CRANBROOK SCHOOL

1	2	5

Centre Number

Student Number

2019

HALF YEARLY TEST

Chemistry

General Instructions

- Assessment Task 2 – Weighting 20%
- Reading time – 5 minutes
- Working time – 1.5 hours
- Write using black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- A separate multiple choice answer sheet is provided for Part A
- A separate formula and data sheet and a Periodic Table are provided

Total marks:
50

This examination has two parts, Part A and Part B

Part A – 10 marks

- Attempt Questions 1-10
- Allow about 18 minutes for this part

Part B – 40 marks

- Attempt Questions 11-19
- Allow about 72 minutes for this part

Part A – 10 marks
Attempt Questions 1-10
Allow about 18 minutes for this part

Use the multiple choice answer sheet for Questions 1-10

1. Which of the following statements about alkenes is **not** correct?

   A. They have reactive double bonds.

   B. They can form addition polymers.

   C. They react mainly by substitution.

   D. They can react with water to form alcohols.

2. Which of the following lists contains substances which are in order of increasing boiling points?

   A. ethanol, ethene, ethane

   B. methanol, ethane, propanol

   C. propanol, ethanol, methanol

   D. methane, methanol, methanoic acid

3. Which statement correctly distinguishes between strong and weak acids of equal volume and concentration?

   A. The strong acid has a higher pH than the weak acid

   B. The strong acid requires a larger volume of sodium hydroxide to be neutralised

   C. The pH of the solution formed from neutralistion by sodium hydroxide of the strong acid will be lower than for the weak acid

   D. All of the above

4. The table below shows the pH and colour ranges of some common acid-base indicators.

Indicator	low pH colour	pH range	high pH colour
bromothymol blue	Yellow	6.0-7.6	blue
phenolphthalein	Colourless	8.3-10	pink

A student carries out the following procedure:

1. Add a few drops of phenolphthalein to 50mL of 0.1M NH_3 solution.
2. Add 50mL of 0.1M $HNO_{3\,(aq)}$ to the NH_3 solution.
3. Add a few drops of a bromothymol blue to the mixture formed from steps 1 and 2.

Which of the following is the best prediction of the colour of the mixture at the end of each step of the procedure?

	Step 1	Step 2	Step 3
A.	colourless	pink	yellow
B.	colourless	pink	green
C.	pink	colourless	yellow
D.	pink	colourless	blue

5. What happens when a few drops of bromine water are added to excess hex-1-ene and the mixture is shaken?

I. The colour of the bromine water disappears.

II. The organic product formed does not contain any carbon-carbon double bonds.

III. 2-bromohexane is formed.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

6. What is the solubility of calcium hydroxide?

   A. 1.08×10^{-2}
   B. 1.36×10^{-2}
   C. 1.12×10^{-3}
   D. 2.24×10^{-3}

7. The equilibrium constant for the following reaction at 2130°C is 0.0025.

   $N_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2NO_{\,(g)}$

   If $[N_2] = 0.81$ mol L^{-1}, $[O_2] = 0.75$ mol L^{-1}, and $[NO] = 0.030$ mol L^{-1}, which of the following statements is correct?

   A. The reaction is at equilbrium
   B. The reaction is not at equilbrium and the forward reaction is occurring faster
   C. The reaction is not at equilbrium and the reverse reaction is occuring faster
   D. The reaction is not at equilbrium and the forward and reverse reactions are occurring at the same rate

8. Which of the following are isomers of pentane?

   I. 2-methylpentane
   II. methylbutane
   III. dimethylpropane

   A. I and II only
   B. I and III only
   C. II and III only
   D. I, II and III

9. A buffer is prepared from Lactic Acid (HLac, pKa = 3.85) and Sodium Lactate (Lac-) such that [HLac] = 0.055 mol L^{-1} and [Lac-] = 0.045 mol L^{-1}. What is the pH of this buffer solution?

   A. 3.17

   B. 3.34

   C. 3.76

   D. 3.95

10. 50.00 mL of 0.0500 mol L^{-1} sulfuric acid reacts with 30.00 mL of 0.200 mol L^{-1} lithium hydroxide solution. What is the pH of the solution formed?

   A. 1.903

   B. 12.097

   C. 12.523

   D. 12.641

Part B– 40 marks
Attempt Questions 11-19
Allow about 72 minutes for this part
Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
Extra writing space is provided at the end of this part. If you use this space, clearly indicate which question you are answering.
Show all relevant working in questions involving calculations.

