



AQA 7405

Introduction to Organic Chemistry II

MECHANISMS • ELECTRON MOVEMENT • E/Z ISOMERISM

ORIGINAL EXAM QUESTIONS | TEST IT → EXAM STYLE → HARDER MIXED → STRETCH

TEST IT	EXAM STYLE	HARDER MIXED	STRETCH
8	8	4	2

22 QUESTIONS MASTERED | 196 TOTAL MARKS

Mapped to AQA Chemistry 7405 sections 3.3.1.2 and 3.3.1.3

Specification checked September 2026

How to use this pack [START HERE](#)

- 1 Read the command word** State gives a concise fact; explain needs a linked reason; draw requires the actual electron or stereochemical diagram.
- 2 Track electrons, not atoms** Every electron-pair arrow must start at the lone pair or bond supplying the pair and end at its destination.
- 3 Apply CIP in order** Compare directly attached atoms first. Continue outward only when there is a tie, stopping at the first difference.
- 4 Audit the result** Check atoms, total charge, carbon valency, radical dots and whether the high-priority groups really give E or Z.

AQA BOUNDARY This pack assesses mechanism conventions and E/Z isomerism. Full named mechanisms, reaction conditions and optical isomerism belong to later topics.

SECTION A TEST IT

Secure the language, electron-flow conventions and first E/Z decisions.

QUESTION 1 | TEST IT

(a) Define the term reaction mechanism. (2 marks)

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(b) State what a curly arrow represents in an electron-pair mechanism. (1 mark)

.....

(c) Define the term free radical. (1 mark)

.....

(d) Distinguish a straight reaction arrow from a curly arrow. (2 marks)

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QUESTION 2 | TEST IT

Classify each supplied change from the structures. No reagent or condition recall is required.

Change	Supplied equation
I	$\text{CH}_3\text{CH}=\text{CHCH}_3 + \text{H}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
II	$\text{CH}_3\text{CH}_2\text{Br} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{NH}_3^+ + \text{Br}^-$
III	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{CH}=\text{CH}_2 + \text{H}_2\text{O}$

(a) State whether I, II and III are addition, substitution or elimination. (3 marks)

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(b) For each change, give one structural feature that supports your classification. (3 marks)

.....

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QUESTION 3 | TEST IT

Figure 1 shows two bonds before fission.

Figure 1 | Bond fission

Br — Br homolytic products:.....

CH₃CH₂ — Br heterolytic products:.....

(a) Complete the products of homolytic fission of Br—Br. Include every radical dot. (2 marks)

(b) For heterolytic fission of CH₃CH₂—Br in which Br receives the bonding pair, add the curly arrow and complete the charged products. (3 marks)

(c) State the difference in electron allocation between homolytic and heterolytic fission. (2 marks)

QUESTION 4 | TEST IT

(a) Define nucleophile and electrophile. (2 marks)

(b) From NH₃, H⁺, OH⁻ and CH₃⁺, identify both nucleophiles and both electrophiles. (4 marks)

(c) Explain why NH₃ can act as a nucleophile even though it is neutral. (2 marks)

QUESTION 5 | TEST IT

Figure 2 shows hydroxide reacting with a proton. The reacting lone pair is shown.

Figure 2 | A lone pair supplies the electron pair



(a) Add the curly arrow and draw the product, including any remaining lone pairs needed to make the product clear. (3 marks)

Add the arrow above, then draw the product here.

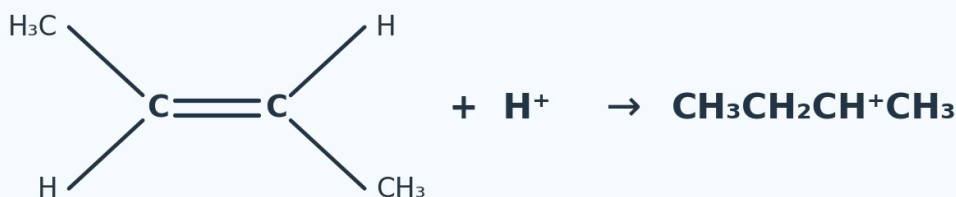
(b) State the total charge before and after the step. (1 mark)

(c) State the exact rule for the tail of this curly arrow. (1 mark)

QUESTION 6 | TEST IT

Figure 3 supplies a step involving but-2-ene. Product selection is not being tested.

Figure 3 | A bond supplies the electron pair



(a) Add the curly arrow that accounts for formation of the new C—H bond. (2 marks)

(b) Explain what happens to the C=C bond order and to its electron pair. (2 marks)

(c) State the total charge before and after the step. (1 mark)

QUESTION 7 | TEST IT

Figure 4 shows ammonia reacting with hydrogen bromide. Both electron-pair movements are required.

Figure 4 | Bond making and bond breaking



(a) Add both curly arrows and draw the products with correct charges. (2 marks)

Draw the products here.

(b) Explain why the second arrow must start at the H—Br bond and end at Br. (2 marks)

(c) Identify the nucleophile and the electrophile in this step. (2 marks)

QUESTION 8 | TEST IT

The step skeletons below are supplied. Conditions and the full reaction are not being recalled.

