# TEMASEK JUNIOR COLLEGE

## 2024 JC2 PRELIMINARY EXAMINATION

## Higher 2

**CHEMISTRY** **9729/01**

Paper 1 Multiple Choice **12 September 2024**

**1 hour**

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

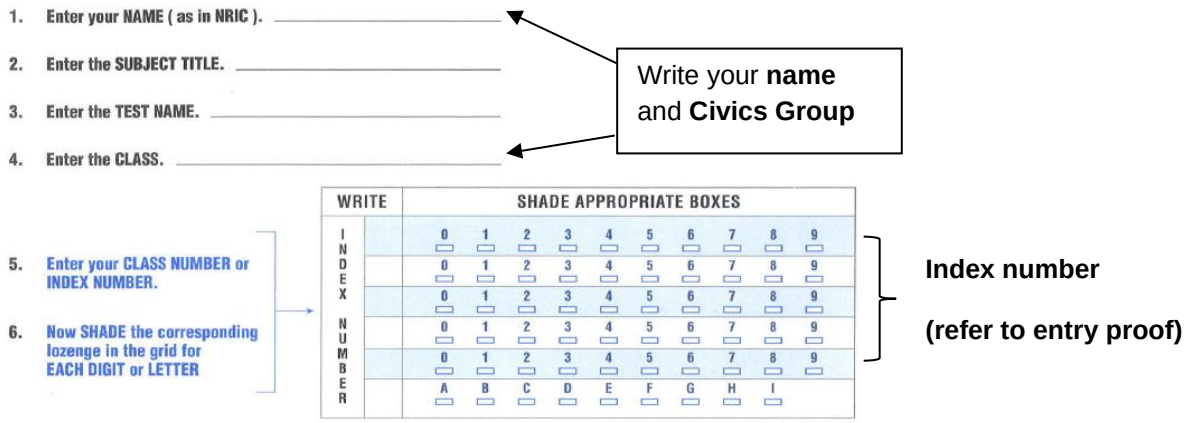
**READ THESE INSTRUCTIONS FIRST**

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.




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

Chlorine radicals is one of the main chemical species responsible for the depletion of ozone from the stratosphere.

What does $^{35}Cl^{\bullet}$ contain?

| | protons | neutrons | electrons |
|---|---|---|---|
| **A** | 18 | 35 | 17 |
| **B** | 18 | 35 | 18 |
| **C** | 17 | 18 | 17 |
| **D** | 17 | 18 | 18 |

Answer: **C**

Chlorine radical is a chlorine atom. The proton number = electron number = 17.

The neutron number = nucleon number – proton number

= 35 – 17 = 18

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

**1** $K_2O_2$ **2** $NaN_3$ **3** $NH_4F$ **4** $K_2CO_3$

**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** | $K^+$ | 19 – 1 = 18 | $O_2^{2-}$ | (2 x 8) + 2 = 18 |
| **2** | $Na^+$ | 11 – 1 = 10 | $N_3^-$ | 3(7) + 1 = 22 |
| **3** | $NH_4^+$ | 7 + 4 – 1 = 10 | $F^-$ | 9 + 1 = 10 |
| **4** | $K^+$ | 19 - 1 = 18 | $CO_3^{2-}$ | 6 + 3(8) + 2 = 32 |

**3** *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.

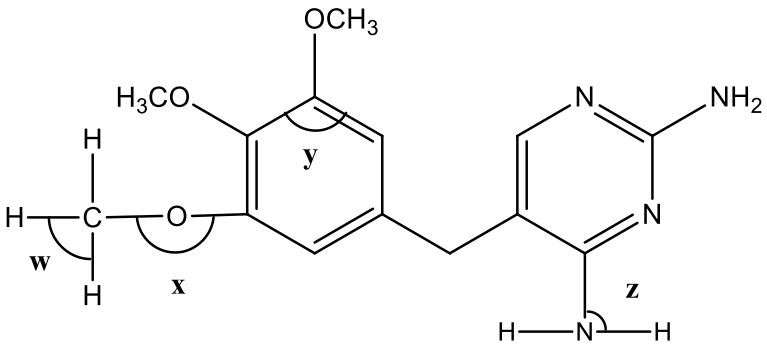
Which of the following shows the sixth ionisation energy of antimony?

**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.

**4** 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

**5** Beryllium chloride, $BeCl_2$, reacts with methylamine, $CH_3NH_2$ 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 $CH_3NH_2$.

**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**

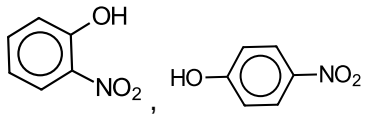
**A & C** Only 4 e around Be on $BeCl_2$, hence electron deficient. It can accommodate another 2 pairs of e from N to achieve octet.
**B** A dative bond is the same as a single covalent bond (strength and length)
**D** The compound formed has no more lone pairs of e on N available for hydrogen bonding.

