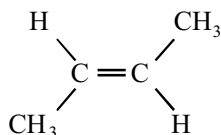
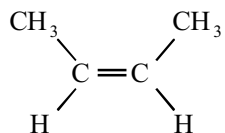


1. (a) (i)

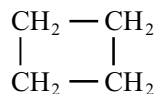
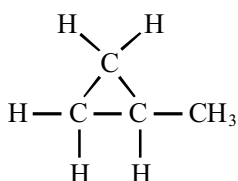
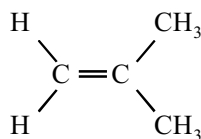
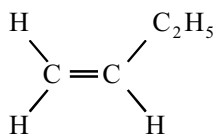


2

(ii) No rotation / restricted rotation around double bond(1)

1

(b) (i)



1

(ii) One end of C=C bond has 2 identical atoms / groups attached (1)

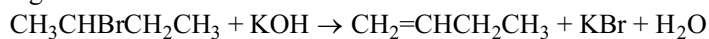
Or if cyclobutane –
no movement / no C=C (1)

1

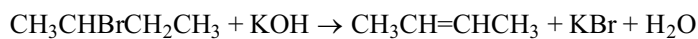
[5]

2. (a) (i)

e.g.



Or



(1)

allow ionic equation with OH^- and Br^-

1

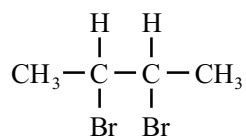
(ii) Elimination (1)

1

(b) (i) brown / red-brown / orange / red-orange / yellow to colourless / fades / decolourises / gets paler (1)

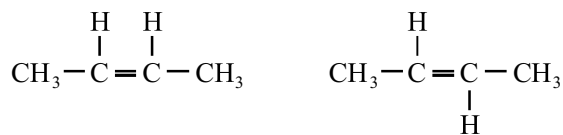
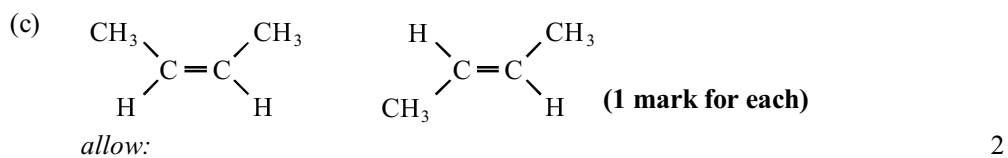
1

(ii)



2,3-dibromobutane (1) accept 3-bromobutan-2-ol if correct
structure drawn for hydroxy product

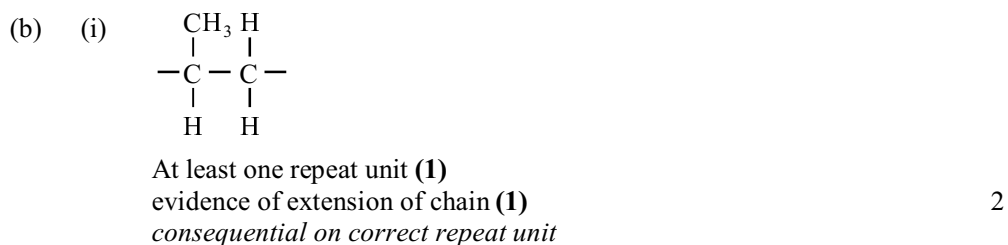
2



- (ii) Restricted (or 'no') rotation about double bond /
2 different groups at each end of double bond **(1)**
geometrical / cis-trans **(1)** 2

[9]

3. (a) Group of compounds with the same general
formula **(1)** that
differ by $-\text{CH}_2-$ **(1)**
Same or similar **chemical** properties / same
functional group **(1)** 3



- (ii) CH_2 **(1)**
empirical formula of propene/ the repeat unit **(1)**
since polymer made by addition reaction / no loss of
small molecules **(1)** 3

- (c) Different chain lengths / areas of crystalline and amorphous structure **(1)** 1

- (d) (i) C-F bond strong / high bond enthalpy / bond not
easily broken / steric hindrance by fluorine around carbon **(1)** 1

- (ii) Non-stick coatings e.g. in saucepans, in pipes, on skis,
stain-proofing of fabrics, waterproof clothing. **(1)** 1

- (e) **Only** single / sigma bonds in ethane (1)
 Ethene **also** has π bond (1)
 π bond weaker (and breaks) / electrons in π bond
 more accessible (1) 3
- [14]**
4. (a) It is a mixture / not a single compound 1
- (b) (i) 2,4-dimethylpentane 1
 (ii) C_7H_{16} 1
 (iii) More volatile / lower boiling point / vaporises more readily / branched so
 doesn't knock / higher octane number 1
 (iv) Heat / high temperature / ≥ 200 °C (1)
 Silica / alumina (catalyst) / zeolites (1) 2
 (v) *Diagram should show:*
 Test tube containing paraffin absorbed on suitable absorbent – (1)
absorbent can be just shown in the diagram
 Aluminium oxide catalyst (1)
 Heat catalyst (1)
 Recognition of collection of gas over water / gas syringe (1) 4
Penalties
 –1 for poor diagram
- (c) (i) $(CH_3)_2C = CH_2$
ACCEPT $(CH_3)_2CCH_2$ 1
 (ii) Elimination 1
 (iii) Potassium hydroxide / KOH / NAQH (1)
 Ethanolic / alcoholic solution + heat / reflux (1) 2
- [14]**
5. (a) (i) $C_2H_6 + Br_2 \rightarrow C_2H_5Br + HBr$ (1)
 $C_2H_4 + Br_2 \rightarrow CH_2BrCH_2Br$ *ALLOW* $C_2H_4Br_2$ (1) 2
IGNORE STATE SYMBOLS
- (ii) (Free) radical / homolytic (1) substitution (1)
 Electrophilic (1) addition (1) 4

