Catholic Junior College

JC 2 Preliminary Examinations

Higher 2

CANDIDATE NAME	
CLASS	**2T**

CHEMISTRY

9729/01

Paper 1 Multiple Choice

Wednesday 29 August 2018

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

WORKED SOLUTIONS

This document consists of **29** printed pages.

1 A sample of tungsten contains four naturally occurring isotopes, ^{182}W, ^{183}W, ^{184}W and ^{186}W.

The relative atomic mass of tungsten in this sample is 183.9. What is the percentage of the isotope ^{182}W in this sample?

Isotope	Relative Abundance (%)
^{182}W	?
^{183}W	?
^{184}W	30.6
^{186}W	28.6

A 10.5 **C** 26.4

B 14.4 **D** 40.8

Answer: C

Let the percentage of ^{182}W be x.

The percentage of ^{183}W would be 100 – 30.6 – 28.6 – x = 40.8 – x

Thus,

$$183.9 = \frac{182x+183(40.8-x)+184(30.6)+186(28.6)}{100}$$

$$x = 26.4$$

2 20 cm^3 of 0.100 mol dm^{-3} of potassium ferrate(VI), K_2FeO_4, reacts with sodium ethanedioate, $Na_2C_2O_4$, in an acidic medium to produce 144 cm^3 of carbon dioxide gas at room temperature and pressure.

The half equation of $C_2O_4^{2-}$ is shown as follows:

$$2CO_2 + 2e^- \rightleftharpoons C_2O_4^{2-}$$

What is the final oxidation state of the iron-containing species after the reaction?

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

Answer: C

Oxidation state of Fe in K_2FeO_4 = +6

Amt of FeO_4^{2-} reacted = $\frac{20}{1000}$ × 0.100 = 0.002 mol

Amt of CO_2 formed = 144 ÷ 24 000 = 0.006 mol

Amt of $C_2O_4^{2-}$ reacted = ½ x 0.006 = 0.003 mol

Ratio of FeO_4^{2-} : $C_2O_4^{2-}$ = 0.002 : 0.003

2 FeO_4^{2-} ≡ 3 $C_2O_4^{2-}$

3 mol of $C_2O_4^{2-}$ will produce 6 mol of e^- and 2 mol of FeO_4^{2-} will accept 6 mol of e^-.

Therefore, 1 mol of FeO_4^{2-} will accept 3 mol of e^-.

Since FeO_4^{2-} is reduced from an oxidation state of +6 to +3.

3 When attracted by a strong magnet, some species are able to exhibit paramagnetism. Such species contain unpaired electrons which are able to spin in a way which aligns parallel to the magnetic field.

Which of the following species in the ground state is able to exhibit paramagnetism?

1 O 2 Al^+ 3 Ti^{2+} 4 Cu^+

A 1 and 3 only

B 2 and 4 only

C 1, 3 and 4 only

D 2, 3 and 4 only

Answer: A (1 and 3 only)

1 O : $1s^2\ 2s^2\ 2p^4$ ($2p_x^2$, $2p_y^1$, $2p_z^1$) there are 2 unpaired electrons in 2p orbital

2 Al^+ : $1s^2\ 2s^2\ 2p^6\ 3s^2$ there are no unpaired electrons

3 Ti^{2+} : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2$ there are 2 unpaired electrons in 3d orbital

4 Cu^+ : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$ there are no unpaired electrons

4 Phosphorus(V) chloride, PCl_5 dissolves in a suitable polar solvent to produce two ions, $[PCl_4]^+$ and $[PCl_6]^-$.

Which of the following shows the correct shape for PCl_5, $[PCl_4]^+$ and $[PCl_6]^-$?

	PCl_5	$[PCl_4]^+$	$[PCl_6]^-$
A	trigonal planar	square planar	square pyramidal
B	trigonal bipyramidal	square planar	octahedral
C	trigonal planar	distorted tetrahedral	square pyramidal
D	trigonal bipyramidal	tetrahedral	octahedral

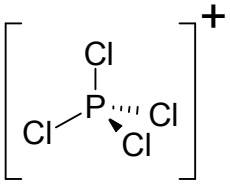
Answer: D

PCl_5 : 5 bond pairs 0 lone pairs of electrons; shape is trigonal bipyramidal

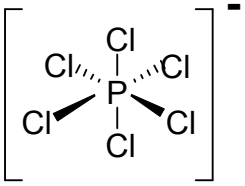
$[PCl_4]^+$: 4 bond pairs 0 lone pairs of electrons; shape is tetrahedral

$[PCl_6]^-$: 6 bond pairs 0 lone pairs of electrons; shape is octahedral

tetrahedral



octahedral



5 The table shows the boiling point of some halogenoalkanes.

compound	boiling point/ °C
CH_3CH_2Cl	12.3
CH_3CH_2Br	34.8
CH_3CH_2I	70.0

Which of the following correctly explains the difference in the boiling point?

1 the electronegativity difference between the halogen and carbon increases from C−C*l* to C−I

2 the strength of permanent dipole-permanent dipole attraction increases from C−C*l* to C−I

3 the strength of instantaneous dipole-induced dipole attraction increases from CH_3CH_2Cl to CH_3CH_2I

4 the bond energy of C−X bond decreases from C−C*l* to C−I

A 1 and 2 only

B 2 and 4 only

C 3 only

D 3 and 4 only

Answer: C (3 only)

N.B. H-bonding > pd-pd> id-id only if size of electron cloud of molecules are similar.

1 the electronegativity difference between the halogen and carbon should **decrease** from C−C*l* to C−I
Statement **does not** explain for the trend of increasing boiling point from CH_3CH_2Cl to CH_3CH_2I.

2 the strength of permanent dipole-permanent dipole attraction **decreases** from C−C*l* to C−I

The statement of option 2 is **incorrect** and **does not** explain for the trend of **increasing** boiling point from CH_3CH_2Cl to CH_3CH_2I.

3 the strength of instantaneous dipole-induced dipole attraction increases from CH_3CH_2Cl to CH_3CH_2I
Statement is **correct** as the total number of electrons increases from CH_3CH_2Cl to CH_3CH_2I and due to the increase in id-id attraction, the boiling point increases from CH_3CH_2Cl to CH_3CH_2I.

4 the bond energy of C-X bond decreases from C−Cl to C−I
Statement is correct but boiling does not break the C−X bond, so this **does not** explain for the trend of **increasing** boiling point from CH_3CH_2Cl to CH_3CH_2I.

6 Which of the following changes will result in the greatest decrease in the density of a fixed mass of ideal gas?

	Pressure	Temperature/ K
A	halves	halves
B	halves	doubles
C	doubles	halves
D	doubles	doubles

Answer: B

Density, $\rho = \frac{m}{V}$

Hence, $\rho = \frac{pM_r}{RT}$

From the formula above, the greatest decrease in density is brought about when **pressure decreases** and **temperature increases**.

7 Consider the following reactions.

Reaction 1: $CH_3^+ + Br^- \rightarrow CH_3Br$

Reaction 2: $HPO_4^{2-} + H_2BO_3^- \rightleftharpoons H_2PO_4^- + HBO_3^{2-}$

Which of the following statement is **not** true about the reactions above?

A Both reactions are acid-base reactions.

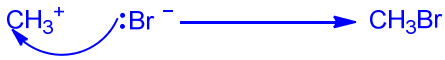
B In reaction 2, HPO_4^{2-} acts as the Brønsted-Lowry base.

