Student Number	
Mark / 100	

2010

TRIAL HSC EXAMINATION

ANSWERS

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Write your Student Number at the top of this page and on the response sheets on pages ...
- Board-approved calculators may be used
- A data sheet and a Periodic Table are provided at the back of this paper. This may be removed for your convenience.

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Total Marks – 100

Section I Pages....

75 marks

This section has two parts, Part A and Part B

Part A –20 marks
•Attempt Questions 1-
•Allow about 35 minutes for this part

Part B – 55 marks
•Attempt Questions .....
•Allow about 1 hour and 45 minutes for this part

Section II Pages .....

25 marks

•Attempt Question 33
•Allow about 45 minutes for this section

Section I
75 marks

Part A – 20 marks
Attempt Questions 1-20
Allow about 35 minutes for this part

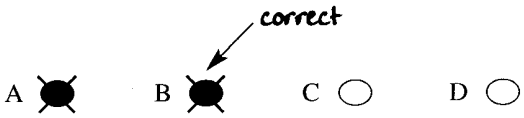
Use the multiple choice answer sheet on page .....

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

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

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



Mark your answers on the ANSWER grid on page.....

Multiple Choice Questions:

1. What type of chemists are employed in research and development laboratories to produce synthetic fibres, adhesives, colloids and surface coatings?

   (A) environmental

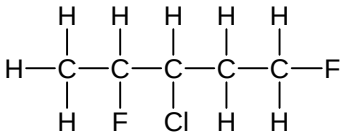
   (B) polymer

   (C) biochemist

   (D) metallurgical

   OUTCOMES: H15, H13

2. What is the IUPAC name of an isomer of the following compound?



(A) 3-chloro-1,4-difluoropentane

(B) 3-chloro-2,3-difluoropentane

(C) 3-chloro-2,5-dichloropentane

(D) 2,5-difluro-3-chloropentane

OUTCOMES:H13

3. The sulfate solution of an unknown cation did not form any precipitate with the chloride ion. Which ion is definitely absent from the solution?

(A) copper (II) ion

(B) iron (II) ion

(C) lead (II) ion

(D) iron (III) ion

OUTCOME: H13

4. Which of the following reactions is definitely exothermic?

(A) $\mathbf{CH_3COOH}\ (aq) + \mathbf{NaOH}\ (aq) \rightarrow \mathbf{NaCH_3COO}\ (aq) + \mathbf{H_2O}\ (l)$

(B) $Ca^{2+}(aq) + CO_3^{2-}\ (aq) \rightarrow CaCO_3(s)$

(C) $NH_4Cl\ (s) \xrightarrow{water} NH_4^+\ (aq) + Cl^-\ (aq)$

(D) $Na^+\ (aq) + e^- \rightarrow Na(s)$

OUTCOME: H7, H8

5. Which of the following is a conjugate acid-base pair?

(A) $CO_2 - HCO_3^-$

(B) $O^{2-} - H_2O$

(C) $PO_4^{3-} - H_2PO_4^-$

(D) $NH_3 - NH_2^-$

OUTCOME: H13

6. A hydrochloric acid solution and a citric acid solution were found to have the same pH. Which statement is correct concerning the citric acid solution?

(A) Both solutions contain the same number of intact acid molecules.

(B) Both solutions contain the same number of ions.

(C) The hydrochloric acid solution has a higher concentration of hydrogen ions.

(D) The citric acid has a higher concentration of intact acid molecules than hydrochloric acid.

7. Ozone reacts with nitric oxide according to the equation:

$$NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$$

0.33 g $NO(g)$ was mixed with 0.36 g $O_3(g)$.

What is the maximum volume of $O_2(g)$ produced at 0°C and 100 kPa?

(A) 0.17 L

(B) 0.19 L

(C) 0.25 L

(D) 0.27 L

8. A student prepares an ester from butanoic acid and methanol. When she distils the mixture she obtains three fractions with the boiling points: 64.7 ºC, 102.3 ºC, 163.3 ºC.

What is the most likely identity of each fraction?

	Boiling Points		
	64.7ºC	102.3ºC	163.3ºC
(A)	**methanol**	**methyl butanoate**	**butanoic acid**
(B)	methanol	butyl methanoate	butanoic acid
(C)	butanoic acid	methanol	butyl methanoate
(D)	butanoic acid	methyl butanoate	methanol

9. A 382.3 g bottle of soda water was decarbonated by adding 17.7 g of salt to it. Salt does not react with the contents but assists with the decarbonation. The final mass of the bottle of soda water after decarbonation was 395 g. What volume of gas was formed at 25ºC and 100 kPa?

(A) 2.6 L

(B) 2.8 L

(C) 17.1 L

(D) 124 L

10. A red cabbage indicator chart is shown below

Colour	Red	Violet	Purple	Blue	Green	Yellow
pH	1 – 2	3 – 4	5 – 7	8 – 9	10 – 11	12 – 14

What colour would the red cabbage indicator be in a 0.005 $molL^{-1}$ solution of H_2SO_4?

(A) Purple

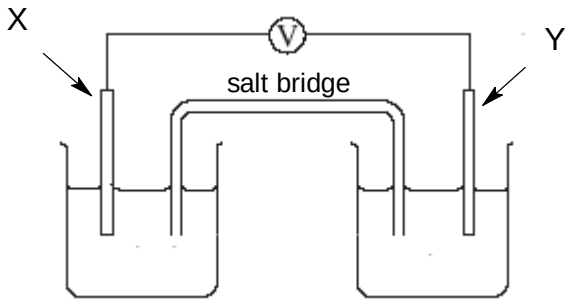
(B) Red

(C) Blue

(D) Yellow

OUTCOME: H8

11. The diagram represents a cell in which two metal electrodes have been placed in solutions containing their respective metallic ions. The metals are connected to a voltmeter.



