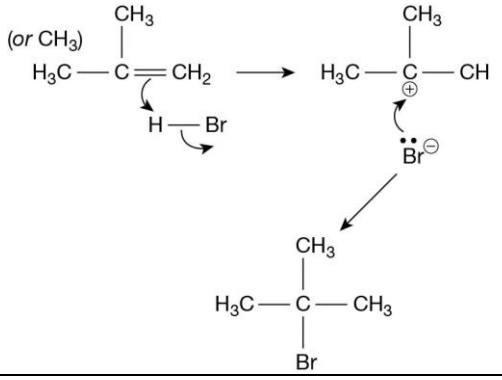
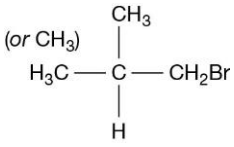
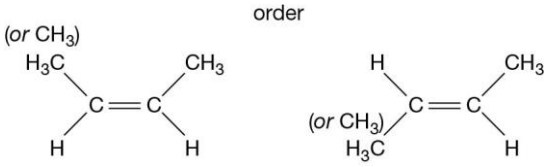
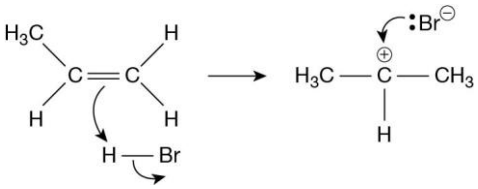
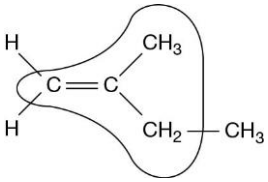
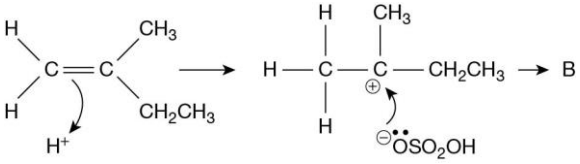
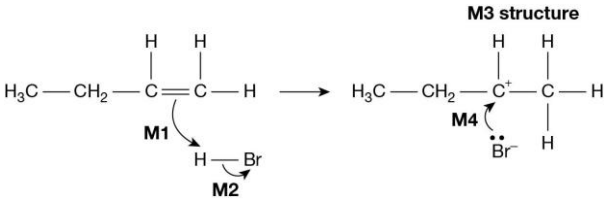
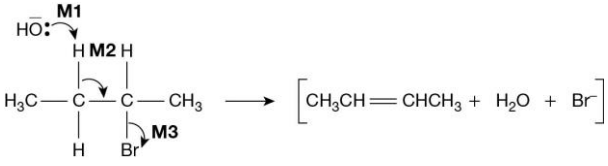
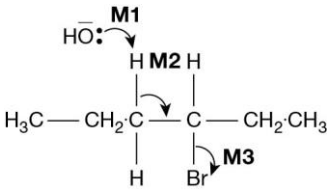
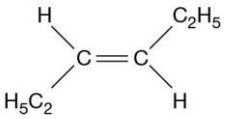
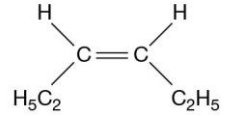
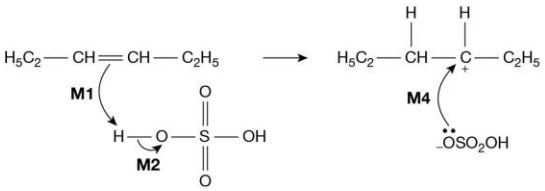
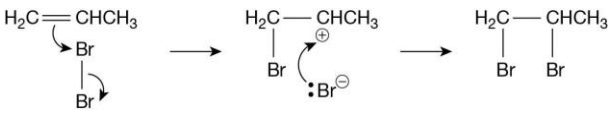
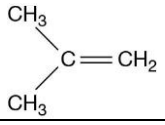
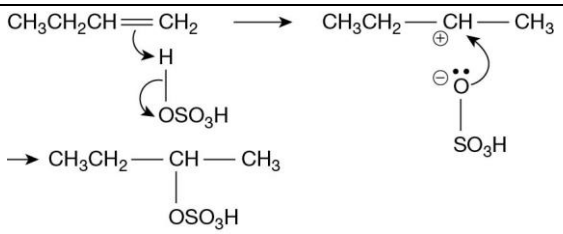
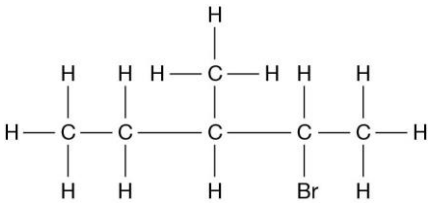
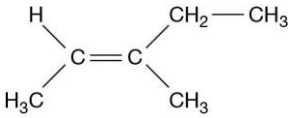
14 Alkenes
Answers to practice questions