C In reaction 2, HBO_3^{2-} is the conjugate acid of $H_2BO_3^-$.

D In reaction 1, a dative covalent bond is formed between CH_3^+ and Br^-.

Answer: C

For Reaction 1:



CH_3^+ behaves as the Lewis acid (electron pair acceptor) while Br^- behaves as the Lewis base (electron pair donor). Hence it is an acid-base reaction (option A is true) which involves the formation of a dative covalent bond. (option D is true)

For Reaction 2:

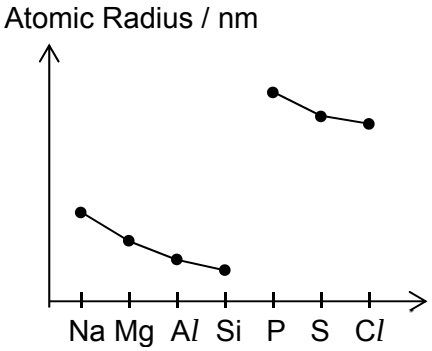
$HPO_4^{2-} + H_2BO_3^- \rightleftharpoons H_2PO_4^- + HBO_3^{2-}$

$H_2BO_3^-$ behaves as the Brønsted-Lowry acid (H^+ donor) while HPO_4^{2-} behaves as the Brønsted-Lowry base (H^+ acceptor). Hence it is an acid-base reaction. (option B is true)

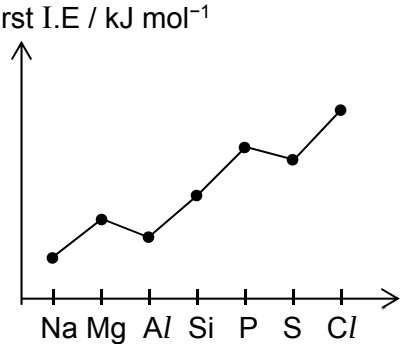
HBO_3^{2-} is the conjugate **base** of $H_2BO_3^-$ (option C is not true)

8 Which of the following sketches shows the correct trend in the stated property for the elements in the third period of the Periodic Table?

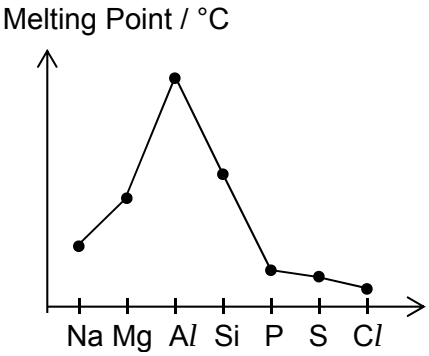
A



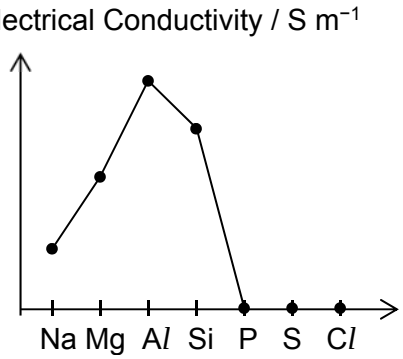
C



B

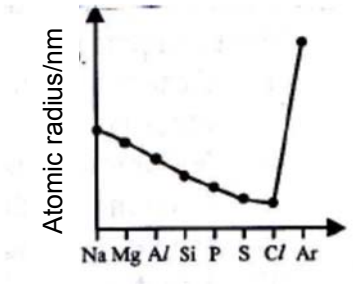


D

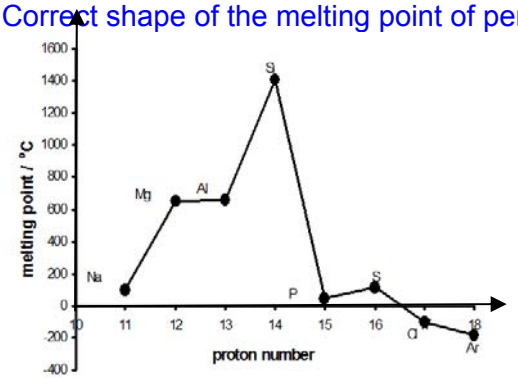


Answer: C

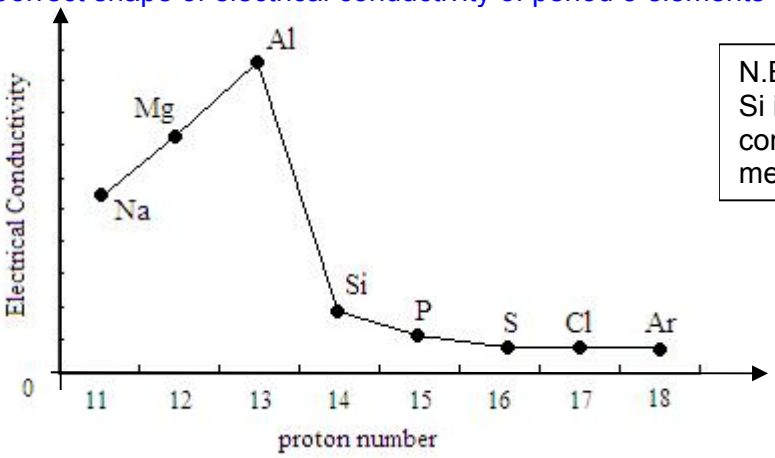
Graph A shows the trends of ionic radius across period 3 elements, not atomic radius. Atomic radius across period should be this.



Correct shape of the melting point of period 3 elements should be this:



Correct shape of electrical conductivity of period 3 elements should be this:



N.B.
Si is a semi-conductor, conductivity should be lower than metal.

9 Compounds of Period 3 elements dissolve in water to form aqueous solutions that are acidic, basic or neutral.

Which of the following sequence shows the order of **increasing** resultant pH when the compounds are added to water?

A $NaCl$, $MgCl_2$, $SiCl_4$

B $AlCl_3$, $SiCl_4$, PCl_5

C Al_2O_3, MgO, SO_2

D P_4O_{10}, SiO_2, MgO

Answer: D. pH 2, pH 7, pH 9

10 Phosphine reacts with hydrogen iodide to form phosphonium iodide in the reaction shown below:

$$PH_3(g) + HI(g) \rightarrow PH_4^+I^-(s) \qquad \Delta H^\ominus = -145.2 \text{ kJ mol}^{-1}; \Delta S^\ominus = -570.8 \text{ J K}^{-1} \text{ mol}^{-1}$$

Which one of the following statement is true for the above reaction?

1 The products are less disordered than the reactants.

2 The reaction is non-spontaneous under standard conditions.

3 As temperature increases, the reaction becomes more spontaneous.

A 1 only

B 2 only

C 1 and 2 only

D 1, 2 and 3 only

Answer: C

1 True. Since $\Delta S^\theta = -570.8 \text{ J K}^{-1} \text{ mol}^{-1}$ (negative value), disorderness of the system has occurred.

2 True.
At 298K, $\Delta G^\theta = \Delta H^\theta - T\Delta S^\theta = (-145.2) - (298)(-570.8/1000)$
$= +24.9 \text{ kJ mol}^{-1} > 0$ (non-spontaneous reaction)

3 False. Since both ΔH^θ and ΔS^θ have negative values, the reaction is only spontaneous at low temperature (so that the magnitude of $-T\Delta S^\ominus$ (+ve) decreases).

