Chemistry

HSC Course

2010

Year 12 Trial HSC Examination

Total marks 100

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours

- Attempt all questions
- Write using blue or black pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your I.D. number on each answer sheet
- Liquid paper must NOT be used on this paper
- For your convenience, the multiple choice answer sheet and periodic table at the back may be removed from the rest of the paper

Total marks – 100
Section I
75 marks
This section has two parts, Part A and Part B

Part A – 20 marks
Attempt questions 1-20 (multiple choice)
Allow about 35 minutes for this part.

Part B – 55 marks
Attempt questions 21 to 34
Allow about 1 hour 40 minutes for this part

Section II – Industrial Chemistry Option
25 marks
Attempt all questions
Allow about 45 minutes for this part

Teachers: J. Jackson, D. Geerling, S. Davis, M. Peck

Task Weighting: 40 %

Multiple-choice Answer Sheet
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

(A) ⬭ (B) ⬬ (C) ⬭ (D) ⬭

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

(A) ⬬ (B) ⊗ (C) ⬭ (D) ⬭

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word correct and drawing an arrow as follows:

correct ↓

(A) ⊗ (B) ⊗ (C) ⬭ (D) ⬭

Section I – Part A

20 marks

Attempt questions 1 – 20.
Allow about 35 minutes for this part.
Select the alternative A, B, C or D that best answers the question AND record your answer on the multiple-choice answer sheet.
The multiple-choice answer sheet is located at the end of the paper and should be detached for your convenience.
Ensure you write your student number on the multiple-choice answer sheet.

1. Which of the following correctly identifies the amphiprotic species with both its conjugate acid and its conjugate base?

	Conjugate acid	*Amphiprotic species*	*Conjugate base*
(A)	HCO_3^-	H_2CO_3	CO_3^{2-}
(B)	NH_4^+	NH_3	NH_2^-
(C)	OH^-	H_2O	H_3O^+
(D)	H_2SO_4	SO_4^{2-}	HSO_4^-

2. In an investigation to compare pH of a strong acid and a weak acid, which pair of solutions would be most appropriate?

(A) 1.0 mol/L 2-hydroxypropane-1,2,3-tricarboxylic acid and 1.0 mol/L ethanoic acid

(B) 0.10 mol/L ethanoic acid and 10 mol/L hydrochloric acid

(C) 1.0 mol/L 2-hydroxypropane-1,2,3-tricarboxylic acid and 0.10 molL-1 hydrochloric acid

(D) 0.10 mol/L ethanoic acid and 0.10 mol/L hydrochloric acid

3. Which of the following pairs of substances would form a buffer solution?

   (A) $HCl_{(aq)}$ / $Cl^-_{(aq)}$

   (B) $H_2PO_4^-{}_{(aq)}$ / $PO_4^{3-}{}_{(aq)}$

   (C) $H_2SO_{4(aq)}$ / $HSO_4^-{}_{(aq)}$

   (D) $CH_3COOH_{(aq)}$ / $CH_3COO^-{}_{(aq)}$

4. The piece of equipment is used in acid-base titrations. Select the statement that most correctly identifies the equipment and describes the rinsing procedures that should be followed when using this piece of equipment.

   (A) Pipette that should be rinsed with distilled water.
   (B) Pipette that should be rinsed with distilled water and then the solution it is to contain.
   (C) Burette that should be rinsed with distilled water.
   (D) Burette that should be rinsed with distilled water and then the solution it is to contain.

5. Which statement best represents Davy's definition of an acid?

   (A) Acids contain oxygen.

   (B) Acids are proton donors.

   (C) Acids contain hydrogen.

   (D) Acids ionise in solution to form hydrogen ions.

6. If energy is released in a acid-base neutralisation at the rate of 57 $kJmol^{-1}$ of base at 25°C, how much energy is released by the complete neutralisation of 25mL of 1.0 $molL^{-1}$HCl and 25mL of 1.0 $molL^{-1}$ NaOH?

   (A) 1425 J

   (B) 1.43 J

   (C) 713 J

   (D) 7.13 kJ

7. Which of the following reactions is not an oxidation-reduction reaction?

   (A) $Li_2O_{(s)} + H_2O \rightarrow 2LiOH_{(aq)}$

   (B) $K_{(s)} + O_{2(g)} \rightarrow KO_{2(s)}$

   (C) $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

   (D) $2Na_{(s)} + H_{2(g)} \rightarrow 2NaH_{(s)}$

8. In a nuclear fission reactor iron-58 is bombarded with neutrons. Iron-58 forms a new isotope of iron. This new isotope then undergoes β decay. Identify the new product after this β decay.

   (A) $^{59}Co_{27}$
   (B) $^{60}Fe_{26}$
   (C) $^{58}Fe_{27}$
   (D) $^{55}Cr_{24}$

9. A student was asked to compare and contrast condensation polymerisation with addition polymerisation. She made these five statements.

   1. They both involve combining small molecules together to make a larger molecule of many repeating units.
   2. An example of an addition polymer is polyethylene whereas an example of condensation polymer is cellulose.
   3. They both require a small molecule such as water as a reactant.
   4. Addition polymers involve adding water to form the polymer whereas condensation polymers involve removing water.
   5. Condensation polymerisation results in the formation of the polymer and another chemical substance whereas addition polymerisation results in the formation of just the polymer.

   Which of these statements is correct?

   (A) 1 and 5
   (B) 2 and 5
   (C) 3 and 4
   (D) 3 and 5

10. The value of the heat of combustion of carbon is measured as 32800 J/g.
    What is the value of the heat of combustion of carbon in kJ/mol?

    (A) 394000
    (B) 394
    (C) 32.8
    (D) 2.73

11. A galvanic cell is based on the following reaction:-

$$3Pb^{+2}_{(aq)} + 2Cr_{(s)} \rightarrow 3Pb_{(s)} + 2Cr^{+3}_{(aq)}$$

    Identify the anode for this galvanic cell.

    (A) $Pb^{+2}_{(aq)}$
    (B) $Cr_{(s)}$
    (C) $Pb_{(s)}$
    (D) $Cr^{+3}_{(aq)}$

12. Iron is more reactive than copper.
Which statement is correct?

(A) Copper is easier to extract from its ore than iron.
(B) Copper will react more readily than iron with sulfuric acid.
(C) Iron requires less energy than copper for extraction from its ore.
(D) Iron is a more abundant element than copper.

13. A mixture containing both ethene and propene undergoes polymerisation under reaction conditions that produces a polymer containing alternating monomer units.
Which of the following segments of polymer could potentially be formed from such a mixture?

(i) $-CH_2-CH_2-CH_2-CH_2-$

(ii) $-CH_2-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-$

(iii) $-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-$

(iv) $-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-$

(v) $-CH_2-\underset{\displaystyle H_3C}{\underset{|}{CH}}-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-$

(A) Structure (ii) only
(B) Structure (i) and (iii) only
(C) Structures (i), (ii) and (iii) only
(D) Structures (i), (ii), (iii) and (iv) only

14. The Haber process is an important industrial process used to produce ammonia gas.
What volume of hydrogen gas, measured at 100kPa and 25^0C, would have reacted to produce 51.10g of ammonia?

(A) 16.52 L
(B) 24.79 L
(C) 102.2 L
(D) 111.6 L

15. Which of the following is NOT a correct statement about ozone?

(A) Ozone is less reactive than normal oxygen
(B) Ozone is a pollutant in the lower atmosphere
(C) Ozone contains a co-ordinate covalent bond
(D) Ozone acts as an upper atmosphere UV radiation shield.

16. Over the last 10 years, Australians have become more aware of the 'hole' in the ozone layer above Antarctica. Which of the following is a reason to be concerned?

    (A) It will allow oxygen to escape and we will have to wear oxygen equipment on Antarctic expeditions.
    (B) It will expose us to increased levels of ultra violet radiation.
    (C) It will cause an increase in ozone levels in the troposphere.
    (D) It will expose us to more CFCs.

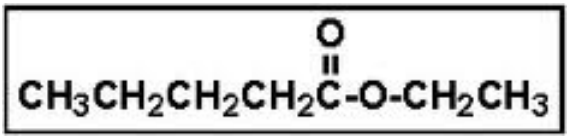
17. Incomplete combustion of hydrocarbons may result in the production of undesirable substances. Which of the following shows TWO such substances?

    (A) water and carbon dioxide
    (B) carbon and carbon monoxide
    (C) hydrogen and carbon
    (D) sulfur dioxide and carbon monoxide

18. What is the purpose of adding chlorine to domestic water supplies?

    (A) clarify the water
    (B) reduce the pH of the water
    (C) remove heavy metal ions like lead from the water
    (D) disinfect the water

19. The formula for an ester with a strawberry fragrance is given below.



    Which alkanol and alkanoic acid was used to make this ester?

    (A) propanol and propanoic acid
    (B) ethanol and butanoic acid
    (C) ethanol and pentanoic acid
    (D) butanol and butanoic acid

20. Which of the following steps in water treatment could be regarded as a physical process?

    (A) flocculation
    (B) filtration
    (C) chlorination
    (D) softening of hard water

Section I – Part B

55 marks

Attempt questions 21 – 33.
Read the whole of each question before commencing it.
Answer the questions in the spaces provided.
If you need additional space, please request an extra writing booklet (using a separate one for each stapled section).
Allow about 1 hour and 40 minutes for this part.

Question 21

A 0.040 mol/L solution of methanoic acid in water has a pH of 2.57.

Assess the extent of ionisation of methanoic acid. 3M

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Question 22

(a) Draw a pH curve for a titration that involves placing 2.0 mol/L NaOH in the conical flask and 10 mol/L CH_3COOH in the burette. 2M

(b) Identify one indicator that would be appropriate to use in the titration described above. 1M

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Question 23

(a) During this course you tested the pH of a number of salts. Outline the results of this investigation, including one acidic and basic salt. 2M

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(b) Account for the results for one salt named above. 2M

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Question 24

Calculate the concentration of a sample of hydrochloric acid when 25.00 mL of 0.05 $molL^{-1}$ sodium carbonate solution was titrated against 24.00 mL of hydrochloric acid. 3M

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Question 25

Assess the use of neutralisation reactions as a safety procedure to minimise damage in chemical spills. (Include examples and equations in your answer) 5M

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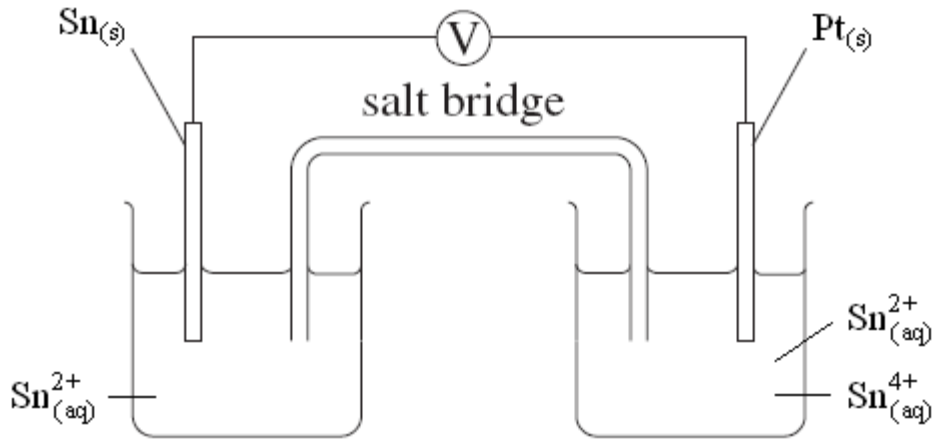
Question 26

In the galvanic cell below, Sn(s) is the anode and Pt(s) is the cathode.



