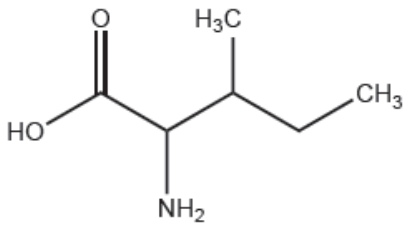
HL Paper 1

Which reagents are needed to convert nitrobenzene to phenylamine in 2 steps?

	Step 1	Step 2
A.	tin and sodium hydroxide	concentrated hydrochloric acid
B.	sodium hydroxide	tin and concentrated hydrochloric acid
C.	concentrated hydrochloric acid	tin and sodium hydroxide
D.	tin and concentrated hydrochloric acid	sodium hydroxide

What is the number of optical isomers of isoleucine?



A. 0

B. 2

C. 4

D. 8

Which statement is correct for a pair of enantiomers under the same conditions?

A. A racemic mixture of the enantiomers is optically active.

B. They have the same chemical properties in all their reactions.

C. They have the same melting and boiling points.

D. They rotate the plane of plane-polarized light by different angles.

Which molecule is chiral?

A. 2-chlorobutane

B. 2,2-dichloropentane

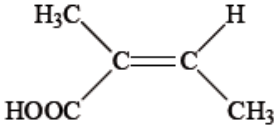
C. Propan-2-amine

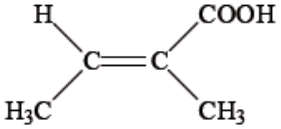
D. 4-hydroxybutanoic acid

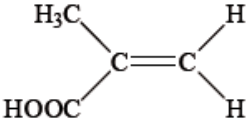
Which molecule can be both reduced by sodium borohydride, $NaBH_4$, and oxidized by warm acidified potassium dichromate(VI)?

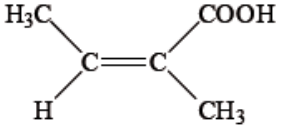
A. $CH_3CHOHCH_2CH_3$
B. $(CH_3)_3CCHO$
C. $(CH_3)_3COH$
D. $(CH_3)_3CCOC(CH_3)_3$

Which two molecules are cis-trans isomers of each other?

W 

X 

Y 

Z 

A. X and Z

B. X and Y

C. W and Y

D. W and Z

Which halogenoalkane reacts the fastest with hydroxide ions in a nucleophilic substitution reaction?

A. 1-chlorobutane

B. 2-chloro-2-methylpropane

C. 1-iodobutane

D. 2-iodo-2-methylpropane

Which molecule exhibits optical isomerism?

A. 3-iodopentane

B. 2-iodo-2-methylpropane

C. 1,3-diiodopropane

D. 2-iodobutane

Propene is reacted first with hydrogen chloride to produce X which is then reacted with aqueous sodium hydroxide to give Y. Finally, Y is reacted with excess acidified potassium dichromate solution.

$$CH_3CHCH_2 \xrightarrow{HCL} X \xrightarrow{NaOH(aq)} Y \xrightarrow{H^+/Cr_2O_7{}^{2-}(aq)} Z$$

What is the major product, Z?

A. $CH_3CH(OH)CH_3$

B. CH_3COCH_3

C. CH_3CH_2CHO

D. $CH_3(CH_2)_2COOH$

Which molecule has a chiral centre?

A. $CH_3CH{=}CHCHO$

B. $(CH_3)_2C{=}CHCH_2OH$

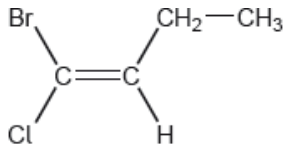
C. $CH_3OCH_2CH_3$

D. $CH_3CHOHCH_2CH_3$

Which molecule contains a chiral carbon?

A. $CH_3CHOHCH_2CH_3$
B. $(CH_3)_3CCHO$
C. $(CH_3)_3COH$
D. $(CH_3)_3COC(CH_3)_3$

What is name of this compound applying IUPAC rules?



