N4/5

CHEMISTRY

UNIT 3

Chemistry in Society

Learning Outcomes & Homework

Unit 3: Chemistry in Society

TOPIC 1: POLYMERS AND PLASTICS

LEVEL N4 N5	After completing this topic, you should be able to:	NOTES (Web 1)	How well I have understood (✓)		
			☺	😐	☹
N4	*I know that synthetic materials are made by the chemical industry. Most plastics and synthetic fibres are made from chemicals derived from oil*				
N4	*I can name some examples of plastics and state their uses, including special properties. polythene, polystyrene, perspex, PVC, nylon, bakelite, formica, kevlar, poly(ethanol), hydrogels and polylactic acid*				
N4	*Biopol is a recently developed degradable plastic. Most plastics are not biodegradable and their low density and durability can cause environmental problems.*				
N4	*Plastics can be either thermoplastic or thermosetting.* *A thermoplastic is one which can be reshaped on heating.* *A thermosetting plastic cannot be reshaped by heating.*				
N4	*Some plastics burn or smoulder to give off toxic fumes, including carbon monoxide, hydrogen chloride and hydrogen cyanide. The toxic gases given off during burning or smouldering can be related to the elements present in the plastic.*				
N4	*Plastics are made up of long chain molecules called polymers. Polymer molecules are made from many small molecules called monomers. Addition polymers are made from small unsaturated molecules, produced by cracking, by a process called addition polymerisation*				
N4	*With addition polymerisation, the small unsaturated molecules join together by the opening of the carbon to carbon double bond. The name of the addition polymer is related to the name of the monomer. The repeating unit or the structure of an addition polymer can be drawn given the monomer structure and vice versa*				
N5	*Condensation polymers are made from monomers with two functional groups per molecule – OH, COOH or* NH_2				
N5	*The repeating unit or the structure of a condensation polymer can be drawn given the monomer structures and vice versa.*				
N5	*Polyesters are examples of condensation polymers.*				
N5	*An amine can be identified from the functional group. Polyamides are examples of condensation polymers. The amide link is formed by the reaction of an amine group with a carboxyl group.*				

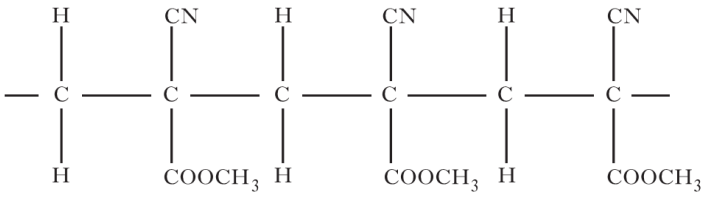
Exercise 3.1

Polymers and Plastics

1) About 2 million tonnes of ethane are produced each year in the UK. Most of this useful alkene is converted into poly(ethene), which is more familiar to people as polythene.

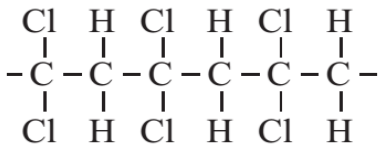
   a) Draw the full structural formula for ethene
   b) Explain, using full structural formulae, how ethene forms polyethene. In your answer, you should show how at least three ethene molecules join together.
   c) Polythene is a thermoplastic. Explain what this means.

2) When superglue sets, a polymer is formed. Part of the polymer structure is shown below:



   a) What is meant by addition polymerisation?
   b) Draw the repeating unit
   c) Draw the full structural formula for the monomer
   d) Name the toxic gas given off when superglue burns

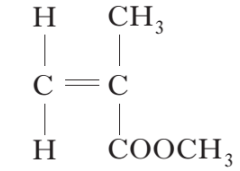
3) Polyvinyldichloride (PVDC) is a plastic used in food packaging. The structure of part of a PVDC molecule is shown.



   a) Draw the full structural formula for the monomer used to make PVDC.
   b) Name a toxic gas produced when PVDC burns.

4) Poly(methyl methacrylate) is a synthetic polymer used to manufacture perspex.

a) What is meant by the term synthetic?
b) The structure of the methyl methacrylate monomer is shown.

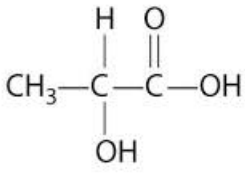


methyl methacrylate

i) Draw a section of the poly(methyl methacrylate) polymer, showing three monomer units joined together
ii) Name the type of polymerisation taking place.

c) Name a toxic gas produced when poly(methyl methacrylate) burns.

5) Poly(lactic) Acid, known as PLA, is a bio-plastic which is bio-degradable. It is made from corn or sugar cane. Bacteria ferment the sugar to produce lactic acid which is then polymerised in a condensation reaction. PLA has been made to make disposable cutlery, waste sacks, sutures used for internal wounds. The structure of lactic acid is shown:



Lactic acid

a) What is meant by bio-degradable?
b) Why do you think PLA can be considered to be a renewable synthetic polymer?
c) Name the two functional groups in lactic acid.

6) Nylon is a condensation polymer formed from the condensation reaction between a monomer containing two amine groups and a second monomer containing two carboxylic acid groups. The resulting polymer is known as a polyamide. The repeating unit for nylon is shown:

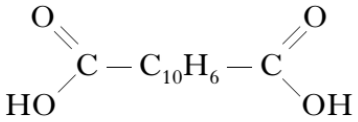
$$-[NH\ (CH_2)_6\ NH\ CO\ (CH_2)_8\ CO\ ]-_n$$

a) Write the full structural formulae for the two monomers from which it is made

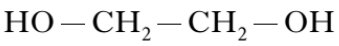
b) Is nylon a condensation polymer or an addition polymer?

c) Explain your choice of answer in (b) above.

7) Diols are widely used in the manufacture of polyester polymers. Polyethylene naphthalate is used to manufacture food containers. The monomers used to produce this polymer are shown.



naphthalenedicarboxylic acid



ethane-1,2-diol

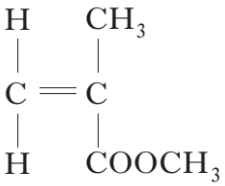
a) Draw the repeating unit for polyethylene naphthalate

b) What is the name of the link formed between the two monomers?