(a) Identify on the diagram the direction of the electron flow AND the positive electrode AND the negative electrode. 2M

(b) It was discovered that the voltmeter reading was +0.29V. Deduce the reduction half equation and the standard reduction potential for the half equation. 2M

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(c) Outline how you would construct a salt bridge in the laboratory. 1M

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Question 27

Outline how Neptunium-239 would be commercially produced. Include a balanced chemical equation. 3M

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Question 28

For a named biopolymer, outline one advantage it has for the environment AND one advantage it has for society. 3M

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Question 29

During the course you performed a first-hand investigation to compare the reactivity of an appropriate alkene with its corresponding alkane in bromine water.
Assess the validity of the procedure used in this investigation. 5M

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Question 30

Explain why ethanol will dissolve in both water and hexane. 3M

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Question 31

The following questions relate to the Haber process.

(a) Identify an industrial use of ammonia. 1M

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(b) Identify the catalyst used in the Haber process and explain why it is used. 3M

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(c) With reference to its uses, evaluate the significance of the development of the Haber process to society between 1910 and 1918. 4M

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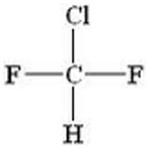
Question 32

The following questions relate to chlorofluorocarbons.

(a) Name the following CFC (chlorofluorocarbon). 1M



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(b) Outline a how a named CFC damages the ozone layer, using chemical equations as appropriate. 4M

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Question 33

The molecules O_2 and O_3 are allotropes and both common in the Earth's atmosphere.
Using Lewis diagrams, show how the shapes of oxygen and ozone are different, identifying any co-ordinate covalent bonds. 2M

Question 34

Outline the difference between destructive and non-destructive testing, using an appropriate example for each type of testing coming from the Production of Materials module. 3M

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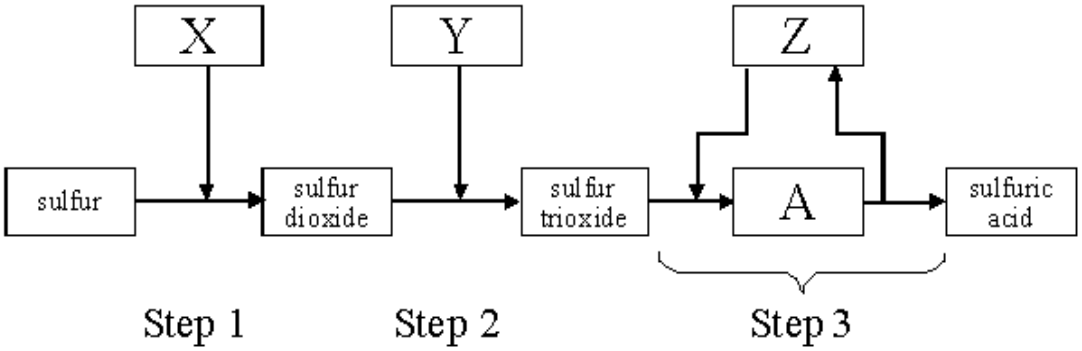
End of Part B

Section II
Option – Industrial Chemistry – 25 marks

Answer the questions in the separate writing booklet provided.
Ensure that you clearly identify each answer [eg. (a) (i) ….].
You may ask for additional writing booklets if required.
Ensure you place your student number on the front of each booklet.
Allow 45 minutes for this section.

a. The diagram summarises the steps in the contact process.

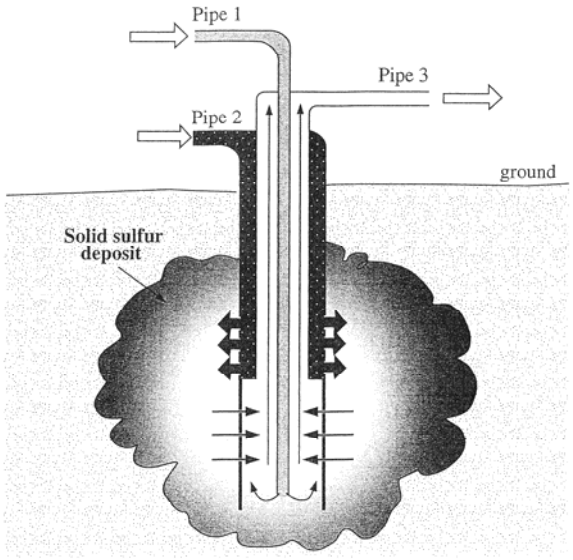


(i) Identify the chemical substances (X, Y and Z) that are added at steps 1, 2 and 3 respectively. 1M

(ii) Identify the name of, and formula for, the intermediary product (identified as A) in step 3. 1M

(iii) Outline THREE conditions that would be used to maximise the efficiency of the second step of the Contact process. 2M

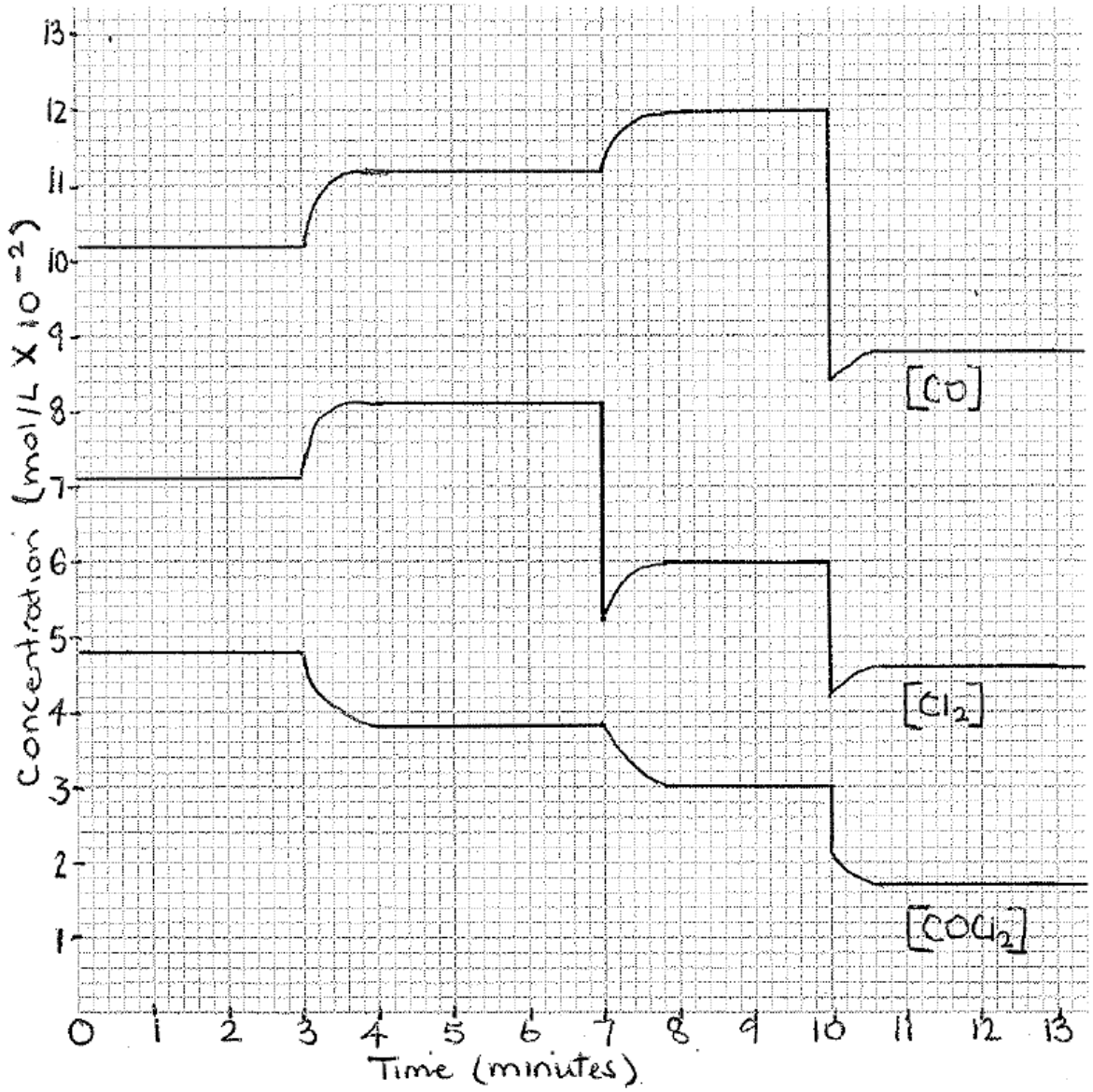
(iv) The following diagram illustrates the Frasch process, used to extract sulfur from underground deposits.



Outline THREE properties of sulfur that enable this extraction process to be efficient. 2M

b. The graph shows the variations in concentration of reactant and product as a function of time for the following system.

$$Cl_{2(g)} + CO_{(g)} \leftrightarrow COCl_{2(g)}$$



(i) Write the expression for the equilibrium constant for this reaction. 1M

(ii) Copy and complete this table in your writing booklet to identify the concentration (mol/L) of each chemical species at t = 2, t = 6, t = 9 and t = 12. In addition, calculate the value of the equilibrium constant at each of these 4 times and place these values into the table. 3M

Time (min)	[CO] (mol/L)	[Cl_2] (mol/L)	[$COCl_2$] (mol/L)	Equilibrium constant (K)	**Do NOT write your answers here – copy this table into your writing booklet.**
2		0.071			
6		0.081			
9					
12			0.017		

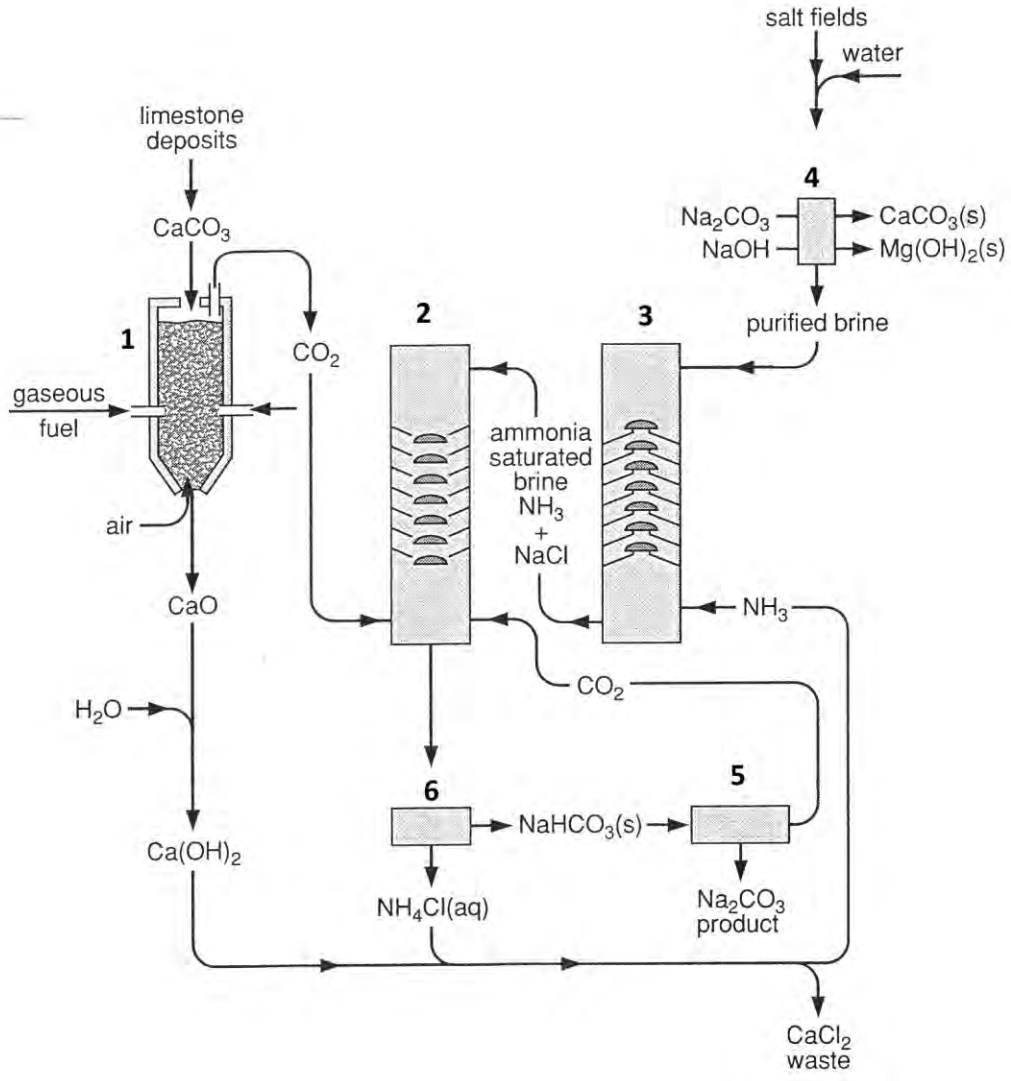
(iii) Three changes (each quite different) have been imposed on this system during the time the system was observed. ONE of the changes is an increase in temperature.

