NAME _____ CLASS **22S**

JURONG PIONEER JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2023

CHEMISTRY 9729/01

Higher 2

Paper 1 Multiple Choice Questions

19 September 2023
1 hour

Candidates answer on the Question paper.

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and exam index 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** or **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.

This document consists of **12** printed pages.

Ans Key

1	**B**	**2**	**C**	**3**	**C**	**4**	**B**	**5**	**D**	**6**	**D**	**7**	**C**	**8**	**A**	**9**	**A**	**10**	**D**
11	**D**	**12**	**A**	**13**	**C**	**14**	**A**	**15**	**C**	**16**	**C**	**17**	**D**	**18**	**A**	**19**	**A**	**20**	**D**
21	**D**	**22**	**B**	**23**	**C**	**24**	**D**	**25**	**D**	**26**	**B**	**27**	**B**	**28**	**C**	**29**	**A**	**30**	**B**

1 Element X has eight more protons than element Y.

Which statement **must** be correct?

A Atoms of element Y are larger than atoms of element X.

B Element X has at least one fully filled shell of electrons.

C Element X and element Y are in the same group.

D Element X and element Y are in the same period.

A: X could be K whereas Y could be Na, K (X) has larger atomic radius than Na (Y). Statement A is not correct all the time.

B: Element X must have at least 9 protons, which means element X must have fully filled 1s subshells.

C: Y could be K whereas X could be Co, they are in the same period (Period 4) but not in the same group. Statement C is not correct all the time.

D: Y could be He whereas X could be Ne, they are in the same group (Group 18) but not in the same period. Statement D is not correct all the time.

Ans: B

2 Molecular dimerisation can be described as the process in which two identical molecules combine to give a single product.

Examples of dimers are: Al_2Cl_6 and $(CH_3CH_2CO_2H)_2$.

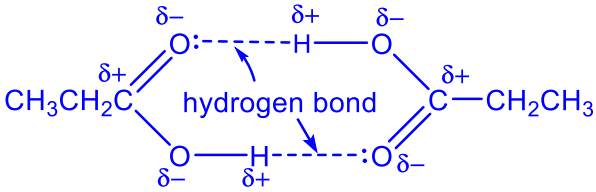
Which statement about the above dimers is **incorrect**?

A Two hydrogen bonds hold the $CH_3CH_2CO_2H$ molecules together in the dimer.

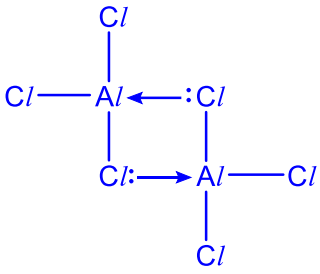
B Each aluminium atom is surrounded by four chlorine atoms in the dimer, Al_2Cl_6.

C $CH_3CH_2CO_2H$ exists as dimers when dissolved in water.

D Al_2Cl_6 dimers are non-polar molecules.



✖A: as seen in the diagram, there are a total of 2 hydrogen bond holding the dimer together.



✖B: as seen in the diagram, each alumnium atom is surrounded by 4 chlorine atoms.

✓C: due to the presence of large amount of H_2O, the $CH_3CH_2CO_2H$ molecule will more likely to form hydrogen bonding with H_2O molecules. Thus, they will exist as monomer.

✖D: the dimer is highly symmetrical, all dipole moments cancel each other so that the dimer is non-polar in nature.

Ans: C

3 Which statement is correct?

A Cl has a relative isotopic mass of 35.5.

B Cl_2 has a relative molecular mass of 70.

C ICl has a relative molecular mass of 162.4.

D $NaCl$ has a relative molecular mass of 58.5.

✖A: Cl has a relative (~~isotopic~~) atomic mass of 35.5. isotopic mass refer to specific isotopes whereas atomic mass take into account of all different isotopes.

✖B: Cl_2 has a relative molecular mass of (~~70~~) 71 (35.5 x 2 = 71).

✓C:

✖D: $NaCl$ has a relative (~~molecular~~) formula mass of 58.5. NaCl is ionic compound, it does not exist as discreet molecules, thus, it only has relative formula mass.

Ans: C

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

The most common scuba diving gas tank typically comprises 11.7% of helium gas, 56.2% of nitrogen gas and 32.1% of oxygen gas by volume.

What is the mass of oxygen gas inside the diving gas tank of 0.018 m^3 and 300 bar at 293K?

A 1.14 kg

B 2.28 kg

C 7.10 kg

D 7100 kg

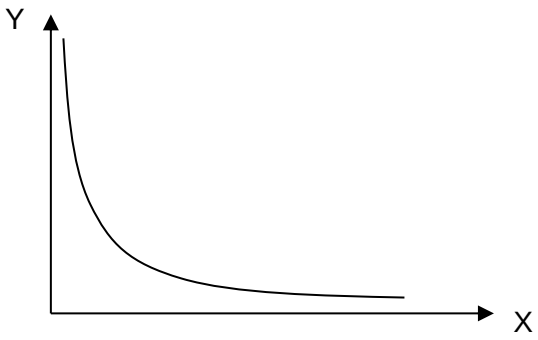
$$pV = nRT \Rightarrow pV = \frac{m}{Mr}RT$$

$$(300\times10^5)(0.018\times32.1\%) = \frac{m}{32.0}\times8.31\times293$$

$$m = 2280g = 2.28kg$$

Ans: B

5 The following graph shows the behaviour of an ideal gas with fixed mass.



Which of following will yield the graph above?

	X-axis	Y-axis	condition
A	p in Pa	pV in Pa m^3	constant temperature
B	p in Pa	ρ (density) in g m^{-3}	constant temperature
C	T in K	V in m^3	constant pressure
D	T in K	$\frac{1}{p}$ in Pa^{-1}	constant volume

A: pV = nRT ⇒ pV = k (since n and T are both constant). Graph is y = k graph.

B: $pV = nRT \Rightarrow p = \frac{\frac{m}{Mr}RT}{V} \Rightarrow p = \rho\frac{RT}{Mr}$ (since T is constant), graph is y = kx graph.

