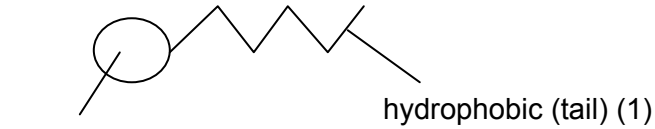
Question	Answer	Marks	Guidance
1 a	**B** (1) not poisonous (1) no smell (1)	3	**A** or **C** scores 0 for the question **allow** ora, eg A is not suitable as it is poisonous (1) **allow** ora, eg D is not suitable as it has a smell (1) **allow D** since it is not poisonous (1)
b i	 	2	**allow** one mark if the correct labels are swapped around **allow** a straight line for the tail **ignore** water loving / water hating
ii	**any two from:** **cell** walls rupture (1) (resulting in) loss of (rigid) structure / a softer texture (1) starch grains swell up (1)	2	 **allow cell** walls break down or burst (1) **ignore** cellulose breaks down **allow** potato becomes softer (1) **allow** starch (molecules) swell up (1) **ignore** cells swell up **ignore** references to surface area **ignore** references to denaturing **ignore** references to proteins
	Total	**7**	

Question	Answer	Marks	Guidance
2	**any two from:** idea that results on animals not (necessarily) same as with humans (1) animals do not have a choice of being tested (1) idea that may harm or hurt the animal / testing is cruel (1)	2	 **allow** idea that animals have rights / morally wrong / unethical (1) **ignore** references to alternative methods of testing cosmetics
	Total	**2**	

Question	Answer	Marks	Guidance
3 a	sand and water ☐ limestone and sand ☐ limestone and clay ✓ limestone and granite ☐ sand and clay ☐	1	**more than one tick scores 0**
b i	**any two from:** steel is strong (under tension) (1) steel is (more) flexible (1) steel stops the concrete stretching / cracking / breaking (1) concrete is hard (1) concrete is strong **under compression** (1)	2	**Assume unqualified answers refer to reinforced concrete** **allow** steel gives concrete (more) strength (1) **allow** concrete cracks (without steel reinforcing) (1) **allow** combines the strength and flexibility of steel with the hardness of concrete (2) **ignore** reinforced concrete is a composite material **if no other mark awarded**, **allow** reinforced concrete is stronger or reinforced concrete is more flexible (1)
b ii	(**C** because) **any two from:** strong**est** (1) (very good) resistance to corrosion (1) easily shaped (1) low density (1) other properties more important than high cost (1)	2	**marks are for explanation** **if A or B chosen scores 0** **allow** doesn't corrode (1) **ignore** light, but **allow** lightweight (1)
	Total	**5**	

Question	Answer	Marks	Guidance
4 a	(no because) **hastelloy** is more resistant to corrosion at **high(er) concentrations** of acid (at 20°C) / ora (1) but (yes because) all (three) metals are more resistant to corrosion at **low(er) temperatures** / ora (1)	2	**marks are for explanations**
b i	0.6 (cm^3/hour) (1)	1	
b ii	(pH) 6	1	
c	$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$ formulae (1) balancing (1)	2	balancing mark is conditional on correct formulae **allow** any correct multiple e.g. $4Al + 6H_2SO_4 \rightarrow 2Al_2(SO_4)_3 + 6H_2$ **allow** = or $\rightleftharpoons$ for arrow **not** 'and' or & for + **allow** one mark for correct balanced equation with incorrect use of upper and lower case formulae e.g. $2Al + 3H_2SO4 \rightarrow Al2(So_4)_3 + 3H_2$
	Total	**6**	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5 a</td><td>argument for:
(world) population is rising /
(so) need to produce more food (1)

argument against:
eutrophication or death of aquatic organisms (from excessive use of fertilisers) /
idea of pollution of water supplies (from excessive use of fertilisers) (1)</td><td>2</td><td>must have an argument for and an argument against the use of fertilisers for 2 marks

allow increasing population to feed (1)
allow fertilisers increase crop yield (1)
allow higher level answers
eg replace essential elements (used by a previous crop) (1)
ignore crops grow bigger or faster or idea of better crops

ignore cost</td></tr>
<tr><td>b i</td><td><table><tr><th>Atom</th><th>Number</th></tr><tr><td>N</td><td>3</td></tr><tr><td>H</td><td>12</td></tr><tr><td>P</td><td>1</td></tr><tr><td>O</td><td>4</td></tr></table>all four correct scores (2)
two or three correct scores (1)
one correct scores (0)</td><td>2</td><td></td></tr>
</table>

