2017 HALF YEARLY EXAMINATION
CHEMISTRY – MAPPING GRID

Exam Section	Question	Marks	Syllabus/Course outcomes	Content	Targeted performance bands	Answer
Part A: Multiple Choice	1	1	H8, H13	9.3.3	2-3	D
	2	1	H9	9.4.4	2-3	A
	3	1	H4	9.4.4	3-4	A
	4	1	H3, H8	9.4.5	3-4	C
	5	1	H9, H13	9.4.4	3-4	C
	6	1	H8, H13	9.3.2	3–4	B
	7	1	H10	9.3.3	3-4	A
	8	1	H3, H13	9.4.5	3-4	C
	9	1	H4	9.4.5	4-5	B
	10	1	H11	9.4.4	4-5	A
	11	1	H8	9.3.4	4-5	C
	12	1	H8, H13	9.3.4	3-4	A
	13	1	H9, H13	9.3.5	3-4	B
	14	1	H6, H13	9.4.4	3-4	C
	15	1	H8	9.3.4	4-5	D
	16	1	H10	9.3.3	4-5	A
	17	1	H10	9.3.2	4-5	D
	18	1	H8, H13	9.3.2	5-6	B
	19	1	H10	9.4.3	5-6	B
	20	1	H10	9.4.5	5-6	A
Section I: Part B: Extended Response	21	3	H11	9.3.1	3-5	
	22	4	H9, H11	9.3.5	3-6	
	23a	1	H4, H8	9.3.4	3-4	
	23b	2	H8, H13	9.3.4	3-4	
	24a	2	H8, H13	9.3.2/4	2-3	
	24b	2	H8, H13	9.3.4	3-5	
	25a	1	H8,H13	9.3.4	2-3	
	25b	1	H8, H11, H13	9.3.4	3-4	
	25c	2	H8, H11	9.3.4	3-4	
	25d	1	H10	9.3.4	3-4	
	26a	2	H10	9.3.4	3-5	
	26b	3	H10	9.3.3	3-6	
	27a	1	H9, H13	9.4.1	2-3	
	27b	2	H4, H9	9.4.1	2-4	
	28	5	H3, H4, H7, H8	9.4.2	2-6	
	29a	2	H11	9.4.5	2-4	
	29b	2	H4, H8	9.4.5	2-4	
	30a	1		9.4.4		
	30b	2		9.4.4		
	31a	2		9.4.3		
	31b	1		9.4.3		
	31c	2		9.4.3		
	31d	3		9.4.3		
	31e	2		9.4.3		

2008 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

CHEMISTRY – MARKING GUIDELINES

The sample answers include features that should be found in a response that receives full marks. For the extended response questions, a set of guidelines is included with a sample answer.

Part A – 20 marks

Questions 1-20 (1 mark each)

Question	Correct Response	Outcomes Assessed	Targeted Performance Bands
1	D	H8, H13	2-3
2	A	H9	2-3
3	A	H4	3-4
4	C	H3, H8	3-4
5	C	H9, H13	3-4
6	B	H8, H13	3–4
7	A	H10	3-4
8	C	H3, H13	3-4
9	B	H4	4-5
10	A	H11	4-5
11	C	H8	4-5
12	A	H8, H13	3-4
13	B	H9, H13	3-4
14	C	H6, H13	3-4
15	D	H8	4-5
16	A	H10	4-5
17	D	H10	4-5
18	B	H8, H13	5-6
19	B	H10	5-6
20	A	H10	5-6

Question 21 (3 marks)

Outcomes Assessed: H11
Targeted Performance Bands: 3-5

Criteria	Marks
• Explains a valid procedure, using either bromothymol blue or litmus and then methyl orange, referring to end point values and correct colours of the indicators	3
• Outlines a valid procedure, using either bromothymol blue or litmus and then methyl orange	2
• Identifies that bromothymol blue or litmus can be used to prove the unknown solution is acidic OR • Identifies that methyl orange distinguishes between a strong and weak acid	1

Sample answer

To prove that a solution is acidic, either litmus solution or bromothymol blue can be used. Litmus has an end point of 5.0-8.0. A litmus solution turns red/pink if an acid is present. It would be blue if basic. Bromothymol blue has an end point of 6.0-7.6. A bromothymol blue solution is yellow in acidic solution. It would be blue if basic

Once it is identified that the unknown solution is acidic, then methyl orange must be used to prove that the solution is NOT strongly acidic. Methyl orange has an end point of 3.1-4.4. Methyl orange is red in strongly acidic solutions. In weakly acidic solutions, methyl orange is yellow.

Hence the unknown solution is weakly acidic if litmus (or bromothymol blue) produces a red/pink (or yellow) colour and the addition of methyl orange produces a yellow colour.

Question 22(4 marks)

Outcomes Assessed: H9, H11
Targeted Performance Bands: 3-6

Criteria	Marks
Makes a clear judgement statement of the importance of refluxing in esterification Outlines the meaning of refluxing/how it works, describing the condenser Explains the reasons for using this technique including the need to heat to maximise yield and increase rate and the volatility of the reactants	4
Outlines the meaning of refluxing, explains the reasons for using this technique and no/vague judgement statement OR Makes a clear judgement statement and describes refluxing and explains reasons for refluxing in terms of need to heat or volatility	3
Outlines the meaning of refluxing and outlines the reasons for using this technique OR Makes a clear judgement statement and explains reasons for refluxing in terms of need to heat or volatility	2
Explains the meaning of refluxing OR explains ONE reason for using this technique	1

Sample answer

Refluxing is of vital importance for the preparation of esters.