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

**A** $K_2O$, $Na_2O$

**B** $AlCl_3$, $AlF_3$

**C** $NH_2CH_2CO_2H$, $HOCH_2CO_2H$

**D** 

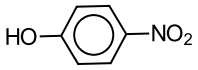

Answer: **C**

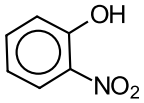
**A: incorrect.** $|LE| \propto \frac{q_{M^+} q_{O^{2-}}}{r_{M^+} + r_{O^{2-}}}$. Since $r_{K^+} > r_{Na^+}$, thus $Na_2O$ has a higher melting point.

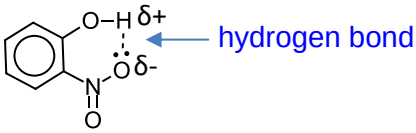
**B: Incorrect.** $AlF_3$ is ionic while $AlCl_3$ is a simple molecular structure $\Rightarrow$ $AlF_3$ higher melting point as large amount of energy is needed to break the strong ionic bond compare ti breaking weak id-id between $AlCl_3$ molecules.

**C**: **Correct.** $NH_2CH_2CO_2H$ exists as zwitterions $H_3^+NCH_2CO_2^-$ held together by strong electrostatic forces of attraction whereas $HOCH_2CO_2H$ molecules are held together by weaker

hydrogen bonding. Hence, $NH_2CH_2CO_2H$ has a higher melting point. Energy needed to break the ionic bond is large than breaking H-bond, Hence, mpt of $NH_2CH_2CO_2H$ is higher.

**D: Incorrect.**  forms **more extensive intermolecular hydrogen bonds**, which requires more energy to overcome, hence higher melting point.

On the other hand, due to intramolecular hydrogen bonding,  forms **less extensive intermolecular hydrogen bonds**, which requires less energy to overcome, hence lower melting point.




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

A solution containing 25 $cm^3$ of 0.1 mol $dm^{-3}$ $VO_2^+$ reacts completely with 0.245 g of zinc. Which of the following can be the vanadium-containing species in the product?

**A** $VO_3^-$ **B** $VO^{2+}$ **C** $V^{3+}$ **D** $V^{2+}$

Answer: **D**

Number of moles of $VO_2^+ = \frac{25}{1000} \times 0.1 = 2.5 \times 10^{-3}$ mol

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

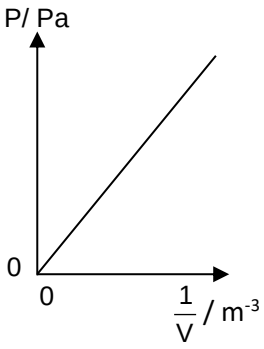
$2VO_2^+ \equiv 3Zn \equiv 6\ e^-$

$VO_2^+ \equiv 3\ e^-$

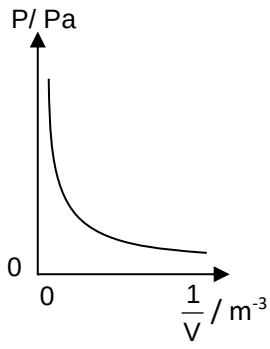
Oxidation state of V in product = +2, hence $V^{2+}$ is formed.

**8** Which graph is a correct representation of Charles' Law?

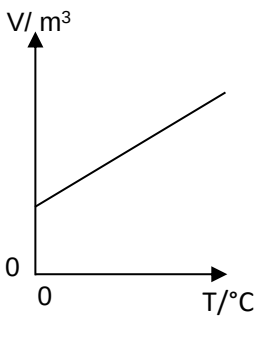
**A**



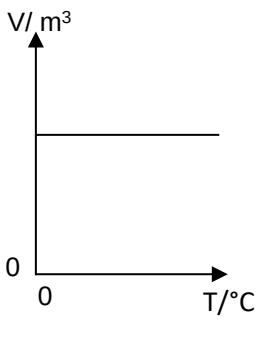

**B**




**C**




**D**




Answer: **C**

Charles Law states that $V \propto T$, hence the graph should be a straight line with positive gradient. V will be 0 at 0K, not at 0°C, so the graph of V against T/°C does not pass through the origin.

Option A shows the correct relationship between P and 1/V, as indicated by Boyle's Law.

**9** The three minerals below are obtained from mines around the world. Each one behaves as a mixture of two carbonate compounds. They can be used as fire retardants because they decompose in the heat, producing $CO_2$. This gas smothers the fire.

| | |
|---|---|
| Barytocite | $BaCa(CO_3)_2$ |
| Dolomite | $CaMg(CO_3)_2$ |
| Huntite | $Mg_3Ca(CO_3)_4$ |

What is the order of effectiveness as fire retardant, from best to worst?

| | best → worst | | |
|---|---|---|---|
| **A** | huntite | dolomite | barytocite |
| **B** | huntite | barytocite | dolomite |
| **C** | dolomite | huntite | barytocite |
| **D** | dolomite | barytocite | huntite |

Answer: **A**

Each mineral behaves as a mixture of two carbonate compounds.

