Sydney Girls High School

Student Number

2019

YEAR 11

Chemistry

Booklet 1 of 2

Part A & B

General Instructions

- Reading time – 5 minutes
- Working time – 60 minutes
- Write using black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Two pages of data sheets and a Periodic Table are provided
- Write your student number on the multiple choice answer sheet and on each booklet

Total marks – 35

Part A – Pages 2-5
10 marks

- Attempt Questions 1 – 10

Part B – Pages 6-8
13 marks

- Attempt Questions 11 – 14

Part C – Pages 9 – 11
12 marks

- Attempt Questions 15 – 16

Part A – 10 marks
Attempt Questions 1 – 10

Use the multiple-choice answer sheet for Questions 1–10

Question 1 and 2 refer to the following information.

A group of students conducted an experiment to investigate the reactivity of four different transition metals (A, B, C and D). They placed small pieces of each metal in separate test tubes with the appropriate test solutions. The result are summarised in the table below.

Metal ions / Metal	$A^{3+}(aq)$	$B^{2+}(aq)$	$C^{4+}(aq)$	$D^{3+}(aq)$
A		No reaction	No reaction	Reaction occurs
B	Reaction occurs		No reaction	Reaction occurs
C	Reaction occurs	Reaction occurs		Reaction occurs
D	No reaction	No reaction	No reaction	

1 Which of these metals is the most easily oxidised?

(A) Metal A

(B) Metal B

(C) Metal C

(D) Metal D

2 Which of these metals is the weakest reducing agent?

(A) Metal A

(B) Metal B

(C) Metal C

(D) Metal D

3 Which half equation best represents the change when sodium metal reacts with dilute hydrochloric acid?

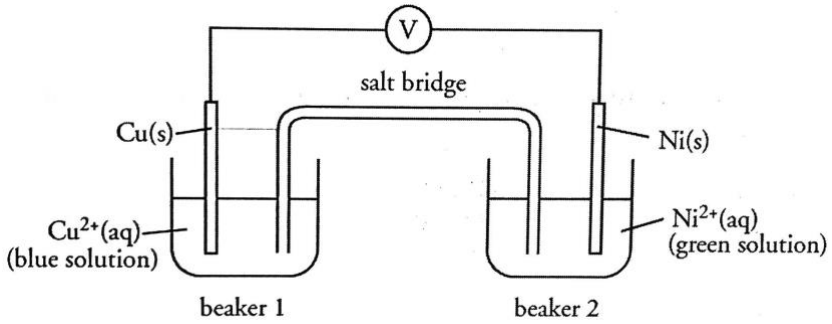
(A) $Na^{2+} + 2e^- \rightarrow Na(s)$

(B) $Na^{2+} \rightarrow Na(s) + 2e^-$

(C) $Na(s) \rightarrow Na^+ + e^-$

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

4 The diagram below shows an electrochemical cell which has copper and nickel electrodes.



What three observations for this cell are correct?

	Observation 1	**Observation 2**	**Observation 3**
(A)	The reading shown on the voltmeter was -0.57 V.	The solution in beaker 1 became a darker blue.	The solution in beaker 2 became a fainter green.
(B)	The reading shown on the voltmeter was -0.11 V.	A red/brown solid form on the copper electrode.	The solution in beaker 1 became a fainter blue.
(C)	A grey solid formed on the nickel electrode.	In beaker 1 the solution became a darker blue.	The solution in beaker 2 became a darker green.
(D)	The nickel electrode was the negative terminal.	A red/brown solid form on the copper electrode.	The solution in beaker 2 became a darker green.

