Candidate Number | | | | | | | | | |

BAULKHAM HILLS HIGH SCHOOL

HIGHER SCHOOL CERTIFICATE

TRIAL EXAMINATION

2009

CHEMISTRY
2 Unit

General Instructions

- Reading time - 5 minutes
- Working time - 3 hours
- Write, using black or blue pen
- Draw diagrams using pencil
- Board approved calculators may be used
- A Data Sheet and a Periodic Table are provided
- Write your candidate number at the top of your answer booklets

Total Marks - 100

SECTION I - 75 marks

This section has two parts, Part A and Part B

Part A (15 marks)
- Attempt Questions 1-15
- Allow about 30 minutes for this section

Part B (60 marks)
- Attempt Questions 16-29
- Allow about 1 hour and 45 minutes for this part

SECTION II - 25 marks

- Attempt ONE question from Questions 30-35
- Allow about 45 minutes for this section

SECTION I - 75 marks

Part A (15 marks)
15 Multiple Choice Questions.
Mark the most correct answer, A, B, C or D on the grid provided.

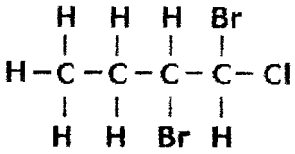
1. Methanol can be produced through the reaction of carbon monoxide with hydrogen as shown below.

$$CO_{(g)} + 2H_{2(g)} \leftrightarrow CH_3OH_{(g)} \quad \Delta H = -155\,kJ\ mol^{-1}$$

Which set of conditions would increase the *equilibrium yield* of methanol?

a) high pressure and temperature
b) low pressure and temperature
c) high pressure and low temperature
d) low pressure and high temperature

2. Observe the following structural diagram



Which of the following is the *systematic name* for this compound?

a) 3,4-dibromo-4-chlorobutane
b) 1,2-dibromo-1-chlorobutane
c) 2,1-dibromo-1-chlorobutane
d) 4-chloro-3,4-dibromobutane

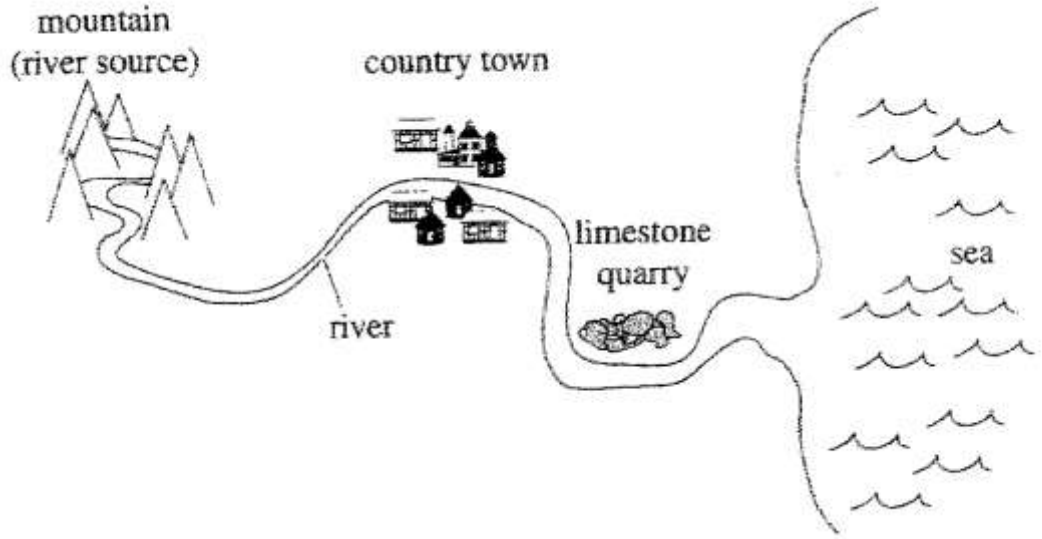
3. The hydronium ion concentration (in mol L^{-1}) of some common substances is given in the table below.

[H_3O^+]	**Substance**
10^{-9}	Baking soda
10^{-5}	Black coffee
10^{-8}	Sea water
10^{-11}	Laundry detergent
10^{-6}	Milk
10^{-13}	Chlorine bleach
10^{-4}	Soda water

Of the listed substances, which of the following are acidic?

a) soda water and chlorine bleach
b) milk and laundry detergent
c) sea water and baking soda
d) black coffee and milk

4. Water quality analyses were performed at different sites on a river as shown on the map.



The table shows the results of the tests performed at different sites.

Site	***Dissolved oxygen (ppm)***	***pH***	***Calcium ion concentration (ppm)***	***Total dissolved solids (gL^{-1})***
1	11	6.8	68	38
2	10	6.8	5	0.10
3	5	7.4	60	0.60
4	5	6.2	4	0.10

The river source in the mountain is

a) site 1
b) site 2
c) site 3
d) site 4

5. An HSC chemistry student carried out some tests on fertiliser *X*. The results are shown below.

- Warming *X* with aqueous NaOH gave a gas which turned red litmus paper blue.
- Mixing aqueous *X* with acidified barium chloride solution gave no reaction
- Mixing aqueous *X* with acidified silver nitrate solution gave a white precipitate

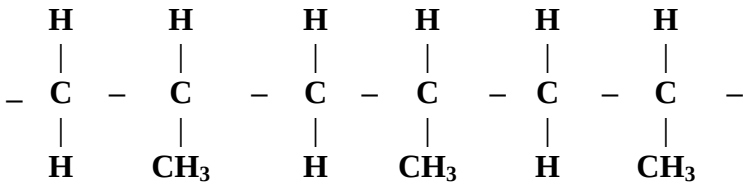
Which ions could be present in fertiliser *X* ?

a) NH_4^+ and Cl^-
b) NH_4^+ and SO_4^{2-}
c) NH_4^+ and NO_3^-
d) K^+ and SO_4^{2-}

6. The reaction of $Br_{2(l)}$ with ethylene produces 1,2- dibromoethane. However when bromine water $Br_{2(aq)}$ is added to ethylene, which other product, apart from 1,2-dibromethane is produced?