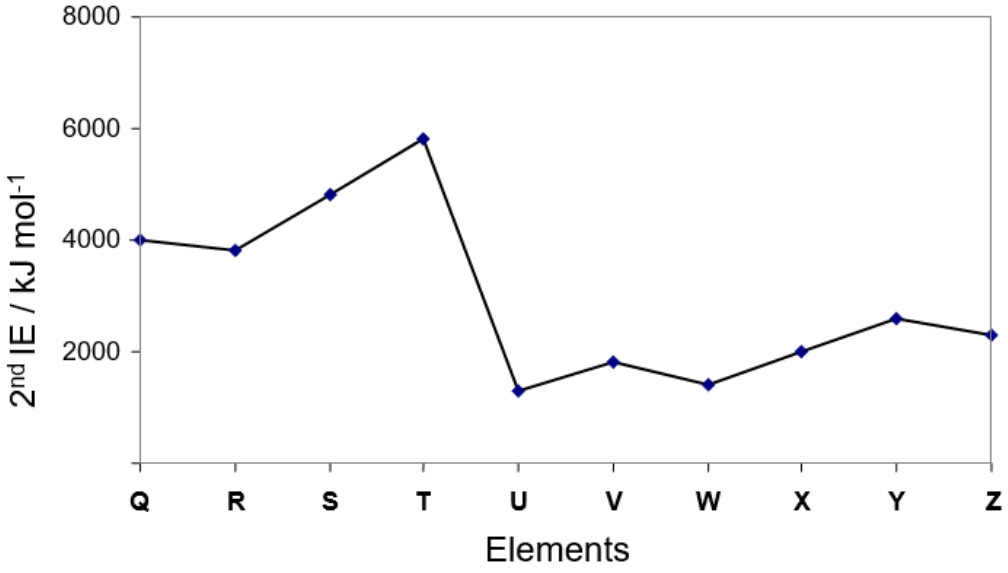
| **mineral** | **formula** | **behaves as a mixture of** |
|---|---|---|
| barytocite | $BaCa(CO_3)_2$ | 1 mol $BaCO_3$ and 1 mol $CaCO_3$ |
| dolomite | $CaMg(CO_3)_2$ | 1 mol $CaCO_3$ and 1 mol $MgCO_3$ |
| huntite | $Mg_3Ca(CO_3)_4$ | 3 mol $MgCO_3$ and 1 mol $CaCO_3$ |

The effectiveness of each of the three minerals as fire retardant is dependent on its **ease of thermal decomposition** to produce $CO_2$, which smothers the fire.

The ease of thermal decomposition of the minerals is dependent on the charge density and hence the polarising power of the respective Group II metal ions ($Ba^{2+}$, $Ca^{2+}$ and $Mg^{2+}$). The order of effectiveness as fire retardant, from best to worst, corresponds to the order of decreasing polarising power of the Group II metal ions: $Mg^{2+}$, $Ca^{2+}$, $Ba^{2+}$.

Huntite is a more effective fire retardant than dolomite as huntite contains more $MgCO_3$ and hence it produces more $CO_2$ upon complete thermal decomposition.

**10** 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 3: Correct.** The oxide of **U** is MgO, which forms a solution of pH 9.

**11** Which sample contains the same number of the named species as the number of molecules in 1 g of hydrogen?

**A** Atoms in 23.0 g of sodium

**B** Electrons in 1 g of helium

**C** Ions in 26.5 g of sodium carbonate

**D** Molecules in 44 g of carbon dioxide

Answer: **B**

Amount of $H_2$ = 0.5 mol

A: amount of Na = 23.0/23.0 = 1 mol

B: amount of He = 1/4 = 0.25 mol; amount of electrons = 0.25 x 2 = 0.5 mol

C: amount of $Na_2CO_3$ = 26.5/ 106 = 0.25 mol; amount of ions = 0.25 x 3 = 0.75 mol

D: amount of $CO_2$ = 1 mol; amount of molecules = 1 mol

**12** 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 negligibe 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 $\Delta T$ is halved, i.e. 3.5°C.

**13** After the closure of a chemical plant in Switzerland, a substitution reaction between a halogenoalkane, **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 / mol $dm^{-3}$ $s^{-1}$ |
|---|---|---|
| 0.1 | 0.1 | $1.5 \times 10^{-5}$ |
| 0.2 | 0.1 | $3.0 \times 10^{-5}$ |
| 0.1 | 0.2 | $3.0 \times 10^{-5}$ |
| 0.3 | $x$ | $1.125 \times 10^{-5}$ |

What conclusions can be drawn about the reaction?