5 The transition metal manganese exists in a range of different oxidation states.

The oxidation states of Mn in MnO_2 and MnO_4^- respectively are,

(A) +2 and +7

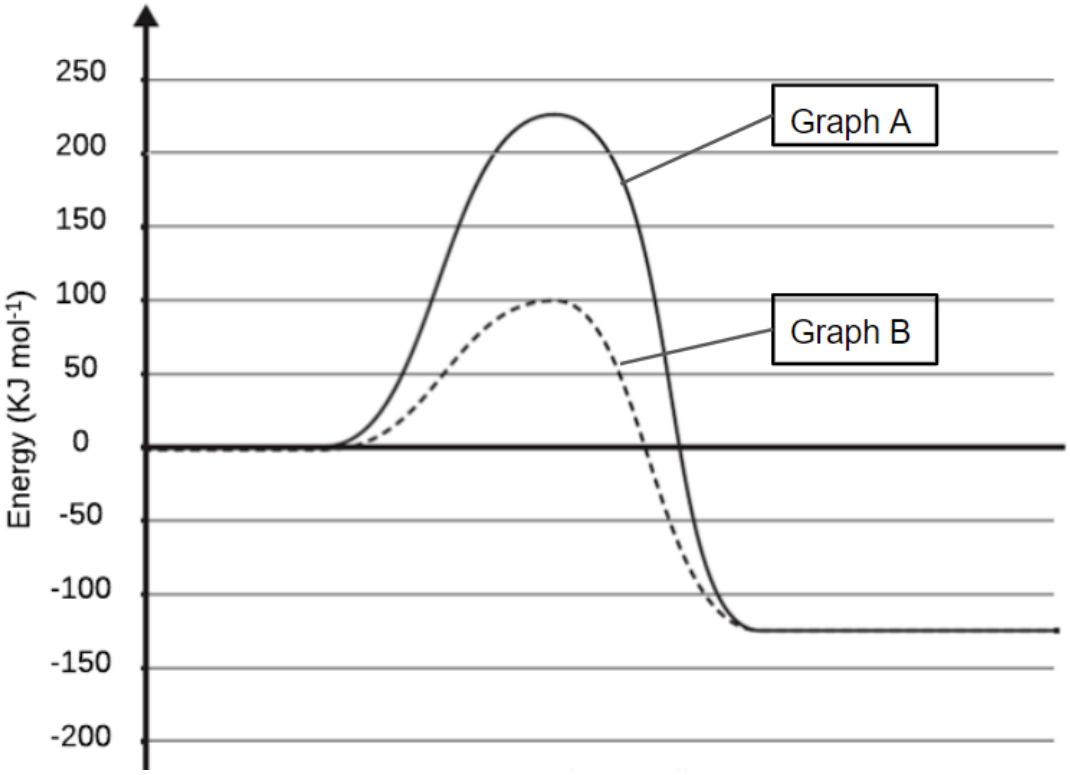
(B) +3 and +6

(C) +4 and +7

(D) +6 and +4

Question 6 and 7 refer to the following information.

The energy profile diagram of a particular reaction is shown below. Graph A represent the uncatalysed reaction and Graph B represent the catalysed reaction.



6 Which of the following is correct?

	E_a of catalysed reaction (kJ mol^{-1})	ΔH of uncatalysed reaction (kJ mol^{-1})
(A)	100	-125
(B)	100	-350
(C)	225	-125
(D)	225	-350

7 What would be the activation energy of the reverse of the reaction in Graph A?

(A) 100 kJ mol^{-1}

(B) 225kJ mol^{-1}

(C) 250 kJ mol^{-1}

(D) 350 kJ mol^{-1}

8 When hydrochloric acid reacts with potassium hydroxide, energy is released because

(A) the reaction involves the breaking of bonds.

(B) the stored energy in the products is greater than the stored energy in the reactants.

(C) the activation energy is greater than the energy released from the hydrogen and oxygen molecules.

(D) as the bonds in the products form, more energy is released than is required to break the bonds in the reactants.

9 Under what circumstances will a change be nonspontaneous regardless of the temperature?

	ΔH	ΔS	$-T\Delta S$	ΔG
(A)	+	–	+	+
(B)	–	+	–	–
(C)	–	–	+	+
(D)	+	+	–	–

10 The equation for the reaction of butane with oxygen is

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g) \qquad \Delta H = -2878 \text{ kJmol}^{-1}$$

When 22g of carbon dioxide is produced in this reaction, the energy change will be:

(A) 180 kJ released

(B) 360 kJ released

(C) 1439 kJ released

(D) 2878 kJ released

Student Number

Part B – 13 marks

Attempt Questions 11 - 14

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 11 (4 marks)

The formulae of 10 substances are given below:

$NaOH$	KCl	$AgNO_3$	$CaCO_3$	N_2
C_2H_6	O_2	H_2SO_4	H_2	CO_2

a) Identify TWO substances that would react together in an aqueous environment to form a precipitate:

i) Write a balanced overall chemical equation including states. 1K

……

ii) Write a net ionic equation including states. 1K

……

b) Which TWO substances will take part in an acid and base reaction in an aqueous environment?

i) Write a balanced overall chemical equation including states. 1K

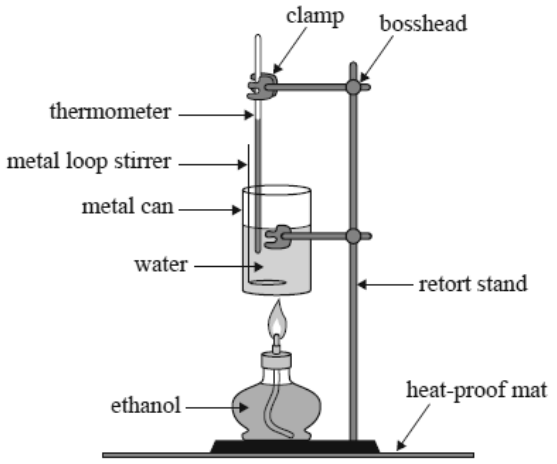
……

ii) Write a net ionic equation including states. 1K

……

Question 12 (4 marks)

Students were asked to perform a first-hand investigation to determine the molar heat of combustion of ethanol (C_2H_5OH). The following extract is from the practical report of one student.