C: $pV = nRT \Rightarrow V = \frac{nR}{p}T$ (since n and p are both constant), Graph is y = kx graph.

D: $pV = nRT \Rightarrow \frac{1}{p}T = \frac{nR}{V}$ (since n and V are both constant), graph is $yx = k \Rightarrow y = \frac{k}{x}$

Ans: D

6 Which description of Dalton's Law is correct?

A Equal volumes of gases at the same temperature and pressure contain equal numbers of molecules.

B The partial pressure of a gas in a mixture is given by the product of its mole fraction and the total pressure.

C The partial pressure of a gas in a mixture is given by the product of its percent by mass and the total pressure.

D The total pressure of a mixture of gases is equal to the sum of the partial pressures of these gases.

A: this is Avogadro's Law, $n \propto V$

B: this is application of Dalton's Law

C: mole ratio does not equal to mass ratio, thus, this is the wrong application of Dalton's Law

D: correct description of Dalton's Law of partial pressure.

Ans: D

7 When iodine is oxidised by nitric acid, a white crystalline solid iodine-containing oxide can be isolated from the mixture.

0.001 mole of this oxide reacts with 0.010 mole of acidified potassium iodide to give 0.006 mole of iodine, I_2.

What is the oxidation number of iodine in the oxide?

A +1 **B** +3 **C** +5 **D** +7

[R]: iodine oxide + $ne^- \longrightarrow I_2$

[O]: $2I^- \longrightarrow I_2 + 2e^-$

Since $I^- : I_2 : e^- = 2 : 1 : 2$, 0.010 mol of I^- will produce 0.005 mol of I_2

Total amount of I_2 produced is 0.006 mol

$\Rightarrow$ amount of I_2 produced from [R] = 0.001 mol

Since $I^- : e^- = 1 : 1$, total amount of electron lost from [O] = 0.010 mol

Total amount of electron gain from [R] = 0.010 mol

$I_2 : e^- = 0.001 : 0.010 \Rightarrow 1 : 10$

$I_2 : I = 2 : 1$, each iodine will gain 5 electron in [R] to form I_2 (with oxidation number 0)

So oxidation number of iodine will be +5 in iodine oxide.

Ans: C

8 Which statements are correct?

1 enthalpy change of combustion of H_2 = enthalpy change of formation of H_2O

2 enthalpy change of atomisation of H_2 = bond energy of H–H

3 enthalpy change of solution of HC*l* = ∑enthalpy change of hydration of H^+ and Cl^-

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

✓1: it is a correct statement

✗2: $\Delta H_{at}H_2$: $\frac{1}{2}$ $H_2(g) \longrightarrow H(g)$, whereas BE(H-H): $H_2(g) \longrightarrow 2H(g)$

∴ BE(H-H) = 2 x $\Delta H_{at}H_2$

✗3: ΔH_{sol} only refer to ionic solid, in which HCl is simple covalent compound. In addition, ΔH_{sol} involves the breaking of ionic bond, i.e. –L.E also. ΔH_{sol} is not simply the sum of hydration energy of the respective ions.

Ans: A

9 *Use of Data Booklet is relevant to this question*

Carbon can exist naturally in two different crystalline forms, diamond and graphite.

carbon (diamond) ⟶ carbon (graphite) $\Delta H^\ominus = -1.9$ kJ mol^{-1}

$\Delta S^\ominus = +3.4$ J K^{-1} mol^{-1}

Which statements are correct **and** explain why diamond does **not** change into graphite at room temperature and pressure?

1 The forward reaction has an extremely small rate constant.

2 $\Delta G^\ominus$ is –2.9 kJ mol^{-1} for the above transformation.

3 The reverse reaction is spontaneous.

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

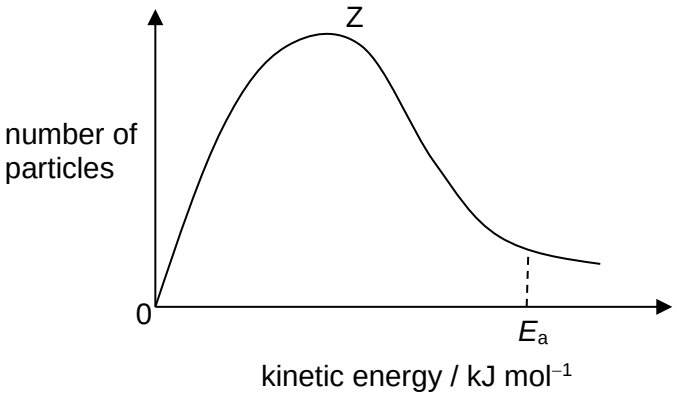
✓1: statement is correct and explain the observation. ΔG for forward reaction is negative, which means the forward reaction is energetically feasible. However, diamond does not change into graphite at room temperature and pressure, which means the forward reaction must be kinetically not feasible due to the extremely small rate constant.

✗2: statement is correct but it does not explain the observation.

✗3: statement is incorrect.

Ans: A

10 The diagram shows the Boltzmann distribution for one mole of a gas. The gas takes part in a reaction with an activation energy, E_a.



Which statement correctly describes the effect of an increase in temperature?

A Peak Z will be higher and fewer molecules will have energy > E_a.

B Peak Z will be higher and more molecules will have energy > E_a.

C Peak Z will be lower and fewer molecules will have energy > E_a.

D Peak Z will be lower and more molecules will have energy > E_a.

As temperature increases, peak of Boltzmann distribution curve will move lower and move rightwards, and there will be more energy contains energy greater than activation energy. Thus, statement D is correct.

Ans: D

11 Hydrogen peroxide solution decomposes. The equation for this reaction is shown.

$$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$$

A 100cm^3 sample of hydrogen peroxide solution is warmed. After 80 minutes, 6.00 dm^3 of oxygen gas, measured at room temperature and pressure, is collected. Under these conditions, the reaction has a constant half-life of 40 minutes.

What is the initial concentration of the hydrogen peroxide solution?