**A** The value of $x$ is 0.025.

**B** **R** could be 2-bromo-2-methylpropane.

**C** The value of the rate constant is $1.5 \times 10^{-4}$.

**D** Only **R** is involved in the rate determining step.

Answer: **A**

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

$x = 0.025$

**B:** 2-bromo-2-methylpropane is a tertiary halogenoalkane and is likely to undergo $S_N1$ mechanism instead of $S_N2$.

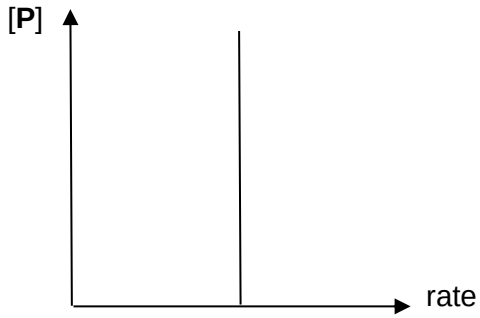
**C**: rate = $k[R][HS^-]$

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

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

**D:** When either [R] or $[HS^-]$ is doubled, the initial rate is doubled. Hence, it is first order with respect to both [R] or $[HS^-]$. Hence, both R and $HS^-$ are involved in the rate determining step.

**14** The kinetics of a reaction **P** → **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.

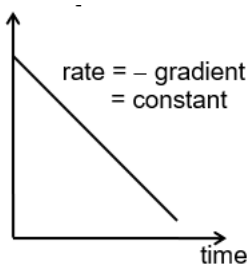
**D** The rate constant remained unchanged when reaction is repeated at a higher temperature.

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 mol $dm^{-3}$ $s^{-1}$.

**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.

**15** $\mathbf{A}(g) + 3\mathbf{B}(g) \rightleftharpoons 2\mathbf{C}(g)$

A 2 $dm^3$ vessel containing 2.00 mol of **A**, 6.00 mol of **B**, and 2.40 mol of **C** is allowed to reach equilibrium. It was found that there was 2.32 mol of **A** was present at equilibrium.

The reaction was repeated using a 4 $dm^3$ vessel. The equilibrium amount of **A** was found to be $y$ mol.

What of the following statement about the above reaction is correct?

**A** The concentration of **C** at equilibrium is 1.76 mol $dm^{-3}$ in the first experiment.

**B** The value of $K_c$ of the second experiment is smaller than the first experiment.

**C** The units of the equilibrium constant is $mol^2\ dm^{-6}$.

**D** y is larger than 2.32 mol.

Answer: **D**

A: **Incorrect.**

| | A(g) | + 3B(g) | ⇌ | 2C(g) |
|---|---|---|---|---|
| Initial / mol | 2.00 | 6.00 | | 2.40 |
| Change / mol | +0.32 | +3(0.32) | | –2(0.32) |
| Eqm / mol | 2.32 | 6.96 | | 1.76 |

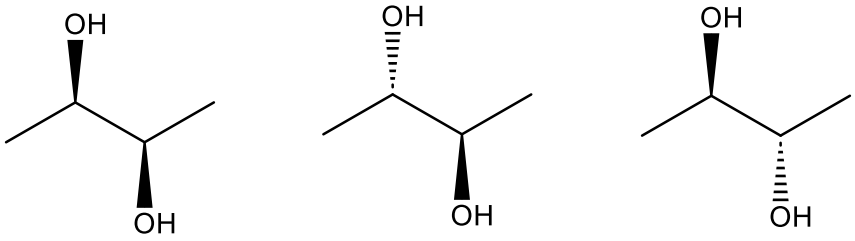
[C] at eqm = $\frac{1.76}{2}$ = 0.880 mol $dm^{-3}$

B: **Incorrect.** When volume increases, the pressure decreases which will affect the position of equilibrium but not the equilibrium constant.

C: **Incorrect.** The unit of the equilibrium constant is $mol^{-2}\ dm^6$.

D: **Correct.** When pressure decreases due to an increase in volume, by LCP, the position of equilibrium shifts to the left to favour the reaction that produces greater number of moles of gas. Therefore, the equilibrium amount of A will increase.

**16** Which of the following statements is correct about the 3 molecules below?




**1** **2** **3**

**A** All three molecules are constitutional isomers.

**B** There is a plane of symmetry in molecule 1.

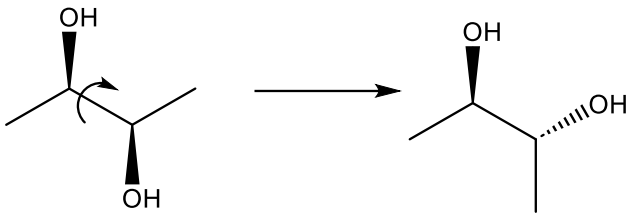
**C** All three molecules are optically active.

**D** Only molecule 1 is optically active.

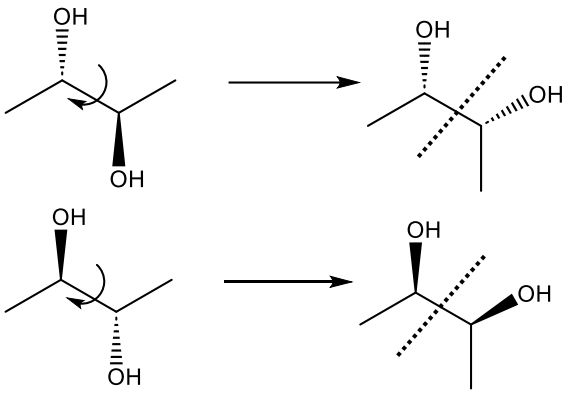
Answer: **D**

**A:** The molecules are stereoisomers.

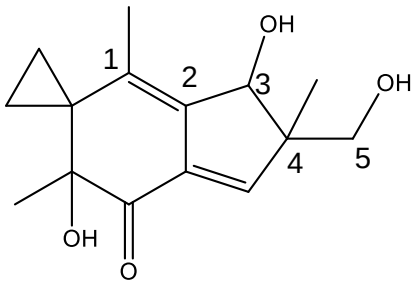
**B:** Molecule 1 does not have a plane of symmetry.