Refluxing is a technique involving attaching a water-cooled reflux condenser onto the top of a distillation flask (or similar). As gases form in the flask during heating, they rise and condense in the condenser and fall back into the flask for re-heating.

Esterification is an equilibrium reaction. It is slow and endothermic. The reaction occurs more successfully (faster and with a higher yield of ester) at higher temperatures and in the gaseous phase. Heating drives the forward reaction and ensures more frequent and effective collisions between reactants. The technique of refluxing allows the required heating.

The technique allows heating over an extended period, without the loss of volatile reactants or products. Without refluxing, reactants would be lost before they have had a chance to react together. The ester product is also volatile and so would not be retained if the heating occurred in an open flask.

The reaction uses and produces flammable and irritating organic compounds. It is safer, both for health and as a precaution against fire, to prevent the escape of the organic compounds. Condensing them back to the liquid state prevents their escape.

Without the use of reflux, esters could not be prepared in a school laboratory in adequate quantities, or without risk of fire or escape of volatile, irritating fumes. Alternate methods, involving open test tubes or flasks, would allow the immediate escape of the ester into the room, posing health and fire safety concerns, and without retaining the desired product.

Question 23 (4 marks)

(a) (1 mark)

Outcomes Assessed: H4, H8
Targeted Performance Bands: 3-4

Criteria	Marks
• States what buffers do and outlines why they are important in natural systems	1

Sample answer

Buffers in natural systems protect the solutions against change in pH. This is important as many natural systems only function effectively within a narrow pH range.

(b) (3 marks)

Outcomes Assessed: H8, H13
Targeted Performance Bands: 3-4

Criteria	Marks
• Writes a correct equilibrium equation for the hydrogen carbonate ion/carbonate ion equilibrium (or the carbonic acid/hydrogen carbonate ion equilibrium) AND uses Le Chatelier's Principle to explain in detail how the buffer system works upon addition of a strong base (identifying the stress is a decrease in $[H_3O]^+$)	3
• Writes a correct equilibrium equation for the hydrogen carbonate ion/carbonate ion equilibrium (or the carbonic acid/hydrogen carbonate ion equilibrium) AND uses Le Chatelier's Principle to partially explain how the buffer system works upon addition of a strong base OR • Writes a partially correct equilibrium equation for the hydrogen carbonate ion/carbonate ion equilibrium (or the carbonic acid/hydrogen carbonate ion equilibrium) AND uses Le Chatelier's Principle to explain in detail how the buffer system works upon addition of a strong base OR • Writes a correct equilibrium equation for the hydrogen carbonate ion/carbonate ion equilibrium (or the carbonic acid/hydrogen carbonate ion equilibrium) AND uses Le Chatelier's Principle to explain how the buffer system works upon addition of a strong acid	2
• Writes a correct equilibrium equation for the carbonic acid/hydrogen carbonate ion equilibrium or the hydrogen carbonate ion/carbonate ion equilibrium OR • Describes how the buffer system works OR • Explains how the buffer system works if a strong acid is added • Uses Le Chatelier's Principle correctly for wrong equation	1

Sample answer

The equilibrium which buffers the solution (and hence prevents significant changes in the pH of the solution) is represented by the equation:

$HCO_3^-\ (aq) + H_2O\ (l) \rightleftharpoons CO_3^{2-}\ (aq) + H_3O^+\ (aq)$ OR

$H_2CO_3\ (aq) + H_2O\ (l) \rightleftharpoons HCO_3^-\ (aq) + H_3O^+\ (aq)$

The solution acts as a buffer because the equilibrium can shift, either to the left or right, if strong acid (H_3O^+) or strong base (OH^-) is added to the system. If strong base is added, the hydroxide ions react with the hydronium ions to form water. This means that $[H_3O^+]$ decreases. According to Le Chatelier's Principle this change is opposed and the equilibrium shifts to the right to make more hydronium ions, keeping the pH almost constant.

Question 24 (4 marks)

24 (a) (2 marks)

Outcomes Assessed: H8, H13
Targeted Performance Bands: 2-3

Criteria	Marks
• TWO correct species identified (either by name or formula)	2
• ONE correct species identified (either by name or formula)	1

Sample answer

Some amphiprotic species (can donate or accept a proton)

- water H_2O
- hydrogen carbonate ion, HCO_3^-
- hydrogen sulfate ion HSO_4^-
- hydrogen phosphate ion $H_2PO_4^-$

Some amphoteric species (can act as an acid or base)

- All amphiprotic substances
- aluminium oxide, Al_2O_3

24 (b) (2 marks)

Outcomes Assessed: H8, H13
Targeted Performance Bands: 3-5

Criteria	Marks
• Correct explanation, with correct equations	2
• Correct explanation OR • Two correct equations	1

Sample answer

An amphiprotic species is one which can act both as a proton donor and a proton acceptor. Hence the amphiprotic species can accept a proton from a stronger acid and donate a proton to a stronger base.