Lab data:	
Mass of water	= 150.0 g
Initial mass of burner	= 182.5 g
Final mass of burner	= 181.1 g
Initial temperature of water	= 24.0°C
Final temperature of water	= 64.0°C

After completing the calculations correctly, the student found that the answer did not agree with the value found on data sheets.

a) Suggest TWO reasons for this. 2P

……

……

……

……

b) Propose TWO ways the student can improve the accuracy of the results. 2P

……

……

……

……

……

Question 13 (3 marks)

The compound ammonium peroxydisulfate, $(NH_4)_2S_2O_8$, dissolves in water according to the following equation.

$$(NH_4)_2S_2O_8(s) \rightarrow 2\ NH_4^+(aq) + S_2O_8^{2-}(aq) \qquad \Delta H = +37.0\ kJ\ mol^{-1}$$

In an experiment, 22.82 g of ammonium peroxydisulfate was dissolved in 100 g of water. If the final temperature of the water was 15.0°C, what is the initial temperature? 3A

.....

.....

.....

.....

.....

.....

Question 14 (2 marks)

The following equation shows the reaction of urea with water at 25 °C,

$$CO(NH_2)_2\,(aq) + H_2O(l) \rightarrow CO_2(g) + 2NH_3(g)$$

The enthalpy change ΔH^o for this reaction is +119.2 kJ mol^{-1} and the entropy change ΔS^o is +354.8 J mol^{-1} K^{-1}. Calculate the Gibbs free energy change, then predict the spontaneity of this reaction. Show all working. 2A

.....

.....

.....

.....

.....

END OF PART B

Booklet 2 of 2

Student Number

Part C – 12 marks

Attempt Questions 15 - 16

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 15 (10 marks)

a) You conducted an experiment to determine the effect of concentration on rate of reaction. Describe a method to safely investigate this, including a relevant chemical equation. 5P

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Question 15 - continued

b) With the aid of a diagram, explain the effect of increasing the concentration of reactants on the rate of reaction. 3K

……

……

……

……

……

c) Explain the effect of increasing temperature on the rate of reaction. 2K

……

……

……

……

……

……

Question 16 (2 marks)

Use the following equations to calculate the enthalpy of dinitrogen tetroxide formation. 2A
Show all working.

$$N_2O_4(g) \rightarrow 2NO_2(g) \qquad \Delta H = 57.93 \text{ kJ}$$

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g) \qquad \Delta H = -113.14 \text{ kJ}$$

$$2NO(g) + O_2(g) \rightarrow N_2O_4(g) \qquad \Delta H = ?$$

……

……

……

……

……

END OF PART C

Sydney Girls High School

Student Number

2019

YEAR 11

Chemistry

Booklet 1 of 2

Part A & B

General Instructions

- Reading time – 5 minutes
- Working time – 60 minutes
- Write using black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Two pages of data sheets and a Periodic Table are provided
- Write your student number on the multiple choice answer sheet and on each booklet

Total marks – 35

Part A – Pages 2-5
10 marks

- Attempt Questions 1 – 10

Part B – Pages 6-8
13 marks

- Attempt Questions 11 – 14

Part C – Pages 9 – 11
12 marks

- Attempt Questions 15 – 16

Part A – 10 marks
Attempt Questions 1 – 10

Use the multiple-choice answer sheet for Questions 1–10

Question 1 and 2 refer to the following information.

A group of students conducted an experiment to investigate the reactivity of four different transition metals (A, B, C and D). They placed small pieces of each metal in separate test tubes with the appropriate test solutions. The result are summarised in the table below.