8) Poly(methyl methacrylate) is a synthetic polymer used to manufacture perspex.

a) What is meant by the term synthetic?

b) The structure of the methyl methacrylate monomer is shown:



methyl methacrylate

(i) Draw a section of the poly(methyl methacrylate) polymer, showing three monomer units joined together.

(ii) Name the type of polymerisation taking place.

c) Name a toxic gas produced when poly(methyl methacrylate) burns.

Unit 3: Chemistry in Society

TOPIC 2: METALS

LEVEL N4 N5	After completing this topic, you should be able to:	NOTES (Web 1)	How well I have understood (✓)		
			☺	😐	☹
	Extraction of Metals from their Ores				
N4	*Ores are naturally occurring compounds of metals, often containing oxygen*				
N4	*The less reactive metals, including gold, silver and copper, are found uncombined in the Earth's crust and the more reactive metals have to be extracted from their ores*				
N4	*Some metals can be obtained from metal oxides by heat alone; some metal oxides need to be heated with other substances, eg carbon or carbon monoxide; other metals cannot be obtained by these methods*				
N4	*Iron is produced from iron ore in the Blast Furnace. The production of carbon monoxide and the reduction of iron oxide are key reactions which take place in the Blast Furnace.*				
N4	*The more reactive metals, including aluminium, are obtained by electrolysis*				

Exercise 3.2

Metals and Extraction

1) Use the boxes below to answer questions a – e.

A. Aluminium	B. C	C, Gold	D. Fe
E. Lead	F. Mg	G. Mercury	H. P
I. Silver	J. Na	K. S	L Tin

a) Which two will not conduct electricity?

b) Which two are usually found uncombined in the Earth's crust?

c) Which one will react vigorously with cold water?

d) Which one is a liquid at room temperature?

e) Which one is extracted from its ore in a blast furnace

f) Steel is an alloy of these two

g) Which 3 metals cannot be extracted from their ores by heating with carbon?

2) There are various ways of extracting metals from their ores depending on the reactivity if the metal. Which method (a, b, or c) would you use to extract:

(i) Aluminium

(ii) Copper

(iii) Iron

(iv) Magnesium]

(v) Silver

(vi) Zinc.

Method
A heat alone
B. Heat with carbon
C. Some other method

3) A student carried out some experiments with four metals and their oxides. The results are shown in the table:

Metal	Reaction with cold water	Reaction with dilute acid	Effect of heat on metal oxide
W	no reaction	no reaction	no reaction
X	no reaction	gas produced	no reaction
Y	gas produced	gas produced	no reaction
Z	no reaction	no reaction	metal produced

a) Place the four metals in order of reactivity (most reactive first)

b) Name the gas produced when metal Y reacts with cold water.

c) Suggest names for metals Y and Z.

4) Explain why it is possible to extract mercury from mercury oxide by heat alone but it is not possible to extract lead from lead oxide by this method?

5) A coin made of pure copper does not last as long as one in which the copper has been alloyed with another metals such as zinc or nickel.

   a) State what is meant by the term “alloy”
   b) Suggest one possible change which is bought about by alloying that causes the coins to last longer.

6) Pure lead melts at 326 C and pure tin melts at 232 C. Solder is an alloy of lead and tin, there are different types of solder which have different compositions. They melt at different temperatures as shown in the data in the table below.

Composition of solder		**Temperature at which completely liquid**
%tin	**%lead**	
10	90	298
20	81	275
30	70	255
40	60	234
50	50	212
70	30	192
80	20	206
90	10	219
100	0	232

(a) Make a general statement about the melting temperature of the solder and its composition

(b) Draw a graph of composition against melting point

(c) Use your graph to predict what the lowest melting temperature would be for lead – tin solder.

(d) What is the composition of this solder?

7) Write word equations and balanced chemical reactions for the following:

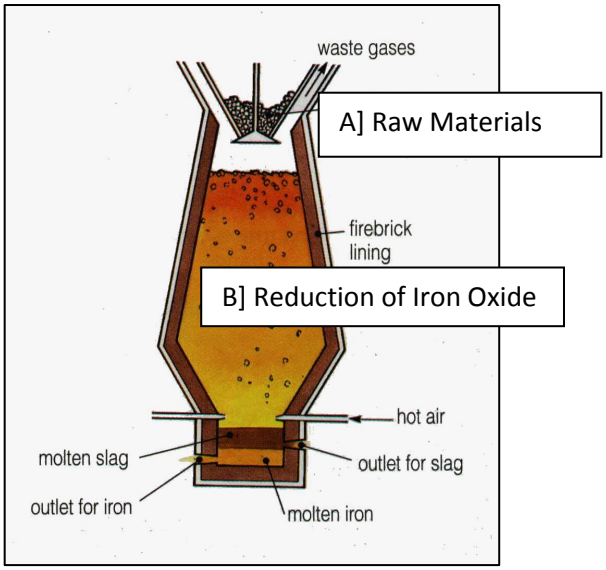
a) Magnesium and sulphuric acid

b) Potassium and water

c) Magnesium and oxygen

d) Aluminium and oxygen

8) Examine the diagram of the blast furnace.



a) Name the three raw materials at **A**

b) Write the balanced chemical equation for the reduction of iron oxide to iron at **B**

c) Using your balanced equation in b), calculate the mass of iron formed from the reduction of 1,500 tonnes of Fe_2O_3 assuming 65% conversion of the ore to iron.

d) Calculate the percent mass of Fe in Fe_2O_3

9) Iron ore is a mixture of compounds. One of these is called siderite and has the composition:

Iron	48.3%
Oxygen	41.4%
Carbon	10.3%

Calculate the empirical formulae of siderite.

10) Copper is produced from the reduction of copper (II) oxide with carbon. The balanced chemical equation is:

$$2CuO_{(s)} + C_{(s)} \rightarrow 2Cu_{(s)} + CO_{2(g)}$$

a) In a copper smelter, how many tonnes of carbon (charcoal or coke) is needed to make 16 tonnes of copper?

b) How many tonnes of copper can be made from 640 tonnes of copper oxide ore?