Which of the following combination of metals would produce the highest reading on the voltmeter?

	Metal X	Metal Y
(A)	tin	zinc
(B)	copper	zinc
(C)	copper	silver
(D)	**magnesium**	**lead**

OUTCOME: H7

12. In a galvanic cell, what is the pathway of anion flow?

	Direction	Medium
(A)	Anode to cathode	Salt bridge
(B)	Anode to cathode	External wire
(C)	**Cathode to anode**	**Salt bridge**
(D)	Cathode to anode	External wire

OUTCOME: H7

13. Glucose, $C_6H_{12}O_6$, is a monomer that can form naturally occurring polymers.

The approximate atomic weights for the elements which make up glucose are shown in the table

Element	Approximate atomic weight
Carbon	12
Hydrogen	1
Oxygen	16

Using data from the table, what would be the approximate molecular weight of a polymer made from 5 glucose monomers?

(A) 810

(B) 828

(C) 882

(D) 900

OUTCOME: H10

14. A student diluted a solution of an acid by mixing 10 ml with 90 ml of water.
If the original acid solution had a pH of 3.1, what is the final pH of the acid solution after dilution?

(A) 1.1

(B) 2.1

(C) 4.1

(D) 5.1

15. What is the major industrial source of ethylene ?

(A) the fermentation of sugars

(B) the ripening of fruits

(C) the cracking of long hydrocarbons

(D) the hydration of ethanol

OUTCOME: H4

16. Given the following equation for the combustion of 1– propanol:

$2\ CH_3CH_2CH_2OH(l)\ +\ 9\ O_2\ (g) \rightarrow\ 6\ CO_2\ (g)\ +\ 8\ H_2O(l)\ +4042\ kJ$

Which of the expressions gives the correct molar heat of combustion of 1–propanol?

(A) $\Delta H = -4042$ kJ

(B) $\Delta H = -2021$ kJ

(C) $\Delta H = +4042$ kJ

(D) $\Delta H = +2021$ kJ

17. Which of the conditions is responsible for producing the given radioactive nucleus?

	Nucleus	Condition
(A)	$^{3}_{2}He$	neutron to proton ratio is too high
(B)	$^{24}_{11}Na$	neutron to proton ratio is too low
(C)	$^{37}_{17}Cl$	**neutron to proton ratio is too high**
(D)	$^{131}_{53}I$	neutron to proton ratio too low

18. The first passenger–carrying balloons were made in the 18th century using hydrogen from the reaction of iron with sulfuric acid.

What mass of iron would be required to produce 25 kL of hydrogen required to fill a balloon at 25ºC and 100 kPa?

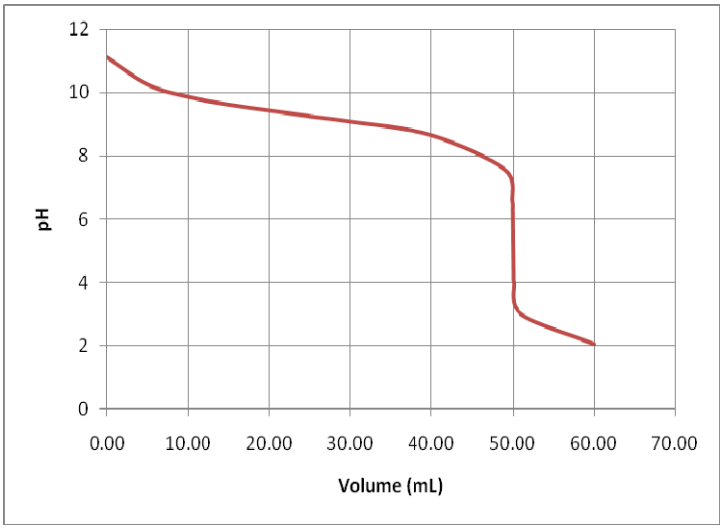
(A) 28 kg

(B) 56 kg

(C) 61 kg

(D) 113 kg

Questions 19 and 20 refer to the figure below



19. Which titration set-up produced the titration curve drawn?

	Solution in the conical flask	Solution in the burette
(A)	HCl	NH_3
(B)	**NH_3**	**HCl**
(C)	CH_3COOH	NaOH
(D)	NaOH	CH_3COOH

Outcome(s): H13, H14

20. What will be a suitable indicator for this titration?

(A) bromothymol blue

(B) phenolphthalein

(C) methyl orange

(D) litmus

Outcome(s): H11

Student Number ……

Section I **Mark -----/20**

Part A

Multiple Choice Answer Sheet

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 ○

Student No. …….

Part B. 55 marks
Attempt questions 21-32
Allow about 1 hour and 45 minutes for this part
▸ *Show all relevant working in questions involving calculations*

Marks

Question 21 (2 marks)

Write a balanced equation to show the dehydration of ethanol to ethylene including the catalyst used. **2**

…….....

Sample Answer :

$$CH_3CH_2OH \xrightarrow[conc\ sulfuric\ acid]{} CH_2{=}CH_2 + H_2O$$

Marking Guidelines

Criteria	*Mark*
Correct balanced equation including catalyst	2
Correct balanced equation without catalyst	1

OUTCOME(S): H9, H10

Question 22 (4 marks)

(a) Draw the structural formula for the monomer vinyl chloride. **1**

……..

(b) Identify the systematic name for the monomer of vinyl chloride. **1**

……..