Metal ions / Metal	$A^{3+}(aq)$	$B^{2+}(aq)$	$C^{4+}(aq)$	$D^{3+}(aq)$
A		No reaction	No reaction	Reaction occurs
B	Reaction occurs		No reaction	Reaction occurs
C	Reaction occurs	Reaction occurs		Reaction occurs
D	No reaction	No reaction	No reaction	

1 Which of these metals is the most easily oxidised?

(A) Metal A

(B) Metal B

(C) Metal C

(D) Metal D

2 Which of these metals is the weakest reducing agent?

(A) Metal A

(B) Metal B

(C) Metal C

(D) Metal D

3 Which half equation best represents the change when sodium metal reacts with dilute hydrochloric acid?

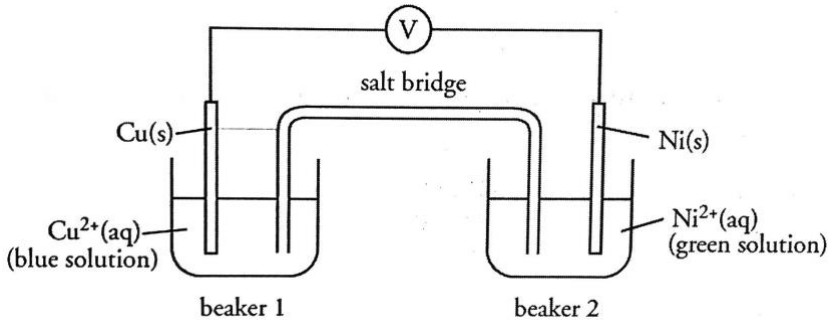
(A) $Na^{2+} + 2e^- \rightarrow Na(s)$

(B) $Na^{2+} \rightarrow Na(s) + 2e^-$

(C) $Na(s) \rightarrow Na^+ + e^-$

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

4 The diagram below shows an electrochemical cell which has copper and nickel electrodes.



What three observations for this cell are correct?

	Observation 1	**Observation 2**	**Observation 3**
(A)	The reading shown on the voltmeter was -0.57 V.	The solution in beaker 1 became a darker blue.	The solution in beaker 2 became a fainter green.
(B)	The reading shown on the voltmeter was -0.11 V.	A red/brown solid form on the copper electrode.	The solution in beaker 1 became a fainter blue.
(C)	A grey solid formed on the nickel electrode.	In beaker 1 the solution became a darker blue.	The solution in beaker 2 became a darker green.
(D)	The nickel electrode was the negative terminal.	A red/brown solid form on the copper electrode.	The solution in beaker 2 became a darker green.

5 The transition metal manganese exists in a range of different oxidation states.

The oxidation states of Mn in MnO_2 and MnO_4^- respectively are,

(A) +2 and +7

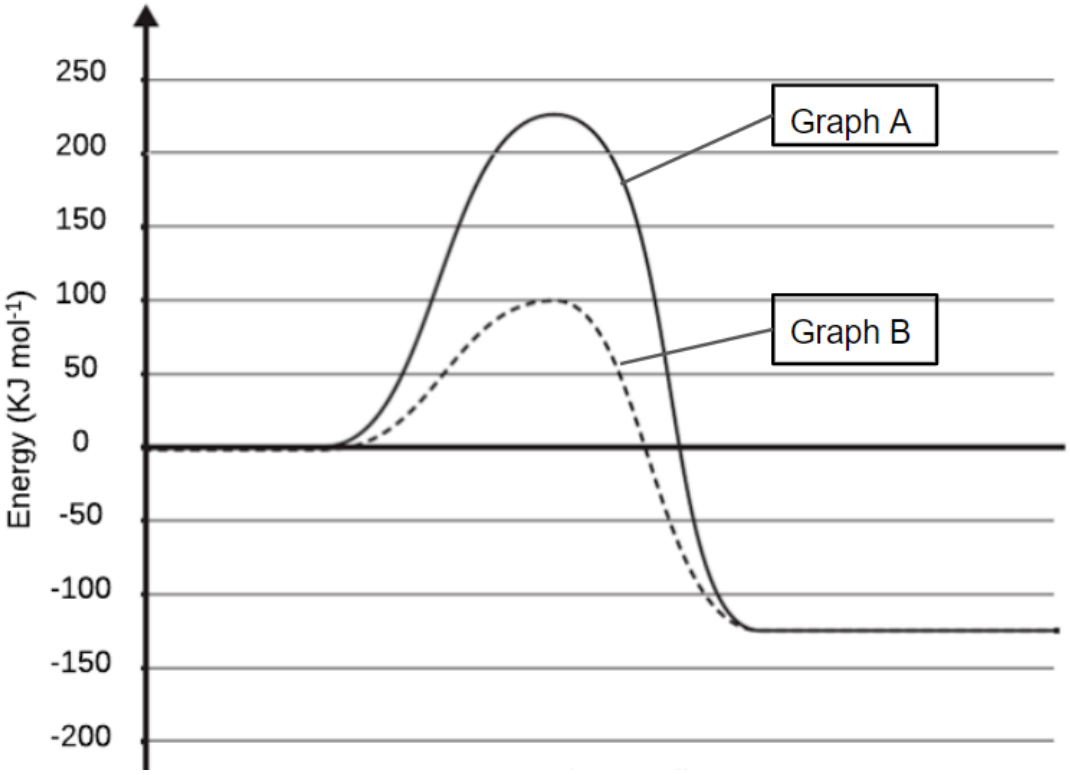
(B) +3 and +6

(C) +4 and +7

(D) +6 and +4

Question 6 and 7 refer to the following information.

