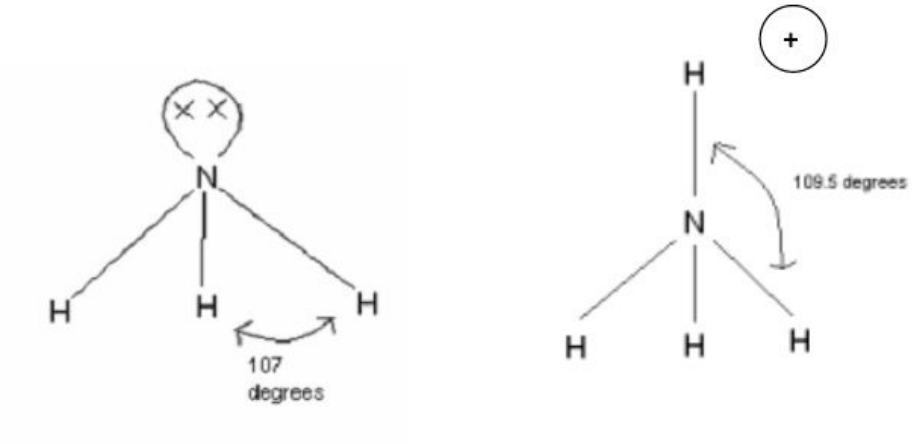
Q1.

(d)

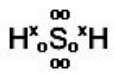


1 mark for each diagram, 1 mark for each correct bond angle
If not 3-dimensional diagram – 1 penalty.

[4]

Q2.

(c) (i)



(1)

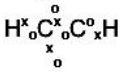
(ii) non-linear/bent/V-shaped **(1)**

(iii) H_2O has hydrogen bonds/H_2S does not <u>or</u>
H_2S has van der Waals' forces only **(1)**

hydrogen bonds are stronger
than van der Waals' forces <u>or</u>
H_2S has weaker intermolecular bonds
than H_2O **(1)** **[4]**

Q3.

2 (a)

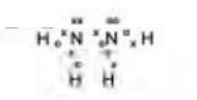


(1) **[1]**

Q4.

1 **(a)** **(i)** between 117° and 120° [1]

(ii)



14 electrons must be shown
single N-N bond [1]
lone pair on each N atom [1]

(iii) between 107° and 109° [1] **[4]**

(b) ethene – van der Waals' forces [1]
hydrazine – hydrogen bonds [1]

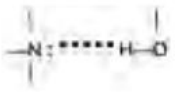
hydrogen bonds are stronger
or van der Waals' forces are weaker [1] **[3]**

(c) correct dipole on O—H and N—H bonds [1]

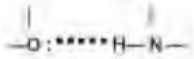
labelled hydrogen bond shown
between an O atom of H_2O and a H atom of N_2H_4
or between an N atom of N_2H_4 and a H atom of H_2O [1]

lone pair on O atom *or* on N atom *in the H bond*

i.e.



or



[1] **[3]**

(e) **(i)** acid – base/neutralization [1]

(ii) N atom has a lone pair of electrons
or N atom can behave as a base
or N atom can form dative bond [1]

(iii) each N atom has a lone pair
or each nitrogen atom can behave as a base
or each nitrogen atom can form a dative bond [1] **[3]**

Q5.

1 **(a) (i)** 2 (1)

(ii) between 104° and 105° (1) [2]

(b)

ethanal	CH_3CHO	**A** (1)
ethanol	CH_3CH_2OH	**C** (1)
methoxymethane	CH_3OCH_3	**A** (1)
2-methylpropane	$(CH_3)_2CHCH_3$	**B** (1)

[4]

(c) (i) hydrogen bonds (1)

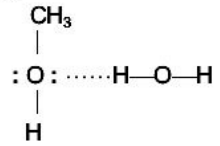
(c) (i) hydrogen bonds (1)

(ii) correct dipole on an -O—H bond (1)

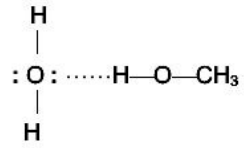
hydrogen bond shown between the lone pair of an O and a H atom in an –OH group (1)

lone pair on O atom of CH_3OH **or** H_2O clearly shown **in the hydrogen bond** (1)

e.g.



or



[4]

(d) hydrogen bonds exist between H_2O molecules (1)

hydrogen bonds cannot form between $C_2H_5OC_2H_5$ molecules (1) [2]

[Total: 12]

Q6.