A 0.66 mol dm^{-3}

B 2.0 mol dm^{-3}

C 3.3 mol dm^{-3}

D 6.6 mol dm^{-3}

Since the reaction has a constant half-life, it must be a 1st order w.r.t H_2O_2, and since the half-life is 40 mins, 80 mins indicates 2 half-life has been passed by.

O_2 (g) is the product being formed, after 1st half-life, $\frac{1}{2}$ of the total product will be formed and after 2nd half-life, ($\frac{1}{2}$ + $\frac{1}{2}$x$\frac{1}{2}$) = $\frac{3}{4}$ of the total product will be formed.

Since O_2 collected is 6 dm^3, the max amount of O_2 could be produced

= 6 ÷ $\frac{3}{4}$ = 8 dm^3

At r.t.p, the amount of 8 dm^3 of O_2 = 8 ÷ 24 = 0.333 mol

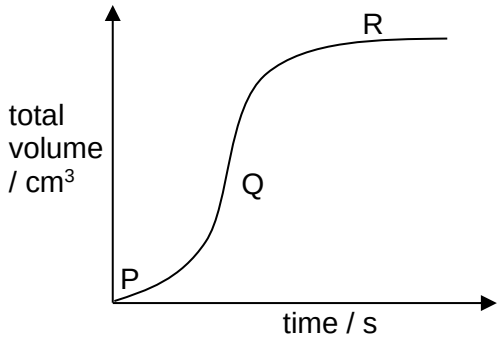
Amount of H_2O_2 = 0.333 x 2 = 0.666 mol

Initial [H_2O_2] = 0.666 ÷ 100/1000 = 6.6 mol dm^{-3}

Ans: D

12 A large excess of magnesium ribbon is added to dilute hydrochloric acid and the volume of hydrogen gas produced is measured as the reaction proceeds. The reaction is exothermic.

The results are shown.



Which row explains the changes in the rate of reaction between points P and Q and between points Q and R?

	between points P and Q	between points Q and R
A	the reaction temperature is increasing	the acid concentration is falling
B	the reaction temperature is increasing	the magnesium has been used up
C	magnesium's surface area is decreasing	the acid concentration is falling
D	magnesium's surface area is decreasing	the magnesium has been used up

From pt P to Q, the graph has an increasing gradient, indicates the rate of reaction increases from pt P to Q. Only temperature increasing could increase the rate of reaction, whereas decrease the Mg surface area will reduce the rate of reaction. Thus, Option C and D are wrong.

From pt Q to R, the graph has a point of inflection where the gradient reaches a max and start to decrease. It corresponds to the concentration of acid falling, which reduces the rate of the reaction. Since the question specified that Mg used is in large excess, it will not been used up. Thus, Option B will be incorrect.

Ans: A

13 The variation of the ionic product of water, K_w, with temperature is given in the table.

Temperature / °C	K_w / mol^2 dm^{-6}
0	1.14×10^{-15}
25	1.00×10^{-14}
50	5.50×10^{-14}

What can be deduced from this information?

A $[H^+]$ is more than $[OH^-]$ as temperature increases.

B pH of water at 50 °C is higher than that at 25 °C.

C As temperature increases, more water ionises.

D The ionisation of water is an exothermic process.

✖A: $[H^+] = [OH^-]$ at all temperatures since they are coming from the self-ionisation of water

✖B: at 25 °C, $[H^+] = 1.00 \times 10^{-7}$, pH = $-\lg[H^+] = 7.0$

At 50 °C, $[H^+] = 2.35 \times 10^{-7}$, pH = $-\lg[H^+] = 6.63$

As such, pH of water at 50 °C is lower than that at 25 °C.

✓C:

✖D: ionisation of water is a bond breaking process, thus, it is endothermic.

Ans: C

14 Which row correctly describes the species in terms of its behaviour as a Lewis base and as a Brønsted-Lowry acid?

	species	Lewis base	Brønsted-Lowry acid
A	CH_3OH	✓	✓
B	NH_4^+	✖	✖
C	OH^-	✖	✖
D	O^{2-}	✖	✓

Lewis base is electron-pair donor, it must contains lone pair of electrons

Brønsted-Lowry acid is a proton donor, it must be able to donate a H^+

✓A: CH_3OH contains lone pair of electrons on O and it can donate a H^+ to form CH_3O^-, thus, it can be both Lewis base or Brønsted-Lowry acid.

✖B: NH_4^+ has no lone pair of electrons, thus, it cannot act as Lewis base, however, it could donate H^+ to form back NH_3, thus, it can act as Brønsted-Lowry acid.

✖C: OH^- contains lone pair of electrons on O, so it can act as Lewis base. It can also donate a H^+ to form O^{2-}, thus, it can also act as Brønsted-Lowry acid.

✖D: O^{2-} contains lone pair of electrons, so it can act as Lewis base. However, it does not contain any H, so it cannot donate H^+, thus, it cannot act as Brønsted-Lowry acid.

Ans: A

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

Natural water in reservoirs often contains very finely divided solid particles of between 1 and 100 nm in diameter which have negative charges on their surface.

One stage in purifying the water consists of adding salt solutions containing high charge density cations which neutralise the negative charges and cause the solid participles to join together and settle out.

Which compound, in aqueous solution, would be the most effective in precipitating finely divided solid particles?

A $MgCl_2$ **B** $FeCl_3$ **C** $AlCl_3$ **D** $SiCl_4$

Based on the info given, the most effective compound must have the highest charge density in aqueous solution.

Mg^{2+} has a charge of 2+ whereas Fe^{3+} and Al^{3+} both have charge of +3. $SiCl_4$ when dissolve in water, it will form SiO_2, no free Si^{4+} ion could be formed.

Charge density $\propto \frac{charge}{radius}$, Al^{3+} has smaller ionic radius than Fe^{3+}. Thus, Al^{3+} will have the highest charge density.

Ans: C

16 Element G is in Period 3 of the Periodic Table. The following four statements describe the properties of element G or its compounds.

Three statements are correct descriptions. One of the statements is not correct because it does not fit with the other three.