With hydronium ions (a stronger acid):

HCO_3^- *(aq)* + H_3O^+ *(aq)* $\rightleftharpoons$ H_2CO_3 *(aq)* + H_2O *(l)*

With hydroxide ions (a stronger base):

HCO_3^- *(aq)* + OH^- *(aq)* $\rightleftharpoons$ CO_3^{2-} *(aq)* + H_2O *(l)*

Question 25 (5 marks)

25 (a) (1 mark)

Outcomes Assessed: H8, H13
Targeted Performance Bands: 2-3

Criteria	Marks
• Correct answer	1

Sample answer

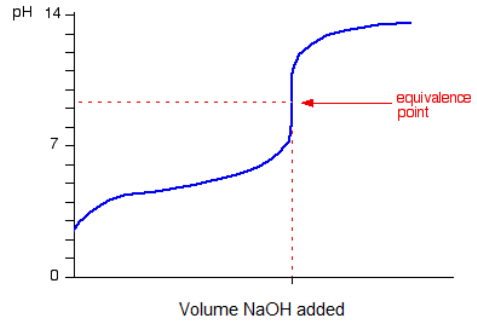
$CH_3COOH\ (aq)\ +\ NaOH\ (aq)\ \rightarrow\ CH_3COO\,Na\ (aq)\ +\ H_2O\ (l)$

25 (b) (1 mark)

Outcomes Assessed: H8, H11, H13
Targeted Performance Bands: 3-4

Criteria	Marks
• Correct curve, showing low to high pH and equivalence point above pH 7	1

Sample answer



25 (c) (2 marks)

Outcomes Assessed: H8, H11
Targeted Performance Bands: 3-4

Criteria	Marks
• Suitable indicator identified, with explanation using the terms end point and equivalence point correctly	2
• Suitable indicator identified	1

Sample answer

Phenolphthalein is suitable, as it changes colour (its end point) from colourless to pink from pH 8.3 to pH 10, which is the pH at the equivalence point of a weak acid-strong base titration.

25 (d) (1 mark)

Outcomes Assessed: H10
Targeted Performance Bands: 3-4

Criteria	Marks
• Correct answer	1

Sample answer

C(NaOH) = 0.142 mol/L
M(NaOH) = 22.99 + 16.00 + 1.008
= 39.998 g/mol

n = m/M
m = nM
= 5.68 g/L

= 0.568 g/100 mL
= 0.568 g/100 g water
= 0.568 % (w/w)

(You need to use same units of mass in a %(w/w) problem

Question 26 (5 marks)

26 (a) (2 mark)

Outcomes Assessed: H10
Targeted Performance Bands: 3-5

Criteria	Mark
• Identifies the type of solution and gives detailed explanation for choice *(working may be shown in Part b)*	2
• Identifies the type of solution with partially correct explanation (no mark for identifying type of solution with incorrect reasoning)	1

Sample answer

$H_2SO_{4\,(aq)} + 2KOH_{\,(aq)} \rightarrow K_2SO_{4\,(aq)} + 2H_2O_{\,(l)}$
$C = \frac{n}{V}$ n = CV
$n(H_2SO_4)$ = 0.150 x 0.1000
= 0.0150 mol
n(KOH) = 0.200 x 0.1000
= 0.020

React in ratio H_2SO_4 : KOH
1 : 2
If H_2SO_4 limiting 0.0150 : 0.0300 *do not have enough KOH for this*
If KOH limiting 0.0100 : 0.0200 *this works, so H_2SO_4 in excess by 0.0150-0.0100 = 0.00500 mol*

As the salt produced in a neutral salt, the resulting solution would be acidic

26 (b) (3 marks)

Outcomes Assessed: H10
Targeted Performance Bands: 3-6

Criteria	Marks
(some of this working may be shown in Part a) • Correctly calculates the moles of both reactants • Correctly determines the moles of acid in excess • Correctly determines the moles of hydronium ions (diprotic acid) • Correctly identifies the volume of the resulting solution • Correctly calculates the concentration of the hydronium ions • Correctly calculates the pH • Gives answer to 3sf	3
• Most of the above	2
• Calculates incorrect pH value with correct equation/working to 3sf OR • Calculates concentration using correct volume of solution	1

Sample answer

$H_2SO_{4\,(aq)} + 2KOH_{\,(aq)} \rightarrow K_2SO_{4\,(aq)} + 2H_2O_{\,(l)}$

$C = \frac{n}{V}$ n = CV

$n(H_2SO_4)$ = 0.150 x 0.1000
= 0.0150 mol

n(KOH) = 0.200 x 0.1000
= 0.020

React in ratio H_2SO_4 : KOH
1 : 2

If H_2SO_4 limiting 0.0150 : 0.0300 *do not have enough KOH for this*

If KOH limiting 0.0100 : 0.0200 *this works, so H_2SO_4 in excess by 0.0150-0.0100 = 0.00500 mol*

Sulfuric acid is diprotic so ratio of sulfuric acid: hydronium ions is 1:2

$H_2SO_{4\,(aq)} + 2H_2O_{\,(l)} \rightarrow SO_4^{\,2-}{}_{(aq)} + 2H_3O^+_{\,(aq)}$

0.00500 0.0100

Volume of resulting solution = 200.0 mL = 0.2000 L

C (H_3O^+)

$C = \frac{n}{V}$

$C = \frac{0.0100}{0.2000}$

= 0.0500 M

pH = -log [H_3O^+]

= - log 0.0500

= 1.301 (3sf) *(in pH, digits before the decimal place are not significant)*

Question 27 (3 marks)

27 (a) (1 mark)

Outcomes Assessed: H9, H13
Targeted Performance Bands: 2-3

Criteria	Marks
• Correctly balanced equation with correct states (water as gas or liquid)	1

Sample answer

$C_8H_{18}\,(l) + \frac{25}{2}O_2\,(g) \rightarrow 8CO_2\,(g) + 9H_2O\,(g)$

27 (b) (2 marks)

Outcomes Assessed: H4, H9
Targeted Performance Bands: 2-4

Criteria	Marks
• Makes a clear judgement statement • Supports this statement referring to either pollution control/health affects or energy efficiency	2
• Explains the problems associated with incomplete combustion in terms of EITHER production of pollutants OR inefficient use of a fuel	1

Sample answer

There is a great need to monitor and manage combustion reactions.