Step	Complete balanced radical equation
1	$\text{Cl}_2 \rightarrow$
2	$\text{Cl}^\bullet + \text{CH}_3\text{CH}_3 \rightarrow \text{HCl} +$
3	$\text{CH}_3\text{CH}_2^\bullet + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl} +$

(a) Complete all three equations. Include a dot on every radical. (6 marks)

(b) Identify the radical formed in step 2 and used in step 3. (1 mark)

(c) Identify the radical regenerated in step 3. (1 mark)

SECTION B

EXAM STYLE

Apply the rules in linked AQA-style questions with structures and data.

QUESTION 9 | EXAM STYLE

A student attempted the electron-pair mechanism for $\text{OH}^- + \text{HBr} \rightarrow \text{H}_2\text{O} + \text{Br}^-$.

Figure 5 | Student attempt

Student attempt



Arrows and products shown exactly as the student drew them

(a) Identify three errors in the student's arrows or products. (3 marks)

(b) Redraw the complete step using two correct curly arrows and correct products. (4 marks)

Correct mechanism and products.

(c) Calculate the total charge on each side of the corrected step. (2 marks)

QUESTION 10 | EXAM STYLE

Consider the supplied overall equation $\text{CH}_3\text{CH}_2\text{Br} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{Br}^-$.

(a) Classify the structural change. (1 mark)

(b) Identify the nucleophile and the electrophilic atom. (2 marks)

(c) Add δ^+ and δ^- to the C—Br bond and explain why those partial charges arise. (2 marks)

(d) State the covalent bond broken and the covalent bond formed. (2 marks)

(e) Explain why the overall equation is not itself a reaction mechanism. (2 marks)

QUESTION 11 | EXAM STYLE

Figure 6 gives an unfamiliar electron-pair step. All species needed are shown.

Figure 6 | Unfamiliar donor-acceptor step



(a) Add the curly arrow for bond formation.

(2 marks)

(b) Draw the product, showing its new bond and overall charge.

(3 marks)

Product structure.

(c) Explain the roles of NH_3 and CH_3^+ and confirm charge conservation.

(2 marks)

QUESTION 12 | EXAM STYLE

(a) Define stereoisomers.

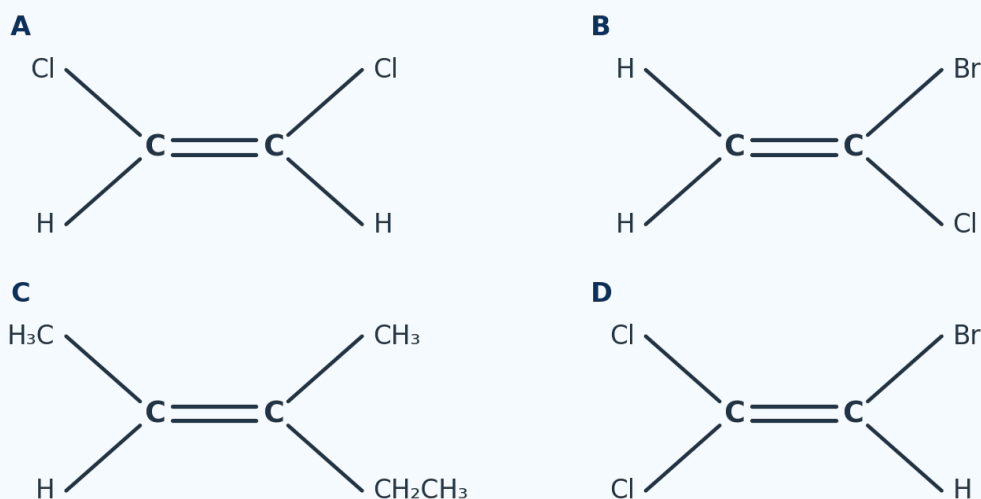
(2 marks)

(b) Explain why E/Z stereoisomerism can arise about a carbon-carbon double bond.

(3 marks)

Figure 7 shows four alkenes. Bonds are displayed to make the groups on each C=C carbon unambiguous.

Figure 7 | E/Z eligibility



(c) For each structure A–D, state whether E/Z isomerism is possible.

(4 marks)

(d) Choose one structure that is not eligible and explain why.

(2 marks)

QUESTION 13 | EXAM STYLE

For each pair, state which group has higher CIP priority.

Pair	Groups to compare	Higher-priority group
I	Cl and OH	
II	CH ₃ and H	
III	NH ₂ and OH	
IV	Br and Cl	

(a) Complete all four rows.

(4 marks)

.....

.....

(b) State the CIP rule used in every comparison above.

(2 marks)

.....

.....

QUESTION 14 | EXAM STYLE

In each comparison, the first atoms attached to the C=C carbon are both carbon. Show how the tie is resolved.

