

PROSPERITY ACADEMY

AS CHEMISTRY 9701

Crash Course

RUHAB IQBAL

ALKENES

COMPLETE NOTES



0331 - 2863334

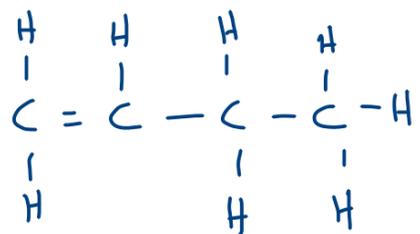


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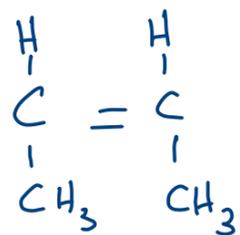


Alkenes: - Unsaturated hydrocarbons containing a C=C bond. Obtained from cracking of alkanes

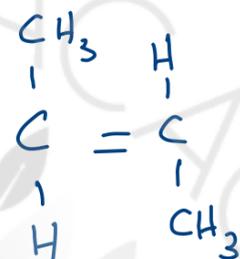
But-1-ene



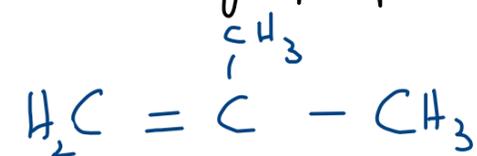
cis-but-2-ene



trans-but-2-ene



2-methyl propene



General formula: - C_nH_{2n}

Intermolecular forces: - Temporary dipoles \rightarrow low m.p. and b.p.

Polar or non polar: - Non polar \rightarrow Insoluble in water

Chemical properties: - The C=C double bond has high electron density and can attract electrophiles

Electrophiles: - A species that accepts a pair of electrons
loving
electron

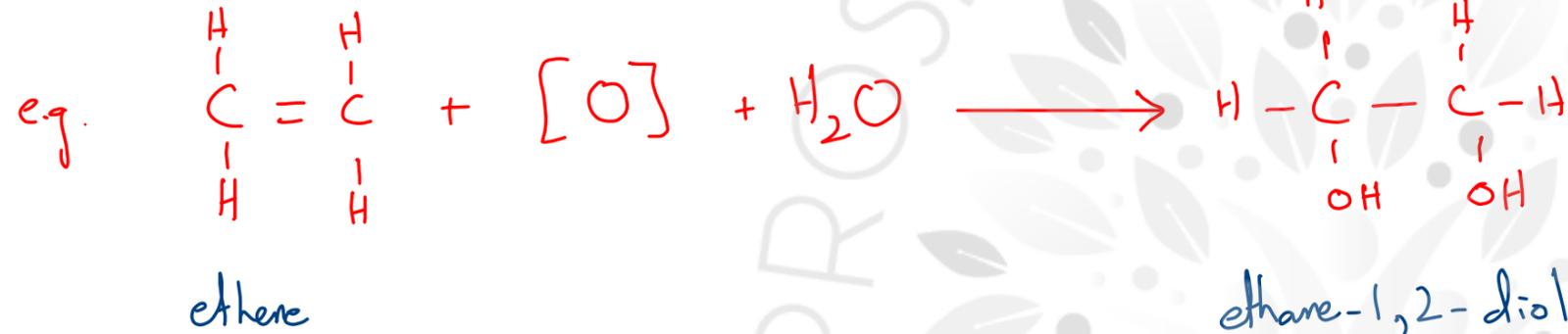
The C=C double bond has a π bond that is weaker than a σ bond as its electron density lies above and below the internuclear axis. Thus a π bond can dissociate and form 2 strong σ bonds.

Reactions of Alkenes:-

1) Combustion: Discussed already

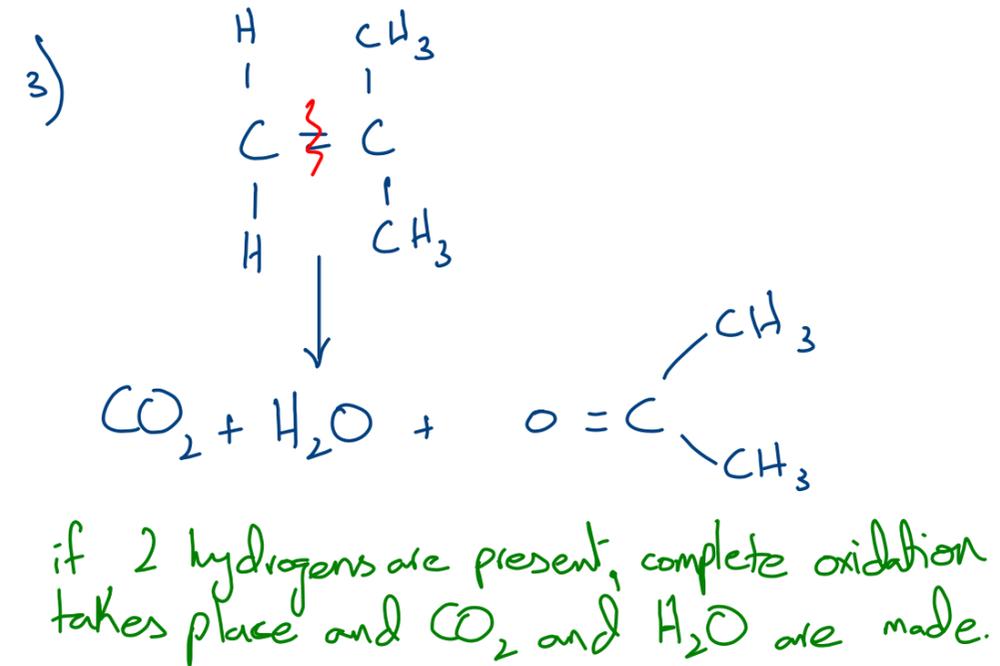
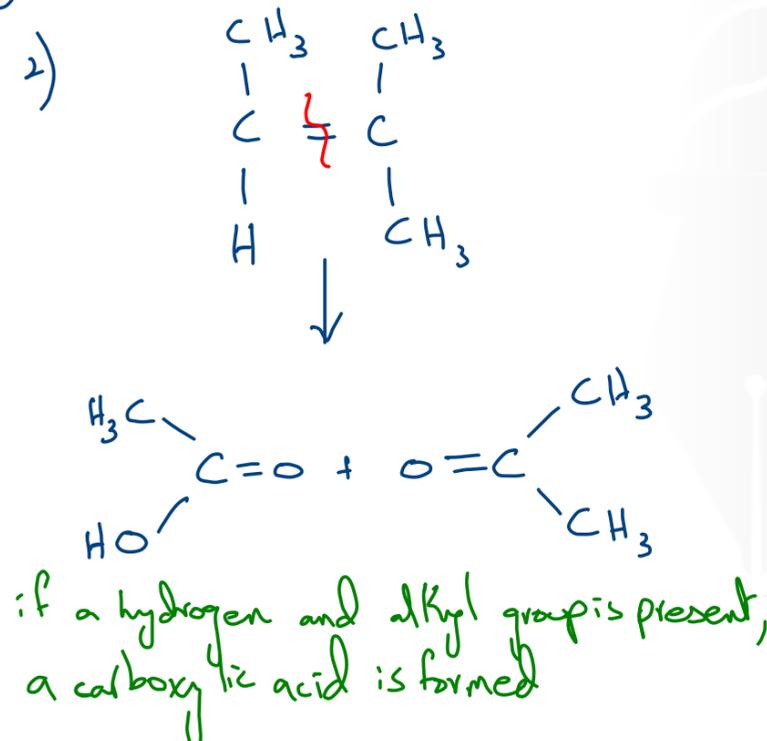
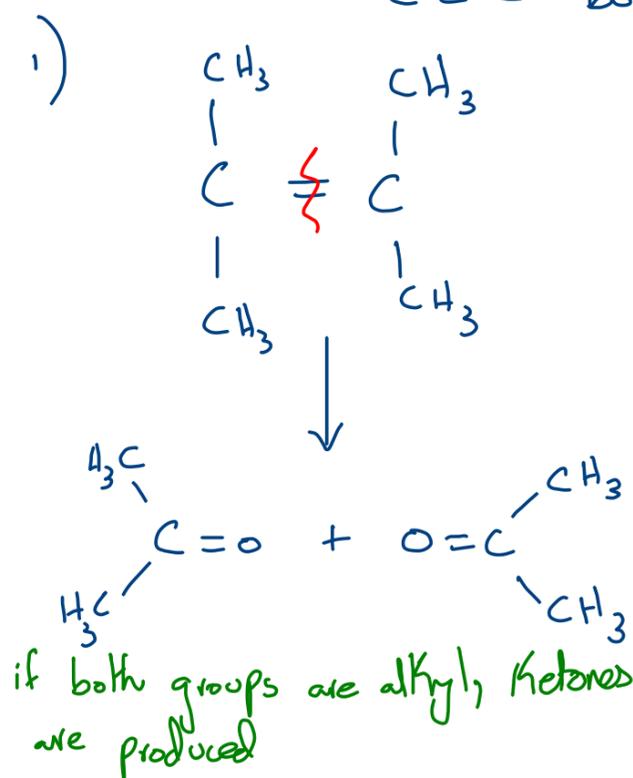
2) Oxidation by KMnO_4

