M1.(a) Crude oil **OR** petroleum

Not petrol.

1

Fractional distillation / fractionation

Not distillation alone.

1

(b) $C_{12}H_{26} + 12.5O_2 \longrightarrow 12CO + 13H_2O$

Allow balanced equations that produce CO_2 in addition to CO.

Accept multiples.

1

(c) (i) M1 Nitrogen and oxygen (from air) react / combine / allow a correct equation

If nitrogen from petrol / paraffin / impurities CE = 0 / 2.

1

M2 at high temperatures

Allow temperatures above 1000 °C or spark.

Not just heat or hot.

M2 dependent on M1.

But allow 1 mark for nitrogen and oxygen together at high temperatures.

1

(ii) $2NO + O_2 \longrightarrow 2NO_2$

Allow multiples.

1

(iii) $4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$

Allow multiples.

1

(d) (i) C_nH_{2n+2}

Allow C_xH_{2x+2}

CnH2n+2

Allow CxH2x+2

1

(ii) $C_{12}H_{26} \longrightarrow C_6H_{14} + C_6H_{12}$

Only.

1

C_3H_7

Only.

1

Zeolite / aluminosilicate(s)

Ignore aluminium oxide.

1

(iii) Larger molecule / longer carbon chain / more electrons / larger surface area

1

More / stronger <u>van der Waals' forces between molecules</u>

Allow dispersion forces / London forces / temporary induced dipole-dipole forces <u>between molecules.</u>

If breaking bonds, CE = 0 / 2.

1

(e) 2,2,3,3,4,4-hexamethylhexane

Only.

Ignore punctuation.

1

Chain

Ignore branch(ed).

1

(f) Cl_2

Only.

Cl–Cl

Not CL_2 or Cl2 or CL2 or Cl^2 or CL^2.
Ignore Chlorine.

1

[16]

M2.(a) Covalent

If not covalent CE = 0/2
If dative covalent CE = 0/2
If blank mark on
Ignore polar
If number of pairs of electrons specified, must be 3

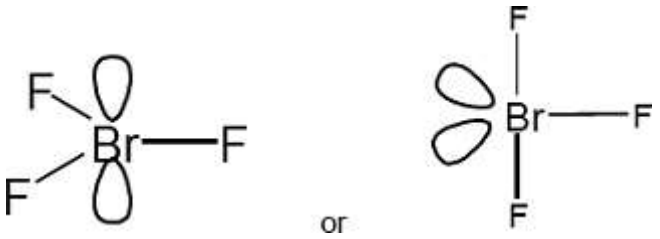
1

Shared <u>pair</u>(s) of electrons / one electron from Br and one electron from F

Not 2 electrons from 1 atom
Not shared pair between ions/molecules

1

(b) (i)



BrF_3 should have 3 bp and 2 lp and correct atoms for the mark
Penalise Fl

1

BrF_3 if trigonal planar shown = 120°

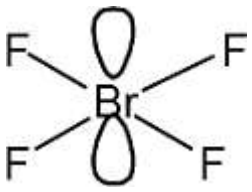
Allow 84 – 90° or 120° and ignore 180°

or if T shape shown 84 – 90°

Irrespective of shape drawn

1

(ii)



BrF_4^- should have 4 bp and 2 lp and all atoms for the mark(ignore sign)

Allow Fl

1

BrF_4^- 90°

Only

Ignore 180°

1

(c) Ionic or (forces of) attraction between ions / bonds between ions

If molecules, IMF, metallic, CE =0

If covalent bonds mentioned, 0/3, unless specified within the BrF_4^- ion and not broken

Ignore atoms

1

Strong (electrostatic) attraction / strong bonds / lots of energy needed to break bonds

1

Between K^+ and BrF_4^- ions/oppositely charged ions / + and – ions

If ions mentioned they must be correct

Strong bonds between + and – ions =3/3

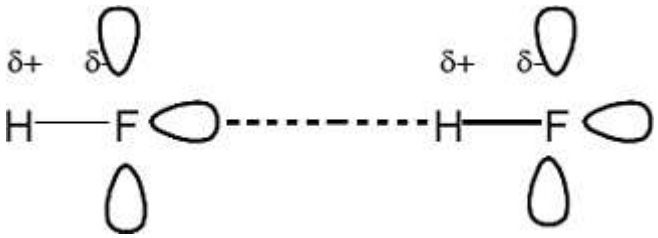
1

(d) (i) Hydrogen bonds/hydrogen bonding/H bonds/H bonding

Not just hydrogen

1

(ii)



One mark for 4 partial charges

One mark for 6 lone pairs

One mark for H bond from the lone pair to the Hδ+

Allow Fl

If more than 2 molecules are shown they must all be correct.Treat any errors as contradictions within each marking point.

CE = 0/3 if incorrect molecules shown.

3

(e) vdw / van der Waals forces between molecules

QoL

Not vdw between HF molecules, CE = 0/2

vdw between atoms, CE = 0/2

If covalent, ionic, metallic, CE=0/2

1

IMF are weak / need little energy to break IMF / easy to overcome IMF

1

[15]

M3.(a) Hydrogen bond(ing)

Allow H bonding.

Penalise mention of any other type of bond.

1

(b) (i) Ammonia is a nucleophile

Allow ammonia has a lone pair.

1

Benzene repels nucleophiles

Allow (benzene) attracts / reacts with electrophiles.

