol}^{-1}}$$

- 16** When 25 cm^3 of 1.0 mol dm^{-3} sodium hydroxide was neutralised with an equal volume of 0.5 mol dm^{-3} sulfuric acid, the temperature of the mixture rose by 7.0°C .

What would be the temperature change if 50 cm^3 of 0.5 mol dm^{-3} sodium hydroxide is neutralised with an equal volume of 0.25 mol dm^{-3} sulfuric acid?

(Assume negligible heat loss in each case.)

- A** 1.8°C **B** 3.5°C **C** 7.0°C **D** 14°C

Answer: **B**

No. of moles of H_2O formed from the neutralisation reaction of both experiments are the same (0.025 mol). Thus the heat evolved for both experiments are the same. However, since the total volume is doubled for the 2nd experiment, the ΔT is halved, i.e. 3.5°C .

- 17** After the closure of a chemical plant in Switzerland, a substitution reaction between **R** and hydrogen sulfide ions is found to take place

initial concentration of R / mol dm^{-3}	initial concentration of hydrogen sulfide ions / mol dm^{-3}	initial rate of reaction / $\text{mol dm}^{-3} \text{ s}^{-1}$
0.1	0.1	1.5×10^{-5}

0.2	0.1	3.0×10^{-5}
0.1	0.2	3.0×10^{-5}
0.3	x	1.125×10^{-5}

What conclusion can be drawn about the reaction?

- A** The reaction is zero order with respect to the concentration of hydrogen sulfide ions.
- B** The overall order of reaction is one.
- C** The value of the rate constant is 1.5×10^{-4} .
- D** The value of x is 0.025.

Answer: **D**

A: When either $[R]$ or $[HS^-]$ is doubled, the initial rate is doubled. Hence, it is first order with respect to both $[R]$ and $[HS^-]$.

B: The overall order of reaction is two.

C: rate = $k[R][HS^-]$

$$1.5 \times 10^{-5} = k (0.1)(0.1)$$

$$k = 1.5 \times 10^{-3}$$

$$D: 1.125 \times 10^{-5} = 1.5 \times 10^{-3} (0.3x)$$

$$x = 0.025$$

- 18** Enzymes are biological catalysts, and many enzymes show specificity.

An example is lipase which hydrolyses triglyceride molecules into glycerol and fatty acids.

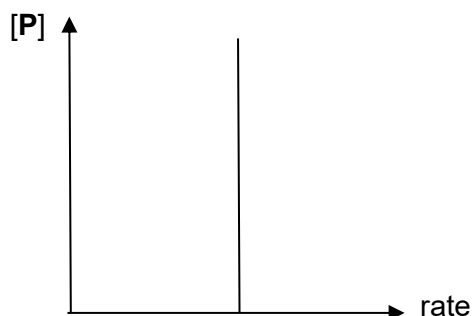
What does specificity mean in this context?

- A** Lipase only works well over a narrow range of temperatures.
- B** Lipase only works well over a narrow pH range.
- C** Lipase only produces glycerol and fatty acids.
- D** Lipase only hydrolyses triglycerides.

Answer: **D**

Specificity refers to the narrow range of substrates that the enzymes can act on. Statements A and B are correct but does not explain specificity.

- 19 The kinetics of a reaction $P \rightarrow Q$ were investigated under different conditions. The following graph was obtained.



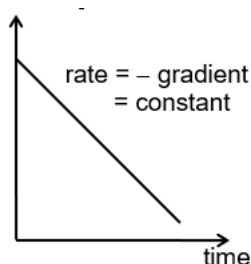
Which of the following statements about the reaction is correct?

- A The unit of the rate constant is s^{-1} .
- B A curve is obtained when $[P]$ is plotted against time.
- C The same graph is obtained when the $[P]$ is plotted against rate constant.
- D The rate constant remained unchanged when reaction is repeated at a higher temperature.

Answer: C

The graph shows that the rate is independent of $[P]$ i.e. a zero order reaction.

A: The units of rate constant is $\text{mol dm}^{-3} \text{s}^{-1}$.



B: The graph should be

C: Rate constant is not affected by concentration changes.

D: A higher temperature results in a faster rate of reaction and a larger rate constant.

- 20 An enzyme, found in the stomach, operates at maximum efficiency when in an aqueous solution buffered at pH 5.