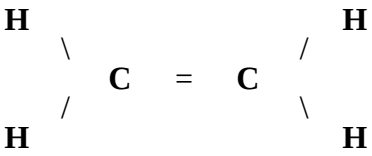
a) $CH_2Br - CH_3$ - 1-bromoethane
b) $CH_2OH - CH_2Br$ - 2-bromo-1-ethanol
c) $CH_2OH - CH_2OH$ - 1,2-ethanediol
d) $CH_3 - CH_3$ - ethane

7. The chain of a certain polymer is shown below.

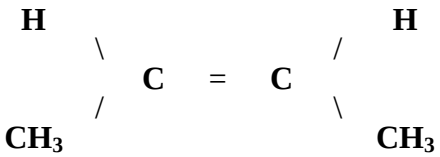


The structural formula of the monomer used to make this polymer is

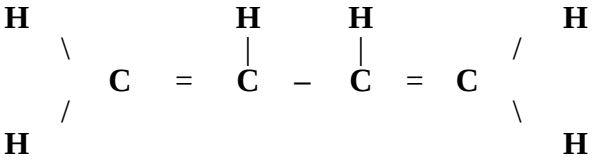
a)



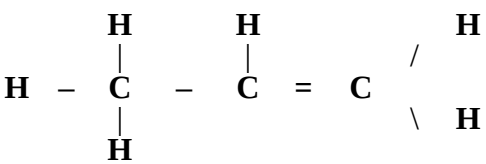
b)



c)



d)



8. In which of the following alternatives are the three compounds listed in order of increasing boiling points.

   a) Butane, butan-l-ol, butanoic acid
   b) Butanoic acid, butan-l-ol, butane
   c) Butanoic acid, butane, butan-l-ol
   d) Butan-l-ol, propanoic acid, butane

9, What did the Bronsted-Lowry definition of acids identify that made it a significant improvement over earlier definitions?

   a) acids contain hydrogen
   b) acids are proton donors
   c) acids contain oxygen
   d) acids are electron-pair acceptors

10. In a titration of a strong base with a strong acid, the following procedure was used:

   i) A burette was rinsed with water and then filled with the standard acid
   ii) A pipette was rinsed with some base solution
   iii) A conical flask was rinsed with some base solution
   iv) A pipette was used to transfer a measured volume of base solution into the conical flask
   v) Indicator was added to the base sample and it was titrated to the endpoint with the acid

   Which statement is correct?

   a) The calculated base concentration will be correct
   b) The calculated base concentration will be too low
   c) The calculated base concentration will be too high
   d) No definite conclusion can be reached about the base concentration

11. Which condition would be best for the fermentation of sugars by yeast?

   a) Low oxygen concentration and a temperature between 25^oC and 35^oC
   b) High oxygen concentration and a temperature between 25^oC and 35^oC
   c) Low oxygen concentration and a temperature between 45^oC and 60^oC
   d) High oxygen concentration and a temperature between 45^oC and 60^oC

12. What is the catalyst for the conversion of ethanol to ethylene?

   a) NaOH
   b) H_2SO_4
   c) HNO_3
   d) Pt

13. Which of the following is a transuranic element?

   a) Caesium
   b) Cerium
   c) Chromium
   d) Curium

14. Neutron-rich radioisotopes such as Co-60 are most likely to be produced in which of the following?

    a) particle accelerator
    b) cloud chamber
    c) nuclear reactor
    d) catalytic cracker

15. What arrangement of an electrochemical cell would electroplate a silver coin with copper?

	Cathode	**Anode**	**Electrolyte**
a)	copper	silver coin	copper sulfate
b)	silver coin	copper	silver nitrate
c)	copper	silver coin	silver nitrate
d)	silver coin	copper	coffer sulfate

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TRIAL EXAMINATION

2009

CHEMISTRY
2 Unit

MULTIPLE CHOICE ANSWER SHEET

QUESTION				
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

Section I (continued)

Part B (60 marks)
Attempt Questions 16-29
Allow about 1 hour and 45 minutes for this part.
Answer the questions in the spaces provided
Show all relevant working in questions involving calculations

Marks

Question 16 (3 marks)

As part of your course work, you prepared an indicator from a natural material.

a) Outline the procedure that you followed. **2**

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b) Outline how you determined whether the indicator you produced was appropriate to test the acidity of a substance. **1**

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Question 17 (4 marks)

a) Using *Lewis electron dot* structures, compare the structures AND relative stabilities molecular oxygen *and* the oxygen free radical. **2**

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b) Using Lewis electron dot structures, demonstrate production of ozone in the stratosphere, AND identify the type of bonding involved. **2**