**C & D:** Only molecule 1 is optically active. Molecules 2 and 3 have an internal plane of symmetry and are optically inactive.




**17** Compound **S** has strong anti-tumour and antiviral activities.




Which of the following statements of compound **S** is correct?

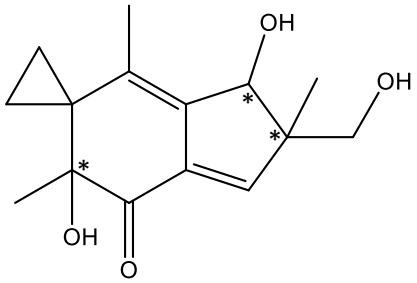
**A** There are four chiral centers.

**B** There are a total of 8 stereoisomers.

**C** The bond length between C1-C2 is the same as C4-C5.

**D** After reacting with lithium aluminium hydride in dry ether, all the carbon atoms are $sp^3$ hybridised.

Answer: **B**

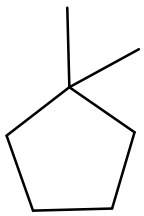



C=C in rings do not exhibit cis-trans isomerism. The number of stereoisomers is $2^3$.

Although both are carbon-carbon single bonds, the sigma bond formed between C1-C2 is due to $sp^2$-$sp^2$ overlap where that between C4-C5 is due to $sp^3$-$sp^3$ overlap. The former has a shorter bond length as the $sp^2$ orbital has a higher s character resulting in more effective overlap.

As lithium aluminium hydride only reduces the ketone, the product still contains C=C ($sp^2$ hybridised).

**18** In the presence of uv light, compound **W** reacts with bromine to give a mixture of products.



Compound **W**

Which of the following about the reaction is correct?

**A** There are three isomeric monobrominated products that can be formed in the ratio of 2:2:3.

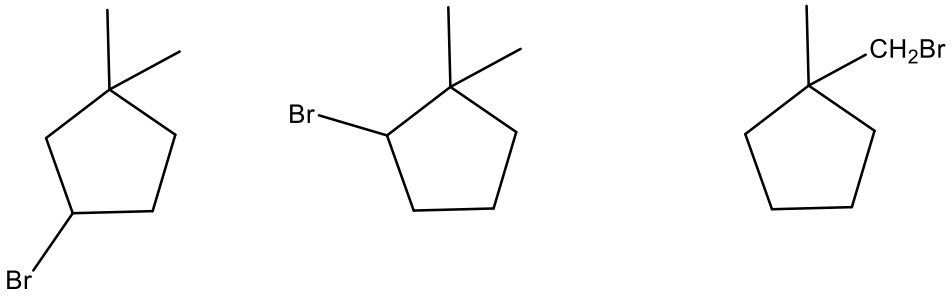
**B** The monobrominated product, $C_7H_{13}Br$, is only formed in the propagation step.

**C** Some other products that can also be formed are $H_2$, HBr and $C_{14}H_{26}$.

**D** The reaction requires a continuous supply of *uv* light.

Answer: **A**

**A: Correct.** The three monobrominated products are:




4 : 4 : 6

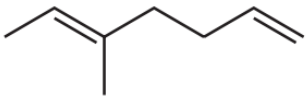
2 : 2 : 3

**B: Incorrect.** The monobrominated product, $C_7H_{13}Br$, can be formed in both the propagation and termination step.

**C: Incorrect.** Hydrogen cannot be formed.

**D: Incorrect.** Only a brief exposure of uv light is required as chain reaction occurs in the propagation step to generate more radicals generated.

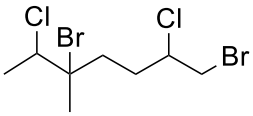
**19** The structure of compound **X** is shown.



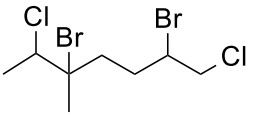
compound **X**

What is the structure of the major product when **X** reacts with BrC*l* dissolved in tetrachloromethane?