Combustion products can vary depending on whether complete or incomplete combustion occurs, so it is vital on the basis of both pollution control and energy efficiency, to ensure that complete rather than incomplete combustion occurs.

The management of combustion reactions involves ensuring that excess oxygen is available so that carbon dioxide, rather than carbon monoxide or carbon, is formed and that the maximum amount of energy is released from a given amount of fuel.

Incomplete combustion produces carbon monoxide (toxic) and carbon (visual pollutant and respiratory problems). Less energy is released per mole or gram of the fuel, so the efficiency of the combustion process is reduced, with negative financial effects.

Question 28 (5 marks)

Outcomes Assessed: H3, H4, H7, H8
Targeted Performance Bands: 2-6

Criteria	Marks
• Supports the need for monitoring and management of the Haber process in terms of yield (referring to LCP and pressure/temperature with correct equation), rate (including the role of the catalyst), energy efficiency and safety issues, economic viability, stoichiometry and identifies the compromise conditions	5
• Supports the need for monitoring and management of the Haber process in terms of most of the following: yield (referring to LCP and pressure/temperature with correct equation), rate (including the role of the catalyst), energy efficiency and safety issues, economic viability, stoichiometry and identifies the compromise conditions	4
• Describes most of the conditions that require monitoring and management including equation or referring to LCP	3
• Describes most of the conditions that require monitoring and management without equation OR • Describes some of the conditions that require monitoring with equation	2
• Describes some condition needing monitoring and management	1

Sample answer:

Scientists need to monitor and manage the Haber Process to maximise yield, increase rate, use energy/resources efficiently and ensure safety.

The Haber Process is an exothermic, reversible reaction

$N_2\ (g) + 3H_2\ (g) \rightleftharpoons 2NH_3\ (g) \quad \Delta H$ = -ve

According to Le Chatelier's Principle, the maximum yield of ammonia would be achieved at the highest pressure and at the lowest temperature, as these conditions drive the equilibrium towards the right.

The maximum rate is achieved at the highest pressure and highest temperature, as the gas molecules are closest and have greatest kinetic energy at these conditions and thus have greatest chance of successful collisions.

High pressure therefore favours both high yield and high rate of production, but the higher costs of maintaining high pressure and the safety risks associated with operating an industrial process at very extreme pressure mean that a compromise lower pressure (of 250 atmospheres rather than 1000 atmospheres) is used.

High temperature favours high rate but low temperature favours high yield. A compromise temperature of 400°C is used (moderate by industrial standards). Scientists achieve the greatest energy efficiency by the use of a catalyst of iron on the surface of iron oxide (magnetite). The catalyst allows the reversible reactions to reach equilibrium faster, by lowering the activation energy for the reaction, at the compromise moderate temperature.

Scientists must not only monitor the temperature and pressure conditions but they must also ensure that the catalyst operates efficiently, that the input gases are free of oxygen and are in the optimum mole ratio and that the product ammonia is removed as it forms.

Question 29 (4 marks)

29 (a) (2 marks)

Outcomes Assessed: H11
Targeted Performance Bands: 2-4

Criteria	Marks
• Outline how the test for BOD is carried out	2
• Some correct information about testing for BOD	1

Sample answer

BOD (biochemical oxygen demand) is a measure (in ppm) of the amount of dissolved oxygen removed from a water sample (usually over a 5-day period) by the oxidation of organic materials in that sample.

1. A sample of water is collected and the DO (dissolved oxygen) measured in ppm, using an electronic probe.
2. The water sample is sealed and placed in the dark for 5 days.
3. After 5 days, the DO is again measured in ppm and the difference between the readings is used as the measure of BOD of the sample.

29 (b) (2 marks)

Outcomes Assessed: H4, H8
Targeted Performance Bands: 2-4

Criteria	Marks
• Explanation of the causes of high turbidity AND high BOD (separate explanations with different reasons)	2
• Explanation of the causes of high turbidity OR high BOD	1

Sample answer

The clearing of a forest or mixed farming could both account for high turbidity. The disturbance to the soil associated with the clearing or ploughing could mean that there would be greater silt and

mud in the run-off from these areas which would result in increased cloudiness of a sample of water (i.e. higher turbidity).

The run-off from a mixed farm could take raw or partially decomposed sewage into the river system. The greater the amount of organic material, the greater the amount of oxygen that is needed (by aerobic bacteria) to break down the sewage. High BOD readings indicate a large reduction in the DO levels of the water, due to the removal of the oxygen required to bring about the breakdown of the organic material.