11) Aluminium is extracted from the ore bauxite.

a) What method is used to extract aluminium from bauxite?
b) Aluminium can be mixed with other metals to make a magnet. What term is used to describe a mixture of metals?
c) The composition of a 250 g magnet is shown:

Metal	aluminium	nickel	cobalt	copper	titanium	iron
% by mass	10	25	20	4	1	40

(i) Calculate the mass, in grams, of aluminium in the magnet. Show your working clearly.
(ii) Using your answer to c(i), calculate the number of moles of aluminium in the magnet. Show your working clearly.

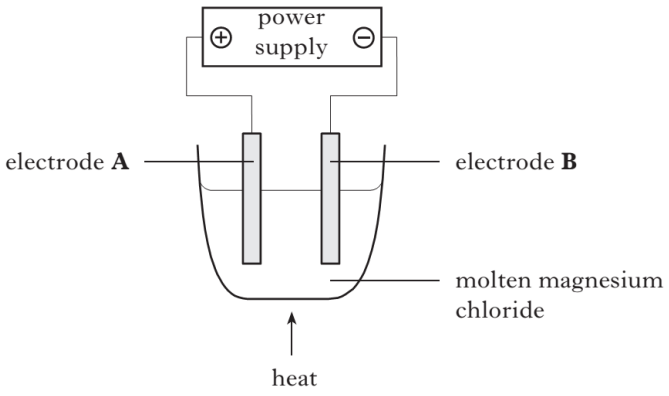
12) Titanium is an important metal used in aircraft manufacture.

a) Titanium can be produced from titanium chloride as shown.

$$2Mg(s) + TiCl_4(\ell) \longrightarrow 2MgCl_2(s) + Ti(s)$$

Name the type of chemical reaction represented by the equation.

b) The magnesium chloride produced can be electrolysed as shown.



(i) At which electrode would magnesium be produced, A or B?
(ii) Write the ion-electron equation for the formation of chlorine. You may wish to use the data booklet to help you.

Unit 3: Chemistry in Society

TOPIC 3: CORROSION AND REDOX

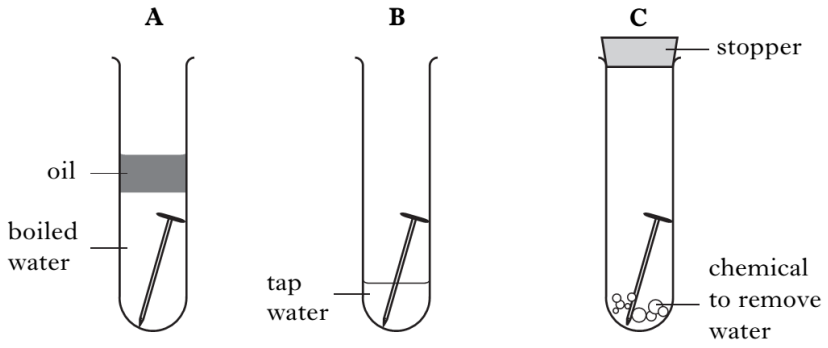
LEVEL N4 N5	After completing this topic, you should be able to:	NOTES (Web 1)	How well I have understood (✓)		
			☺	😐	☹
	Corrosion				
N4	*Corrosion is a chemical reaction which involves the surface of a metal changing from an element to a compound.*				
N4	*Different metals corrode at different rates*				
N4	*The term rusting is applied to the corrosion of iron. Both water and oxygen, from the air, are required for rusting*.				
N5	*When iron rusts, initially the iron atom loses two electrons to form iron(II) ions which can be oxidised further to give iron(III)ions. Electrons lost by the iron during rusting are accepted by the water and oxygen to form hydroxide ions*				
N4	*Ferroxyl indicator can be used to detect the presence of iron(II) ions and hydroxide ions. Ferroxyl indicator turns blue in the presence of iron(II) ions and pink in the presence of hydroxide ions*				
N4	*Acid rain and salt increases the rate of corrosion by providing an electrolyte*				
N4	*When attached to metals higher in the electrochemical series, electrons flow to the iron, and when attached to metals lower down in the series, electrons flow from the iron.*				
N4	*Iron does not rust when attached to the negative terminal of a battery. Electrons flowing to the iron prevent rusting.*				
N4	*Painting, greasing, electroplating, galvanising, tin-plating and coating with plastic give a surface barrier to air and water which can provide physical protection against corrosion*				
N4	*Galvanising (dipping in molten zinc) and the use of scrap magnesium result in electrons flowing to the iron giving sacrificial protection. Scratching tinplate increases the rate of rusting of iron.*				

LEVEL N4 N5	After completing this topic, you should be able to:	NOTES (Web 1)	How well I have understood (✓)		
			☺	😐	☹
	Electrochemistry and REDOX				
N5	*Electricity can be produced by connecting different metals together, with an electrolyte, to form a simple cell.*				
N5	*The voltage between different pairs of metals varies and this leads to the electrochemical series*				
N5	*Displacement reactions occur when a metal is added to a solution containing ions of a metal lower in the electrochemical series. Ionic equations can be written for displacement reactions, and the spectator ions omitted*				
N5	*The reaction of metals with acids can establish the position of hydrogen in the electrochemical serie*				
N5	*Electricity can be produced in a cell by connecting two different metals in solutions of their metal ions*				
N5	*Electricity can also be produced in a cell when at least one of the half-cells does not involve metal atoms*				
N5	*Electrons flow in the external circuit from the species higher in the electrochemical series to the one lower in the electrochemical series*				
N5	*Electrons flow in the external circuit from the species higher in the electrochemical series to the one lower in the electrochemical series*				
N5	*The purpose of the 'ion bridge' (salt bridge) is to allow the movement of ions to complete the circuit*				
N5	*Oxidation is a loss of electrons by a reactant in any reaction. A metal element reacting to forma compound is an example of oxidation*				
N5	*Reduction is a gain of electrons by a reactant in any reaction. A compound reacting to forma metal is an example of reduction*				
N5	*Ion-electron equations can be written for oxidation and reduction reactions. Ion-electron equations can be combined to produce redox Equations. Reduction and oxidation occur together – hence REDOX*				

Exercise 3.3

Corrosion and Redox

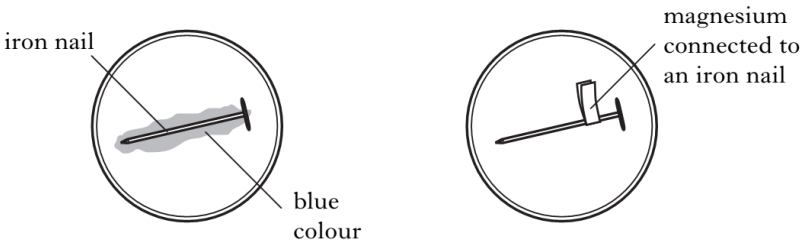
1) A student investigated the rusting of iron. He set up three test tubes each containing a clean iron nail.