Which statement is **not** correct?

A Element G is a solid at room temperature which conducts electricity.

B The chloride GCl_3 reacts with water to give an acidic solution.

C Element G forms a chloride, GCl_3, which reacts with more chlorine to give GCl_5.

D Adding NaOH(aq) to the solution resulting from the reaction of GCl_3 with water produces a white precipitate which is soluble in an excess of NaOH(aq)

A: Element G can be Na, Mg and Al

B: Element G can be Al or P

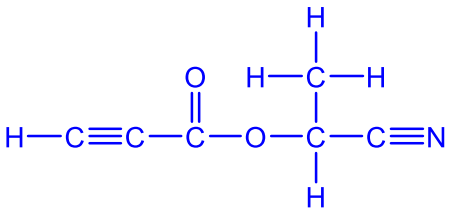
C: Element G can only be P

D: Element G can only be Al

Ans: C

17 How many σ and π bonds are present in one $HC{\equiv}C{-}CO_2CH(CH_3)CN$ molecule?

	σ	π
A	10	3
B	10	5
C	13	3
D	13	5



each triple bond contains 1 σ bond and 2 π bonds, as such, there are a total of 13 σ bonds and 5 π bonds.

Ans: D

18 The unsaturated hydrocarbon octa-1,3,5,7-tetraene can display *cis-trans* isomerism.

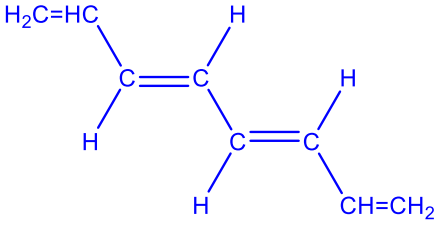
$CH_2{=}CHCH{=}CHCH{=}CHCH{=}CH_2$
octa-1,3,5,7-tetraene

How many isomers exist?

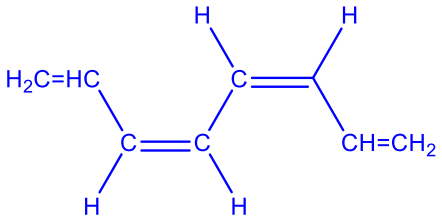
A 3 **B** 4 **C** 8 **D** 16

There are a total of 4 C=C double bonds, of which, two of them are able to exist cis-trans isomerism, as the two terminal C=C double bonds have two same H attached to the same carbon. So the total number of isomer exist = $2^2 = 4$.

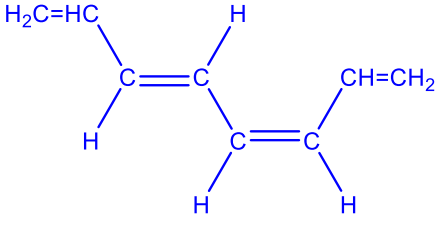
However, since the molecule is highly symmetrical, two of the isomers are exactly the same. Thus, there are a total of 3 isomers exist.



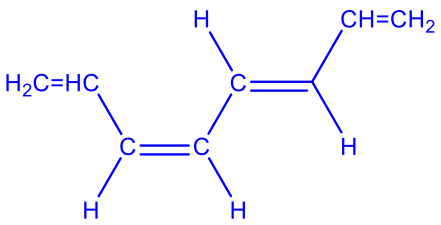
trans-trans



cis-cis



trans-cis



cis-trans

These two structures are the same structures, just flip 180° horizontally

Ans: A

19 The substitution reaction between $CH_4(g)$ and $Br_2(g)$ in the presence of ultraviolet light involves the following steps.

$$Br_2 \xrightarrow{uv} 2\dot{B}r$$

$$CH_4 + \dot{B}r \longrightarrow \dot{C}H_3 + HBr$$

$$\dot{C}H_3 + Br_2 \longrightarrow CH_3Br + \dot{B}r$$

Why is this called homogenous catalysis?

1 Bromine radicals are in the same physical phase as bromine and methane.

2 Bromine and methane are in the same physical phase.

3 The initiation step involves the homolytic fission of bromine molecules into two bromine radicals.

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

Homogenous catalysis refers to the catalysts and the reactants are in the same phase.

Based on the mechanism given, the catalyst here is Br• since it is regenerated.

As such, only statement 1 explains that catalyst and the reactants are in the same phase.

Both statement 2 and 3 are correct, but they do not answer the question.

Ans: A

20 Which reaction is a termination step in the chain reaction between chlorine and ethane, in the presence of ultraviolet light?

A $\bullet CH_2CH_3 + \bullet CH_3 \longrightarrow CH_3CH_2CH_3$

B $\bullet CH_2CH_3 + Cl_2 \longrightarrow CH_3CH_2Cl + \bullet Cl$

C $\bullet CH_2CH_3 + H\bullet \longrightarrow CH_3CH_3$

D $\bullet CH_2CH_3 + \bullet CH_2CH_3 \longrightarrow CH_3CH_2CH_2CH_3$

Termination step for a FRS mechanism must involve collision between both radicals, thus, B will be the wrong option.

In FRS mechanism, H• will never be produced, thus, Option C is wrong.

Termination step of a FRS mechanism will be possible to produce alkane that double the C number of the original reactant. Since this reaction involves ethane, C_2H_6. Trace amount of alkane with 4 carbons could be formed. Thus, answer will be D.

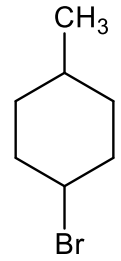
Ans: D

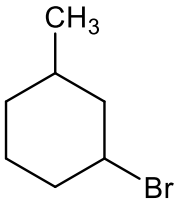
21 Compound U, $C_7H_{13}Br$, reacts with hot alcoholic NaOH to produce two compounds, V and W.

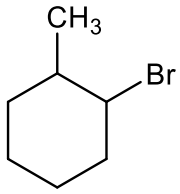
On reaction with Br_2, V gives a product, $C_7H_{12}Br_2$, which exists as a mixture of four enantiomers

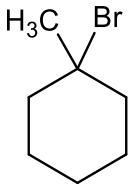
On reaction with Br_2, W gives a product, $C_7H_{12}Br_2$, which is achiral.