- (b) (i)
$$\left(\begin{array}{cc} \text{H} & \text{H} \\ | & | \\ -\text{C} & - & \text{C}- \\ | & | \\ \text{H} & \text{Cl} \end{array} \right)_n$$
 1
- (ii)

Water pipes window or door frames clothing bottles coating on electrical cables flooring NOT plastic / PVC / carrier bags	Any one	1
--	----------------	---
- (iii) Persists in the environment / persisting as litter
 OR non-biodegradable / not broken down by bacteria (1)
 because of strong C-Cl bond (1)
 OR
 combustion / burning (1)
 produces toxic gases /acidic gases/HCl (1)
NOT chlorine 2
- [10]**
6. (a) • A species with a lone pair / pair of electrons (1)
NOT “negative ion” alone or as an alternative
 • which it uses / donates to form a (dative) covalent bond (1) 2
- (b) (i) • Ammonia / NH₃ (in ethanol) (1)
 • heat (1) **NOT** heat under reflux *UNLESS* in a sealed tube
If a temperature is quoted it must be greater than 100°C
 • in sealed tube / under pressure / concentrated (1)
If a pressure is quoted it must be greater than 1 atm
 Conditions are dependent on correct reagent.
 If ammonia and an additional reagent **max (1)** for two correct conditions. 3

- (ii) Carbon-bromine bond stronger / higher bond enthalpy than carbon – iodine / E_a for C-Br is higher than C-I
IGNORE any extra explanations involving the alkyl groups

1

- (c) Identify bonds broken **and** made (1)

e.g. Energy in + 464 or + 3340

AND Energy out (-) 656 or (-) 3532 (1)

Energy needed to break bonds – energy released to make bonds = 36 (1)

e.g. C-I + 464 – 656 = + 36

or C-I + 3340 – 3532 = + 36 (1)

Correct evaluation dependent on use of 36 (1)

i.e. C-I = 228 kJ mol⁻¹ (1)

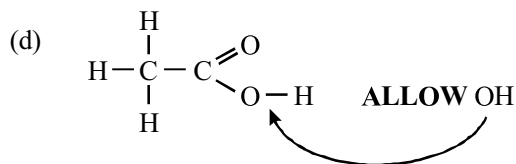
Correct answer with some correct working (3)

If final answer is negative max (2)

If 36 is on the wrong side, then 156 max 2 (-156 (1))

If miss out 36, then ±192 **max 1**

3



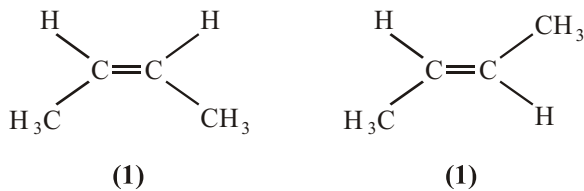
1

[10]

7. (a) (i) 1,2-dichloroethane 1
 (ii) CH₂ = CHCl / CH₂CHCl 1
 (iii) e.g. dissolve / bubble HCl in water / absorb in an alkali / condense the HCl(g) 1
 (b) (i) Species having unpaired electron 1
 (ii) Action of UV radiation/sunlight / named initiator / photoflood 1

- (c) (i) Water / OH⁻ 1
(ii) Unshared / lone pair of electrons on a legitimate nucleophile based on (c)(i) **(1)**
(c)(i) "nucleophile" attacks / forms bond with C of C – Cl **(1)** 2
(iii) Chloride ion / Cl⁻ 1
(iv) Add silver nitrate solution **(1)**
white ppt **(1)** 2
- [11]**
8. (a) (i) a particle / species /group with an unpaired electron /OWTTE 1
(ii) $\begin{matrix} ++ \\ +\text{Cl}+ \\ ++ \end{matrix}$ 1
(iii) homolytic 1
- (b) B and C 1
- (c) (i) $\text{C}_1_2 + \text{CH}_4 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$ 1
(ii) $+242 + 4 + -339 = -93 \text{ kJ mol}^{-1}$
(A + B + F)
OR
 $+4 - 97 = -93 \text{ kJ mol}^{-1}$
(B + C)
Method **(1)**
answer with units **(1)** 2
- (d) (i) -242 kJ mol^{-1} 1
(ii) Exothermic because a bond has been formed. 1
- (e) Less endothermic **(1)**
the bond is weaker **(1)** 2
- [11]**
9. (a) (i) $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$ **(1)** 1
(ii) UV (radiation) / Sunlight **(1)** Not light 1

(b) (i)



2

(ii) restricted rotation around double bond (1)

Allow no rotation at room temperature

two different groups on each double bonded carbon (1)

2

(iii) 2,3-dichlorobutane (1)

