

Section A

Q1 The products obtained by cracking an alkane, X, are methane, ethene and propene. The mole fraction of ethene in the products is 0.5.

What is the identity of X?

A C_6H_{14}

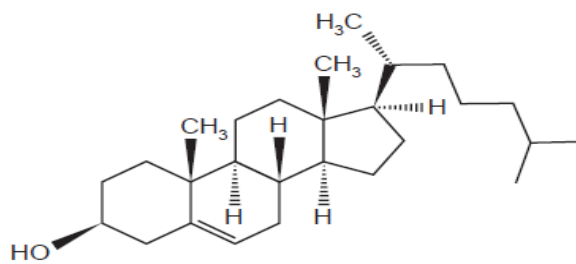
B C_8H_{18}

C C_9H_{20}

D $C_{11}H_{24}$

Q2 This question should be answered by considering the reactions of $KMnO_4$ with different functional groups under the stated conditions.

The diagram shows the structure of the naturally-occurring molecule cholesterol.



cholesterol

Cholesterol is separately treated with

- cold, dilute acidified $KMnO_4$,
- hot, concentrated acidified $KMnO_4$.

What is the change in the number of chiral carbon atoms in the molecule during each reaction?

	cold, dilute acidified $KMnO_4$	hot, concentrated acidified $KMnO_4$
A	+1	0
B	+1	-1
C	+2	0
D	+2	-1

Q3 The depletion of the ozone layer in the upper atmosphere reduces the Earth's natural protection

from harmful ultraviolet radiation.

Which compound would cause the most depletion of the ozone layer?

A CCl_3F

B CF_4

C $CHClF_2$

D CH_2F_2

Q4 Which statement does not correctly describe the polymer PVC?

A Combustion of PVC waste produces a highly acidic gas.

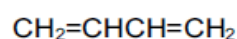
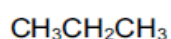
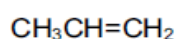
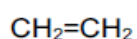
B PVC molecules are saturated.

C The empirical formula of PVC is the same as the empirical formula of its monomer.

D The repeat unit of PVC is $-(CHClCHCl)-$

Q5 Oct-1-ene, $CH_3(CH_2)_5CH=CH_2$, is subjected to thermal cracking.

Which combination of compounds W, X, Y and Z can be obtained?



W

X

Y

Z

A W, X, Y and Z

C W, X and Z only

B W, X and Y only

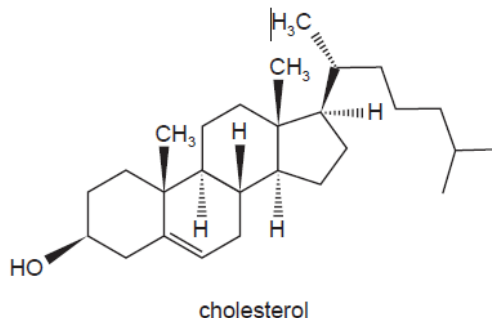
D W and X only

Q6 Bromine reacts with ethene to form 1,2-dibromoethane.
 What is the correct description of the organic intermediate in this reaction?
 A It has a negative charge. B It is a free radical.
 C It is a nucleophile. D It is an electrophile.

Q7 Pentane, C₅H₁₂, is reacted with chlorine in the presence of ultraviolet light. A compound R is found in the products. R has molecular formula C₅H₁₀Cl₂. Each molecule of R contains one chiral carbon atom.
 Which two atoms of the pentane chain could be bonded to chlorine atoms in this isomer?
 A 1 and 3 B 1 and 5 C 2 and 3 D 2 and 4

Q8 Ethene reacts with steam in the presence of sulfuric acid.
 $C_2H_4 + H_2O \rightarrow CH_3CH_2OH$
 What type of reaction is this?
 A acid / base B addition
 C hydrolysis D substitution

Q9 This question should be answered by considering the reactions of KMnO₄ with different functional groups under the stated conditions.
 The diagram shows the structure of the naturally-occurring molecule cholesterol.



Separate oxidation reactions are carried out using different conditions.

