National 5 Chemistry
Unit 3.3 Fertilisers

		Lesson	Traffic Light		
			Red	Amber	Green
31 32	Growing plants require nutrients, including compounds containing nitrogen, phosphorus or potassium • fertilisers are substances which restore to the soil elements essential for healthy plant growth		☹	😐	☺
33	Ammonia and nitric acid are important compounds used to produce soluble, nitrogen-containing salts that can be used as fertilisers. • fertilisers must be soluble if they are to be absorbed by plants through their roots		☹	😐	☺
34	Ammonia is a pungent, clear, colourless gas • ammonia dissolves in water to produce an alkaline solution • ammonium hydroxide solution is formed although the balance is more molecule of ammonia than ions of ammonium and hydroxide ammonia + water ⟶ ammonium ion + hydroxide ion $NH_{3(aq)} + H_2O_{(l)} \longrightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$		☹	😐	☺
35	Ammonia solutions react with acids to form soluble salts ammonia solution + acid ⟶ ammonium salt + water ammonia solution + hydrochloric acid ⟶ ammonium chloride + water $NH_4OH_{(aq)} + HCl_{(aq)} \longrightarrow NH_4Cl_{(aq)} + H_2O_{(l)}$		☹	😐	☺
36	The Haber Process is the industrial process where ammonia is made for production of fertilisers $N_{2(g)} + 3H_{2(g)} \xrightarrow[\text{catalyst}]{\text{iron}} 2NH_{3(g)}$ Nitrogen + Hydrogen ⟶ Ammonia		☹	😐	☺
37	At low temperatures the forward reaction is too slow to be economical • if the temperature is increased, the rate of reaction increases • however as the temperature increases, the backward reaction becomes increases • 100% ammonia is never produced as the rate of breakdown of ammonia eventually equals the rate of formation of ammonia • an iron catalyst is used to increase reaction rate		☹	😐	☺
38 39	The Ostwald process uses ammonia, oxygen and water to produce nitric acid. • ammonia is the starting material for the commercial production of nitric acid. • a platinum catalyst is used in this process. $4NH_3 + 7O_2 \xrightarrow[\text{catalyst}]{\text{platinum}} 4NO_2 + 6H_2O$ ammonia + oxygen ⟶ nitrogen dioxide + water water ↓ Nitric acid		☹	😐	☺

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Past Paper Question Bank
Unit 3.3 Fertilisers

JABchem

Outcome	Original Specimen Paper	New Specimen Paper	Nat5 2014	Nat5 2015	Nat5 2016	Nat5 2017	Nat5 2018	Nat5 2019	Nat5 2020	Nat5 2021						
31 32						mc17	mc20									
33					L6a(ii)											
34								L3b								
35																
36		L12b(i)	L7a(i)	L5a	L1c(ii)	mc18										
37	L11b	L12b(ii)														
38 39		L12c	L7b(i)				mc21 L10c									

Nat5	Answer	% Correct	Reasoning
2017 MC 17	A	70	☑A Oxygen is not an essential element for healthy plant growth ☒B Nitrogen in an essential element for plants and found in fertilisers ☒C Potassium in an essential element for plants and found in fertilisers ☒D Phosphorus in an essential element for plants and found in fertilisers
2017 MC 18	B	95	☒A Nitric acid is made by the Ostwald Process ☑B Ammonium is made by the Haber Process ☒C Alkenes can be made by cracking alkanes ☒D Esters are made by the condensation of alcohols and carboxylic acids
2018 MC 20	C	-	☒A Ammonium chloride contains the element nitrogen and is soluble ☒B Ammonium phosphate contains elements nitrogen & phosphorus and is soluble ☑C sodium chloride does not contain nitrogen, phosphorus or potassium ☒D Sodium phosphate contains the element phosphorus and is soluble
2018 MC 21	C	-	☒A Nickel is the catalyst used in the production of margarine from vegetable oil ☒B Platinum is the catalyst in the Ostwald Process where nitric acid is produced ☑C iron is the catalyst in the Haber Process where ammonia is produced ☒D Rhodium is a transition metal used in a catalytic converter in a car