Which of the following combinations of substances would give the necessary buffer solution?

- A 2 mol of HCl and 1 mol of $\text{CH}_3\text{CO}_2\text{H}$

Which statement could explain why silver nanoparticles are more reactive than silver foil?

- A** They act as catalysts for the reaction.
- B** They contain a much greater concentration of silver.
- C** They have a very high surface area to volume ratio.
- D** They do not have an unreactive oxide layer.

Answer: **C**

There is a large increase in surface area to volume ratio which makes interaction between the surfaces of particles very important. If the reacting particles have greater surface area (nanoparticles), there would have more sites for chemicals to bind or react with it and the rate of reaction would increase.

23 Which of the following is a pair of constitutional isomers?

- A** $(\text{CH}_3)_3\text{CCO}_2\text{H}$ and $\text{CH}_3\text{CH}(\text{CH}_3)\text{CO}_2\text{H}$
- B** $\text{CH}_2\text{C}(\text{CH}_3)\text{CO}_2\text{H}$ and $\text{CH}_3\text{CHCHCO}_2\text{H}$
- C** $(\text{CH}_3)_2\text{CHCO}_2\text{H}$ and $\text{CH}_3\text{CH}(\text{CO}_2\text{H})\text{CH}_3$
- D** $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_3$ and $\text{CH}_3\text{OCOCH}_2\text{CH}_3$

Answer: **B**

A: Both compounds have different molecular formula and are not isomers.

B: Both compounds have the $\text{C}=\text{C}$ at a different position and are positional isomers.

C & D: Both show the same structure and are not chain isomers.

24 Compound **X**, C_4H_8 , reacts with bromine via an addition reaction.

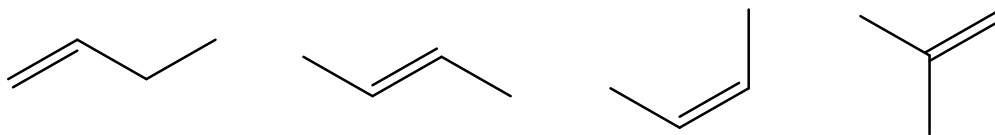
What is the maximum number of isomers of compound **X**, considering both constitutional isomerism and cis-trans isomerism?

- A** 1
- B** 3
- C** 4
- D** 5

Answer: **C**

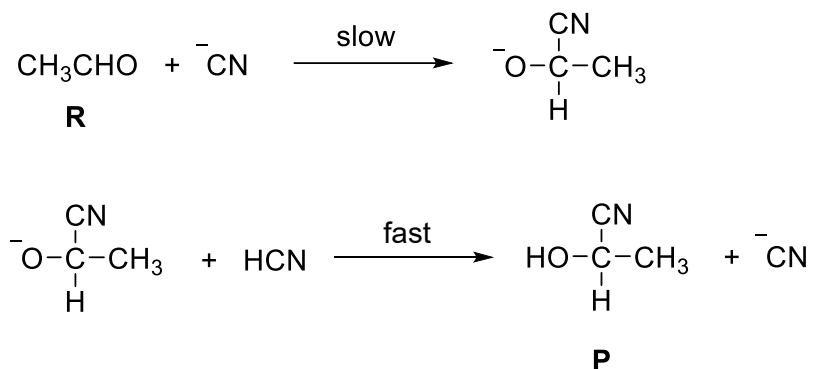
Since **X** undergoes an addition reaction with bromine, it is an alkene.