1

[7]10. (a) (i) $C_2H_6(g)/(l) \rightarrow C_2H_4(g) + H_2(g)$ *If a state symbol is missing (0)*

If (aq) (0)

1

(ii) At high pressure reaction goes in direction to reduce pressure/to oppose change by Le Chatelier's principle (1)
towards side with fewer molecules/moles (1)

2

(b) Shapes of orbitals between and above carbon

*If p orbitals drawn must show overlapping*Shapes (1) ACCEPT crescents for π bonds NOT lines for σ bond

2

Labels (1)

(c) Addition of bromine **water/solution** (1)from yellow/brown/orange to **colourless** (1)*OR***acidified** potassium manganate(VII) (1)from pink/purple to **colourless** (1)

2

(d) Addition (1)

Electrophilic/electrophile *OR* appropriate *explanation* (1)

2

[9]

11. (a) H₂ / hydrogen *NOT* H (1)
 Ni / nickel
 OR platinum / Pt / palladium / Pd (1)
 (Ni) 140 – 180 ° C / heat (1) 3
 OR (Pt / Pd) room temperature
 If no reagent but other parts correct (1)
 Incorrect reagent (0)

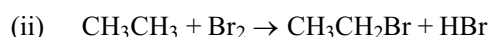
- (b) (i)
- $$\begin{array}{cccc}
 & \text{H} & \text{H} & \text{H} & \text{H} \\
 & | & | & | & | \\
 \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} - \text{H} \\
 & | & | & | & | \\
 & \text{H} & \text{H} & \text{Br} & \text{H}
 \end{array}$$
- (ii) electrophile / electrophilic *IGNORE any reference to addition* 1

- (c) potassium manganate(VII) / potassium permanganate / MnO₄⁻ / manganate(VII) ions *IGNORE acid or alkali* 1
ACCEPT name or formula

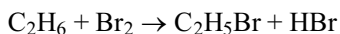
- (d)
- $$\begin{array}{cc}
 \text{H} & \text{C}_2\text{H}_5 \\
 | & | \\
 - \text{C} & - \text{C} - \\
 | & | \\
 \text{H} & \text{H}
 \end{array}$$
- Correct structure (1) – *only one repeat until identified*
 Continuation (1)
IGNORE ()_n 2

[8]

12. (a) (i) (Free) radical
ACCEPT homolytic radical
NOT radical ion 1



OR

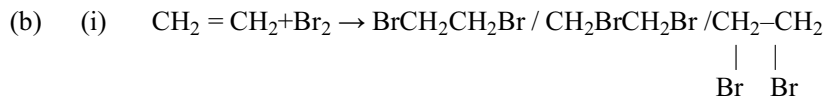


ACCEPT multiple substitution only if the equation balances

Can be full structural formula

If H_2 is one product then (0)

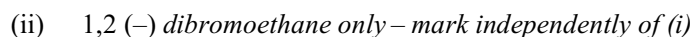
1



Ethene shown with double bond + Br_2 (1)

product (1)

2



IGNORE punctuation

1

QWC (c) Ethene has a π / double bond (1)

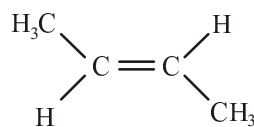
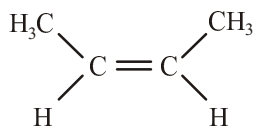
Ethane has σ only / single only / no π / no double bond (1)

π (in ethene) weaker than C–H (in ethane) / high electron density in C=C relative to C–H bond (1)

3

[8]

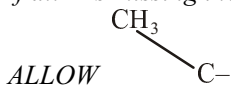
13. (a) (i)



Can show C in straight line if H's clearly cis or trans.

If H is missing once but bond is shown, no penalty.

If all H's missing then (1) only awarded for both structures



2

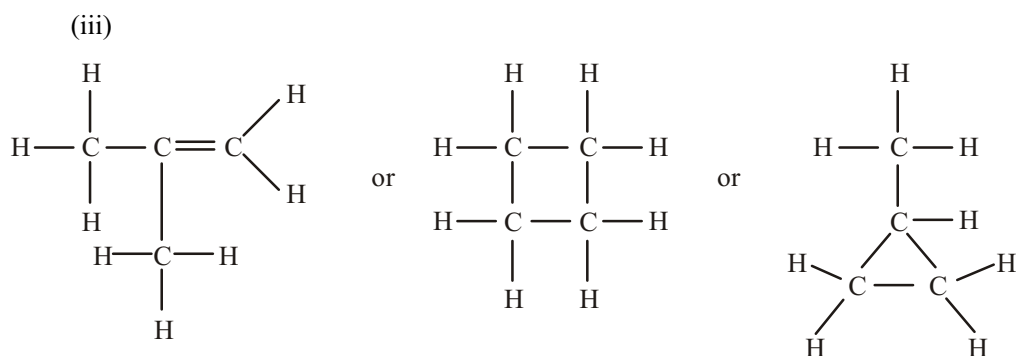
(ii) (Both have) no/restricted rotation about C=C (rotation would require π bond to break) (1)

but but-1-ene has two identical groups on a doubly bonded carbon atom (1)