Student A deduces that an increase in temperature was imposed on the system at t = 3. However, student B deduces that an increase in temperature was imposed on the system at t = 10.

Which student is correct? Use equilibrium constant values to explain your conclusion. 3M

(iv) Deduce whether this reaction is exothermic or endothermic. Explain your answer. 3M

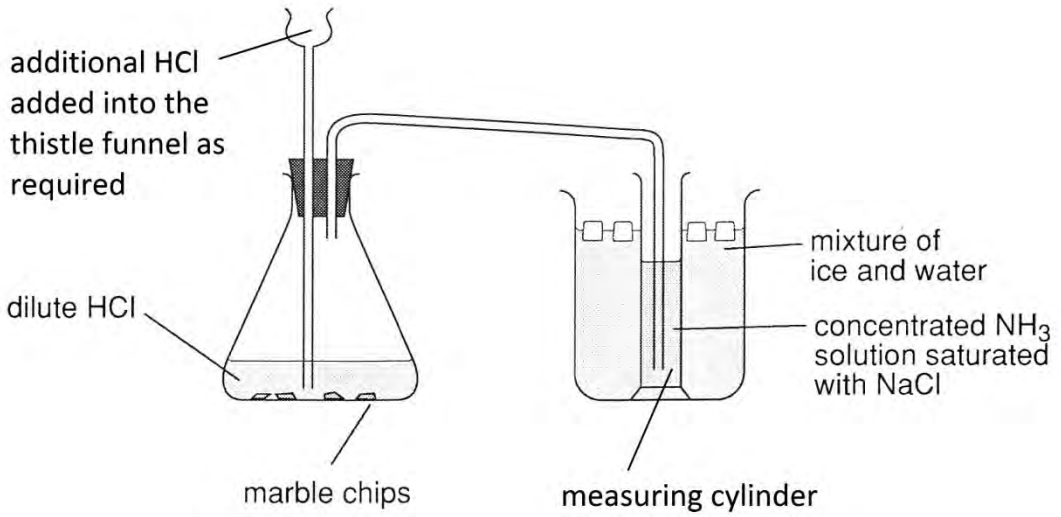
c. The flowchart below summarises the Solvay process.



(I) An industrial Solvay process plant uses 1.0×10^2 tonne of calcium carbonate. Calculate the mass of calcium chloride waste produced. 2M

This question continues on the next page.

(II) The diagram below shows one way of modelling a step of the Solvay process in a school laboratory.



(i) The flowchart (on the previous page) that summarises the Solvay process shows 6 steps, numbered 1 to 6. The modelling carried out in the school laboratory represents which one of these steps? Write the corresponding number in your writing booklet. 1M

(ii) Identify the gas being produced inside the flask containing marble chips. 1M

(iii) Outline ONE reason why a beaker of cold water and ice is used to cool the measuring cylinder and its contents. 1M

(iv) Write an equation for the overall reaction that occurs in the measuring cylinder. 1M

This question continues on the next page.

(v) Assess the risks of recycling ammonia in a laboratory model. 3M
A section of a Materials Safety and Data sheet for ammonia is provided.

Product Name: AMMONIA - ANHYDROUS

Other name(s): Ammonia anhydrous; Ammonia gas; Anhydrous ammonia; Ammonia liquid; Big N; Ammonia cylinder (used).
Recommended Use: Fertilizer; preparation of fertilizers; chemical synthesis; condensation catalyst; latex preservative; manufacture of explosives; rocket fuel.
Hazards identification
This material is hazardous according to criteria of ASCC; HAZARDOUS SUBSTANCE.
Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
Risk Phrases: Flammable. Toxic by inhalation. Causes burns. Risk of serious damage to eyes. Very toxic to aquatic organisms.
Safety Phrases: Keep locked up and out of the reach of children. Keep container in a well ventilated place. Keep away from sources of ignition - No Smoking. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing, gloves and eye/face protection. In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible).
Poisons Schedule:S6 Poison.

EXPOSURE CONTROLS / PERSONAL PROTECTION

Ammonia: 8hr TWA = 17 mg/m3 (25 ppm), 15 min STEL = 24 mg/m3 (35 ppm)
As published by the National Occupational Health and Safety Commission.
TWA - The time-weighted average airborne concentration over an eight-hour working day, for a five-day working week over an entire working life. STEL (Short Term Exposure Limit) - the average airborne concentration over a 15 minute period which should not be exceeded at any time during a normal eight hour work day. According to current knowledge this concentration should neither impair the health of, nor cause undue discomfort to, nearly all workers. These Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.
Engineering controls:
Ensure ventilation is adequate to maintain air concentrations below Exposure Standards. Use with local exhaust ventilation or while wearing air supplied mask. Ammonia gas is generally lighter than air and will disperse under normal conditions. However, when ammonia liquid contacts air, the gas produced may be heavier than air. Prevent concentration in hollows or sumps. Do NOT enter confined spaces where vapour may have collected. An asphyxiant gas which can lead to the reduction of the oxygen concentration by displacement or dilution. The minimum oxygen content in air should be 18% by volume under normal atmospheric pressure.
Personal Protective Equipment:
The selection of PPE is dependant on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.
Orica Personal Protection Guide No. 1, 1998: J - OVERALLS, RUBBER BOOTS, AIR MASK , GLOVES (Long), APRON. * Not required if wearing air supplied mask.
GENERAL: Avoid all contact. Ensure safety shower and eyewash station is close at hand. Persons who could be subject to ammonia exposure must not wear contact lenses. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.
EYE PROTECTION: Wear gas tight goggles which have a seal between the face and the frame. A full face shield shall only be worn to supplement the protection provided by the gas tight goggles.
SKIN PROTECTION: Wear coveralls, or full length trousers with a long sleeved shirt, with gloves and boots. Available information suggests that gloves made from chlorobutyl-proofed fabric or butyl rubber should be suitable for intermittent contact. However, due to variations in glove construction and local conditions, a final assessment should be made by the user. A complete encapsulating suit is recommended for heavy exposures.
RESPIRATORY PROTECTION: Use with adequate ventilation.

END OF EXAM

Multiple-choice Answer Sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

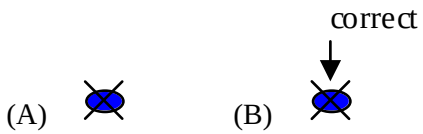
Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

(A) ⬭ (B) ⬬ (C) ⬭ (D) ⬭

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

(A) ⬬ (B) ⊗ (C) ⬭ (D) ⬭

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word correct and drawing an arrow as follows:



Part A

1.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
2.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
3.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
4.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
5.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
6.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
7.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
8.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
9.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
10.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
11.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
12.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
13.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
14.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
15.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
16.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
17.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
18.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
19.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
20.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭

Marking Guidelines THSC Exam 2010
Year 12 CHEMISTRY

Multiple choice

Question	Answer		Question	Answer
1	C		11	B
2	D		12	A
3	D		13	A
4	D		14	D
5	C		15	A
6	A		16	B
7	A		17	B
8	any		18	D
9	A		19	any
10	B		20	B

21.

Marking criteria	*Marks*
Calculates the theoretical pH of a strong monoprotic acid of 0.40 mol/L as 1.39 OR $[H^+]$=0.00269 mol/L AND Calculates the extent of ionisation as 6.7% AND Provides an assessment statement about the extent of ionisation.	3
Includes TWO of the above points	2
Includes ONE of the above points	1

22.a.

Marking criteria	*Marks*
The graph includes pH values on the Y axis AND shows an equivalence point >8 AND the curve moves in the correct shape starting at a high pH and finishes at a low pH	2
Graph shows equivalence point at .8 OR the curve is the correct shape starting at a high pH and finishes at a low pH	1

22.b.

Marking criteria	*Marks*
Identifies the appropriate indicator as phenolpthalein	1

23.a.

Marking criteria	*Marks*
Includes correct results for TWO salts	2
Includes correct results for ONE salt	1

23.b.

Marking criteria	*Marks*
Provides an equation showing the hydrolysis of the salt in water to produce the results shown in part a.	2
Describes the hydrolysis process OR outlines the pH as a result of the parent acid and bases	1

24.

Marking criteria	*Marks*
Provides the correct result of 0.10 mol/L	3
Correct calculation but with a stoichiometric error	2
Correct equation provided OR a correct calculation of number of moles of Na_2CO_3 carried out	1

25.

Marking criteria	*Marks*
Provides an assessment of the safety of neutralisation reactions in regard to chemical spills AND Includes mention of at least TWO specific neutralisation reagents AND includes TWO equations that include acid AND base neutralisation AND supporting statements	5
Provides an assessment of the safety of neutralisation reactions in regard to chemical spills AND Includes mention of at least ONE specific neutralisation reagent AND includes TWO equations that include acid AND base neutralisation AND supporting statements	4
Provides an assessment of the safety of neutralisation reactions in regard to chemical spills AND Includes mention of at least ONE specific neutralisation reagent AND includes TWO relevant equations (each making a different point)	3
Provides an assessment AND ONE example of a neutralisation reagent AND ONE relevant equation	2
Includes one true statement	1

26.a.

Marking criteria	*Marks*
Labels the diagram to show the electron flow through the external wired from the tin electrode to the platinum electrode AND Identifies the positive electrode as the Pt and the negative electrode as the Sn	2
Labels the diagram to show the electron flow through the external wired from the tin electrode to the platinum electrode OR Identifies the positive electrode as the Pt and the negative electrode as the Sn	1

26.b.

Marking criteria	*Marks*
Deduces the reduction half equation as:- $Sn^{4+} + 2e^- \rightarrow Sn^{2+}$ AND provides the working to correctly calculate the reduction potential as +0.15 V	2
Deduces the reduction half equation as :- $Sn^{4+} + 2e^- \rightarrow Sn^{2+}$ OR Provides the working to correctly calculate the reduction potential as +0.15 V	1

26.c.

Marking criteria	*Marks*
Outlines an appropriate method for making a salt bridge using a suitable metal salt solution such as potassium nitrate and absorbent paper	1

27.

Marking criteria	*Marks*
Outlines how neptunium is produced including :- * the source of the neutrons used * the formation of the unstable U-239 * the beta emission to produce Np-239 * write a correct equation for the process occurring	3
Includes two of the above points	2
Includes one of the above points	1

28.