The isomers are

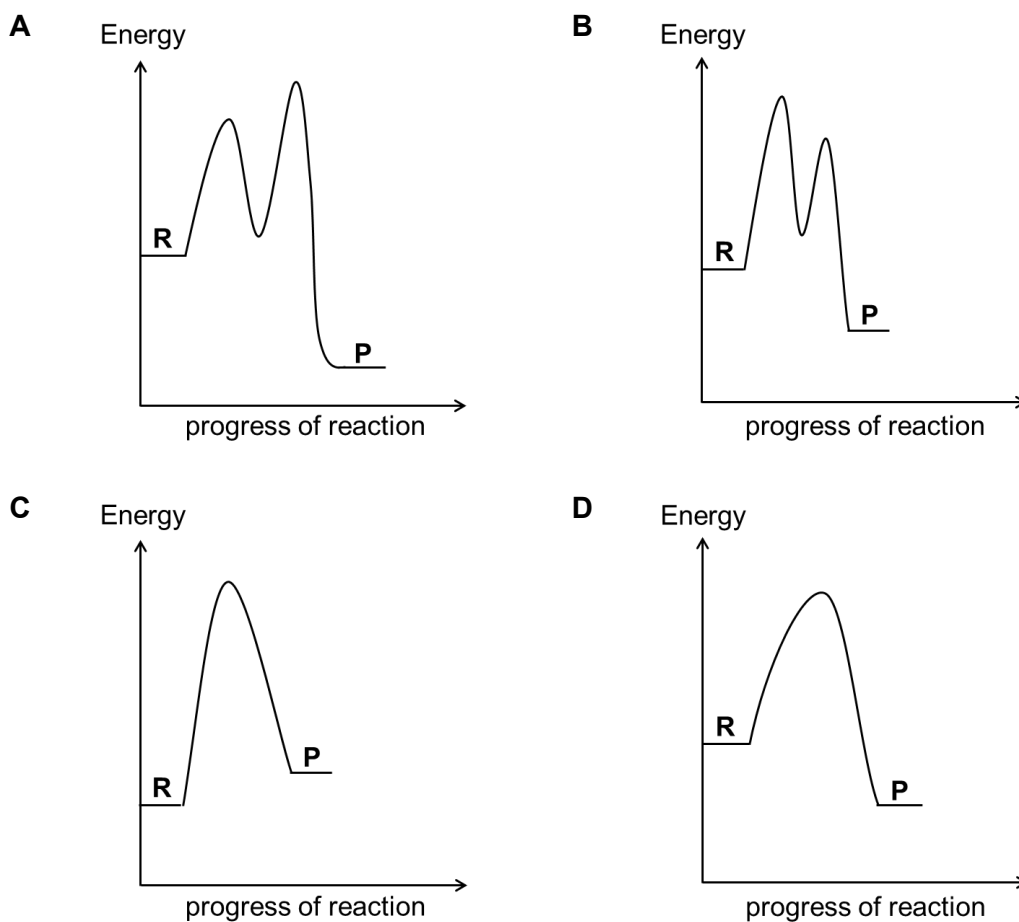


25 The use of the *Data Booklet* is relevant to this question.

Ethanal, **R**, undergoes addition reaction with HCN in the presence of CN^- ions to form a cyanohydrin, **P**, via a two-step reaction.



Which of the energy profile diagrams best describes the reaction from **R** to **P**?



Answer: **B**

Nucleophilic addition is a 2 step reaction where the 1st step is the slow step (formation of anion intermediate), so the 1st E_a will be larger than the 2nd E_a .

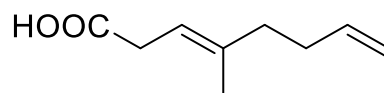


Bonds broken: C=O (740) and C-H (410)

Bond formed: C-O (360), O-H (460) and C-C (350)

Enthalpy change of reaction = -20 kJ mol^{-1} (exothermic rxn)

- 26** The structure of compound **X** is shown.



compound **X**

Which of the following are true about compound **X**?

- 1** The molecular formula of **X** is $\text{C}_9\text{H}_{14}\text{O}_2$.
- 2** **X** has 2 π bonds.
- 3** **X** can decolourise bromine water.

A 1, 2 and 3

B 1 and 2

C 2 and 3

D 1 and 3

Answer: **D**

A: correct

B: incorrect as **X** has 3 pi bonds (2 from alkene and 1 from COOH)

C: alkene group decolourises bromine water

- 27** How much water must be added to 2 dm^3 of HCl of pH 2.0 to increase the pH to 3.0?

A 1.0 dm^3

B 10 dm^3

C 18 dm^3

D 20 dm^3

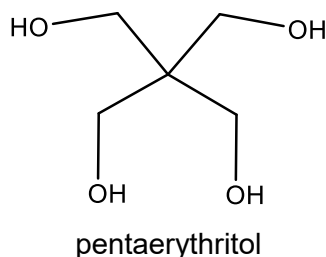
Answer: **C**

At pH 2, $[\text{H}^+] = 0.01 \text{ mol dm}^{-3}$

At pH 3, $[\text{H}^+] = 0.001 \text{ mol dm}^{-3}$

For conc to decrease by 10x, volume increases by 10x to 20 dm³, so (20 – 2) dm³ water has to be added.