Test tube	Observation after one week
A	Nail stayed bright
B	Nail rusted
C	Nail stayed bright

a) Suggest why the nail in test tube **A** did not rust.

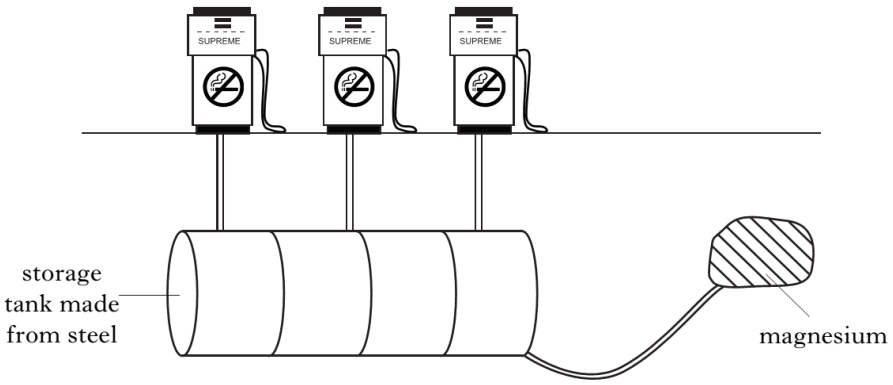
b) The student also set up two dishes containing clean iron nails set in a gel containing ferroxyl indicator. The diagram below shows the result after 1 day.



(i) Write the symbol for the iron ion which turns ferroxyl indicator blue.

(ii) Explain why the magnesium connected to the iron nail prevents rusting.

2) Steel can also be used to make storage tanks for diesel. One method of protecting the tanks from rusting is to connect magnesium metal to them.

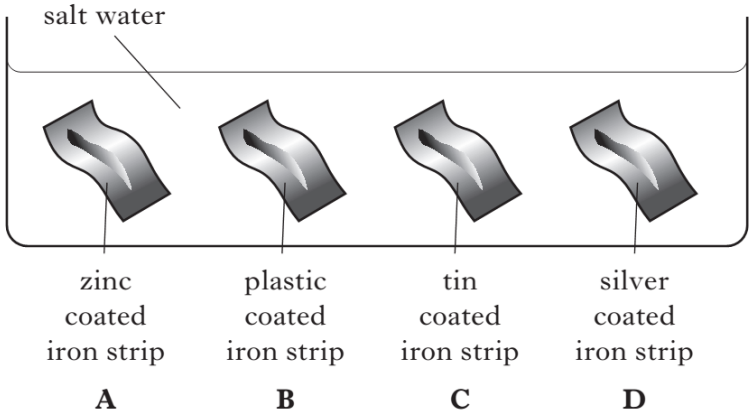


a) Name two substances which must be present for steel to rust.
b) Name the type of protection provided by the magnesium.
c) Suggest another method of preventing steel from rusting.

3) Iron can be coated with a physical barrier to prevent rusting.

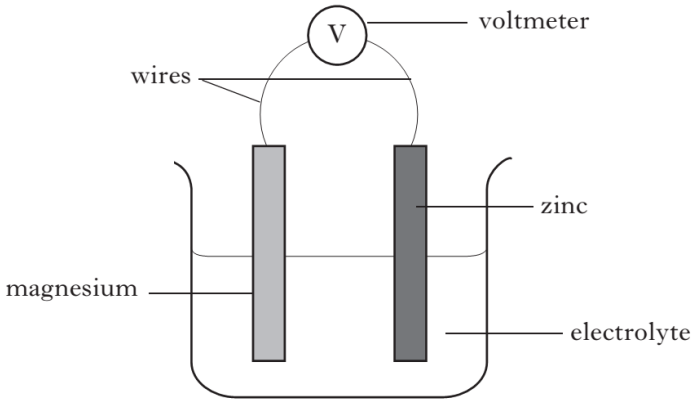
a) How does coating iron prevent rusting?

b) A student investigated the rusting of iron. The coatings on four strips of iron were scratched to expose the iron. The strips were then placed in salt water.



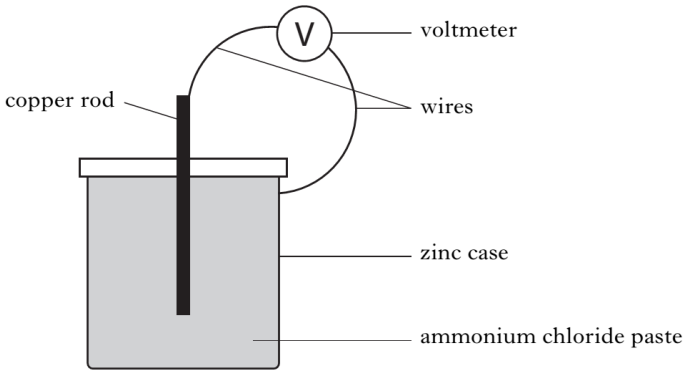
(i) Which iron strip has been galvanised, A, B, C or D and why?
(ii) Which iron strip would have rusted most quickly, A, B, C or D and why?

4) The diagram below shows a cell.



a) Name the type of charged particle that flows through the wires.
b) The voltage of the cell shown above is 1·51 V. Name a metal which could replace zinc to produce a greater voltage. (You may wish to use page 7 of the data booklet to help you).

5) A student set up the following cell.



