Question	Answer	Marks	Guidance
1 (a)	both correct charges of ions (calcium 2+ and nitrogen 3–); M2 8 electrons around nitrogen (can be 3 dots and 5 crosses **or** 5 crosses and 3 dots **or** all dots **or** all crosses, but reject any other combinations of dots and crosses); M3 Two electrons on the inner shell on any nitride ions/nitrogen atom: allow 2x or 2o once;	**3**	Charges can be shown anywhere **I** missing symbols for nitrogen **R** wrong symbol of nitrogen **anywhere** **A** if electron configuration of nitride is given as 2,8 or N is given as 2,5 **I** any missing inner shells as long as one is present *General guidance:* **I** electron configuration / symbol of calcium ion **I** formulae / stoichiometry Covalent can score **only** M3
(b)(i)	/ repeated / pattern / framework / periodic / ordered / alternating / organised; (of)particles / atoms / molecules / ions / cations / anions;	**2**	**I** layers **A** ionic / molecular / atomic **I** arrangement / bonding / properties
(b)(ii)	(so that ionic) charges balance or cancel / charge = 0 / no charge / number of positive = number of negative charges / charge is neutral or neutralised; M2 3(–) × 2 = 2(+) × 3 ;	**2**	**A** 6(+) = 6(–) **I** statements about electron transfer / valency / ox state unless valency is referring to ionic charges e.g. valencies 3+ and 2– can get credit if used properly Ratio of ions is 3:2 therefore ratio of charges is 2:3 scores 2

Question	Answer	Marks	Guidance
(c)	it (refers to Ca) / Calcium / Ca (atom) loses / gives / donates electrons / e / e ;		**A** half-equation with electrons on right-hand side **R** calcium ion / Ca^{2+}
	(these are) gained by nitrogen / N / N_2 ;		**A** half-equation with electrons on left-hand side **R** nitride ion / N^3 **I** numbers of electrons / charges on ions / oxidation state / valency if mentioned **R** reference to oxygen / hydrogen if there is a suggestion that oxygen / hydrogen are involved in the reaction **I** reference to oxygen / hydrogen if in general statement e.g. oxidation is gain of oxygen
	nitrogen / N / N_2 is reduced so calcium / Ca is the reducing agent (these two statements could be split i.e. not in same sentence) **OR** reducing agents are electron donors / give / lose electrons **OR** calcium / Ca is oxidised (by electron loss) therefore calcium is the reducing agent (these two statements could be split i.e. not in same sentence);	**3**	Electrons / e / e move from calcium to nitrogen get marks 1 and 2 **A** calcium / Ca / it is a reductant or calcium / Ca / it reduces

2 **(a** (making) fertilisers / nitric acid / nylon / explosives / urea
(for) cleaning products (allow oven cleaner) / refrigeration

(b) equilibrium / reversible

(c) (nitrogen)air / atmosphere [1]

(hydrogen) methane / water / steam / alkane / named alkane / hydrocarbon / crude oil or petroleum / natural gas [1]

(d) iron [1]

(e) (i) rate increases / faster

More (effective) collisions [1]

(ii) yield decreases [1]

(forward reaction) exothermic / reverse reaction endothermic / high temp favours endothermic reaction [1]

(f) (i) yield increases [1]

less / fewer molecules or moles or volume on RHS ORA / high pressure favours reaction which produces fewer molecules or moles or volume [1]

(ii) particles / molecules clos**er** / more particles per unit area or volume / more molecules per unit area or volume / more concentration / particles have less space between them **and** more collisions [1]

(iii) safety issues / higher cost [1]

(g) 3 bond pairs between N & H [1]

Lone pair on N [1]

(h) (proton / H^+ acceptor

(ii) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ [2]

Formula of $(NH_4)_2SO_4$ (1)
The rest (1)

[Total:18]

3 **(a** soft because weak forces between layers/sheets/rows [1]

layers can slip/slide [1]

good conductor because electrons can move/mobile [1]

(b) it is soft: pencils **or** lubricant **or** polish [1]
good conductor: electrodes **or** brushes (in electric motors) [1]