- 28 Pentaerythritol is an intermediate in the production of paint.



Which of the following statements about pentaerythritol are correct?

- 1 It decolourises hot acidified potassium manganate(VII).
- 2 It reacts with propanoic acid to form a sweet-smelling compound.
- 3 It can react with excess hot concentrated sulfuric acid to form alkene.

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

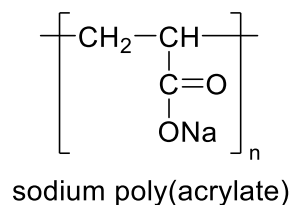
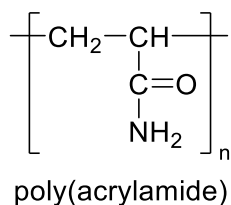
Answer: **B**

Option 1: Correct as primary alcohol is oxidised by KMnO₄ to carboxylic acid.

Option 2: Correct as alcohol reacts with carboxylic acid to form an ester.

Option 3: Incorrect, there is no adjacent H to the OH for elimination of H₂O.

- 29 Poly(acrylamide) and sodium poly(acrylate) are super absorbent polymers (SAP) used in various hygienic products like diapers.



Which statement is correct for these SAP?

- A** Both are condensation polymers.
- B** Both are non-biodegradable polymers.

- C** Poly(acrylamide) is formed between $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ and NH_3 in the presence of DCC.
- D** Sodium poly(acrylate) can form hydrogen bonding between two polymer chains.

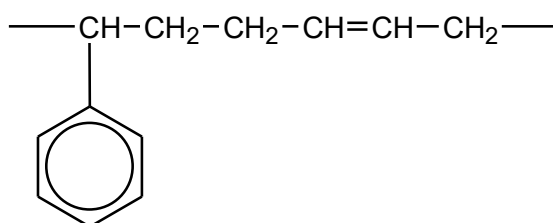
Answer: **B**

Both are addition polymers, not condensation polymers, there is no ester or amide linkages on the polymer main/backbone chains. → **A and C are incorrect**

Addition polymers are non-biodegradable as there is mainly non-polar C-C bonds presents in the repeating units. → **B is correct**

Sodium poly(acrylate) is unable to form hydrogen bond between chains as there is no H atom bonded to electronegative N/O/F atom. → **D is incorrect**

- 30** A polymer has the repeat unit:



Which statement about this polymer is **incorrect**?

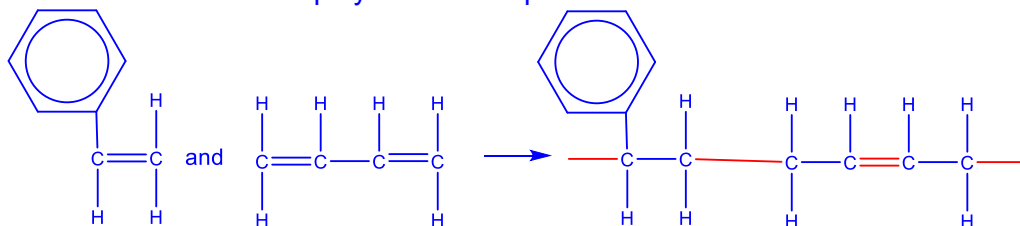
- A** It can be hydrolysed by heating with dilute aqueous sulfuric acid.
- B** $\text{CH}_2=\text{CHCH}=\text{CH}_2$ is one of the monomers.
- C** It is a copolymer made up of two different monomers.
- D** It is capable of forming a thermosetting polymer.

Answer: **A**

A is incorrect. Absence of amide or ester functional group, it cannot undergoes hydrolysis with dilute aqueous sulfuric acid.

B is correct because $\text{CH}_2=\text{CHCH}=\text{CH}_2$ is one of the monomers.

C is correct because it is a copolymer made up of two different monomers.



D is correct. The presence of double C=C bond in the repeat unit allow further addition polymerisation with the monomers, leads to formation of cross-link between the polymer chains.

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