Question 11 (4 marks)

In your course you carried out an investigation where you made an indicator.

a) Describe how you made the indicator. **2**

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b) Explain how indicators work. **2**

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Question 12 (4 marks)

Quantitatively compare the solubility of lead iodide in water and in a 0.250 mol L^{-1} sodium iodide solution.

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Question 13 (4 marks)

Aboriginal and Torres Strait Islander Peoples have applied chemical processes in everyday lives.

a) Outline an example of an application of a chemical process used by Aboriginal and Torres Strait Islander Peoples. **2**

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b) Explain how the process works chemically. **2**

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Question 14 (3 marks)

A mixture of 0.100 M NO, 0.050 M H_2 and 0.100 M H_2O was placed in a container and sealed. There was no N_2 present initially. It was allowed to reach equilibrium. At equilibrium, the concentration of NO was found to be 0.062 M. Calculate the equilibrium constant. The equation is given below:

$$2NO_{(g)} + 2H_{2(g)} \rightleftharpoons N_{2(g)} + 2H_2O_{(g)}$$

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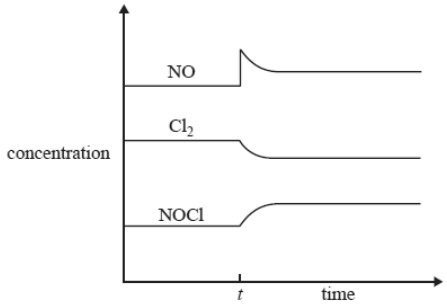
Question 15 (3 marks)

The graph below shows concentration over time for the reversible reaction
$2NO_{(g)} + Cl_{2(g)} \rightleftharpoons 2NOCl_{(g)}$



a) Identify the stress introduced at time 't'. **1**

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b) Explain the response by this chemical system to the stress. **2**

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Question 16 (4 marks)

Analyse the use of sodium hydrogen carbonate to clean up acid and base spills.

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Question 17 (4 marks)

Increasing temperature increases rate of reaction.

a) Explain why both the forward and reverse reactions in a reversible reaction occur at a faster rate if the temperature is increased. **2**

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b) Explain why the position of equilibrium changes at different temperatures. **2**

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Question 18 (7 marks)

A student wanted to determine the heat of combustion of pentan-1-ol using a calorimeter. To do this, they burned 1.55 g of pentan-1-ol to heat 250.0 mL of water from 10.0^{o}C to 38.0^{o}C.

a) Draw the structural formula of pentan-1-ol. **1**

b) Identify the class of alcohol in which pentan-1-ol belongs. **1**

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c) Using the student's data, calculate the heat of combustion of 1-pentanol. **3**

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d) Identify how you would expect the student's value to compare with the literature value (e.g. in the SI Data Book) for pentan-1-ol. Explain your answer. **2**

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Question 19 (7 marks)

Butanoic acid can be prepared in the laboratory from an alcohol.

a) Name the alcohol needed for this reaction. **1**

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b) Write a structural formula equation to show this reaction. **2**

c) Describe the reagents and conditions needed for this reaction to occur. **2**

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d) Assess the need for refluxing in this reaction. **2**

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End of Preliminary Examination

Extra writing space for Part B

2019 Chemistry Half Yearly Test Marking Guidelines

Test Section	Question	Marks	Outcomes	Targeted Performance Bands	Answer
Part A: Multiple Choice	1	1	12-14	2-4	C
	2	1	12-14	3-5	D
	3	1	12-13	3-5	C
	4	1	12-13	3-5	C
	5	1	12-14	3-5	A
	6	1	12-12	3-5	A
	7	1	12-12	4-5	B
	8	1	12-14	4-5	C
	9	1	12-13	5-6	C
	10	1	12-13	5-6	B
Part B	11a	2	12-2/13	2-4	
	11b	2	12-13	3-5	
	12	4	12-4/12	4-6	
	13a	2	12-12/13	2-4	
	13b	2	12-12/13	3-5	
	14	3	12-6/12	3-5	
	15a	1	12-5/12	3-4	
	15b	2	12-12	3-5	
	16	4	12-5/13	3-5	
	17a	2	12-6/12	4-5	
	17b	2	12-6/12	4-5	
	18a	1	12-7/14	2-4	
	18b	1	12-14	2-4	
	18c	3	12-6/14	3-5	
	18d	2	12-14	3-5	
	19a	1	12-14	3-5	
	19b	2	12-7/14	4-6	
	19c	2	12-14	4-6	
	19d	2	12-14	5-6	