The energy profile diagram of a particular reaction is shown below. Graph A represent the uncatalysed reaction and Graph B represent the catalysed reaction.



6 Which of the following is correct?

	E_a of catalysed reaction (kJ mol^{-1})	ΔH of uncatalysed reaction (kJ mol^{-1})
(A)	100	-125
(B)	100	-350
(C)	225	-125
(D)	225	-350

7 What would be the activation energy of the reverse of the reaction in Graph A?

(A) 100 kJ mol^{-1}

(B) 225kJ mol^{-1}

(C) 250 kJ mol^{-1}

(D) 350 kJ mol^{-1}

8 When hydrochloric acid reacts with potassium hydroxide, energy is released because

(A) the reaction involves the breaking of bonds.

(B) the stored energy in the products is greater than the stored energy in the reactants.

(C) the activation energy is greater than the energy released from the hydrogen and oxygen molecules.

(D) as the bonds in the products form, more energy is released than is required to break the bonds in the reactants.

9 Under what circumstances will a change be nonspontaneous regardless of the temperature?

	ΔH	ΔS	$-T\Delta S$	ΔG
(A)	+	–	+	+
(B)	–	+	–	–
(C)	–	–	+	+
(D)	+	+	–	–

10 The equation for the reaction of butane with oxygen is

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g) \qquad \Delta H = -2878 \text{ kJmol}^{-1}$$

When 22g of carbon dioxide is produced in this reaction, the energy change will be:

(A) 180 kJ released
(B) 360 kJ released
(C) 1439 kJ released
(D) 2878 kJ released

1	C	2	D
3	C	4	D
5	C	6	A
7	D	8	D
9	A	10	A

Student Number

Part B – 13 marks

Attempt Questions 11 - 14

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 11 (4 marks)

The formulae of 10 substances are given below:

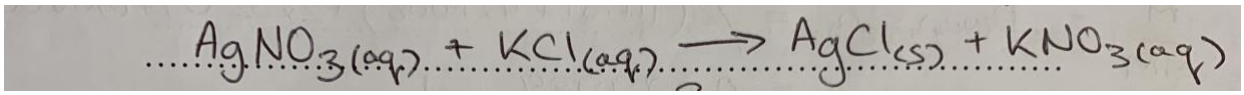
NaOH	KCl	$AgNO_3$	$CaCO_3$	N_2
C_2H_6	O_2	H_2SO_4	H_2	CO_2

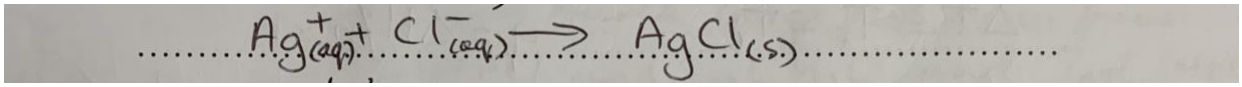
a) Identify TWO substances that would react together in an aqueous environment to form a precipitate:

i) Write a balanced overall chemical equation including states. 1K

ii) Write a net ionic equation including states. 1K

Correct balanced chemical equation with correct states	**1**
Correct net ionic equation with correct states	**1**





NaOH (aq) + AgNO3 (aq) → AgOH (s) + NaNO3 (aq)

Ag + (aq) + OH- (aq) → AgOH (s)

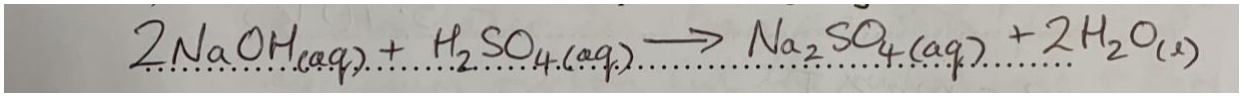
- calcium carbonate has very low solubility 0.013 g/L at 25°C

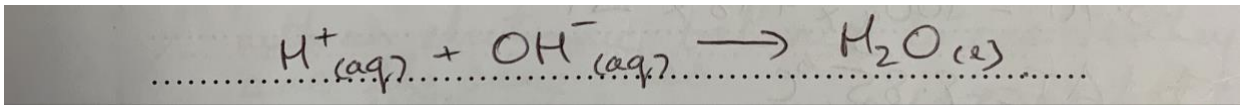
b) Which TWO substances will take part in an acid and base reaction in an aqueous environment?