(c) (i) every silicon atom is bonded/attached to 4 oxygen atoms or every oxygen bonded/attached to two silicon atoms [1]

(ii) Any **two** from:
high melting point/boiling point
hard
colourless crystals/shiny
poor/non-conductor of electricity/insulator
insoluble in water [2]

[Total: 8]

4 **(a** **<u>Bromine</u>**

Physical: reddish-brown liquid **or** brown liquid **or** volatile liquid/low boiling point liquid **or** poor/non-conductor (of electricity) **or** soluble in water **or** soluble in organic/non-polar solvents [1]

Chemical: Reacts with water **or** reacts with iodides (in solution) **or** displaces iodine **or** reacts with alkenes/named alkene/unsaturated hydrocarbons **or** reacts with alkane in UV/named alkane in UV **or** valency/oxidation state(–)1 **or** forms Br **or** gains or shares 1 electron **or** combines or reacts with metals/named metal **or** combines or reacts with non-metals/named non-metal **or** oxidising agent **or** bleaches litmus paper/indicator paper **or** corrosive **or** forms acidic oxides [1]

(b) **<u>Graphite</u>**

Physical: (good) conductor (of electricity) **or** soft **or** lubricant **or** high melting point/high boiling point **or** grey black **or** black solid **or** slippery or greasy (to touch) **or** brittle/breaks when subjected to stress **or** insoluble in water [1]

Chemical: reducing agent **or** reduces metal oxides/named metal oxide **or** reacts with/burns in air/oxygen **or** forms an acidic oxide (CO_2) **or** valency/oxidation state of 2 or 4 [1]

(c) **<u>Manganese</u>**

Physical: (good) conductor (of heat/electricity) **or** high melting point/high boiling point **or** forms coloured compounds/coloured ions **or** hard **or** strong **or** high density **or** malleable **or** ductile **or** sonorous **or** shiny [1]

Chemical: Variable or different valency/oxidation state/oxidation number **or** catalytic activity **or** forms coloured compounds/coloured ions **or** forms complex ions/complexes **or** reacts with acids **or** reducing agent **or** reacts with non-metals [1]

[Total: 6]

5 **(a) (i)** 3 [1]

(ii) 70 [1]

(b) Add octane (or other liquid hydrocarbon) (to soot) [1]

COND(on addition of **any** solvent) filter (to remove insoluble forms of carbon) [1]

(allow to) evaporate **or** heat **or** warm **or** leave in sun(to get crystals of fullerene) [1]

(c) graphite [1]

(ii) delocalised electrons/free electrons/sea of electrons [1]

COND (on electrons) move/mobile/electrons flow [1]

(iii) Any **two** from: [2]
potassium oxide
potassium hydroxide
potassium carbonate
potassium hydrogencarbonate (bicarbonate)

[Total: 10]

6 **(a)** A and E **need both** (1)

(b) D (1) [1]

(c) C (1) [1]

(d) B (1) [1]

(e) F (1) [1]

(f) E (1) [1]

(g) C (1) [1]

[Total: 7]

7 **(a)** **(i)** add carbon / animal charcoal [1]
filter [1]

OR

repeat experiment without indicator [1]
using same quantity / volume of acid [1]

(ii) add magnesium metal / carbonate / oxide / hydroxide
to (hot) (hydrochloric) acid [1]

cond: until in excess **or** no more dissolves **or** reacts [1]

cond: filter (to remove unreacted solid) [1]

(b) number of moles of HC*l* = 0.020 x 2.20 = 0.044 [1]
number of moles of LiOH = 0.044
concentration of LiOH = 0.044/0.025 = 1.769 (mol / dm^3) [1
accept 1.75 to 1.77 need 2 dp
correct answer scores = 2

(c) (for LiC*l*.2H_2O)
mass of one mole = 78.5 [1]
percentage water = 36 / 78.5 x 100 [1]
45.9 so is LiC*l*.2H_2O [1
only award the marks if you can follow the reasoning and it gives 45.9% of water

note: if correct option given mark this and ignore the rest of the response

allow: max 2 for applying a correct method to another hydrate, [1] for the method and [1] for the correct value, working essential

[Total: 10]