Part B –40 marks

Question 11 (4 marks)
11 (a) (2 marks)

Criteria	Marks
Provides all of the main steps involved in making the indicator	2
Provides most of the main steps	1

Sample answer

Blueberries were used to make the indicator as they contain anthocyanins which change colour in acids/bases

- The blueberries were cut and crushed in a mortar and pestle
- The crushed blueberries were placed in a beaker and water added
- The mixture was boiled using a Bunsen burner
- The mixture was cooled
- The mixture was filtered through filter paper into a conical flask
- The blueberry indicator was collected

11 (b) (2 marks)

Criteria	Mark
Relates the change in colour of an indicator by writing an equation and outline what happens in acidic and basic solution according to Le Chatelier's Principle	2
Partially correct explanation	1

Sample answer

Indicators are generally weak acids where the acid and its conjugate base are different colours. For the weak acid indicator HIn:

$$\underset{\text{Colour 1}}{HIn_{(aq)}} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + \underset{\text{Colour 2}}{In^-_{(aq)}}$$

In acids, the indicator equilibrium is subjected to a stress of increased $[H_3O^+]$. According to Le Chatelier's Principle, the stress is opposed and favours the reverse reaction to reduce $[H_3O^+]$ and Colour 1 is seen.
In bases, the OH- ions of the base react with the H_3O^+ ions of the indicator. Therefore the stress is a decrease in $[H_3O^+]$. According to Le Chatelier's Principle, the stress is opposed and favours the forward reaction to increase $[H_3O^+]$ and Colour 2 is seen.

Question 12 (4 marks)

Criteria	Marks
Correctly calculates solubility in both water and sodium iodide solution with full working and **units** and states that the lead iodide is more soluble in water	4
Correctly calculates solubility in both water and sodium iodide solution with working with units OR Mostly correctly calculates solubility in both water and sodium iodide solution with working and states that the lead iodide is more soluble in water	3
Correctly calculates solubility in either water or sodium iodide solution with working and states that the lead iodide is more soluble in water	2
Some correct calculations	1

Sample answer – correct units question

K_{sp} (PbI_2) = 9.8×10^{-9} (from data sheet)

$PbI_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2I^-_{(aq)}$

$K_{sp} = [Pb^{2+}] [I^-]^2$

In water:	In 0.025 mol L^{-1} NaI ([I-] = [NaI] 1:1 ratio)
$[Pb^{2+}] = s$ $[I^-] = 2s$ $K_{sp} = [Pb^{2+}] [I^-]^2$ $9.8 \times 10^{-9} = s \times (2s)^2$ $= s \times 4s^2$ $= 4s^3$ $s^3 = 9.8 \times 10^{-9} / 4$ $= 2.45 \times 10^{-9}$ $s = 1.4 \times 10^{-3}$ mol L^{-1} (2sf)	$[Pb^{2+}] = s$ $[I^-] = 0.025$ mol L^{-1} $K_{sp} = [Pb^{2+}] [I^-]$ $9.8 \times 10^{-9} = s \times (0.250)^2$ $s = 9.8 \times 10^{-9} / (0.250)^2$ $= 1.6 \times 10^{-7}$ mol L^{-1} (2sf)

Question 13 (4 marks)

13 (a) (2 marks)

Criteria	Mark
Gives the main features of a valid example of an application of chemistry used by ATSI Peoples	2
Gives brief information about an application of chemistry	1

Sample answer

Cycads contain a fruit that is eaten by Indigenous Australians. This fruit contains a toxin. The toxin is water soluble. Through the process of leaching in running water the toxin is removed and washed away

13 (b) (2 marks)

Criteria	Marks
Links the process outlined in a) with a chemical principle, including an equation	2
Links the process outlined in a) with a chemical principle	1

Sample answer

A solubility equilibrium is set up between the solid and aqueous forms of the toxin

Cycasin $_{(s)}$ $\rightleftharpoons$ cycasin $_{(aq)}$

When water is added, this reduces the concentration of cycasin $_{(aq)}$. According to Le Chatelier's Principle, this stress is opposed and favours the reaction that increases cycasin $_{(aq)}$ which is the forward reaction. Therefore, more of the solid toxin in the fruit is converted to soluble toxin which can then be washed away.