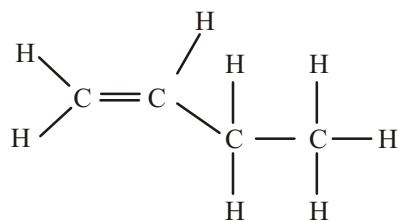
but-2-ene does not (1)

OR other way round

3



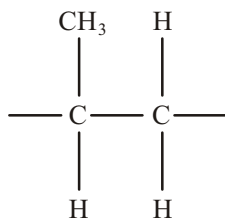
ALLOW



Do not need to show all bonds eg can be $-\text{CH}_3$, $-\text{C}_2\text{H}_5$

1

(b) (i)



Skeleton (1)

Indication of continuation conditional on a two carbon saturated chain in the skeleton. (1)

2

(ii) Unreactive *OR* non-biodegradable (1)

So occupies / fills site *OR* remains in the site *OR* causes visual pollution (1)

2^{nd} mark consequential on 1^{st}

NOT "Do not decompose/decay" for 1^{st} mark but allow 2^{nd} mark

2

[10]

14. (a) Alkene

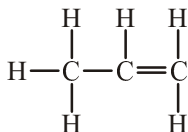
1

- (b) $\text{CH}_2=\text{CHCH}_2\text{CH}_3$ / $\text{CH}_3\text{CH}=\text{CHCH}_3$ / $\text{CH}_2=\text{C}(\text{CH}_3)_2$ / $\text{CH}_2=\text{C}(\text{CH}_3)\text{CH}_3$
 double bond need not be shown
 ACCEPT displayed formula
 Mark independently of a
 Watch for incorrect numbers of H in the middle of the chain

1

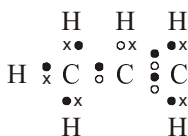
[2]

15. (i)



1

(ii)



ALLOW all dots or crosses

ALLOW TE for a butene/pentene in (a)(i)

IGNORE circle

1

[2]

16. $(\text{CH}_3)_2\text{C}=\text{CH}_2$

ALLOW displayed formula (1)

ALLOW $\text{C}(\text{CH}_3)_2=\text{CH}_2$ $\text{CH}_3\text{C}(\text{CH}_3)=\text{CH}_2$ $\text{CH}_3\text{CCH}_3=\text{CH}_2$ $\text{CCH}_3\text{CH}_3=\text{CH}_2$ $\text{CH}_3\text{CH}_3\text{C}=\text{CH}_2$ double bond need **not** be shown, but if **single** bond displayed (0)

(2-)methylpropene

2 - methylprop - 1 - ene

2 - methylprop - 2 - ene

} IGNORE punctuation, spaces etc

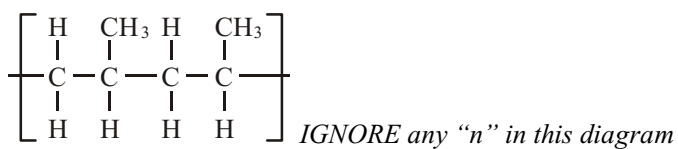
Mark independently

No transferred error allowed

2

[2]

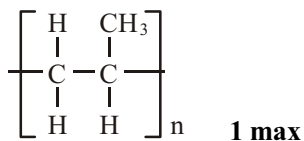
17. (a) (i) 2(-)chloropropane
- $$\begin{array}{c}
 \text{H} \quad \text{Cl} \quad \text{H} \\
 | \quad | \quad | \\
 \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\
 | \quad | \quad | \\
 \text{H} \quad \text{H} \quad \text{H}
 \end{array}$$
- No internal TE from name to structure*
MUST be fully displayed 2
- (ii)
- IGNORE* rest of molecule
- $$\begin{array}{c}
 \text{(1)} \\
 | \delta^+ (\delta^-) \\
 -\text{C}-\text{Cl} \\
 | \\
 \text{(1)} \\
 \text{:OH}^-
 \end{array}$$
- Mark independently
 Must attack the carbon
 ALLOW attack by oxygen or negative charge or lone pair 2
- ACCEPT* OH^- *NOT* OH^-
NOT C^+
- (b) (i) Elimination
NOT in conjunction with additional incorrect information
 eg “nucleophile” 1
- (ii) Sodium hydroxide / NaOH/potassium hydroxide / KOH (1)
Any additional incorrect reagent (0)
NOT alkali on its own for 1st mark
 Alcoholic solution / ethanolic solution **and** heat / warm / reflux (1)
 2nd mark is dependent on mention of correct reagent or “alkali”
 “aqueous” negates 2nd mark eg KOH(aq) + heat (1) – ie reagent mark
 NaOH(alc) + heat (2) 2
- (c) (i) Hydrogen/H bonding 1
- (ii)
- $$\begin{array}{c}
 \text{CH}_3 \quad \quad \quad \text{CH}_3 \\
 | \quad \quad \quad | \\
 \text{CH}_3\text{C}-\text{O}-\text{H} \cdots \text{O}-\text{CHCH}_3 \\
 | \quad \quad \quad | \\
 \text{H} \quad \quad \quad \text{H}
 \end{array}$$
- H-bond and rest of molecule (1)*
angle must be between 3 atoms for a correct H bond (1)
 ALLOW HOH 106-108° 2
- (d) (i)



Brackets optional but continuation must be shown

4 carbon chain with 6Cs overall in structure (1)

methyl groups can be on C₁ and C₃, C₁ and C₄, C₂ and C₄, C₂ and C₃ (1)



