2017 NJC H1 Chemistry Prelim Paper 1 Suggested Answers

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

1 Amount of methane = $\frac{5}{24000}$

Hence, number of molecules = $\frac{5}{24000}$ × 6.02 x 10^{23}

Ans: B

2 The two ions contain the same number of protons and electrons, but different number of neutrons. The electronic configuration of Fe^{2+} is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$. (Electrons are removed from 4s orbital first when forming cations.)

The angle of deflection by an ion in an electric field is inversely proportionate to its charge to mass ratio.

E.g the larger the charge to mass ratio, the greater the deflection.

$^{54}_{26}Fe^{2+}$ ion has a smaller charge to size ratio than $^{56}_{26}Fe^{2+}$. Hence, $^{54}_{26}Fe^{2+}$ will be deflected more.

Ans: B

3 2nd contraction of 40 cm^3 is due to that of CO_2 reacting with the NaOH.

For the first contraction,

initial total vol = 110 cm^3 of hydrocarbon + O_2

final total vol after cooling back to rtp = 40cm^3 of CO_2 + unreacted O_2

110 – (unreacted O_2 + 40) = 30

Vol of unreacted O_2 = 40 cm^3

	C_xH_y (g)	+ $(x+\frac{y}{4})$ O_2 (g)	→	x CO_2 (g)	+ $\frac{y}{2}$ H_2O (l)
Initial vol / cm^3	10	100		0	-
Final vol / cm^3	0	40		40	-
Vol reacted/ produced/ cm^3	10	60		40	
Reacting mol ratio	1	6		4	

Comparing the mol ratio, x =4,

$x+\frac{y}{4}$ = 6, y = 8

Hence, the formula of the hydrocarbon = C_4H_8

Ans: A

4 Making reference to the I.E. values from Data Booklet, we can conclude that **I** is potassium.

Element **C** is A*l*, it is in Group 13.

Element **F** is S and it exists as S_8 molecules. The lowest boiling point is Ar gas (element **H**).

Ion of **E** (P^{3-}, 0.212 nm) is larger than that of **J** (Ca^{2+}, 0.099nm)

Element **D** and **G** are Si and C*l* respectively. The compound formed is $SiCl_4$.

Ans: **C**

5 Given that both **X** and **Y** form ionic compounds with Ca, both are non-metals and are group 16.

For X to form **X**F_6 molecule while **Y** is unable to do so, that means that **X** has energetically accessible vacant d orbitals to expand beyond octet configuration while **Y** does not.

Ans: D

6 **A** $K_c = \frac{[CH_3COOCH_2CH_3][H_2O]}{[CH_3CH_2OH][CH_3COOH]}$ = no units

B $K_c = \frac{[NH_4^+][OH^-]}{[NH_3]}$ = mol dm^{-3}

C $K_c = \frac{[NH_3]}{[N_2][H_2]^3}$ = $mol^{-2}dm^6$

D $K_c = \frac{[Cr_2O_7^{2-}]}{[CrO_4^{2-}]^2[H^+]^2}$ = $mol^{-3}dm^9$

Ans: C

7 $CH_3C(CH_3)_2NH_2$ has the lowest boiling point among all the other molecules. All the molecules has 1 NH_2 group, which means they all have the same degree of hydrogen bonding between the molecules. Hence, the difference lies in the temporary dipole – induced dipole (td−id), where the $CH_3C(CH_3)_2NH_2$ is the most branched with least surface area of contact between molecules and experiences the weakest td−id among all the molecules.

Ans: D

8 **A** Refers to the enthalpy change of atomisation which is endothermic

B The neutralisation reaction between OH^- and H^+ to give H_2O is exothermic

C The formation of bonds between 2 C*l* to give C*l*$_2$ is exothermic

D Enthalpy change combustion is always exothermic

Ans: A

9 The reaction is a 2 step reaction, hence the reaction pathway must reflect 2 activation energy. Also, the overall enthalpy change is negative, which means the energy level of the product must be lower than the reactants.