- cold, dilute acidified KMnO₄
- hot, concentrated acidified KMnO₄

Which statements about the products formed are correct?

	cold, dilute acidified KMnO ₄ : number of hydroxy groups present	hot, concentrated acidified KMnO ₄ : number of 6-membered rings remaining
A	1	2
B	1	3
C	3	2
D	3	3

Q10 Many different compounds have been used in aerosol sprays, refrigerators and in making foamed plastics.
 Which compound will cause the most ozone depletion?
 A CCl₃F
 B CH₂FCHCl F
 C CH₃CH₂CH₂CH₃
 D N₂O

Q11 A reaction between chlorine and propane in ultraviolet light produces two isomeric monochloropropanes, C_3H_7Cl , as products.

Which information about this reaction is correct?

	type of bond fission in initiation step	expected ratio of 1-chloropropane to 2-chloropropane produced
A	heterolytic	1 : 1
B	heterolytic	3 : 1
C	homolytic	1 : 1
D	homolytic	3 : 1

Q12 Bromine and propene undergo an addition reaction.

Which is a property of the product?

- A It exists in cis-trans isomers.
C It possesses a chiral centre.

- B It is more volatile than propene.
D It possesses hydrogen bonding.

Q13 The cracking of a single hydrocarbon molecule, C_nH_{2n+2} , produces two hydrocarbon molecules only. Each hydrocarbon product contains the same number of carbon atoms in one molecule. Each hydrocarbon product has non-cyclic structural isomers. What is the value of n ?

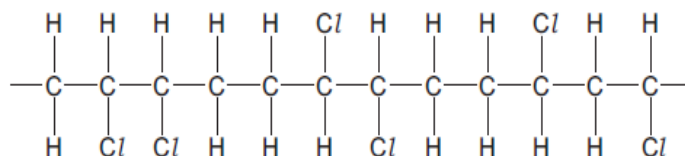
- A 4 B 6 C 8 D 9

Q14 High-energy radiation in the stratosphere produces free-radicals from chlorofluoroalkanes, commonly known as CFCs.

Which free-radical is most likely to result from the irradiation of $CHFCICF_2Cl$?

- A $CHFCIC\dot{C}FCI$
B $\dot{C}HCICF_2Cl$
C $\dot{C}HFCF_2Cl$
D $\dot{C}FCICF_2Cl$

Q15 A molecule of a polymer contained the sequence shown.



Which monomer could produce this polymer by addition polymerisation?

- A $CHCl=CHCl$
B $CH_2=CHCl$
C $CH_3CCl=CHCl$
D $CH_3CCl=CH_2$

Section B

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

Q16 Which alkenes, on reaction with steam at 600 K and 6×10^6 Pa pressure in the presence of a phosphoric acid catalyst, could produce an alcohol containing a chiral carbon atom?

- 1 $(\text{CH}_3)_2\text{C}=\text{CH}_2$
- 2 $\text{CH}_3\text{CH}=\text{CHCH}_3$
- 3 $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$

Q17 Which statements about the photochemical chlorination of ethane are correct?

- 1 Hydrogen gas is one of the products.
- 2 A propagation step in the mechanism is $\text{C}_2\text{H}_6 + \text{Cl} \cdot \rightarrow \text{C}_2\text{H}_5 \cdot + \text{HCl}$.
- 3 The initiation step is the homolytic fission of chlorine.

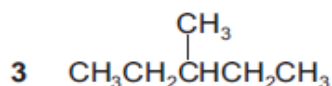
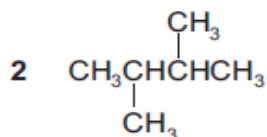
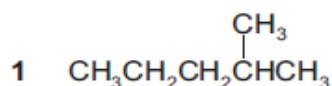
Q18 Which molecules would be present in the mixture produced by the photochemical chlorination of methane?

- 1 hydrogen
- 2 hydrogen chloride
- 3 dichloromethane

Q19 Which are properties of fluoroalkanes?

- 1 They are less reactive than the corresponding chloroalkanes.
- 2 They are non-flammable.
- 3 The C–F bond is stronger than the C–Cl bond.

Q20 During the bromination of methane, the free radical $\text{CH}_3 \cdot$ is generated. A possible terminating step of this reaction is the formation of C_2H_6 by the combination of two free radicals. What could be produced in a terminating step during the bromination of propane?



Q21 Which reagents and conditions will convert propane into 1-chloropropane?