Pair	Groups	Ordered comparison and higher priority
I	CH ₂ OH and CH ₃	
II	CHO and CH ₂ OH	
III	CH=CH ₂ and CH ₂ CH ₃	

(a) For each pair, write the attached-atom lists in decreasing atomic number and identify the higher-priority group. (9 marks)

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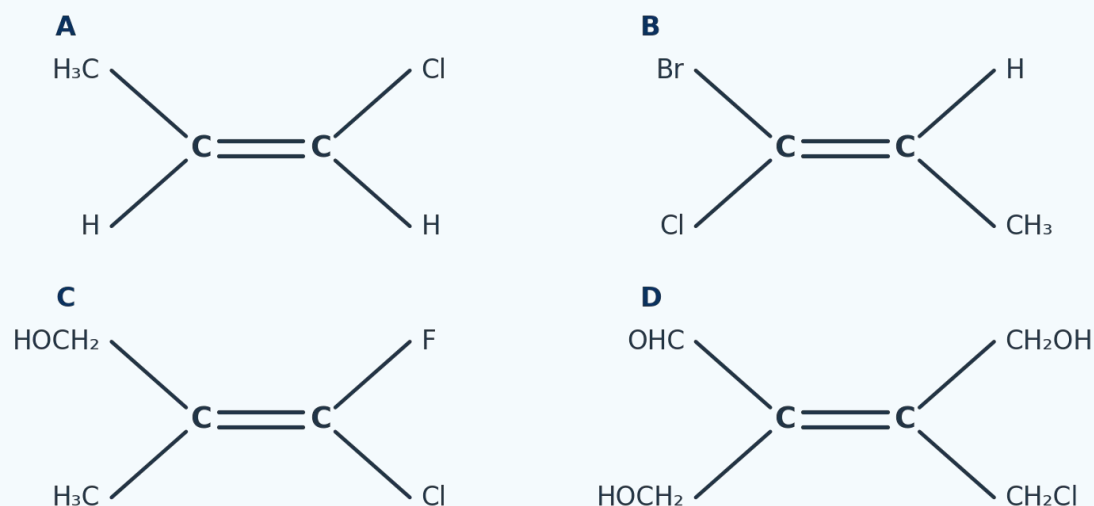
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QUESTION 15 | EXAM STYLE

Determine each descriptor using CIP priorities, not the visual size of a group.

Figure 8 | Assign E or Z



(a) For each structure A–D, identify the higher-priority group on each C=C carbon.

(4 marks)

(b) Assign E or Z to each structure.

(4 marks)

QUESTION 16 | EXAM STYLE

(a) Explain why pent-1-ene does not show E/Z isomerism.

(2 marks)

(b) Draw E-pent-2-ene. Your drawing must make the relative positions of CH₃ and CH₂CH₃ unambiguous.

(3 marks)

E-pent-2-ene

(c) Draw Z-pent-2-ene. Your drawing must make the relative positions of CH₃ and CH₂CH₃ unambiguous.

(3 marks)

Z-pent-2-ene

SECTION C

HARDER MIXED

Select, combine and audit several rules without a scaffolded route.

QUESTION 17 | HARDER MIXED

Figure 9 shows three student electron-pair arrows in red. Every panel contains an error.

Figure 9 | Diagnose and repair electron flow

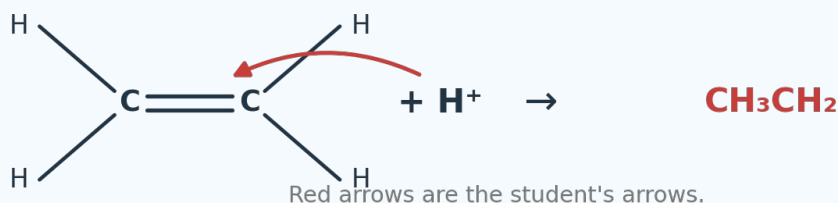
A



B



C



(a) For each panel A–C, identify precisely why the arrow is invalid.

(3 marks)

(b) For each panel, state the correct electron source and destination.

(3 marks)

(c) Redraw all three panels with correct arrows and chemically valid products.

(6 marks)

A, B and C: corrected arrows and products.

QUESTION 18 | HARDER MIXED

A two-step radical sequence has overall equation $\text{CH}_3\text{CH}_3 + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{HCl}$. Choose from the candidate steps.

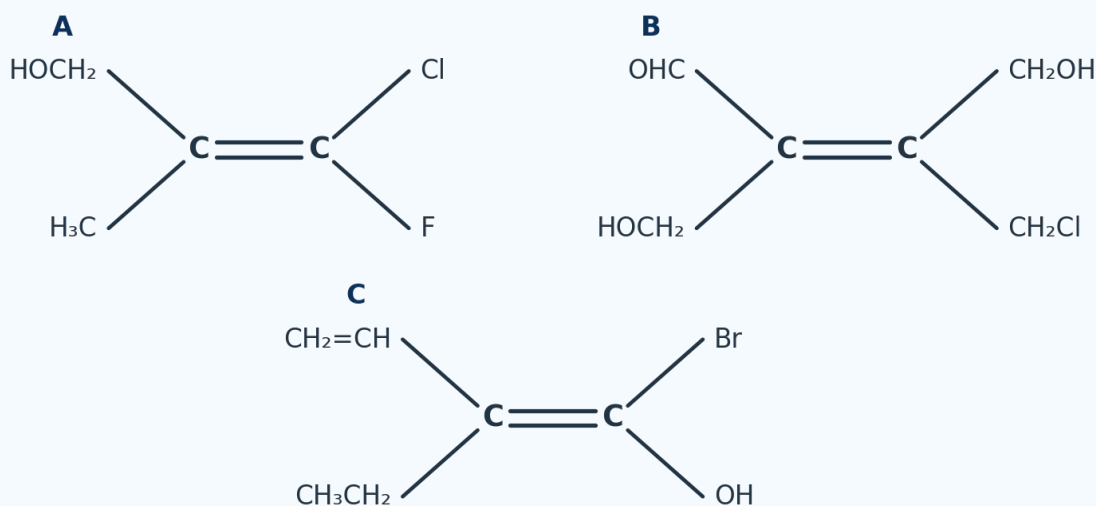
Step	Candidate equation
P	$\text{Cl}^\bullet + \text{CH}_3\text{CH}_3 \rightarrow \text{HCl} + \text{CH}_3\text{CH}_2^\bullet$
Q	$\text{Cl}^- + \text{CH}_3\text{CH}_3 \rightarrow \text{HCl} + \text{CH}_3\text{CH}_2^-$
R	$\text{CH}_3\text{CH}_2^\bullet + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{Cl}^\bullet$
S	$\text{CH}_3\text{CH}_2^\bullet + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl}$