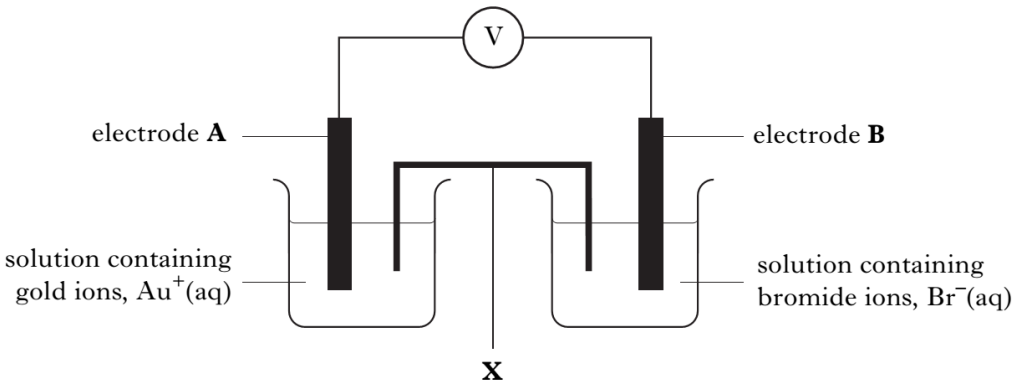
a) In this cell, the purpose of the ammonium chloride is to complete the circuit. What term is used to describe an ionic compound, like ammonium chloride, which is used for this purpose?

b) Circle the correct word, in each bracket, to complete the sentence below:

In the cell the electrons flow from copper / zinc to copper / zinc through the paste / wires.

c) Why do batteries stop producing electricity after some time?

6) A technician set up the following cell:



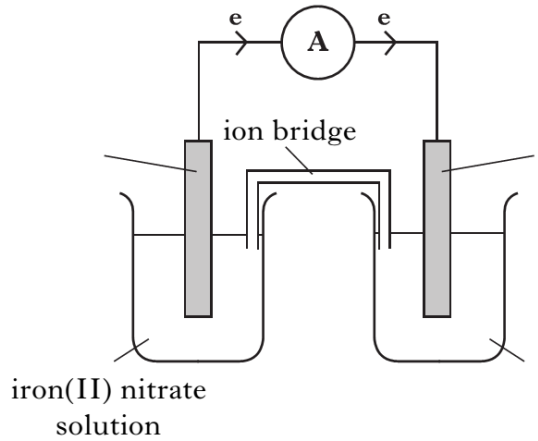
The reaction taking place at electrode B is: $2Br^-(aq) \longrightarrow Br_2(\ell) + 2e^-$

a) State the direction of electron flow.
b) Write the ion-electron equation for the reaction taking place at electrode A (you may like to use the data book to help you).
c) Name the piece of apparatus labelled X.

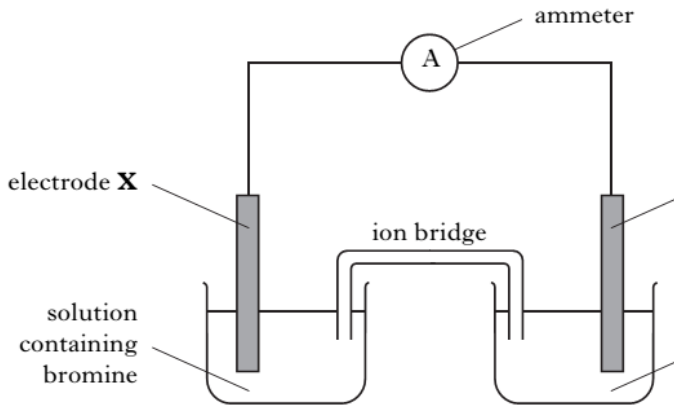
7) Iron displaces silver from silver(I) nitrate solution. The equation for the reaction is:

$$Fe(s) + 2Ag^+(aq) + 2NO_3^-(aq) \longrightarrow Fe^{2+}(aq) + 2Ag(s) + 2NO_3^-(aq)$$

a) Identify the spectator ion(s).
b) Describe a chemical test, including the result, to show that $Fe^{2+}(aq)$ ions are formed.
c) Write the ion-electron equations for the reduction and oxidations steps in the reaction (You may wish to use the data book to help you).
d) This reaction can also be carried out in a cell. Complete the three missing labels.



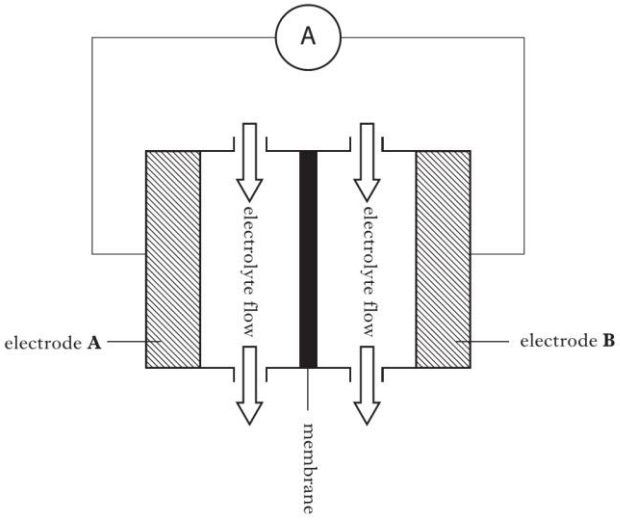
8) A student set up the cell shown:



The reaction taking place at electrode Y is: $2I^-(aq) \longrightarrow I_2(s) + 2e^-$

a) Name the type of chemical reaction taking place at electrode Y.
b) State the direction of the electron flow.
c) Describe a test, including the result, which would show that iodine had formed at electrode Y.
d) Write the ion-electron equations for the chemical reaction taking place at electrode X and Y.

9) In Australia flow cells are used to store the energy from solar cells.



a) The reaction taking place at electrode A when the cell is providing electricity is:

$$Zn \longrightarrow Zn^{2+} + 2e^-$$

Name the type of chemical reaction taking place at electrode A.
b) State the direction of electron flow.
c) Name the non-metal, that conducts electricity, which could be used as an electrode.

