11.3 Alkenes

Set B Answer key

A Multiple choice

3 MARKS

1 **B** $(CH_3)_2C{=}CHCH_2CH_2C(CH_3){=}CHCH_2CH_2OH$ [1]

Note: 1° alcohols can be oxidised to carboxylic acids using hot acidified potassium manganate(VII).
Products of oxidation:

A CH_3CO_2H, $CH_3COCH_2CH_2COCH_3$ and $HO_2CCH_2CO_2H$
B CH_3COCH_3, $HO_2CCH_2CH_2COCH_3$ and $HO_2CCH_2CO_2H$
C CH_3COCH_3, $HO_2CCH_2CH_2CO_2H$ and $CH_3CH_2CO_2H$
D CH_3COCH_3, $CH_3COCH_2COCH_3$ and $HO_2CCH_2CO_2H$

2 **C** It gives a diol with cold, alkaline potassium dichromate(VI). [1]

Incorrect: only potassium manganate(VII), not potassium dichromate(VI), can oxidise alkenes.

A Correct. Free radical substitution can occur with any H (not bonded to C=C) on the alkyl chain.
B Correct. Each carbon atom in the C=C has two different groups attached to it.
D Correct. Both benzene and Muscalure are non-polar molecules that can form instantaneous dipole–induced dipole interactions with one another. Muscalure can thus dissolve in benzene and be removed from fly paper.

3 **D** 1,2-dibromopropane [1]

B Structured questions

21 MARKS

4 **(a)** KOH in ethanol, heat [1]

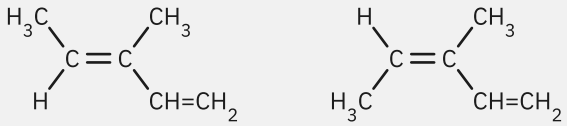
(b) D: $CH_3CH{=}C(CH_3)CH{=}CH_2$ *or* $CH_3CH{=}CHC(CH_3){=}CH_2$ [1]

B: $CH_3CH_2CH(CH_3)CH_2CH_3$ *or* $CH_3CH(CH_3)CH_2CH_2CH_3$ [1]

(c) Any 2 of: $CH_3CHBrCH(CH_3)CHBrCH_3$, $CH_3CH_2CBr(CH_3)CH_2CH_2Br$, $CH_3CHBrCH(CH_3)CH_2CH_2Br$, $CH_3CH_2CBr(CH_3)CHBrCH_3$ [2]

(d)

Condition for cis-trans isomerism to exist: the carbon atoms that are part of the C=C must each have two different groups or atoms bonded to them. Number of stereoisomers = $2^1 = 2$ **[2]** **[1]**



In cyclohexene, only the cis isomer exists (with the alkyl groups on the same side of C=C). There is no trans isomer due to ring strain. The trans isomer could only be formed by breaking the carbon–carbon single bond in cyclohexene. **[1]**

5 **(a)**

The sp^2 hybrid orbitals of each carbon atom of the C=C bond lie in a trigonal plane, while the sp^3 hybrid orbitals of the adjacent carbon atom are arranged tetrahedrally. In the "trans" form, the sp^3 hybrid orbital of one of the adjacent carbon atoms would not be able to overlap head-on effectively with the sp^2 hybrid orbital of the doubly bonded carbon atom to form a C–C σ bond. *or* The trans isomer of cyclohexene, if formed, would experience considerable strain in the ring and would be (energetically) unstable. **[1]**

As such, the trans isomer of cyclohexene does not exist, and cyclohexene cannot exhibit geometrical isomerism. **[1]**

(b)

Regardless of whether cis-hex-3-ene or trans-hex-3-ene reacts with hydrogen bromide, the same carbocation intermediate, $CH_3CH_2CH_2C^+HCH_2CH_3$, is formed. **[1]**

As the positively charged carbon atom is sp^2 hybridised, it is equally probable for the bromide ion to attack from above or below the trigonal plane containing the positively charged carbon atom. This leads to the formation of a pair of enantiomers in a 1 : 1 ratio. **[1]**

(c)

CH_3CH_2COOH and $HOOCCH_2COOH$ **[1]** **[1]**

6 **(a)**

$CH_3CH{=}CH_2 \rightarrow CH_3CH(OSO_3H)CH_3$ (cold, concentrated H_2SO_4) **[1]**

$CH_3CH(OSO_3H)CH_3 \rightarrow CH_3CH(OH)CH_3 + H_2SO_4$ (H_2O, warm) **[1]**

(b)

$CH_3CHClCH_3 \rightarrow CH_3CH{=}CH_2 + NaCl + H_2O$ (NaOH, ethanol, heat) **[1]**

$CH_3CH{=}CH_2 \rightarrow CH_3CHBrCH_2Br$ (Br_2/CCl_4, dark) **[1]**

(c)

$CH_3CH_2CH_2CH_2OH \rightarrow CH_3CH_2CH{=}CH_2$ (excess concentrated H_2SO_4, 170 °C) **[1]**

$CH_3CH_2CH{=}CH_2 \rightarrow CH_3CH_2CH(OSO_3H)CH_3$ (concentrated H_2SO_4, cold), then

$CH_3CH_2CH(OSO_3H)CH_3 \rightarrow CH_3CH_2CH(OH)CH_3 + H_2SO_4$ (H_2O, warm) **[1]**