(c) Describe two uses of polyvinylchloride in terms of its properties. **2**

…….

a Sample Answer

correct full structural formula for vinyl chloride

b Sample Answer

chloroethene

c Sample Answer

uses include ; electrical insulation, garden hoses, drainage and sewage pipes, household guttering and downpipes
properties : hard, brittle and inclusions improves its flexibility and thermal stability.

a Marking Guidelines

Criteria	*Mark*
Correct structural formula monomer of vinyl chloride	1

b Marking Guidelines

Criteria	*Mark*
Correct systematic name for vinyl chloride	1

c Marking Guidelines

Criteria	*Mark*
Correct description of two properties related to uses	2
Correct description of one property related to use OR identification of two uses OR identification of two properties	1

OUTCOME: H9, H10

Question 23 (6 marks)

Evaluate the potential use of a named biopolymer relating it to its properties.
Include the name of the specific enzyme or organism used in the production of the biopolymer. **6**

Marking Guidelines

Criteria	Mark
Evaluation of the potential use of a named biopolymer with the name of the organism or enzyme and discussion of the advantages and disadvantages related to the properties of uses of the biopolymer. Coherent, logical progression through the discussion and evaluation.	6
Any one of the above missing	5
Any two of the above missing	4
Any three of the above missing	3
Any four of the above missing	2
Any five of the above missing	1

Sample Answer :

Eg Biopolymer = Biopol ; bacterium – Alcaligenes eutrophus

Advantages : biodegradable, biocompatible, made from renewable resources, similar properties to synthetic polymers eg polyethylene.

Disadvantages : expensive to produce at present and a slow process.

Evaluation : Biopol has great potential use as a future to replace synthetic polymers due to its properties of biodegradability and production from a renewable resource which means it positive has high environmental impact on the environment.

OUTCOME: H3, H4

Question 24 (4 marks)

Explain the use of ONE named radioisotope in industry OR medicine in terms of its properties. **4**

Sample answer ;

various radioisotopes relating use to property of a named radioisotope in industry or medicine.
Eg.Technetium – 99m used in medicine for imaging and diagnostic purposes ; short half-life, 6 hours ; ability to be tagged to brain, heart or lung ; non-intrusive ; but risk with exposure to gamma radiation.

Marking Guidelines

Criteria	*Mark*
Correct and thorough explanation of use related to properties of an identified radioisotope used in industry or medicine	4
Outline of the use related to property of an identified radioisotope in industry or medicine	3
Outlines a use of an identified radioisotope OR the properties of the isotope.	2
Identifies a radioisotope used in industry or medicine	1

Question 25 (4 marks)

(a) Write a balanced chemical equation showing ONE metallic oxide acting as as a base.. **1**

…….

(b) Outline the relationship between position of elements in the Periodic Table and acidity / basicity of oxides. Include specific examples of elements in your answer. **3**

OUTCOME:H6, H10

Sample Answer:

8 a *Sample Answer*

$Na_2O + 2HCl \rightarrow 2NaCl + H_2O$

8 b *Sample Answer*

Top right hand side produces acidic oxides with non-metals eg SO_2
Left hand side produces basic oxides with metals eg NaOH
End of transition metal area and semi metal area produces amphoteric oxides
Eg Al_2O_3 or ZnO

8a **Marking Guidelines**

Criteria	*Mark*
Correct balanced equation showing metal oxide reacting as a base	1

8b **Marking Guideline**

Criteria	*Mark*
Correct identification of location of metal oxides as basic, non-metal oxides as acidic and amphoteric oxides towards end of transition metals in the Periodic Table with examples	3
Correct identification of location of two of the above in the Periodic Table with examples	2
Correct location of one of the above in the Periodic table with example	1

Question 26 (4 marks)

One acidic oxide found in the atmosphere is $SO_2(g)$

(a) Identify one natural and one industrial source of $SO_2(g)$ **2**

	Source of $SO_2(g)$
Natural	
Industrial	

Answer:

	Source of $SO_2(g)$
Natural	*Volcanoes*
Industrial	*Power plants burning coal*

Marking Criteria- outcome H4

Marks	*Criteria*
2	Natural and industrial source
1	One of the above

(b) Write an equation to demonstrate the acidic nature of $SO_2(g)$ **1**

…….

Answer:

$$SO_2(g) + H_2O(l) \rightleftharpoons H_2SO_3(aq)$$

(c) At 25º C and 100 kPa, what volume of $SO_2(g)$ would be needed to produce 1.50 L of 1.50 mol L^{-1} acid **2**

……...

Answer:

No of moles of acid = 1.50 X 1.50
= 2.25
Therefore 2.25 moles of $SO_{2(g)}$ is required
Volume of $SO_{2(g)}$ = 2.25 X24.79 L
= 55.8 L

Marking Criteria- outcome H10

Marks	**Criteria**
2	Correct calculation of moles of acid and volume of SO_2
1	One of the above

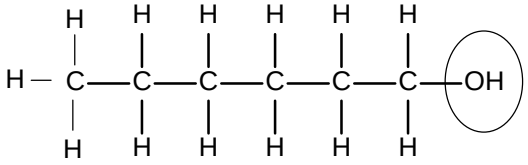
Qustion 27 (5 marks)

(a) Draw the structural formula of 1-hexanol and methanoic acid.
Circle and name the functional groups in these molecules. **2**

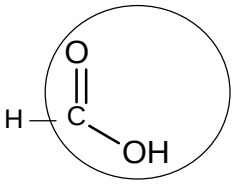
1- hexanol	*methanoic acid*

Answer:

The alkanol functional group,-OH, in alkanols



The alkanoic acid functional group, -COOH, in alkanoic acids

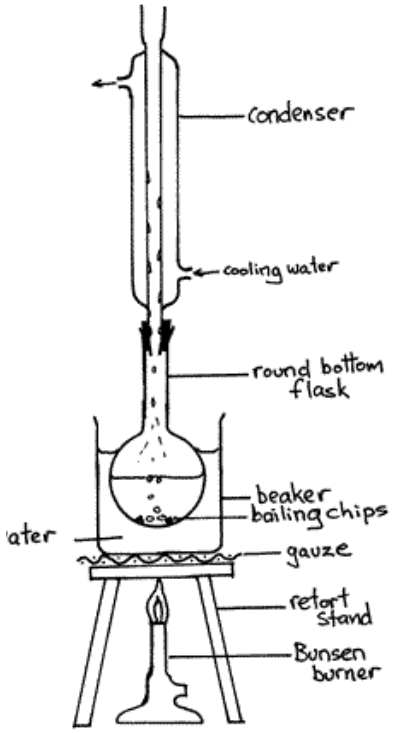


Marking Criteria- outcome H6

Marks	Criteria
3	1-hexanol and methanoic acid- correct structural formula 1-hexanol correct functional group identified and named methanoic acid-correct functional group identified and named
2	Two of the above
1	One of the above

(b) Draw a fully labelled diagram of the apparatus and reagents needed for the esterification reaction between 1-hexanol and methanoic acid. **3**

Answer:



Retort stand, clamps and bossheads have not been drawn for clarity of diagram
Flask should have alkanol, alkanoic acid,conc. H_2SO_4

Marking Criteria- outcome H9,13

Marks	*Criteria*
3	Correctly drawn and labelled condenser with water in and out Flask containing reactants and catalyst Hot plate or Bunsen and water bath
2	Two of the above
1	One of the above

Question 28 (6 marks)
Amphiprotic substances have the ability to work as buffers in natural systems.

Explain why natural systems require buffers and using a specific example of an amphiprotic substance show how this can behave as a buffer. Include equations in your answer. **6**

OUTCOMES:H13, H6,H8

Sample Answer:

Natural systems such as the human body require buffer to maintain the optimum pH for metabolism and enzyme action. Variation in pH can result in illness. (W2) Amphiprotic species that work as buffers in the blood are the $H_2PO_4^-$ and HPO_4^{2-} ions. (Sx). Both the $H_2PO_4^-$ ion and the HPO_4^{2-} are amphiprotic and are able to work as acids as both have dissociable protons and as bases as both contain non-bonding pairs of electrons which can be shared with a proton. Depending on what they are reacting with, they can act as acids or bases and hence are able to act as a buffer since buffers maintain pH by reacting with small amounts of acids or bases added to them:

$$H_2PO_4^- + H_3O^+ \rightleftharpoons H_3PO_4 + H_2O \quad \text{(acting as a base) (eqn1)}$$

$$H_2PO_4^- + OH^- \rightleftharpoons HPO_4^{2-} + H_2O \quad \text{(acting as an acid) (eqn2)}$$

In a buffer system, when an acid is added, the amphiprotic substance such as the $H_2PO_4^-$ ion reacts with the added acid, minimising the effect of the added acid.

When a base is added, the same amphiprotic ion, $H_2PO_4^-$, combines with the added OH^- minimising its effect. (Ex)

Marking Guidelines

Criteria	***Marks***
explains the buffer action explains thoroughly (2 marks) why buffers are needed in natural systems gives an example of amphiprotic substance(s) show using two equations how the amphiprotic substance react with both acid and base links the amphiprotic nature to behavior as a buffer	6
explains the buffer action explains cursorily why buffers are needed in natural systems gives an example of amphiprotic substance(s) show using two equations how the amphiprotic substance react with both acid and base	5

links the amphiprotic nature to behavior as a buffer	
only 4 of the above	4
only 3 of the above	3
only 2 of the above	2
only 1 of the above	1

Question 29 (5 marks)

A 0.2845 g sample of impure sodium carbonate required 24.65 mL of an HCl solution for titration. A 0.2204 g sample of pure sodium carbonate required 20.06 mL of the HCl solution of the same concentration.
What is the percentage of sodium carbonate in the sample? **5**

OUTCOMES: H10,H13

Sample Answer:

Calculation of the concentration of standard HCl:

$Na_2CO_3\ (aq)\ +\ 2\ HCl(aq)\ \rightarrow\ 2\ NaCl\ (aq)\ +\ CO_2(g)\ +\ H_2O(l)$

(1 mark no subscripts required)

$mole\ HCl\ = 2\ x\ mole\ Na_2CO_3$ *(1 mark)*

$$mole\ HCl\ = 2\ \frac{mass\ Na_2CO_3}{MM\ Na_2CO_3} = \frac{0.2204}{2(22.99)+12.01+3(16.00)} = 4.159\ x\ 10^{-3}\ mole$$

$$C_{HCl}\ =\ \frac{mole\ HCl}{V\ HCl} = 0.2073\ mol\ L^{-1}$$ *(1 mark)*

Analysis of the unknown sodium carbonate sample

$$mole\ Na_2CO_3\ =\ \frac{1}{2}\ mole\ HCl$$

$$mole\ Na_2CO_3\ =\ \frac{1}{2}\ x\ C_{HCl}\ x\ V_{HCl} = \frac{1}{2}\ x\ 0.2073\ x\ 0.02465 = 2.555\ x\ 10^{-3}\ mole$$ *(1 mark)*

$mass\ Na_2CO_3\ =\ mole\ x\ MM\ Na_2CO_3\ = 2.555\ x\ 10^{-3}\ x\ (2\ (22.99)\ +\ 12.01\ +\ 3\ (16.00)$

$= 0.2708\ g$ *(1 mark)*

$$\%\ purity = \frac{mass\ Na_2CO_3}{mass\ sample}\ x100\% = \frac{0.2708}{0.2845}\ x\ 100 = 95.18\ \%$$ *(1 mark)if expressed to the proper number of significant figures*

Question 30 (4 marks)