- 1 Cl_2 and sunlight
- 2 conc. HCl, reflux
- 3 PCl_5

1. B
2. D
3. A
4. D
5. A
6. D
7. A
8. B
9. C
10. A
11. D
12. C
13. C
14. C
15. B
16. C
17. C
18. C
19. A
20. B
21. D

Q1 Crude oil contains a mixture of hydrocarbons together with other organic compounds which may contain nitrogen, oxygen or sulfur in their molecules.

At an oil refinery, after the fractional distillation of crude oil, a number of other processes may be used including 'cracking', 'isomerisation', and 'reforming'.

(a) (i) What is meant by the term '*cracking*' and why is it carried out?

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.....

(ii) Outline briefly how the cracking of hydrocarbons would be carried out.

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(iii) Construct a balanced equation for the formation of heptane, C₇H₁₆, by cracking tetradecane, C₁₄H₃₀.

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(June 2011 P21)

Q2 Halogenoalkanes have been widely used as aerosol propellants, refrigerants and solvents for many years.

Fluoroethane, CH₃CH₂F, has been used as a refrigerant. It may be made by reacting ethene with hydrogen fluoride.

You are to calculate a value for the C–F bond energy in fluoroethane.

(a) Use relevant bond energies from the *Data Booklet*, and the equation below to calculate a value for the bond energy of the C–F bond.



(b) Another halogenoalkane which was used as a refrigerant, and also as an aerosol propellant, is dichlorodifluoromethane, CCl₂F₂.

State **two** reasons why compounds such as CH₃CH₂F and CCl₂F₂ have been used as aerosol propellants and refrigerants.

.....

.....

CCl₂F₂ is one of many chlorofluorocarbon compounds responsible for damage to the ozone layer in the stratosphere.

(c) By using relevant data from the *Data Booklet*, and your answer to **(a)** suggest why CCl₂F₂ is responsible for damage to the ozone layer in the stratosphere whereas CH₃CH₂F is not.

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.....

Both $\text{CH}_3\text{CH}_2\text{F}$ and CCl_2F_2 are greenhouse gases.

The 'enhanced greenhouse effect' is of great concern to the international community.

(d) (i) What is meant by the term *enhanced greenhouse effect*?

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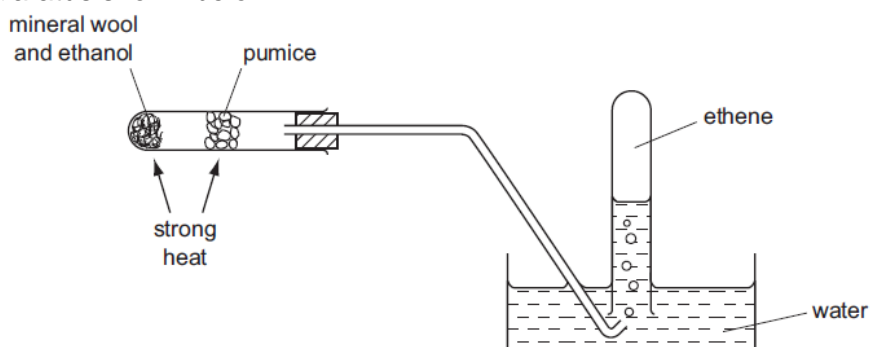
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(ii) Water vapour is the most abundant greenhouse gas.

What is the second most abundant greenhouse gas?

(June 2011 P22)

Q3 One method of preparing ethene in a school or college laboratory is from ethanol by using the apparatus shown below.



(a) (i) Write a balanced equation for this reaction.

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(ii) What *type of reaction* is this?

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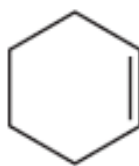
(iii) Give the chemical name of a reagent other than pumice that could be used to carry out this reaction. It is not necessary to use the same apparatus.

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(b) Ethene is bubbled into two separate test-tubes, one containing aqueous hydrogen bromide and the other containing cold, dilute acidified potassium manganate(VII). In **each** case, describe any colour changes you would see and give the structural formula of the organic product.

	aqueous hydrogen bromide	cold, dilute acidified potassium manganate(VII)
colour at start		
colour after reaction		
structural formula of organic product		

(c) Cyclohexene has the following structural formula.



(i) What is the molecular formula of cyclohexene?.....