11 The reaction of acidified aqueous potassium iodide with aqueous hydrogen peroxide:

$$2I^-(aq) + H_2O_2(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l)$$

is thought to involve the following steps:

$H_2O_2 + I^- \rightarrow H_2O + OI^-$ (slow)
$OI^- + H^+ \rightarrow HOI$ (fast)
$HOI + H^+ + I^- \rightarrow I_2 + H_2O$ (fast)

Which of the following conclusion can be drawn from this information?

1 The acid is acting as a catalyst only.

2 The reaction is pseudo-first order with respect to H_2O_2.

3 The reaction rate is independent of the pH of the solution.

A 1 only

B 3 only

C 1 and 2 only

D 1, 2 and 3 only

Answer: B

1 False. H^+ is consumed in Step 2 and 3 and are not regenerated. Hence the acid (H^+) is not acting as a catalyst, it is a reactant in this reaction.

2 False.
Since the first step is the slow step, the rate equation is

$$\text{rate} = k[H_2O_2][I^-]$$

The reaction is first-order with respect to both H_2O_2 and I^-. Statement 2 can only be true if a large concentration of I^- is used so that the rate equation can be simplified to

$$\text{rate} = k'[H_2O_2] \qquad \text{where } k' = k[I^-]$$

However, it is not mentioned in the question that a large concentration of I^- is used in the experiment.

3 True. The rate equation does not involve H^+, hence the pH does not affect the reaction rate.

12 A first-order decomposition reaction is shown below.

$$AB(g) \rightarrow A(g) + B(g)$$

The half-life of the reaction was found to be 3.47 s.

What is the time taken for AB(g) to reach one-third of its initial concentration?

A 3.0 s **B** 3.5 s **C** 5.5 s **D** 7.0 s

Answer: C

Using the following formula,

$\frac{c_t}{c_o} = \left(\frac{1}{2}\right)^n$, where n = no. of half-lives = $\frac{\text{time taken}}{t_{1/2}}$

If [AB] is $\frac{1}{3}$ of the initial concentration, $\frac{c_t}{c_o} = \left(\frac{1}{3}\right)$

$$\frac{1}{3} = \left(\frac{1}{2}\right)^n$$

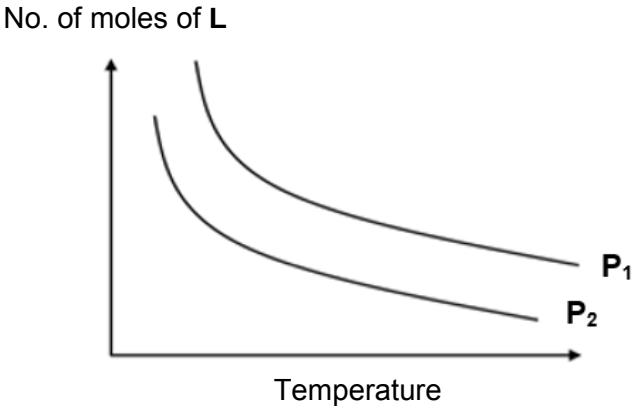
$\lg\left(\frac{0.5}{1.5}\right) = n \lg\left(\frac{1}{2}\right)$

n = 1.585

time taken = 1.585 x 3.47 = 5.5 s

13 The graph below shows how the number of moles of compound **L** varies with temperature at two different pressures of $\mathbf{P_1}$ and $\mathbf{P_2}$ respectively.
L could be any of the following compounds shown in the equation at equilibrium.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -197 \text{ kJ mol}^{-1}$$



What is the correct identity of **L** and the correct magnitude of pressures $\mathbf{P_1}$ and $\mathbf{P_2}$?

	Identity of **L**	magnitude of pressures $\mathbf{P_1}$ and $\mathbf{P_2}$
A	SO_2	$\mathbf{P_1 > P_2}$
B	SO_2	$\mathbf{P_1 < P_2}$
C	SO_3	$\mathbf{P_1 > P_2}$
D	SO_3	$\mathbf{P_1 < P_2}$

Answer: C

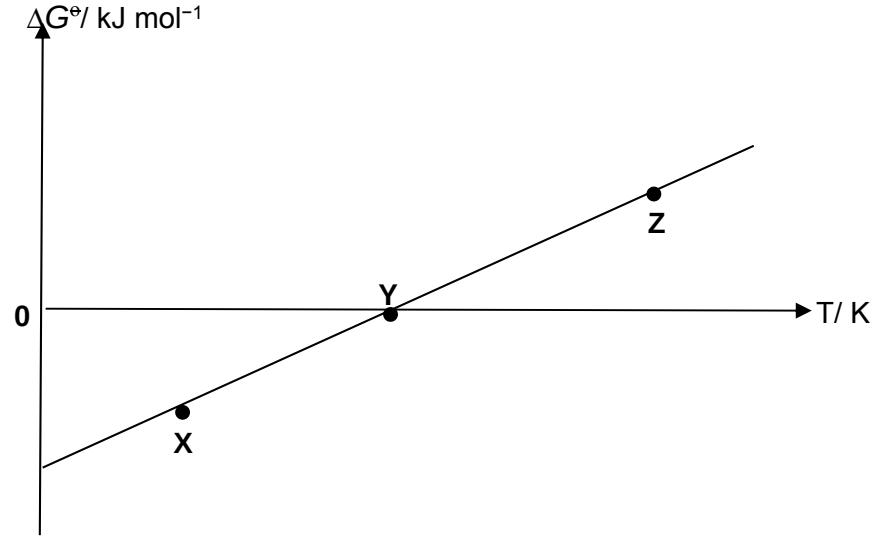
Since forward reaction is exothermic, higher temperatures will favour the backward endothermic reaction. At higher temperature, $[SO_2]$ and $[O_2]$ increases while $[SO_3]$ decreases. Thus the two downward–sloping graphs applies to SO_3.

At a higher pressure, forward reaction is favoured since the product has less moles of gaseous particles, therefore $[SO_3]$ increases.
Thus, $\mathbf{P_1 > P_2}$.

14 When nitrogen dioxide, NO_2, and nitrogen monoxide, NO, is mixed, the gases react to form dinitrogen trioxide, N_2O_3. The reaction is shown in the following equilibrium.

$$NO_2(g) + NO(g) \rightleftharpoons N_2O_3(g)$$

The graph below shows how the $\Delta G^{\ominus}$ varies with temperature for the above reaction.



Using the graph above, deduce which of the following statement is true about the reaction at equilibrium?

A At point **X**, more NO_2 is present as compared to that at point **Y**.

B At point **X**, the K_c value is likely to be greater than 1.

C At point **Y**, the rate of forward reaction is greater than that of backward reaction.

D At point **Z**, more N_2O_3 is present compared to that at point **Y**.