What would you use to clean an acid spill in the laboratory? Justify your choice. If you were an assistant in Arrhenius' laboratory in 1884, would Arrhenius have advised you to use this same substance to clean the acid spill? Give reasons for your answer. **4**

OUTCOMES: H1, H2, H8

Sample Answer:

I will use sodium hydrogen carbonate since it is a weak base, a proton acceptor. (1 mark – CH2) that can safely neutralize the acid spill even if an excess is used . Visual indication of the completion of neutralization is provided by the stopping of the fizzing reaction.
(1 mark – W2)

Arrhenius would NOT have advised me to use sodium hydrogen carbonate, since the only bases according to Arrhenius are those ones that dissociate in water to produce OH^- and have OH^- in their structure, in addition, the substance has to be dissolved in water to even act as a base. (1 mark - CH)

Criteria	*Marks*
• sodium hydrogen carbonate or sodium carbonate and justification for the choice	2
• Arrhenius will not advise and correct reason	2

Question 31 (6 marks)

A typical Australian ammonia plant using the Haber process employs a temperature range of 450 – 550^{o}C, a pressure range of 15-18 Mpa, (~250 atm) and magnetite as catalyst. Justify the use of these conditions in the manufacture of ammonia. Write a relevant equation including the energy term. **6**

OUTCOMES: H12, H13, H11, H10, H7, H8

Sample Answer:

The Haber process is a technique to manufacture ammonia using the following reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92\ kJ/mol \qquad (E)$$

Temperature:

The reaction is exothermic and hence, at equilibrium, according to Le Chatelier, an increase in temperature favours (T) the reverse reaction, therefore lower ammonia yield. Use of low temperature will result in a very slow reaction rate. A compromise temperature, therefore, is used to obtain an acceptable yield and rate of reaction (TE) .

Catalyst:

Catalysts hasten the reaction, since the compromise lower temperature used in practice, results in a lower rate of reaction, therefore, a catalyst is employed. Catalysts lower the activation energy allowing the reaction to proceed faster at a lower temperature (C)

Pressure:

As shown by the equation, the number of molecules of the reactants exceed the number of molecules of the product (4:2) (P) and therefore an increase in pressure, according to Le Chatelier will favour the forward reaction,(PE), shifting the equilibrium towards the side with less number of molecules.

Marking Guidelines

Criteria	*Marks*
balanced equation of the reaction	1
effect of temperature	2
effect of catalyst	1
effect of pressure	2

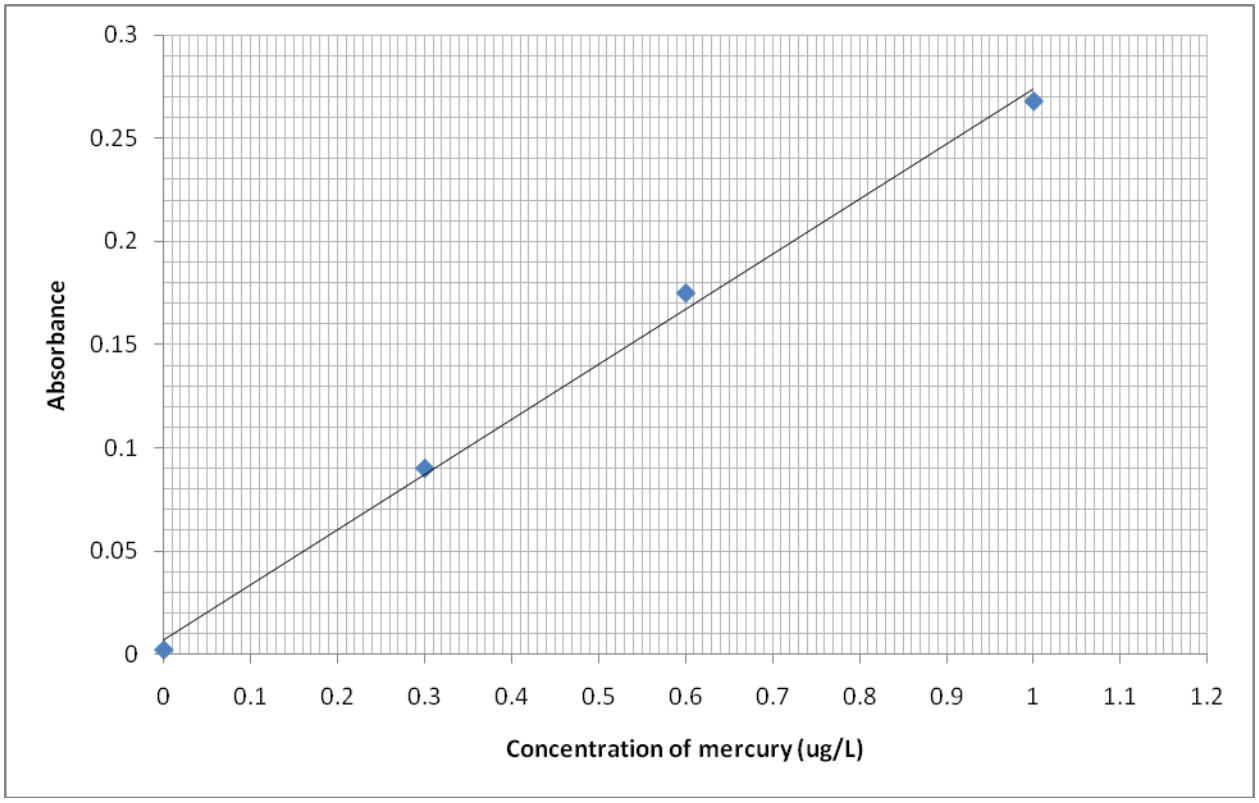
Question 32 (5 marks)
A bottle of *Cool Springs* water was analysed for mercury using AAS. The analysis consisted of accurately measuring 250.00 mL of *Cool Springs* water sample, evaporating it to about 50 mL and then diluting it with demineralised water, accurately to 100.00 mL. Standard mercury solutions and the treated *Cool Springs* water sample were then passed through the AAS. The results are tabulated below:

Concentration of mercury standard solution ($\mu g\ L^{-1}$)	Absorbance
0.00	0.002
0.30	0.090
0.60	0.175
1.00	0.268
Treated *Cool Springs* samples recorded an average absorbance of 0.140	

$1\ \mu g = 10^{-6}\ g$

(a) Use the grid to plot a calibration curve. Label your graph. **2**

Sample Answer



Marking Guidelines

Criteria	*Marks*
correct axes orientation (dependent-independent variable)	1
correct plotting of points and line of best fit	1

(b) The US Environmental Protection Agency, (EPA) has estimated a safe daily intake limit of mercury of 0.1 μg /kg of body mass.
What volume in litres of the bottled water can a 50 kg person safely drink daily without the adverse effect of mercury poisoning? 5

***Sample Answer**:*
from the graph, a 0.140 absorbance of the treated sample is equivalent to 0.50 μg L^{-1} – mercury concentration (1 mark)

concentration of mercury in untreated bottled water = 0.50 μg L^{-1} x concentration factor

$$= 0.50 \times \frac{100}{250} = 0.20\,\mu g\,L^{-1}$$

Mass of mercury allowed for a 50 kg person = 0.10 μg/kg x 50 kg = 5 μg (1 mark)

Volume of bottled water containing this mass $= \frac{5.0}{0.2} = 25\,L$ (1 mark)

Criteria	*Marks*
correct reading of concentration from calibration plot	1
use of correct dilution factor	1
calculation of volume of bottled water	1

2010 JRAHS TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Section II

25 marks
Attempt question 33
Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Marks

(a) During your practical work you performed first hand investigations to observe reactions of sulfuric acid.

(i) Identify a risk associated with your procedures and outline a safety precaution taken to minimise the risk. **2**

(ii) Describe how sulfuric acid is diluted in the laboratory safely and explain why this procedure is necessary. **2**

(b) Dinitrogen tetroxide, N_2O_4 (*g*), dissociates to form nitrogen dioxide (*g*), according to the equation:

$$N_2O_4\ (g) \rightleftharpoons 2NO_2\ (g)$$

0.45 mol of N_2O_4 gas is placed in an empty 1.00 L vessel at 100°C. When the system reaches equilibrium, 0.36 mol of NO_2 gas is present in the vessel.

(i) Calculate the equilibrium constant, *K*, for this reaction at 100°C. **3**

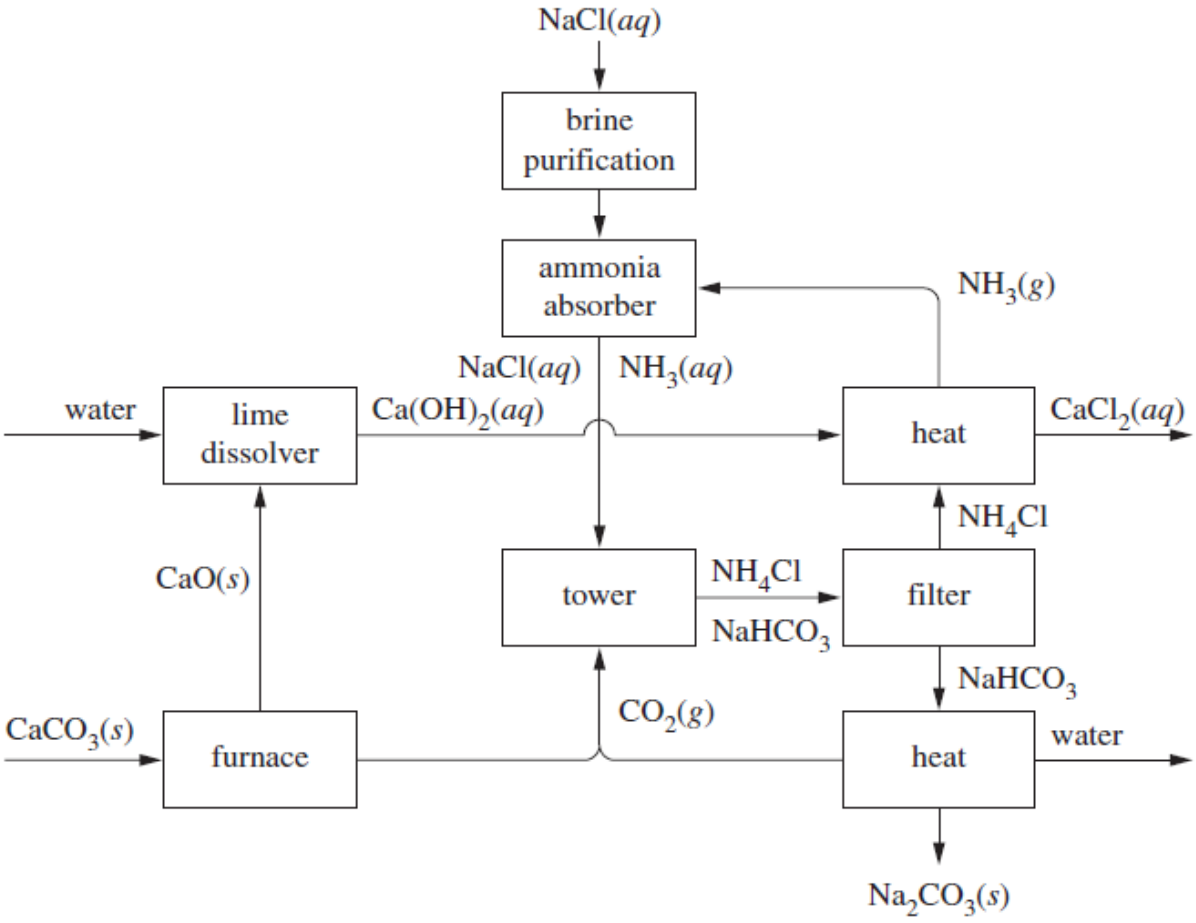
(ii) At 25°C, the equilibrium constant in this reaction is 0.144. Is this reaction endothermic or exothermic? Give an explanation for your answer. **2**

(c) Sodium hydroxide can be made industrially by the electrolysis of sodium chloride.