→ With cold dilute acidified KMnO_4 (dil KMnO_4 (aq) + H_2SO_4)
- Diol is formed



- Observation:- purple solution turns colourless
- can be used as a test of alkenes

→ With hot concentrated acidified KMnO_4 (conc. KMnO_4 (aq) + H_2SO_4)
- $\text{C}=\text{C}$ bond ruptured

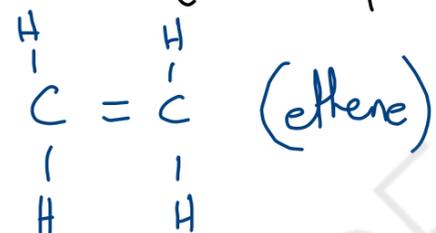


3) Polymerization: Alkenes undergo addition polymerization

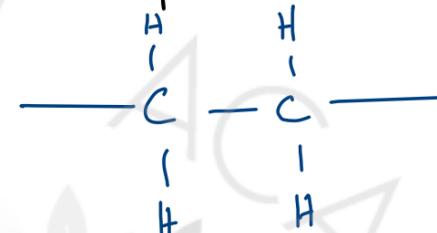
Polymer

1) Polyethene

Monomer (Name & Formula)

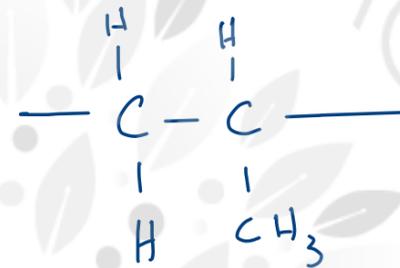
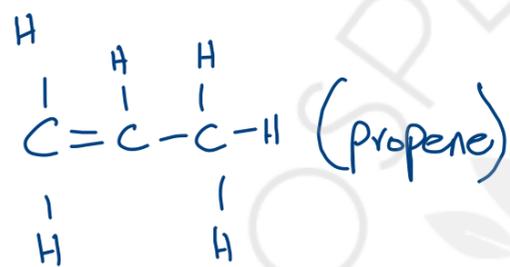


Repeat Unit



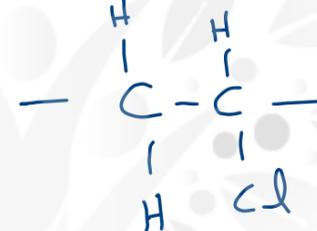
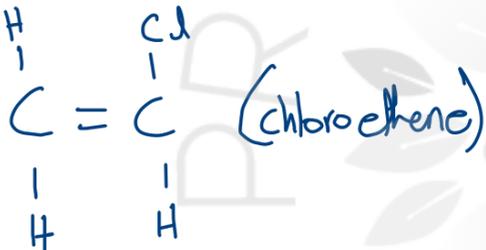
Uses
plastic bags

2) Polypropene



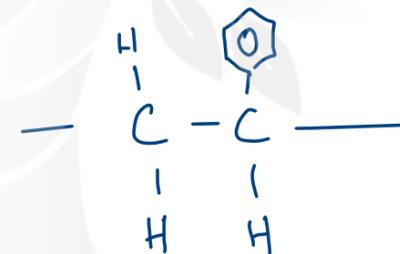
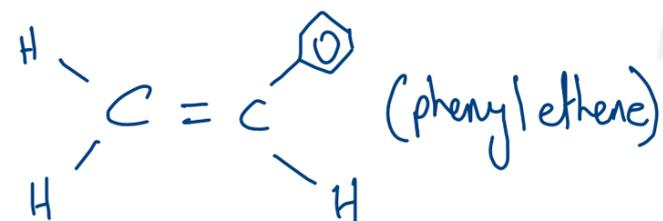
plastic boxes, crates,
waterproof sheets