What could U be?

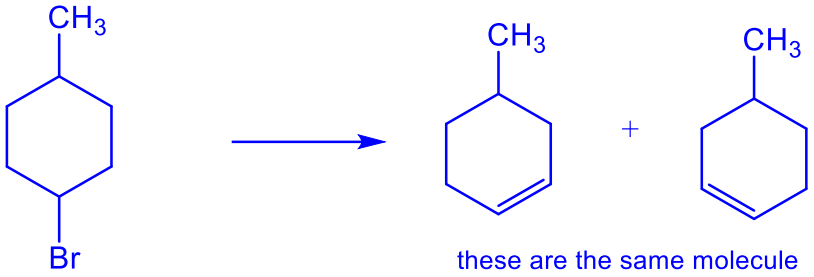
A 

B 

C 

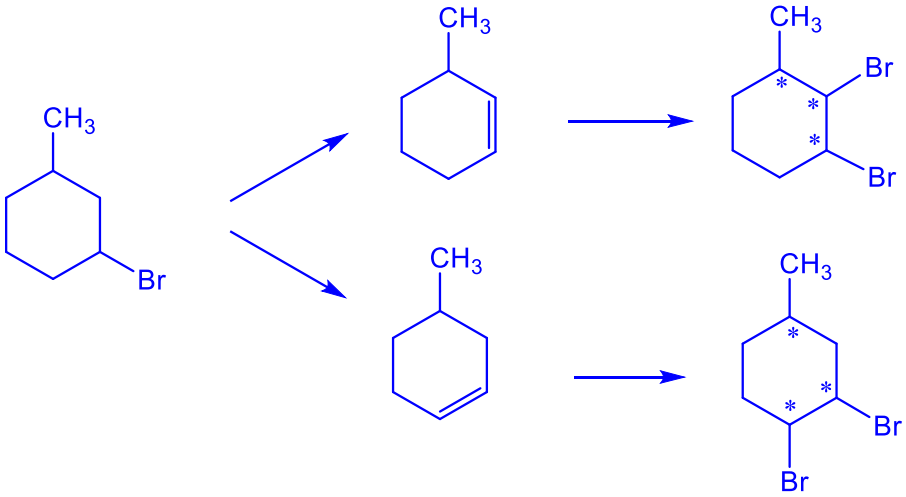
D 

✖A: elimination of molecule A will form only 1 product.

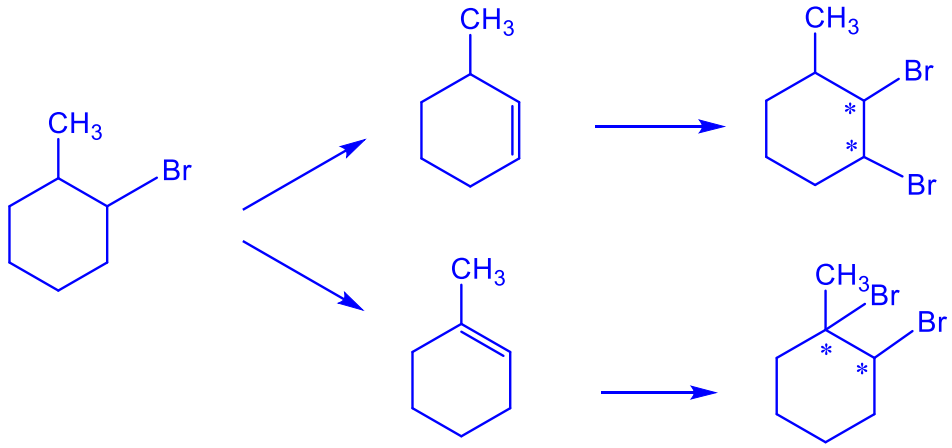


these are the same molecule

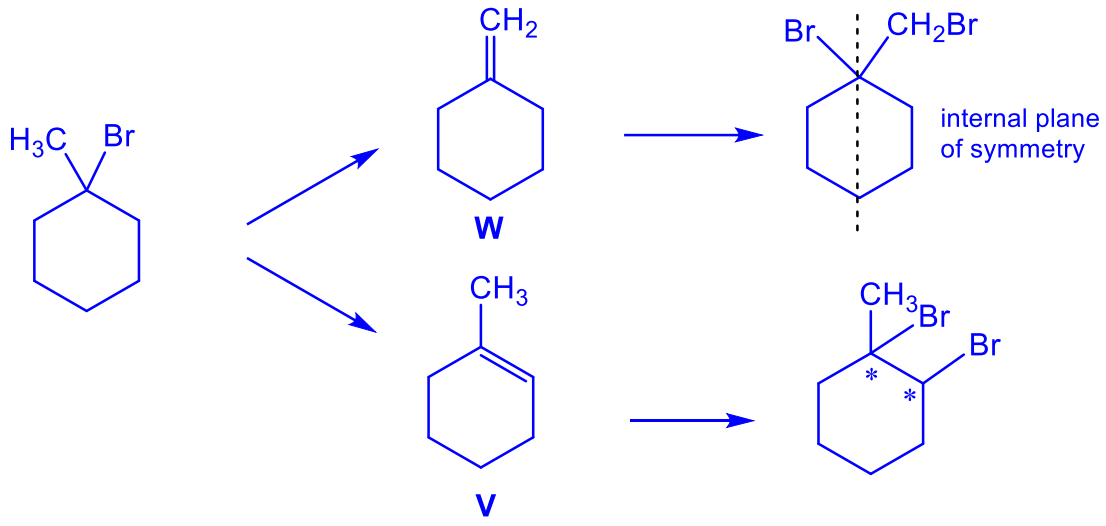
✖B: Both final products contains 2 chiral centres, so both products exists as a mixture of four enantiomers.



✖C: Both final products contains 3 chiral centres, so both products exists as a mixture of eight enantiomers.



