

Question	Answer	Marks	Guidance
1 (a)	<p>both correct charges of ions (calcium 2+ and nitrogen 3-);</p> <p>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);</p> <p>M3 Two electrons on the inner shell on any nitride ions/nitrogen atom: allow 2x or 2o once;</p>	3	<p>Charges can be shown anywhere I missing symbols for nitrogen R wrong symbol of nitrogen anywhere</p> <p>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</p> <p><i>General guidance:</i> I electron configuration/symbol of calcium ion I formulae/stoichiometry Covalent can score only M3</p>
(b)(i)	<p>/ repeated / pattern / framework / periodic / ordered / alternating / organised;</p> <p>(of) particles / atoms / molecules / ions / cations / anions;</p>	2	<p>I layers</p> <p>A ionic / molecular / atomic I arrangement / bonding / properties</p>
(b)(ii)	<p>(so that ionic) charges balance or cancel / charge = 0 / no charge / number of positive = number of negative charges / charge is neutral or neutralised;</p> <p>M2 $3(-) \times 2 = 2(+) \times 3$;</p>	2	<p>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</p>

Question	Answer	Marks	Guidance
(c)	<p>it (refers to Ca)/Calcium/Ca (atom) loses/gives/donates electrons/e/e ;</p> <p>(these are) gained by nitrogen/N/N₂ ;</p> <p>nitrogen/N/N₂ 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);</p>	3	<p>A half-equation with electrons on right-hand side R calcium ion/Ca²⁺</p> <p>A half-equation with electrons on left-hand side R nitride ion/N³⁻ 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</p> <p>Electrons/e/e move from calcium to nitrogen get marks 1 and 2</p> <p>A calcium/Ca/it is a reductant or calcium/Ca/it reduces</p>

- 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 OR / high pressure
favours reaction which produces fewer molecules or moles or volume [1]
(ii) particles / molecules closer / 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) **Bromine**
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) **Graphite**
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 (CO₂) **or** valency/oxidation state of 2 or 4 [1]

(c) **Manganese**
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 [1]
to (hot) (hydrochloric) acid
- cond:** until in excess **or** no more dissolves **or** reacts [1]
- cond:** filter (to remove unreacted solid) [1]
- (b) number of moles of HCl = $0.020 \times 2.20 = 0.044$ [1]
number of moles of LiOH = 0.044
concentration of LiOH = $0.044/0.025 = 1.769$ (mol / dm³) [1]
accept 1.75 to 1.77 need 2 dp
correct answer scores = 2
- (c) (for LiCl.2H₂O) [1]
mass of one mole = 78.5 [1]
percentage water = $36 / 78.5 \times 100$ [1]
45.9 so is LiCl.2H₂O [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]