Unit 3: Chemistry in Society

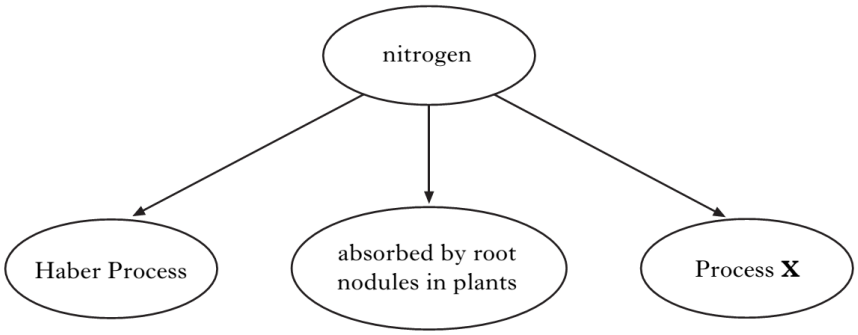
TOPIC 4: FERTILISERS

LEVEL N4 N5	After completing this topic, you should be able to:	NOTES (Web 1)	How well I have understood (✓)		
			☺	😐	☹
N4	*Increasing world population has led to a need for more efficient food production and that manufactured fertilisers are required to replace the essential nutrients removed from the soil by crops*				
N4	*growing plants require nutrients, including compounds of phosphorus and potassium as well as nitrogen and that different crops need fertilisers containing different proportions of N, P and K*				
N4	*Nitrogen-fixing bacteria in root nodules of some plants can convert atmospheric nitrogen into nitrogen compounds*				
N4	*describe the nitrogen cycle in terms of recycling of nitrogen between plants and animals and describe the various pathways by which nitrogen is gained and lost in the nitrogen cycle*				
N4	*give examples of the effect of artificial fertilisers on lochs and rivers, and define the term eutrophication*				
N4	*explain in terms of solubility and essential elements why the following are useful, synthetic fertilisers:* • *ammonium salts* • *potassium salts* • *nitrates* • *phosphates*				
N4	*state that ammonia and nitric acid are nitrogen compounds which are used to make fertilisers*				
N4	*describe the industrial manufacture of ammonia from nitrogen and hydrogen (Haber Process)*				
N4	*describe the catalytic oxidation of ammonia to form nitrogen dioxide – a step in the industrial manufacture of nitric acid (Ostwald Process)*				
N4	*state that the catalytic oxidation of ammonia can be carried out in the laboratory*				
N5	*Be able to calculate the percentage composition of elements in a fertiliser (or any) compound, and be able to calculate the empirical and chemical formula from given percent composition figures for the constituent elements*				

Exercise 3.4

Fertilisers

1) Nitrogen is essential for healthy plant growth. Nitrogen from the atmosphere can be fixed in a number of ways.

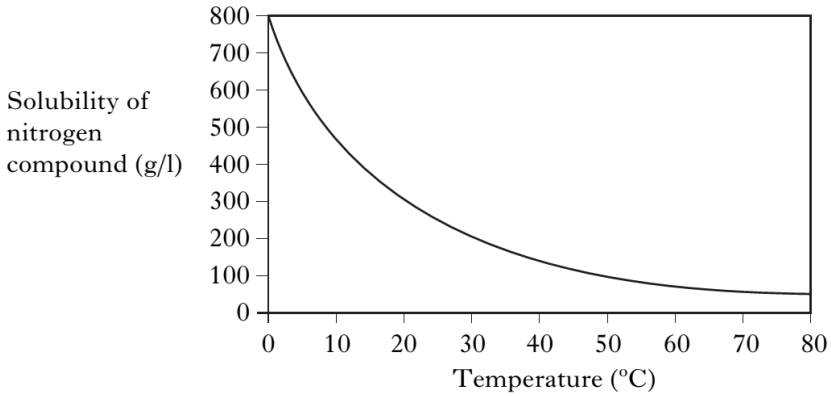


a) X is a natural process which takes place in the atmosphere, producing nitrogen dioxide gas. What provides the energy for this process?

b) What is present in the root nodules of some plants which convert nitrogen from the atmosphere into nitrogen compounds?

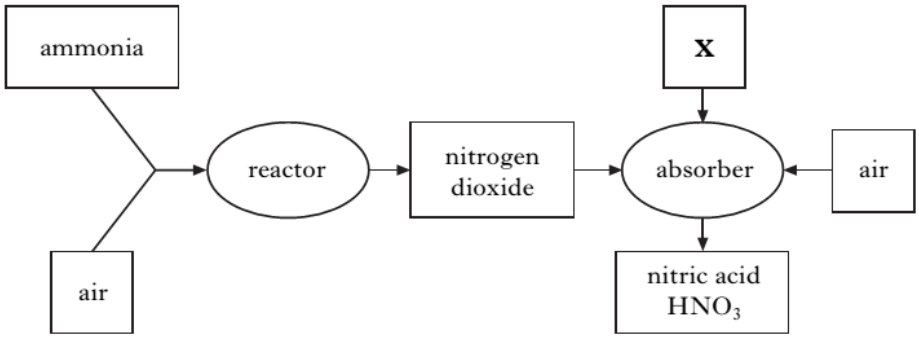
c) The Haber Process is the industrial method of converting nitrogen into a nitrogen compound. Name the nitrogen compound produced.

d) The nitrogen compound produced in the Haber Process dissolves in water. The graph shows the solubility of the nitrogen compound at different temperatures.



Write a general statement describing the effect of temperature on the solubility of the nitrogen compound.

2) The flow diagram shows how ammonia is converted to nitric acid.



a) Name the industrial process used to manufacture nitric acid

b) The reactor contains a platinum catalyst. Why is it **not** necessary to continue heating the catalyst once the reaction has started?

c) Name substance X.

d) The reaction is carried out at temperatures between 380 °C and 450 °C. Why are higher temperatures not used?

e) Ammonia and nitric acid react together to form ammonium nitrate, NH_4NO_3
Calculate the percentage by mass of nitrogen in ammonium nitrate (sbow your working clearly).

3) Potassium hydroxide reacts with sulphuric acid to form potassium sulphate, which can be used as a fertiliser.

$$KOH(aq) + H_2SO_4(aq) \longrightarrow K_2SO_4(aq) + H_2O(\ell)$$

a) Balance the above equation.

b) Name the type of chemical reaction taking place.

c) Calculate the percentage, by mass, of potassium in potassium sulphate, K_2SO_4. Show your working clearly.

d) Ammonium phosphate is also used as a fertiliser. Write the ionic formula for ammonium phosphate.