3) Poly(chloroethene) [PVC]
polyvinyl chloride



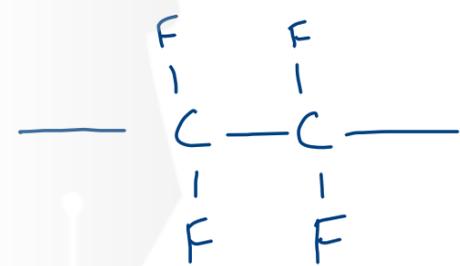
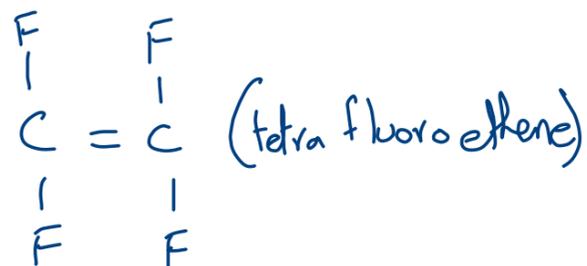
water pipes

4) Poly(phenyl ethene)
polystyrene



coffee cups, packaging
material

5) Poly tetrafluoroethene
PTFE / Teflon

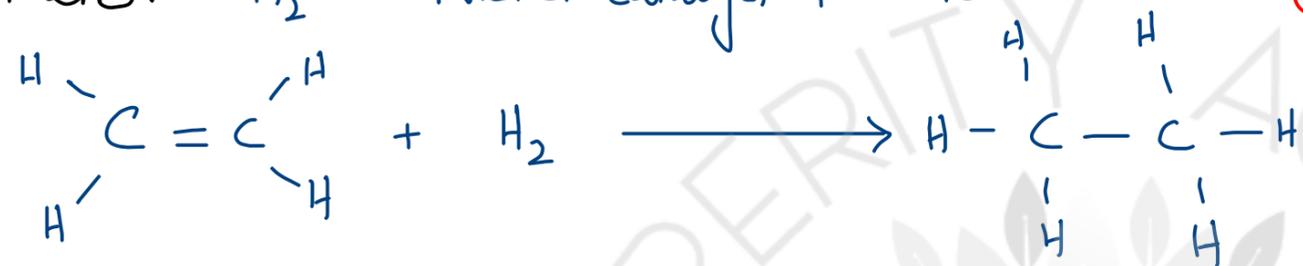


non stick coating on cookware

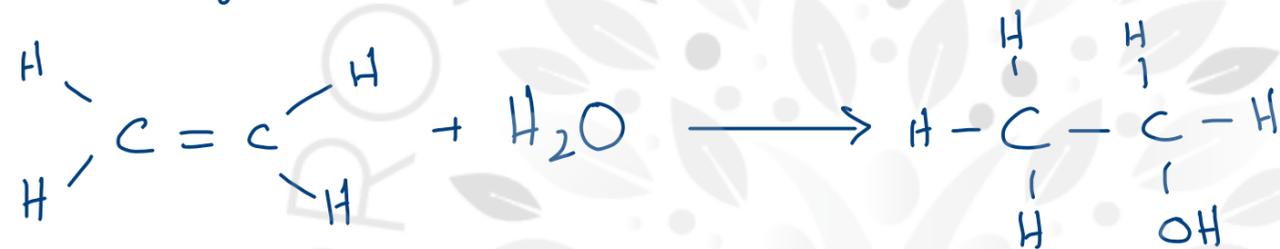
- Upon addition polymerization, unsaturated compounds turn into saturated compounds
- Addition polymers are non biodegradable and burning them releases harmful gases (CO , CO_2 , Cl_2 in PVC) and if not burned they accumulate in landfills. They should always be reused and recycled.

4) Electrophillic addition reactions

- Hydrogenation of ethene:- $H_2 + \text{Nickel catalyst} + 180^\circ C$ (Used in making of margarine)



- Addition of H_2O to ethene: $H_2O(g) + 350^\circ C + 60-70 \text{ atm} + \text{conc } H_3PO_4 \text{ catalyst}$ (Used in manufacture of ethanol)

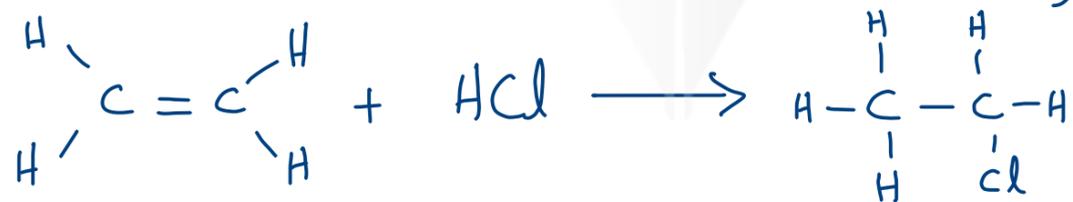


- Addition of halogens to ethene: Cl_2 or Br_2 (no other conditions)



Add $Br_2(aq)$ to alkene, brown solution turns colourless \rightarrow Test for alkenes

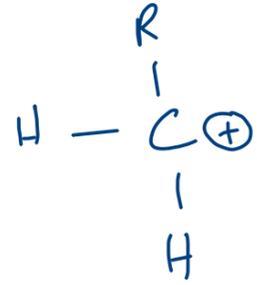
Addition of hydrogen halides to ethene:- HCl or HBr (no other conditions)



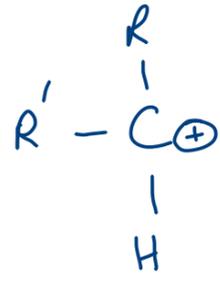
Mechanism:- Electrophilic addition

Heterolytic fission:- Breaking of a bond in such a way that one atom takes both the electrons. Shown by \curvearrowright (Full arrowhead)

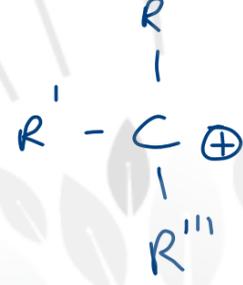
Carbocation:- An alkyl group carrying a single positive charge on one of its carbon atoms



primary carbocation
(1 alkyl group)