Nat5	Answer	Reasoning
2014 7a(i)	Haber Process	Nitrogen + Hydrogen $\xrightarrow{\text{iron catalyst}}$ Ammonia
2014 7b(ii)	Water or H_2O	Nitric acid is made by dissolving nitrogen dioxide in water to form nitric acid. Some nitrogen monoxide is also formed during the reaction which is recycled back into the process.
2015 5a	Iron	Iron is the catalyst in the Haber Process where nitrogen and hydrogen react to become ammonia NH_3.
2016 1c(ii)	Haber Process	Nitrogen + Hydrogen $\xrightarrow{\text{iron catalyst}}$ Ammonia
2016 6a(ii)	Ammonium contains nitrogen	Fertilisers contain soluble compounds of one or more of the following elements Nitrogen | Phosphorus | Potassium
2018 10c	Ostwald Process	ammonia + oxygen $\xrightarrow[\text{catalyst}]{\text{platinum}}$ nitrogen monoxide + water $4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$ $4NO \xrightarrow{\text{oxygen}} NO_2$ $NO_2 \xrightarrow{\text{water}}$ Nitric Acid
2019 3b	Blue or purple	Ammonia NH_3 gas dissolves in water to form alkaline ammonium hydroxide solution. Alkali on the damp/moist pH paper will turn blue/purple. $NH_{3(g)}$ (ammonia) + $H_2O_{(l)}$ (water) $\longrightarrow$ $NH_4^+{}_{(aq)}$ (ammonium ion) + $OH^-{}_{(aq)}$ (hydroxide ion)

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Outcome	Int2 2000	Int2 2001	Int2 2002	Int2 2003	Int2 2004	Int2 2005	Int2 2006	Int2 2007	Int2 2008	Int2 2009	Int2 2010	Int2 2011	Int2 2012	Int2 2013	Int2 2014	Int2 2015
31 32	L4b				L6c			mc23							mc24	mc28
33																
34		mc18	mc19	mc16	mc26 L6b						mc18					
35																
36																
37																
38 39																

Int2	Answer	% Correct	Reasoning
2001 MC 18	D	66	Ammonia is an alkali: <table><tr><td>Acidic</td><td>Neutral</td><td>Alkaline</td></tr><tr><td>pH < 7</td><td>pH=7</td><td>pH>7</td></tr></table>
2002 MC 19	D	67	Ammonia dissolves in water to form the weak alkali ammonium hydroxide ∴ pH >7
2003 MC 16	A	79	☑A ammonia dissolves in water to form the weak alkali ammonium hydroxide (pH>7) ☒B non-metal oxides e.g. carbon dioxide dissolve in water to form an acid (pH<7) ☒C non-metal oxides e.g. sulphur dioxide dissolve in water to form an acid (pH<7) ☒D sodium chloride dissolves in water to give a neutral solution (pH=7)
2004 MC 26	A	38	☑A Nitrogen dioxide is an acidic oxide so reacts with an alkaline solution ☒B Ammonia forms an alkali in water so does not react with an alkaline solution ☒C Oxygen is neutral so does not react with and alkaline solution ☒D Argon is neutral in water so does not react with an alkaline solution
2007 MC 23	C	71	☒A Can be used as a fertiliser: soluble compound containing nitrogen ☒B Can be used as a fertiliser: soluble compound containing potassium + nitrogen ☑C Cannot be a fertiliser as it does not contain nitrogen, potassium or phosphorus ☒D Can be used as a fertiliser: soluble compound containing potassium
2010 MC 18	A	74	☑A Ammonia dissolves in water to form ammonium hydroxide ∴ alkaline pH>7 ☒B Carbon dioxide dissolves in water to form carbonic acid ∴ acidic pH<7 ☒C Sulphur Dioxide dissolves in water to form sulphurous acid ∴ acidic pH<7 ☒D Sodium chloride dissolves in water to form a neutral solution ∴ pH=7
2014 MC 24	D	57	☒A sodium nitrate is suitable as a fertiliser as it is soluble and contains nitrogen ☒B ammonium nitrate is suitable as a fertiliser as it is soluble and contains nitrogen ☒C ammonium sulphate is suitable as a fertiliser as it is soluble and contains nitrogen ☑D sodium sulphate is not a fertiliser as it has no nitrogen, phosphorus or potassium
2015 MC 28	D	73	☒A ammonium nitrate NH_4NO_3 contains the element nitrogen ☒B ammonium sulphate $(NH_4)_2SO_4$ contains the element nitrogen ☒C potassium nitrate KNO_3 contains the element nitrogen ☑D potassium sulphate K_2SO_4 cannot be used as a fertiliser as it lacks nitrogen