4) Calculate the percentage by mass of nitrogen in each of the following compounds which are used as fertilisers.

   a) Sodium nitrate
   b) Calcium nitrate
   c) Ammonium nitrate
   d) Ammonium sulphate

5) Phosphorous is an important plant nutrient as it regulates leaf development and size. Phosphorous is found as calcium phosphate $Ca_3(PO_4)_2$, but this is converted into calcium dihydrogenphosphate $Ca(H_2PO_4)_2$ which is then used as fertiliser.

   a) Calculate the percentage by mass of phosphorous in:
      (i) Calcium phosphate
      (ii) Calcium dihydrogenphosphate

   b) Calcium phosphate is converted to calcium dihydrogenphosphate by reaction with sulphuric acid (H_2SO_4). The only other product of the reaction is calcium sulphate. Write a balanced chemical equation for this reaction.

   c) Refer to the solubility tables on page 5 of the data book and explain why calcium dihydrogenphosphate is preferred to calcium phosphate as a fertiliser.

6) Urea is a fertiliser. Its composition by mass is shown in the table:

Nitrogen	46.7%
Hydrogen	6.7%
Carbon	19.9%
Oxygen	26.7%

   Calculate the empirical formula.

Unit 3: Chemistry in Society

TOPIC 5: ENVIRONMENTAL CHEMISTRY

LEVEL N4 N5	After completing this topic, you should be able to:	NOTES (Web 1)	How well I have understood (✓)		
			☺	😐	☹
N4	*Chemists play an important role in society by monitoring our environment to ensure that it remains healthy and safe and that pollution is tackled as it arises.*				
N4	*Be able to describe the major techniques for monitoring the environment and methods for reducing pollution including qualitative precipitation, titration with calculations, and chromatography, and spectroscopy (flame tests), separation and purification techniques*				
N4	*Chromatography includes techniques such as paper chromatography, thin layer chromatography, gas chromatography and high performance liquid chromatography*				
N4	*Be able to work our RF values for chromatography samples*				
N4	*Be able to carry out paper chromatography experiments and calculate the RF value and interpret the results*				
N4	*Be able to carry out titration experiments to determine the level of acidity in river and loch samples*				
N4	*Be able to describe the source and chemistry of major environmental pollutants in air, water and soil:* • *Acid rain* • *Agricultural chemicals including fertilisers and pesticides* • *CFCs and the impact on the ozone layer* • *Industrial contaminants*				
N4	*Be able to discuss the major EU directives on water and air quality and interpret graphical, geographical and chemical data*				
N4	*Be able to describe the important of naturally occurring radioactivity with particular reference to monitoring Radon*				

Exercise 3.5

Environmental Chemistry

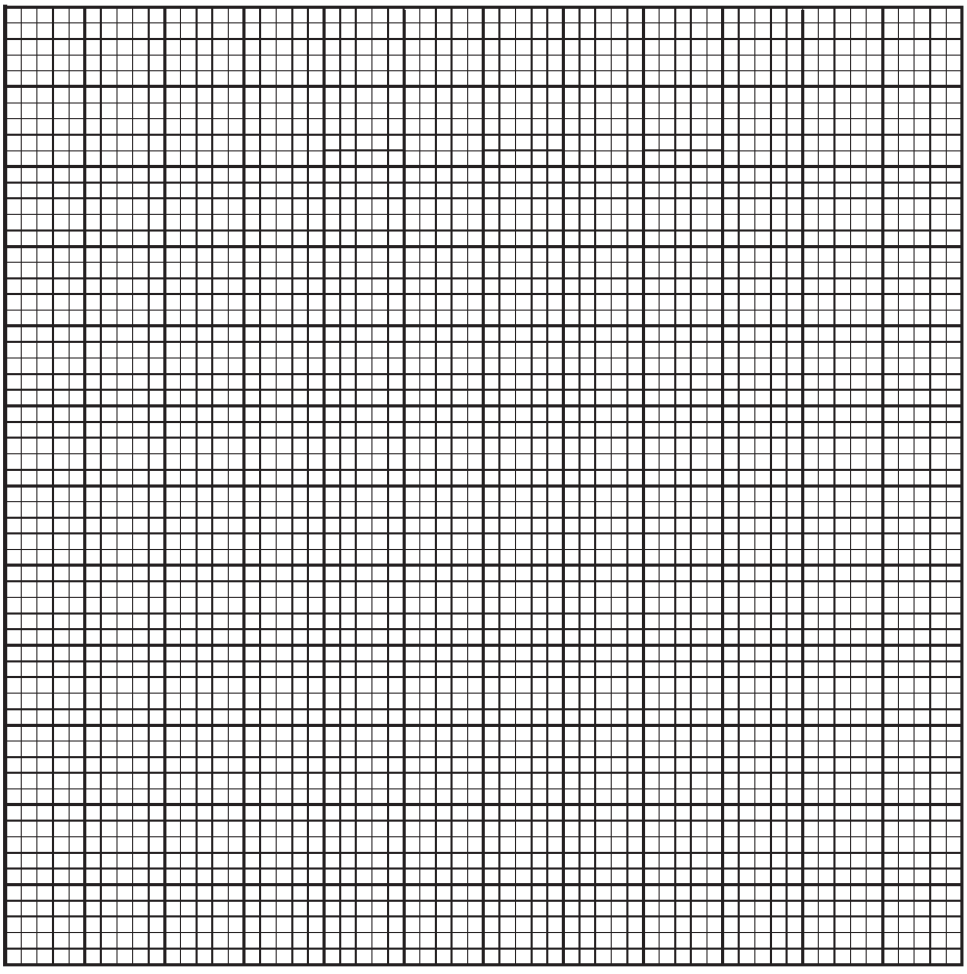
1) When sulphur dioxide dissolves in water in the atmosphere “acid rain” is produced. Circle the correct phrase to complete the sentence

   a) Compared with pure water, acid rain contains a higher / a lower / the same concentration of hydrogen ions

   b) The table shows information about the solubility of sulphur dioxide.