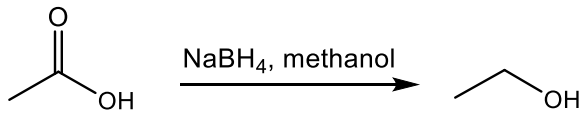
✓D: Product from W contains an internal plane of symmetry, thus, it is achiral molecule, whereas product from V contains 2 chiral centres, which the molecule exists as 2^2 = 4 enantiomers.



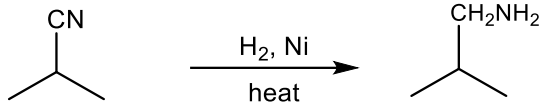
Ans: D

22 Which of the following transformation will occur under the given conditions?

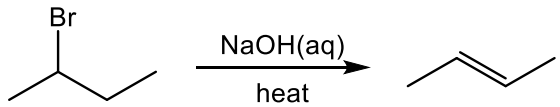
A



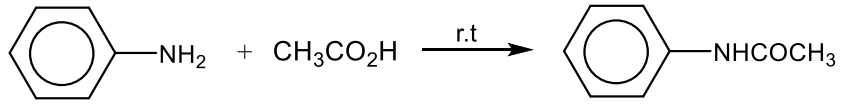
B



C



D



✗A: $NaBH_4$, methanol is a weaker reducing agent and can only reduce carbonyl compound. It cannot reduce carboxylic acid. Only $LiAlH_4$, dry ether works in this case.

✓B:

✗C: NaOH(aq) will favour nucleophilic substitution instead of elimination, so the product will be $CH_3CH(OH)CH_2CH_3$ instead. Elimination will be favoured when a stronger base is used, i.e. NaOH dissolve in alcohol, such as ethanol.

✗D: acid-base reaction will take place when amine is mixed with carboxylic acid. Acyl chloride must be used before condensation reaction to form amide could take place.

Ans: B

23 Two isomeric alcohols, L and M, have molecular formula C_4H_9OH.

L is oxidised to carbonyl compound Q which gives a silver mirror with Tollen's solution.

M is oxidised to carbonyl compound R which does **not** give a silver mirror with Tollen's solution.

Which of L and M gives a yellow precipitate with alkaline I_2(aq)?

A Insufficient data is given to answer this question

B L only

C M only

D Neither L nor M

Q is positive with Tollen's reagent ⇒ Q contains aldehyde group ⇒ L contains primary alcohol ⇒ L will be negative for iodoform test

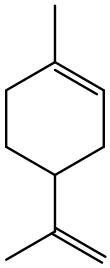
R is carbonyl compound and negative with Tollen's reagent ⇒ R contains a ketone group

The only possible ketone that is formed from alcohol C_4H_9OH is $CH_3COCH_2CH_3$. Thus, M must be $CH_3CH(OH)CH_2CH_3$, and M will be positive for iodoform test.

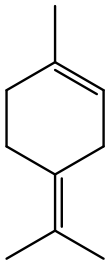
Ans: C

24 A diketo acid is a compound with two ketone groups and one carboxylic acid group.

limonene



terpinolene



Which statement about the reactions of limonene and terpinolene are correct?

1 When reacted with an excess of hydrogen and a nickel catalyst, limonene and terpinolene produce the same compound.

2 An excess of hot acidified $KMnO_4$ reacts with limonene and with terpinolene to form different diketo acids.

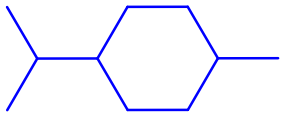
3 Both limonene and terpinolene can be formed from the same dichloroalkane under suitable conditions.

A 1 and 2 only

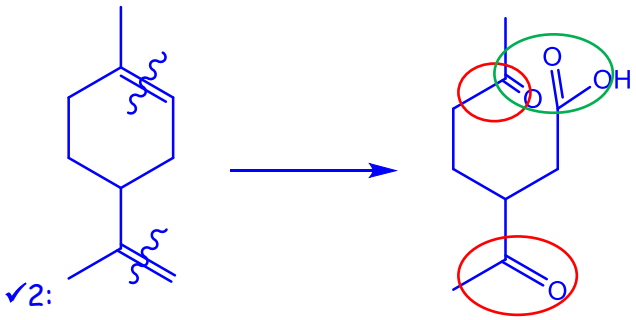
B 1 and 3 only

C 2 and 3 only

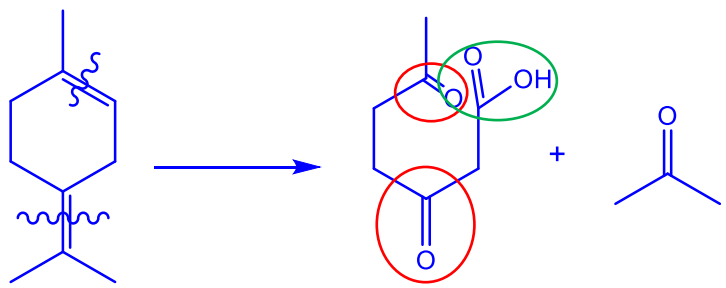
D 1, 2 and 3

✓1: When limonene and terpinolene reacts with excess H_2 and Ni catalyst, all C=C will be reduced to C-C, so both reactant will generate the following pdt,  .