Ans: B

10 Given Bond dissociation energy of H–C*l* is +432 kJ mol^{-1}

A Energy is taken in to change the state of HC*l* from (s) to (g) and then to break the H–C*l* bond. Hence energy change is more than + 432 kJ mol^{-1}

B Energy is taken in to to break the H–C*l* bond. Hence energy change is + 432 kJ mol^{-1}

C Energy is given off to form the H–C*l* bond and to change the state of HC*l* from (g) to (s). Hence energy change is less than − 432 kJ mol^{-1}

D Energy is given off to form the H–C*l* bond. Hence energy change is = − 432 kJ mol^{-1}

11 A weak acid dissociates partially in water according to the following equation:

$CH_3CO_2H \rightleftharpoons CH_3CO_2^- + H^+$

Some of the heat from the enthalpy change of neutralisation between H^+ and OH^- is compensated towards the dissociation for CH_3CO_2H. Hence less energy is released from the neutralisation reaction involving a weak acid and strong base.

Note that acid base reaction always go to completion.

Ans: C

12 Titration of a strong acid (H_2SO_4) with a weak base (NH_3). Equivalent point pH is less than 7 as NH_4^+ is a weakly acidic cation.

Methyl orange will be a suitable indicator as the working pH range of methyl orange coincides with the region of sharp pH change at equivalent point of this titration.

Ans: A

13 A buffer consists of a weak base and its conjugate acid, or a weak acid and its conjugate base.The conjugate acid-base pair differs from each other by one H^+.

A HC*l* is the limiting reagent, final solution mixture contains unreacted CH_3CO_2Na and CH_3CO_2H. They are conjugate acid-base pair and forms a buffer solution.

B CH_3CO_2H is the limiting reagent, final solution mixture contains unreacted NaOH and CH_3COO^-. This is not a buffer solution.

C No reaction between the two compounds. This is not a buffer solution.

D Both reactants react completely. Only NaC*l* is present in the solution. Not a buffer solution.

Ans: A

14 Substitute the values inside and see which one fits.

Ans: C

Units for rate = mol $dm^{-3}min^{-1}$

When p =1,q = 0, rate = k[**X**]

Units for rate constant, k = $\frac{\text{mol dm}^{-3}\text{min}^{-1}}{\text{mol dm}^{-3}}$ = min^{-1}. Hence r = 0.

15 **A** Melting point increases from Na to Si before decreasing to the non-metals.

B Ionic radius decreases from Na^+ to Si^{4+} and increases to the non-metals anions. (Check Data Booklet)

C Electrical conductivity increases from Na to A*l* and then decreases for Si and conductivity drop to zero for the non-metals.

D pH of chlorides decreases from Na to Si and remains low for the chlorides of non-metals.

Ans: B

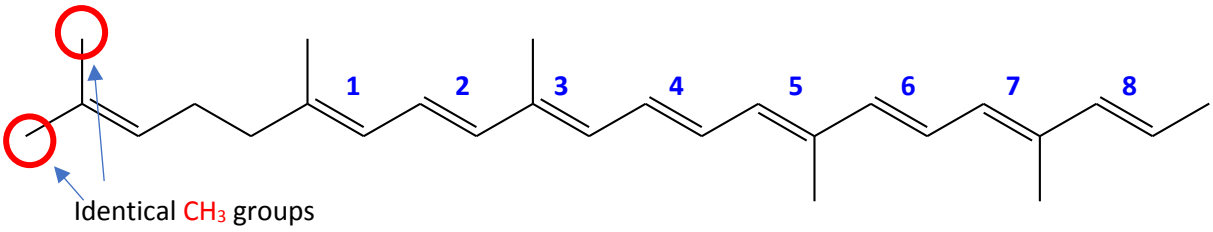
16 Radioactive decay of iodine is a first-order reaction with half-life, $t_{½}$ = 8 days

$$\underset{1:0}{\text{I}:\text{Xe}} \xrightarrow{1^{st}\ t_{½}} \underset{½:\ ½}{\text{I}:\text{Xe}} \xrightarrow{2^{nd}\ t_{½}} \underset{¼:¾}{\text{I}:\text{Xe}} \xrightarrow{3^{rd}\ t_{½}} \underset{{}^{1}/_{8}\ {}^{7}/_{8}}{\text{I}:\text{Xe}}$$

Time period = 3 × $t_{½}$ = 3 × 8 = 24 days

Ans: C

17 The <u>two conditions</u> required for geometric isomerism to exist:
(i) <u>restricted rotation</u> about a bond by the presence of a double bond (usually C=C bonds)
(ii) <u>two different groups</u> on **each of the carbon atoms** with restricted rotation.