i) Write a balanced overall chemical equation including states. 1K

ii) Write a net ionic equation including states. 1K

Correct balanced chemical equation with correct states	**1**
Correct net ionic equation with correct states	**1**

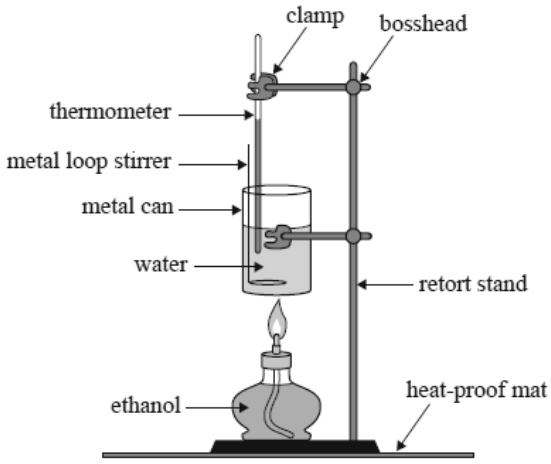




- Simplify 2H+ (aq) + OH- (aq) → H2O (l)

Question 12 (4 marks)

Students were asked to perform a first-hand investigation to determine the molar heat of combustion of ethanol (C_2H_5OH). The following extract is from the practical report of one student.



Lab data:	
Mass of water	= 150.0 g
Initial mass of burner	= 182.5 g
Final mass of burner	= 181.1 g
Initial temperature of water	= 24.0°C
Final temperature of water	= 64.0°C

After completing the calculations correctly, the student found that the answer did not agree with the value found on data sheets.

a) Suggest TWO reasons for this. 2P

.....

Two correct reasons provided • Heat loss to surroundings • Standard conditions (298K and 1 atm) might not apply • Incomplete combustion	**2**
One Correct reason provided	**1**

b) Propose TWO ways the student can improve the accuracy of the results. 2P

Two correct improvements provided **e.g.** • keep the distance between the wick and the calorimeter as low as possible • a lid or insulation could be used to reduce heat loss of the calorimeter • ensure the thermometer is not touching the bottom of the calorimeter	**2**
One Correct improvement provided	**1**

- Using more precise equipment will not improve the reasons provided in a) significantly

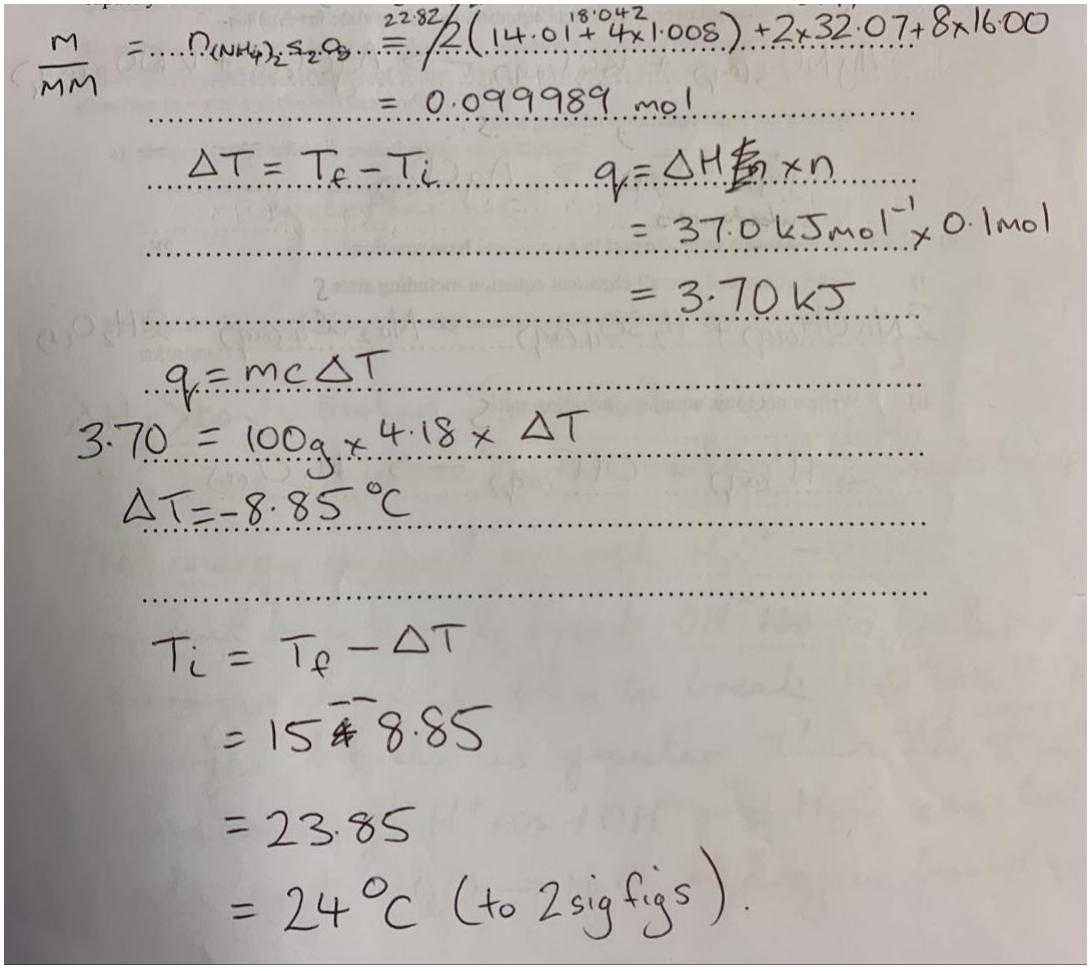
Question 13 (3 marks)