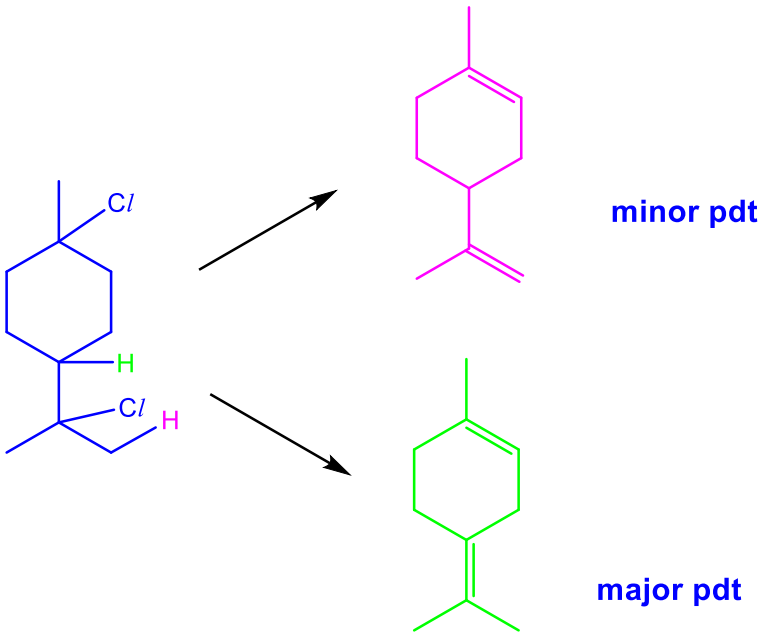
✓2:



limonene will form di-keto acid



terpinolene forms different di-keto acid.



✓3:

Ans: D

25 Chiral chloroalkanes can undergo nucleophilic substitution with NaOH(aq) to form alcohols.

The reaction mechanism is either S_N1 or S_N2.

Which statements are correct?

1 Inversion of configuration occurs in the S_N2 mechanism.

2 Product mixture from the S_N1 mechanism results in no optical activity.

3 The hydrolysis of tertiary chloroalkane takes place by the S_N1 mechanism because the substituent alkyl groups stabilise the carbocation intermediate.

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

✓1: S_N2 mechanism will result in inversion of configuration for chiral reactants.

✓2: S_N1 mechanism will result in the formation of racemic mixture, which shows no optical activity.

✓3: Tertiary chloroalkane prefers S_N1 mechanism as the tertiary carbocation intermediate formed is stabilised by 3 electron-donating alkyl groups.

Ans: D

26 What is produced when $CH_3NHCH_2CONH_2$ is added to an excess of hot $HNO_3(aq)$?

A $CH_3\overset{+}{N}H_2CH_2CONH_2$

B $CH_3\overset{+}{N}H_2CH_2CO_2H$

C $CH_3NHCH_2C\overset{+}{O}NH_3$

D $CH_3\overset{+}{N}H_2CH_2COO^-$

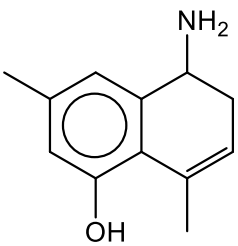
Amide undergoes nucleophilic addition-substitution, forming carboxylic acid and ammonium salt. Since the carboxylic acid is a stronger acid than conjugated acid from ammonium group, thus amine will be protonated

Ans: B

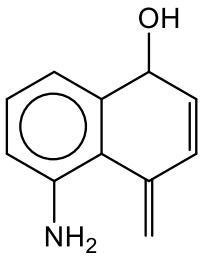
27 When mixed with aqueous Br_2, 1 mole of T reacts with 4 moles of $Br_2(aq)$.

What could T be?

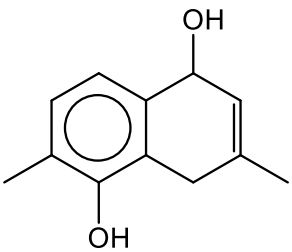
A



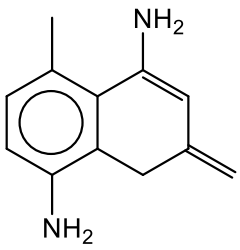
B



C

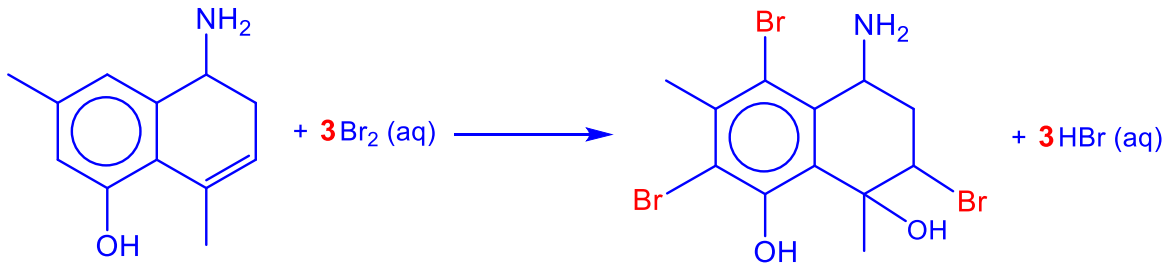


D

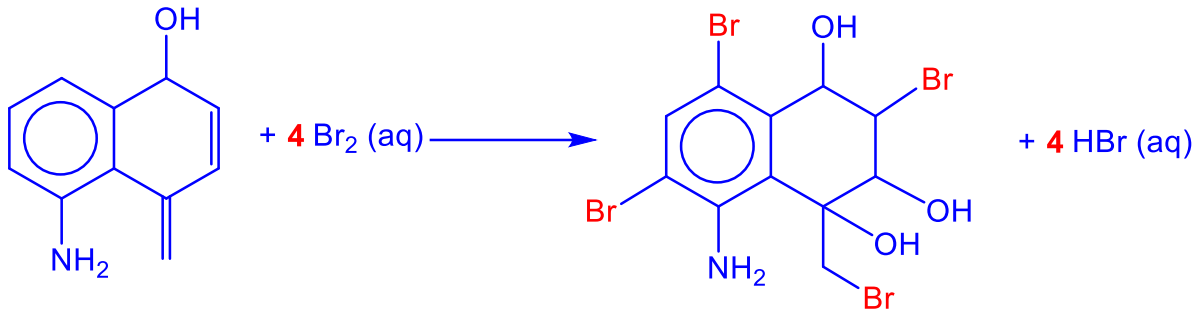


When phenol or phenylamine react with $Br_2(aq)$, tri-substitution at position 2,4 and 6 will take place. Each C=C will react with 1 mole of $Br_2(aq)$. As such, the reaction with $Br_2(aq)$ with each option are as follows:

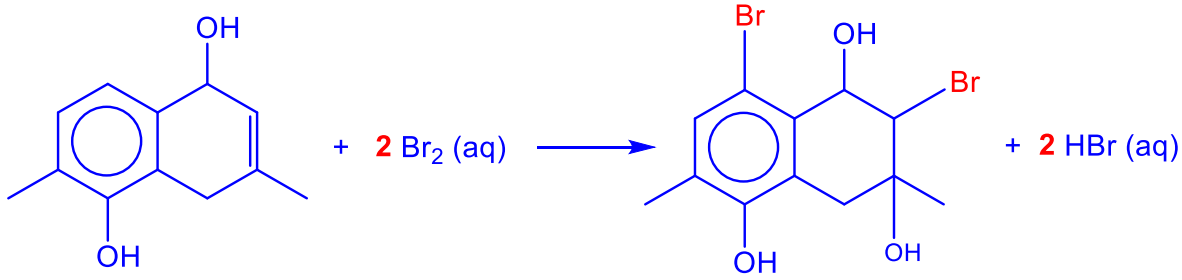
A:



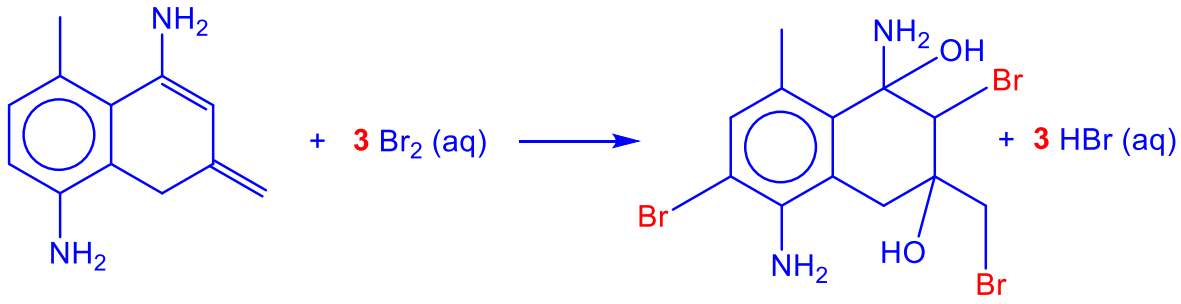
B:



C:



D:



Ans: B

28 When ethyl ethanoate, $CH_3C^{16}O_2C_2H_5$, undergoes acid hydrolysis in a solution containing $H_2{}^{18}O$, atoms of ^{18}O isotope appears in the product as $CH_3CO^{18}OH$ and **not** as $C_2H_5{}^{18}OH$.

What is the correct deduction from this observation?

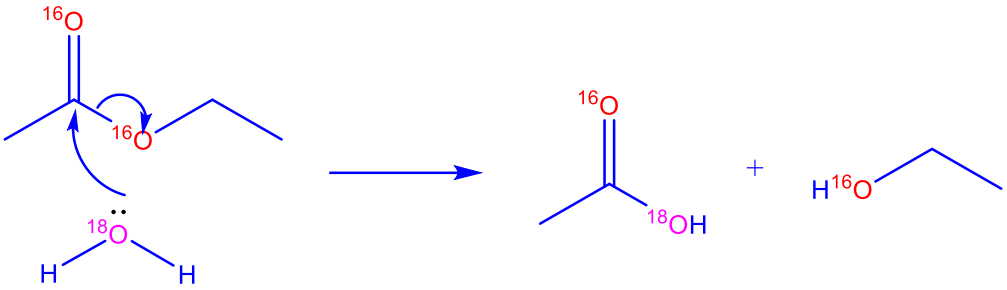
A A ^{16}O–C bond is stronger than a ^{18}O–C bond.

B The O–C bond in the O–C_2H_5 group of the ester is broken

C The C–O single bond in the –COO group of the ester is broken.

D The $H_2{}^{18}O$ attracts a δ+ carbon atom in the C_2H_5 group.

The simplified version of ester hydrolysis is as below, which clearly shows where the oxygens are



As such, only statement C correctly describes what is happening in the hydrolysis process.

Ans: C

29 Consider the following standard electrode potentials of 4 different half-cells.

$E^{\ominus}(P^+/P) = -0.30$ V	$E^{\ominus}(Q^{2+}/Q) = -0.80$ V	$E^{\ominus}(R/R^-) = +0.30$ V	$E^{\ominus}(S^+/S) = +1.80$ V

Which of the following statements are correct under standard conditions?

1 A cell consisting of P^+/P half-cell and S^+/S half-cell has an e.m.f of +2.10 V.

2 P could be oxidised by Q^{2+}.

3 Q^{2+} could be oxidised by R.

4 S^+ is the strongest reducing agent among all the species listed.

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

✓1: $E_{cell} = E_{red} - E_{ox} = (+1.80) - (-0.30) = +2.10$ V

✗2: $E_{cell} = E_{red} - E_{ox} = (-0.80) - (0.30) = -0.50$ V < 0 (energetically not feasible). Thus, P could not be oxidised by Q^{2+}.

✗3: Q^{2+} cannot be oxidised as Q^{2+} is an oxidising agent based on the half equation.

✗4: S^+ has the most positive E value, it indicates that it is the easiest to get reduced, which indicates that S^+ is the strongest oxidising agent.

Ans: A

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

Olympic gold medals are made from pure silver with a total of 6 g of gold electroplated over the surface of the medals.

Commercially, the most common electrolyte used in electroplating of gold is potassium gold cyanide, $KAu(CN)_2$.

How long does it take to complete the electroplating of one Olympic gold medal if the current used is 2.0 A?

A 735 s **B** 24.5 min **C** 49.0 min **D** 1.02 h

From the formula $KAu(CN)_2$, since oxidation state of K is +1 and CN is -1, so Au will have an oxidation state of +1. Every mole of Au will require 1 mole of electron for complete reduction.

$Q = It = n_eF$

$(2.0)t = (6/197.0)(96500)$

$t = 1,470\ s = 24.5\ min$

Ans: B

END OF PAPER