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.

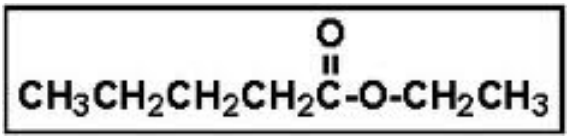
17. Incomplete combustion of hydrocarbons may result in the production of undesirable substances. Which of the following shows TWO such substances?

    (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

.....

.....

.....

.....

.....

.....

.....

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

.....

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

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

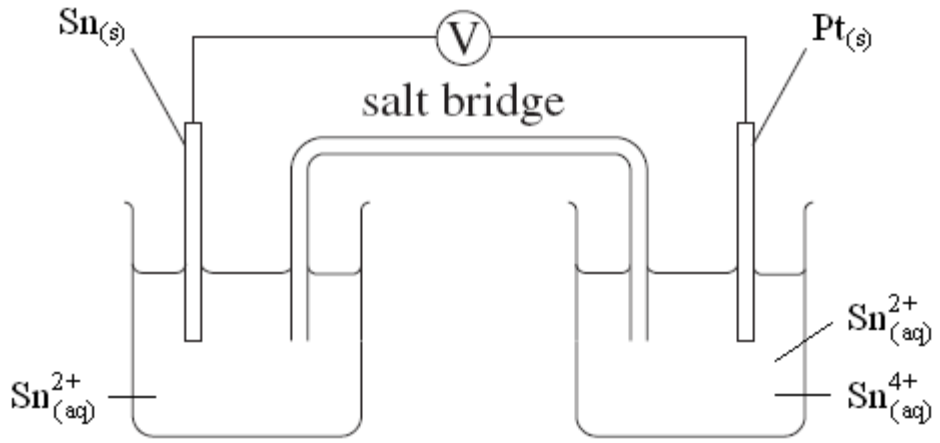
.....

.....

.....

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

.....

.....

.....

.....

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

.....

.....

Question 27

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

.....

.....

.....

.....

.....

.....

.....

Question 28

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

.....

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Question 30

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

.....

.....

.....

.....

.....

.....

Question 31

The following questions relate to the Haber process.

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

.....

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

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

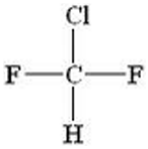
.....

.....

Question 32

The following questions relate to chlorofluorocarbons.

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



.....

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

.....

.....

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

.....

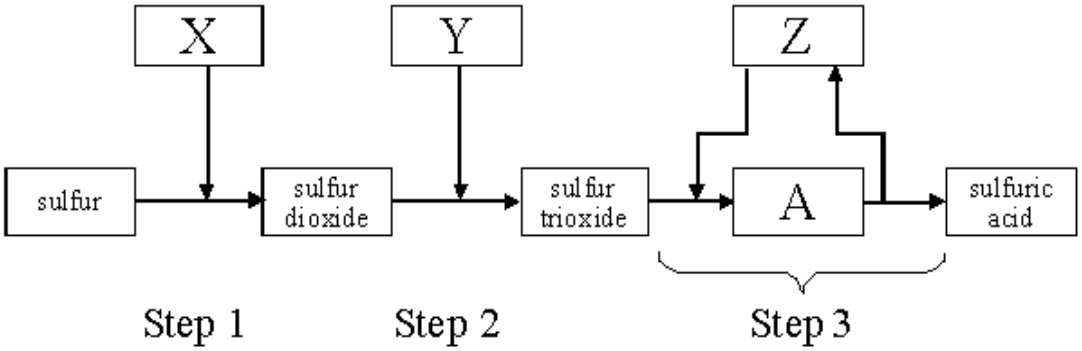
.....

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.

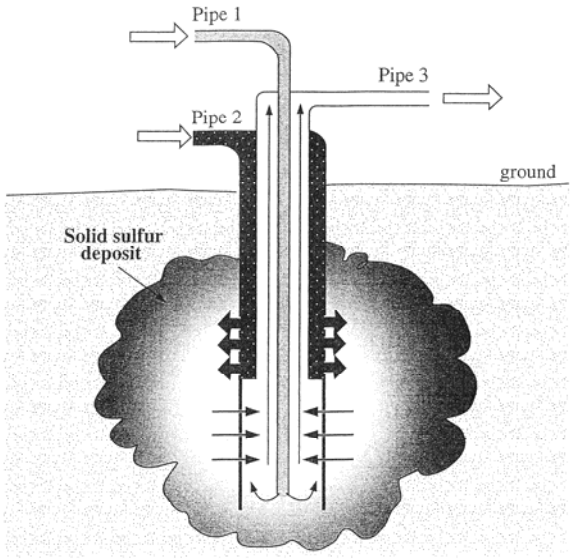


(i) Identify the chemical substances (X, Y and Z) that are added at steps 1, 2 and 3 respectively. 1M

