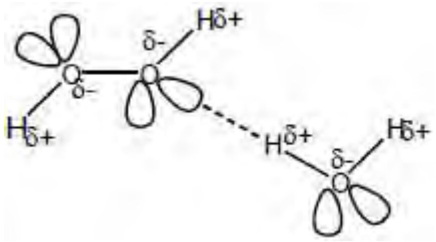
**M1.**(a) 94−105.5° **1**

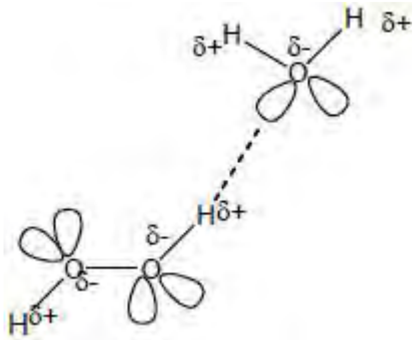
(b) (i) Hydrogen bond(ing) / H bonding / H bonds

*Not just hydrogen* **1**

(ii)




**OR**




*1 mark for all lone pairs*

*1 mark for partial charges on the O and the H that are involved in H bonding*

*1 mark for the H-bond, from Hδ+ on one molecule to lone pair on O of other molecule* **3**

(c) Electronegativity of S lower than O or electronegativity difference between H and S is lower

*Mark independently* **1**

No hydrogen bonding between $H_2S_2$ molecules

Or only van der Waals / only dipole-dipole forces between $H_2S_2$ molecules

*If breaking covalent bonds CE = 0*

1

**[7]**

**M2.**(a) (i) The power of an atom or nucleus to withdraw or attract electrons ***OR*** electron density ***OR*** a pair of electrons (towards itself)

*Ignore retain*

1

In a covalent bond

1

(ii) More protons / bigger nuclear charge

1

Same or similar shielding / electrons in the same shell or principal energy level / atoms get smaller

*Not same sub–shell*
*Ignore more electrons*

1

(b) Ionic

*If not ionic then CE = 0 / 3*
*If blank lose M1 and mark on*

1

Strong or many or lots of (electrostatic) attractions (between ions)

*If molecules / IMF / metallic / atoms lose M2 + M3, penalise incorrect ions by 1 mark*

1

Between + and − ions / between $Li^+$ and $F^-$ ions / oppositely charged ions

*Allow strong (ionic) bonds for max 1 out of M2 and M3*

1

(c) Small electronegativity difference / difference = 0.5

*Must be comparative*

*Allow 2 non-metals*

**1**

(d) (i) (simple) <u>molecular</u>

*Ignore simple covalent*

**1**

(ii) $OF_2 + H_2O \longrightarrow O_2 + 2HF$

*Ignore state symbols*
*Allow multiples*
*Allow $OF_2$ written as $F_2O$*

**1**

(iii) 45.7% O

**1**

$$\begin{pmatrix} O & F \\ \frac{45.7}{16} & \frac{54.3}{19} \end{pmatrix}$$

*If students get M2 upside down lose M2 + M3*
*Check that students who get correct answer divide by 16 and 19 (not 8 and 9). If dividing by 8 and 9 lose M2 and M3 but could allocate M4 ie max 2*

**1**

(2.85 2.85)
( 1 1 )

EF = <u>OF or FO</u>

*Calculation of OF by other correct method = 3 marks*
*Penalise Fl by 1 mark*

**1**

MF (= 70.0 / 35) = $O_2F_2$ or $F_2O_2$

**1**

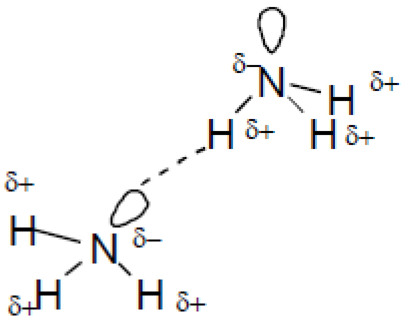
**[14]**

**M3.**(a) (i) Hydrogen bonds / H bonds

*Not just hydrogen.*

**1**

(ii)