Question	Answer	Marks	Guidance
b ii	**Level 3** **States the name of the acid <u>and</u> the alkali needed to make ammonium phosphate** **AND** **fully describes how ammonium phosphate can be made.** Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **Level 2** **States the name of the acid <u>and</u> the alkali needed to make ammonium phosphate** **AND** **attempts to describe how ammonium phosphate can be made.** Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **Level 1** **States the name of the acid <u>and</u> the alkali needed to make ammonium phosphate** **OR** **attempts to describe how ammonium phosphate can be made.** Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **Level 0** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to A** **Indicative scientific points may include:** **Acid** needed is phosphoric acid / H_3PO_4 **Alkali** needed is ammonia / ammonium hydroxide / NH_3 / NH_4OH **ignore** ammonia hydroxide **To make ammonium phosphate:** • titrate the acid with the alkali, using an indicator / add the acid to the alkali (or vice versa), using an indicator • repeat the titration until consistent results are obtained • use the titration result to add the correct amounts of acid and alkali together without the indicator / decolourise indicator with carbon • evaporate (most of) the solution • leave the remaining solution to crystallise **allow** add excess ammonia to phosphoric acid and then heat the mixture to drive off the excess ammonia **Use the L1, L2, L3 annotations in Scoris. Do not use ticks.**
	Total	**10**	

Question	Answer	Marks	Guidance
6 a	**any one from:** idea of easier for quality control / idea that batches can be traced and recalled (1) idea of matching seasonal demand (1) often only a small amount of the drug is needed / not in high demand / ora (1) idea that you can switch to making a different drug (1)	1	**allow** idea of fluctuating demand (1) **allow** (drugs) aren't needed all the time (1) **allow** idea that made in batches so that they don't go out of date (1) **ignore** references to cost
b	**any two from:** takes a long time to research or test the drug (1) raw materials may be rare (1) purification procedures may be expensive / quality control is expensive (1) may be difficult to automate so expensive labour costs (1) idea that strict safety laws have to be met (1)	2	**allow** idea that many tests need to be carried out (in developing a drug) (1) **allow** raw materials are difficult to extract (from plants) (1) **ignore** raw materials are expensive **allow** idea of high wages for skilled workers / scientists (1)
	Total	**3**	

Question	Answer	Marks	Guidance
7	**Level 3** **Analyses table to evaluate advantages AND disadvantages of <u>all three</u> types of treatment AND explains fully how attaching magnesium to iron helps to prevent rusting.** Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **Level 2** **EITHER** **Analyses table to evaluate advantages AND disadvantages of <u>all three</u> types of treatment** **OR** **Analyses table to evaluate advantages AND disadvantages of <u>two</u> types of treatment AND attempts to explain how attaching magnesium to iron helps to prevent rusting.** Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **Level 1** **EITHER** **Analyses table to evaluate an advantage AND a disadvantage of <u>one</u> type of treatment** **OR** **attempts to explain how attaching magnesium to iron helps to prevent rusting.** Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **Level 0** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to A/A*.** **Indicative scientific points may include:** **Evaluations** • idea that painting is cheap but does not last long • idea that alloying is the best method of rust prevention but is the most expensive • idea that alloying is difficult to do • idea that attaching magnesium is expensive but lasts a long time **How attaching magnesium to iron helps prevent rusting** • idea that magnesium is a sacrificial metal • idea that magnesium is more reactive than iron and so reacts instead of the iron • magnesium loses electrons in preference to iron • magnesium is a better reducing agent • magnesium is easier to oxidise **ignore** reference to magnesium rusting **Use the L1, L2, L3 annotations in Scoris; do not use ticks.**
		6	