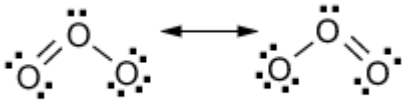
Question 30 (3 marks)

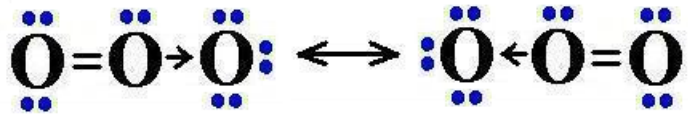
Question 30a) 1 mark

Outcomes Assessed:
Targeted Performance Bands: 2-4

Criteria	Marks
• Correct Lewis structure showing both bonding and non-bonding electron pairs	1

Sample answer





Question 30b) 2 marks

Outcomes Assessed: H4, H8
Targeted Performance Bands: 2-4

Criteria	Marks
• Gives detailed explanation of reactivity referring to the strength of the covalent bonds in both oxygen and ozone	2
• Outlines how reactivity is related to bond strength	1

In diatomic oxygen (O_2) the oxygen atoms are held together by a double bond (a bond strength of 2). In ozone (O_3), the bond strength is 1.5, as it is a resonance structure (there is not one double bond and one single bond but rather, both exist in both places at the same time)

Question 31 (10 marks) need to write scheme and sample answers

31a) (2 marks)

Outcomes Assessed:
Targeted Performance Bands:

Criteria	Marks
• States that ppm is a measure of concentration or refers to ratio and identifies it as equivalent to mg per litre	2
• Identifies mg/L as ppm	1

Sample answer

Parts per million is a unit of concentration used for very dilute solutions. It is a weight to weight ratio of the number of mass units per million units of total mass

The ppm is equal to the mg of the substance of interest in 1 litre or 1 kg of the total volume/mass

31b) (1 mark)

Outcomes Assessed:
Targeted Performance Bands:

Criteria	Marks
• Correctly uses graph to determine all three concentrations within acceptable range (if to 1sf, shows working on graph)	1

Sample answer

Sample 1: 4.3-4.6 ppm
Sample 2: 5.6-5.9 ppm
Sample 3: 7.5-7.8 ppm

31c) (1 mark)

Outcomes Assessed:
Targeted Performance Bands:

Criteria	Marks
• Correctly calculates all three masses (in grams) showing working	2
• Correctly calculates all three masses in grams without working OR	1

Sample answer

Sample 1: 4.5mg/1L = 0.45mg/100mL = 0.00045g
Sample 2: 5.8mg/1L = 0.58mg/100mL = 0.00058g
Sample 3: 7.7mg/1L = 0.77mg/100mL = 0.00077g

31d) (3 marks)

Outcomes Assessed:
Targeted Performance Bands:

Criteria	Marks
• Correctly calculates the % of magnesium for all three samples showing working	3
• Calculates the % of magnesium per mass of sample with working with same minor error throughout OR • Correctly calculates the % of magnesium for all three samples without working	2
• Correctly calculates some % magnesium values	1

Sample answer

Sample 1: $\frac{0.00045}{0.39}$ x 100 = 0.12%

Sample 2: $\frac{0.00058}{0.53}$ x 100 = 0.11%

Sample 3: $\frac{0.00077}{0.71}$ x 100 = 0.11%

31e) (2 marks)

Outcomes Assessed:
Targeted Performance Bands:

Criteria	Marks
• Correctly calculates the mass (in grams) of Mg in 1t from average value	2
• Some correct working	1

Sample answer:

Average % Mg in sample = ($\frac{0.00045}{0.39} + \frac{0.00058}{0.53} + \frac{0.00077}{0.71}$) x 100

= 0.11%

Mass in grams per tonne = $\frac{0.11}{100}$ x 1000000

= 1100g

CRANBROOK SCHOOL

Student Number:

2017

HSC Half Yearly Examination

Assessment Task 2

Chemistry

Reading time	5 minutes
Writing time	2 hours
Total Marks	70
Task weighting	20%

General Instructions

- Write using blue or black pen
- Diagrams drawn using pencil
- A Board-approved calculator may be used
- All relevant working should be shown for each question

Additional Materials Needed

- Multiple Choice Answer Sheet
- Periodic Table & Data Sheet

Structure & Suggested Time Spent

- **Part A** (Multiple Choice) 20 Marks
  Attempt all questions (1-20)
  Allow about 35 minutes
- **Part B** (Extended Response) 50 Marks
  Attempt all questions (21-31)
  Allow about 1 hour 25 minutes

This paper must not be removed from the examination room

Disclaimer
The content and format of this paper does not necessarily reflect the content and format of the HSC examination paper.

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Part A – Multiple Choice Questions (20 marks)

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

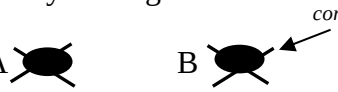
Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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 have changed 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:



1. The triprotic, naturally occurring acid is:

(A) sulfuric acid
(B) acetic acid
(C) hydrochloric acid
(D) citric acid

2. The ozone layer is located in the

(A) stratosphere
(B) ionosphere
(C) mesosphere
(D) troposphere

3. Molecules known as CFCs

(A) are very stable, generally unreactive compounds.
(B) are highly active and dangerous chemicals in the troposphere.
(C) dissolve readily in water so cause pollution of rivers and dams.
(D) only react with active metals such as the Group 1 and 2 elements.

4. The chemical added to water supplies to ensure that the water is alkaline so that precipitation can occur is

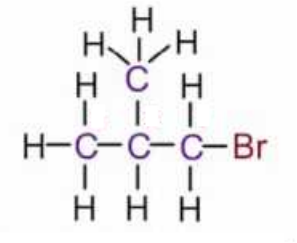
(A) chlorine

(B) sodium fluoride

(C) lime

(D) iron (III) chloride

5. What is the correct IUPAC name for the compound shown below?



(A) 2-methyl-3-bromopropane

(B) 2-methyl-1-bromopropane

(C) 1-bromo-2-methylpropane

(D) 3-bromo-2-methylpropane

6. An indication that an oxide is classed as acidic is when it

(A) reacts with water to form a base or with a salt to form an acid.