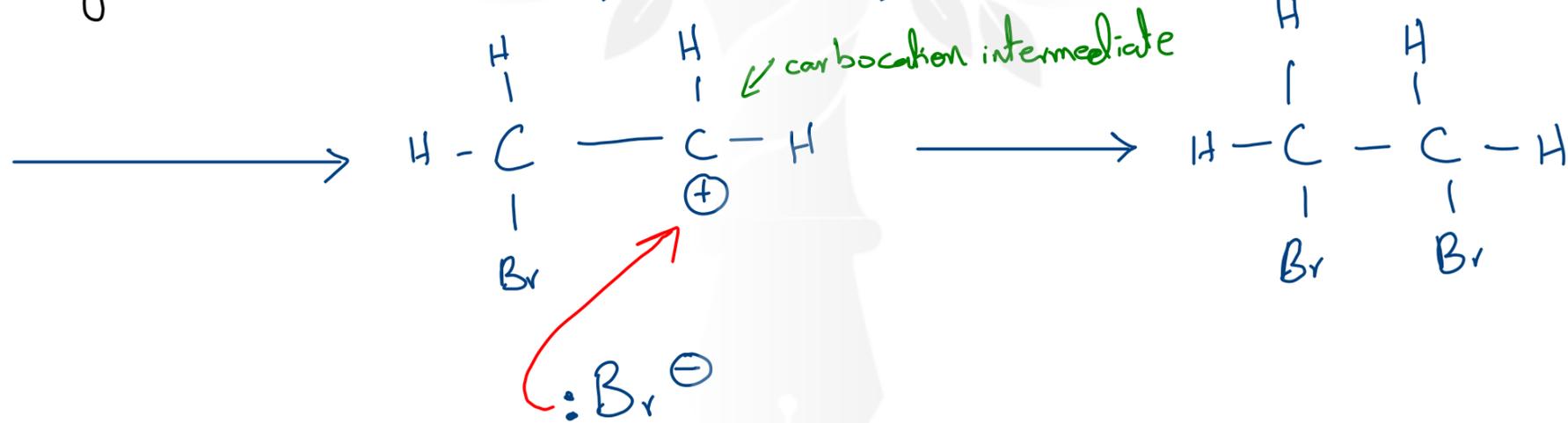
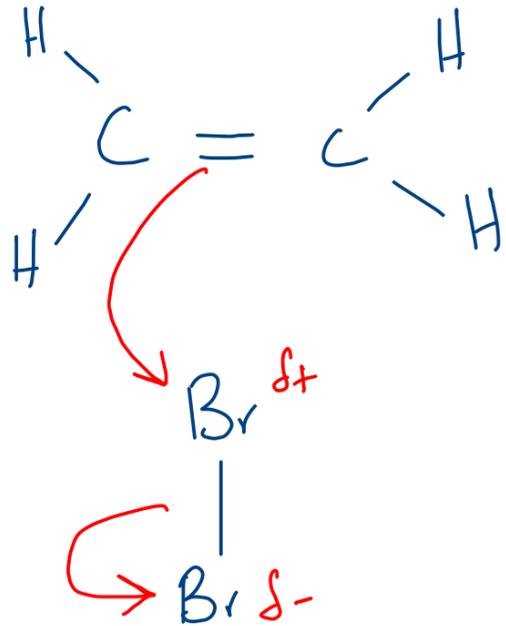
secondary carbocation
(2 alkyl groups)



tertiary carbocation
(3 alkyl groups)

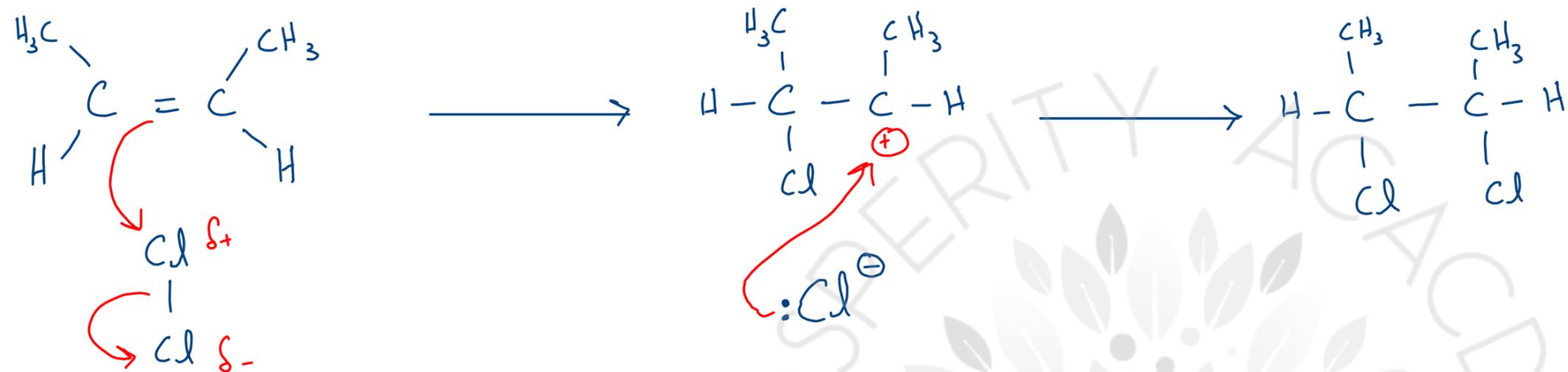
Positive inductive effect:- pushing of electron density by a group.

Electrophilic addition to symmetrical alkanes:- i) $\text{Br}_2 + \text{C}_2\text{H}_4$



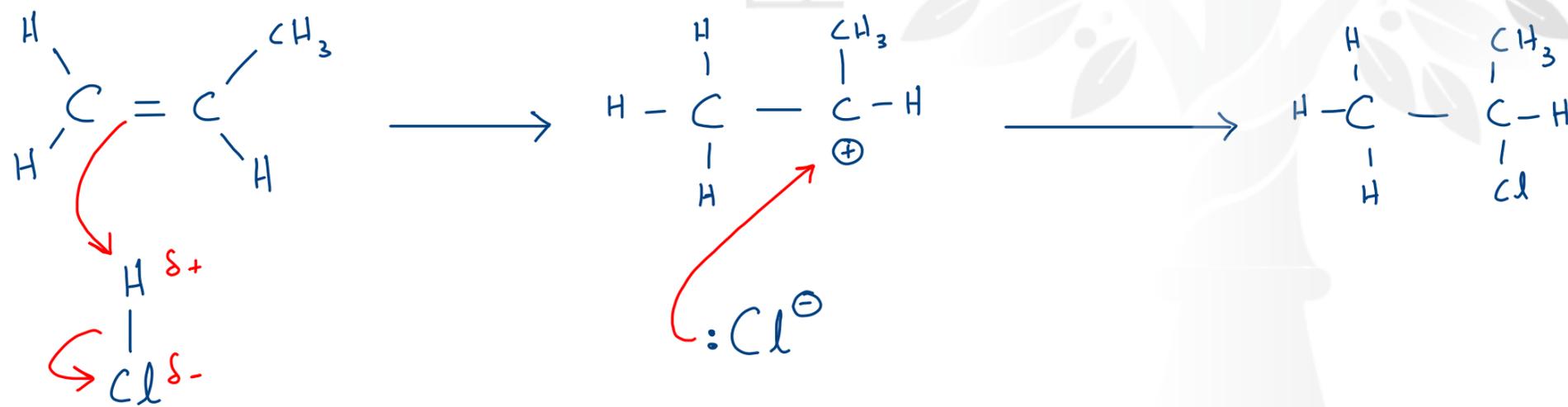
Temporary poles induced in Br_2 due to high electron density in $\text{C}=\text{C}$