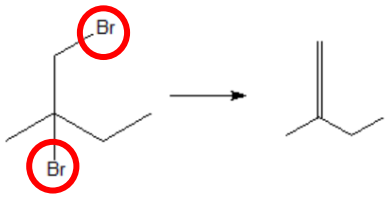
No. of geometric isomers: $\mathbf{2^n = 2^8}$

Ans: C

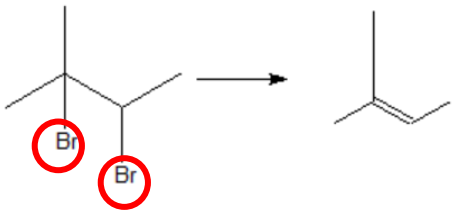
18 During the ***addition*** reaction, two Br atoms are added across the C=C bond when Br_2 reacts with alkene.

To obtain the alkene from the addition product, remove two Br atoms (circled) and reform the C=C as shown below.

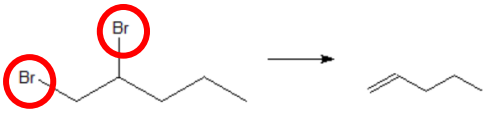
A



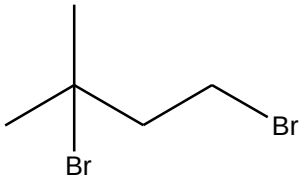
C



B

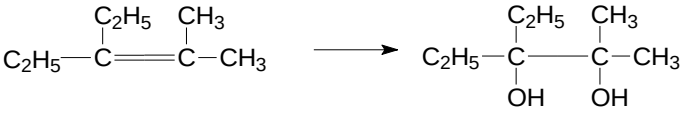


D



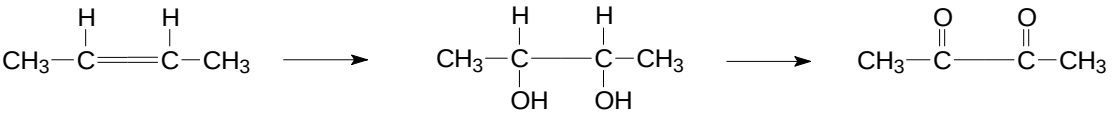
Ans: D

19 **A**



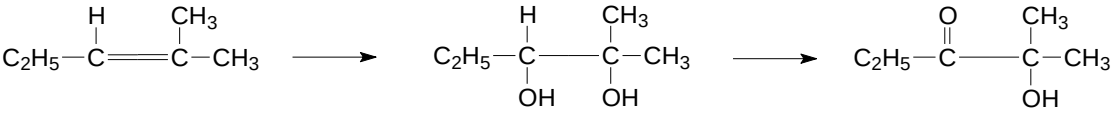
(3°) (3°) (No further oxidation for 3° alcohol)

B



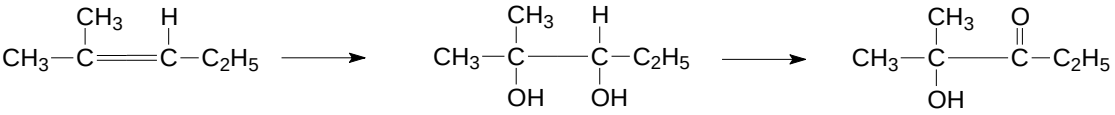
(2°) (2°) (diketone)

C



(2°) (3°)

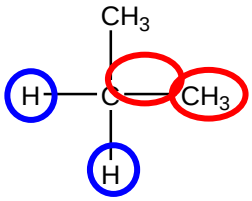
D



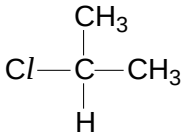
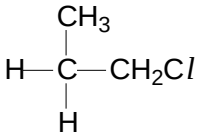
(3°) (2°)

Ans: B

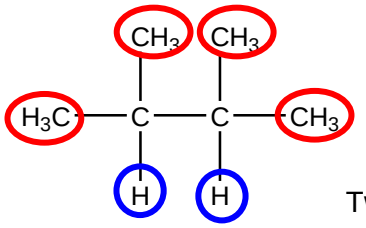
20 **A**



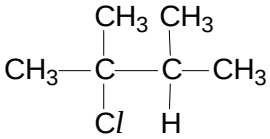
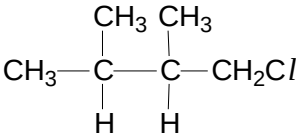
Two different types of H in the ratio of 2 : 6 (1 : 3)