Explain the different products of electrolysis of aqueous and molten sodium chloride. Use equations to demonstrate your answer. **4**

(d) Distinguish between soaps and synthetic detergents in terms of their chemical composition and their behaviour in hard water. **4**

(e) The diagram shows a flowchart of the reactions involved in the Solvay process.



(i) Identify the major product of the Solvay process and describe one of its uses. **2**

(ii) Describe the chemistry involved in the recovery of ammonia during the process. **2**

(iii) Discuss two environmental issues associated with the process and explain how these issues are addressed. **4**

Year 12 Chemistry Trial answers 2010

(a) During your practical work you performed first hand investigations to observe reactions of sulfuric acid.

(i) Identify a risk associated with your procedures and outline a safety precaution taken to minimise the risk. 2

Sample Answer

Sulfuric acid can burn the skin and eyes. Safety goggles and gloves were worn when handling sulfuric acid.

Marking criteria	***Marks***
• Identifies one risk and the steps taken to reduce the risk	*2*
• Identifies one risk	*1*

(ii) Explain how sulfuric acid is diluted in the laboratory and describe why this process is necessary. 2

Sample Answer

Concentrated sulfuric acid should always be added to water in dilution. The ionization of sulfuric acid is exothermic, if water is added to acid, the heat released could cause the water to boil and cause spitting of concentrated acid, adding acid to water allows the heat to dissipate in a large volume.

Marking criteria	***Marks***
• Describes the ionization of acid as exothermic • Correctly identifies acid added to water	*2*
• Correctly identifies acid added to water	*1*

Outcomes : H7,8,11

(b) Dinitrogen tetroxide, N_2O_4 (g), dissociates to form nitrogen dioxide (g), according to the equation

$$N_2O_4\ (g) \leftrightarrow 2NO_2\ (g)$$

0.45 mol of N_2O_4 gas is placed in an empty 1.00L vessel at 100^0C. When the system reaches equilibrium, there is 0.36 mol of NO_2 gas present in the vessel

(i) Calculate the numerical value of the equilibrium constant for this reaction at 100^0C 3

Sample Answer

	N_2O_4 (g)	↔	$2NO_2$ (g)
Initial	*0.45*		*0*
Used/made	*0.18*		*0.36*
Equilibrium	*0.27*		*0.36*

$$K = \frac{[NO_2]^2}{[N_2O_4]}$$

$$K = \frac{[0.36]^2}{[0.27]}$$

$$= 0.48$$

Marking criteria	***Marks***
• Gives the K expression • Calculates the equilibrium concentrations • Correctly calculates K from equilibrium concentrations	*3*
• Two of the above	*2*
• One of the above	*1*

(ii) At 25^0C, the numerical value of the equilibrium constant in this reaction is 0.144. Is this reaction endothermic or exothermic? Give an explanation for your answer.

2

Sample Answer

At 100^0, K = 0.48, and at 25^0, K = 0.144. As temperature increases, K increases.
An increase in temperature favours the endothermic reaction (Le Chatelier).
If K is increasing, then the numerator is increasing i.e the products. Therefore the forward reaction is endothermic.

Marking criteria	***Marks***
• Identifies the forward reaction as endothermic • Explains in terms of Le Chatelier's principle	*2*
• Identifies the forward reaction as endothermic OR • Recognises that K increases as temperature increases	*1*

Outcomes : H8,10,12,14

(c) Sodium hydroxide can be made industrially by the electrolysis of sodium chloride. 4
Explain the different products of electrolysis of aqueous and molten sodium chloride.
Use equations to demonstrate your answer.

Sample Answer
In molten sodium chloride the ions available are Na^+ and Cl^- only.
In aqueous sodium chloride there are Na^+ and Cl^- and water, so the products of electrolysis will be different.
For molten sodium chloride the oxidation reaction at the anode is

$2Cl^- \rightarrow Cl_2 + 2e^-$

The cathode reaction is

$Na^+ + e^- \rightarrow Na\ (l)$

For aqueous sodium chloride the oxidation reaction could be

$2Cl^- \rightarrow Cl_2 + 2e^-$ *for concentrated solution, or*

$H_2O \rightarrow \frac{1}{2}O_2\ (g) + 2H^+ + 2e^-$ *for dilute solution*

The reduction reaction at the cathode for aqueous sodium chloride is

$H_2O + e^- \rightarrow \frac{1}{2}H_2(g) + OH^-$ *as water will be reduced before* Na^+

Marking criteria	***Marks***
• *Gives TWO equations(or four half equations) to show the different products of electrolysis of molten and aqueous sodium chloride* • *Explains the different products (must have liquid sodium)*	*4*
• *Gives TWO (or four half equations) equations to show the different products of electrolysis of molten and aqueous sodium chloride OR* • *Explains the different products with ONE correct equation*	*3*
• *Explains the products of aqueous or molten with ONE correct equation (or two half equations) OR* • *Outlines the different products*	*2*
• *Identifies the different products OR* • *Gives one correct equation(or two half equations)*	*1*