A. E 1-bromo-1-chlorobut-1-ene

B. Z 1-bromo-1-chlorobut-1-ene

C. E 1-bromo-1-chloro-2-ethylethene

D. Z 1-bromo-1-chloro-2-ethylethene

Which statements about substitution reactions are correct?

I. The reaction between sodium hydroxide and 1-chloropentane predominantly follows an S_N2 mechanism.

II. The reaction between sodium hydroxide and 2-chloro-2-methylbutane predominantly follows an S_N2 mechanism.

III. The reaction of sodium hydroxide with 1-chloropentane occurs at a slower rate than with 1-bromopentane.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Which compound can exist as stereoisomers?

A. CH_3CH_2CHO

B. $CH_3CH_2COCH_3$

C. $CH_3CH(CH_3)_2$

D. $CH_3CH_2CHOHCH_3$

Which isomers exist as non-superimposable mirror images?

A. cis-trans isomers

B. diastereomers

C. enantiomers

D. structural isomers

Which molecule exhibits optical isomerism?

A. 3-chloropentane

B. 2-chlorobutane

C. 1,3-dichloropropane

D. 2-chloro-2-methylpropane

Which type(s) of stereoisomerism, if any, is/are present in the molecule CH_2=CHCHBrCH_3?

A. Optical only

B. Geometric only

C. Optical and geometric

D. Neither optical nor geometric

Which factors affect the rate of nucleophilic substitution in halogenoalkanes?

I. The nature of the attacking nucleophile

II. The identity of the halogen

III. The structure of the halogenoalkane

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

What does a polarimeter measure?

A. Colour of reaction mixture

B. Polarity of a molecule

C. Configuration of a molecule as R or S

D. Rotation of plane-polarized light

Which reaction occurs via a free-radical mechanism?

A. $\mathrm{C_2H_6 + Br_2 \rightarrow C_2H_5Br + HBr}$

B. $\mathrm{C_2H_4 + Br_2 \rightarrow C_2H_4Br_2}$

C. $\mathrm{C_4H_9I + OH^- \rightarrow C_4H_9OH + I^-}$

D. $\mathrm{(CH_3)_3CI + H_2O \rightarrow (CH_3)_3COH + HI}$

Halogenoalkanes can undergo $\mathrm{S_N1}$ and $\mathrm{S_N2}$ reactions with aqueous sodium hydroxide. Which halogenoalkane will react fastest with a $0.1\ \mathrm{mol\,dm^{-3}}$ solution of aqueous sodium hydroxide?

A. 2-chloro-2-methylpropane

B. 2-iodo-2-methylpropane

C. 1-chlorobutane

D. 1-iodobutane

What is the product of the reaction between pentan-2-one and sodium borohydride, $NaBH_4$?

A. Pentan-1-ol

B. Pentan-2-ol

C. Pentanoic acid

D. Pentanal

Which compound could rotate the plane of polarization of polarized light?

A. $(CH_3)_2CHCH_2Cl$

B. $CH_3CH_2CH_2CH_2Cl$

C. $CH_3CH_2CHClCH_3$

D. $(CH_3)_3CCl$

What is the major organic product formed from the reaction of $(CH_3)_3CBr$ with a concentrated, ethanolic solution of KOH?

A. $(CH_3)_3COH$

B. $(CH_3)_2CCH_2$

C. $(CH_3)_2CO$

D. $(CH_3)_2CHO$

Which halogenoalkane reacts fastest with sodium hydroxide?

A. 1-iodobutane

B. 1-chlorobutane

C. 2-chloro-2-methylpropane

D. 2-iodo-2-methylpropane

1-bromobutane, $CH_3CH_2CH_2CH_2Br$, can be converted to 1-aminopentane, $CH_3CH_2CH_2CH_2CH_2NH_2$, in a two-step process.

$$CH_3CH_2CH_2CH_2Br \xrightarrow{I} CH_3CH_2CH_2CH_2CN$$
$$CH_3CH_2CH_2CH_2CN \xrightarrow{II} CH_3CH_2CH_2CH_2CH_2NH_2$$

What are the reagents **I** and **II**?