Product		
Probability of forming	2	6

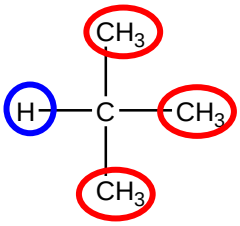
B



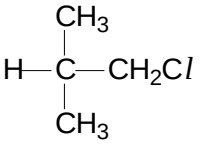
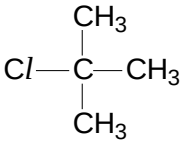
Two different types of H in the ratio of 2 :12 (1 : 6)

Product		
Probability of forming	2	12

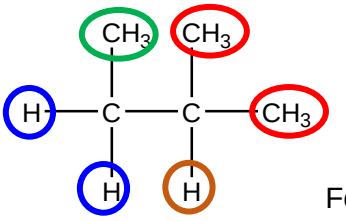
C



Two different types of H in the ratio of 1 : 9

Product		
Probability of forming	9	1

D

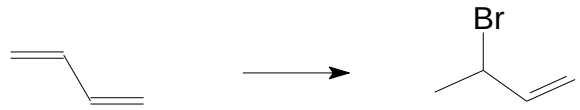


Four different types of H in the ratio of 2 : 3 : 1 : 6

Ans: A

21 During the addition of **H-X** to an alkene, the electrophile, hydrogen atom, is added to the carbon with the greater number of hydrogen atoms while the halogen atom is added to the carbon with the fewer number of hydrogen atoms to obtain the major product.

Since there are two C=C bonds in one buta-1,3-diene molecule, when 1 molecule of HBr is added, only 1 Br atom will be added to one of the two C=C bonds.

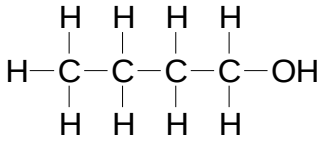


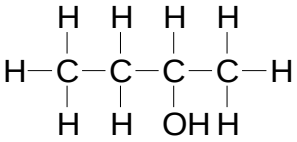
buta-1,3-diene

Ans: B

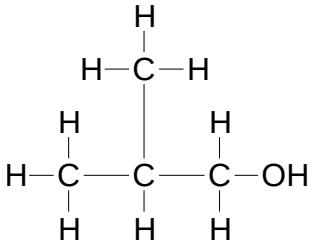
22 No. of structural isomers of alcohol with the molecular formula, $C_4H_{10}O$ = 4

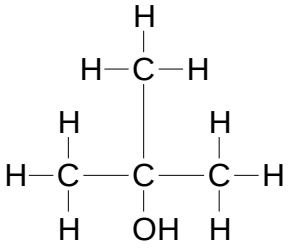
For 4 carbon chain:





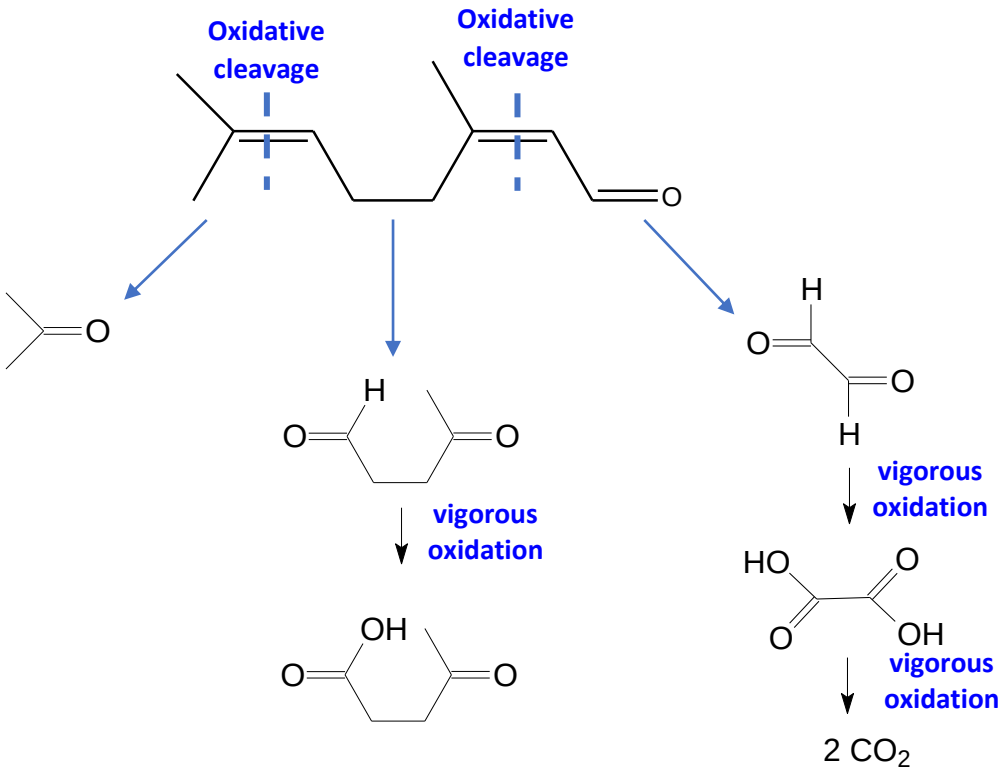
For 3 carbon chain





Ans: D

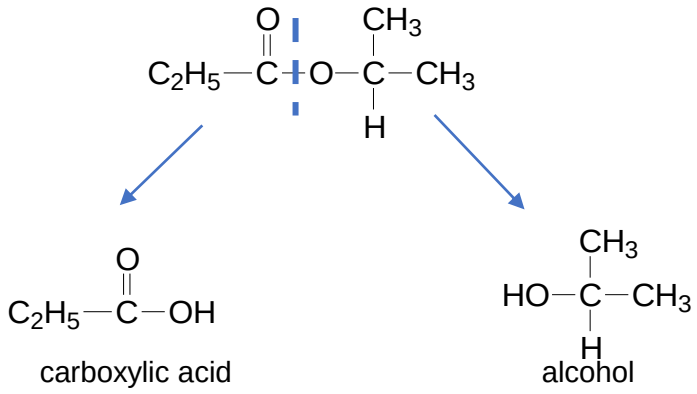
23



Therefore, $(CO_2H)_2$ is not the final product.

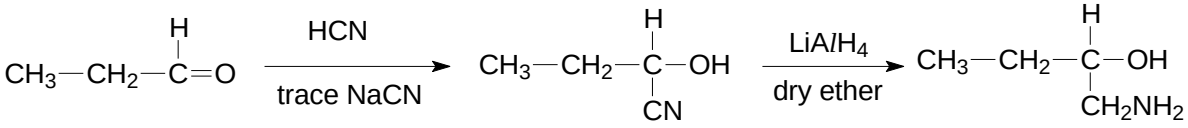
Ans: D

24 Ester has the formula. $C_2H_5CO_2CH(CH_3)_2$ with the following structure:



Ans: C

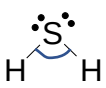
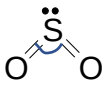
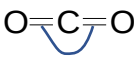
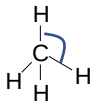
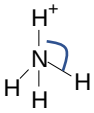
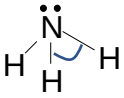
25



final product

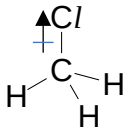
Ans: A

26

	Species **I**	Species **II**
1	H_2S  (107°)	SO_2  (118^O)
2	CO_2  (180°)	CH_4  (109.5°)
3	NH_4^+  (109.5°)	NH_3  (107°)

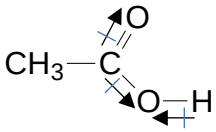
Ans: D (Option 1 only)

27 **1** CH_3Cl



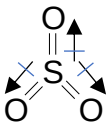
Net dipole moment (polar)

2 CH_3CO_2H



Net dipole moment (polar): dipole moments do not cancel out completely.

3 SO_3



No net dipole moment (Non-polar): dipole moments cancel out completely

Ans: B (Option 1 and 2 only)

28 **1** <u>Standard enthalpy changes of formation of ethane</u>

$2C(s) + 3H_2(g) \rightarrow C_2H_6(g)$

Standard enthalpy changes of formation is defined as the heat absorbed or evolved when one mole of a substance is formed from its constituent elements in their standard states at 298 K and 1 bar.

2 <u>Standard enthalpy changes of combustion of methane</u>

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

Standard enthalpy changes of combustion is defined as the heat evolved when one mole of a substance is completely burnt in excess oxygen at 298 K and 1 bar.