1 **(a)** A*l* $1s^2\ 2s^2 2p^6\ 3s^2 3p^1$ (1)

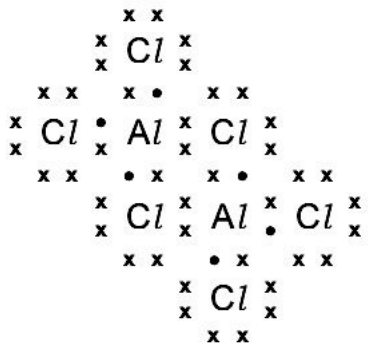
Ti $1s^2\ 2s^2 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2$ **or**

$1s^2\ 2s^2 2p^6\ 3s^2\ 3p^6\ 4s^2 3d^2$ penalise any error (1) [2]

(b) **(i)** pass chlorine gas (1)
over heated aluminium (1)

(ii) aluminium glows (1)
white/yellow solid formed (1)
chlorine colour disappears/fades (1) (any 2)

(iii)



correct numbers of electrons, i.e.

3 • per A*l* atom **and 7x** per C*l* atom

i.e. 6 • and 42 **x** in total (1)

dative bond C*l* to A*l* clearly shown by $^{x}_{x}$ (1) [6]

(c) chlorine is a strong/powerful oxidising agent (1) [1]

(d) **(i)** $n(Ti) = \frac{0.72}{47.9} = 0.015$ (1)

(ii) $n(Cl) = \frac{(2.85 - 0.72)}{35.5} = 0.06$ (1)

(iii) 0.015 : 0.06 = 1:4
empirical formula of **A** is $TiCl_4$
Allow ecf on answers to **(i)** and/or **(ii)**. (1)

(iv) $Ti + 2Cl_2 \rightarrow TiCl_4$ (1)
Allow ecf on answers to **(iii)**. [4]

(e) covalent/not ionic (1)
simple molecular **or**
mention of weak intermolecular forces **or**
weak van der Waals's forces between molecules (1) [2]

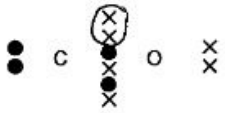
[Total: 14 max]

Q7.

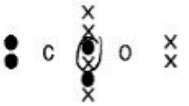
1 **(a)** fewer electrons in Cl_2 than in Br_2 (1)
smaller van der Waals' forces in Cl_2 **or** stronger van der Waals' forces in Br_2 (1) [2]

(b) CO has a permanent dipole **or** N_2 does not (1)
permanent dipole-permanent dipole interactions are stronger than those from induced dipoles (1) [2]

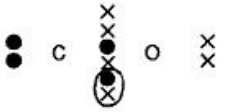
(c) (i) a co-ordinate bond (1)



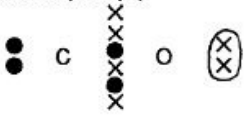
(ii) a covalent bond (1)



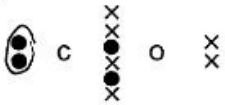
or



(iii) a lone pair (1)



or

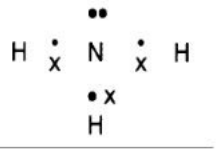


penalise any groups of 3 or 4 electrons that are circled [3]

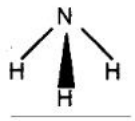
(d) CO and HCN both have a dipole **or** N_2 does not have a dipole (1) [1]

Q8.

(c) (i) 'dot-and-cross' diagram (1)

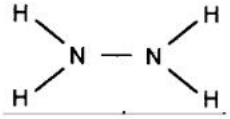


(ii)



(1)

(iii) minimum is



allow bond angle around N atom between 109° and 104° (1) **[4]**

(d) –2 (1) **[1]**

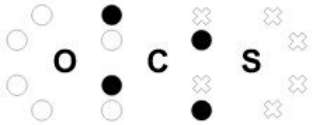
Q9.

(f) (i) both have very similar/same van der Waals' forces (1)

(ii) CH_3F has permanent dipole (1) [2]

Q10.

(f) (i)



(1)

(ii) 180° (1) [2]

Q11.

(c) (i) around the N atom there is only one lone pair
around the S atom there are two lone pairs **both** (1)

(ii) angle (a) **or** sulfur – **no mark for this**

because two lone pairs repel more than one lone pair **or**
lone pair-lone pair repulsions are stronger
than lone pair-bond pair repulsions (1) [2]

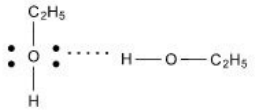
Q12.

(d) (i) hydrogen bonds (1)

(ii) lone pair on O atom of C_2H_5OH (1)

correct dipole $O^{\delta-}$—$H^{\delta+}$ on bond in one molecule of ethanol (1)

hydrogen bond shown between lone pair of an O atom and a hydrogen atom, i.e.



(1) [4]

Q13.