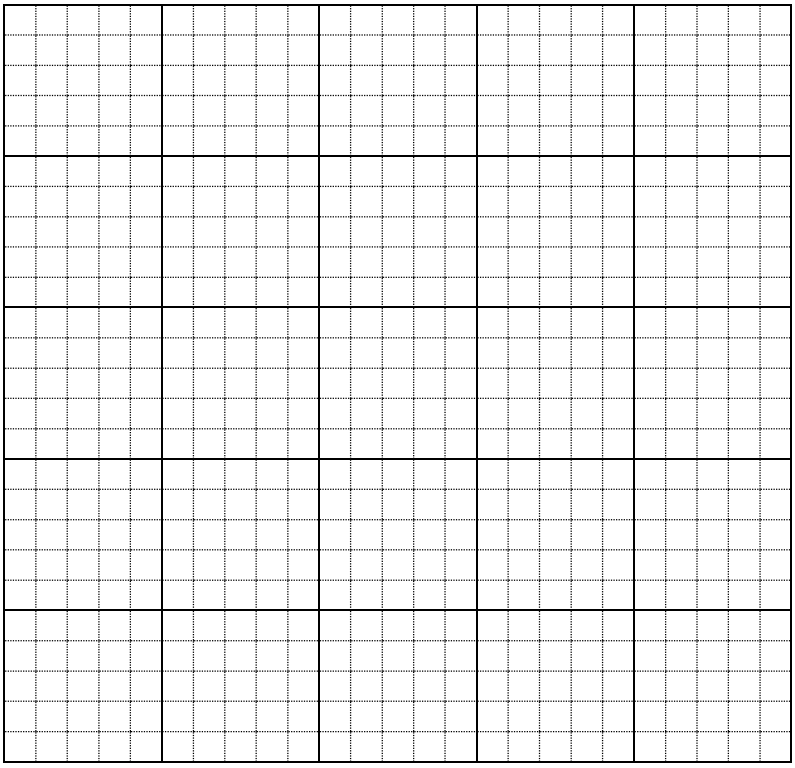
Marks

Question 18 (8 marks)

In monitoring the effect of discharge effluent on river water quality, a chemist uses *atomic absorption spectroscopy* to compare the sodium ion concentrations above and below the discharge point in a river. The table below shows the absorbance values at a wavelength of 589 nm, for water samples, and also those for a range of standard solutions.

Solution	Na^+ Concentration (mgL^{-1})	Absorbance at 589 nm(%)
Standard	10	16
Standard	20	34
Standard	40	63
Standard	60	98
Upriver Sample 1		4
Upriver Sample 2		5
Downriver Sample 1		54
Downriver Sample 2		43

a) Plot the 'Standards' on the grid below. (Label axes) **2**



b) Complete the entries for Na^+ concentration of water samples **in the table above** **2**

c) Assess the downstream water quality for freshwater organisms for which the maximum sodium ion concentration is 100 ppm. **2**
Explain why water quality might change in periods of low rainfall.

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Marks

Question 19 (5 marks)

During the 1970's it was discovered that the Earth's ozone layer was decreasing. It was noted that the decrease in ozone concentration was particularly severe over Antarctica. The concern was so great that in 1987 a number of nation states, including Australia, signed the Montreal Protocol to begin phasing out CFCs. **5**

Assess the effectiveness of the Montreal Protocol in reversing the decline in the ozone concentration over Antarctica.

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Question 20 (6 marks)

a) Describe a test that could be performed at home to identify whether the household's water supply is 'hard' or 'soft'. **2**

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Marks

Question 21 (3 marks)

The hydrogen carbonate ion, HCO_3^- is an amphiprotic species.

a) Describe an amphiprotic species. **1**

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b) Write suitable equations to describe the amphiprotic nature of the hydrogen carbonate ion. **2**

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Question 22 (3 marks)

Buffers are important in many natural systems. Describe the effect of buffers with reference to a specific example in natural systems. **3**

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Question 23 (4 marks)

Assess the impact of the recent development of a named biopolymer on society and the environment. **4**

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Marks

Question 24 (7 marks)

The flowchart shows a series of steps involved in the production of ethyl propanoate. **7**

Glucose → mixture containing ethanol → pure ethanol → ethyl propanoate

Describe the chemistry and procedures involved in each of these steps, using diagrams where appropriate. (You may use the blank page opposite, for diagrams)

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Marks

Question 25 (3 marks)

A student prepared a solution of a particular triprotic acid, H_3PO_4 by dissolving 0.98g of the solid acid in 250.0 mL of water. Assuming this acid is a strong acid, calculate the pH of the acid solution prepared. **3**