(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

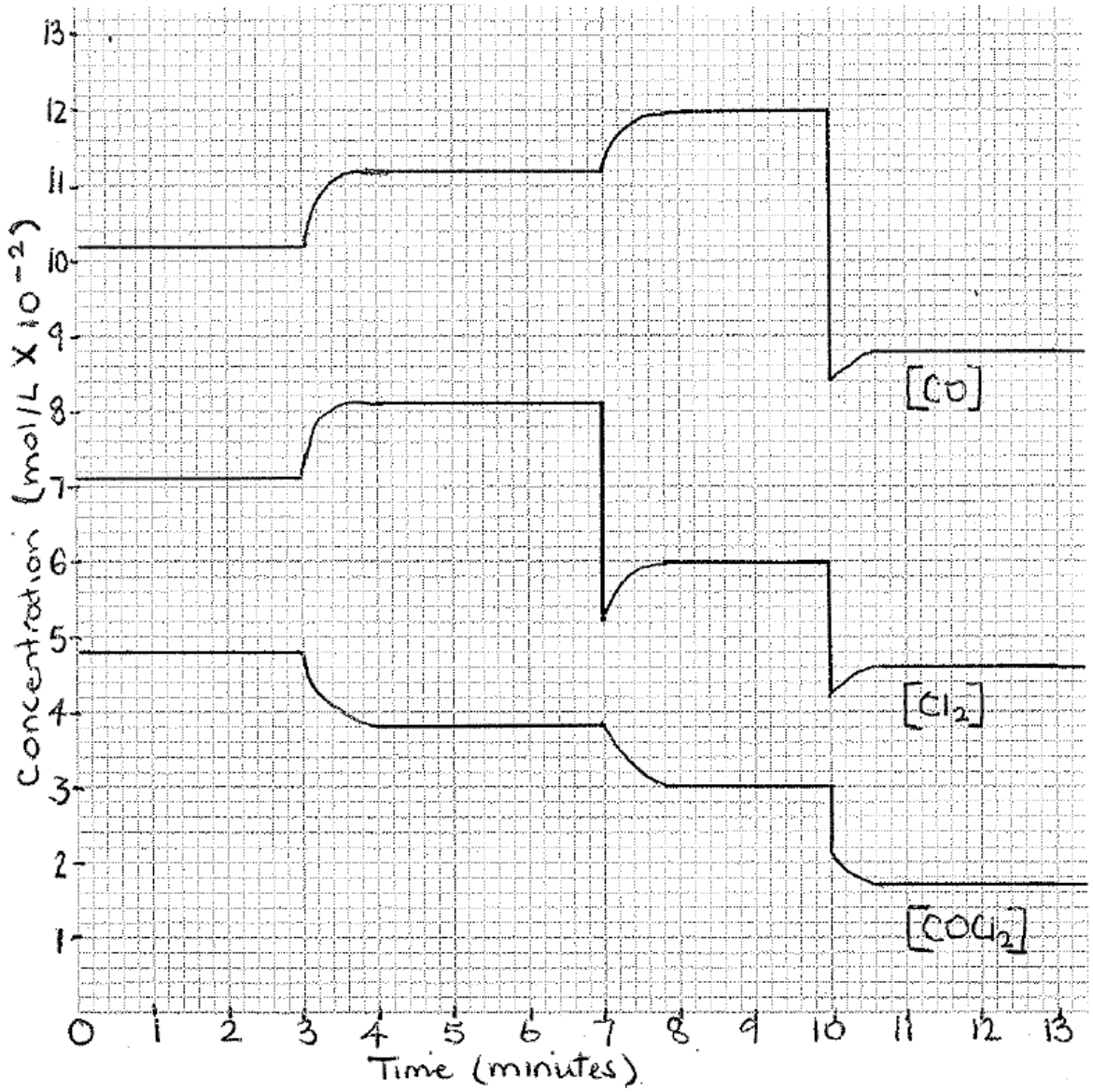
(iv) The following diagram illustrates the Frasch process, used to extract sulfur from underground deposits.