Question 14 (3 marks)

Criteria	Marks
Correctly uses ICE table and K expression to calculate answer to 2sf	3
Correctly uses ICE table and K expression to calculate answer with incorrect sf OR Correctly uses ICE table and K expression without including steam to calculate answer to 2sf	2
Correctly uses ICE table and K expression without using steam to calculate answer with incorrect sf	1

Sample answer – Significant figures question

Equation	$2NO_{(g)}$ + $2H_{2(g)}$ ⇌ $N_{2(g)}$ + $2H_2O_{(g)}$			
Initial Concentration ($mol.L^{-1}$)	0.100	0.050	0	0.100
Change in Concentration ($mol.L^{-1}$)	-0.038	-0.038	+0.019	+0.038
Equilibrium Concentration ($mol.L^{-1}$)	0.062	0.012	0.019	0.138

$$K = \frac{[N_2][H_2O]^2}{[NO_2]^2[H_2]^2}$$

$= (0.019) \times (0.138)^2 / (0.062)^2 \times (0.012)^2$

$= 653.68$

$= 6.5 \times 10^2$ mol^{-1} L or 650 mol^{-1} (2sf)

Question 15 (3 marks)

15 (a) (1 mark)

Criteria	Mark
Correctly identifies what occurred at time = t	1

Sample answer

$NO_{(g)}$ was added

15 (b) (2 marks)

Criteria	Marks
The response shown on the graph, including the extent of the changes is linked with Le Chatelier's Principle	2
The response shown on the graph, without referring to the extent of the changes is linked with Le Chatelier's Principle	1

Sample answer

Adding NO to the container causes the stress of an increase in [NO]. This is the vertical rise on the graph. According to Le Chatelier's Principle, the stress is opposed and favours the reaction that reduces [NO], which is the forward reaction.

Therefore, as seen on the graph, the two reactant concentrations decrease and the product concentration increases. The amount of change in concentration is different as it is in proportion to the mole ratio of the equation (2:1:2)

Question 16 (4 marks)

Criteria	Marks
Identifies the amphiprotic nature of the hydrogen carbonate ion, provides 2 correct equations to show this and includes the implications of it being harmless and a solid	4
Identifies the amphiprotic nature of the hydrogen carbonate ion, provides 2 mostly correct equations to show this and includes the implications of it being harmless and a solid OR Identifies the amphiprotic nature of the hydrogen carbonate ion, provides 2 correct equations to show this	3
Identifies the amphiprotic nature of the hydrogen carbonate ion, provides 2 mostly correct equations to show this OR Identifies the amphiprotic nature of the hydrogen carbonate ion and implications of being harmless or a solid	2
Identifies the amphiprotic nature of the hydrogen carbonate ion	1

Sample answer

Sodium hydrogen carbonate, due to being amphiprotic, can be used to treat both acid and base spills.

$HCO_3^-{}_{(aq)} + H_3O^+{}_{(l)} \rightleftharpoons H_2O_{(l)} + H_2CO_{3(aq)}$ (Acting as a base by accepting a proton)

$HCO_3^-{}_{(aq)} + OH^-{}_{(l)} \rightleftharpoons H_2O_{(l)} + CO_3^{2-}{}_{(aq)}$ (Acting as an acid by donating a proton)

Sodium hydrogen carbonate is a harmless solid. Therefore it is safe to handle and can be used in excess and it does not spread the spill.

Question 17 (4 marks)

17 (a) (2 marks)

Criteria	Marks
Identifies that a higher temperature means the reactant and product particles have more energy and links this with increased chance of collisions and more particles with energy equal to or greater than the activation energy resulting in a faster rate for both forward and reverse reactions	2
Identifies that a higher temperature means the reactant and product particles have more energy and links this with increased chance of collisions OR more particles with energy equal to or greater than the activation energy resulting in a faster rate for both forward and reverse reactions	1

Sample answer

Increasing the temperature of a chemical system causes all the species in the reaction to have more energy. This causes them to move faster and have a greater chance of collision. In addition, there will be more of the reactant and product particles with energy equal to or greater than the activation energy. The result is that both the 'reactants' and 'products' react more easily and therefore the rate is faster for both the forward and reverse reactions

17 (b) (2 marks)

Criteria	Marks
Links the change in temperature with the favouring of the forward or reverse reaction depending upon the enthalpy sign with Le Chatelier's Principle and therefore a change in K or equilibrium position	2
Provides general details about shifting depending upon the sign of the enthalpy	1

Sample answer

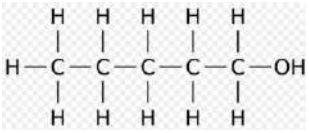
In a reversible reaction, the forward and reverse reactions have opposite enthalpy signs but the same magnitude. Therefore with the stress of a temperature change, the effect depends upon the enthalpy sign. If the forward reaction is endothermic and increase in temperature will favour the endothermic reaction, increasing products and increasing K. If this temperature stays the same, this change in position will be permanent.