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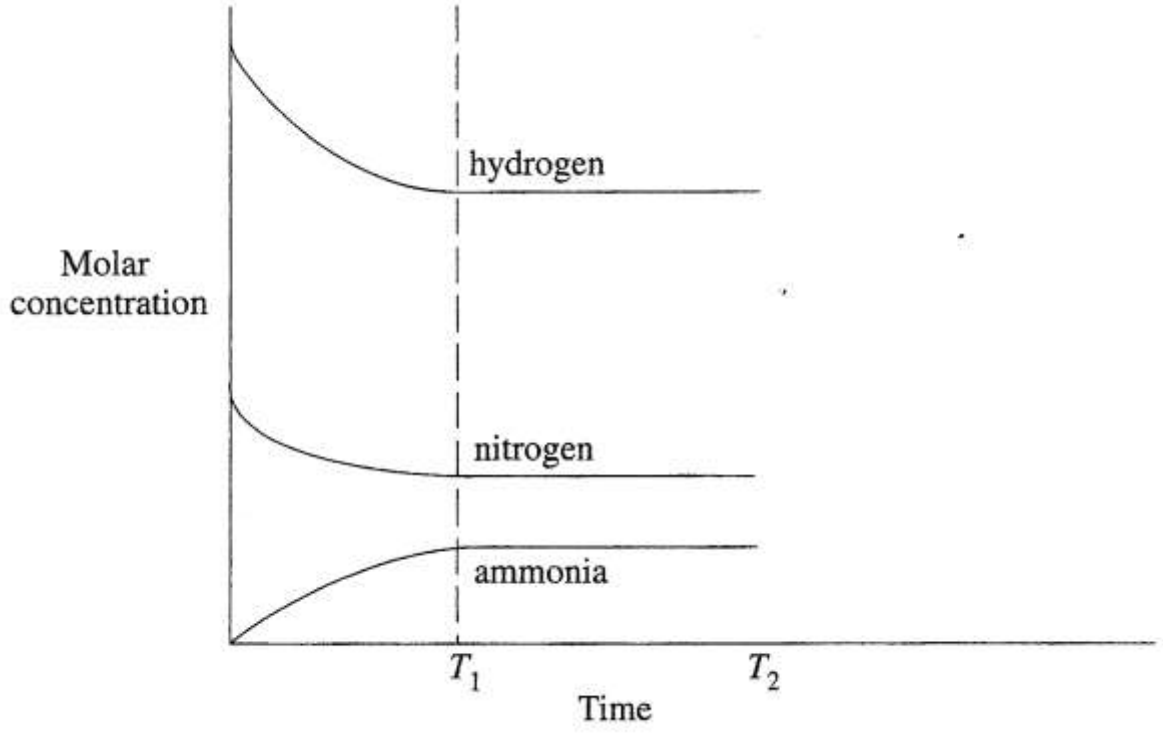
Question 26 (4 marks)

The graph shows the variation in concentration of reactants and product with time for the Haber process.



a) State why the concentrations of reactants and product do not change between T_1 and T_2 **1**

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Marks

Question 26 (continued)

b) At time T_2 the volume of the reaction vessel was reduced.

i) Sketch on the graph how the concentrations of reactants and product would change after the volume was reduced. **1**

ii) Explain the changes shown on your graph. **2**

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Question 27 (3 marks)

A student studying the mass change that occurs during fermentation added glucose, water and yeast to a flask and stoppered the flask with some cotton wool.

The student measured the mass of the flask daily for seven days. The table shows the data collected.

Day	Mass(g)
1	381.05
2	376.96
3	373.42
4	370.44
5	370.42
6	370.40
7	370.39

a) Calculate the moles CO_2 released between days 1 and 7 **1**

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b) Calculate the mass of glucose that underwent fermentation between days 1 and 7. Include a balanced chemical equation in your answer. **2**

Marks

Question 28 (3 marks)

a) Write a balanced chemical equation for the complete combustion of ethanol. **1**

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b) A mass of 72.5g of ethanol was burnt completely in air. Calculate the volume of carbon dioxide that was produced at 25^{o}C and 100kPa. **2**

Question 29 (5 marks)

There are many benefits and problems associated with the use of radioisotopes in industry and medicine. **5**

Evaluate the impact on society of the use of radioisotopes in both industry and medicine. In your answer, give examples of specific radioisotopes, making reference to their chemical properties.

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Marks

Question 29 (continued)

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Question 30

Evaluate the importance of monitoring and managing the conditions used in the Haber process. **5**

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Section II

(25 marks)
Allow about 45 minutes for this section.
Show all relevant working in questions involving calculations.

Marks

Question 31 - The Chemistry of Art

a) Describe examples of pigments and their chemical composition used by traditional Aboriginal culture. **2**

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b) Ancient Egyptian culture and Roman societies used pigments as cosmetics. They had no knowledge of the chemical composition and thus of any potential health risk of the pigments used. **3**

Identify a pigment and describe how it was used as a cosmetic. With reference to the chemical composition of the pigment, make an assessment of the health risks associated with its use.

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c) Outline the processes used and the chemistry involved in the preparation of a **named** medieval art work. **4**

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Marks

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d) Describe features of the Bohr model of the atom. Discuss limitations of this model. **3**

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TRIAL EXAMINATION

2009

CHEMISTRY
2 Unit

MULTIPLE CHOICE ANSWERS

QUESTION				
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**

Trial HSC marking 2009

Q16a

mark	criteria
2	• Shred red cabbage/ beetroot etc • Simmer in boiling water to release the dye
1	1 of the above

Q16b

mark	criteria
1	• Set up serial dilutions over a large pH range (ie, acidic and basic solutions) • Check for a colour change over a range of pH values OR: • Use known household acids and bases • Varying colours where seen

Did not have to give actual colours, but some students were giving the wrong colours. Your had to test the indicator in both acid and base solutions.

Q17a

mark	criteria
2	• Link O radicals instability to unpaired electrons (2electrons short of octet) • Link O_2 double bond to greater stability • Correct Lewis edot diagram for both O and O_2
1	• Correct Lewis edot diagram for both O and O_2 Or • Correct linkage between both structures and their stability

Q17b.

mark	criteria
2	• Equation for the production of O_3, using Lewis diag • Labelling of coord covalent bonding in O_3
1	1 of the above

18a, The graph.

mark	criteria
2	• Correct scale on both axes • X axis labelled with quantity and units • Y axis labelled with quantity and units • Points plotted correctly • Line sharp, straight • pencil
1	3, 4 or 5 of the above

Q18b

mark	criteria
2	All 4 values read off the graph correctly
1	2 or 3 values read off curve correctly

Q18c

mark	criteria
2	• Make judgement that downstream water is safe for freshwater organisms ($[Na^+]$ is less than 100pm) • Explain the effect of low rainfall on $[Na^+]$
1	• One of the above

Q19

mark	criteria
5	• CFCs release $Cl^·$ which attack O_3 • Hole over Antarctica in spring due to Polar vortex, constant darkness of winter, stratospheric clouds on which Cl_2 forms, which are suddenly releases $Cl^·$ Radicals in spring ✓ Montreal Protocol - what it set out to do ✓ Alternatives to CFCs/halons (at least one required) ✓ A benefit of the alternative ✓ Judgement on MP's effectiveness.
4	5 of the above
3	4 of the above
2	3 of the above
1	2 of the above

(Not all the points for Antarctic hole were required, though a demonstration of the understanding of the process was.)