(B) reacts with water to form an acid or with a base to form a salt.

(C) reacts with a base to form an acid.

(D) turns red litmus to a blue colour.

7. A solution of HCl is changed from a pH of 1 to a pH of 3. This means that the concentration of the H_3O^+ ions has

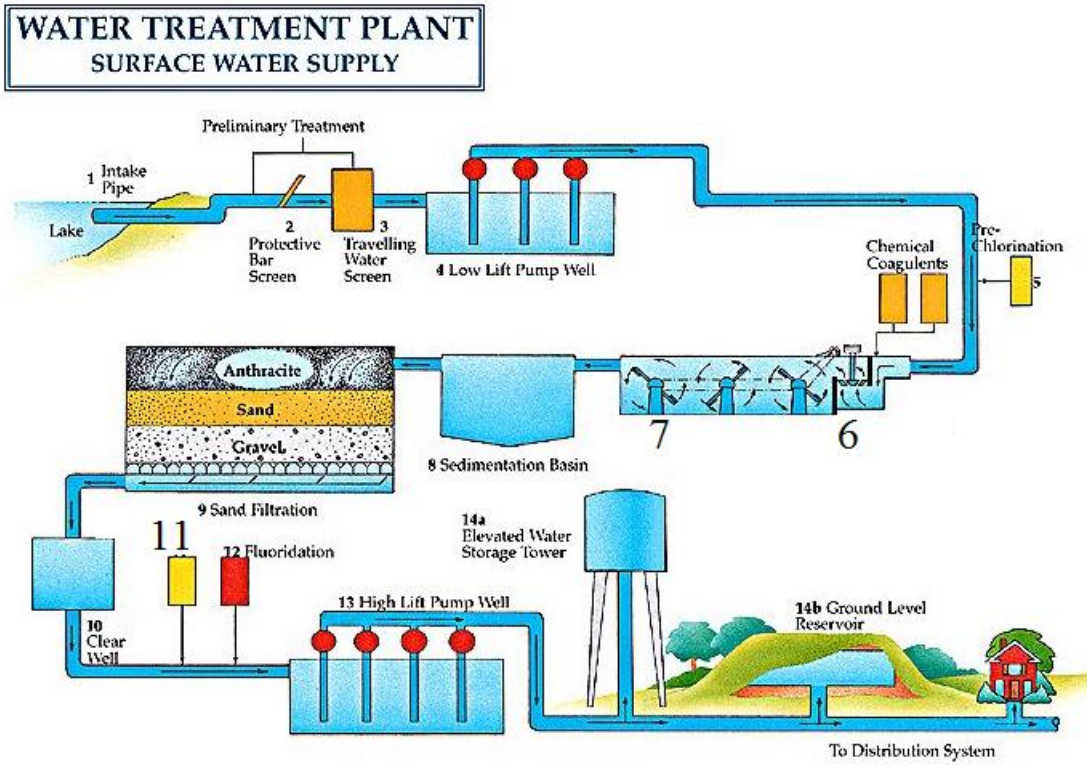
(A) decreased by a factor of 100.

(B) decreased by a factor of 2.

(C) increased by a factor of 100.

(D) increased by 2.

8. The diagram below shows how water is treated for drinking in a large city. The labels for steps 6, 7 and 11 are missing.



What are the missing labels, in order, of step 6, 7 and 11?

(A) flocculation, coagulation, lime treatment

(B) lime treatment, chlorination, membrane filtering

(C) coagulation, flocculation, chlorination

(D) coagulation, flocculation, lime treatment

9. A chemist measured the concentration of calcium ions in a small lake and found it to be 145 ppm. Two weeks later, he returned to the lake and found the concentration of ions to be 345 ppm. Which of the following is the best explanation for this?

(A) Heavy rain has concentrated the ions that were first measured in the lake

(B) Runoff from rainfall in the surrounding forest has added calcium ions into the lake

(C) Eutrophication is occurring due to fertiliser runoff from a nearby farm

(D) Household use of soap is making the water hard

10. Identify the correct statement comparing a chlorine free radical and a chlorine atom.

(A) There is no difference in the electron arrangement of the free radical and the atom.

(B) The free radical has fewer electrons than the atom.

(C) The free radical has more electrons than the atom.

(D) The free radical has unpaired electrons, whereas the atom does not.

11. In a titration of a weak acid with a strong base

(A) equal volumes of the acid and base have reacted at the equivalence point.

(B) equal numbers of moles of the acid and base have reacted at the equivalence point.

(C) equal numbers of moles of hydrogen ions and hydroxide ions have reacted at the equivalence point.

(D) the equivalence point is reached at a pH less than 7.

12. The conjugate base of the hydronium ion is:

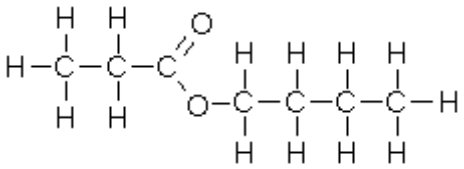
(A) water

(B) the hydroxide ion

(C) the oxide ion

(D) oxygen gas

13. Identify the following compound.



(A) Heptanoic acid

(B) 1-butyl propanoate

(C) 1-propyl butanoate

(D) 1-propyl pentanoate

14. Co-ordinate covalent bonding occurs in

(A) ammonia, NH_3

(B) ethylene, C_2H_4

(C) the hydronium ion, H_3O^+

(D) methane, CH_4

15. Some salts, when dissolved in water, produce acidic or alkaline solutions, while others produce neutral solutions. Which is the CORRECT statement?