***OR** benzene repels electron rich species or lone pairs.*

***OR** C–Cl bond is short / strong / weakly polar.*

1

(ii) H_2 / Ni **OR** H_2 / Pt **OR** Sn / HCl **OR** Fe / HCl

Ignore dil / conc of HCl.

Ignore the term „catalyst".

Allow H_2SO_4 with Sn and Fe but not conc.

Ignore NaOH following correct answer.

Not $NaBH_4$ nor $LiAlH_4$.

1

(iii) conc HNO_3

conc H_2SO_4

1

If either or both conc missed can score 1 for both acids.

1

$HNO_3 + 2H_2SO_4 \longrightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$

OR using two equations

$HNO_3 + H_2SO_4 \longrightarrow H_2NO_3^+ + HSO_4^-$

$H_2NO_3^+ \longrightarrow H_2O + NO_2^+$

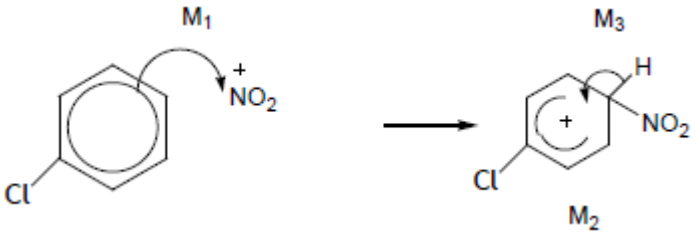
Allow 1:1 equation.

$HNO_3 + H_2SO_4 \longrightarrow NO_2^+ + H_2O + HSO_4^-$.

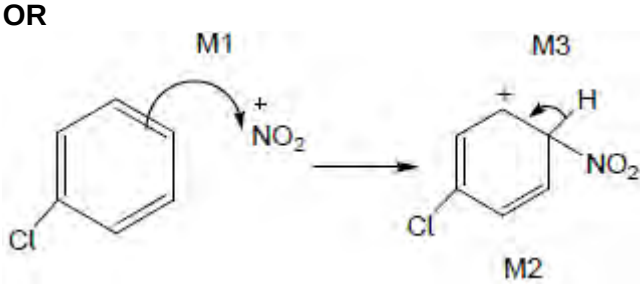
1

(iv) Electrophilic substitution

1



OR

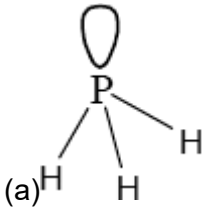


- *Ignore position or absence of Cl in M1 but must be in correct position for M2.*
- *M1 arrow from within hexagon to N or + on N.*
- *Allow NO_2^+ in mechanism.*
- *Bond to NO_2 must be to N for structure mark M2.*
- *Gap in horseshoe must be centered around correct carbon (C1).*
- *+ in intermediate not too close to C1 (allow on or "below" a line from C2 to C6).*
- *M3 arrow into hexagon unless Kekule.*
- *Allow M3 arrow independent of M2 structure.*
- *Ignore base removing H in M3.*
- *+ on H in intermediate loses M2 not M3.*

3

[11]

M4. (a)



Need to see 3 P–H bonds and one lone pair (ignore shape).

1

(b) Coordinate / dative

If not coordinate / dative then chemical error CE=0 unless blank or covalent then M1 = 0 and mark on.

1

Pair of electrons on P(H_3) donated (to H+)

Do not allow a generic description of a coordinate bond.

1

(c) 109.5° / 109½ / 109° 28□

Allow answers in range between 109° to 109.5°

1

(d) Difference in electronegativity between P and H is too small

Allow P not very electronegative / P not as electronegative as N, O and F / P not electronegative enough / P not one of the 3 most electronegative elements.

Do not allow phosphine is not very electronegative.

1

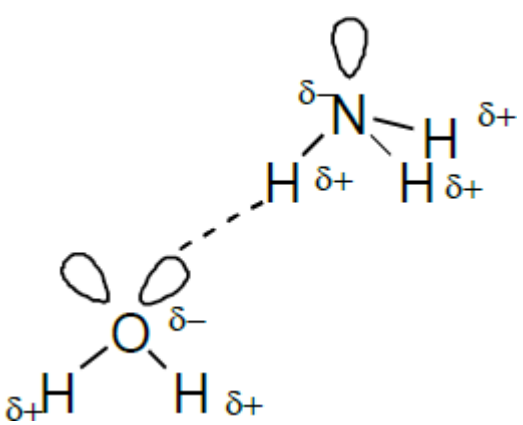
[5]

M5.(a) Hydrogen bonding / hydrogen bonds / H-bonding / H-Bonds

Not just hydrogen.

1

(b)

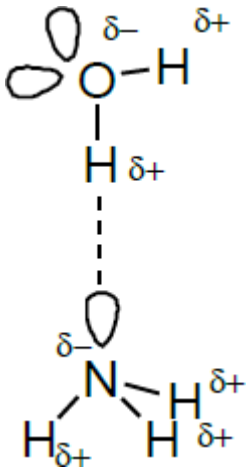


One mark for minimum of 4 correct partial charges shown on the N-H and O-H

One mark for the 3 lone pairs.

One mark for H bond from the lone pair on O or N to the $H^{\delta+}$

OR



The N-H-O should be linear but can accept if the lone pair on O or N hydrogen bonded to the H

If wrong molecules or wrong formula, CE = 0/3

3

(c) (Phosphine) does not form hydrogen bonds (with water)

1

[5]