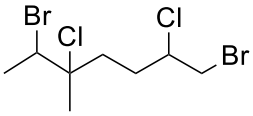
**A**



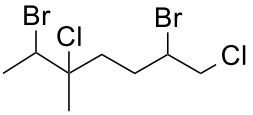

**B**



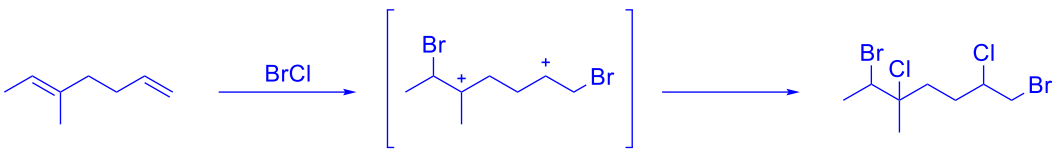

**C**




**D**

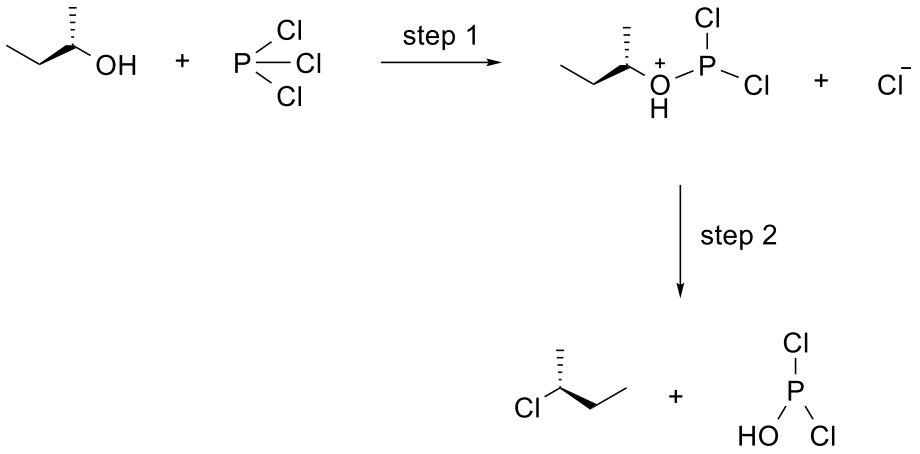



Answer: **C**




most stable carbocation

**20** Chloroalkanes can be prepared by reacting an alcohol with phosphorus trichloride, $PCl_3$. The reaction takes place via a two-step reaction shown below.




Which of the following statements is correct?

**A** $PCl_3$ acts as a nucleophile in step 1.

**B** Water can be used as a solvent in this reaction.

**C** Step 2 follows a $S_N1$ mechanism.

**D** The transition state in step 2 is trigonal bipyramidal about a carbon atom.

Answer: **D**

**A:** Incorrect as alcohol is the nucleophile. P has a δ+ charge due to electronegative C*l* atom which is attacked by electron rich O atom in the alcohol.

**B:** Incorrect as $PCl_3$ will be hydrolysed in water.

**C:** Incorrect as step 2 follows a $S_N2$ mechanism (deduced from the inversion of stereochemistry).

**D:** From the end product, there is an inversion of configuration. Step 2 follows a $S_N2$ mechanism in which the transition state is trigonal bipyramidal about a C atom.

**21** Which of the following compounds produce **both** ethanoate ions and triiodomethane when heated with alkaline aqueous iodine?

**1** $CH_3COOCH_2CH_3$

**2** $CH_3CH(OH)CHI_2$

**3** $CH_3CH_2CH(OH)CH_3$

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

Answer: **B**

Option 1: correct.

$CH_3COOCH_2CH_3$ undergoes alkaline hydrolysis to form $CH_3COO^-$ + $CH_3CH_2OH$ (which further reacts with alkaline aq iodine to form $CHI_3$)

Option 2: correct.

$CH_3CH(OH)CHI_2$ reacts with alkaline aq iodine to form $CHI_3$ and $CH_3COO^-$.

Option 3: incorrect.

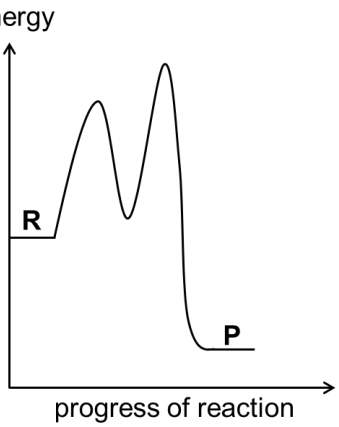
$CH_3CH_2CH(OH)CH_3$ reacts with alkaline aq iodine to form $CHI_3$ and $CH_3CH_2COO^-$.

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

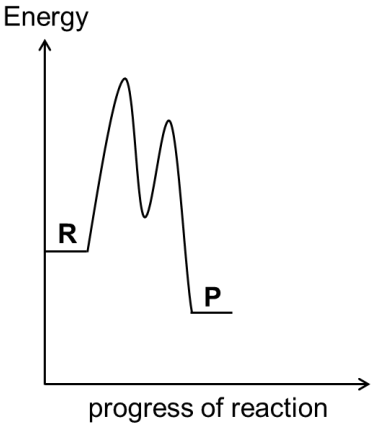
Ethanal undergoes addition reaction with HCN in the presence of $^-CN$ ions to form a cyanohydrin.

Which of the energy profile best describes the reaction from ethanal, **R**, to its cyanohydrin product, **P**?