Q20

Lather?

mark	criteria
2	• Add some soap to water sample. Shake. • Give positive result if the water is hard and if the water is soft
1	One of the above

Q21(a)

Criteria	mark
Correctly describes amphiprotic substance	1

Substances that can either act as a Bronsted acid or base OR a substance that can be a proton acceptor or a proton donor

(b)

Criteria	Mark
*Correctly writes a chemical equation for the reaction of HCO_3^- as an acid *Correctly writes a chemical equation for the reaction of HCO_3^- as a base	2
*Only ONE chemical equation correctly written or Both equations correct but no states mentioned	1

$HCO_{3\,(aq)}^- + H_2O_{(l)} \longleftrightarrow H_2CO_{3(aq)} + OH^-_{(aq)}$

$HCO_{3\,(aq)}^- + H_2O_{(l)} \longleftrightarrow H_3O^+_{(aq)} + CO_{3\,(aq)}^{2-}$

Q22

Criteria	mark
*Describes a buffer *Describes an example of a natural system that uses a buffer including the buffer *Writes a chemical equation to demonstrate the effect of adding an acid/base	3
*Description of buffer not adequate *Describes an example of a natural system that uses a buffer including the buffer *Writes a chemical equation to demonstrate the effect of adding an acid/base	2
*Describes a buffer OR *Names an example of a natural system that uses a buffer including the buffer OR *Writes a chemical equation to demonstrate the effect of adding an acid/base	1

A chemical buffer is a weak acid in equilibrium with a similar conc of conjugate base to reduce the effect on a system of changes in the amounts of acids or alkali.
One example of a buffer in a natural system is the H_2CO_3/HCO_3^- buffer in human blood.

$H_2CO_{3(aq)} + H_2O_{(l)} \longleftrightarrow HCO_{3\,(aq)}^- + H_3O^+_{(aq)}$

Enzymes only operate at their optimum over a very narrow pH range, so this buffer helps to reduce the effect of changes in pH in the blood as acids and bases are introduced to the blood from food or drinks. When acids are introduced , the H_3O^+ conc increases. The equilibrium shifts to the left to counter the change. When the base is added, the OH^- conc increases and the equilibrium shifts to the right by reacting the OH^- with H_3O^+ and restoring the pH.

Q23

Criteria	Mark
*Defines and correctly names a biopolymer *Describes its uses and how it is produced *Outlining advantages and disadvantages of using the biopolymers with reference to society and environment *Assess its potential for future use	4
*Defines and correctly names a biopolymer *Describes its uses and how it is produced *Outlines advantages and disadvantages of using biopolymers	3
*Correctly names AND defines a biopolymer AND *Outlines one advantage and one disadvantage of using biopolymers OR *Describe its use and briefly describe how it is produced	2
*Correctly names OR defines a biopolymer OR Outlines an advantage or disadvantage of using biopolymer OR Outlines a use of a biopolymer	1

A biopolymer is a naturally occurring polymer produced by living organisms including plants, animals and microorganisms. New biopolymers are being developed with special properties and which have the benefit of being both biodegradable and renewable. The biodegradability of biopolymers makes their use advantageous in certain applications And will greatly reduce the amount of plastic wastes in our landfill.
Examples of biopolymers include:
Polyhydroxyalkanoates (PHA) such as Polyhydroxybutyrate (PHB)
Polylactic acid (PLA)
Cyclodextrins (CD)
PHA – produced by bacteria (Alcaligenes eutropus) can be melted, moulded and shaped into various forms and used instead of normal synthetic plastics.
PHA – Plants like sugar cane are genetically modified by inserting bacterial genes to produce raw materials needed for the manufacture of nylon, certain plastics, glue and lubricants.
PLA – wastes from crops such as potatoes, corn and maize contain starch which can be broken down into simple sugars by enzymes. Lactic bacteria can ferment these to produce lactic acid which can undergo condensation polymerization to produce Polylactic Acid. This can be used for such things as food packaging, plant pots, disposable plates ans cutlery.
In future, as petroleum reserves decline and prices rise, the production of plastics by bacteria may become economically viable.

Glucose is fermented to produce aqn ethanol mixture. Fermentation is carried out in large vats. Yeast is added to the glucose solution under anaerobic conditions as it provides the enzyme zymase which catalyses the process. Max. yield id achieved at optimal conditions (35 C) pH of with inorganic nutrient such as ammonium phosphate

$C_6H_{12}O_6$ (aq) ---------- $2CO_{2(g)}$ + $2CH_3CH_2OH_{(aq)}$

The ethanol is purified by distillation. This process involves heating a mixture until ethanol boils at 78 C. The ethanol vapour is cooled and then condensed.

(DIAGRAM OF DISTILLATION)

Ethanol obtained is purified by adding a dehydrating agent to remove water. Pure ethanol is then mixed with propanoic acid and heated under reflux to produce the ester ethylpropanoate. The mixture is heated using a water bath. Conc sulfuric acid is added to speed up the reaction during refluxing.