Question	Answer	Marks	Guidance
8 a i	transparent (1)	1	**allow** insoluble (in water) / waterproof / does not react with water (1) **allow** clear / see through / colourless (1) **allow** does not biodegrade / does not decompose / does not decay (1) **allow** does not photodegrade (1) **ignore** shatterproof / strong
a ii	(aluminium car body) will corrode less / does not corrode (1)	1	**assume unqualified answer refers to aluminium** **allow** (aluminium car body) will have a longer lifetime (1) **allow** aluminium does not rust (1) but **not** aluminium does not rust as easily (0) **allow** aluminium does not oxidise (in air) (1) **ignore** aluminium is less corrosive **allow** car will have better fuel economy (1) **allow** ora for steel **ignore** aluminium is easier to mould / is more flexible **not** stronger
b	(PVC) has high flexibility / is flexible / aw (1) (PVC) has low (electrical) conductivity / is a poor (electrical) conductor / does not conduct (electricity) / aw (1)	2	**ignore** references to density **allow** is an (electrical) insulator (1)
	Total	**4**	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>9 a</td><td><table><tr><th></th><th>Number of atoms</th></tr><tr><td>nitrogen</td><td>2</td></tr><tr><td>hydrogen</td><td>8</td></tr><tr><td>sulfur</td><td>1</td></tr><tr><td>oxygen</td><td>4</td></tr></table>(1)</td><td>1</td><td></td></tr>
<tr><td>b</td><td>names of reactants:
(acid is) sulfuric acid (1)
(alkali is) ammonia / ammonium hydroxide / ammonium carbonate / ammonium hydrogencarbonate (1)

AND

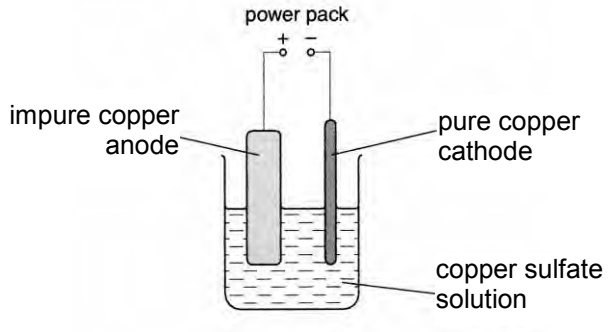
any one from:

acid is titrated with alkali using an indicator / idea of controlled addition of acid to alkali with use of indicator (1)

(heat to) evaporate water / leave solution to crystallise (1)</td><td>3</td><td>allow correct formulae or mix of formula and name
H_2SO_4
NH_3 / NH_4OH / $(NH_4)_2CO_3$ / NH_4HCO_3
not ammonium / NH_4 / ammonia hydroxide

allow acid is added to alkali (or vice versa) until a neutral solution is obtained (1)
allow idea of controlled addition of acid to alkali with use of pH meter or test with indicator paper (1)</td></tr>
</table>

Question	Answer	Marks	Guidance
c	**[Level 3]** **Answer describes advantages AND disadvantages of conditions used** **AND** **includes the balanced symbol equation for the reaction.** Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **[Level 2]** **Answer describes an advantage AND a disadvantage of conditions used** **OR** **includes the balanced symbol equation for the reaction.** Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **[Level 1]** **Answer describes <u>either</u> an advantage <u>or</u> a disadvantage of conditions used** **OR** **includes the symbol equation for the reaction (may not be balanced).** Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to A*** **Indicative scientific points may include:** **Symbol equation** $NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$ **allow** any correct multiple, including fractions **allow** = / ⇌ instead of → **not** and / & instead of '+' **Advantages of conditions listed** • high temperature or temperature of 900°C increases rate of reaction • (platinum) catalyst reduces costs • (platinum) catalyst increases rate of reaction • atmospheric pressure means lower energy costs • atmospheric pressure means lower plant costs **Disadvantages of conditions listed** • high temperature or temperature of 900°C increases energy use or expensive • high temperature reduces percentage yield • (platinum) catalyst is (initially) expensive • atmospheric pressure means slower rate of reaction **allow** answers in terms of position of equilibrium e.g. more moles on LHS so should use higher pressure e.g. if reaction is exothermic equilibrium is on LHS at higher temperature **Use the L1, L2, L3 annotations in Scoris; do not use ticks.**
	Total	**10**	