Temperature /°C	0	20	30	40	50	60
Solubility in g/100 cm^3	22·0	10·0	6·0	3·0	2·0	1·5

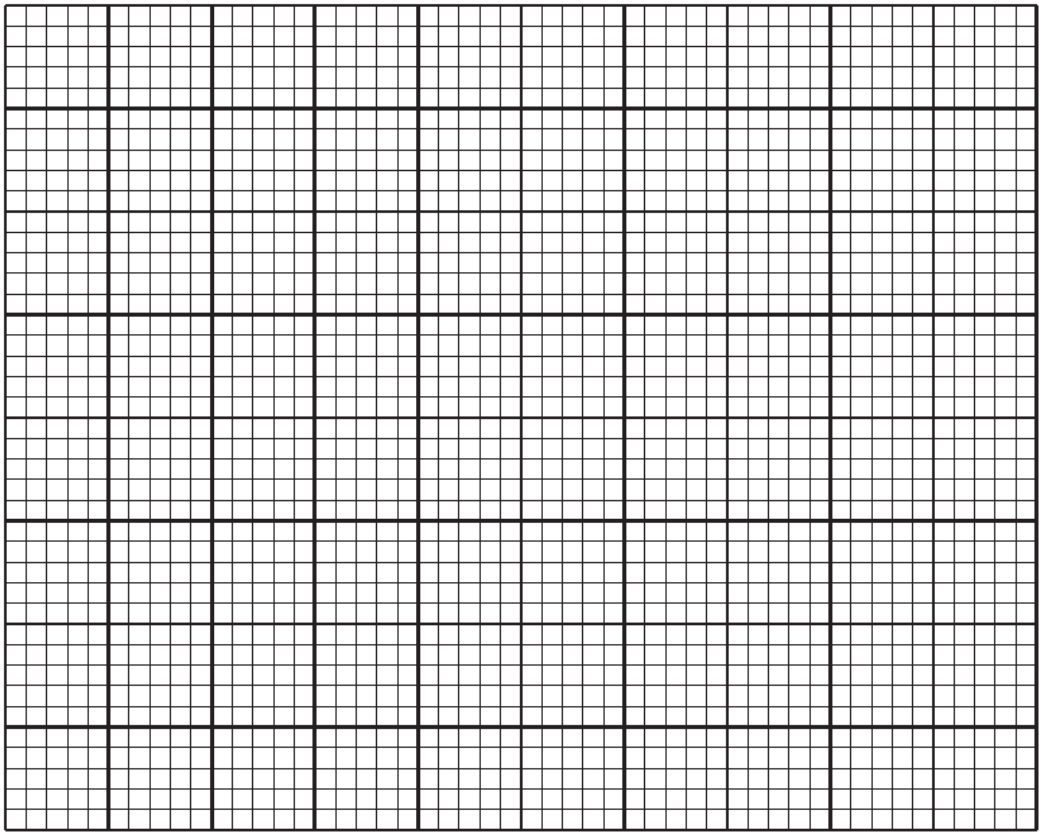
Draw a line graph of solubility against temperature



2) The table shows the mass of various pollutants produced by recycling aluminium.

Pollutant	Mass of pollutant produced per tonne of aluminium/kg
sulphur dioxide	1·0
dust	1·5
carbon monoxide	2·5
nitrogen oxides	7·0
hydrocarbons	5·0

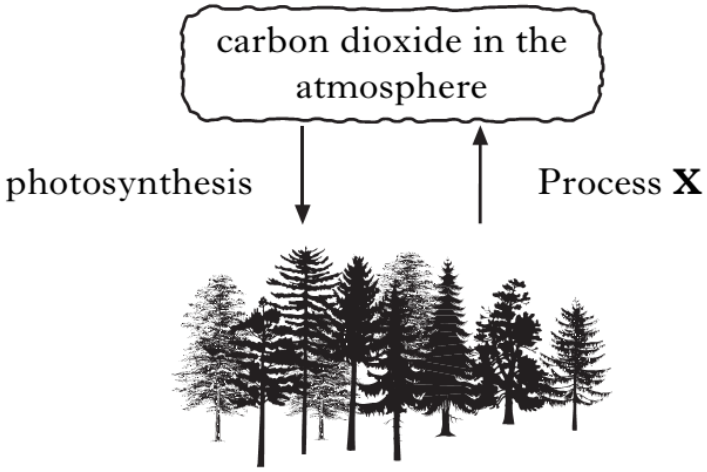
a) Present the information as a bar graph



b) When sulphur dioxide reacts with water in the atmosphere, acid rain is produced. Give one example of a damaging effect of acid rain.

c) Write the balanced chemical equation for the formation of acid rain.

3) Forests are important in maintaining the level of carbon dioxide in the atmosphere.



a) Name process X
b) Write the word and chemical equation for photosynthesis
c) The table shows how the level of carbon dioxide in the atmosphere has changed since 1975.

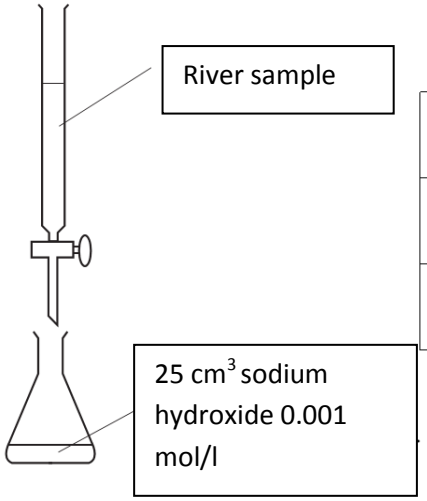
Year	Level of carbon dioxide/units
1975	330
1985	345
1995	358
2005	374
2015	

Predict the amount of carbon dioxide in the atmosphere in 2015.

d) What industrial processes produce CO_2?

4) Biologists from the Institute of Terrestrial Ecology have been monitoring the spawning success of salmon and par survival rates in the head water of an important local salmon river. Data collected for the past 5 years suggest poor fertilisation of the salmon ova and high mortality of salmon par. The lead scientist commissioned an environmental chemist from the Macaulay Land Research Institute to establish whether acid rain could be the cause of the poor survival and fertilisation rates.

The environmental chemist collected samples over a 12 month period. Her titration results for the month of June and experimental set-up are shown below.



	Rough titre	1st titre	2nd titre
Initial burette reading/cm^3	0·3	0·2	0·5
Final burette reading/cm^3	26·6	25·3	25·4
Volume used/cm^3	26·3	25·1	24·9

The equation for the reaction is:

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

a) Using the results in the table, calculate the concentration of acid in the river sample required to neutralise the sodium hydroxide solution.

b) How could she improve the reliability of her advice to her ecology colleague?