(DIAG OF REFLUXING)

$CH_3CH_2OH_{(l)}$ + $CH_3CH_2COOH_{(l)}$ ---------- $CH3CH_2\ COOCH_2CH_{3(l)}$ + $H_2O_{(l)}$

The mixture is refluxed to avoid the loss of volatile reactants. The volatile substances are returned to the flask for further heating.

The excess acid in the mixture can be removed by adding sodium carbonate and the ester can be purified by distilling the mixture.

Q24

Criteria	Marks
*Describes the three processes accurately AND *2 labeled diagrams drawn *2 balanced chemical equations correctly written	7
*Describes three processes adequately AND *3 labeled diagrams drawn *2 chemical equations correctly written OR Describe 2 processes + 2 diagrams + 2 balanced equations	6
*Names three correct processes AND *2 labeled diagrams drawn AND *2 chemical equations correctly written OR Describe 2 processes + 1 diagram + 2 equations OR Describe 3 processes + 2 balance equations	5
*Names three processes AND *2 labeled diagrams drawn AND *At least one chemical equation correctly written OR Describe 2 processes + 2 diagrams/2 balanced equations OR Describe 2 processes + 1 diagram + 1 balanced equation	4
*Names three correct processes AND *2 labeled diagrams drawn OR Describe 1 process + 1 diagram + 1 balances equation	3
*Names three correct processes OR *Draws 2 labeled diagrams OR Describe 1 process + 1 balance equation/1 diagram	2
*A labeled diagram OR A correct chemical equation OR a correct process named	1

Q25

Criteria	Mark
* Correctly calculates the number of moles of acid AND *Correctly calculates the concentration of the acid AND *Calculates the concentration of Hydrogen ions AND *Calculates the pH to two sig fig	3
*Correctly calculates the number of moles of acid AND *Correctly calculates the concentration of the acid AND *Calculates the pH of the acid but not to two sig fig	2
*Correctly calculates the number of moles of acid OR *Correctly calculates the concentration of the acid OR *Correctly calculates the concentration of hydrogen ions	1

$M_r = 3.024 + 30.97 + 64 = 98.004$

Moles = 0.98/98.004 = 0.0099 moles/L

$H^+ = (0.0099 \text{ X } 3) / 0.25L = 0.119$ mol/L

$pH = -\log (H^+)$
$= 0.92$

26 (a).

Criteria	Marks
• Identifies that the chemical reaction has attained a state of chemical or dynamic equilibrium between T1 and T2	1

The parallel horizontal lines indicate that there is no change in the concentration of any of the reactants or products indication that the reaction has reached a state of dynamic equilibrium (chemical equilibrium)

(b).i.

Criteria	Marks
• Graph should show a proportional increase in pressure for each reactant and product as the volume decreases as a vertical line • Graph should show a proportional curving decrease in amount of each reactant, and a proportional curving increase in the amount of product to attain a new equilibrium position	1

(b).ii

Criteria	Marks
• Recognises that a decrease in volume increases the pressure of each reactant and product (not included- and that the change is proportional to their molar concentrations) • States that the system will attain chemical equilibrium by adjusting pressures according to Le Chatelier's Principle • States that the equilibrium shifts to the side of reaction with the least number of moles • Identifies the relative changes in the concentrations of reactants and products	2
• Any two of the above	1

what happens to reactants and what happens to products

27(a).

Criteria	Marks
• Correctly calculates the moles of CO_2 released between days 1 and 7	1

Loss in mass due to CO_2= 381.05-370.39= 10.66g

Moles of CO_2 = 10.66/44= 0.24 mol

(b).

Criteria	Marks
• Gives an equation for the fermentation of glucose showing correct stoichiometry OR • Shows evidence of knowing that 1 mole of glucose ferments to give 2 moles of carbon dioxide • Calculates the number of moles of glucose • Calculates molar mass of glucose • Calculates the mass of glucose	2
• Gives an equation for the fermentation of glucose showing correct stoichiometry OR • Shows evidence of knowing that 1 mole of glucose ferments to give 2 moles of carbon dioxide • Calculates the number of moles of glucose • Calculates molar mass of glucose (any 1 of the above)	1

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2\,CO_2$

Moles of glucose= 0.24/2 = 0.12 mol

$M_{C6H12O6}$= 12x6 + 1.008x12 + 16x6 = 180.096 g/mol

Mass of glucose = 180.096x0.12= 21.61g

28(a).

Criteria	Marks
• Gives a balanced equation for the complete combustion of ethanol • Equation must show subscripts	1

$C_2H_5OH_{(l)/(g)} + 3O_{2(g)} \rightarrow 2\,CO_{2(g)} + 3\,H_2O_{(l)/(g)}$

(b).

Criteria	Marks
• Calculates the number of moles of ethanol burnt • Calculates the number of moles of carbon dioxide produced • Calculates the volume of carbon dioxide produced • Answer must provide units and correct number of significant figures (otherwise 1 mark)	2
• Calculates the number of moles of ethanol burnt OR • Calculates the number of moles of carbon dioxide produced	1

M_{C2H5OH}= 2x12.0 + 6x1.008 + 16.0 = 46.048g/mol

n_{C2H5OH}= m/M= 72.5/46.048= 1.5744 mol

n_{CO2}=2x1.5744=3.1488mol

V_{CO2}=3.1488x24.79=78.059= 78.1L (3 sig. Figs)

Na-24 – all sodium salts soluble in water

- Tc-99m – large number of ... half-life

29.