Answer: B

Since the reaction is at equilibrium, rate of forward reaction = rate of backward reaction for all points X, Y and Z. **(option C is incorrect)**

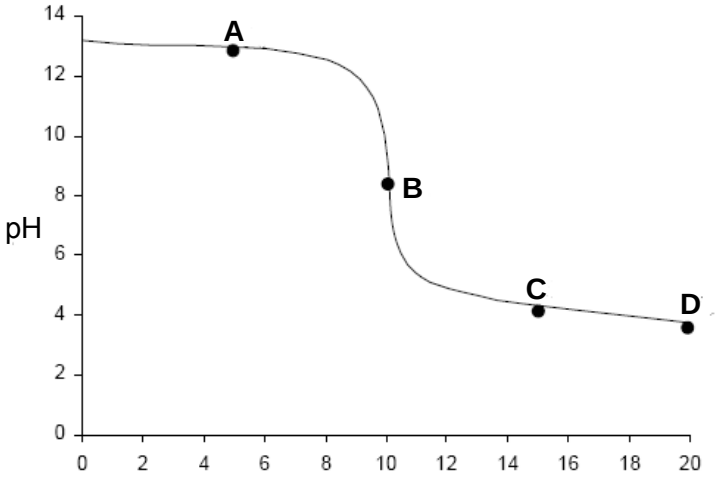
At point **X**, $\Delta G^{\theta} < 0$, P.O.E lies more to the right and forward reaction occurs more readily compared to backward reaction.
Since $K_c = \frac{[N_2O_3]}{[NO_2][NO]}$,
Therefore K_c value is likely to be greater than 1 at point **X**. **(option B is correct)**

At point **Y**, $\Delta G^{\theta} = 0$.
Comparing point **X** and **Y**, **less** NO_2 gas is present at **X** since P.O.E lies more to the right at point **X** compared to point **Y**. **(option A is wrong)**

At point **Z**, $\Delta G^{\theta} > 0$, P.O.E lies more to the left and backward reaction occurs more readily compared to forward reaction. K_c is lesser than 1. Therefore, at point **Z**, **less** N_2O_3 gas is present as compared to that at point **Y**. **(option D is wrong)**

15 The pH changes when 0.100 mol dm^{-3} CH_3CO_2H is added dropwise to 10.0 cm^3 of 0.100 mol dm^{-3} NaOH(aq) as shown below.

At which point on the graph does pH = pK_a, where K_a is the acid dissociation constant of the weak acid?



Answer: D

For pH = pK_a, $[A^-] = [HA]$

$HA + NaOH \rightarrow NaA + H_2O$

At A, species present: NaOH and NaA

At equivalence point B, A^- ion hydrolyses in water, $A^- + H_2O \rightleftharpoons HA + OH^-$

At C, $[A^-] \neq [HA]$

At D,

n_{HA} = 20.00/1000 x 0.100
= 2 x 10^{-3} mol

n_{OH^-} = 10.0/1000 x 0.100
= 1 x 10^{-3} mol

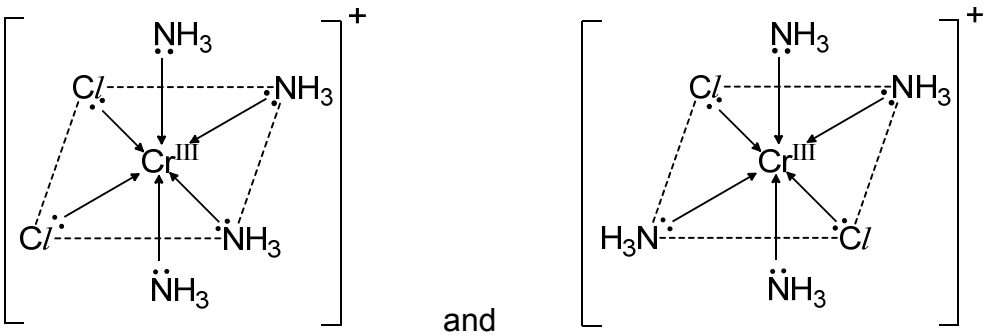
n_{A^-} formed = 1 x 10^{-3} mol

n_{HA} unreacted = 2 x 10^{-3} mol − 1 x 10^{-3} mol
= 1 x 10^{-3} mol

At D, $[A^-] = [HA]$

16 Coordination complexes with more than one type of ligand can exist in a number of stereoisomeric forms.

For example, the chromium(III) complex $[Cr(NH_3)_4Cl_2]^+$ can refer to the two stereoisomers as shown:

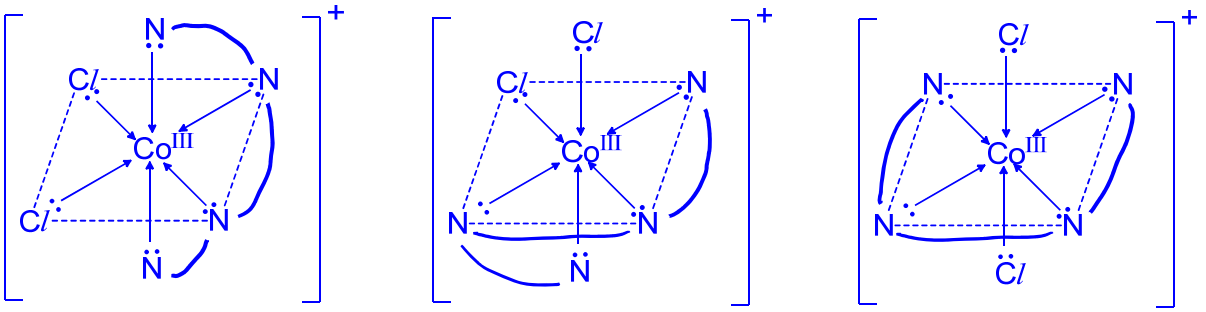


How many stereoisomers can the cobalt(III) complex $[Co(trien)Cl_2]^+$ have?
(trien = $(NH_2CH_2CH_2NHCH_2)_2$, a tetradentate ligand)

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

Answer: C

There are three stereoisomers for $[Co(trien)Cl_2]^+$.

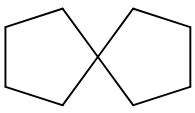


Middle two N in same plane. Three N in same plane. All four N in same plane.

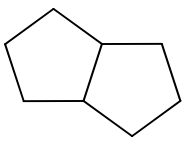
17 Cyclopentane undergoes substitution with bromine.

What is a possible by-product of this reaction?

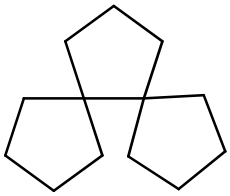
A



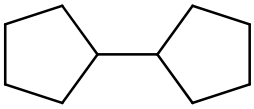
C



B

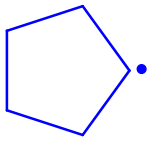


D

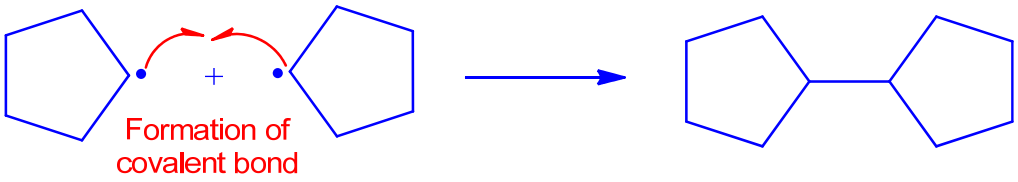


Answer: D

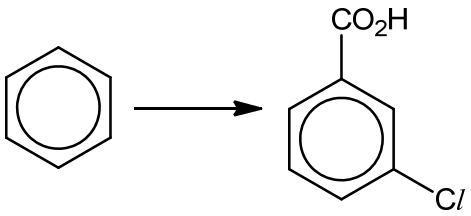
In **A**, **B** and **C**, the cyclopentane units are sharing carbon atoms, whereas in **D**, the carbon atoms of each cyclopentane unit are separate from other cyclopentane units. In free radical substitution, the termination step between two alkyl radicals gives rise to a new C-C bond, and the number of carbon atoms in the product should be the sum of that in the alkyl radicals.

The radical formed should be 

Hence the termination step between two alkyl radicals should be:



18 3-chlorobenzoic acid can be synthesized from benzene in three steps.