3 <u>Standard enthalpy changes of formation of calcium carbonate</u>

$Ca(s) + C(s) + \frac{3}{2} O_2(g) \rightarrow CaCO_3(s)$

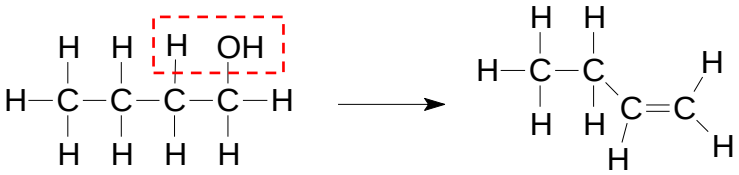
Standard enthalpy changes of formation is defined as the heat absorbed or evolved when one mole of a substance is formed from its constituent elements in their standard states at 298 K and 1 bar.

Ans: A (Option 1, 2 and 3)

29 Concentrated H_2SO_4 is a common reagent used for elimination reaction (elimination of H_2O).

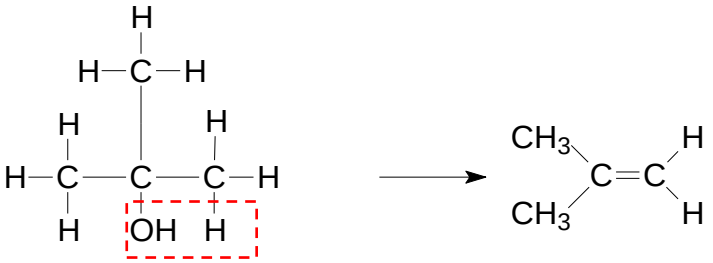
During the elimination reaction, OH and the H on the adjacent carbon atom is removed to form an alkene.

1 $CH_3CH_2CH_2CH_2OH$



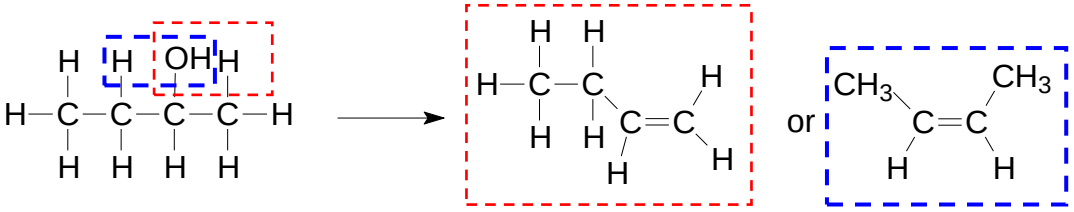
In this asymmetrical molecule, there is only one adjacent carbon atom next to the carbon atom with the OH group. Hence, there is only 1 product formed.

2 $CH_3C(OH)(CH_3)_2$



In this symmetrical molecule, there are three adjacent carbon atoms next to the carbon atom with the OH group. Hence, there is only 1 product formed.

3 $CH_3CH_2CH(OH)CH_3$



In this asymmetrical molecule, there are two adjacent carbon atoms next to the carbon atom with the OH group. Hence, there are 2 products formed.

Ans: B (Option 1 and 2 only)

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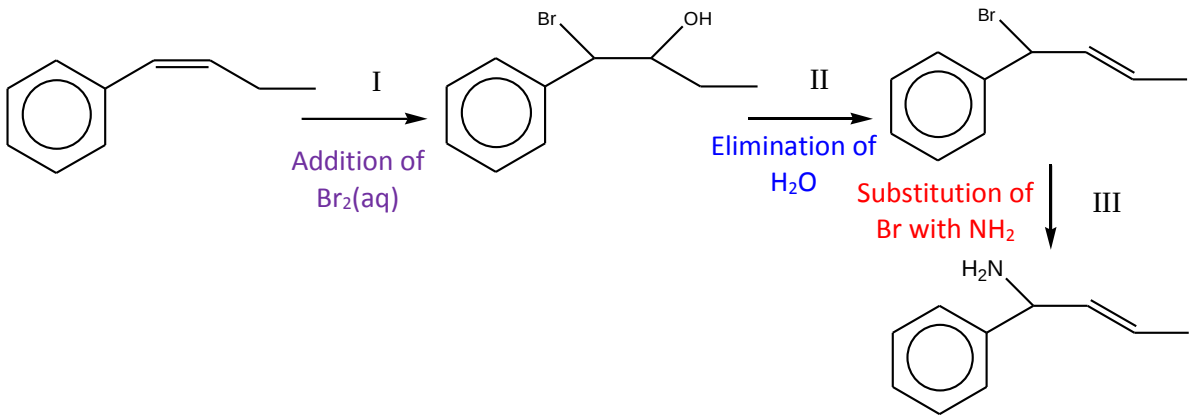

Ans: A (Option 1, 2 and 3)