Int2	Answer	Reasoning
2000 4b	Fertilisers	Fertilisers are soluble compounds containing the following elements: Nitrogen Phosphorus Potassium
2004 6b	Turns blue	Ammonia gas dissolves in the water on damp pH paper and turns it blue. Ammonia dissolves in water to form ammonium hydroxide
2004 6c	Fertiliser	Fertilisers are soluble compounds containing the elements: <table><tr><td>Nitrogen</td><td>Phosphorus</td><td>Potassium</td></tr></table>

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Past Paper Question Bank
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Outcome	2000 Credit	2001 Credit	2002 Credit	2003 Credit	2004 Credit	2005 Credit	2006 Credit	2007 Credit	2008 Credit	2009 Credit	2010 Credit	2011 Credit	2012 Credit	2013 Credit		
31 32		13a(ii)												11a(ii)		
33																
34					18b											
35			18c													
36	17a	16a							18c					11b		
37	17b		18d(ii)										12c			
38 39						15b(i) 15b(ii)				14a(i) 14a(ii) 14a(iii)		19b(i) 19b(ii)				

SG Credit	Answer	Reasoning
2000C 17a	Haber Process	Nitrogen + Hydrogen $\xrightarrow{\text{iron}}$ Ammonia
2000C 17b	Ammonia breaks down or yield decreases	The Haber Process does not give 100% ammonia as it starts to breaks down as fast as it is produced. The higher the temperature the less ammonia is produced.
2001C 13a(ii)	ammonium phosphate	Data booklet p8 gives names of NH_4^+ and PO_4^{3-} ions
2001C 16a	Iron	Nitrogen + Hydrogen $\xrightarrow{\text{iron}}$ Ammonia
2002C 18c	ammonium phosphate	Ammonia forms ammonium hydroxide in water and is neutralised by phosphoric acid: ammonium hydroxide + phosphoric acid $\longrightarrow$ ammonium phosphate + water
2002C 18d(ii)	Ammonia breaks down before reaching 100% NH_3	$N_2 + 3H_2 \longrightarrow 2NH_3$ reaction never reaches 100% NH_3 as the NH_3 breaks back down to the reactants.
2004C 18b	Above 7	Ammonium hydroxide solution produced so an alkaline pH (above 7) is formed in the water

2005C 15b(i)	Ostwald Process	$NH_3 + O_2 \xrightarrow[\text{catalyst}]{Pt} NO_2 + H_2O$ NO_2 gas dissolves in water to form nitric acid HNO_3
2005C 15b(ii)	The reaction is exothermic or gives out heat	The reaction in the Ostwald Process gives out enough heat energy to maintain the high temperature once the reaction is hot enough to get started.
2008C 18c	ammonia NH_3	$N_{2(g)}$ + $3H_{2(g)}$ $\xrightarrow{\text{iron catalyst}}$ $2NH_{3(g)}$ nitrogen hydrogen ammonia
2009C 14a(i)	Ostwald	Ammonia + Oxygen $\xrightarrow[\text{catalyst}]{\text{platinum}}$ Nitrogen Dioxide + Water Nitrogen Dioxide dissolves in Water to make Nitric Acid
2009C 14a(ii)	Exothermic Reaction Or heat given off	The Ostwald process is exothermic and the heat energy released during the reaction is enough to keep the reaction hot enough to proceed, as long as there is enough reactants to continue reaction.
2009C 14a(iii)	water	NO_2 dissolves in water to form nitric acid (air must be present)
2011C 19b(i)	platinum	$NH_3 + O_2 \xrightarrow[\text{catalyst}]{Pt} NO_2 + H_2O$
2011C 19b(ii)	Reaction is exothermic	Ostwald Process is exothermic and gives out heat. Once reaction starts, the heat given off during the reaction is enough to heat the reactions from that point onwards.
2012C 12c	Answer to include:	Reactions can be faster at higher temperatures and can produce more product in a shorter time.
2013C 11a(ii)	Restore essential elements to soil	Fertilisers are • soluble compounds • containing at least one element from potassium, phosphorus or nitrogen added to soil to restore the essential element compounds to the soil to aid growth of plants.
2013C 11b	Iron	Nitrogen + Hydrogen $\xrightarrow{\text{iron}}$ Ammonia