Marking criteria	*Marks*
Identifies a biopolymer AND Outlines one advantage for the environment AND outlines the advantage for society	3
Identifies a biopolymer AND EITHER outlines one advantage for the environment OR outlines one advantage for society	2
Identifies a biopolymer	1

29.

Marking criteria	*Marks*
Make a judgement on the validity of the procedure and supports the judgement using FOUR or FIVE pieces of supporting criteria	4 - 5
Provides TWO or THREE features of the design of the FHI that ensured its validity	2 - 3
Make a judgement on the validity of the procedure OR Provides ONE feature of the design of the FHI that ensured its validity (OR not)	1

30.

Marking criteria	*Marks*
Explains the polar and non-polar qualities of ethanol and shows how it dissolves in both water and hexane via the like dissolves like principle	3
Explains the polar and non-polar qualities of ethanol and shows how it dissolves in either water or hexane via the like dissolves like principle	2
Explains the polar and non-polar qualities of ethanol.	1

31.a.

Marking criteria	*Marks*
Identifies an industrial use of ammonia	1

31.b.

Marking criteria	*Marks*
Identifies magnetite (Fe_3O_4; iron (II/III oxide) as the catalyst used AND explains that a catalyst lowers the activation energy requirement (cause), increasing the reaction rate (effect)	3
Identifies magnetite AND EITHER identifies that it lowers activation energy OR Identifies that it increases the reaction rate	2
Identifies magnetite as the catalyst used OR identifies that a catalyst lowers the activation energy requirement OR identifies that a catalyst increases the reaction rate	1

31.c.

Marking criteria	*Marks*
Describes the uses of ammonia and links this to the war (including supply issues) and makes an evaluation of the significance (i.e it was *very* significant)	4
Describes the uses of ammonia and links this to the war OR Describes a use of ammonia and links this to the war and makes an evaluation	3
Describes a use of ammonia and links this to the war	2
Makes a link between the production of ammonia and the war	1

32.a.

Marking criteria	*Marks*
Identifies chlorodifluoromethane	1

32.b.

Marking criteria	*Marks*
Thorough outline of how a named CFC damages the ozone layer including three relevant equations	4
Partial outline including three relevant equations OR Thorough outline including one to two equations OR Thorough outline including three equations for a non-CFC	3
Thorough outline OR three equations OR Partial outline including three equations for a non-CFC OR Thorough outline including one-two equations for a non-CFC OR partial outline and one-two equations	2
Partial outline OR one-two equations OR Partial outline and one-two equations for a non-CFC	1

33.

Marking criteria	*Marks*
Draws Lewis structures for O_2 and O_3 AND Identifies the coordinate covalent bond in ozone AND Diagram shows the shape of the molecule	2
Draws Lewis structure for O_2 and O_3 OR identifies the coordinate covalent bond in ozone	1

34.

Marking criteria	*Marks*
Outlines destructive and non-destructive testing and provides examples for each from the Production of Materials unit	3
Outlines one type of testing and gives an appropriate example OR provides an example of each type of testing OR outlines both types of testing	2
Outlines one type of testing OR Provides an example of one type of testing	1

OPTION – Industrial Chemistry

a. (i).

Marking criteria	*Marks*
Identifies X as oxygen/air, Y as oxygen/air and Z as sulfuric acid.	1

a.(ii).

Marking criteria	*Marks*
Identifies the intermediary as oleum with the formula of $H_2S_2O_7$.	1

a.(iii).

Marking criteria	*Marks*
Identifies THREE conditions used to maximize the efficiency of the second step of the contact process AND gives a specific factual feature for each :- ➔ Moderate temperature of 450 – 600^{o}C ➔ Pressure just above atmospheric pressure of 150 kPa ➔ Use of V_2O_5 as the catalyst ➔ Use an excess of air in a 5:1 ratio (air:SO_2) ➔ Remove the SO_3 as it is produced	2
Identifies TWO conditions that are manipulated OR Identifies ONE condition that is manipulated AND gives a specific factual feature of that condition	1

a.(iv).

Marking criteria	*Marks*
Gives the main features of TWO properties of sulfur that allow the Frasch process to be successful AND Identifies another property of sulfur that is useful	2
Gives the main features of ONE property of sulfur that allows the Frasch process to be successful OR Identifies TWO properties of sulfur that allow the Frasch process to be successful.	1

b.(i).

Marking criteria	*Marks*
Writes the correct expression, including "K ="	1

b.(ii).

Marking criteria	*Marks*
Provides a replica of the table presented in the exam paper that has all column headings and units given AND All pieces of data entered into the table have been correctly read off the graph AND Calculates the correct value for K at each of the FOUR times specified	3
Provides a replica of the table presented in the exam paper with most pieces of data correctly entered into it AND Calculates the correct value for K for TWO of the times specified.	2
Provides THREE pieces of correct data, entered into a table	1

b.(iii).

Marking criteria	*Marks*
Identifies the student that student A is correct* AND (1) States that the only condition that alters the value of K is a change in temperature (2) Compares the K values for t = 2 and t = 6 and identifies they are different* (3) Compares the K values for t = 9 and t = 12 and identifies they are different* *or makes a different judgement that is CONSISTENT with the K values presented in b (ii)	3
Identifies the student that student A is correct* AND Presents ONE of points (1), (2), (3) outlined above *or makes a different judgement that is CONSISTENT with the K values presented in b (ii)	2
Identifies that student A is correct OR Identifies that a change in temperature is the only factor that changes the value of K *or makes a different judgement that is CONSISTENT with the K values presented in b (ii)	1

b.(iv).

Marking criteria	*Marks*
(1) States that the reaction is exothermic (2) Identifies, from the graph OR from the K values, that increasing the temperature has resulted in an increase in [reactants] and thus favoured the reverse reaction (3) States Le Chateliers principle (LCP) in full (4) Uses LCP to explain that the reverse reaction must be endothermic since it will absorb heat and hence minimise the disturbance imposed on the equilibrium system	3
TWO of the points outlined above	2
ONE of the points outlined above	1

c. (I).

Marking criteria	*Marks*
Calculates the number of moles of $CaCO_3$ as 999000.8093… mol (NOT rounded off) AND Thus, calculates the correct mass of $CaCl_2$ as 1.1 X 10^2 tonne (2 significant figures)	2
Calculates the number of moles of $CaCO_3$ as 999000.8093… mol (NOT rounded off) OR Calculates the correct mass of $CaCl_2$ based on an incorrect calculation of the moles of $CaCO_3$	1

c.(II).(i).

Marking criteria	*Marks*
Identifies Step 2.	1

c.(II).(ii)

Marking criteria	*Marks*
Identifies the gas as carbon dioxide (acid + carbonate ➔ salt + water + carbon dioxide)	1

c.(II).(iii).

Marking criteria	*Marks*
Provides an appropriate reason for cooling the measuring cylinder ➔ Reaction is exothermic, so using as ice bath, removes heat, forcing the equilibrium to shift to the right ➔ CO_2 is more soluble in water at lower temperatures ➔ $NaHCO_3$ precipitates out of solution at lower temperatures, enabling it to be separated from the more soluble $CaCl_2$.	1

c.(II).(iv).

Marking criteria	*Marks*
Presents a correct, balanced chemical equation :- $NaCl_{(aq)} + NH_{3(aq)} + CO_{2(aq)} + H_2O_{(l)} \rightarrow NH_4Cl_{(aq)} + NaHCO_{3(s)}$	1

c.(II).(iv).

Marking criteria	*Marks*
(1) Makes a clear judgement that working with ammonia is highly risky (2) Outlines three or more risks associated with the use of ammonia, using data provided by the supplied MSDS (3) Outlines safety precautions that should be used in a laboratory setting to address the risks identified OR Relates the identified risks to the laboratory setting	3
Makes a clear judgement that working with ammonia is highly risky AND Outlines two risks associated with the use of ammonia, using data provided by the supplied MSDS	2
Makes a judgement that working with ammonia is highly risky OR Outlines some risks associated with the use of ammonia using data provided by the supplied MSDS OR Outlines safety precautions that should be followed when working with ammonia using data provided by the supplied MSDS	1

Exemplar answers

2010 THSC Exam – Chemistry

1	2	3	4	5	6	7	8	9	10
B	D	D	D	C	A	A	D	A	B

11	12	13	14	15	16	17	18	19	20
B	A	A	D	A	B	B	D	C	B

Question 21

A 0.040 mol/L solution of methanoic acid in water has a pH of 2.57.
Assess the extent of ionisation of methanoic acid. 3M

$= 10^{-pH}$

0.04M of methanoic acid, $[H^+] = 10^{-2.57} = 2.69 \times 10^{-3}$ M ✓

∴ Degree of ionisation $= \frac{[H^+]}{[HCOOH]} = \frac{[2.69 \times 10^{-3}]}{[0.040]} \times 100$ 3

$= 6.73\%$ ionised ✓

Thus it can be stated that methanoic acid is a weak acid, having only partially ionised in water to form H_3O^+. ✓

$H_2O + HCOOH \rightleftharpoons H_3O^+ + COO^-$. Methanoic acid is only 6.73% ionised, meaning not all HCOOH molecules have ionised to form hydronium ions.

If fully ionised, should have a pH of $-\log_{10}[0.040] = 1.40$, however since only partially ionised pH is much lower. The extent of ionisation is much lower than that such as of HCl (100% ionised) it is not fully ionised.

A 0.040 mol/L solution of methanoic acid in water has a pH of 2.57.
Assess the extent of ionisation of methanoic acid. 3M

Degree of ionisation $= \frac{[H^+]}{[HA]} \times 100\%$ $[H^+] = 1 \times 10^{-pH}$

$= 1 \times 10^{-2.57}$ ✓

$= \frac{(1 \times 10^{-2.57})}{0.04} \times 100\%$

$= 6.7288...$ 3

$\doteq 6.73\%$ ✓

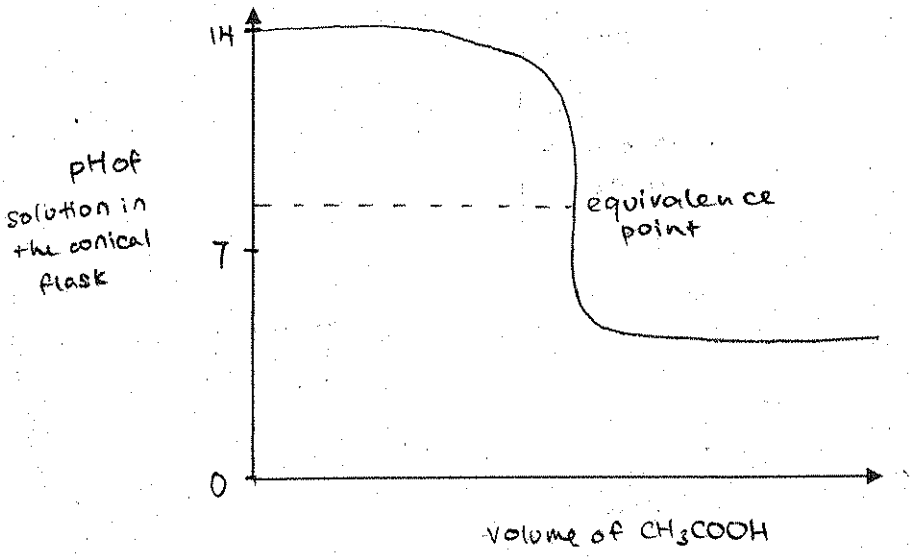
The methanoic acid has a low extent of ionisation as can be seen from the derived result of 6.73%. This means that it is a weak acid and does not completely ionise in water. ✓

2

Question 22

(a) Draw a pH curve for a titration that involves placing 2.0 mol/L NaOH in the conical flask and 10 mol/L CH_3COOH in the burette. acid against base 2