Criteria	Marks
✓ Identifies a radioisotope used in industry ✓ Describes industrial uses of radioisotopes ✓ Identifies a radioisotopes used in medicine ✓ Describes medical uses of radioisotopes ✓ Identifies a benefit of using radioisotopes in industry ✓ Identifies a benefit of using radioisotopes in medicine ✓ Outlines two problems with the use of radioisotopes ✓ Discusses how the choice of radioisotopes can be influenced by their chemical properties ✓ Makes an evaluation having discussed controlling problems and benefits	5
Any 6 of the above plus an evaluation	4
• Identifies a radioisotope used in industry • Describes industrial uses of radioisotopes • Identifies a radioisotope used in medicine • Describes medical uses of radioisotopes • Identifies a benefit using radioisotopes in industry	3

• Identifies a benefit of using radioisotopes in medicine • Outlines a problem with the use of radioisotopes OR • Identifies a radioisotope used in industry • Describes industrial uses of radioisotopes • Identifies a radioisotope used in medicine • Describes medical uses of radioisotopes • Identifies two benefits of using radioisotopes in industry • Outlines a problem with the use of radioisotopes OR • Identifies a radioisotope used in industry • Describes industrial uses of radioisotopes • Identifies a radioisotope used in medicine • Describes medical uses of radioisotopes • Identifies two benefits of using radioisotopes in medicine • Outlines a problem with the use of radioisotopes OR • Identifies a radioisotope used in industry • Describes industrial uses of radioisotopes • Identifies a radioisotope used in medicine • Describes medical uses of radioisotopes • Identifies a benefit of using • Outlines two problems with the use of radioisotopes (evaluation does not contribute for 3)	
• Identifies a radioisotope used in industry • Describes industrial uses of this radioisotope • Identifies a radioisotope used in medicine • Describes medical uses of this radioisotope • Identifies a benefit and a problem with the use of radioisotopes (evaluation does not contribute for 2)	2
• Identifies a radioisotopes used in industry AND • Describes the industrial uses of this radioisotope OR • Identifies a radioisotopes used in medicine AND • Describes a medical use of this radioisotope (evaluation does not contribute for 1)	1

Cobalt-60m is a radioisotope used in both medicine and industry. Cobalt-60 emits gamma radiation and is used for irradiation in cancer treatment and sterilisation of medical supplies. Gamma irradiation can be used to prolong the shelf life of certain foods and for the imaging of high technology parts for example in the aviation industry. Cancer treatment by irradiation avoids invasive surgery and gamma photography provides non-destructive testing of parts. Being a gamma emitter a cobalt-60 source requires extensive shielding by lead or concrete to protect workers from radiation damage when operating the source. A cobalt-60 source is chemically stable and does not oxidise or corrode over the period of its use.

Technetium-99m is a radioisotope used extensively in nuclear medicine. It is a gamma emitter and can be used for medical diagnosis through the imaging of cancer without invasive surgery. Tc-99m is a transition metal and can have a range of oxidation states. This allows it to be attached to a variety of molecules that can concentrate in different tissues. This isotope has a short half life and being a gamma emitter exposes the patient to only low levels of harmful ionising radiation. Medical personnel administering radioisotopes need to be monitored for radiation exposure and procedures need to be in place in case on accidental spillage.

Americium-241 is an alpha emitter used in household smoke detectors. Like Co-60 it is chemically inert and the source does not oxidise of breakdown over its period of use. Being an alpha emitter people handling a smoke detector are easily shielded from harmful ionising radiation. Old smoke detectors with radioactive sources pose an environmental hazard as they can end up in landfill sites with the potential of leaching radioisotopes into ground water.

The use of radioisotopes come with a range of problems that need to be managed, however, their use also provides unique benefits and solutions to a wide range of problems. Society can benefit from the use of radioisotopes given that these problems can be managed.

30.

ALWAYS GIVE HABER EQUATION

Criteria	Marks
✗ Uses an equation to describe the Haber process ✗ States that the Haber process is exothermic ✓ Identifies conditions of temperature and pressure for carrying out the Haber process • Makes an evaluation on the need to choose conditions of temperature and pressure that will maximise yield of the Haber process AND • Describes using Le Chateliers Principle how changing the temperature can affect the Haber process, and consequently yield • Describes using Le Chateliers Principle how changing the pressure can affect the Haber process, and consequently yield OR ✓ Describes fully two other reasons for monitoring but must state reasons or possible sources of contaminants or reason for maintenance of 1:3 stoichiometry (answer must relate to chemical and energy concerns and not costs and economics)	5
• Uses an equation to describe the Haber process • States that the Haber process is exothermic • Identifies conditions of temperature and pressure for carrying out the Haber process • Makes an evaluation on the need to choose conditions of temperature and pressure that will maximise yield of the Haber process AND • Describes relating to Le Chateliers Principle how changing the temperature can affect the Haber process, and consequently yield • Describes relating to Le Chateliers Principle how changing the pressure can affect the Haber process, and consequently yield OR • Describes fully two other reasons for monitoring but must state reasons or possible sources of contaminants or reason for maintenance of 1:3 stoichiometry (any S of above) OR • Uses an equation to describe the Haber process • States that the Haber process is exothermic • Identifies conditions of temperature and pressure for carrying out the Haber process • Makes an evaluation on the need to choose conditions of temperature and pressure that will maximise yield of the Haber process AND • Describes using how changing the temperature can affect the Haber	4