(A) When sodium chloride is added to water, the pH increases slightly.

(B) When sodium ethanoate is added to water, the concentration of hydrogen ions increases.

(C) When sodium carbonate is added to water, the pH decreases.

(D) When ammonium nitrate is added to water, the concentration of the hydroxide ions decreases.

16. The pH of a 0.050 mol/L solution of sulfuric acid is closest to:

(A) 1.0

(B) 1.3

(C) 2.0

(D) $10^{-1.3}$

17. When 1 mole of zinc is reacted with 250 mL of 1.0 mol L^{-1} hydrochloric acid, the volume of the hydrogen gas formed, at 25°C and 100 kPa, is closest to

(A) 24.8 L

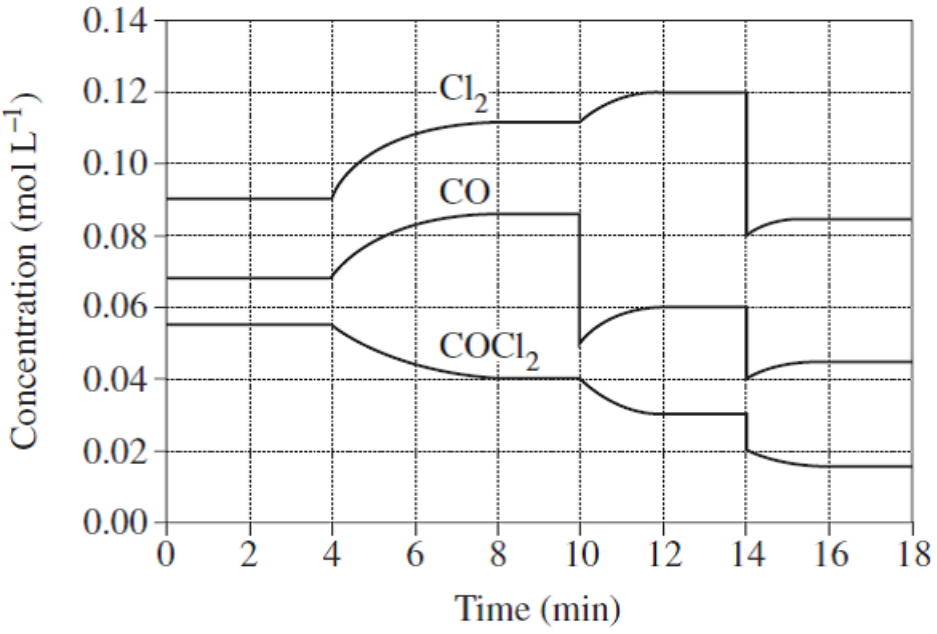
(B) 12.4 L

(C) 6.2 L

(D) 3.1 L

18. The graph below shows the concentrations of the species involved in the following reversible reaction occurring in a closed system over 18 minutes

$$COCl_{2\,(g)} \rightleftharpoons Cl_{2\,(g)} + CO_{(g)} \quad \Delta H = +108\ kJ.mol^{-1}$$



What stress was applied at time t = 4 minutes?

(A) The pressure was reduced

(B) Heat was added

(C) Some CO was removed

(D) The reaction vessel was cooled

19. A 1.23 g sample of lawn fertiliser was analysed for its sulfate content. After filtration and drying, 1.09 g of barium sulfate was recovered.

What is the percentage of sulfate in the lawn fertiliser?

(A) 16.8

(B) 36.5

(C) 46.2

(D) 89.0

20. The amount of dissolved oxygen in a sample can be determined by the Winkler method. Manganese ion is added to the sample, which is made alkaline by the addition of hydroxide ions, and a precipitate of $MnO(OH)_2$ forms.

$$2Mn^{2+}\,(aq) + O_2\,(g) + 4OH^-\,(aq) \rightarrow 2MnO(OH)_2\,(s)$$

The precipitate is then dissolved in acid and reacted with potassium iodide solution. Iodine and manganese ions are formed.

$$MnO(OH)_2\,(s) + 2I^-\,(aq) + 4H^+\,(aq) \rightarrow I_2\,(aq) + Mn^{2+}\,(aq) + 3H_2O\,(l)$$

The third step involves titration with thiosulfate solution to determine the amount of iodine present.

$$I_2\,(aq) + 2S_2O_3^{2-}\,(aq) \rightarrow 2I^-\,(aq) + S_4O_6^{2-}\,(aq)$$

When a sample of water was analysed, a total of 0.80 mol of thiosulfate was used in the reaction.

How many moles of oxygen were present in the original sample?

(A) 0.20

(B) 0.40

(C) 0.80

(D) 1.60

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2017 HIGHER SCHOOL CERTIFICATE
HALF YEARLY EXAMINATION
CHEMISTRY

Student Number

Part B – 50 marks
Attempt Questions 21-31

Allow about 1 hour and 25 minutes for this part

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 21 (3 marks)

Marks

A student was asked to confirm that an unknown solution was a ***weak acid***, using ONLY TWO of the four indicators, phenolphthalein, methyl orange, litmus and bromothymol blue. Explain a procedure that the student could use to do this. **3**

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Question 22 (4 marks)

Marks

Esterification is performed in the laboratory by the method known as “refluxing”.
Assess the importance of this technique for the preparation of esters. **4**

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Question 23 (4 marks)

Marks

Many natural systems contain buffer solutions.
Sodium hydrogen carbonate and carbonate ions can be used to make a buffer solution.