*M1 – lone pair on each N.*

*M2 – correct partial charges must be shown on the N and H of a bond in each molecule.*

*M3 – for the H bond from lone pair on N to the Hδ[+] on the other $NH_3$ molecule.*

*If not ammonia molecules, CE = 0 / 3.*

**3**

(b) Lone pair / both electrons / 2 electrons / electron pair on $N(H_3)$ is donated to $B(Cl_3)$

*Allow both electrons in the bond come from $N(H_3)$.*

**1**

(c) (i) The power of an <u>atom</u> or <u>nucleus</u> to withdraw or attract electron<u>s</u> or electron density or a pair of electrons (towards itself)

**1**

in a <u>covalent</u> bond

**1**

(ii) LiF **OR** $Li_2O$ **OR** LiH

*Allow $Li_2O_2$, allow correct lithium carbide formula.*

**1**

(iii) $BH_3$ / $H_3B$

*Allow $B_2H_6$ / $H_6B_2$*

*Do not allow lower case letters.*

**1**

**[9]**

**M4.**C

**[1]**

**M5.**(a) This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

All stages are covered and the explanation of each stage is generally correct and virtually complete.

Answer is communicated coherently and shows a logical progression from stage 1 and stage 2 to stage 3. Steps in stage 3 must be complete, ordered and include a comparison.

**Level 3**
**5 – 6 marks**

All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete.

Answer is mainly coherent and shows a progression from stage 1 and stage 2 to stage 3.

**Level 2**
**3 – 4 marks**

Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning.

**Level 1**
**1 – 2 marks**

Insufficient correct Chemistry to warrant a mark.

**Level 0**
**0 marks**

**Indicative Chemistry content**

**Stage 1:** difference in structure of the two acids

- The acids are of the form RCOOH
- but in ethanoic acid R = $CH_3$
- whilst in ethanedioic acid R = COOH

**Stage 2:** the inductive effect

- The unionised COOH group contains two very electronegative oxygen atoms
- therefore has a negative inductive (electron withdrawing)effect
- The $CH_3$ group has a positive inductive (electron pushing) effect

**Stage 3:** how the polarity of OH affects acid strength

- The O–H bond in the ethanedioic acid is more polarised / H becomes more $\delta^+$
- More dissociation into $H^+$ ions
- Ethanedioic acid is stronger than ethanoic acid

6

(b) Moles of NaOH = Moles of $HOOCCOO^-$ formed = $6.00 \times 10^{-2}$

*Extended response*

1

Moles of HOOCCOOH remaining = $1.00 \times 10^{-1} - 6.00 \times 10^{-2}$

= $4.00 \times 10^{-2}$

1

$K_a = [H^+][A^-] / [HA]$

$[H^+] = K_a \times [HA] / [A^-]$

1

$[H^+] = 5.89 \times 10^{-2} \times (4.00 \times 10^{-2} / V) / (6.00 \times 10^{-2} / V) = 3.927 \times 10^{-2}$

1

pH = $-\log_{10}(3.927 \times 10^{-2}) = 1.406 = 1.41$

*Answer must be given to this precision*

1

(c) $5H_2C_2O_4 + 6H^+ + 2MnO_4^- \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

**OR** $5C_2O_4^{2-} + 16H^+ + 2MnO_4^- \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

1

Moles of $KMnO_4$ = 20.2 × 2.00 × $10^{-2}$ / 1000 = 4.04 × $10^{-4}$

1

Moles of $H_2C_2O_4$ = 5 / 2 × 4.04 × $10^{-4}$ = 1.01 × $10^{-3}$

1

Concentration = moles / volume (in $dm^3$)

= 1.01 × $10^{-3}$ × 1000 / 25 = 4.04 × $10^{-2}$ (mol $dm^{-3}$)

*If 1:1 ratio or incorrect ratio used, M2 and M4 can be scored*

1

**[15]**