- (a) Select the two valid radical steps. (2 marks)
- (b) Write the two selected equations, show which radical cancels, and recover the overall equation. (4 marks)
- (c) Identify the radical intermediate and the radical regenerated. (2 marks)
- (d) Explain one flaw in Q and one flaw in S. (2 marks)
- (e) Explain why electron-pair curly arrows are not used for these radical steps. (2 marks)

QUESTION 19 | HARDER MIXED

For each alkene, justify both priority decisions by showing the first point of difference.

Figure 10 | Multi-stage CIP comparisons



- (a) For A, determine the higher-priority group on each carbon, show the decisive comparison and assign E or Z. (5 marks)
- (b) Repeat for B. (5 marks)
- (c) Repeat for C, applying the multiple-bond convention where needed. (5 marks)

QUESTION 20 | HARDER MIXED

Compound X has molecular formula $C_5H_8Cl_2$. It contains one five-carbon chain and one $C=C$ bond beginning at carbon 2. One chlorine atom is bonded to each $C=C$ carbon.

- (a) Deduce the structural formula of X and give its systematic name without an E/Z descriptor. (3 marks)

Structure and name.

- (b) Explain why X can show E/Z isomerism. (2 marks)

- (c) Identify the higher-priority group on each $C=C$ carbon. (2 marks)

- (d) Draw the E isomer of X, showing all four groups around $C=C$ clearly. (3 marks)

E isomer.

SECTION D STRETCH / SYNOPTIC

Reconstruct unfamiliar electron flow and connect mechanism notation to stereochemistry.

QUESTION 21 | STRETCH / SYNOPTIC

The supplied two-step sequence is an electron-flow exercise. No reaction or condition recall is required. X is formed in step 1 and used in step 2.

Figure 11 | Reconstruct a two-step sequence

STEP 1**STEP 2**

- (a) In step 1, identify the nucleophile and electrophile. (2 marks)

- (b) Draw the curly arrow and the complete structure of X, including its charge. (3 marks)

Step 1 arrow and intermediate X.

- (c) In step 2, draw both curly arrows needed to transfer H^+ from X to NH_3 . (4 marks)

Step 2 electron-pair movements.

(d) Write the overall equation after X is cancelled and confirm total charge conservation. (3 marks)

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(e) Explain why X is an intermediate. (2 marks)

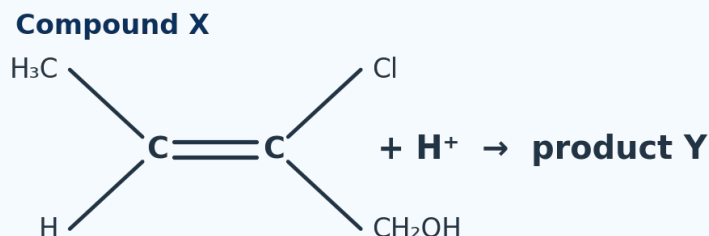
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QUESTION 22 | STRETCH / SYNOPTIC

Figure 12 shows compound X and a supplied first step in which H^+ attaches to the left-hand C=C carbon. Product selection is not being tested.

Figure 12 | Stereochemistry and electron movement



(a) Explain why X is eligible for E/Z isomerism. (2 marks)

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.....

(b) Identify the higher-priority group on each C=C carbon and justify each decision. (4 marks)

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.....

(c) Assign E or Z to X. (1 mark)

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(d) Draw the opposite stereoisomer of X. (3 marks)

Opposite stereoisomer.

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.....

(e) Add the curly arrow from C=C to H^+ and draw the stated carbocation product Y. (3 marks)

Electron-pair arrow and product Y.

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(f) Explain why E/Z stereoisomerism about the original C=C bond is no longer possible in Y. (2 marks)

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AQA 7405

Introduction to Organic Chemistry II

ANSWERS & MARK SCHEME

FULLY WORKED. PRECISELY MARKED. BUILT FOR IMPROVEMENT.

TEST IT	EXAM STYLE	HARDER MIXED	STRETCH
8	8	4	2

22 QUESTIONS MASTERED | 196 TOTAL MARKS

Mapped to AQA Chemistry 7405 sections 3.3.1.2 and 3.3.1.3

Specification checked September 2026

Specification coverage audit [AQA 7405](#)

AQA area	Assessed content	Questions
3.3.1.2	Equation versus mechanism; addition, substitution and elimination	1, 2, 10
3.3.1.2	Homolytic/heterolytic fission; radicals and balanced radical steps	3, 8, 18
3.3.1.2	Nucleophiles, electrophiles, partial charge and carbocations	4, 10, 11, 21
3.3.1.2	Curly-arrow source/destination; bond making and breaking; mechanism audit	5–7, 9, 17, 21, 22
3.3.1.3	Stereoisomers; origin and eligibility of E/Z isomerism	12, 16, 20, 22
3.3.1.3	CIP rules, tie resolution, multiple bonds, E/Z assignment and drawing	13–16, 19, 20, 22

BOUNDARY CHECK Every mechanism or equation needed beyond the introductory conventions is supplied. Named later mechanisms, reagents, conditions and optical isomerism are not assessed.