3-chlorobenzoic acid

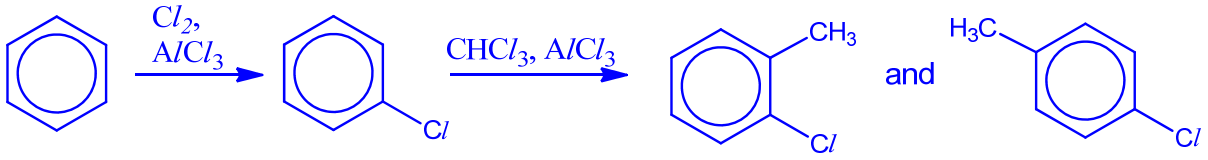
Which of the following is the best method for this synthesis?

	Step 1	Step 2	Step 3
A	Cl_2, $AlCl_3$	CH_3Cl, $AlCl_3$	$KMnO_4$, H_2SO_4
B	Cl_2, $AlCl_3$	$KMnO_4$, H_2SO_4	CH_3Cl, $AlCl_3$
C	CH_3Cl, $AlCl_3$	$KMnO_4$, H_2SO_4	Cl_2, $AlCl_3$
D	CH_3Cl, $AlCl_3$	Cl_2, $AlCl_3$	$KMnO_4$, H_2SO_4

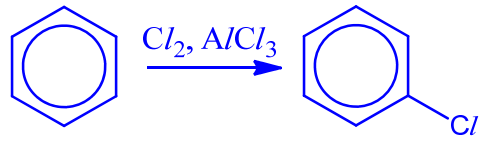
Answer: C

In this synthesis, we need to substitute $-CH_3$ (which is subsequently oxidised to $-CO_2H$) and $-Cl$ onto the benzene ring. Since both $-CH_3$ and $-Cl$ are 2,4-directing, but we want a 1,3-disubstituted product, we need to get $-CH_3$ on the ring first so that we can oxidise it to $-CO_2H$, which is 3-directing.

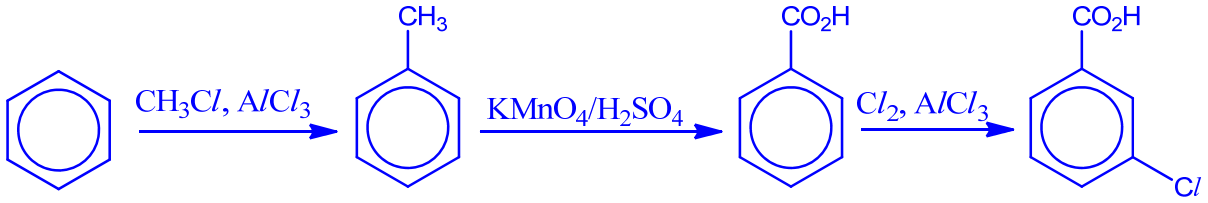
Option **A:** $-CH_3$ is substituted on 2- and 4-positions instead of the 3-position.



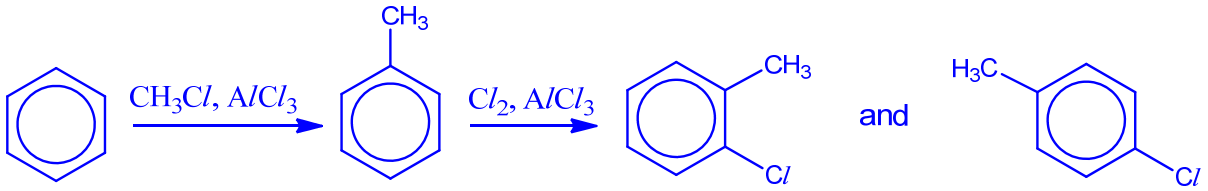
Option **B**: No alkyl side-chain for $KMnO_4$ to oxidise in Step 2.



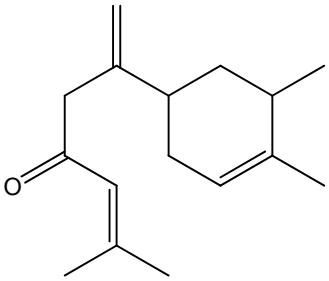
Option **C**:



Option **D**: –C*l* is substituted on 2- and 4-positions instead of the 3-position.



19 The structure of a β-atlantone derivative is shown below.



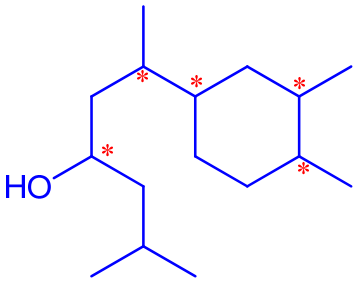
When it is completely reacted with hydrogen in the presence of platinum when heated, how many chiral centres does the product molecule possess?

A 2 **B** 3 **C** 4 **D** 5

Concept: Alkenes, Carbonyl Compounds: Reduction using H_2/Pt

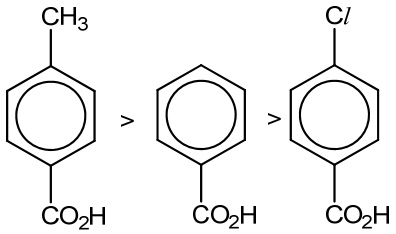
Answer: D

Reduction of C=C bonds and the ketone functional group gives the following product, which has 4 chiral centres:

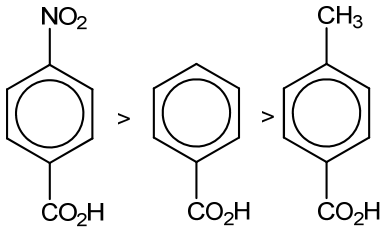


20 Which of the following correctly lists the compounds in order of decreasing acidity in aqueous solution?

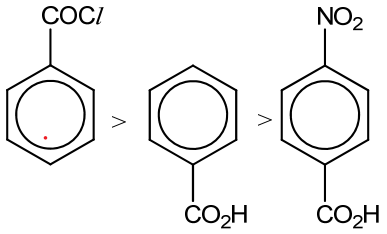
A



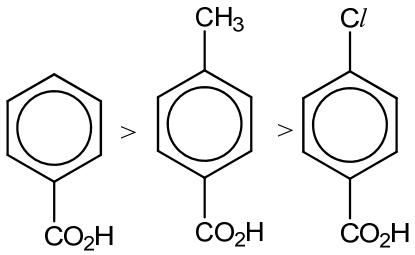
B



C



D



Answer: B

Electron-withdrawing group	$-NO_2$, $-Cl$
Electron-donating group	$-CH_3$

***Refer to Pg 17 of Data Booklet for the list of electron-donating groups (which activate ring reactivity) and electron-withdrawing groups (which deactivate ring reactivity).

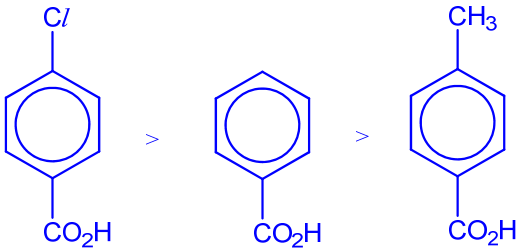
Note that

- electron-withdrawing groups increase acid strength by dispersing the negative charge on O atom and stabilizing the carboxylate ion; while
- electron-donating groups intensify the negative charge on O atom and destabilise the carboxylate ion.