The compound ammonium peroxydisulfate, $(NH_4)_2S_2O_8$, dissolves in water according to the following equation.

$$(NH_4)_2S_2O_8(s) \rightarrow 2\ NH_4^+(aq) + S_2O_8^{2-}(aq) \qquad \Delta H = +37.0\ kJ\ mol^{-1}$$

In an experiment, 22.82 g of ammonium peroxydisulfate was dissolved in 100 g of water. If the final temperature of the water was 15.0°C, what is the initial temperature? 3A

• **The number of mole for ammonium peroxydisulfate is correctly calculated n = 0.09999 mol**	**1**
• **Correctly find q = ΔH x n = 3.70 kJ**	**1**
• **Correct substitution into q = mcΔT and find T = 23.9°C**	**1**



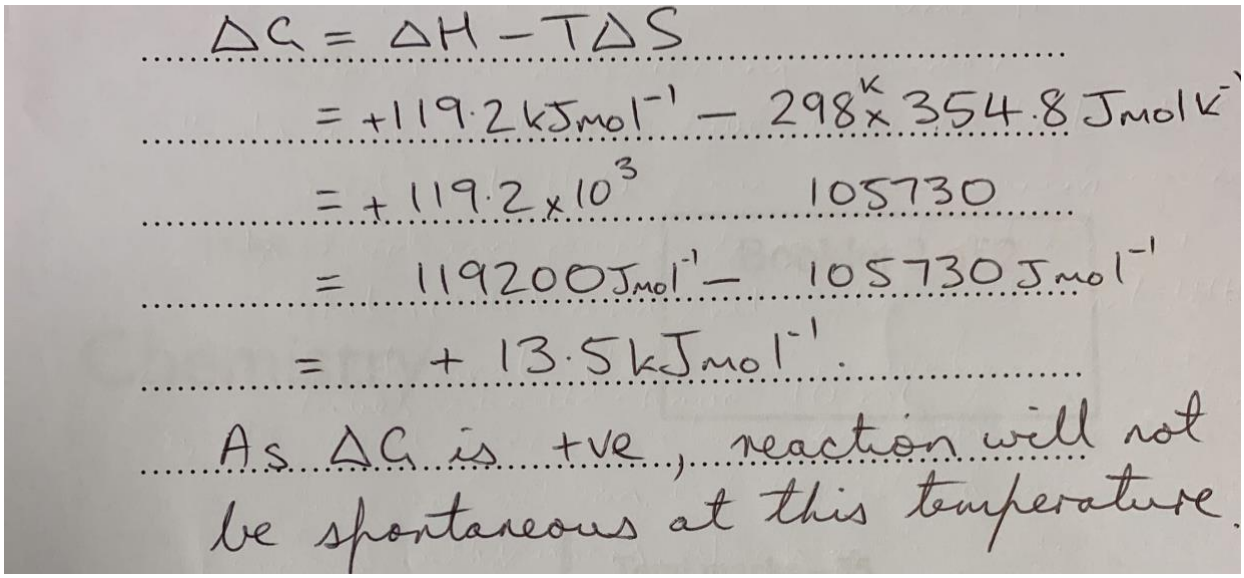
Question 14 (2 marks)

The following equation shows the reaction of urea with water at 25 °C,

$$CO(NH_2)_2\,(aq) + H_2O(l) \rightarrow CO_2(g) + 2NH_3(g)$$

The enthalpy change ΔH^o for this reaction is +119.2 kJ mol^{-1} and the entropy change ΔS^o is +354.8 J mol^{-1} K^{-1}. Calculate the Gibbs free energy change, then predict the spontaneity of this reaction. Show all working. 2A