HOW MARKING WORKS Each bracketed point is worth one mark unless stated otherwise. Accept chemically equivalent wording where it preserves the required electron, charge, structure or CIP meaning.

SECTION A TEST IT — ANSWERS

Short, exact marking points for the foundational questions.

TEST IT 1 6 marks

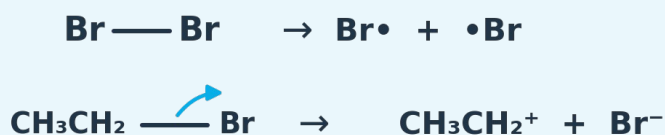
- (a) A step-by-step account of a reaction [1] showing bond breaking, bond formation and/or electron movement [1].
 (b) Movement of a pair of electrons [1].
 (c) A species containing an unpaired electron [1].
 (d) A straight reaction arrow shows that reactants form products [1]; a curly arrow tracks an electron pair within a mechanism [1].
COMMON ERROR A curly arrow does not show the path travelled by an atom.

TEST IT 2 6 marks

- (a) I addition [1]; II substitution [1]; III elimination [1].
 (b) I: H atoms add across C=C and the bond order falls to C—C [1]. II: Br is replaced by NH₃/NH₃⁺ while the carbon skeleton is retained [1]. III: H and OH are removed from adjacent atoms and C=C forms, with water lost [1].
ACCEPT Any equivalent structural observation that uniquely supports the classification.

TEST IT 3 7 marks

- (a) Br• + •Br, with a radical dot on each Br [2].
 (b) Curly arrow starts at the C—Br bond and ends at Br [1]; products are CH₃CH₂⁺ [1] and Br[−] [1].
 (c) Homolytic fission gives one bonding electron to each atom [1]; heterolytic fission gives both bonding electrons to one atom [1].
COMMON ERROR A radical dot represents one unpaired electron; it is not a negative charge.



TEST IT 4 8 marks

- (a) Nucleophile: electron-pair donor [1]. Electrophile: electron-pair acceptor [1].
 (b) Nucleophiles: NH₃ [1] and OH[−] [1]. Electrophiles: H⁺ [1] and CH₃⁺ [1].
 (c) NH₃ has an available lone pair on N [1] that it can donate to form a covalent bond [1].

TEST IT 5

5 marks

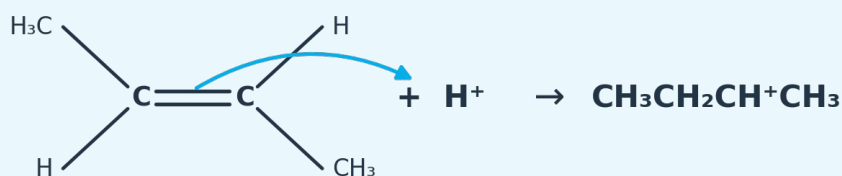
- (a) Curly arrow from the shown O lone pair to H^+ [1]; $\text{H}-\text{O}-\text{H}$ product [1] with a neutral O and chemically consistent remaining lone pairs [1].
 (b) Total charge is $-1 + +1 = 0$ before and 0 after [1].
 (c) The arrow tail must begin at the electron pair that moves—the O lone pair [1].



TEST IT 6

5 marks

- (a) Curly arrow begins on one line of $\text{C}=\text{C}$ [1] and points to H^+ [1].
 (b) $\text{C}=\text{C}$ becomes $\text{C}-\text{C}$ [1]; one π -bond electron pair forms the new $\text{C}-\text{H}$ bond [1].
 (c) Total charge is $+1$ before and $+1$ after [1].



TEST IT 7

6 marks

- (a) Arrow from the N lone pair to H [1]; arrow from $\text{H}-\text{Br}$ to Br [1]. Products NH_4^+ and Br^- .
 (b) The $\text{H}-\text{Br}$ bonding pair must move to Br as the bond breaks [1], preventing H from being left with two covalent bonds and giving Br^- [1].
 (c) NH_3 is the nucleophile [1]; H of HBr is the electrophile [1].



TEST IT 8

8 marks

- (a) 1: $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$ [2]. 2: $\text{Cl}\cdot + \text{CH}_3\text{CH}_3 \rightarrow \text{HCl} + \text{CH}_3\text{CH}_2\cdot$ [2]. 3: $\text{CH}_3\text{CH}_2\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{Cl}\cdot$ [2].
 (b) $\text{CH}_3\text{CH}_2\cdot$ [1].
 (c) $\text{Cl}\cdot$ [1].

COMMON ERROR Every radical must carry its dot in every equation, and each individual step—not only the overall change—must balance.