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Outcome	2000 General	2001 General	2002 General	2003 General	2004 General	2005 General	2006 General	2007 General	2008 General	2009 General	2010 General	2011 General	2012 General	2013 General		
31 32		14b	17c			19c(i)	12b(i)			16a(ii)	16a 16b					
33			17b				12b(ii)									
34	21b					19b				16b				17a		
35																
36			15b										11a			
37																
38 39		14a(i) 14a(ii)												17b		

SG General	Answer	Reasoning
2000G 21b	damp pH paper turns blue	$NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$ ammonia water ammonium hydroxide
2001G 14a(i)	Ostwald Process	Ammonia + Oxygen $\xrightarrow[\text{catalyst}]{\text{platinum}}$ Nitrogen Dioxide + Water Nitrogen Dioxide dissolves in Water to make Nitric Acid
2001G 14a(ii)	water	
2001G 14b	fertiliser	Ammonium Nitrate (NH_4NO_3) is a soluble compound containing nitrogen and can be used as a fertiliser.
2002G 15b	Haber Process	Nitrogen + Hydrogen $\xrightarrow{\text{iron catalyst}}$ Ammonia

2002G 17b	fertilisers must be soluble	Fertilisers are soluble compounds containing one or more of the elements: Nitrogen | Phosphorus | Potassium
2002G 17c	potassium	
2005G 19b	turns moist pH paper blue	NH_3 + H_2O ⟶ $NH_4^+ + OH^-$ ammonia → ammonium hydroxide (alkali)
2005G 19c(i)	nitrogen	3 essential elements for plants growth are Potassium, Nitrogen and Phosphorus
2006G 12b(i)	potassium or phosphorus	Fertilisers are soluble compounds which contain at least one of: Nitrogen, Potassium and/or Phosphorus
2006G 12b(ii)	solubility	All nitrates are soluble and fertilisers must be soluble
2009G 16a(ii)	Potassium K or phosphorus P	3 essential elements for plant growth are: Potassium, Phosphorus and Nitrogen
2009G 16b	Ammonia or NH_3	ammonium nitrate + calcium hydroxide ⟶ calcium nitrate + water + ammonia $2NH_4NO_3$ + $Ca(OH)_2$ ⟶ $Ca(NO_3)_2$ + $2H_2O$ + $2NH_3$
2010G 16a	potassium or phosphorus	Fertilisers are soluble compounds containing the elements: Nitrogen | Phosphorus | Potassium
2010G 16b	Must be soluble in water	A fertiliser is a soluble compound with one or more of the following elements: nitrogen, potassium and phosphorus
2012G 11a	Haber Process	Nitrogen + Hydrogen ⇌ (Fe catalyst) Ammonia N_2 + $3H_2$ ⇌ (Fe catalyst) $2NH_3$
2013G 17a	Blue/purple	Ammonia gas is given off when ammonium salts are heated with strong alkalis e.g. calcium hydroxide. Ammonia dissolves in water to form ammonium hydroxide which turns pH paper blue/purple.
2013G 17b	Ostwald Process	$NH_3 + O_2 \xrightarrow[\text{catalyst}]{Pt} NO_2 + H_2O$ NO_2 dissolves in water to form nitric acid