2) But-2-ene + Cl₂



Electrophilic addition to non symmetrical alkenes:- *Hydrogen goes to the carbon with most hydrogen*

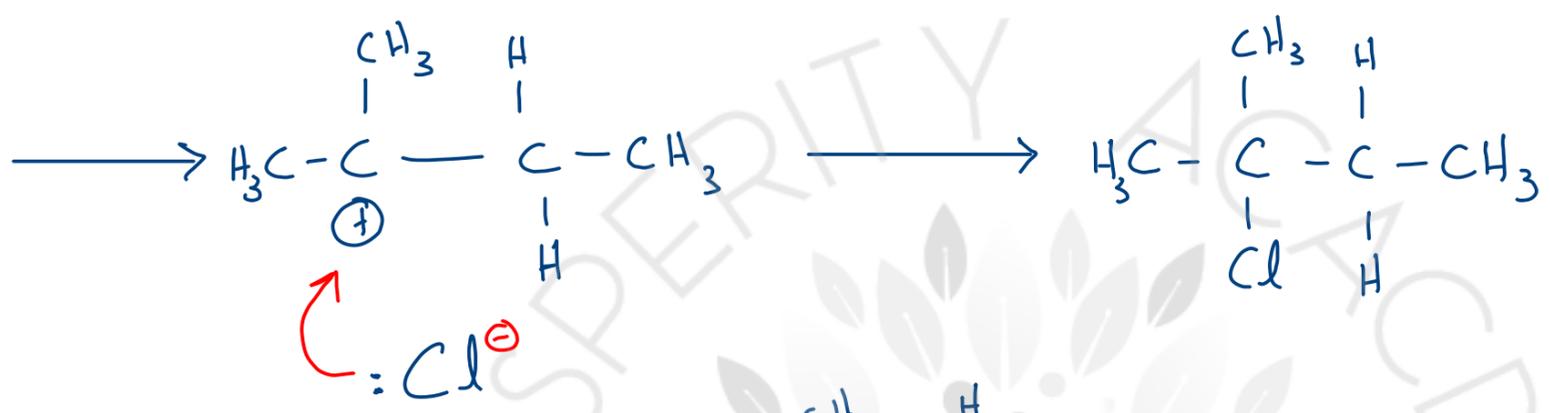
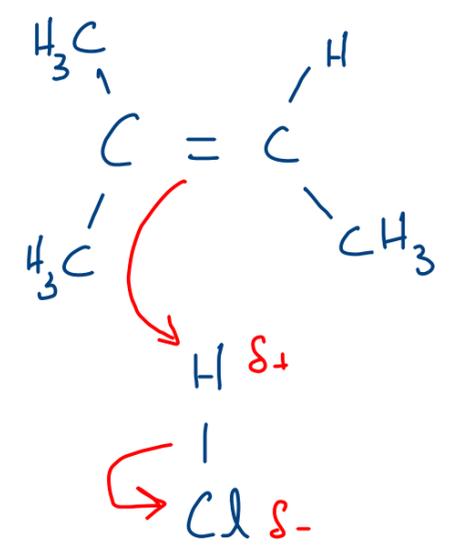
3) Propene + HCl :-



- The carbocation made in the process is a secondary carbocation whereas a primary carbocation would be made otherwise.
- A secondary carbocation is more stable as the alkyl groups on it have a greater positive inductive effect and can stabilise it to a greater degree
- The other alternative CC(C)[CH2+] is made but only in trace amounts

alkyl groups push electron density reducing the magnitude of the +ve charge

4) 2-methyl but -2-ene + HCl



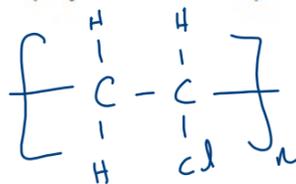
- The other alternative $\text{H}_3\text{C}-\text{C}(\text{H})-\text{C}(\text{CH}_3)(\text{Cl})-\text{CH}_3$ is made in trace amounts

The tertiary carbocation formed in this process is more stable than the secondary carbocation formed otherwise as the alkyl groups on it push more electron density towards it, stabilising it.

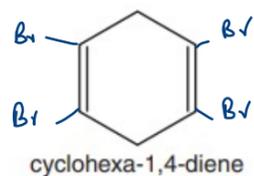
2 Chloroethene, $\text{CH}_2=\text{CHCl}$, is the monomer of pvc.

What are the C-C-C bond angles along the polymeric chain in pvc?

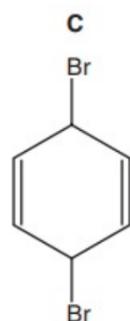
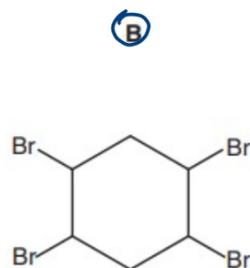
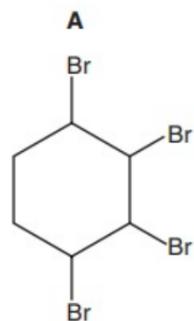
- (A) They are all 109° .
(B) Half are 109° and half are 120° .
(C) They are all 120° .
(D) They are all 180° .



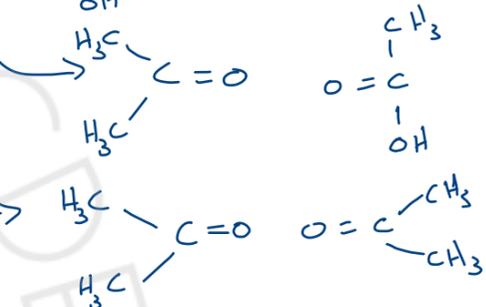
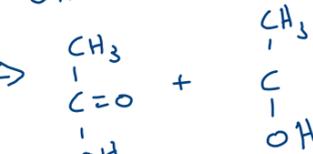
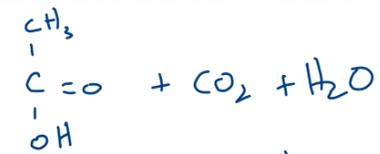
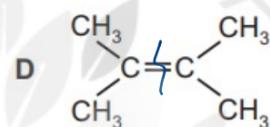
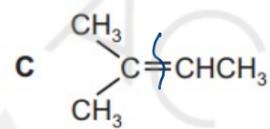
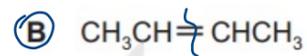
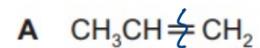
6 Cyclohexa-1,4-diene is treated with a solution of bromine in tetrachloromethane.