SECTION B

EXAM STYLE — ANSWERS

EXAM STYLE 9

9 marks

- (a) Any three: attack arrow is backwards; the breaking arrow does not start at H—Br; the breaking arrow does not end at Br; H₂O is incorrectly shown as positive; Br product is missing its negative charge. [3]
 (b) Arrow from an O lone pair of OH⁻ to H [1]; arrow from H—Br to Br [1]; H₂O [1] and Br⁻ [1].
 (c) Reactants: -1 + 0 = -1 [1]. Products: 0 + -1 = -1 [1].



EXAM STYLE 10

9 marks

- (a) Substitution [1].
 (b) OH⁻ is the nucleophile [1]; the carbon bonded to Br is the electrophilic atom [1].
 (c) Cδ⁺—Brδ⁻ [1] because Br is more electronegative and attracts the bonding pair more strongly [1].
 (d) C—Br is broken [1]; C—O is formed [1].
 (e) The equation shows only the overall change [1], not the step-by-step electron-pair movements/bond-making and bond-breaking route [1].

EXAM STYLE 11

7 marks

- (a) Curly arrow starts at the N lone pair [1] and ends at the positively charged carbon of CH₃⁺ [1].
 (b) Product has a new C—N bond [1], four bonds to N [1] and overall + charge: CH₃NH₃⁺ [1].
 (c) NH₃ donates the electron pair and is the nucleophile; CH₃⁺ accepts it and is the electrophile [1]. Charge is +1 before and +1 after [1].



EXAM STYLE 12

11 marks

- (a) Compounds with the same structural formula [1] but a different spatial arrangement of atoms [1].
 (b) C=C is planar [1]; the π bond restricts rotation about C=C [1]; therefore different fixed spatial arrangements can exist [1].
 (c) A yes [1]; B no [1]; C yes [1]; D no [1].
 (d) B: the left C=C carbon has two H groups, or D: the left C=C carbon has two Cl groups [1], so that carbon does not have two different attached groups [1].

COMMON ERROR Four different groups overall are not required. Each C=C carbon must have two different attached groups.

EXAM STYLE 13

6 marks

- (a) I Cl [1]; II CH₃ [1]; III OH [1]; IV Br [1].
 (b) Compare the atoms directly attached to the C=C carbon first [1]; the atom with the higher atomic number has higher priority [1].

EXAM STYLE 14

9 marks

- (a) I: CH₂OH gives (O,H,H), while CH₃ gives (H,H,H) [2]; CH₂OH has higher priority [1].
 II: CHO is treated as (O,O,H), while CH₂OH gives (O,H,H) [2]; CHO has higher priority [1].
 III: CH=CH₂ is treated as (C,C,H), while CH₂CH₃ gives (C,H,H) [2]; CH=CH₂ has higher priority [1].
 The listed atoms are arranged in decreasing atomic number and the atom behind the bond is excluded.

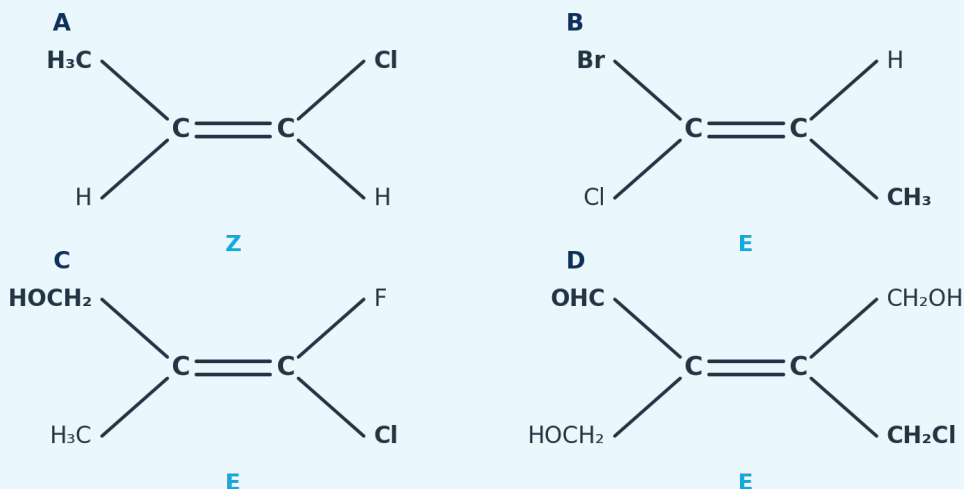
EXAM STYLE 15

8 marks

(a) A: CH_3 and Cl [1]. B: Br and CH_3 [1]. C: CH_2OH and Cl [1]. D: CHO and CH_2Cl [1].

(b) A Z [1]; B E [1]; C E [1]; D E [1].

For C, CH_2OH outranks CH_3 because (O,H,H) beats (H,H,H). For D, CHO beats CH_2OH and CH_2Cl beats CH_2OH at the first point of difference.



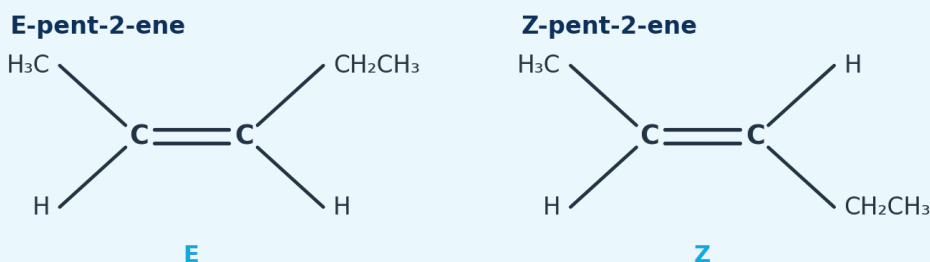
EXAM STYLE 16

8 marks

(a) The terminal $\text{C}=\text{C}$ carbon in pent-1-ene is CH_2 and therefore has two identical H groups [2].