Outcomes : H8, H11

(d) Distinguish between soaps and synthetic detergents in terms of their chemical composition and effect in hard water. 4

Sample Answer

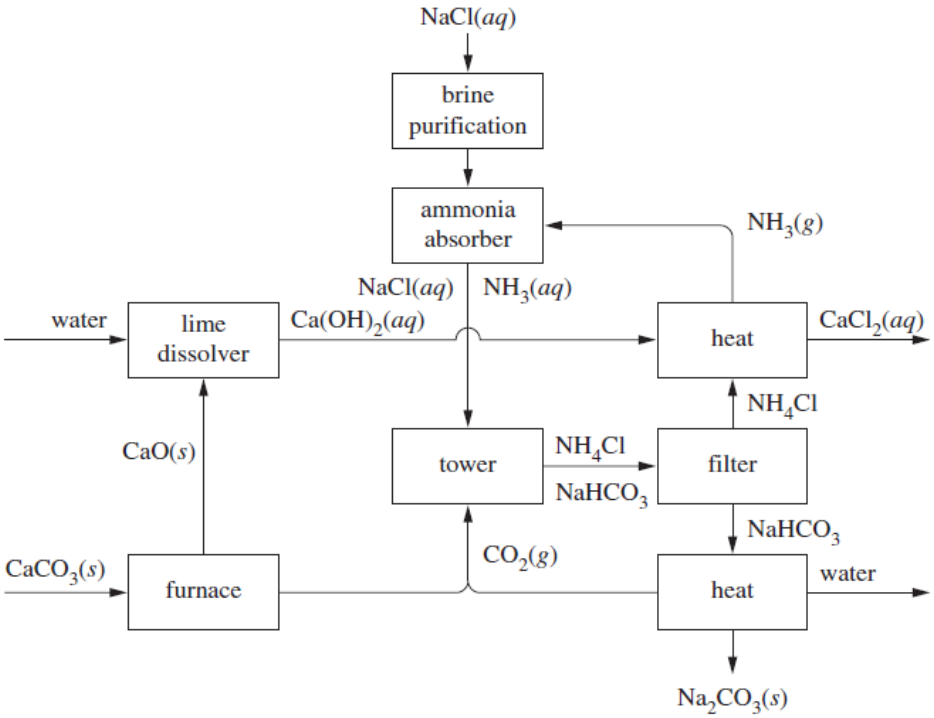
	Soaps	*Detergents*
Chemical composition	*Soaps are sodium or potassium salts of long chain fatty acids. The metal cation is a spectator ion and anion has a long non-polar hydrocarbon tail and a polar head (COO^-). They are made from animal fat or vegetable oil*	*Salts of long chain hydrocarbons with a sulfate or sulfonate polar head and a long non-polar hydrocarbon tail. They are made from petroleum*
Effect in hard water	*Soaps do not lather well in hard water. The anions form precipitates the Ca and Mg ions from the hard water forming a scum on clothes and reducing the cleaning ability of the soap*	*Detergent anions lather well in hard water as the anions do not form precipitates with the cations in the hard water*

Marking criteria	***Marks***

• Gives the chemical composition and the effect in hard water of both soaps and detergents	*4*
• Outlines the effect in hard water of a soap and a detergent AND • Gives the chemical composition of a soap OR a detergent	*3*
• Outlines the effect in hard water of a soap and a detergent OR • Gives the chemical composition of a soap and a detergent OR • Gives the chemical composition of a soap or a detergent and describes its effect in hard water	*2*
• Identifies a soap OR • Identifies a detergent • Outlines the effect in hard water of either a soap or a detergent	*1*

Outcomes : H3,4,9

(e) The diagram is a flowchart of the reactions involved in the Solvay process.



(i) Identify the major product of the Solvay process and describe one of its uses. 2

Sample Answer

Na_2CO_3 is the major product in the Solvay process. It can be used as a water softener in soaps and detergents

Marking criteria	***Marks***
• Identifies the major product as sodium carbonate • Describes one of its uses	*2*
• Identifies the major product as sodium carbonate	*1*

Outcomes : H10,13

(ii) Describe the chemistry involved in the recovery of ammonia during the process. 2

Sample Answer

Calcium oxide from the heating of calcium carbonate (limestone) is dissolved in water to make calcium hydroxide.

Calcium hydroxide is reacted with ammonium chloride from the solvay tower to form calcium chloride, water and ammonia

$2NH_4Cl(aq) + Ca(OH)_2(aq) \rightarrow 2NH_3(g) + CaCl_2(aq) + 2H_2O(l)$

Marking criteria	***Marks***
• Describes the chemistry involved	*2*
• Outlines the chemistry involved	*1*

Outcomes :H7,H8,H10,H14

(iii) Discuss two environmental issues associated with the process and explain how these issues are addressed. 4

Sample Answer

Environmental issue	*How it is addressed*
Dust produced by the crushing of limestone	*Dust can cause visual hazards and respiratory problems. This can be addressed by improving truck loading facilities, upgrading dust suppression in the plant, using wetting solution to suppress dust in open areas and using bag filters to reduce dust.*
Disposal of excess waste product calcium chloride.	*The calcium chloride cannot be discharged into rivers as it causes raised levels of chloride ions that can kill plants and fish. Calcium chloride can be disposed of in land fill or disposed of in the ocean where the ion concentration may be diluted. The waste calcium chloride can also be used in fertilizer and brick manufacture.*

Marking criteria	***Marks***
• Discusses TWO environmental issues and how they are addressed	*4*
• Discusses one issue and outlines another issue	*3*
• Outlines two issues	*2*
• Identifies one issue	*1*

Outcomes :H4

End of Test