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		

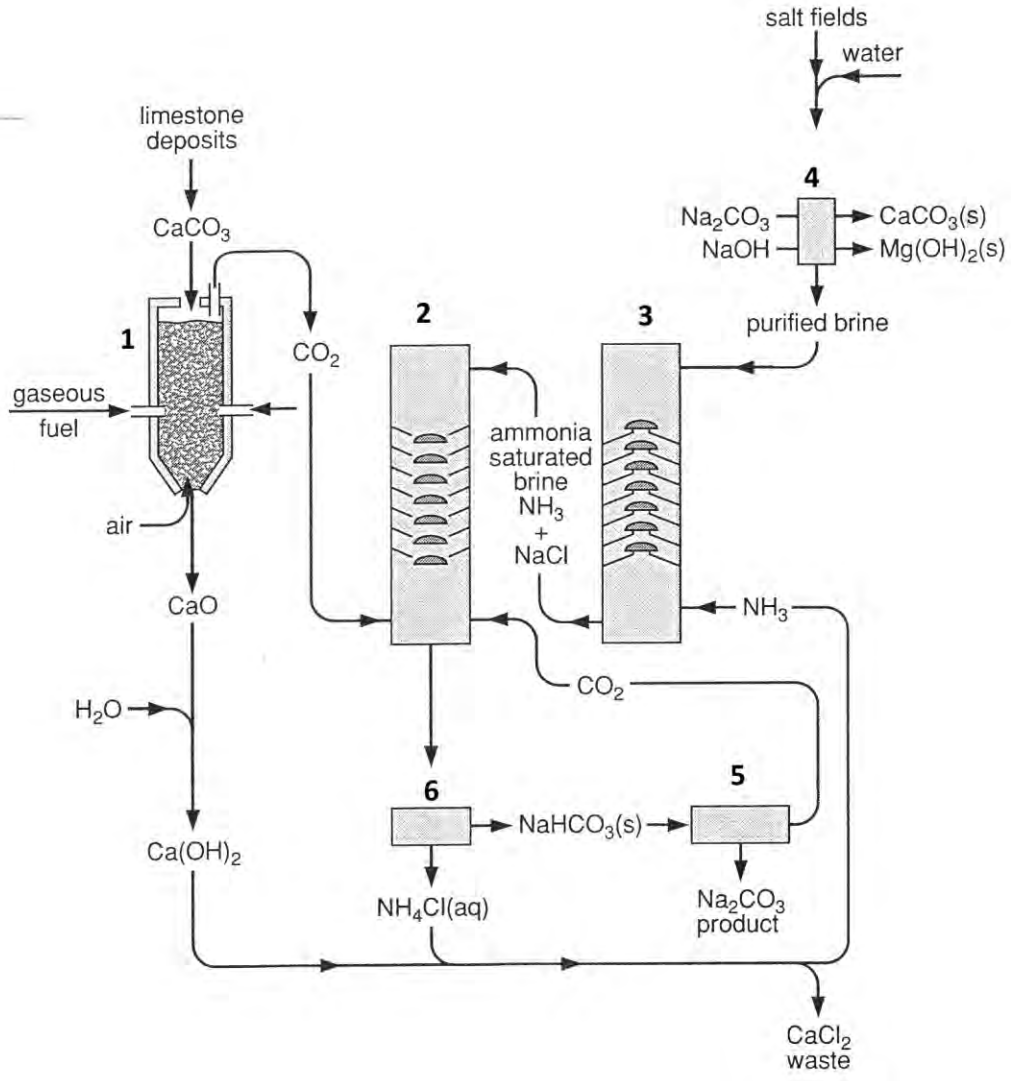
(iii) Three changes (each quite different) have been imposed on this system during the time the system was observed. ONE of the changes is an increase in temperature.

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

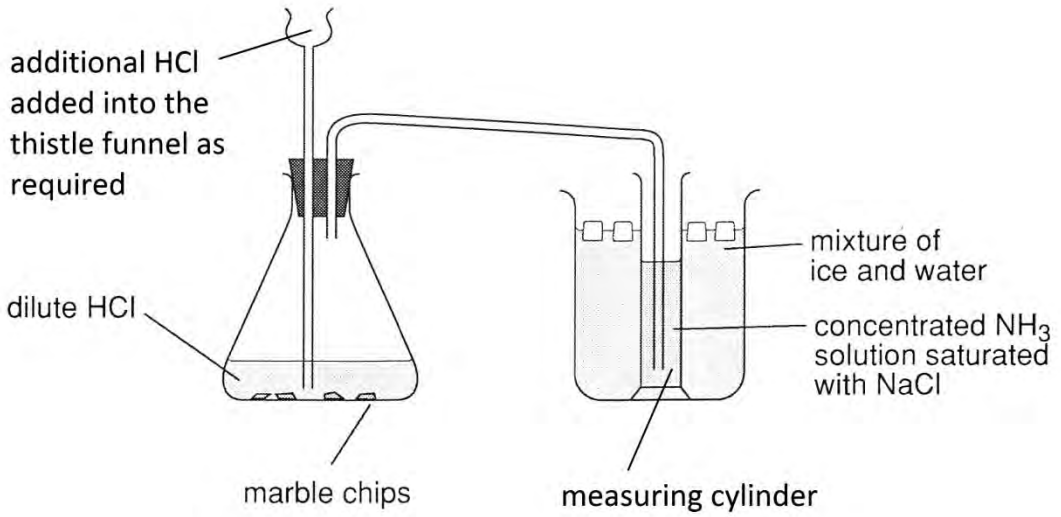
c. The flowchart below summarises the Solvay process.



(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.

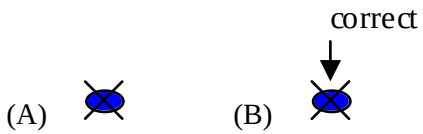
Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

(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