2

- (ii) (big molecule) so large number of electrons (1)

Hence **large/strong van der Waals'** forces

(to be overcome to change state)(1)

2

[14]

18. (a) (i) (2-methylbut-1,3-diene)
~~M P P m P P H N M P m P N~~
 (1) (1)

IGNORE punctuation

ALLOW 1 max if correct answer is pre-fixed by cis / trans

2

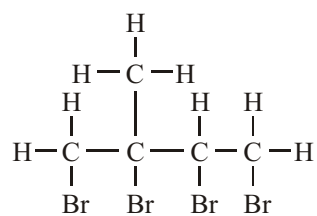
- (ii) From orange/yellow/brown to colourless (1)
 NOT red NOT clear

1

- (iii) addition (1)
 electrophilic (1)
 in either order

2

- (iv)



Methyl group need not be displayed

1

- (b) (i) Van der Waals' (forces)
 ACCEPT Van der Walls
 NOT vdw

1

- (ii) Q because (unbranched) so greater area of **contact / closer packing**
 (between molecules) (1)

hence greater Van der Waals/vdw forces (1)

2nd mark dependent on 1st

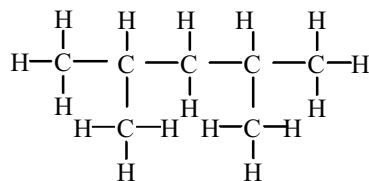
Incorrect isomer chosen (0)

Fully correct reverse argument (2)

2

[9]

19. (a) (i)

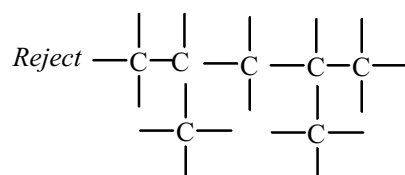
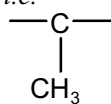


1

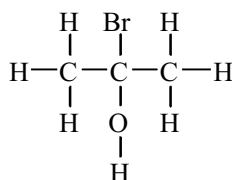
Accept CH₃ in branches

But do not allow bond directly to H

i.e.

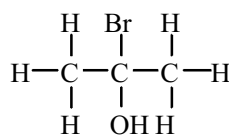


(ii)

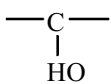


1

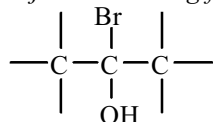
Accept



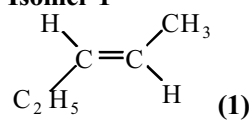
Reject bond pointing directly to H i.e.
in OH i.e.



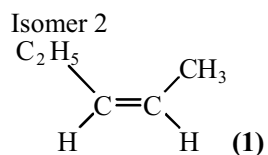
Reject Hs missing from carbons i.e.



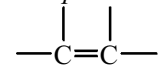
(b) **Isomer 1**



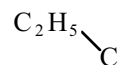
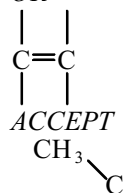
(1)



Accept 90° bond angles e.g



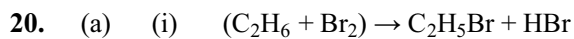
OR



If incorrect alkene eg but-2-ene, allow (1) for both cis and trans isomers

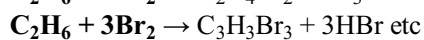
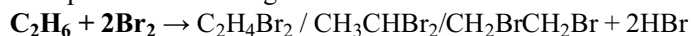
2

[4]



OR

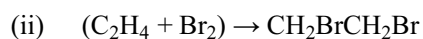
multiple substitution e.g.



1

Accept $\text{CH}_3\text{C H}_2\text{Br}$ or full structural formula

Reject $\text{C}_2\text{H}_6 + 3\text{Br}_2 \rightarrow 2\text{C} + 6\text{HBr}$



1

Reject $\text{C}_2\text{H}_4\text{Br}_2$

- (b) (i) ethane C–H bond **and** ethene C=C bond (1)
 ALLOW carbon–carbon if double in type of bond
 ethane type: σ /sigma **and** ethene type: π /pi (1)
 OR mark horizontally

2

Reject σ and π for ethene

(ii) π /pi bond is weaker (than the σ /sigma bond) 1

Accept π /pi bond requires less energy to break

OR

π /pi bond has lower bond enthalpy

Reject π breaks more easily

Reject π bond is weak

OR

π /pi bond has higher electron density (than the σ /sigma bond)

Accept π /pi bond has more accessible electron density

[5]

21. (a) (i) 2,2,4-trimethylpentane 1
Ignore punctuation (Commas and hyphens may be interchanged)

Accept 2,4,4 - trimethylpentane

Reject pentan for pentane

2-dimethyl-4

methylpentane

2,2-dimethyl-4-methyl

pentane

2-methyl-4,4-dimethyl

pentane

2,4-trimethylpentane

(ii) C_4H_9 1

Accept $C_8H_{18} \rightarrow C_4H_9$

(iii) C_2H_4 1

Reject CH_2CH_2

(iv) Positive because energy is required to break (C-C) bonds
(and not completely replaced (from new bonds made))
OR Positive because cracking requires (continuous) supply of
heat so must be endothermic 1