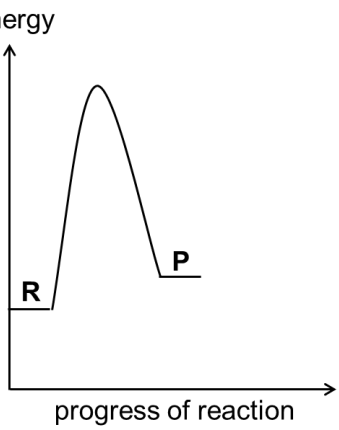
**A**



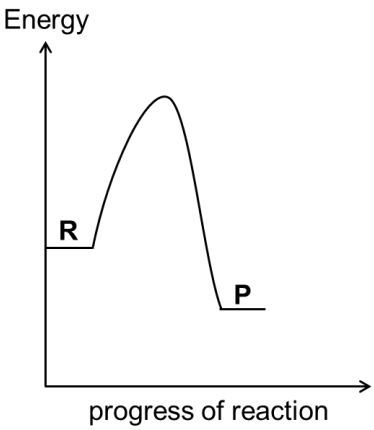

**B**




**C**




**D**




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 $E_a$.

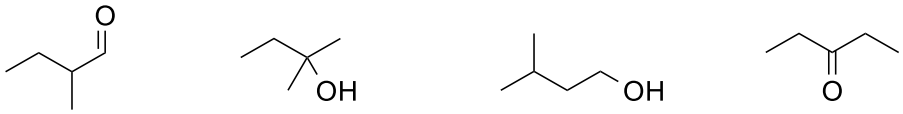
$CH_3CHO + HCN \rightarrow CH_3CH(CN)(OH)$

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)

**23** The structures of four compounds are shown below.




Which of the following pairs of reagents can be used to distinguish the four compounds from each other?

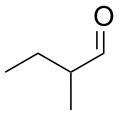
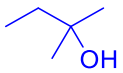
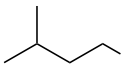
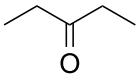
**A** sodium metal and alkaline potassium manganate (VIII)

**B** 2,4-dinitrophenylhydrazine and sodium metal

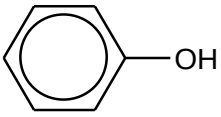
**C** alkaline potassium manganate (VIII) and Fehling's solution

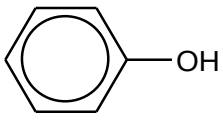
**D** Fehling's solution and sodium metal

Answer: **A**

| **Reagent** |  |  |  |  |
|---|---|---|---|---|
| **2,4–DNPH** | ✓ | | | ✓ |
| **Fehling's** | ✓ | | | |
| **Sodium** | | ✓ | ✓ | |
| **$KMnO_4$ / $OH^-$** | ✓ | | ✓ | |

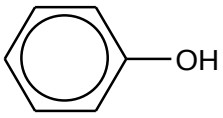
**24** Which of the following shows the correct order of increasing acidity?

**A**  < $CH_3CH_2OH$ < $CH_3CH_2CO_2H$ < $CH_3CHFCO_2H$

**B** $CH_3CH_2OH$ <  < $CH_3CH_2CO_2H$ < $CH_3CHFCO_2H$

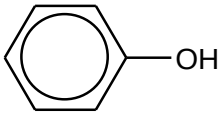
**C**

$CH_3CHFCO_2H$ < $CH_3CH_2CO_2H$ < $CH_3CH_2OH$ <




**D**

$CH_3CHFCO_2H$ < $CH_3CH_2OH$ < $CH_3CH_2CO_2H$ <



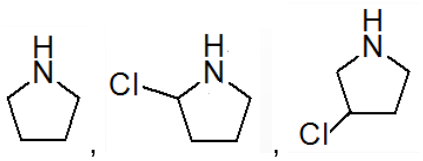

Answer: **B**

$CH_3CHFCO_2H$ is the most acidic. The electron withdrawing F disperse the negative charge on oxygen and stabilises the anion formed.

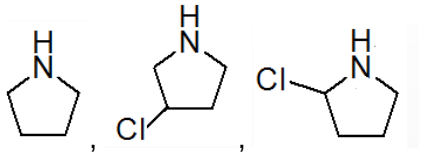
$CH_3CH_2OH$ is the least acidic (neutral) as it is an ester.

**25** Which one of the following shows the given molecules arranged in order of decreasing $pK_b$ values?

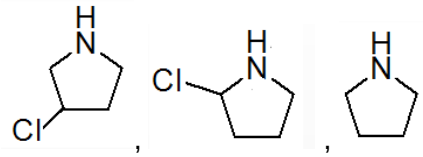
**A**



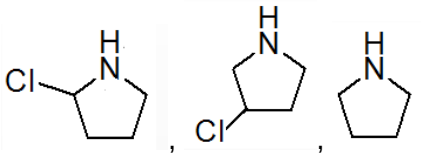

**B**




**C**



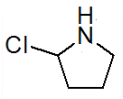

**D**




Answer: **D**

The lower the $pK_b$, the stronger the base.