Which product is formed?



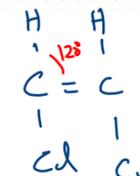
15 Which hydrocarbon, on treatment with hot acidified potassium manganate(VII), would give ethanoic acid only?



19 The compound 1,2-dichloroethene, $\text{C}_2\text{H}_2\text{Cl}_2$, has been used as an industrial solvent for a number of compounds including fats, camphor and caffeine.

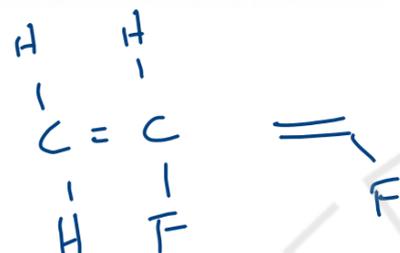
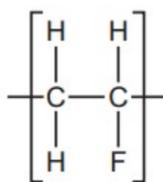
Which statement about this compound is **incorrect**?

- (A) The compound can be catalytically hydrogenated. ✓
(B) The compound is a planar molecule. ✓
(C) The compound shows *cis-trans* isomerism. ✓
(D) The compound shows optical isomerism. ✗



31 Fluoroalkenes are used to make polymers such as poly(vinyl)fluoride (PVF).

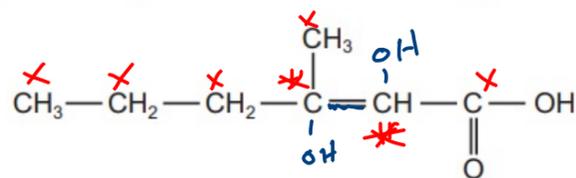
PVF is used to make non-flammable interiors for aircraft. The diagram shows the repeat unit of the polymer PVF.



What is the skeletal formula of the monomer of PVF?



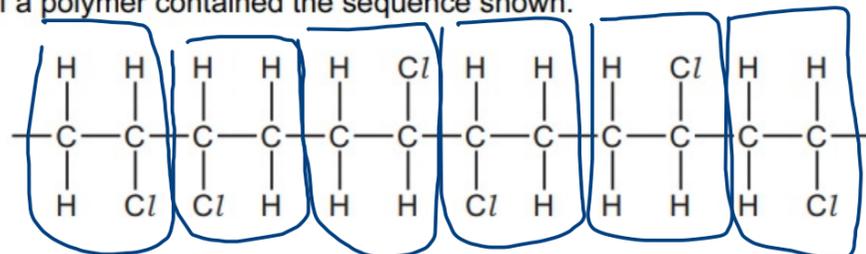
33 An unpleasant smelling chemical produced in the human armpit is 3-methylhex-2-enoic acid.



If this compound is reacted with a cold, dilute, acidified solution of potassium manganate(VII), how many chiral centres will be produced?

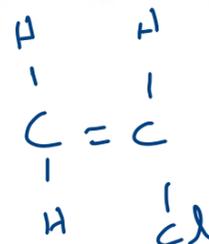
- A 0 B 1 C 2 D 3

37 A molecule of a polymer contained the sequence shown.



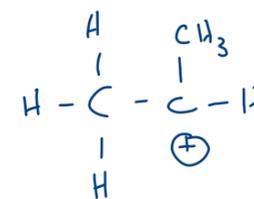
Which monomer could produce this polymer by addition polymerisation?

- A $\text{CHCl}=\text{CHCl}$
 B $\text{CH}_2=\text{CHCl}$
 C $\text{CH}_3\text{CCl}=\text{CHCl}$
 D $\text{CH}_3\text{CCl}=\text{CH}_2$

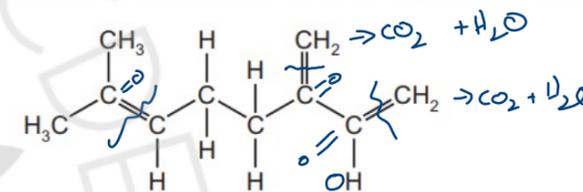


56 Which intermediate ion forms in the greatest amount during the addition of HBr to propene?

- A $\text{CH}_3\text{CH}^+\text{CH}_3$
 B $\text{CH}_3\text{CH}_2\text{CH}_2^+$
 C $\text{CH}_3\text{CH}^-\text{CH}_2\text{Br}$
 D $\text{CH}_3\text{CHBrCH}_2^-$



79 A species of termite produces a chemical defence secretion which contains the molecule shown.



To help determine the structure of this compound, it is treated with hot, concentrated, acidified manganate(VII) ions.

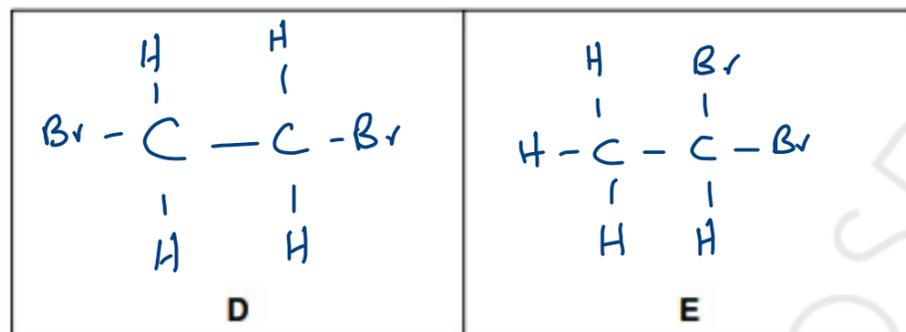
Which compounds are produced in this reaction?