(b) E-pent-2-ene: CH_3 and CH_2CH_3 are on opposite sides of $\text{C}=\text{C}$ [1], connectivity/valency correct [1], double-bond geometry unambiguous [1].

(c) Z-pent-2-ene: CH_3 and CH_2CH_3 are on the same side of $\text{C}=\text{C}$ [1], connectivity/valency correct [1], double-bond geometry unambiguous [1].



SECTION C

HARDER MIXED — ANSWERS

Full reasoning chains for diagnosis, radical deduction and multi-stage CIP.

HARDER MIXED 17

12 marks

(a) A: the arrowhead ends on the + sign instead of the positively charged carbon atom [1]. B: the arrow is reversed; it starts at Br rather than the $\text{C}-\text{Br}$ bond [1]. C: the arrow starts at H^+ rather than $\text{C}=\text{C}$ [1].

(b) A source Cl lone pair, destination C^+ [1]. B source $\text{C}-\text{Br}$ bonding pair, destination Br [1]. C source $\text{C}=\text{C}$ π pair, destination H^+ [1].

(c) A forms CH_3Cl with a $\text{C}-\text{Cl}$ bond [2]. B forms CH_3^+ and Br^- [2]. C forms CH_3CH_2^+ with a new $\text{C}-\text{H}$ bond and the positive charge shown [2].

COMMON ERROR The head does not point vaguely at a bond. It ends at the atom that receives the pair or at the position where the new bond is formed.

Harder Mixed 17 | Corrected model diagrams (continued)

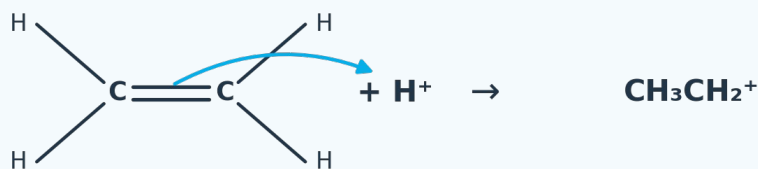
A



B



C



HARDER MIXED 18

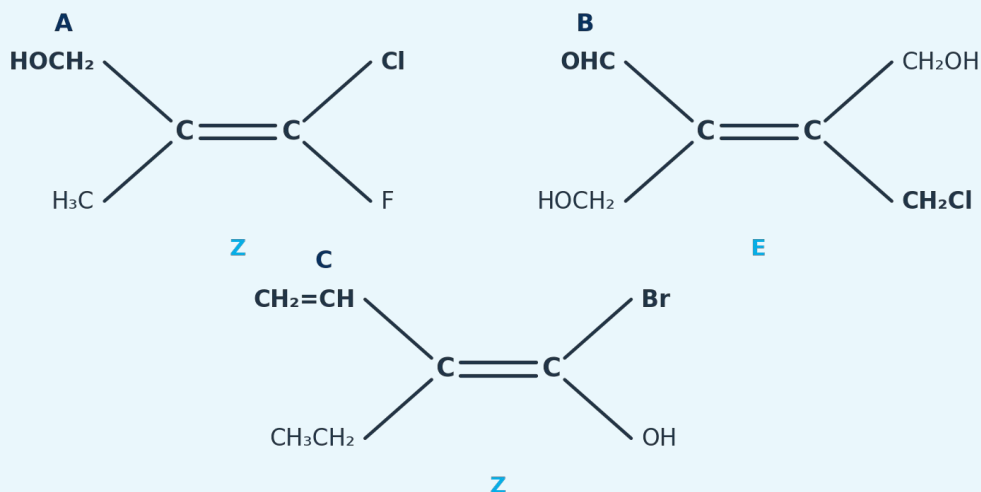
12 marks

- (a) P [1] and R [1].
 (b) P and R written with every radical dot [2]; $\text{CH}_3\text{CH}_2\cdot$ appears on both sides and cancels [1]; sum gives $\text{CH}_3\text{CH}_3 + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{HCl}$ [1].
 (c) $\text{CH}_3\text{CH}_2\cdot$ is the intermediate [1]; $\text{Cl}\cdot$ is regenerated [1].
 (d) Q uses ions rather than the required radicals/unpaired-electron species [1]. S loses one chlorine atom and is not balanced [1].
 (e) Electron-pair curly arrows represent pairs [1], whereas radical steps involve movement of single electrons and AQA does not require curly arrows for radical mechanisms [1].