Accept two C-C bonds are broken and one C=C made

Reject positive because it only occurs at high temperature

- (v) $C_8H_{18} + 17/2 O_2 \rightarrow 8CO + 9H_2O$
 OR $2C_8H_{18} + 17 O_2 \rightarrow 16CO + 18H_2O$
 OR $C_8H_{18} + 9/2 O_2 \rightarrow 8C + 9H_2O$ (or doubled)
 Oxygen on left and correct formulae of products (1)
 balancing (1)
 Second mark depends on first and a sensible hydrocarbon formula must be used. 2
- Accept balanced equations including CO and/or C with CO₂
 17/2 can be written 8.5 or 8½
 Allow balanced equations based on C₈H₁₈ with a smaller alkane in the products for 1 mark eg
 C₈H₁₈ + O₂ → CO + C₇H₁₆ + H₂O (1)*
- (b) (i) Increase in pressure: No effect as number of moles/molecules (of gas) doesn't change during reaction (1)
 Increase in temperature: **more NO** as forward reaction endothermic OWTTE (1)
 One mark for two correct predictions with incorrect explanations 2
Reject increase in temperature moves equilibrium to the right
- (ii) Rate increases as converter gets hotter (as reaction is exothermic) 1
- (iii) N₂ / nitrogen is (major) part of air/ N₂ unreactive/ not poisonous/ not a greenhouse gas / not acidic 1
Accept correct harmful properties of other 3 gases
- (iv) Line from level of reactants to maximum labelled E_A (1)
 Curve of similar shape above existing curve, starting and finishing at same levels, with maximum above original maximum (1) 2
- [12]**
22. (a) (i) A and/or propene 1
*Accept prop-1-ene
 Reject A and any other letter*

- (ii) B C and D (any order)
 3 correct for **2 marks**
 2 correct for **1 mark**
 1 letter, correct or incorrect O eg B
 2 letters both correct 1 BC
 2 letters 1 correct 1 wrong O BE
 3 letters, all correct 2 BCD
 3 letters, 2 correct 1 wrong 1 BCE
 3 letters, 1 correct 2 wrong O ABE
 4 letters, 3 correct 1 wrong 1 BCDE
 4 letters, 2 correct 2 wrong O ABDE
 5 letters O ABCDE 2
- (b) (i) 2-bromopropane 2 (-) bromo (-) propane
 2 Bromo Propane 2, bromopropane 1

Reject bromopropane
Reject bromo-2-propane
Reject 2-bromopropene
- (ii) poly(propene) or polypropene 1

Accept polly(propene)
Accept polypropylene

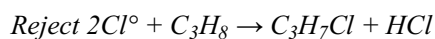
Reject poly porpene
Reject polypropane
- (c) (i) potassium/sodium hydroxide (**1**)
 (concentrated)
 ethanol(ic)/alcoholic AND heat/reflux 2

Accept KOH/NaOH
Reject alkali on its own
Reject any mention of water/aqueous/pressure (-1)
- (ii) Elimination (reaction) 1

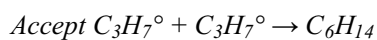
*Reject any qualification of elimination e.g nucleophilic /
 electrophilic cracking*
- (d) (i) $\text{Cl}_2 \rightarrow 2\text{Cl}^\bullet$
 Ignore state symbols 1

Reject not 2 Cl(g)
Reject $\text{Cl}_2 \rightarrow 2\text{Cl}$

- (ii) $C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$
Ignore state symbols 1



- (iii) 2 (,) 3 (-)dimethyl butane (1) Ignore punctuation
Reaction between two
 $CH_3-CH-CH_3$ (1) dot must be shown on central
carbon atom
Termination (1) 3



Accept chain termination

Reject 2,3 methylbutane

Reject $CH_3CHCH_3^\circ$

[13]

23. (a) (i) Amount of $CO_2 = \frac{53}{24000}$
= 0.0022 (mol)

Accept 0.002 with working

$$\text{Amount of } H_2O = \frac{0.020}{18}$$

= 0.0011 (mol) 3

Amount of C = 0.0022 mol = 0.0265(g)

Amount of H = 0.0022 mol = 0.0022(g)

Any one of above needed for 1st mark (1)

Mass of O in Z = 0.0714 (g)

OR amount of O in Z = 0.0045 (mol)

Some clear indication they have done it correctly (1)

Empirical formula CHO_2 (1)

- (ii) $(CHO_2)_y = (12 + 1 + 2 \times 16)y = 90$
Y = 2
Molecular formula $C_2H_2O_4$
Allow TE from (i)
Allow $C_2H_2O_4$ with no working
Allow any indication they know how to do it
eg 'n × empirical mass = molar mass' 1

Reject $C_4H_{10}O$ only (no connection with (i))