- 1 CO_2 ✓
 2 CH_3COCH_3 ✓
 3 $\text{CH}_3\text{CO}_2\text{H}$ ✗

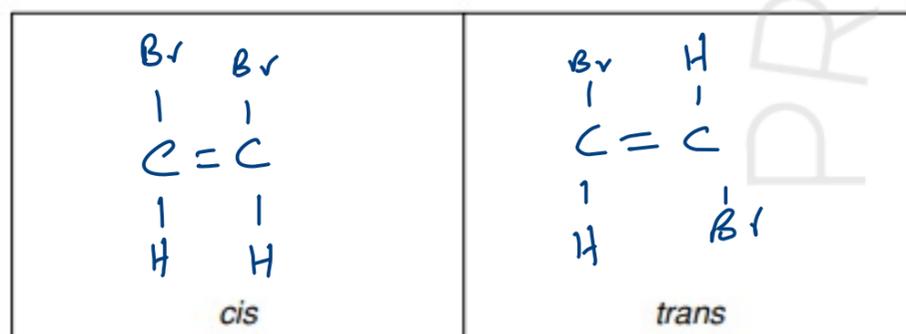
4 Two types of isomerism found in organic compounds are structural isomerism and *cis-trans* isomerism.

(a) Draw displayed formulae for

(i) two structural isomers of $C_2H_4Br_2$,



(ii) the *cis*- and the *trans*- isomers of $C_2H_2Br_2$.



[4]

(b) (i) The *cis*- isomer of $C_2H_2Br_2$ can be converted into **one** of the structural isomers of $C_2H_4Br_2$. State the reagent(s) and conditions you would use to do this.

H_2 gas, temp of $180^\circ C$ and Nickel catalyst

(ii) Which of your structural isomers, **D** or **E**, would be formed? Explain your answer.

isomer formed is **D**

reason **Bromines are present on separate C atoms**

[3]

6 Dodec-1-ene has the structure shown.



(a) Draw the structures of the organic molecules produced when dodec-1-ene reacts with each of the following.

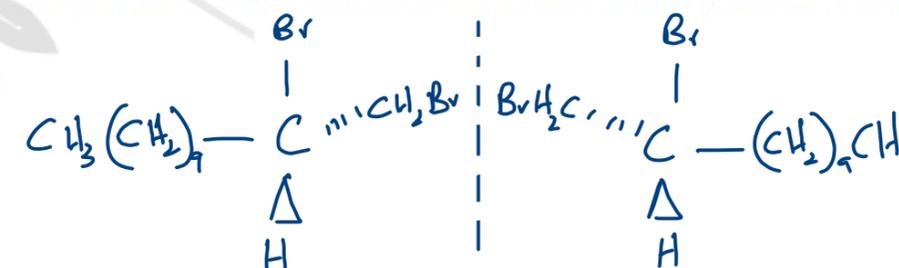
(i) bromine	(ii) hydrogen bromide
$CH_3(CH_2)_9CH(Br)CH_2Br$	$CH_3(CH_2)_9CH(Br)CH_3$
(iii) hot, concentrated manganate(VII) ions	(iv) steam
$CH_3(CH_2)_9COOH$	$CH_3(CH_2)_9CH(OH)CH_3$

[4]

(b) (i) What type of isomerism is shown by the organic products in (i), (ii) and (iv)?

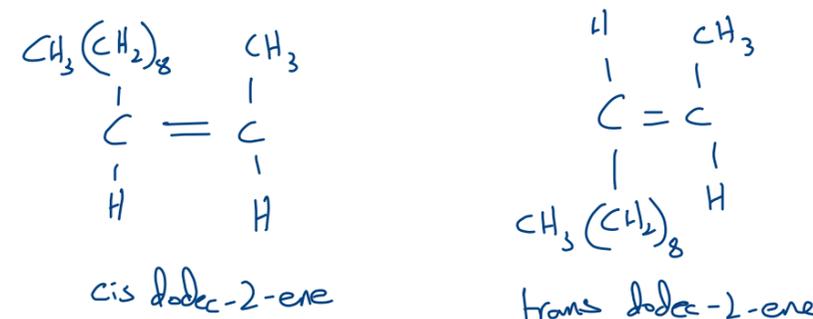
optical isomerism

(ii) Draw structures to represent these isomers, choosing any **one** of these products.



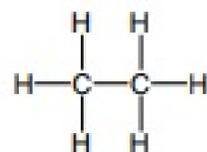
[3]

(c) Dodec-2-ene shows another type of isomerism. Draw and label diagrams which show these two isomers.

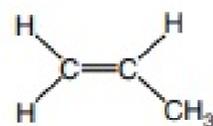


[2]

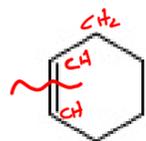
- 7 Crude oil is the principal source of hydrocarbons. The following are examples of such hydrocarbons.



ethane



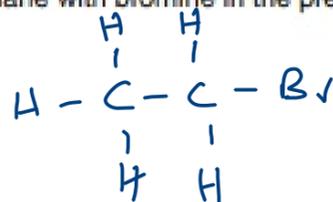
propene



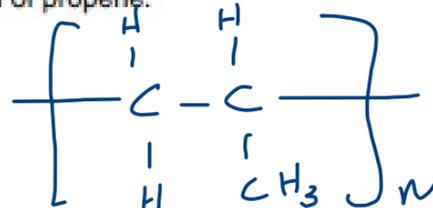
cyclohexene

- (a) Give the structural formulae of the organic products in the following reactions.

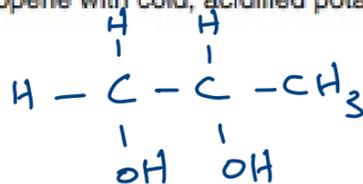
- (i) The reaction of ethane with bromine in the presence of u.v. light.



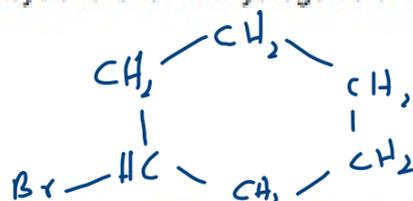
- (ii) The polymerisation of propene.



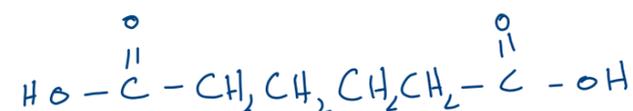
- (iii) The oxidation of propene with cold, acidified potassium manganate(VII).



- (iv) The reaction of cyclohexene with hydrogen bromide.



- (v) The reaction of cyclohexene with hot acidified potassium manganate(VII).

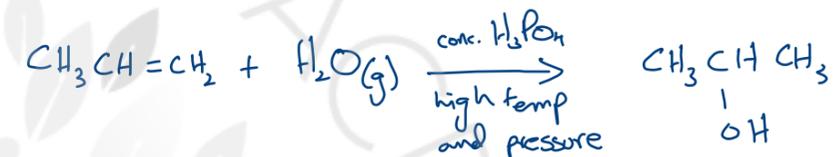


- (b) Write equations for the following reactions.