Question number	Answer	Marks	Guidance
1 (a)	*molecular formula:* C_4H_8 *empirical formula:* CH_2	1 1	This is a revision of earlier chapters.
1 (b) (i)	*name of mechanism:* electrophilic addition  	1 4	Remember that reactions of alkenes are electrophilic addition. In the mechanism the δ+/δ– is on the HBr. You will not get a mark for this so you can leave them out. However if the δ+/δ– is the wrong way round then you will lose a mark.
1 (b) (ii)	*Structure*:  *explanation*: major product formed via tertiary carbocation *or* minor product formed via primary carbocation primary carbocation less stable than tertiary carbocation	1 1 1	
1 (c)	isomer 1 either order isomer 2  *name: Z*-but-2-ene *name: E*-but-2-ene	2	If the two big groups are on the same side it is *Z*.
2 (a)	curly arrow <u>from lone pair</u> on oxygen of hydroxide ion to H atom on C–H adjacent to C–Br curly arrow <u>from single bond</u> of adjacent C–H <u>to adjacent single bond</u> C–C curly arrow <u>from C–Br bond</u> to side of Br atom	1 1 1	 You can get the last mark here even if you can't get the first two

			right.
3 (a) (i)		4	One mark will be penalised if polarity is included incorrectly, e.g., bond is shown as  or  or δ+/δ– is wrong way round.
3 (a) (ii)	+ $CH_3CH_2CH_2$	1	
4 (a)		1	You may circle the 4 C´s separately
4 (b)		4	The curly arrow goes from the centre of the double bond to the H+ ion. Also you must show the lone pair on the O: and the curly arrow goes from the lone pair to the + ion.
5 (a)	Position(al) (isomerism)	1	
5 (b)	 **M1** must show an arrow from the double bond towards the H atom of the H–Br molecule **M2** must show the breaking of the H–Br bond. **M3** is for the structure of the secondary carbocation. **M4** must show an arrow from the lone pair of electrons on the negatively charged bromide ion towards the positively charged carbon atom of either a primary or secondary carbocation. **NB The arrows here are double-headed**	4	Penalise one mark from <u>their</u> total if half-headed arrows are used M1 Ignore partial negative charge on the double bond. M2 Penalise partial charges on H–Br bond if wrong way and penalise formal charges Penalise M3 if there is a bond drawn to the positive charge Penalise once only in any part of the mechanism for a line and two dots to show a bond <u>Maximum any 3 of 4 marks</u> for wrong reactant or primary carbocation. If Br_2 is used, <u>maximum 2 marks</u> for their mechanism Do not penalise the use of "sticks"
5 (c)		3	Penalise one mark from <u>their</u> total if half-headed arrows are used Penalise M1 if covalent KOH Penalise M3 for formal charge on C of the C-Br or incorrect partial charges on C-Br

	M1 must show an arrow from the lone pair on oxygen of a negatively charged hydroxide ion to a correct H atom **M2** must show an arrow from a C-H bond adjacent to the C-Br bond towards the appropriate C-C bond. Only award if an arrow is shown attacking the H atom of an adjacent C-H (in M1) **M3** is independent provided it is from their original molecule. Award full marks for an E1 mechanism in which M2 is on the correct carbocation. **NB The arrows here are double-headed**		Penalise M3 if an extra arrow is drawn from the Br of the C-Br bond to, for example, K+ Ignore other partial charges Penalise once only in any part of the mechanism for a line and two dots to show a bond. Maximum any 2 of 3 marks for wrong reactant or wrong product (if shown) or a mechanism that leads to but-1-ene Accept the correct use of "sticks" for the molecule except for the C-H being attacked
6 (a) (i)	 **M1** must show an arrow from the lone pair on oxygen of a negatively charged hydroxide ion to the correct H atom **M2** must show an arrow from the correct C-H bond to the correct C-C bond. Only award if an arrow is shown attacking the H atom of the correct C-H bond in **M1** **M3** is independent but **CE=0 if nucleophilic substitution** **N.B these are double- headed arrows**	3	Penalise one mark from their total if half-headed arrows are used Penalise **M3** for formal charge on C of the C-Br or incorrect partial charges on C-Br Ignore other partial charges Penalise once only in any part of the mechanism for a line and two dots to show a bond.
6 (a) (ii)	**M1** E isomer  **M2** Z isomer 	2	Award 1 mark if both correct stereoisomers but in the wrong places Accept no other alkenes. Be reasonably lenient on the bonds to ethyl (or to CH_2CH_3) since the question is about E and Z positions but penalise once only if connection is clearly to the CH_3 of CH_2CH_3 Accept linear structures
6 (a) (iii)	**M1** (Compounds / molecules with) the same structural formula **M2** with atoms/bonds/groups arranged differently in space ***OR*** atoms/bonds/groups that have different spatial	2	Penalise **M1** if "same structure" Ignore references to " same molecular formula" or "same empirical formula" or any reference to "displayed formula" Mark independently