	I	II
A.	ammonia	hydrogen with nickel
B.	ammonia	hydrochloric acid
C.	potassium cyanide	ammonia
D.	potassium cyanide	hydrogen with nickel

Which molecule contains a chiral carbon?

A. $CH_3CH_2CHBrCH_2CH_3$

B. $CH_3CH_2CHBrCH_3$

C. $CH_2BrCH(CH_3)CH_2Br$

D. $CH_3CH_2CH_2CH_2CH_2Br$

How many four-membered ring isomers are there of dichlorocyclobutane, $C_4H_6Cl_2$?

A. 3

B. 4

C. 5

D. 6

What should be changed to alter the rate of nucleophilic substitution of tertiary halogenoalkanes?

A. The nucleophile

B. The concentration of the nucleophile

C. The concentration of the tertiary halogenoalkane

D. The size of the reaction flask

Which pair of isomers always shows optical activity?

A. Cis-trans

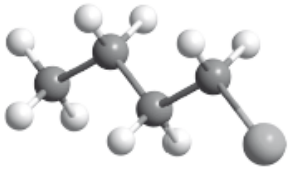
B. Enantiomers

C. Conformational

D. E/Z

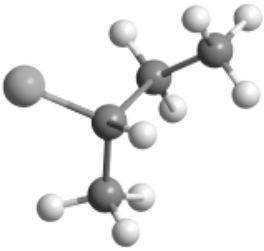
Which compound is optically active?

A.



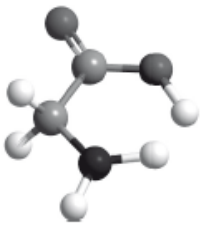
1-chlorobutane

B.



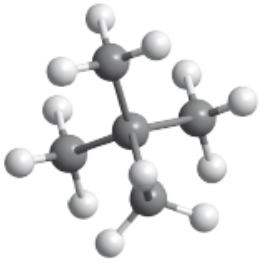
2-chlorobutane

C.



2-aminoethanoic acid

D.



2,2-dimethylpropane

Which compound can exist as stereoisomers?

A. 1,2-dichloroethane

B. 1,1-dichloroethene

C. Butan-2-ol

D. Propan-2-ol

Which statement is correct about the enantiomers of a chiral compound?

A. Their physical properties are different.

B. All their chemical reactions are identical.

C. A racemic mixture will rotate the plane of polarized light.

D. They will rotate the plane of polarized light in opposite directions.

Which compound has a chiral carbon?

A. Propan-2-ol

B. 1-bromo-2-methylbutane

C. 3-bromopentane

D. Ethane-1,2-diol

What is the correct order for the **increasing** rate of hydrolysis of halogenoalkanes by dilute aqueous sodium hydroxide?

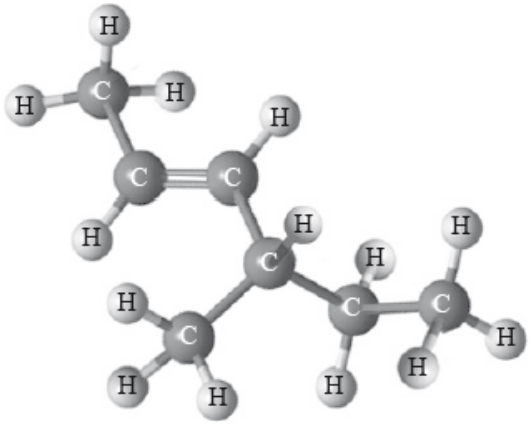
A. $CH_3CH(CH_3)CH_2Cl < CH_3CHClCH_2CH_3 < (CH_3)_3CCl < (CH_3)_3CBr$

B. $(CH_3)_3CBr < (CH_3)_3CCl < CH_3CHClCH_2CH_3 < CH_3CH(CH_3)CH_2Cl$

C. $(CH_3)_3CCl < (CH_3)_3CBr < CH_3CHClCH_2CH_3 < CH_3CH(CH_3)CH_2Cl$

D. $CH_3CHClCH_2CH_3 < CH_3CH(CH_3)CH_2Cl < (CH_3)_3CBr < (CH_3)_3CCl$

What is the name of the following compound applying IUPAC rules?