$NaOH + CH_3COOH \rightarrow NaCH_3COO + H_2O$



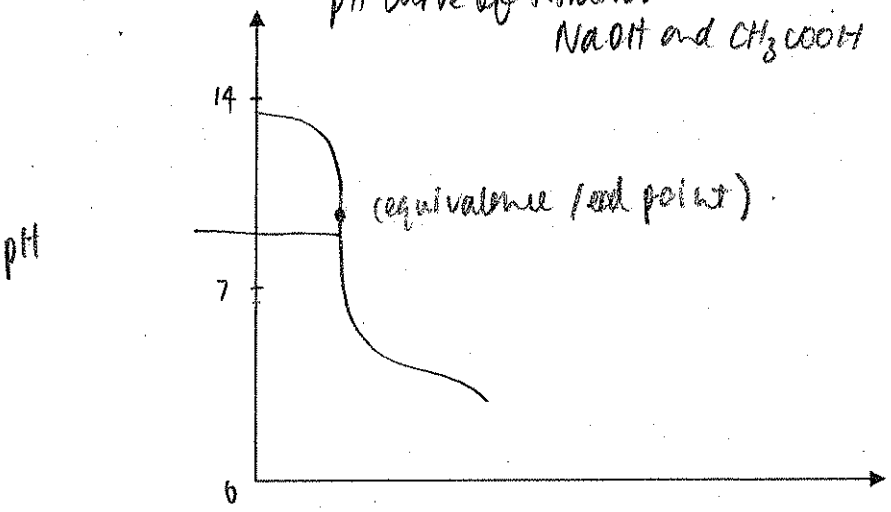
Graph of pH of solution in conical flask against volume of CH_3COOH

✓ 2

Question 22

(a) Draw a pH curve for a titration that involves placing 2.0 mol/L NaOH in the conical flask and 10 mol/L CH_3COOH in the burette. strong weak. 2M

pH curve of titration NaOH and CH_3COOH



2

(b) Identify one indicator that would be appropriate to use in the titration described above. 1M

Phenolphthalein. 1

3

Question 23

(a) During this course you tested the pH of a number of salts. Outline the results of this investigation, including one acidic and basic salt. 2M

- NH_4Cl is an acidic salt. ✓
- Na_2CO_3 is a basic salt. ✓ 2

These salts in aqueous solution had indicators adding to them (litmus solution) which red showed acid, blue basic and a purple which was neutral.

(a) During this course you tested the pH of a number of salts. Outline the results of this investigation, including one acidic and basic salt. SA, WB SB WA NaOH 2M

The pH of one acidic salt, namely ammonium sulphate ($(NH_4)_2SO_4$) ✓ had a pH of about 4 while one basic salt, namely ~~Mg(OH)2 magnesium~~ ~~oxide~~ $NaHCO_3$ sodium bicarbonate had a pH of about 8. ✓ 2

It was found that salts with parent acids and bases that were strong formed neutral salts. Those with a strong parent acid and weak parent base formed acidic salts like NH_4NO_3 ✓ while those with weak parent acids and strong parent bases formed basic salts like $NaCH_3COO$ (sodium acetate) ✓ 2

All salts were dissolved in solution and tested with indicators. It was found that non-metal salts are acidic, eg. NH_4Cl and metal salts were basic, eg. Na_2O, MgO ✓ 2

The results in this investigation showed that a large variety of salts were not neutral but instead were acidic salts like NH_4Cl ✓ or basic salts ($NaCH_3COO$ and Na_2CO_3 ✓). Trends in results show an acidic salt could be made from strong acid/weak base and vice versa for basic salt. And neutral was made from (strong)/strong) or (weak acid/weak base) such as NaCl ($NaOH/HCl$) 2

(b) Account for the results for one salt named above. 2M

NH_4Cl (Ammonium Chloride) is an acidic salt, as it hydrolyses in water to form NH_4^+ and Cl^-. The NH_4^+ being a strong conjugate acid of a weak base will react with water to form H_3O^+.

$NH_4^+(aq) + H_2O \rightleftharpoons NH_3(aq) + H_3O^+(aq)$ ✓✓

The formation and presence of H_3O^+ causes the solution to be acidic, thus NH_4Cl is an acidic salt. 2

(b) Account for the results for one salt named above. 2M

NH_4Cl is a soluble ionic salt that fully dissociates in aqueous solution.

$NH_4Cl(aq) \rightleftharpoons NH_4^+(aq) + Cl^-(aq)$

NH_4^+ – can act as a Bronsted Lowry acid because it can donate a proton.
– can not act as a Bronsted Lowry base because it can't accept a proton

Cl^- – can not act as a Bronsted Lowry acid because it can't donate a proton.
– will not act as a Bronsted Lowry base because it is the weak conjugate of a strong acid (HCl) 2

therefore, NH_4Cl hydrolyses in water producing hydronium ions thus, NH_4Cl is an acidic salt. $NH_4^+_{(aq)} + H_2O_{(l)} \rightleftharpoons NH_3(aq) + H_3O^+_{(aq)}$ ✓

Question 24

Calculate the concentration of a sample of hydrochloric acid when 25.00 mL of 0.05 $molL^{-1}$ sodium carbonate solution was titrated against 24.00 mL of hydrochloric acid. 3M

$2HCl_{(aq)} + Na_2CO_{3(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

$V = 0.024mL$. $V = 0.025L$

$c = 0.05 molL^{-1}$

$n_{Na_2CO_3} = c.V = 0.025 \times 0.05 = 0.00125 mol$.

$n_{Na_2CO_3} : n_{HCl}$

1 : 2 3

$n_{HCl} = n_{Na_2CO_3} \overset{\times 2}{=} 0.00125mol \times 2 = 0.0025mol$

$c_{HCl} = \frac{n}{V} = \frac{0.0025}{0.024} = 0.1 molL^{-1}$ (1 sig fig)

5

Question 24

Calculate the concentration of a sample of hydrochloric acid when 25.00 mL of 0.05 $molL^{-1}$ sodium carbonate solution was titrated against 24.00 mL of hydrochloric acid. 3M

$2HCl_{(aq)} + Na_2CO_{3(s)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

$24mL_1\ C=?\quad 25mL_1\ 0.05M$

$n_{Na_2CO_3} = C.V = 0.05 \times 0.025 = 0.00125\ mol$

From eqn 1, $n_{HCl} = 2 \times n_{Na_2CO_3} = 2 \times 0.00125 = 0.0025\ mol$

$C_{HCl} = \frac{n}{V} = \frac{0.0025}{0.024} = 0.1041666...$

$= 0.1042\ mol/L$

3

Question 25

Assess the use of neutralisation reactions as a safety procedure to minimise damage in chemical spills. (Include examples and equations in your answer)

The use of neutralisation reactions is an excellent safety procedure to minimise damage in chemical spills, this is because they are able to convert the acidic/basic substance into a more neutral/safe substance. A good substance used in chemical spills is $NaHCO_{3(s)}$, a weak solid base. This is because it is amphiprotic, meaning it can neutralise both acids and bases, thus minimising the damage. $NaHCO_{3(s)} + OH^- \rightarrow Na_2CO_{3(s)} + H_2O_{(l)}$

$NaHCO_{3(s)} + H_3O^+ \rightarrow Na^+ + H_2CO_{3(s)} + H_2O_{(l)}$

Furthermore, since it is a weak base and solid, heat produced due to the exothermic neutralisation reaction will be less than with a stronger acid/base, in addition being a powdered base is advantageous as it can soak up chemical spills, reducing its volume making it easier to clean up. This is especially the case in large spills of strong acids such as HCl or strong bases such as NaOH. Thus the use of neutralisation reactions as a safety procedure in spills is excellent as it can convert acidic/basic spills into harmless substances, making more safe to the people in the area. Though the exothermic reaction may cause fumes, carrying out in well ventilated areas

and using a weak acid/base would minimise this risk, thus minimising damage. Eg. $NaHCO_3$ - soak up the spill prevented it to contaminate into other areas such as sewers/drains etc, minimising damage; also when $NaHCO_3$ neutralises, it fizzes producing $CO_2(g)$, thus when fizing stops it gives indication of end of neutralisation, thus knowing when the area is safe from the spill. Acids and bases are highly corrosive/caustic, thus it can cause major damage to many things, thus through neutralisation it reduces this damage by neutralising it.

Assess the use of neutralisation reactions as a safety procedure to minimise damage in chemical spills. (Include examples and equations in your answer) 5M

5

Spills of basic solutions or acidic solutions are detrimental to our environment. Therefore to minimise the damage in the chemical spill a neutralisation reaction is performed through the use of an ~~amphiprotic~~ amphoteric substance (eg. $NaHCO_3$).

- With an Acid spill:

Eq ✓ $HCl_{(aq)} + NaHCO_{3(s)} \rightarrow NaCl_{(s)} + H_2O_{(l)} + CO_{2(g)}$

The spill of strong acid HCl would be very harmful to both humans ~~and~~ as it can cause severe burning, as well as the environment, kill plants by burning them. Due to this the spill is mopped up through placing the solid $NaHCO_3$ around the spill to stop it from spreading and allowing the neutralisation reaction to occur. The products made from this reaction are NaCl salt, water and CO_2 gas which is easier to clean and less harmful to the environment.

- Likewise with a base spill:

Eq $3NaOH_{(aq)} + NaHCO_{3(s)} \rightarrow 2Na_2O_{(s)} + 2H_2O_{(l)} + CO_{2(g)}$. ✓

Eq ✓ Strong base is harmful to society and the environment as it can kill plant growth, etc. Due to this base spills use $NaHCO_3$ to neutralise the spill and from this reaction, the resulting products become Na_2O, H_2O and CO_2 which is easier to clean and less harmful.

7

Assess the use of neutralisation reactions as a safety procedure to minimise damage in chemical spills. (Include examples and equations in your answer)

During chemical spills, it is often crucial to neutralise any acidic
As or basic spills as they can cause damage to the material, or anyone who
comes into contact with it. However, neutralisation reactions are highly
exothermic and care must be taken to prevent contact with skin. Also,
the use of strong acids and base may even cause more damage after
neutralising, as if used in excess as ~~they are~~ acids are highly corrosive
and bases, caustic. A suitable substance that may be used to neutralise
SS spills, is $NaHCO_3$ which is amphiprotic and can ~~dissolve~~ neutralise both acids and
bases. ✓ e.g $NaHCO_{3(s)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$
EQ ×2 ✓ or $NaHCO_{3(s)} + NaOH_{(aq)} \rightarrow Na_2CO_{3(aq)} + H_2O_{(l)}$
EQ
Another suitable substance is Na_2CO_3 as both of these are available in
SS's solid form and can be stored easily, and cleaned up easily. Also, with
$NaHCO_3$, the neutralisation process can be monitored by observing
SS fizzing from the production of CO_2 gas.
Any excess of these substances can be ~~all~~ easily cleaned up
with water. Before any of this can be done, the spill must be isola
with the use of either vermiculite or sand.
Therefore, ✱ neutralisation reactions are essential in minimising and effective.
damage in chemical spills as they are able to neutralise the acid
or base, but extra care and suitable substances must be used

Assess the use of neutralisation reactions as a safety procedure to minimise damage in chemical spills. (Include examples and equations in your answer) 5M

The use of neutralisation reactions are a very effective safety procedure 5
in minimalising damage in chemical spills, but are more effective
in conjunction with other procedures, such as placing sand on the
chemical to soak it up and removing it from the area in this
way before using neutralisation. If a strong acid or a strong
base is spilt, a weak acid (for bases) ~~and~~ or a weak base (for acids)
must be used, and in solid form, as this is a less vigorous reaction,

