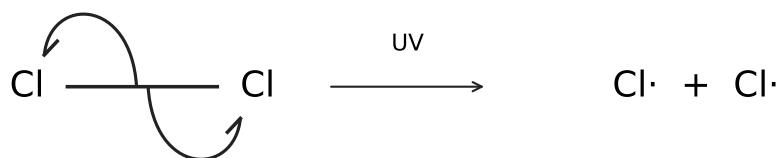


## Solutions

Original authored guidance. Arrow starts must identify the actual bond or electron pair, not a positive charge.

### 2.1

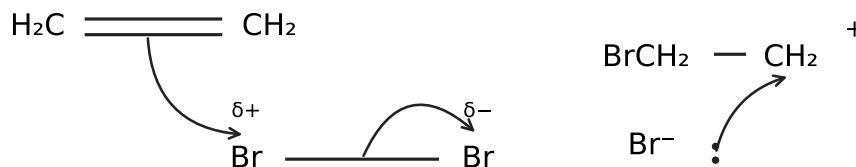


Homolysis: one electron from the bond goes to each chlorine atom.  
Each curly half-arrow tracks one electron.

Award for  $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$  and UV, two half-arrows starting at the bond and ending at different Cl atoms.

**2.2**  $\text{Cl}\cdot + \text{CH}_4 \rightarrow \text{HCl} + \text{CH}_3\cdot$ ;  $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$ ;  $2\text{CH}_3\cdot \rightarrow \text{C}_2\text{H}_6$ .  
Propagation regenerates a radical, allowing further reaction with the remaining molecules.  
Termination consumes radicals without regenerating one.

### 2.3



Product:  $\text{BrCH}_2\text{---CH}_2\text{Br}$

Simple electrophilic-addition model:  $\pi$  pair  $\rightarrow \text{Br}\delta^+$ ;  $\text{Br}-\text{Br}$  pair  $\rightarrow \text{Br}\delta^-$ .  
A bromide lone pair supplies the second C-Br bond.

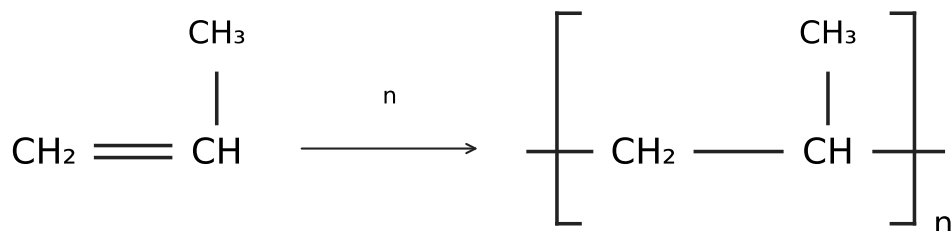
Award induced  $\text{Br}\delta^+ \text{---} \text{Br}\delta^-$  polarity,  $\pi$ -bond pair arrow to  $\text{Br}\delta^+$  and  $\text{Br}-\text{Br}$  pair arrow to  $\text{Br}\delta^-$ ,  $\text{BrCH}_2\text{CH}_2^+$  plus  $\text{Br}^-$  with a lone-pair arrow to the positive carbon, and 1,2-dibromoethane product. This syllabus-level model makes no claim about a unique stereochemical product from every substituted alkene.

**3.1**  $\text{CH}_3\text{---CH}^+\text{---CH}_3$  is secondary;  $\text{CH}_3\text{---CH}_2\text{---CH}_2^+$  is primary. The secondary carbocation is more stable, so its route is favoured;  $\text{Br}^-$  attack gives 2-bromopropane as the major product. Product ratio is not explained by a carbon atom simply wanting more bonds.

**3.2** Chloromethane can undergo further radical substitution to form dichloromethane.

Two methyl radicals can combine in termination to form ethane. Further substitution and competing termination products create a mixture requiring separation rather than one directly pure product.

### 3.3

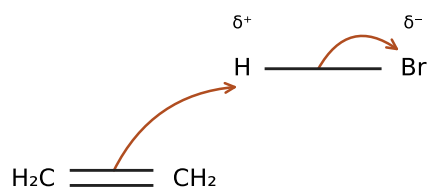


Propene → poly(propene); continuation bonds cross the brackets.  
Side groups stay attached; no small molecule is eliminated.

Award correct monomer and methyl side group, single-bond backbone, continuation bonds/brackets/n and balanced n monomers. Both monomer  $\text{C}_3\text{H}_6$  and repeat-unit composition have empirical ratio  $\text{CH}_2$ , so empirical formula does not reveal molecular size or connectivity.

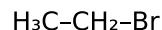
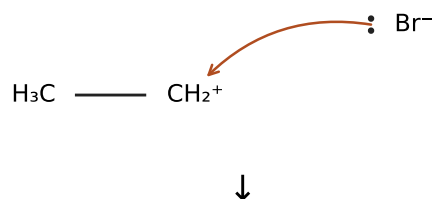
### 3.4

1 Form the ethyl carbocation



$\pi$  pair  $\rightarrow$  H; H-Br pair  $\rightarrow$  Br

2 Bromide donates its lone pair



bromoethane

$\text{H}\delta^+-\text{Br}\delta^-$  polarity; pair arrow from  $\text{C}=\text{C}$  to H and pair arrow from  $\text{H}-\text{Br}$  to Br;  $\text{CH}_3\text{CH}_2^+$  plus  $\text{Br}^-$  and bromide lone-pair arrow to the positive carbon; bromoethane  $\text{CH}_3\text{CH}_2\text{Br}$ . The two ethene carbons are equivalent, so either direction of proton addition leads to the same connectivity.