A. *cis*-4-methylhex-2-ene

B. *cis*-4-ethylpent-2-ene

C. *trans*-4-methylhex-2-ene

D. *trans*-4-ethylpent-2-ene

The hydrolysis of tertiary bromoalkanes with a warm dilute aqueous sodium hydroxide solution proceeds by a two-step S_N1 mechanism.

Step I: $R - Br \rightarrow R^+Br^-$

Step II: $R^+ + OH^- \rightarrow R - OH$

Which description of this reaction is consistent with the above information?

	Step I	Step II	Rate expression
A.	fast	slow	rate = k[R–Br]
B.	slow	fast	rate = k[R–Br]
C.	fast	slow	rate = k[R–Br][OH^-]
D.	slow	fast	rate = k[R–Br][OH^-]

What is the product of the reduction of 2-methylbutanal?

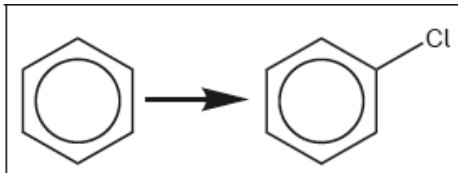
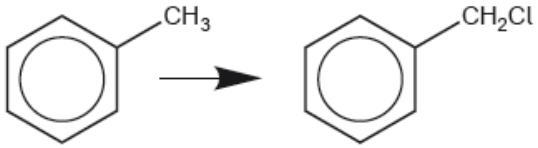
A. 2-methylbutan-1-ol

B. 2-methylbutan-2-ol

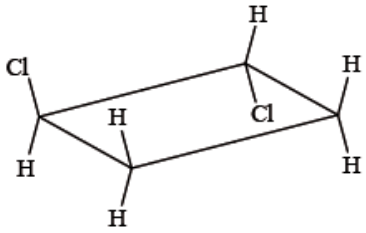
C. 3-methylbutan-2-one

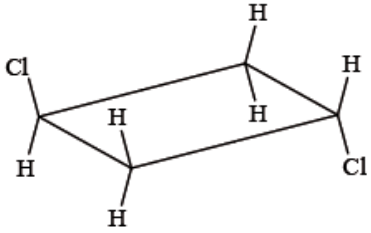
D. 2-methylbutanoic acid

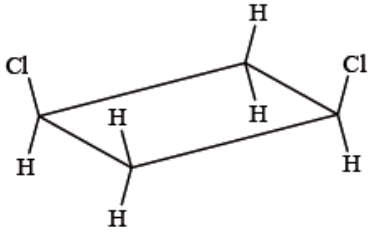
Which is the correct combination of substitution reaction mechanisms?

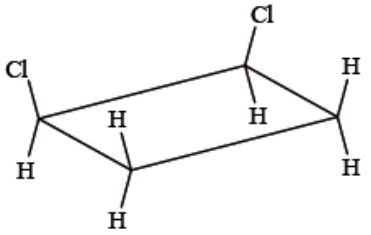
	 reaction mechanism	 reaction mechanism
A.	electrophilic	free radical
B.	nucleophilic	nucleophilic
C.	free radical	electrophilic
D.	free radical	nucleophilic

Which structure is a geometric isomer of *cis*-1,2-dichlorocyclobutane?

A. 

B. 

C. 

D. 

In which order should the reagents be used to convert benzene into phenylamine (aniline)?

	1st reagent	2nd reagent	3rd reagent
A.	NaOH	Sn / conc. HCl	conc. HNO_3 / conc. H_2SO_4
B.	Sn / conc. HCl	NaOH	conc. HNO_3 / conc. H_2SO_4
C.	conc. HNO_3 / conc. H_2SO_4	Sn / conc. HCl	NaOH
D.	NaOH	conc. HNO_3 / conc. H_2SO_4	Sn / conc. HCl

Which statement about isomerism is correct?