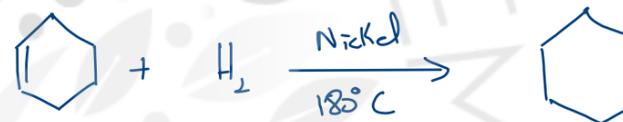
- (i) The complete combustion of ethane.



- (ii) The action of steam on propene in the presence of a catalyst.



- (iii) The reaction of cyclohexene with hydrogen in the presence of a catalyst.



[3]

- (c) The process of cracking produces useful substances from oil.

- (i) Explain why cracking is useful.

Larger alkanes are converted to smaller ones such as octane which is used as motor fuel. Alkenes are also obtained which are further used to synthesize more organic products.

- (ii) Suggest an equation for the cracking of $\text{C}_{16}\text{H}_{34}$ into at least three fragments.



[5]

[3]

15 But-2-ene, $\text{CH}_3\text{CH}=\text{CHCH}_3$, is an important compound which is obtained from the cracking of hydrocarbons present in crude oil.

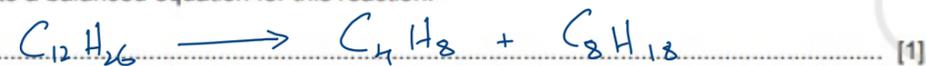
(a) Give two different conditions under which long chain hydrocarbons may be cracked.

Thermal cracking :- 500°C of temperature and 10 atm pressure
 Catalytic cracking :- SiO_2 & Al_2O_3 catalyst with heating

[2]

(b) Dodecane, $\text{C}_{12}\text{H}_{26}$, is a long chain hydrocarbon which is present in crude oil and which can be cracked to form but-2-ene and an alkane.

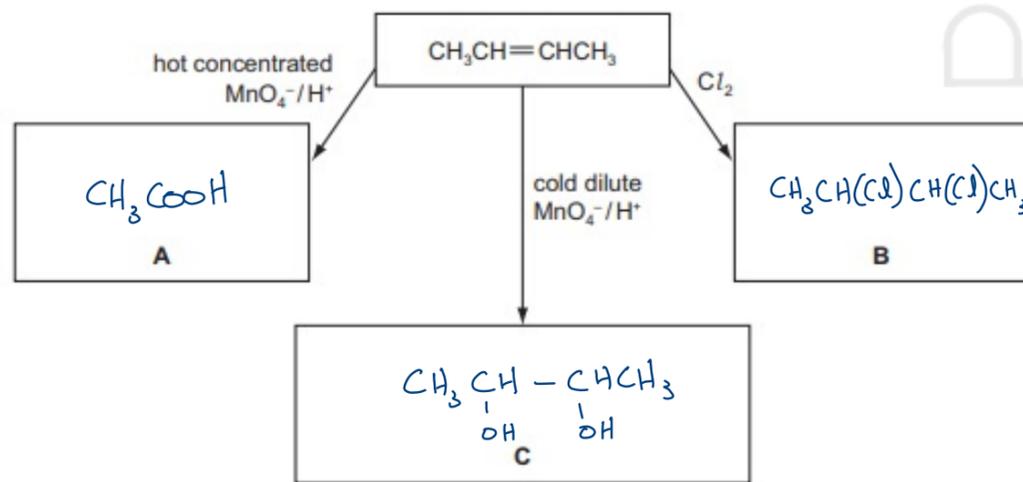
Write a balanced equation for this reaction.



[1]

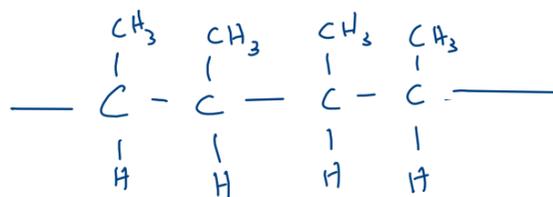
(c) Some reactions of but-2-ene are shown below.

In the boxes below, give the structural formulae of the organic compounds A to D.



(e) But-2-ene can be polymerised to give poly(butene).

Draw the structural formula of a portion of the polymer chain in poly(butene) showing two repeat units.



[1]

19 (b) $(\text{CH}_3)_2\text{C}=\text{C}(\text{CH}_3)_2$

(i) name 2,3-dimethylbut-2-ene [1]

(ii) Draw the skeletal formula of the organic product of the reaction of this compound with cold, dilute, acidified manganate(VII) ions.

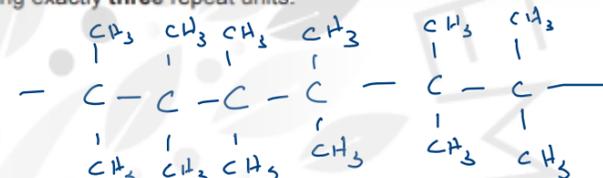


[1]

(iii) Name the organic product of the reaction of this compound with hot, concentrated, acidified manganate(VII) ions.

Propanone [1]

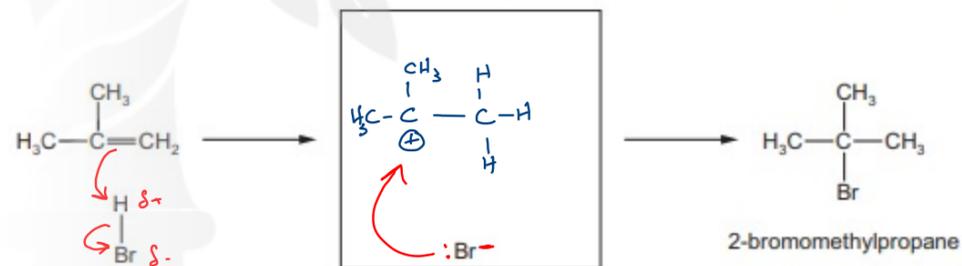
(iv) Draw the structure of part of a molecule of the addition polymer formed from this compound, showing exactly three repeat units.



(c) $(\text{CH}_3)_2\text{C}=\text{CH}_2$

(i) name 2-methylpropene [1]

(ii) Complete the mechanism for the reaction of this compound with hydrogen bromide. Include all necessary curly arrows, lone pairs, charges and partial charges.



[4]

(iii) Explain fully why 2-bromomethylpropane is the major product of this reaction while only relatively small amounts of 1-bromomethylpropane are produced.

The tertiary carbocation is more stable than the primary carbocation formed otherwise as the alkyl groups on it produce a greater positive effect by pushing their electron density towards the intermediate and reducing the magnitude of + charge.

[3]