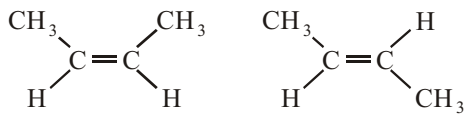
- (iii) (0.01 mol **Z** contain $\frac{20.0 \times 1.00}{1000} = 0.02$ (mol) **(1)**
 Accept formula alone for **Z**
- CO₂H
 |
 CO₂H **(1)** 2
 Accept fully/partially displayed formula
- (iv) **W** CH₂=CH₂ **(1)**
X CH₂BrCH₂Br **(1)**
Y CH₂OHCH₂OH **(1)**
 Look out for TE and internal TE
 Eg **W** CH₃CHCH₂
X CH₃CHBrCH₃
Y CH₃CHOHCH₃
 is worth **1 max** 3
 Accept full credit for consistent answers based on other gaseous alkenes eg CH₃CHOHCH₂OH etc
- (v) C₂₀H₄₂ → C₁₈H₃₈ + C₂H₄ **(1)**
 Allow C₁₇H₃₆ + C₃H₆ OR C₁₆H₃₄ + C₄H₈ 1
 Accept TE for **W**
 Accept any balanced equation including ethane
- (b) Potassium manganate(VII)/KMnO₄ **(1)**
 Sulphuric acid/H₂SO₄ consequential on potassium manganate **(1)**
 ALLOW 'acidified potassium manganate(VII)' for both marks 2
 Accept TE for **W** alkene and corresponding monohydric alcohol
 1. H₂SO₄/sulphuric acid
 2. H₂O/water
 Reject other Roman numerals after managate

[12]

24. (a) (i) 2-bromobutane
 the "2" must be in front of "bromo"
 Ignore punctuation and capitals 1

- (ii) $\text{CH}_3\text{CHBrCH}_2\text{CH}_3 + \text{KOH} \rightarrow \text{CH}_3\text{CHOHCH}_2\text{CH}_3 + \text{KBr}$
 OR
 $\text{CH}_3\text{CHBrCH}_2\text{CH}_3 + \text{OH}^- \rightarrow \text{CH}_3\text{CHOHCH}_2\text{CH}_3 + \text{Br}^-$ 1
Accept C₂H₅ instead of CH₂CH₃
Allow K⁺ as spectator ion
Reject eqns with NaOH
- (iii) water / H₂O / aqueous ethanol 1
Accept C₂H₅OH (aq) / aqueous alcohol/KOH(aq)/aqueous
Do not penalise use of NaOH(aq) again
Reject just "ethanol / ethanolic / alcoholic (KOH)"
- (iv) nucleophilic substitution (both needed) 1
Accept reasonable phonetic spelling
- (b) (i) $\text{CH}_3\text{CHBrCH}_2\text{CH}_3 + \text{OH}^- \rightarrow \text{CH}_3\text{CH}=\text{CHCH}_3 + \text{H}_2\text{O} + \text{Br}^-$
 OR
 $\text{CH}_3\text{CHBrCH}_2\text{CH}_3 + \text{OH}^- \rightarrow \text{CH}_2=\text{CHCH}_2\text{CH}_3 + \text{H}_2\text{O} + \text{Br}^-$
 Double bond need not be shown 1
Accept C₂H₅ instead of CH₂CH₃
Ignore spectator ions
- (ii) Ethanol / C₂H₅OH / CH₃CH₂OH /

$$\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{OH} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$$
 1
Accept alcohol OR Ethanolic/alcoholic
Accept KOH/NaOH
Reject C₂H₆O
Reject any mention of water/aqueous
- (iii) elimination
 ignore "nucleophilic" 1
Reject electrophilic elimination

- (c) (i)  1
- bond to H of CH₃ on left carbon
structure with 90° bond angles*
- (c) (ii) no / restricted rotation around double bond / C=C / π – bond (1)
has two different groups joined to **each** C (of double bond) OR each (carbon of C=C) has a CH₃ and a H (1) 2
- limited rotation
on the carbon*
- (d) (i) nickel / Ni
OR platinum / Pt
OR palladium / Pd 1
- (d) (ii) butane / CH₃CH₂CH₂CH₃ 1
- C₂H₅ for CH₃CH₂
JUST “C₄H₁₀”*
- [12]**
25. (a) (i) (Concentrated) sulphuric acid/H₂SO₄ (1)
Water/H₂O (1)
Any order 2
- Accept phosphoric acid
1 HBr 2 NaOH/KOH (2)
H₂SO₄ + NaOH/KOH (1 max)
H₂O and high T and P and catalyst (1 max)*
- Reject dilute/aq sulphuric acid
H₂SO₄ + Na₂Cr₂O₇ (0)
H₂O alone (0)
H₂O + × (eg H₂O₂) (0)*

- (ii) Butan(e) -1,2-diol 1
- Ignore punctuation*
1,2-butan(e)diol
1,2-dihydroxybutane
- Reject buta-1,2-diol*
Reject but-1,2-diol
Reject 1,2-diolbutan(e)
Reject any formula
- (iii) 1,2-dibromobutane 1
- Ignore punctuation*
Reject any formula
- (iv) Hydrogen bromide/HBr 1
- Ignore (aq)
- Accept KBr + H₂SO₄/H₃PO₄*
Accept any other metal
Accept bromides
- (b) **Two** reactants come together to make **one** product 1
- Accept one reagent added across double bond*
Accept use judgement but in general look for 'two...become one'
Accept 'two or more reactants give one product'
- Reject 'adding 1 atom'*
Reject just 'unsaturated becomes saturated'
Reject just 'the double bond breaks'
Reject '2 molecules are joined'
- (c) (i) A species/molecule/ion with a space for/which can accept (a pair of) electrons (to make a dative covalent bond) 1
- Accept an electron deficient entity*
Accept electron deficient ion
- Reject just 'a lover of negative charge'*
Reject positive ion
*Reject electron deficient **element***
- (ii) $\text{Br}^{\delta+} - \text{Br}^{\delta-} / \text{Br}^{\delta+}$ 1
- Accept Br⁺*
Be generous on symbols for delta
Reject Br₂