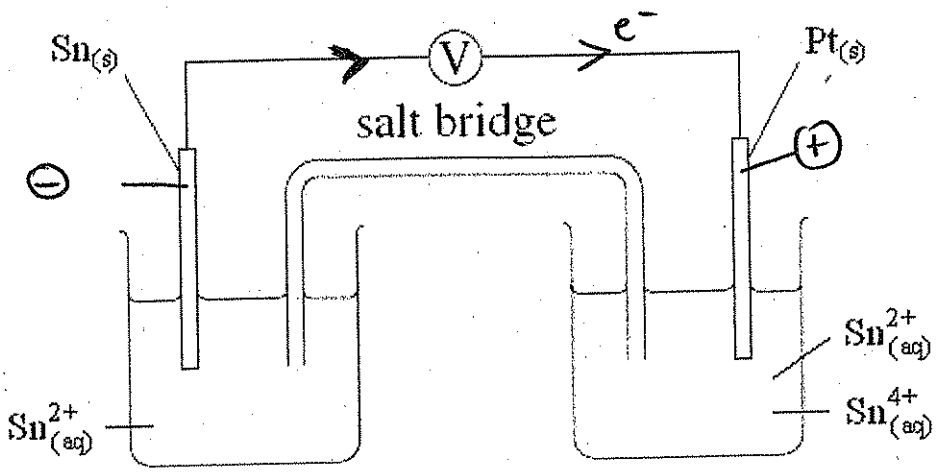
and since neutralisation is an exothermic reaction, will produce less heat. This makes it suitable as a safety procedure. For example, if H_2SO_4 (aq) was spilt, it could be neutralised with Na_2CO_3 (s): $H_2SO_{4(aq)} + Na_2CO_{3(s)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)} + CO_{2(g)}$ which can be disposed of safely. If NaOH was spilt, another chemical reaction could be used to minimise damage since strong bases are highly caustic, they can cause a lot of damage eg. to human skin. Thus, neutralising the base will minimise this damage. Since H_2SO_4 has a high affinity for water, it will exothermically dehydrate skin or wood (e.g. if it comes into contact with them) causing a lot of damage. Neutralising the acid will minimise this damage. Since it is a highly exothermic process, the neutralisation, as with NaOH, must be performed away from anywhere that further damage can be caused. For this reason it is effective to use the sand method above. NaOH can be neutralised using a weak acid, such as H_2CO_3:

$$2NaOH_{(aq)} + H_2CO_{3(aq)} \rightarrow Na_2CO_{3(aq)} + 2H_2O_{(l)}$$

Using these procedures (neutralisation reactions) are an effective and safe procedure if done properly

Question 26

In the galvanic cell below, Sn(s) is the anode and Pt(s) is the cathode.



(a) Identify on the diagram the direction of the electron flow AND the positive electrode AND the negative electrode. 2

2M

(b) It was discovered that the voltmeter reading was +0.29V. Deduce the reduction half equation and the standard reduction potential for the half equation. 2M

$Sn(s) \rightleftharpoons Sn^{2+}(aq) + 2e^-$: oxidation $E_{ox} = +0.14V$ |+

$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$: reduction $E_{red} = x$.

$E_o = +0.29V$.

$\therefore E_o = E_{ox} + E_{red}$ 2

$+0.14 + E_{red} = +0.29V$.

$E_{red} = 0.29 - 0.14$

$= 0.15V$.

(c) Outline how you would construct a salt bridge in the laboratory. 1M

This would be done by folding filter paper into a lengthship then soaking it in $KNO_3(aq)$. The two ends can then be placed in each beaker. 1

In the laboratory, a salt bridge is constructed by soaking a paper towel or filter paper into a saturated potassium nitrate solution ($KNO_{3(aq)}$) and placing either end in each beaker as seen above 1

Question 27

Outline how Neptunium-239 would be commercially produced. Include a balanced chemical equation. 3M

Neptunium-239 is a transuranic element as it has an atomic number greater than 92 (Np-93). Transuranic elements with atomic numbers 93, 94, 95 are produced in a nuclear reactor via neutron bombardment. The controlled fission of substances such as Uranium-235 is used to release neutrons which are then used to bombard a target. The fusion of the neutron into the nucleus of the target atom makes it unstable, forming a new element. As it decays commercially to produce Neptunium-239, Uranium-238 is bombarded with neutrons in a nuclear reactor such as the one in USAS Hexagus to form unstable U-239 which beta decays to form Neptunium-239 3

$^{238}_{92}U + {}^{1}_{0}n \rightarrow {}^{239}_{92}U \rightarrow {}^{239}_{93}Np + {}^{0}_{-1}e$.

Question 27

U-238
N

fission is better term.

Outline how Neptunium-239 would be commercially produced. Include a balanced chemical equation.

3M

Neptunium-239 would be produced in a nuclear reactor. In a nuclear reactor, the uncontrolled decay of uranium-235 provide a source of neutrons, which are bombarded at the target nuclei and fuses to produce neutron rich isotopes. Uranium-238 is bombarded with neutrons to produce uranium-239, which undergoes beta decay to produce neptunium-239. 3

$^{238}_{92}U + {}^{1}_{0}n \longrightarrow {}^{239}_{92}U \longrightarrow {}^{239}_{93}Np + {}^{0}_{-1}e$ The neutron does not need to accelerated to high speeds because it has no and there is no repulsion between it and the target nuclei charge

Question 28

For a named biopolymer, outline one advantage it has for the environment AND one advantage it has for society.

3M

Polylactic Acid (PLA) is a biodegradeable polymer which exhibits high strength and stiffness. One advantage of PLA for the environment is the fact that it is biodegradable, meaning it can be easily decomposed, compared to current non-biodegradable plastics, thus not causing long term disposal problems as plastics that cannot be decomposed can end up in oceans etc which may kill marine organisms. The advantage PLA has for society is that it can be derived from plant wastes crops, thus reducing society's dependence on fossil fuels, providing an alternative way to produce plastics besides from crude oil, a non-renewable source. 3

Bi Opol is a biopolymer which is ~~both~~ both renewable and biodegradable. Because it is biodegradable it has a significant positive impact on the environment because it will break down ~~and~~ in the environment unlike LDPE "plastic bags" which ~~can~~ don't break down and can kill wildlife. Because it is renewable it can ease the pressure of fossil fuel reserves which are being ~~at the rate~~ used up quickly. It can provide society ~~with~~ with a sustainable, renewable source of plastics for society and hence allow for the continued production of cheap plastics because in the future fossil ~~fuels~~ fuel reserves will dwindle, and plastics ~~produced~~ derived from fossil fuels will become more expensive. 3

Question 29

During the course you performed a first-hand investigation to compare the reactivity of an appropriate alkene with its corresponding alkane in bromine water.
Assess the validity of the procedure used in this investigation. 5 5M

The procedure for this FHI was valid. All variables but the independent variable were controlled (which was either the ~~alk~~ alkene or alkane used), the controlled variables were the amount of alkene/alkane used, the amount[2] of bromine solution added to each ~~test~~, amount[3] of shaking that was applied to each and also the environment in which the experiment was conducted[4] (inside laboratory). This meant that it was only the nature of the alkenes and the alkenes that influenced what the dependent variable was (colour change). The aim of the experiment was to compare reactivity of ~~the appropriate~~ alkene and alkane thus the use of corresponding alkenes/alkanes ensured similarity of two (difference just the double bond). Also these alkenes/alkanes were liquid in that allowed observations to be made; as opposed to the use of gases that can lead to false observations consisting to

invalid procedure. the alkane used was hexane and hexene was the alkene. After wards cyclohexane and cyclohexene were used, and although different to hexane/hexene, the similarity between cyclohexane/cyclohexene (corresponding) and the reaction results help validate the results thus procedure is valid (it answers aim).

* In this investigation, cyclohexane and cyclohexene were chosen to be compared in terms of reactivity. 1cm³ of cyclohexane and 1cm³ of cyclohexene were placed in two clean seperate test tubes, 3 drops of bromine water were added to each test tube and both were agitated for 30 seconds. The colour changes were observed and the experiment was repeated.
* The procedure was carried out in a cool/dark room (where there was low UV light) at relatively constant temperatures.
* The procedure of this investigation is highly valid because:
  → All variables were controlled except for the ones that needed to be changed ie the independent and dependent variables. The same amount of cyclohexane and cyclohexene (1cm³) were added to both test tubes and the same amount of bromine water was added. Agitation was done for equal amounts of time.
  → cyclohexane and cyclohexene were chosen because they are similar in structure, varying only by a double bond or lack thereof, allowing the aim to be effectively answered as the difference in reactivity can merely be accounted by the presence of the double bond. They are also more stable than their straight chained families and hence will not react in air, allowing for the conclusion to be valid. They are also liquids making them easy to compare (unlike shorter chains which are gases).
  → Bromine water is yellow, hence the change in colour allows us to effectively conclude that a reaction has occurred. It is known that a reaction will occur with cyclohexane if it is exposed to UV hence the experiment was carried out in a dark room to prevent this, allowing us to effectively compare reactivity.
* The procedure is highly valid as all variables were effectively controlled and the aim was able to be answered as students were able to effectively compare the reactivities of an alkane and alkene.

3

Question 29

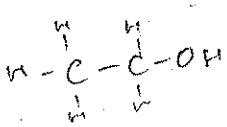
During the course you performed a first-hand investigation to compare the reactivity of an appropriate alkene with its corresponding alkane in bromine water.
Assess the validity of the procedure used in this investigation. 5M

In this ~~procedure~~ investigation, the procedure used to compare the reactivity of in this case, hexene and hexane was valid as we controlled variables, allowing us to measure what was intended. Equal volumes of Hexane and Hexene was used (20mL) placing in two separate test tubes as well as adding 10mL (Too much) of Bromine water to each tube. Furthermore, we carried out this experiment in the absence of UV light (controlled variable) as UV light can decolonise the tan bromine water. Furthermore, choice of Hexane and hexene was used as they are liquid at room temp, making it easy to manage as well as being similar substances (alkane/corresponding alkene) which ~~only~~ differ in the presence of a double bond in Hexene, thus allowing us to validly measure/compare reactivity of the alkane & alkene. Also both test tubes, were shakened with the same intensity as well for same period of time allowing us to observe the results and thus compare reactivity. Thus, in this investigation, the procedure used was valid as we controlled all variables such as UV light/reactants/intensity of shaking etc allowing us to compare reactivity, as intended by aim of experiment

5

Question 30

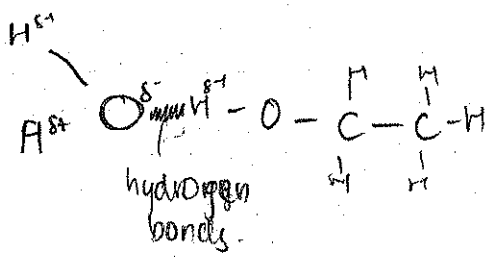
Explain why ethanol will dissolve in both water and hexane. 3M



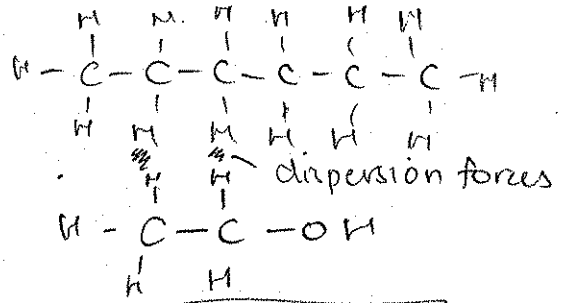
Ethanol is a versatile solvent, being able to dissolve in both water and hexane. This is because ethanol contains a polar hydroxyl end (O-H) as well as a non polar alkyl end ($R-CH_3$). Thus in water, ethanol molecules experiences hydrogen bonds with water molecules, which is much stronger than the weak dispersion forces between ethanol molecules, thus will dissolve in water. In the case of hexane, ethanol as ethanol breaks away.