Question	Answer	Marks	Guidance
10 a	(copper because) good resistance to corrosion (1) **or** (aluminium because) good resistance to corrosion (1) low density (1) **or** (stainless steel because) good resistance to corrosion (1) strong (1) cheap(est) (1) **or** (titanium because) good resistance to corrosion (1) strong (1) low density (1)	3	**No mark for the metal – the mark is for the correct reason** **ignore** other properties **allow** copper does not rust (1) but **not** copper does not rust as easily **allow** aluminium does not rust (1) but **not** aluminium does not rust as easily **allow** lightweight (1), but **ignore** just light **allow only** £900 per tonne (1) **allow** titanium does not rust (1) but **not** titanium does not rust as easily **allow** lightweight (1), but **ignore** just light
b		2	**all three** labels correct scores 2 marks **one or two** labels correct scores 1 mark
	Total	**5**	

Question			Answer	Marks	Guidance
11	(a)	(i)	4 (1)	1	
		(ii)	15 (1)	1	
	(b)		**Level 3 (5–6 marks)** **Names <u>both</u> the reagents needed** **<u>AND</u>** **Describes a neutralisation experiment, including how both a neutral solution <u>and</u> solid ammonium sulfate is obtained.** Quality of written communication does not impede communication of the science at this level. **Level 2 (3–4 marks)** **Names <u>both</u> the reagents needed** **<u>AND</u>** **Attempts to describe a neutralisation experiment.** Quality of written communication partly impedes communication of the science at this level. **Level 1 (1–2 marks)** **Names <u>one</u> of the reagents needed** **<u>OR</u>** **Attempts to describe a neutralisation experiment.** Quality of written communication impedes communication of the science at this level. **Level 0 (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	**This question is targeted at grades up to A*.** **Indicative scientific points may include:** **names of reagents** • acid is sulfuric acid • alkali is (a solution of) ammonia or ammonium hydroxide or ammonium carbonate. **method** • sulfuric acid is added to ammonia solution until a neutral solution is formed • neutral solution obtained by use of pH meter / indicator solution / indicator paper / universal indicator solution • the neutral solution is evaporated until saturated • solution is allowed to stand and crystallise • crystals are filtered off and dried. **allow** idea of 'evaporation to dryness' as an alternative to crystallisation **N.B.** It is not necessary to describe a titration method to get Level 3. **Use the L1, L2, L3 annotations in scoris; do not use ticks.**
			Total	**8**	

Question			Answer	Marks	Guidance
12	(a)		**any one from:** idea that pharmaceutical drugs are usually required or made in smaller quantities (1) idea that pharmaceutical drugs are made as required (1) **any one from:** idea that fertilisers are made in large quantities (1) idea that fertilisers are made 24/7 (1)	2	must be **one** comment on pharmaceutical drugs and **one** on fertilisers for two marks **allow** idea that can control each batch for purity (1)

Question			Answer	Marks	Guidance
	(b)		**Level 3 (5–6 marks)** **Calculates the atom economy for the given reaction** **AND** **Explains clearly why an industrial process should have as high an atom economy as possible.** Quality of written communication does not impede communication of the science at this level. **Level 2 (3–4 marks)** **Calculates the atom economy for the given reaction** **OR** **Gives at least two reasons why an industrial process should have as high an atom economy as possible.** Quality of written communication partly impedes communication of the science at this level. **Level 1 (1–2 marks)** **Gives a reason why an industrial process should have as high an atom economy as possible** **OR** **calculates the required formula masses of magnesium nitrate and water.** Quality of written communication impedes communication of the science at this level. **Level 0 (0 marks)** Insufficient or irrelevant science such as repeating the question. Answer not worthy of credit.	6	**This question is targeted at grades up to A*.** **Indicative scientific points may include:** **reasons for need for high atom economy:** • to reduce the production of unwanted products (makes less waste is **not** sufficient) • to make the process more sustainable • in this reaction water is the only unwanted product so the process is very green. **calculation of atom economy:** • recall $\text{atom economy} = \frac{\text{molecular mass of all of the desired products}}{\text{sum of all of the molecular masses of all of the products}} \times 100\%$ • formula mass of magnesium nitrate = 148 • formula mass of water = 18 • formula mass of all products = 166 • atom economy = 89%. **Use the L1, L2, L3 annotations in scoris; do not use ticks.**
			Total	**8**	