(a) Outline why buffers are important in natural systems. **1**

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(b) Write an equilibrium equation to represent the hydrogen carbonate ion/carbonate ion buffer system and use this equation and Le Chatelier's Principle to explain how the buffer system works if a strong base is added. **3**

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Question 24 (4 marks)

Marks

The terms amphiprotic and amphoteric are both used in relation to the acid/base properties of substances.

(a) Identify:

(i) an amphiprotic species …… **1**

(ii) an amphoteric species …… **1**

(b) Explain why the substance you identified as amphiprotic is classified in this way. Write equations for any reactions you describe. **2**

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Question 25 (5 marks)

Marks

A titration was performed in order to determine the concentration of a solution of ethanoic acid. Sodium hydroxide solution was used to neutralise 25.0 mL of the ethanoic acid solution. Excess sodium hydroxide was added so that a curve could be drawn, to show the pH changes before and after the end point.

(a) Write a balanced equation for the neutralisation reaction. **1**

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(b) Sketch a curve to show the changes in pH before and after the end point. **1**

(c) State the name of a suitable indicator for use in this titration and justify your choice. **2**

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(d) The sodium hydroxide solution used had a concentration of 0.142 mol/L. Express this concentration as a percentage by mass (% (w/w)). **1**

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Question 26 (5 marks)

Marks

100.0 mL of a solution of 0.150 mol/L sulfuric acid was added to a solution containing 100.0 mL of 0.200 mol/L potassium hydroxide.

(a) Explain if the resulting solution would be acidic, alkaline or neutral **2**

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(b) Calculate the pH of the resulting solution (assuming that the sulfuric acid is completely ionised). **3**

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Question 27 (3 marks)

Marks

Combustion reactions are important in industry and for society. Scientists must monitor and manage combustion reactions.

(a) Write an equation for the complete combustion of octane, C_8H_{18}. **1**

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(b) Evaluate the need for the monitoring and management of combustion reactions. **2**

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Question 28 (5 marks)

Marks

"Scientists must monitor and manage the industrial production of ammonia by the Haber process"

Justify the need for scientists to monitor and manage the Haber process **5**

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Question 29 (4 marks)

Marks

TWO common tests of water quality involve measurement of turbidity and of BOD (biochemical oxygen demand).

(a) Outline how the test for BOD is carried out. **2**

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(b) A water sample was taken from a river which collected run-off from an area which had been recently cleared of forest and run-off from a mixed farm (farming both crops and animals). The water had a high level of turbidity and a high BOD reading. Explain how the activities along the river could account for these high readings. **2**

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Question 30 (3 marks)

Marks

(a) Draw the Lewis structure of ozone. **1**

(b) Explain why ozone is more reactive than oxygen **2**

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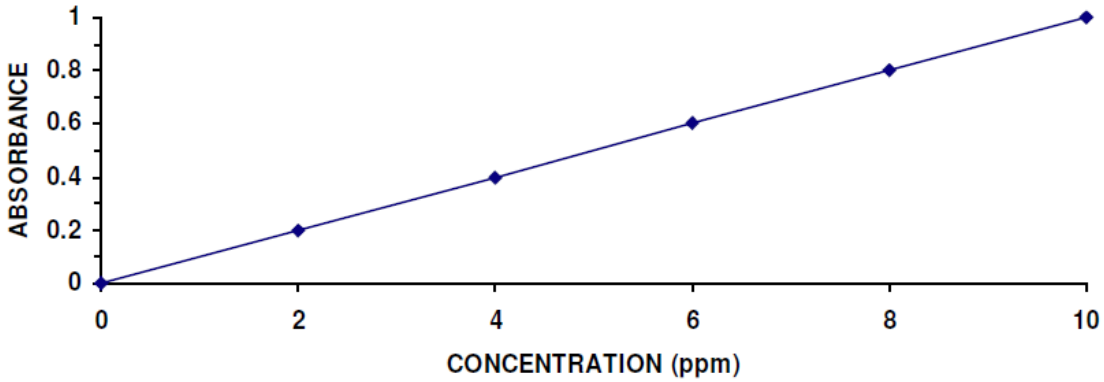
Question 31 (10 marks)

Marks

Magnesium is present in chlorophyll, the green pigment in plants, which is involved in photosynthesis. When sugar is extracted from sugar cane, the crushing adds very small amounts of magnesium. How much is present is determined by AAS. Standard solutions containing magnesium are prepared, their concentrations covering the expected range of concentrations in the samples to be tested.

The standard solutions were used to draw the calibration curve below.



Three samples were extracted and tested using the AAS machine:

Sample 1: Contains 0.39g sugar in 100mL water, gave an absorbance reading of 0.45 units.
Sample 2: Contains 0.53g sugar in 100mL water, gave an absorbance reading of 0.58 units.
Sample 3: Contains 0.71g sugar in 100 mL water, gave an absorbance reading of 0.77 units.

a) Outline what is meant by the unit 'parts per million' **2**

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b) Determine the concentration of magnesium in each sample, using the calibration curve. **1**

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c) Calculate the amount, in grams, of magnesium present in each sample. **2**

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d) Calculate the % of magnesium in each sample. **3**

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e) Calculate the average % of magnesium in each sample and use that value to calculate the mass in grams of magnesium per tonne (1000 kg) of sugar. **2**

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