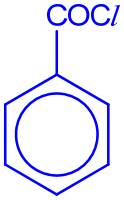
Hence option B is correct.

For the other options,

A & D The correct order should be

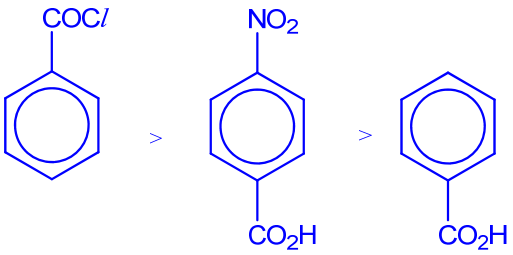


C Note that the following compound

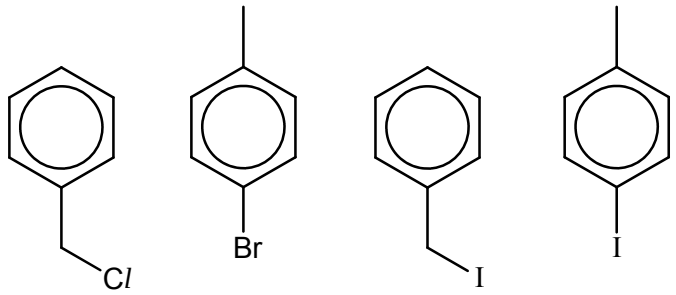


is an acyl chloride and undergoes hydrolysis readily to give HC*l* which is a strong acid, hence it is the strongest acid.

Hence, the correct order should be



21 Equal amounts of compounds **W**, **X**, **Y** and **Z** are added separately to four test-tubes containing equal concentrations of ethanolic silver nitrate solution in a heated water bath. No precipitate forms in two of the tubes. In the other two tubes, precipitates form at different rates.



W **X** **Y** **Z**

Which statements are correct?

1 The compounds which do not form a precipitate are **X** and **Z**.
2 The colour of the precipitate which forms the fastest is white.
3 The precipitate which forms the fastest weighs more than the other precipitate.

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

Answer: B

1 In both **X** and **Z**, and halogen is directly connected to the benzene ring. This results in a stronger C−X bond, hence **X** and **Z** do not undergo nucleophilic substitution.✓
2 The C-I bond is weaker than the C−C*l* bond, hence it will break more readily. The colour of the precipitate should be yellow instead of white (which is the colour of AgC*l*), since it is AgI that forms the fastest. ×
3 Since equal amounts (i.e., no. of moles) of the compounds **W** to **Z** are used, the same no. of moles of precipitate should form for **X** and **Z**. The M_r of AgI is greater than that of AgC*l*, so the AgI precipitate should weigh more than the AgC*l* precipitate. ✓

22 The following reaction gives a mixture of organic products.

Which of the following statements are true?

1 The organic products formed are mainly alcohols.

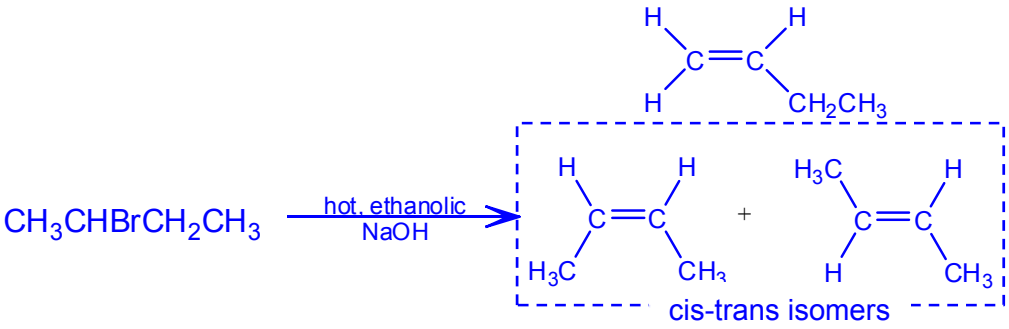
2 The predominant type of reaction occurring is nucleophilic substitution.

3 There is a pair of cis-trans isomers among the organic products.

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

Answer: D

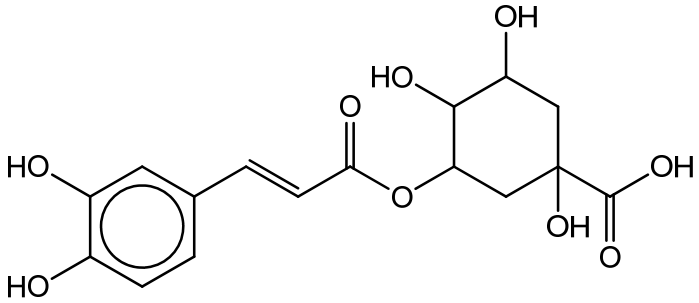
The reaction type is **elimination**. HBr can be eliminated from carbons 1 & 2, or carbons 2 & 3, to give three products, among which there is a pair of cis-trans isomers.



Do not confuse this reaction with the nucleophilic substitution of Br by OH^-, which takes place preferably under aqueous conditions instead of ethanolic conditions.

23 Chlorogenic acids account for up to 8% of the composition of unroasted coffee beans. More than 40 different varieties have been identified in green coffee beans, with 5-caffeoylquinic acid being the most prevalent.

The structure of 5-caffeoylquinic acid is shown below.



5-caffeoylquinic acid

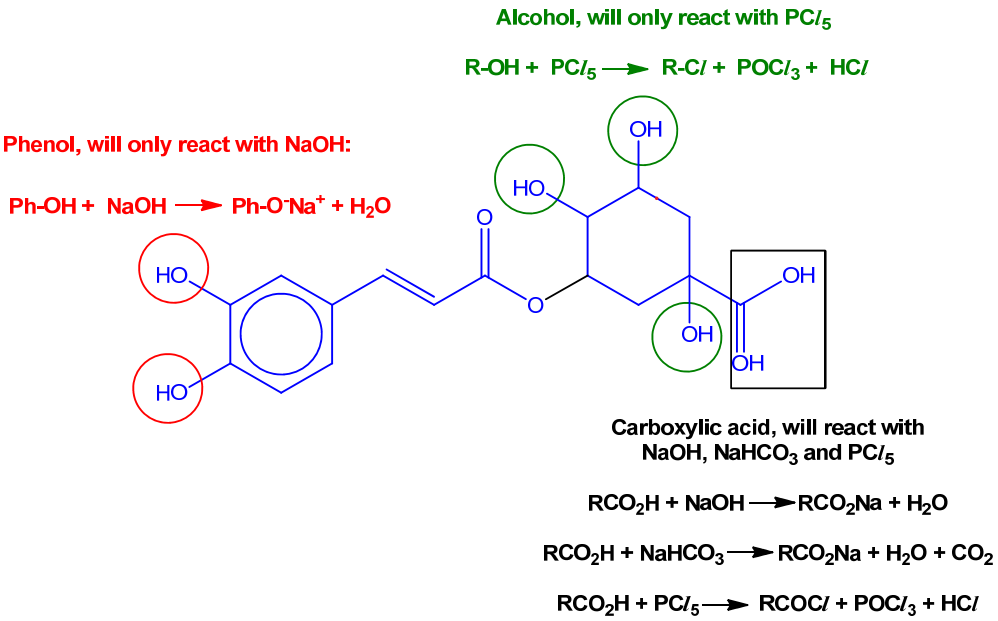
How many moles of aqueous sodium hydroxide, sodium hydrogencarbonate and phosphorus(V) chloride will react with one mole of 5-caffeoylquinic acid at room temperature?