HARDER MIXED 19

15 marks

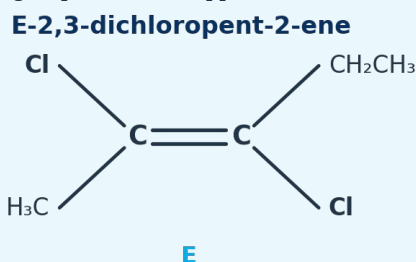
- (a) A left: CH_2OH beats CH_3 because $(\text{O}, \text{H}, \text{H}) > (\text{H}, \text{H}, \text{H})$ [2]. Right: Cl beats F by atomic number [2]. Both high-priority groups are above $\text{C}=\text{C}$, so A is Z [1].
 (b) B left: CHO is $(\text{O}, \text{O}, \text{H})$, which beats CH_2OH $(\text{O}, \text{H}, \text{H})$ [2]. Right: CH_2Cl is $(\text{Cl}, \text{H}, \text{H})$, which beats CH_2OH $(\text{O}, \text{H}, \text{H})$ [2]. The high-priority groups are opposite, so B is E [1].
 (c) C left: $\text{CH}=\text{CH}_2$ is treated as $(\text{C}, \text{C}, \text{H})$, which beats CH_2CH_3 $(\text{C}, \text{H}, \text{H})$ [2]. Right: Br beats O by atomic number [2]. Both high-priority groups are above $\text{C}=\text{C}$, so C is Z [1].



HARDER MIXED 20

10 marks

- (a) $\text{CH}_3\text{C}(\text{Cl})=\text{C}(\text{Cl})\text{CH}_2\text{CH}_3$ [2]; 2,3-dichloropent-2-ene [1].
 (b) Each $\text{C}=\text{C}$ carbon has two different attached groups [1], and rotation about $\text{C}=\text{C}$ is restricted [1].
 (c) Cl has higher priority than CH_3 on C2 [1]; Cl has higher priority than CH_2CH_3 on C3 [1].
 (d) Correct connectivity and valency [1]; both Cl groups shown on opposite sides of $\text{C}=\text{C}$ [1]; unambiguous E geometry [1].



SECTION D

STRETCH / SYNOPTIC — ANSWERS

Complete unfamiliar mechanisms, then connect electron flow to stereochemistry.

STRETCH / SYNOPTIC 21

14 marks

- (a) H_2O is the nucleophile [1]; CH_3^+ is the electrophile [1].
 (b) Arrow from an O lone pair to C^+ [1]; $\text{C}-\text{O}$ bond formed [1]; X is CH_3OH_2^+ with the + charge shown [1].
 (c) Arrow from the NH_3 lone pair to H on X [2]; arrow from the $\text{O}-\text{H}$ bond back to O [2].
 (d) $\text{H}_2\text{O} + \text{CH}_3^+ + \text{NH}_3 \rightarrow \text{CH}_3\text{OH} + \text{NH}_4^+$ after X cancels [2]; total charge is +1 on both sides [1].
 (e) X is formed in step 1 [1] and used up in step 2, so it does not appear in the overall equation [1].

STEP 1



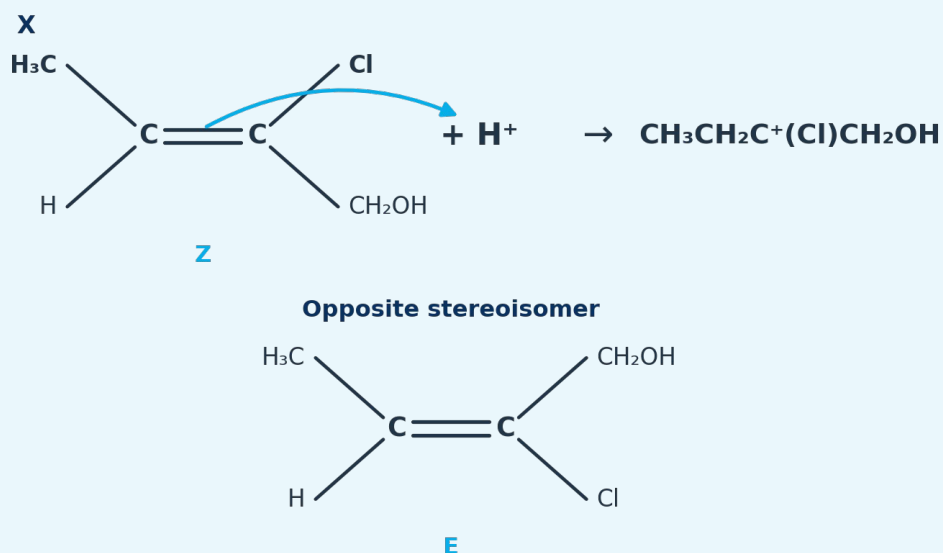
STEP 2



STRETCH / SYNOPTIC 22

15 marks

- (a) The left C=C carbon has CH₃ and H; the right has Cl and CH₂OH [1]. Each C=C carbon therefore has two different groups [1].
- (b) Left: CH₃ outranks H because C has higher atomic number than H [2]. Right: Cl outranks CH₂OH because Cl has higher atomic number than C [2].
- (c) The high-priority groups CH₃ and Cl are on the same side, so X is Z [1].
- (d) Opposite stereoisomer has CH₃ and Cl on opposite sides [1], correct connectivity/valency [1] and an unambiguous C=C drawing [1].
- (e) Arrow begins at C=C and ends at H⁺ [2]; product is CH₃CH₂C⁺(Cl)CH₂OH with the positive charge on the stated right-hand carbon [1].
- (f) The original C=C is now C—C [1], so free rotation is possible and E/Z stereoisomerism about that bond no longer applies [1].



FINAL EXAMINER CHECK Before awarding a drawing mark, verify the arrow tail, arrowhead, charge, carbon valency, radical dots, four C=C substituents and the actual CIP priorities—not merely the visual arrangement.