1 **(a) (i)** $6Li + N_2 = 2Li_3N$
species (1) balancing (1)

**(ii)** $N^3$ ion drawn correctly [1]

Charges correct (minimum 1 × Li ion and 1 nitride ion) [1]

**(b)** 3 × shared pairs between N and 3 × F [1]

only 2 non-bonding electrons on N, 6 non-bonding electrons on each F
(COND on first point) [1]

**(ii)** Strong attractive forces/strong ionic bonds in lithium nitride [1]

weak (attractive) forces between molecules in $NF_3$ [1]

[Total: 8]

2 **(a) (i)**

| Group number | I | II | III | IV | | VI | V |
|---|---|---|---|---|---|---|---|
| symbol | | Mg | A*l* | Si | | S | C*l* |
| number of valency electrons | 1 | | 3 | 4 | | 6 | |
| valency | 1 | | 3 | 4 | | 2 | |

(1) for each I [2]

**(ii)** number of valency electrons = the group number (1) [1]

**(iii)** for Na to A*l*
the valency is the same as the number of valency (outer) electrons (1)

(because) this is the number of electrons **lost** (for full energy level) (1)

for P to C*l*
the valency is 8 – [number of valency (outer) electrons]
**or** valency + valency electrons = 8 (1)

(because) this is number of electrons **needed** (or to be **gained**) (for full energy level) (1)

**(b) (i)** Assume change is from L to R unless clearly stated:
basic to amphoteric to acidic (2) [2]

**(ii)** ionic (metal) chlorides on the left (1)
covalent (non-metal) chlorides on the right (1) [2]

[Total: 11]

3 **(a** any **three** from:
(it would have) more than one or variable valency / oxidation state / oxidation number (1)

(metal / element / titanium / it has a) high density (1)

coloured compounds / ions / solutions (1)

form complex (ions) (1)

(element/compound act as) catalyst (1) [3]

**(b)** $ScF_3$ (1)

correct charges on **both** ions (1)

8 electrons around (each) fluoride (1) [3]

**(c)** name or formula of strong acid and alkali (1)

reacts with or neutralises both acid and base or alkali (then amphoteric) (1)

it dissolves / soluble in both(acid and alkali) or form solutions in both (1) [3]

[Total: 9]

4 **(a** repeat without indicator / repeat using same volumes of acid and alkali **or** use carbon / charcoal to remove indicator (1)

evaporate / heat / warm / boil / leave in sun (1)

until most of the water has gone / some water is left / saturation (point) / crystallisation point (1)

leave / allow to cool / allow to crystallise (1)

filter (off crystals) / wash(with distilled water) / dry crystals with filter paper / dry crystals in warm place / oven / windowsill (1) [5]

**(b)** 0.062 (1)

0.031 (1)

3.97 g (1)

55.4% (1) [4]

5 **(a) (i)** proton or $H^+$ acceptor [1]

**(ii)** (measure) pH or (use) UI indicator [1]
**note**: can be implied need not be explicit
sodium hydroxide has higher pH / ammonia(aq) has lower pH [1]
(this sentence would score 2 marks)
**or**
appropriate colours with UI / appropriate numerical values [1]
ammonia is closer to green, blue-green, turquoise or lighter blue
sodium hydroxide is darker blue / purple / violet [1]
**or**
measure electrical conductivity [1]
can be implied need not be explicit
ammonia (aq) is the poorer conductor/ sodium hydroxide is the better conductor [1]

**(b)** any five from:

- high pressure favours lower volume side / movement to right / ammonia side, **or** high pressure increases the yield
- high pressure increases rate
- low temperature favours exothermic reaction / increases yield / favours the forward reaction
- low temperature gives low rate or vice versa
- catalyst increases rate or lowers activation energy
- 450 °C low enough to give an economic yield but with catalyst gives a fast enough rate
  note need whole concept to get this compromise temperature point [5]

**(c)** $2NH_3 + NaClO \rightarrow N_2H_4 + NaCl + H_2O$ [2
not balanced only 1

**(d)** 4 hydrogen atoms 1 bonding pair each [1]
2 nitrogen atoms with 1 bonding pair between them [1]
one non-bonding pair on each N (need not be seen as a pair) [1]

**(e)** pH increases [1]

**(ii)** oxygen needed for rusting / removes oxygen / reacts with oxygen [1]

**[Total: 15]**

6 **(a (i)** any ambiguous formula, e.g. $GeH_3$-$GeH_2$-$GeH_3$ [1]

**(ii)** $Ge_nH_{2n+2}$ [1]
**NOT** C instead of Ge

**(b)** correct formula
**COND** 4bps around germanium atom [1]
**COND** 3nbps and 1bp around each chlorine atom [1]

**(c)** four oxygen atoms around each germanium atom [1]
two germanium atoms around each oxygen atom [1]
tetrahedral [1]

**(d)** oxidation [1]
**COND** increase in oxidation number [1]
**ACCEPT:** electron loss

7 **(a** Any three of:
iron is harder
iron has higher density
**ACCEPT:** heavier **or** potassium lighter
iron has higher mp **or** bp
iron has higher tensile strength **or** stronger
iron has magnetic properties [3]
**NOTE:** has to be comparison, e.g. iron is hard (0) but iron is harder (1)
**NOT:** appearance e.g. shiny
**ACCEPT:** comparative statements relating to potassium

**(b)** potassium hydrogen (1) and potassium hydroxide (1)
zinc hydrogen (1) and zinc oxide (1)
copper no reaction (1) [5]

**[Total: 8]**