	arrangements / different orientation.		
6 (b)	**M3** Structure  ***M1*** must show an arrow from the double bond towards the H atom of the H – O bond OR HO on a compound with molecular formula for H_2SO_4 M1 could be to an H+ ion and M2 an independent O – H bond break on a compound with molecular formula for H_2SO_4 **M2** must show the breaking of the O ─ H bond. **M3** is for the structure of the carbocation. **M4** must show an arrow from the lone pair of electrons on the correct oxygen of the negatively charged ion towards a correct (positively charged) carbon atom. **NB The arrows here are double-headed**	4	**M1** Ignore partial negative charge on the double bond. **M2** Penalise partial charges on O – H bond if wrong way and penalise formal charges In M2 do not penalise incorrect structures for H_2SO_4 **M4** NOT HSO_4^- For **M4**, credit as shown or —**:**OSO_3H ONLY with the negative charge anywhere on this ion OR <u>correctly</u> drawn out with the negative charge placed correctly on oxygen Penalise once only in any part of the mechanism for a line and two dots to show a bond <u>Max 3 of any 4 marks</u> for wrong organic reactant or wrong organic product (if shown) Accept the correct use of “sticks”
7 (a)	*electrophile:* electron pair / lone pair acceptor or electron-deficient species *addition:* reaction which increases number of substituents or converts a double bond to single bond	1 1	A species can be an atom, molecule or ion, but not a + ion.
7 (b)	*Mechanism:*  *name of product:* 1,2-dibromopropane	4 1	Don’t forget that the curly arrow shows from where the pair of electrons flow, i.e from the middle of the double bond to the δ+ on the Br. Then, the lone pair (which must be shown) on the Br– flows towards the + on the carbon giving the product.
8 (a) (i)	but-1-ene	1	
8 (a) (ii)	two H on one carbon of double bond	1	
8 (a) (iii)	$CH_3CH{=}CHCH_3$	1	

8 (a) (iv)		1	
8 (b) (i)	electrophilic addition	1	Both words are needed.
8 (b) (ii)		1	
8 (b) (iii)	via more stable carbocation which is secondary	1 1	
9 (a) (i)	**3**-bromo-**3**-methylpentane ONLY	1	Must be correct spelling but ignore hyphens and commas
9 (a) (ii)	Electrophilic addition (reaction)	1	Both words needed Accept phonetic spelling
9 (a) (iii)	**M1** Displayed formula of 2-bromo-3-methylpentane  **M2** Position(al) (isomerism)	2	All the bonds must be drawn out but ignore bond angles **Do not forget to award this mark**
9 (a) (iv)	Structure of (E)-3-methylpent-2-ene 	1	The arrangement of groups around the double bond must be clear with the ethyl group attached in the correct order. Ignore bond angles. Accept C_2H_5 for ethyl Be lenient on C ─ C bonds. The main issue here is whether they have drawn an (E) isomer. Accept "sticks" for C ─ H bonds and correct skeletal formula
10	<u>Stage 1</u> Consider the groups to the right hand carbon of	1	

	the C=C bond. Consider the atomic number of the atoms attached. Carbon has a higher atomic number than hydrogen, so CH_2CH_2OH takes priority. <u>Stage 2</u> Consider the groups joined to the left hand carbon of the C+C bond. Both groups contain carbon atoms, so continue to consider atoms further away. The propyl group has a higher priority than the ethyl group. <u>Stage 3</u> The highest priority groups, propyl and CH_2CH_2OH, are on the same side of the C=C bond so the isomer is *z*. The rest of the name is 4-ethylhept-3-en-1-ol	1 1 1 1 1	