process, and consequently yield • Describes using how changing the pressure can affect the Haber process, and consequently yield OR • Describes fully two other reasons for monitoring but must state reasons or possible sources of contaminants or reason for maintenance of 1:3 stoichiometry • Makes an evaluation on the need to choose conditions of temperature and pressure that will maximise yield of the Haber process	
• Uses an equation to describe the Haber process • States that the Haber process is exothermic • Identifies conditions of temperature and pressure for carrying out the Haber process • Describes relating to Le Chateliers Principle how changing the temperature can affect the Haber process, and consequently yield • Describes relating to Le Chateliers Principle how changing the pressure can affect the Haber process, and consequently yield OR • Describes fully two other reasons for monitoring but must state reasons or possible sources of contaminants or reason for maintenance of 1:3 stoichiometry (any 4 of above) OR • Uses an equation to describe the Haber process • States that the Haber process is exothermic • Identifies conditions of temperature and pressure for carrying out the Haber process • Describes two reasons for monitoring the Haber process	3
• Uses an equation to describe the Haber process • States that the Haber process is exothermic • Identifies conditions of temperature and pressure for carrying out the Haber process • Describes two reasons for monitoring the Haber process (any 3 of the 5 possible points above)	2
• Uses an equation to describe the Haber process OR • States that the Haber process is exothermic OR • Identifies conditions of temperature and pressure for carrying out the Haber process OR • Describes using how changing the temperature can affect the Haber process, and consequently yield OR • Describes using how changing the pressure can affect the Haber process, and consequently yield	1

The Haber process is the process used for producing ammonia from nitrogen and hydrogen gas by the reaction,

$$3H_{2(g)} + N_{2(g)} \leftrightarrow 2NH_{3(g)}$$

The reaction is exothermic and comes to chemical equilibrium. Conditions need to be monitored to maximise the yield of ammonia. The industrial process is carried out at temperatures of about 500°C and at pressures of about 350 atmospheres. (A magnetite catalyst is used to lower the operating temperatue)

Elevated temperatures are necessary to increase the rate of a chemical reaction and can increase the yield of a process. However, since the reaction is exothermic the chemical equilibrium according to Le Chatelier's principle is shifted in favour of the reactants at high temperatures. This lowers the expected yield. Temperature must be monitored because if it becomes too high low equilibrium levels of ammonia are produced. If temperature becomes too low the rate of reaction becomes too slow.

High pressures are used to increase the amount of ammonia. According to Le Chatelier's principle at high pressures the equilibrium shifts in the direction of reaction to lower the overall number of gaseous molecules producing more ammonia. Pressure must be monitored because low pressures result in smaller amounts of ammonia at equilibrium than at high pressures.

The conditions chosen provide optimal conditions for the production of ammonia and represent a balance between the rate of reaction and the position of the chemical equilibrium.

Q31 (a)

Criteria	Mark
Names more than 2 pigments and their correct chemical formulae and their color.	2
*Names at least 2 pigments and their correct chemical formulae or color	1

Red Ochre	red	$Fe_2O_3.H_2O$ (red iron oxide- haematite)
Yellow Ochre	yellow	$Fe_2O_3.H_2O$ (goethite + clay)
White clay	white	$Al_2O_3.2SiO_2.2H_2O$
Charcoal black	black	C
Bone Black	black	$C + Ca_3(PO_4)_2$

(b)

Criteria	Mark
*Identify a pigment used for cosmetics AND *Writes the correct chemical formula *Assesses at least two health risks associated with its use.	3
*Identify a pigment used for cosmetics AND *Writes the correct chemical formula	2
*Identify a pigment used for cosmetics OR *Writes the correct chemical formula	1

Eye – malachite, chrysocolla, galena, stibnite, orpiment, oxides of Cu, Fe and Mg
Face make-up – white lead
Rouge – red phosphorus
Lipstick – cinnabar (HgS)
Other metallic poisons used were Pb, Hg, As, Sb

Assessing risks:

Q31c)

Criteria	marks
- full name of painting e.g. Madonna and Child with Saints (1 mark) - mention the following: wood panel linen canvas glued to wood with animal glue layers of gesso - grosso then sottile - made from calcium sulfate or chalk mixed with glue (1 mark) - mention the following: pigment egg tempera gilding with gold varnish (1 mark) - Chemistry names of at least two pigments or other process involving chemicals (1 mark)	4
Three of above points	3
Two of above points	2
One of above points	1

31d)

Criteria	marks
- features of Bohr model (any two of the following) * atoms with electrons in fixed orbits * electrons in orbit do not radiate energy in the ground state *when electrons absorb energy they move to higher energy levels *when excited electrons return to their ground state, they emit radiation which is equal to the difference in energy of the two states *energy depends on radius as only particular orbits are available (1 mark) - limitations (any two of the following) *it cannot be used to predict the intensity of spectral lines *cannot explain hyperfine structure e.g. sodium doublet *cannot explain the splitting of spectral lines in the presence of a magnetic field (Zeeman effect) *only applies to hydrogen (2 marks)	3
Two of the above	2
One of the above	1

31e)i)
ii is the absorption spectrum

31e)ii)

Criteria	marks
Emission spectrum -mention gas discharge tube, slit, prism, screen or (spectroscope) - spectrum appears as coloured lines on a black background. (2 marks) Absorption spectrum -mention white light , cool gas, slit, prism, screen or (spectroscope) - spectrum appears as dark lines on a continuous spectrum. (2 marks)	4
Three of the above points	3
Two of the above points	2
One of the above points	1

31f)i)
orange-red (1 mark)

31f)ii)

Criteria	marks
-titanium dioxide reflects all colours, this will give a pure white -zinc oxide reflects some UV radiation which is good for preventing sunburn	2
One of the above	1

31f)iii)
Zinc oxide the most effective.

31g)

Criteria	marks
-describe how the method works -describe what is measured -how the method identifies pigments -two advantages	4
Three of the above points	3
Two of the above points	2
One of the above points	1