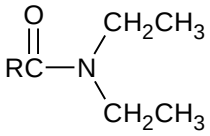
Hence, molecules should be arranged from weakest base to the strongest base.




is the least basic due to the close proximity of the electron withdrawing C*l* atom, which decreases the electron density on the N atom.

 is the most basic due to the presence of two electron release groups, and the absence of any electron withdrawing groups.

**26** A hallucinogen has the following structure:



Which one of the following is likely to be formed when the hallucinogen is boiled with excess hydrochloric acid?

**A** $(CH_3CH_2)_2NH$ **B** $(CH_3CH_2)_2NH_2^+$

**C** $RCONH(CH_3CH_2)_2^+$ **D** $RCOO^-$

Answer: **B**

**A, D:** Amine and carboxylate salt can't be obtained after *acidic* hydrolysis
**C:** Not possible as the amide bond will be hydrolysed + amides are neutral and will not be protonated

**27** The following reaction has a negative $E^{\theta}_{cell}$ so it does not occur under standard conditions.

$2NO_3^-(aq) + 8H^+(aq) + 6Cl^-(aq) \longrightarrow 2NO(g) + 4H_2O(l) + 3Cl_2(g)$

However, the reaction may be made to proceed under non-standard conditions. Which of the following changes will **not** aid the reaction to proceed?

**A** Addition of NaCl

**B** Addition of HCl

**C** Addition of $KNO_3$

**D** Addition of AgCl

Answer: **D**

[O]: $2Cl^- \rightarrow Cl_2 + 2e^-$ $E^{\ominus} = +1.36V$

[R]: $NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O$ $E^{\ominus} < +1.36V$ (since $E^{\theta}_{cell}$ is negative)

**A, B:** When $[Cl^-]$ is increased, the eqm position of $Cl_2 + 2e^- \rightleftharpoons 2Cl^-$ shifts to the left to decrease $[Cl^-]$, favouring the oxidation reaction. $E(Cl_2/Cl^-)$ becomes less positive than +1.36V.

**B, C:** When $[H^+]$ and/or $[NO_3^-]$ is increased, by LCP, the position of the equilibrium $NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO + 2H_2O$ shifts to the right to decrease $[H^+]$ /$[NO_3^-]$, favouring the reduction reaction. $E(NO_3^-/NO)$ becomes more positive.

**D:** AgC*l* is a sparingly soluble salt and does not increase $[Cl^-]$ to a large extent.

**28** Which of the following statements is correct when a solution of $CuSO_4(aq)$ is electrolysed using pure Cu electrodes?

**1** The cathode increases in size

**2** Oxygen gas is produced at the anode

**3** The blue solution fades over time

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

Answer: **D**

**Option 1: Correct.** $Cu^{2+}$ is reduced at the cathode and Cu is deposited on the cathode.
**Option 2: Incorrect.** Cu electrode is oxidised at the anode. Hence $O_2$ gas is not produced.
**Option 3: Incorrect.** For each $Cu^{2+}$ discharged at the cathode, a $Cu^{2+}$ is generated at the anode. Thus, the number of $Cu^{2+}$in the $CuSO_4$ solution remain the same. Due to this, there will be no change in the intensity of the blue colour of the $CuSO_4$ solution

**29** Which properties of the first-row transition elements are correct?

**1** Atomic radius is relatively constant

**2** First ionisation energy is relatively constant

**3** They have variable oxidation states

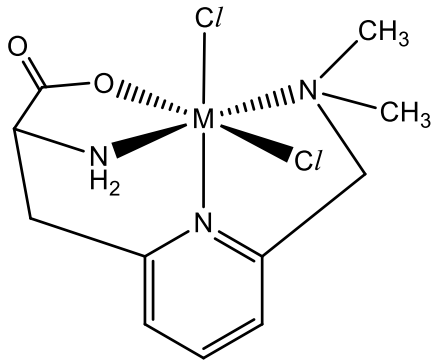
**A** 1,2 and 3 **B** 1 and 2 **C** 2 and 3 **D** 1 and 3

Answer: **A**

**Options 1, 2:** With reference to data from Data Booklet, the values are relatively constant.

**Option 3:** Transition elements can exhibit a variety of oxidation states due to close proximity in energy of the 3d and 4s electrons. Thus, both 3d and 4s electrons are available for bond formation (both ionic and covalent).

**30** Which of the following statements regarding the metal complex below is **incorrect**?




**A** The oxidation number of M is +2

**B** One of the ligands is an amino acid

**C** The complex contains a tetradentate ligand

**D** The complex contains 2 types of ligands

Answer: **A**

**A: Incorrect.** Ligand contains one negative charge, $–COO^-$, 2 $Cl^-$, total 3 negative charges. Since the metal complex is neutral, the oxidation number of M is +3.
**B: Correct.** $–CHNH_2CO_2H$ is an amino acid group
**C & D: Correct.** M is octahedral complex, consists of 2 types of ligands: 1 amino acid (tetradentate ligand) & 2 $Cl^-$