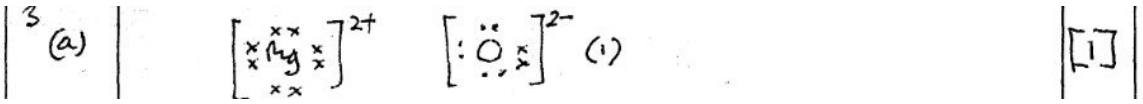
1 (a) (i)

S atom has 6 **and C** atom has 4 electrons (1)

S=C double bonds (4 electrons) clearly shown (1)

(ii) linear **and** 180° (1) [3]

Q14.

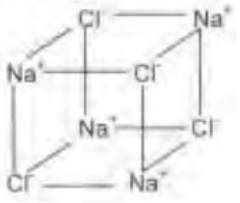


Q15.

1 **(a)** ionic$^-$ (1)

Na^+ and Cl^- (1)

arranged in cubic lattice (diagram required)



(1)

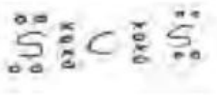
each na^+ ion surrounded by six Cl^- ions
or each Cl^- ion surrounded by six Na^+ ions
may be in diagram or stated in words (1) **[4]**

(b) in the solid, the ions cannot move (1)

in the melt, the ions move
or carry the charge/current (1) **[2]**

Q16.

(a)



sulphur atom has 6 /carbon atom has 4 electrons (1)

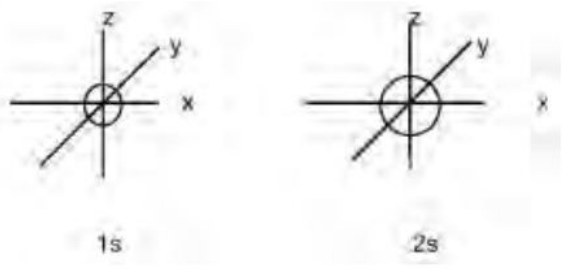
S=C double bonds (4 electrons) clearly shown (1) **[2]**

(b) linear (1)

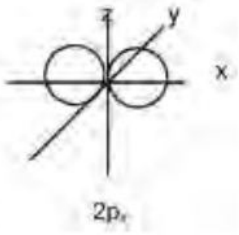
180^o (1) **[2]**

Q17.

1 (a)



spherical (1) larger spherical (1)



double lobes along the *x*-axis (1) [3]

(b) (i) attraction between bonding electrons and nuclei (1)

attraction is electrostatic (1)

(ii) H_2 s-s **overlap** clearly shown

must **not** be normal dot/cross diagram (1)

H*Cl* s-p **overlap** clearly shown

overlap must involve s and p orbitals (1) [4]

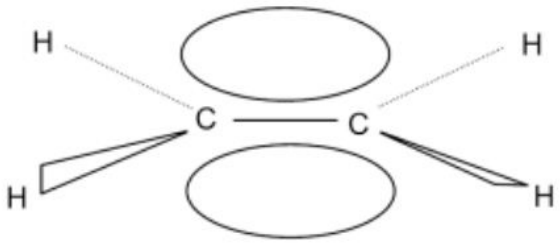
(c) (i) bonding electrons are unequally shared **or**

the molecule has a dipole/δ+ and δ- ends to molecule (1)

(ii) the H and C*l* atoms have different electronegativities

or chlorine is more electronegative than hydrogen (1) [2]

(d)



allow two 'sausages' above **and** below the C-C axis

or two p orbitals **overlapping** sideways
to form one (localised) π bond over two carbon atoms (1) [1]

(e) $\Delta H_f^o = 2(-393.7) + 2(-285.9) - (-1411)$

$= +\ 51.8\ kJ\ mol^{-1}$ (units given in qu.) (3)

penalise errors: no 2 for –393.7
no 2 for –285.9
wrong sign for –(–1411) [3]

[Total: 13]

Q18.

(b) (i) giant ionic lattice (may be in diag.) (1)

strong ionic bonds (1)

(ii) simple molecular **or** discrete molecules

(may be shown in a diagram) (1)

with **weak** intermolecular forces **or**

weak van der Waals' forces

between them (1) [4]

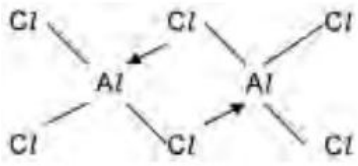
(e) (i) 460 K Al_2Cl_6 (1)

1150 K $AlCl_3$ (1)

(ii) correct **dot-and-cross** diagram for $AlCl_3$ (1)

(iii) correct displayed structure for Al_2Cl_6 (1)

two correct co-ordinate bonds (1)



[5]

Q19.