Question 18 (5 marks)

18 (a) (1 mark)

Criteria	Mark
Correctly drawn	1

Sample answer



18 (b) (1 mark)

Criteria	Mark
Correctly identifies the class of alcohol	1

Sample answer

Primary alcohol

18 (c) (3 marks)

Criteria	Marks
Correctly calculates heat flow (q) and moles of fuel burnt to correctly determine the heat of combustion in kJ/mol	3
Most of the above	2
Some of the above	1

Sample answer

$m(H_2O) = 0.250kg$ $C(H_2O) = 4.18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$ $\Delta T(H_2O) = 38.0 - 10.0$ $= 28.0 \text{ K}$ $q = mC\Delta T$ $= 0.250 \times 4.18 \times 10^3 \times 28.0$ $= 29260 \text{ J}$	$m(C_5H_{11}OH) = 1.55g$ $M(C_5H_{11}OH) = (5 \times 12.01) + (12 \times 1.008) + (16.00)$ $= 88.146 \text{ g mol-1}$ $n = \frac{m}{M}$ $= \frac{1.55}{88.146}$ $= 0.0176 \text{ mol}$

$\Delta H = -q/n$

$= -29.260/0.0176$
$= 1663.97 \text{ kJ mol}^{-1}$
$= 1.66 \times 10^3 \text{ kJ mol}^{-1}$ (3sf)

18 (d) (2 marks)

Criteria	Marks
Correctly identifies the students value would be lower and links this to BOTH heat loss to the environment AND incomplete combustion	**2**
Correctly identifies the students value would be lower and links this to EITHER heat loss to the environment OR incomplete combustion OR Refers to both heat loss to the environment AND incomplete combustion	**1**

Sample answer

The student's value would be lower than the literature value for two reasons. Firstly, the heat generated from the combustion of the pentan-1-ol would not have only heated the water, but also the calorimeter and the surrounding air. Therefore less heat energy transferred to the water would cause a lower than expected temperature change and therefore enthalpy value. In addition, it is very unlikely to have been complete combustion. The enthalpy value for incomplete combustion is lower than for complete.

Question 19 (7 marks)

19 (a) (1 mark)

Criteria	Mark
Correctly names the alcohol	1

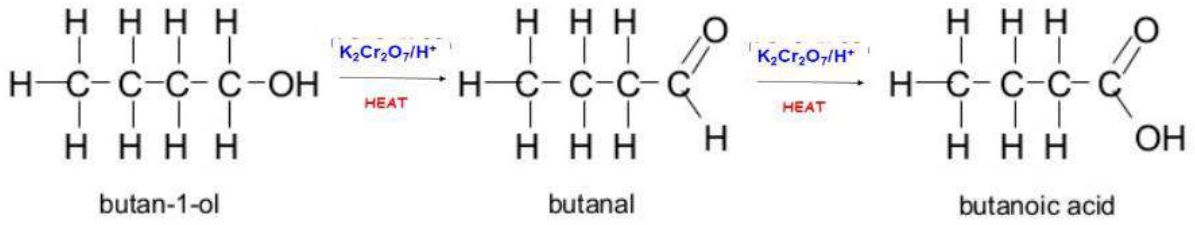
Sample answer

Butan-1-ol

19 (b) (2 marks)

Criteria	Mark
Draws correct structural formulae for all three species and included conditions on arrow	2
Mostly correct	1

Sample answer



19 (c) (2 marks)

Criteria	Marks
Correctly identifies the need for an oxidising agent that is acidified and heating under reflux	2
Correctly identifies the need for an oxidising agent and heat	1

Sample answer

For this reaction to occur in addition to the primary alcohol you need an excess of acidified oxidising agent such as potassium dichromate and you need to heat it under reflux

19 (d) (2 marks)

Criteria	Marks
Makes a clear judgement statement that says reflux must occur, supported by valid criteria	2
Vague judgement with valid criteria OR No judgement with well described criteria OR Clear judgement with vague criteria	1

Sample answer

Refluxing is essential to produce butanoic acid from butan-1-ol. Without refluxing, the aldehyde produced in the first oxidation would be lost due to its volatility. Refluxing returns the aldehyde to the reaction vessel for further oxidation to the carboxylic acid.