	NaOH(aq)	$NaHCO_3$(aq)	PCl_5(s)
A	6	3	6
B	5	1	3
C	4	3	4
D	3	1	4

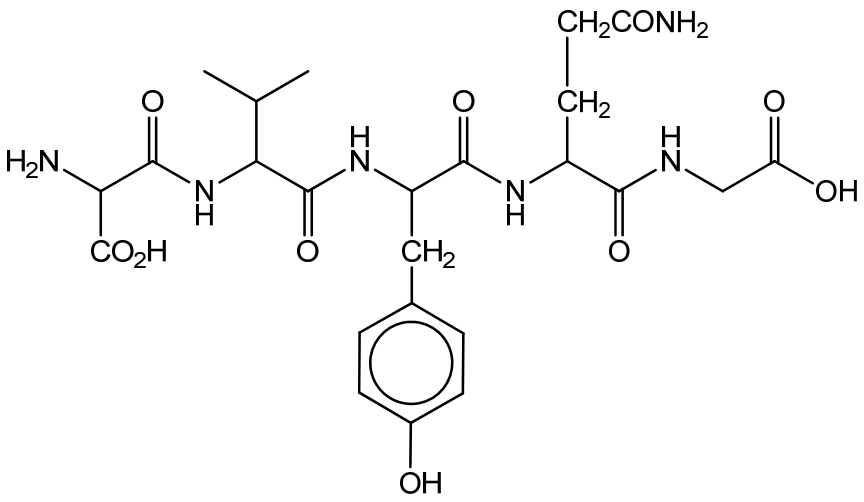
Answer: D

Note:

- NaOH(aq) will react with phenols and carboxylic acids only.
- $NaHCO_3$(aq) will react with carboxylic acids only.
- PCl_5(s) will react with alcohols and carboxylic acids only.

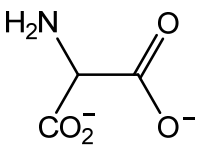


24 The structure of a polypeptide chain is shown below.

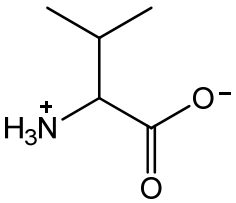


Which of the following will be formed when this polypeptide chain is heated under reflux with 6 mol dm^{-3} of NaOH(aq)?

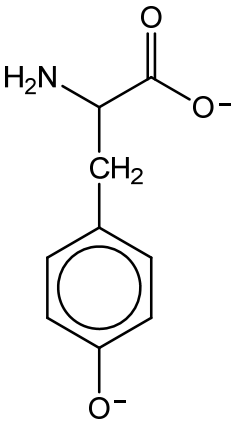
1



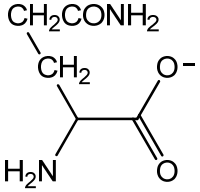
2



3



4



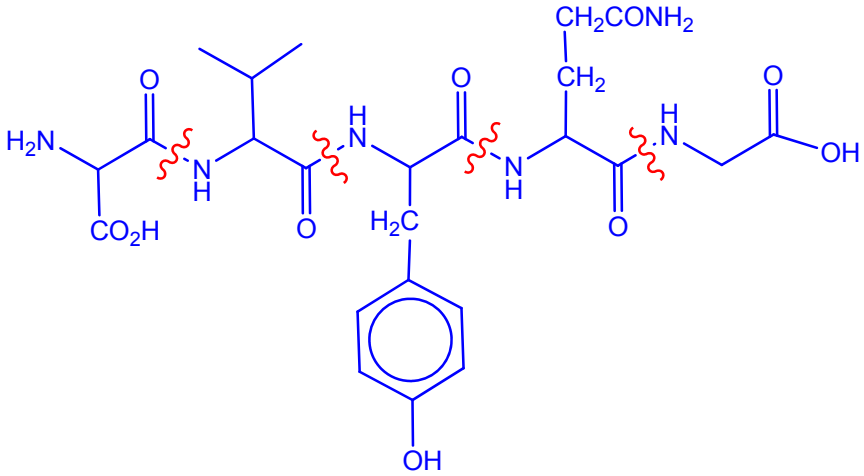
A 1 and 3 only

B 2 and 4 only

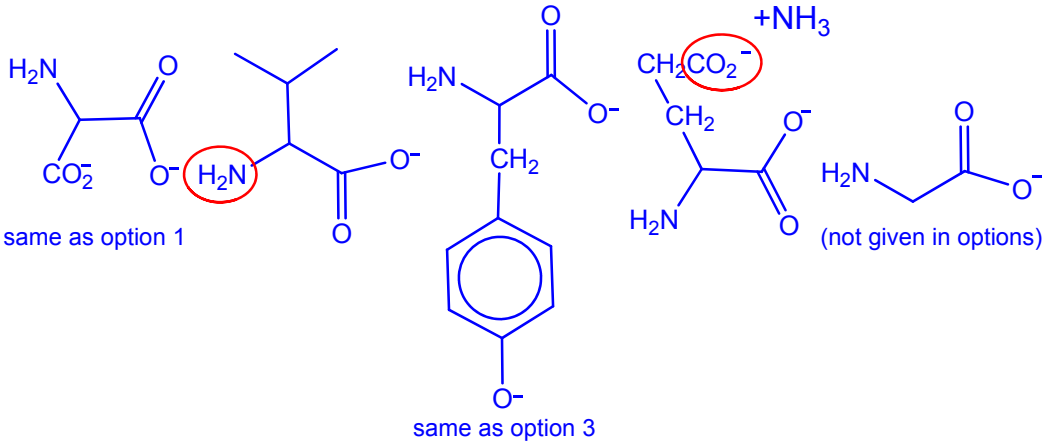
C 1, 3 and 4 only

D 1, 2, 3 and 4

Answer: A (1 and 3 only)



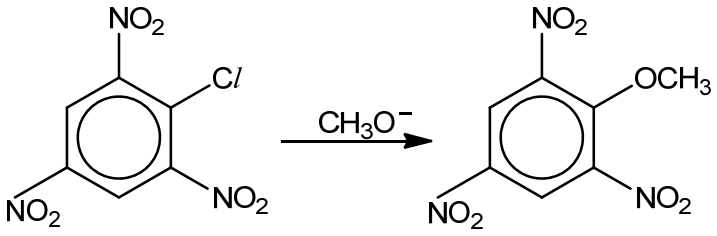
Upon hydrolysis with NaOH(aq), the correct products should be:



Option 2 is wrong as there should not be $-NH_3^+$ present when NaOH is used.

Option 4 is wrong as the amide group ($-CONH_2$) of the R-group should also be hydrolysed

25 Methoxide anion, CH_3O^-, can be generated when methanol reacts with sodium metal. The following reaction shows how methoxide anion reacts with an organic compound under suitable conditions.



Which of the following is the correct mechanism for the above reaction?