(ii) Draw the structural formula of the compound formed when cyclohexene is reacted with bromine.

(iii) State as fully as you can what *type of reaction* this is.

.....
(iv) Draw the structural formula of the compound formed when cyclohexene is reacted with hot concentrated acidified potassium manganate(VII).

(June 2012 P21)

Q4 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.

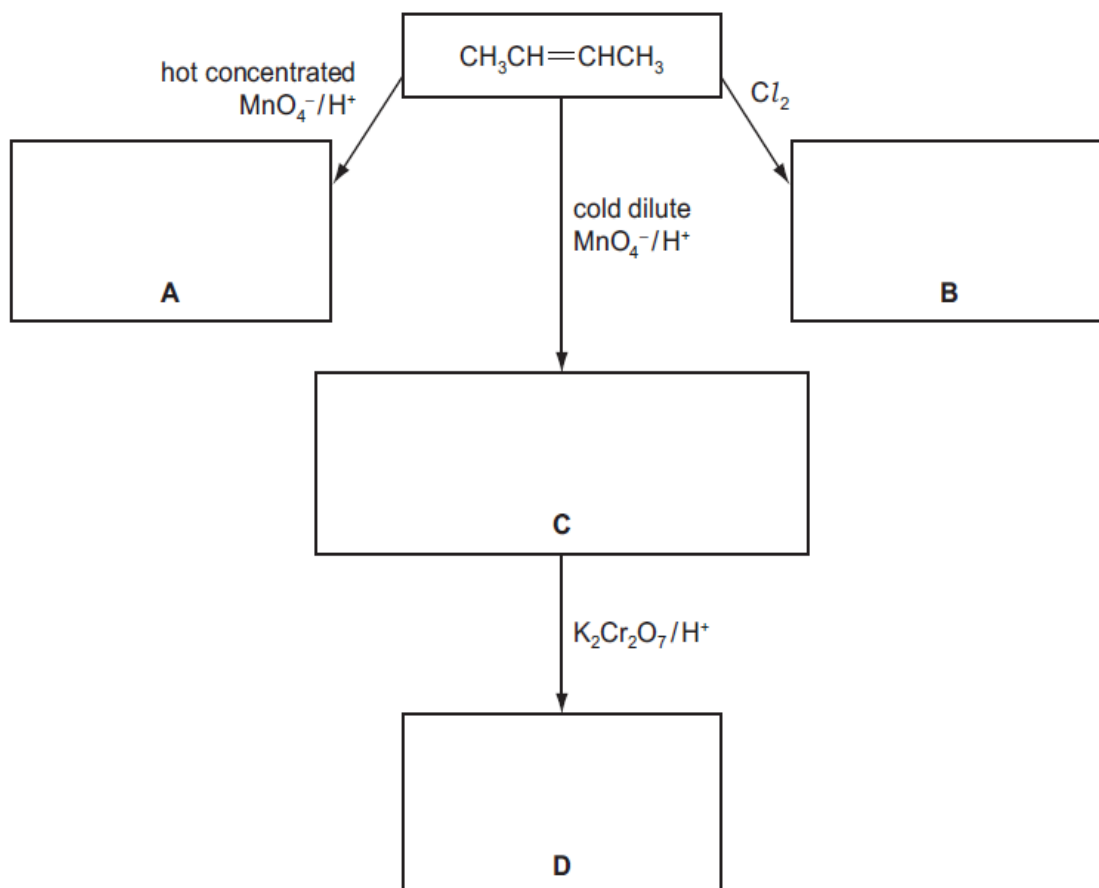
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(b) Dodecane, $\text{C}_{12}\text{H}_{26}$, is a long chain hydrocarbon which is present in crude oil and which can be cracked to form but-2-ene and an alkane.

Write a balanced equation for this reaction.

.....
(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**.



(d) (i) Draw the **skeletal** formula of compound **D**.

(ii) By using the letters **A** to **D** as appropriate, identify those compounds which are chiral. If there are none, write 'none'.

(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.

(f) Compound **C** is a liquid which can be reacted with concentrated sulfuric acid to give a gas, **E**, which will decolourise aqueous bromine when passed through it. Suggest the **structural** formula of **E**.

(ii) Suggest the **structural** formula of the product of the reaction between **E** and an excess of bromine.