2 (a) (i) H–C–H 117 to 120° (1)
C=C=O 180° (1)

(ii) molecule contains **both** ketone **and** alkene (1) [3]

(b) (i) $C_2H_2O + 2O_2 \rightarrow 2CO_2 + H_2O$ (1)

(ii) from eqn., 42 g $C_2H_2O \rightarrow 48$ dm^3 of CO_2 (1)

whence 3.5 g $C_2H_2O \rightarrow \frac{48 \times 3.5}{42}$ dm^3 of CO_2 (1)

= 4.0 dm^3 of CO_2 (1)

or $n(C_2H_2O) = \frac{42}{3.5} = 0.0833$ (1)

$n(CO_2) = 2 \times 0.083 = 0.0166$ (1)

vol. of $CO_2 = 0.0166 \times 24 = 4.0$ dm^3 (1)

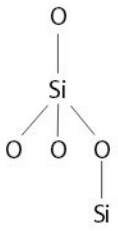
allow e.c.f. on wrong eqn. in **(b)(i)**

penalise significant figure error [4]

Q20.

1 **(a)** CO_2 is simple molecular/simple covalent/has discrete molecules (1)
CO_2 has induced dipole – induced dipole interactions/
van der Waals' forces/weak intermolecular forces (1)
SiO_2 is giant molecular/giant covalent/macromolecular (1)
SiO_2 has strong covalent bonds (1)
[any 3]

(b) minimum is 4-valent Si-O (1)
and at least one Si-O-Si (1)
i.e.



[2]

(c) **(i)** for an ideal gas, **any four** from the following
the molecules behave as rigid spheres (1)
there are no/negligible intermolecular forces
between the molecules (1)
collisions between the molecules are perfectly elastic (1)
the molecules have no/negligible volume (1)
the molecules move in random motion (1)
the molecules move in straight lines (1)
the kinetic energy of the molecules is
directly proportional to the temperature (1)
the pressure exerted by the gas is due to the collisions
between the gas molecules and the walls of the container (1)
not an ideal gas obeys $pV = nRT$
(max 4)

(ii) there are intermolecular forces between CO_2 molecules/
CO_2 molecules have volume (1) [5]

(d) graphite has delocalised electrons (1) [1]

(e) **(i)** $SiO_2 + 2C \rightarrow SiC + CO_2$ **or**
$SiO_2 + 3C \rightarrow SiC + 2CO$ (1)

(ii) diamond **because** SiC is hard (1) [2]

[Total: 13]

Q21.

(b) (i) giant lattice (may be in diagram) (1)
with strong ionic bonding (1)

(ii) ionic (1)

(iii) –1 (1)

(iv)

correct numbers of electrons (1)
correct charges (1)

(v)

compound	MgH_2	AlH_3	PH_3	H_2S
oxidation number of element in the hydride	+2	+3	–3	–2

correct oxidation nos. for MgH_2 **and** AlH_3 (1)
correct oxidation nos. for PH_3 **and** H_2S (1) [8]

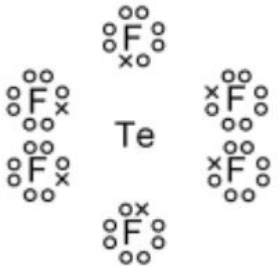
Q22.

1 (a)

number of bond pairs	number of lone pairs	shape of molecule	formula of a molecule with this shape
3	0	trigonal planar	BH_3
4	0	tetrahedral	CH_4 allow other Group IV hydrides
3	1	pyramidal **or** trigonal pyramidal	NH_3 allow other Group V hydrides
2	2	non-linear **or** bent **or** V-shaped	H_2O allow other Group VI hydrides

1 mark for each correct row (3 × 1) [3]

(b) (i)



(1)

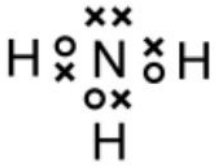
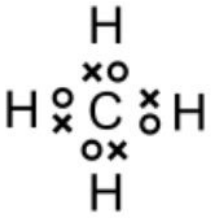
(ii) octahedral **or** square-based bipyramid (1)

(iii) 90° (1) [3]

[Total: 6]

Q23.

1 (a)

NH_3	CH_4
	
pyramidal	tetrahedral

both 'dot-and-cross' diagrams correct (1)
NH_3 is pyramidal **or** trigonal pyramidal (1)
CH_4 is tetrahedral (1) [3]

(b) (i) nitrogen and hydrogen have different electronegativities (1)
N–H bond has a dipole **or**
$N^{\delta-}—H^{\delta+}$ **or**
bonding pair is unequally shared (1)

(ii) molecule is not symmetrical **or**
dipoles do not cancel out (1)

(iii) NH_3 has higher boiling point than expected from M_r value **or** has higher boiling point than methane
or NH_3 is soluble in water (1) [4]

(c) three covalent N–H bonds (1)
one co-ordinate (dative covalent) N–H bond (1)
one ionic bond between NH_4^+ and Cl^- (1) [3]

[Total: 10]