A electrophilic addition

B electrophilic substitution

C nucleophilic addition

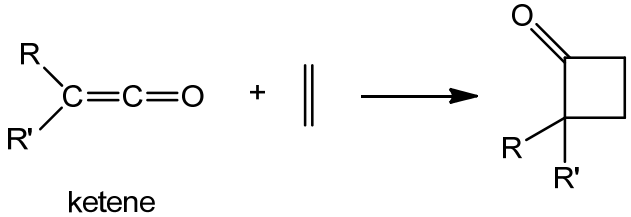
D nucleophilic substitution

Answer: D

Methoxide anion, CH_3O^-, is a **nucleophile** (lone pair of electrons to be donated) which is attracted to the **electron deficient C** of the benzene ring bonded to C*l*. (Due to the presence of 3 electron withdrawing NO_2 groups, the C–C*l* bond is highly polarised and weakened)
Since the benzene ring is restored at the end of the reaction, this reaction is a **substitution** reaction instead of an addition reaction. Hence, the correct mechanism of this reaction is a nucleophilic substitution.

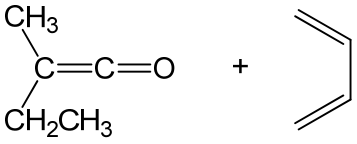
(Note that under normal conditions, C–C*l* bond of chlorobenzene does have partial double bond character and will **NOT** be hydrolysed.)

26 Ketenes contain a carbon involved in both alkene and ketone functional groups. It is a reactive compound which undergoes cycloaddition reaction readily with unsaturated compounds to form cyclic rings. One example of such a reaction is shown below.

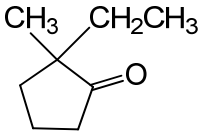


ketene

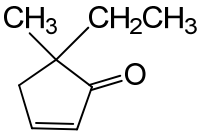
Which of the following is the correct product formed for the following cycloaddition reaction?



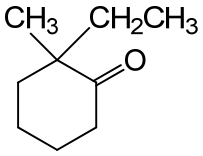
A



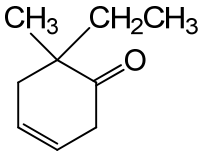
B



C



D

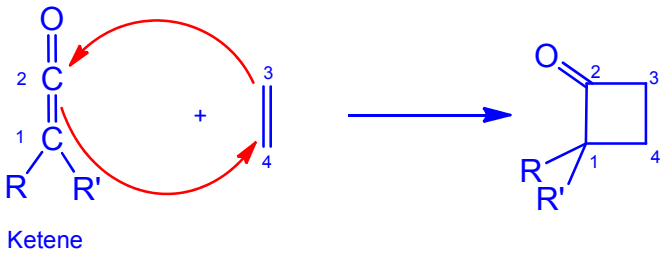


Answer: D

A and B cannot be the correct answer as there would be a loss of 1 C from the reactants to molecules A and B.

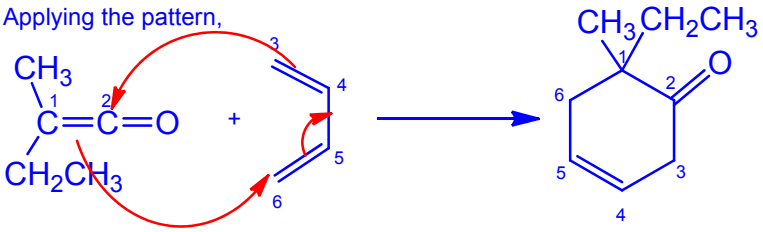
C is not the correct answer because there is an addition of 2 H due to a missing C=C. (by comparing the M_r of the reactants and C). In the given reaction, the number of H and C and O should still stay the same after the cycloaddition reaction.

Recognising the pattern,



Ketene

Applying the pattern,



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

When a current is passed through a solution of butanoic acid, $CH_3CH_2CH_2CO_2H$, the following reaction occurs at the cathode.

$$CH_3CH_2CH_2CO_2H + 4H^+ + 4e^- \rightarrow CH_3CH_2CH_2CH_2OH + H_2O$$

Oxygen is produced at the anode.

Which volume of oxygen, measured at room temperature and pressure, is produced when 0.015 mol of butanoic acid is electrolysed?

A 90 cm^3 **B** 180 cm^3 **C** 360 cm^3 **D** 720 cm^3

Answer: C

The half-equation for the oxidation of water to produce oxygen (under acidic conditions) is as follows:

$$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$$

Hence, $O_2 \equiv 4e^- \equiv CH_3CH_2CH_2CO_2H$

No. of moles of O_2 = 0.0150 mol

Volume of O_2 = 0.0150 x 24000 = 360 cm^3

28 Some standard reduction potentials are given below.

$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1.07 V
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1.33 V
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36 V
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1.52 V

Which oxidation is **not** feasible under standard conditions?

A chloride ions by acidified manganate(VII) ions

B bromide ions by chlorine

C manganese(II) ions by acidified dichromate(VI) ions

D chromium(III) ions by chlorine

Answer: C

A chloride ions by acidified manganate(VII) ions
$E_{cell}^{\ominus} = 1.52 - 1.36 > 0$ ✓

B bromide ions by chlorine
$E_{cell}^{\ominus} = 1.36 - 1.07 > 0$ ✓

C manganese(II) ions by acidified dichromate(VI) ions
$E_{cell}^{\ominus} = 1.33 - 1.52 < 0$ ×

D chromium(III) ions by chlorine
$E_{cell}^{\ominus} = 1.36 - 1.33 > 0$ ✓

29 A compound of chromium with the general formula $CrCl_3.6H_2O$ forms an aqueous solution. When this solution is treated with an excess of aqueous silver nitrate, only two third of the total chloride present is precipitated as $AgCl$.

Which of the following represents the structure of the chromium-containing ion present in the original compound?

A Cr^{3+}

B $[Cr(H_2O)_6]^{3+}$

C $[Cr(H_2O)_5Cl]^{2+}$

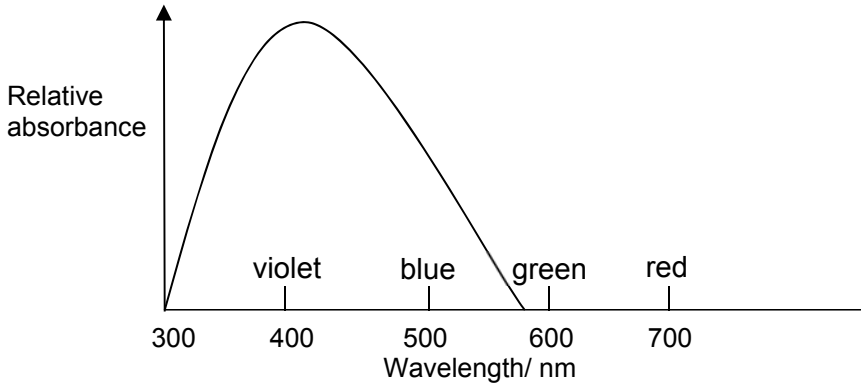
D $[Cr(H_2O)_4Cl_2]^{+}$

Answer: C

Since only two third of the total chloride present is precipitated as $AgCl$, the complex of the chromium compound is $[Cr(H_2O)_5Cl]^{2+} \bullet 2Cl^-$, where 2 Cl^- are free ions and are not bonded to the central metal ion through dative bonding and thus free to react with silver ions to form $AgCl$ ppt.

30 The chromium picolinate complex is soluble in water and the visible absorption spectrum of the complex is shown below:

[A visible absorption spectrum is a graph depicting the absorption of radiation by a material over a range of visible light wavelengths.]



What is the most likely colour of the chromium picolinate complex?

A violet

B blue

C yellow

D green

Answer: C

In general, the observed colour of an object corresponds to the wavelengths that are not absorbed by the object. The colour observed is complementary of the colour of light (wavelengths) absorbed. Since the complex absorbed light in the violet/blue region, the colour observed will be yellow/orange.