A. But-1-ene and but-2-ene are geometrical isomers.

B. But-1-ene has two geometrical isomers.

C. Butan-1-ol and butan-2-ol are optical isomers.

D. Butan-2-ol has two optical isomers.

What effect of optical isomers on plane-polarized light can be measured using a polarimeter?

A. Reflection

B. Emission

C. Rotation

D. Absorption

Propanitrile can be prepared by reacting bromoethane with potassium cyanide. Which statement is **not** correct about the reaction between bromoethane and potassium cyanide?

A. The reaction is bi-molecular.

B. The reaction follows the S_N2 mechanism.

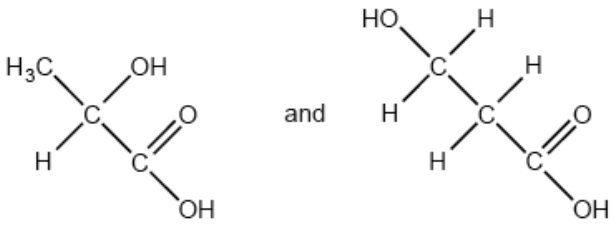
C. Homolytic fission occurs between the carbon-bromine bond in bromoethane.

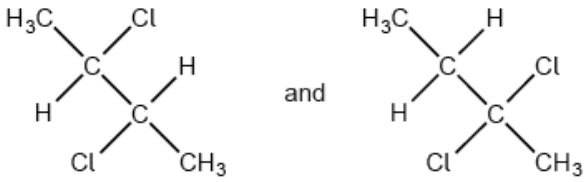
D. The cyanide ion, $:CN^-$, acts as a nucleophile.

Which statement is correct about the major reaction between 1-chloropropane, $CH_3CH_2CH_2Cl$, and dilute sodium hydroxide solution, NaOH (aq)?

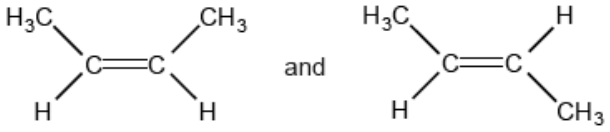
A. The rate equation is second order.
B. The hydroxide ion acts as a Brønsted–Lowry base.
C. The reaction has two distinct steps.
D. Water is a product.

Which pair are geometric isomers?

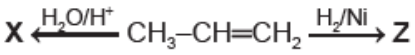
A. 

B. 

C. 

D. 

Propene reacts separately with H_2O/H^+ and H_2/Ni to give products **X** and **Z** respectively.



What are the major products of the reactions?

	X	Z
A.	$CH_3CH(OH)CH_3$	$CH_3CH_2CH_3$
B.	$CH_3CH_2CH_2OH$	$CH_3C{\equiv}CH$
C.	$CH_3C(O)CH_3$	$CH_3CH_2CH_3$
D.	$CH_3CH(OH)CH_3$	$CH_3C{\equiv}CH$

Which statement about stereoisomers is correct?

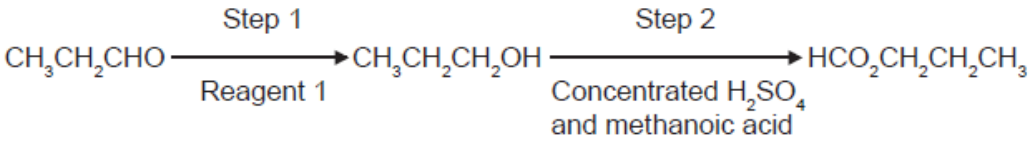
A. 1,2-dichloroethane has two geometrical isomers.

B. 1,2-dichloroethane has two optical isomers.

C. 1,2-dichloroethene has two geometrical isomers.

D. 1,2-dichloroethene has two optical isomers.

Which is correct for the conversion of propanal to propyl methanoate?



	Reagent for step 1	Reaction type in step 1	Reaction type in step 2
A.	H_2O	hydration	addition
B.	$K_2Cr_2O_7$, dilute H_2SO_4	oxidation	nucleophilic substitution (condensation)
C.	$NaBH_4$	reduction	oxidation
D.	$NaBH_4$	reduction	nucleophilic substitution (condensation)