3

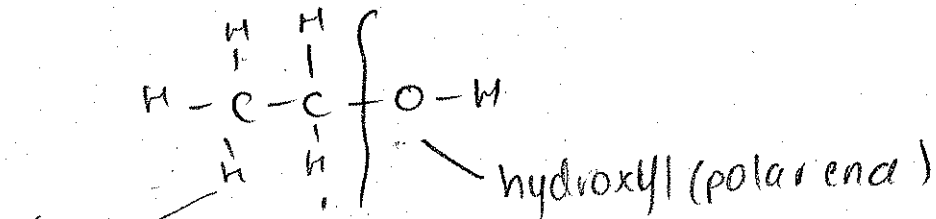
molecules, due to the alkyl group, will experience stronger dispersion forces with the non-polar molecules of hexane, thus breaking the intermolecular/weak dispersion forces between ethanol molecules and thus dissolving in hexane.
Due to the polar nature of the hydroxyl groups, it can dissolve in polar solvents such as water, forming stronger hydrogen bonds than the intermolecular forces between ethanol and due to non-polar nature of alkyl group, it can dissolve in non polar solvents such as hexane ("like dissolves like"



Water & Ethanol



Ethanol & Hexane



Ethanol

Question 30

Explain why ethanol will dissolve in both water and hexane. 3M

Ethanol dissolves in water because it contains the hydroxyl (OH) group which is polar and hence can form dipole-dipole forces or hydrogen bonds with water, which is also a polar substance, causing it to dissolve. Ethanol can also dissolve hexane because it contains a short non-polar hydrocarbon chain (ethyl group) which can form dispersion forces with non-polar hexane, causing it to dissolve. 3

5

Question 31

The following questions relate to the Haber process.

(a) Identify an industrial use of ammonia. 1M

production of explosives, such as TNT ✓ 1

Used as a component of fertilisers such as $(NH_4)_2SO_4$. 1

Ammonia is used in the Solvay process, for the production of Na_2CO_3 and $NH_4Cl(aq)$.

(b) Identify the catalyst used in the Haber process and explain why it is used. 3M

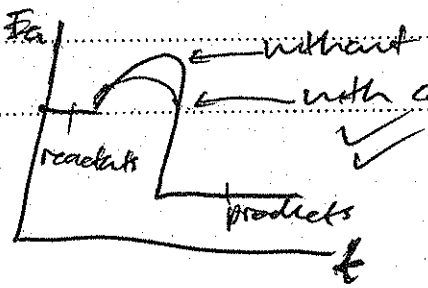
* The catalyst used is magnetite (Fe_3O_4). ✓
* It is used because it allows the reaction to occur faster by lowering the activation energy (E_A) (amount of energy required by reactants to successfully react) by providing an alternate reaction pathway. 3
* Because the Haber process is exothermic: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H < 0$, an increase in temperature will decrease yield in accordance with Le Chatelier's principle. By using a 'catalyst', a lower temperature can be used to increase yield while the decreased rate of reaction is compensated by the catalyst as it allows for the reaction to occur more successfully at lower temperatures of about 400°C (despite reactants having less kinetic energy) due to lower E_A.

(b) Identify the catalyst used in the Haber process and explain why it is used. 3M

The catalyst used in the Haber process is ~~Fe~~ Fe_3O_4 (meteitite). ✓
The use of a catalyst allows for a lower temperature (less energy) to be used and and therefore increase in the ~~rate~~ of reaction, as the catalyst provides an alternate pathway of lower activation energy (E_A) for the reaction. The catalyst is able to weaken the bonds of reactant molecules substantially or even break them into separate atoms. Thus, less energy is needed to break the bonds of N_2 and H_2 so that more NH_3 can be produced at a quicker rate, as a higher fraction of the reactants will possess the required E_A to overcome the energy barrier stopping them from reactants. This means less heat can be used, which would decrease the yield of ammonia since it is an exothermic reaction and damage the actual catalyst

(b) Identify the catalyst used in the Haber process and explain why it is used. 3M

magnetite Fe_3O_4 iron II (III oxide (in powder form)
It allows the reaction to be carried out at a lower activation energy & speeds up the reaction. (i.e. provides an alternative pathway for the reaction to take place) 3



Great answer

plural.

(c) With reference to its uses, evaluate the significance of the development of the Haber process to society between 1910 and 1918. 4M

social, political.

WorldWar I was going on this time. The Haber process was developed by German Fritz Haber. Germany had, had its access to ammonia blockaded by Britian. Ammonia, being essential to making explosives and fertilizer, was running low in Germany. Haber developed the Haber process, in which he could take readily available nitrogen and hydrogen and combine them to make required ammonia $(N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)})$ 4
As a result, ammonia was available again. It allow Germany's war effort to continue, resulting in the death of many more people, as the explosive allowed hermany to continue fighting. This was very significant. Furthermore, Germans were beginning to starve. The ammonia, was used to make fertiliser, and it grew a large amount of food for German people. It allowed the German government to maintain popularity as people were not starving.

(c) With reference to its uses, evaluate the significance of the development of the Haber process to society between 1910 and 1918. 4M

The development of the Haber process was very significant during 1910-1918 especially in Germany due to WWI that was occuring. the allies of Germany had stopped the importing nitric acid and nitrogen compounds

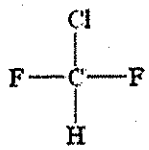
7

that was needed to be used to make explosives for the war effort but also for farming — for fertilisers to grow crops of society to live. Natural supplies such as guano was also depleting; which caused Germany to suffer in their war effort and daily lives. The Haber process, developed by Fritz Haber used nitrogen and hydrogen in the air to produce ammonia which could be used to make fertilisers and nitric acid. This not only allowed society to continual living but also Germany was able to continue fighting in the war (extending its time, but also killing more people by use of explosive, TNT). 4

Question 32

The following questions relate to chlorofluorocarbons.

(a) Name the following CFC (chlorofluorocarbon). 1M



chlorodifluoromethane. 1

(b) Outline a how a named CFC damages the ozone layer, using chemical equations as appropriate. 4M

CFCs are emitted in the troposphere (mostly from industries) but their inertness meant that the could not be destroyed by sunlight and/or oxygen. CFCs built up and slowly moved into the stratosphere in which they met short wavelength UV radiation which breaks it up to chlorine radicals. eg. CCl_3F + uv light $\longrightarrow$ $Cl\cdot + CCl_2F$ ✓

CCl_2F_2 + uv light $\longrightarrow$ $Cl\cdot + CClF_2$

These chlorine radicals attaches to oxygen of ozone molecule, removing it and thus destroying the ozone molecule. 4

$Cl\cdot + O_3 \longrightarrow ClO\cdot + O_2$ ✓

The $ClO\cdot$ would also react with oxygen radicals in the stratosphere forming more $Cl\cdot$ which destroyed more ozone molecules

$ClO\cdot + O\cdot \longrightarrow Cl\cdot + O_2$ ✓

Although the $Cl\cdot$ eventually gets removed, many ozone has been destroyed and removed from ozone layer — causing the thinning of the ozone — ozone depletion. ✓

(b) Outline a how a named CFC damages the ozone layer, using chemical equations as appropriate.

4M

Named CFC: CFC 11 : CCl_3F ✓

When CFC's are released into the environment, they readily surpass the troposphere and reach the stratospheric ozone layer due to their low reactivity. However as they reach this layer, they are broken down by intense UV light: $CCl_3F_{(g)} + UV\ light \rightarrow CCl_2F^{\bullet}_{(g)} + Cl^{\bullet}_{(g)}$ ✓

This released chlorine radical then reacts with ozone, thereby effectively destroying it. $Cl^{\bullet}_{(g)} + O_{3(g)} \rightarrow ClO^{\bullet}_{(g)} + O_{2(g)}$ ✓ However the process does not stop, the $ClO^{\bullet}$ formed then ~~photodissociates due to the light it used~~ reacts with an oxygen free radical: $ClO^{\bullet}_{(g)} + O^{\bullet}_{(g)} \rightarrow Cl^{\bullet}_{(g)} + O_{2(g)}$ ✓

As a result, the $Cl^{\bullet}$ radical is again reformed, thereby setting up a chain reaction in which 1 CFC molecule destroys 1000's of O_3 molecules. Due to this destruction of ozone, the ozone layer thins out and has resulted in the formation of the ozone hole. Hence, this is how CFC 11 (a named CFC) damages the ozone layer by destroying ozone molecules. Excellent

4

(b) Outline a how a named CFC damages the ozone layer, using chemical equations as appropriate.

4M

CFC's are relatively inert and are not removed in the troposphere - they slowly diffuse into the stratosphere where it undergoes photodissociation under U.V light, producing chlorine free radicals that destroy the ozone layer. An example would be trichlorofluoromethane (CCl_3F)

$CFCl_3(g) \xrightarrow{U.V} CFCl_2^{\bullet}(g) + Cl^{\bullet}(g)$ ✓

$Cl^{\bullet}(g) + O_3(g) \rightarrow ClO^{\bullet}(g) + O_2(g)$ ✓

$ClO^{\bullet}(g) + O^{\bullet}(g) \rightarrow Cl^{\bullet} + O_2(g)$ ✓

As seen, one molecule of $CFCl_3$ can decompose to a chlorine free radical which attacks ozone and then re-forms allowing a chain reaction to occur whereby one $CFCl_3$ molecule can ~~still~~ remove many ozone molecules, effectively damaging the ozone layer.

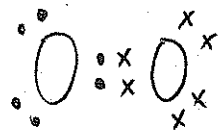
As seen, a CFC such as trichlorofluoromethane destroys the ozone layer through releasing chlorine free radicals when decomposed under U.V light which can repeatedly attack ozone molecules, thus destroying the ozone layer.

4

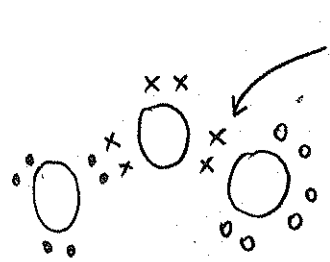
19

Question 33

The molecules O_2 and O_3 are allotropes and both common in the Earth's atmosphere.
Using Lewis diagrams, show how the shapes of oxygen and ozone are different, identifying any co-ordinate covalent bonds. 2M



O_2



O_3

2

Question 34

Outline the difference between destructive and non-destructive testing, using an appropriate example for each type of testing coming from the Production of Materials module. 3M

Destructive - the type of testing that involves changing the chemical properties of substances so that they are unable to be reformed or reproduced for future use in other areas. An example of destructive testing is in the bromine water - cyclohexene practical. The ~~clear~~ cyclohexene was combined with the yellow bromine water and a color change was observed (showing a chemical reaction took place). The cyclohexene ~~could~~ cannot be reproduced as it has chemically combined with the water and so, it is a destructive test.

Non-destructive - the type of testing that does not involve chemically changing a substance so that it can be reformed and re-used for further testing in other areas. One example of non-destructive testing is the modelling of polymerisation. No new chemicals were formed and the models equipment could be re-used.

End of Part B

Outline the difference between destructive and non-destructive testing, using an appropriate example for each type of testing coming from the Production of Materials module. 3M

Destructive tests are those that destroy the ~~product~~ materials that it is testing, changing into another substance and causing it to be unable to be reused. Example: Burning ethanol to test for KJ/mol.

3

On the other hand, non-destructive testing does not destroy the material and the material can be reused and reformed. Example, ~~testing~~ boiling water during the test for ethanol's KJ/mol.