- (d) (i) Reaction 2 1
Reject two answers
- (ii) Oxidation number of carbon increases
or
 oxygen is added (to the organic compound) 1
Reject loss of electrons alone / loss of electrons and addition of oxygen
- (e) (i) Butane/ $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ 1
Accept displayed formulae
Accept C_2H_5 instead of CH_3CH_2
Reject C_4H_{10}
- (ii) Hydrogen **(1)**
 Nickel **(1)** 2
Accept H_2
Accept Ni
Accept platinum/Pt or palladium/Pd
Reject H
- (iii) Chlorine **(1)**
 UV/ultraviolet/sunlight **(1)** 2
Accept Cl_2
Accept visible light
Reject just 'light'

[15]

26. (a) (i) Any two of
- (same) general formula
*Accept (Same) **general** molecular formula*
Reject (Same) molecular formula
 - (successive) members differ by CH_2
 - (same) functional group/ (similar/same) chemical properties/reactions
 - regular trend in physical properties
Reject same physical properties
Reject reference to a specific reaction e.g. same reaction with chlorine
- IGNORE “same properties” 2
- (ii) alkene(s) 1
- Reject C=C*
Reject alkane
- (iii) electrophilic addition (**1**) both needed
 IGNORE heterolytic and penalise homolytic
 hydrogen chloride/HCl (**1**) 2
- Reject (Dilute) hydrochloric acid/dilute HCl /HCl(aq)*
- (b) same **molecular** formula (**1**)
Accept same numbers of each atom
- different structural formulae/displayed formulae/
 arrangement of atoms (**1**) 2
- Accept different structure*
Reject different arrangement in space

- (c) 1-bromopropane faster (1)

Stand alone

*Accept reverse statement**Any answer which gives 1-chloropropane as faster scores zero overall*

because C-Br bond weaker (than C-Cl) (1)

*Accept reverse argument**Reject if no reference to carbon-halogen bond*

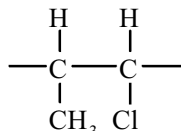
IGNORE attempted explanations of why C-Br bond weaker

therefore lower activation energy/ E_{act} (1)[Lower E_{act} must be related to C-X bond]

3

Accept reverse argument

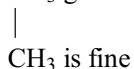
- (d)



2 carbon chain with continuation bonds in repeat unit (1)

All other atoms correct (1)

IGNORE subscript n

IGNORE where the bond to the CH_3 goes e.g.

2

*If more than one repeat unit given and number of repeat units stated or the repeat unit identified (2)**If repeat unit not stated or identified can score 2nd mark only**Reject 3 carbon chain**Or**Any repeat unit containing a double bond scores zero*

- (e) Restricted rotation around double bond (1)

*Accept no rotation/double bond cannot rotate (at room temperature)*1-chloropropene has two different groups on **both** carbons/**each** carbon (in the double bond)(but propene does not) (1)

2

*Accept propene has two identical groups on **one** carbon (of the double bond) (but 1-chloropropene does not)***[14]**

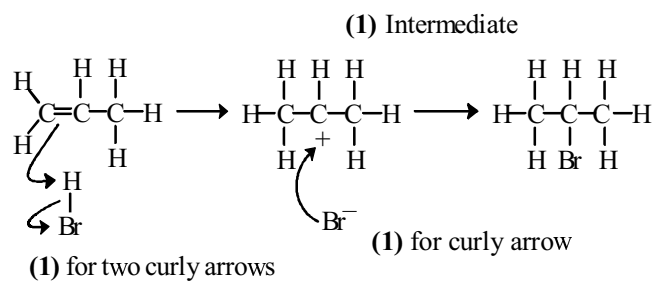
27. (a) C 1
 (b) D 1
 (c) A 1
 (d) D 1 [4]

28. (a) A 1
 (b) C 1 [2]

29. B [1]

30. C [1]

31. (a) (i)

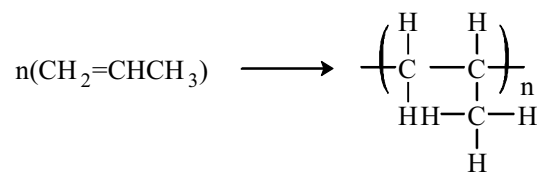


3

Reject inaccurate placing of curly arrows

- (ii) The secondary carbocation/carbonium ion is more stable than the primary (so forms when H^+ adds)
 OR
 The secondary carbocation/carbonium ion is stable because the methyl groups are electron donating 1
- (iii) 2-bromopropane 1
- (b) Acidified potassium manganate(VII) / potassium permanganate / $KMnO_4(aq)$ 1

(c)



balanced and double bond broken (1)

CH₃ on side chain (1)

2

Reject CH₃ in unbranched chain

(d) Poly(propene) is non-biodegradable / won't break down in wet conditions (1) 1

(e) (i) propagation 1

(ii) C₆H₁₄ / hexane /
Structural, displayed or skeletal formulae of hexane 1**[11]**