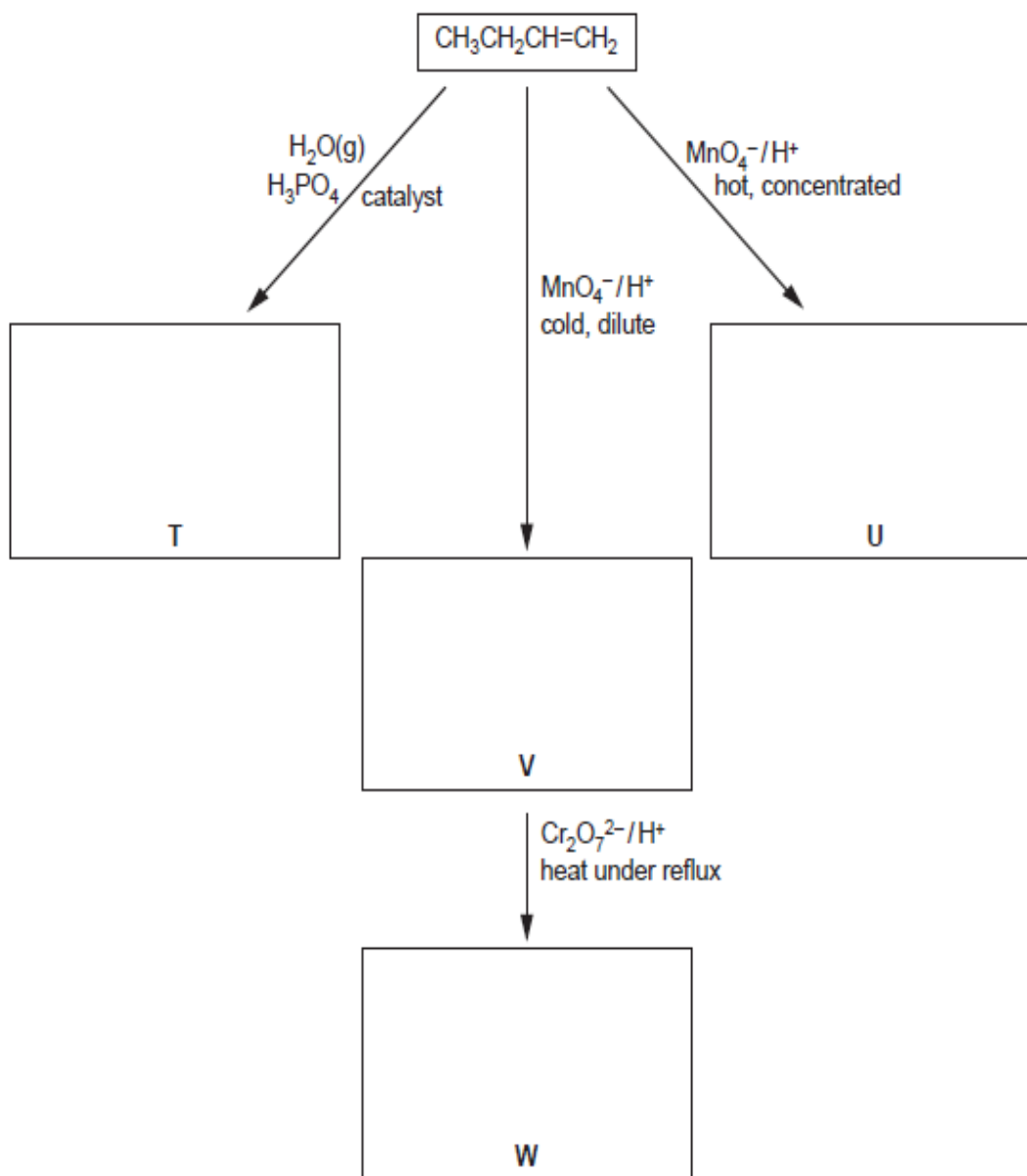
(iii) What *type of reaction* occurs between **E** and an excess of bromine?.....

(June 2012 P21)

Q5 But-1-ene, $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$, is an important compound in the petrochemical industry.

(a) Some reactions of but-1-ene are given below.

In **each** empty box, draw the structural formula of the organic compound formed.



(Nov 2011 P21)