Outline the difference between destructive and non-destructive testing, using an appropriate example for each type of testing coming from the Production of Materials module. 3M

— destructive testing → the apparatus (chemical substances & equipment) cannot be reused ~~bc~~ an irreversible chemical reaction has occured. 3
e.g. bromine water test on alkanes & alkenes, the chemical substances cannot be reused to perform another test.
— non-destructive testing → the testing method can be reused as no irreversible chemical reaction has occured allowing the process to be used again.
eg. using a voltmeter to test/measure the voltage generated by a galvanic cell → the voltmeter could be used again and again on other galvanic cells.

Section II
Industrial chemistry

a) i) X → O_2
Y → O_2
Z → H_2SO_4

ii) Oleum - $H_2S_2O_7$

a) i) X - dry air
Y - dry air
Z - sulfuric acid
ii) A - oleum ($H_2S_2O_7$)

(iii) * using a catalyst in order to increase the rate of reaction, hence producing the products faster as equilibrium is achieved faster. The catalyst is vanadium(V)oxide (V_2O_5), This increases the efficiency at which SO_3 is made.

$$SO_{2(g)} + \tfrac{1}{2}O_{2(g)} \rightleftharpoons SO_{3(g)} \quad \Delta H < 0.$$

* Using several catalyst beds of different temperatures. The first bed at 550°C for conversion rate (70% converted) and the other beds at 400°C for yield (99.7% converted). This ensures that $SO_{3(g)}$ is produced as fast and as much as possible to ensure maximum efficiency.

* providing an excess of air. Air : SO_2 is supplied in a ratio of 5:1 and since air is about 20% oxygen, this leaves a ratio of 1:1 for $SO_2 : O_2$. An excess of O_2 will drive equilibrium right in accordance with Le Chatelier's principle, thus increasing yield to ensure maximum efficiency.

(iii) $2SO_{2(g)} + 2O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ $\Delta H < 0$ exo.

According to Le Chatelier's Principle, if a system is at equilibrium is disturbed by a having a change imposed on it, then the system at equilibrium will shift to minimise the effect of the disturbance.

High Pressure of 150 kPa which would favour the forward reaction since there are less moles of gaseous molecules. ↓ thus increasing yield

Catalyst Vanadium (V) oxide (V_2O_5) which provides an alternate pathway which requires less energy for the reaction to take place. thus increasing the rate of reaction. and hence maximises rate of reaction

Temperatures of 600°C, 400°C and 400°C in the three separate catalyst beds. The successively lower temperature would favour the forward exothermic reaction thus increasing yield.

(iv). • low density ✓ 2.07 g/cm³ so compressed air can push ~~SiO_2~~ sulfur & air mixture up against gravity ✓

• low m.p. 113°C so the superheated water can melt the sulfur at 165°C. ✓

• insoluble in water so that it easily solidifies out at surface. ✓

2

(+60°C)

(iv) 1- sulfur has an mpt of 113°C. As superheated water is mixed into the sulfur deposit, the sulfur turns from solid to liquid. This allows extraction to be done quickly due to the watery medium.

2 2- sulfur by itself is non-toxic. Chemists can monitor the process closely without being exposed to ~~danger~~ hazardous, toxic gases. This allows for efficiency.

3- sulfur is relatively inert. Although it melts due to the superheated water, it does not react with it. When $S_{(l)}$ is cooled, no further process needs to occur to seperate the sulfur & water.

b)i) $K_{eq} = \frac{[COCl_{2(g)}]}{[Cl_{2(g)}] \times [CO_{(g)}]}$

ii)

Time (min)	[CO] (mol/L)	$[Cl_2]$ (mol/L)	$[COCl_2]$ (mol/L)	Equilibrium constant (k)
2	0.102	0.071	0.048	6.628
6	0.112	0.081	0.038	4.189
9	0.120	0.060	0.030	4.167
12	0.088	0.046	0.017	4.200

3

3

at $t=2$ $K_{eq} = \frac{0.048}{0.071 \times 0.102}$

$= 6.628$

at $t=6$ $K_{eq} = \frac{0.038}{0.081 \times 0.112} = 4.189$

at $t=9$ $K_{eq} = \frac{0.03}{0.120 \times 0.060}$

$= 4.167$

at $t=12$, $K_{eq} = \frac{0.017}{0.046 \times 0.088}$

$= 4.1999$

(iii). Student A is correct. It was $t=3$.

The equilm constant was approx. $K \approx 4.2$ throughout the experiment after the change in temperature was imposed. At time $t=3$, the $K = 6.6$.

3 Only a change in temperature will cause a change in the value of K.

Since the value of K changed from $t=2$ to $t=6$, we can deduce that temp. change was at $t=3$.

(iii) Student A is correct, as at $t=9$ and $t=12$, the equilibrium constant was at roughly the same constant (≈ 4.17) (slightly off due to experimental errors) while at $t=2$ and $t=6$, there was a clearly

3 different K value, thus student B was wrong of temp change at $t=9$, while student A was correct of temp change at $t=3$ as the The only factor that changes the equilibrium constant is temp since there was a change in K value from $t=2$ and at $t=6$ Student A is correct in that at $t=3$, an increased in temperature was imposed, $t=2$ ($K=6.628$), $t=6$ ($K=4.189$).

iv) This reaction is EXOTHERMIC.

Le Chatelier's principle states that if a system in equilibrium is disturbed, the system will readjust itself to minimise the disturbance until a new equilibrium is reached.

This means that an increase in temp will favour the ENDOTHERMIC reaction as it absorbs heat.

An increase in temp at t=3 has caused the K value to fall from 6.628 to 4.189, indicating a decrease in the amount of products ∴ more reactants are being formed ∴ reaction is shifting LEFT (i.e. reverse reaction is being favoured due to the ↑temp

∴ reverse reaction is ENDOTHERMIC

∴ forward reaction is EXOTHERMIC.

3

Well explained.

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b)iv) The change in temperature caused the K value to decrease, in other words, cause the concentration of the products to decrease. Since the increased in temp favoured the reverse reaction, this means that the reverse reaction is endothermic as equilibrium shifts left to counteract the increase in temp in accordance with Le Chatelier's principle which states that when a system at equilibrium is disturbed, equilibrium will shift in order to counteract/minimise the disturbance until a new equilibrium is reached.

3

In this case, to counteract the increase in temp, the excess heat is minimised by favouring the endothermic reaction to use up some excess heat. Because the K value drops, the concentration of the product drops, meaning the reverse reaction is endothermic as it is favoured. Hence, the forward reaction is exothermic.

c) i) $2NaCl_{(aq)} + CaCO_{3(s)} \rightarrow Na_2CO_{3(s)} + CaCl_{2(aq)}$

$m(CaCO_3) = 1.0 \times 10^2 \times 1000$

$= 100000\ kg$

$= 10^8\ g.$

$n(CaCO_3) = \frac{m}{M}$

$= \frac{10^8}{(40.08 + 12.01 + 3 \times 16)}$

$= 999100.8\ mol$

$n(CaCl_2) = n(CaCl_2)$

$= 999100.8\ mol$

$\therefore m(CaCl_2) = M \cdot n$

$= 999100.8 \times (40.08 + 2 \times 35.45) = 1.1 \times 10^2$ tonnes.

(II) i) Step 8

ii) $CO_{2(g)}$

iii) As gases dissolve better at low temperatures, the $CO_{2(g)}$ coming into the measuring cylinder will dissolve quicker & react with the solution

iv) $NaCl_{(aq)} + NH_{3(aq)} + CO_{2(g)} + H_2O_{(l)} \rightarrow NH_4Cl_{(aq)} + NaHCO_{3(s)}$

iii) At low temperatures, (about 0°C), the reaction between water, NaCl, NH_3 and CO_2 causes sodium hydrogen carbonate to precipitate out, which is the desired outcome in the solvay process. Hence to model the low temp, the reaction is carried out in a beaker of cold water and ice → to cause $NaHCO_3$ to precipitate out to produce Na_2CO_3.

iv) Ammonia is dangerous to recycle ~~because~~ in a laboratory model, because it is flammable, toxic by inhalation, corrosive to skin and eyes.

Flammable - In a laboratory model, recycling ammonia means first working with heat, in a laboratry model, heat comes from a naked flame, hence any spillages of ammonia can lead to exposure to the naked flame, causing combustion which could lead to a fire.

Toxicity - Due to toxic fumes produced by ammonia, this experiment would need to be carried out in the fume cupboard of the laboratory. This is unsafe, as working in the fume cupboard with flame and volatile gas could lead to ~~extra~~ a spill or fire, as it is awkward to work effectively in a fume cupboard.

corrosive - If ammonia got in contact with skin or eyes, then serious damage may result, such as severe burns or blindness. This can be overcome by the wearing of safety glasses, an apron and leather enclosed shoes. (Hair should also be tied back for added safetly).

Although measures can be taken to minimise risks, it is still unsafe, and should not be attempted to recycle ammonia in a laboratory model.

v) There is a high risk involved when recycling ammonia in a lab model. This is due to the fact, if not recycled properly and by experienced personnel it can lead to many health effects etc. When recycling ammonia, it must be done so in well ventilated areas as well as away from heat sources as Ammonia is a flammable substance. Furthermore, should be recycled in

well ventilated area or otherwise use of fume cupboard, as ammonia has a high risk as if inhaled it can cause unconsciousness and even death. Adequate skin, eye and respiratory protection is required as in a small confined space of lab, ammonia can cause burns and is ~~highly~~ toxic if inhaled.

Furthermore, the exposure to NH_3 gas when recycling should be limited to about 15 mins in a low concentration as this will not result in any serious health problems.

Thus when recycling NH_3 gas in a lab it comes with many risks and thus many safety procedures needs to be carried out before and after recycling.

(IV) The use of recycling ammonia in a laboratory model ~~one~~ is not a practical, viable process due to the extent of health risks, monitoring, preventions required for it to take place. As seen in the data sheet, the recycling of ammonia may cause burns and damages to eyes. Thus protective clothing, gloves, rubber boots, gas tight goggles, full face shield and full length clothing is required. In the labratory, this is highly impractical and extremely dangerous as the ~~health~~ risks are magnified and multiplied in a smaller, enclosed area. Good ventilation is required to ensure there is no inhalation of toxic gases. This may be difficult ~~considering the layouts~~ and, confined laboratories would need to be modified to suit this requirement. Also ~~this~~ it would require constant and careful monitoring of oxygen content (18%) to ensure the asphyxiant ammonia gas wouldn't cause the reduction of oxygen content. Thus considering the level of risks and issues it incurs, the recycling of ammonia in a laboratory model ~~does~~ does not appear to be a safe, advantageous process.

3

v) There are many risks involved to the student if ammonia is recycled in the laboratory, as it is classified to be ~~an~~ a hazardous ~~chem~~ chemical in the MSDS sheet.

* Ammonia poses many risks such as being a toxic gas for inhalation, it causes burns, can cause ~~a~~ serious damage to the eyes.
Hence in the laboratory, students must wear safety goggles, protective clothing & perform the experiment in a well ventilated area or a fume cupboard.
* In the laboratory, there is a lack of sophisticated equipment to safely recycle the ammonia gas whereas in the actual Solvay process, there is much expensive equipment and monitoring used to recycle ammonia gas.
* There are too many risks associated with the recycling of ammonia in the laboratory as listed above. The risks are too dangerous for students and hence the recycling of ammonia in the lab should not be carried out. ~~The reaction should~~ as there is a lack of equipment and technology. To ensure the safety of students in a lab, it would be much wiser to carry out the model described by the diagram reaction in a fume cupboard and not recycle ammonia.

3 great answer

these are NOT gas tight ∴ are useless