• **Correct substitution into $\Delta G = \Delta H - T\Delta S$, and find ΔG = +13.5 kJ mol^{-1}**	**1**
• **Correct prediction from the sign of ΔG**	**1**



END OF PART B

Booklet 2 of 2

Student Number

Part C – 12 marks

Attempt Questions 15 - 16

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

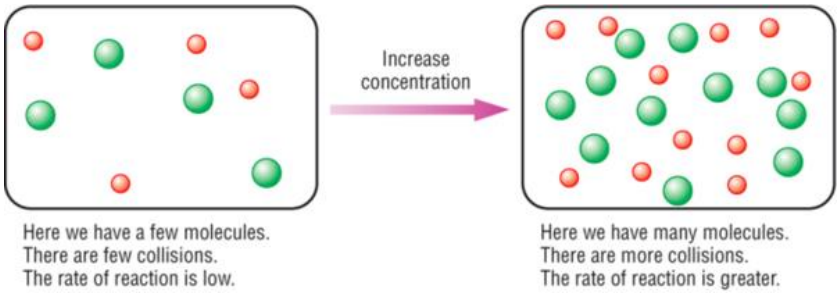
Question 15 (10 marks)

a) You conducted an experiment to determine the effect of concentration on rate of reaction. Describe a method to safely investigate this, including a relevant chemical equation. 5P

• **Consider the safety aspect of the experiment** • **Experiment must be fair, controlled, observable and repeatable** • **Correct independent and dependent variables identified** • **All equipment used must be identified (stopwatch, electronic balance)** • **One relevant chemical equation included**	**5**
Missing one or more points	**2-4**
Some relevant information	**1**

b) With the aid of a diagram, explain the effect of increasing the concentration of reactants on the rate of reaction.
3K

• **Increasing concentration of reactants increases rate of reaction** • **Increasing the concentration means there are more reactant particle/ increases the frequency of collisions between reactants in a given space (volume). This increases the chance that reactant particles will collide. The increased frequency of collisions results in a faster rate of reaction.** • **Relevant labelled diagram provided**	**3**
Missing one point as indicate above	**2**
One correct point provided	**1**



c) Explain the effect of increasing temperature on the rate of reaction. 2K

• **Increasing temperature increases rate of reaction** • **As the temperature increases 1. the particles move faster resulting in more collisions which in turn leads to a faster reaction. And 2. There are more collisions which have enough activation energy to result in a successful collision.**	**2**
One correct reason provided	**1**

Question 16 (2 marks)

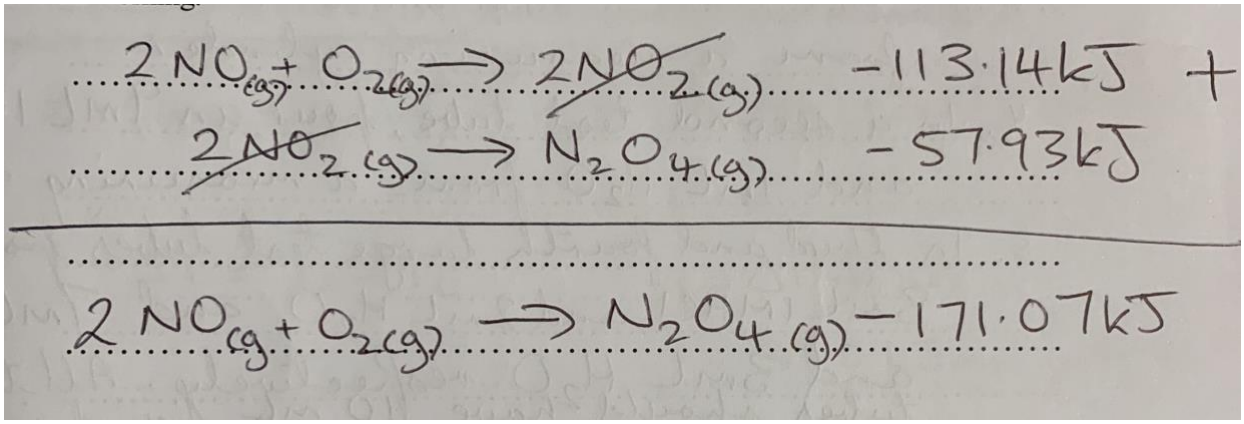
Use the following equations to calculate the enthalpy of dinitrogen tetroxide formation. 2A
Show all working.

$$N_2O_4(g) \rightarrow 2NO_2(g) \qquad \Delta H = 57.93 \text{ kJ}$$

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g) \qquad \Delta H = -113.14 \text{ kJ}$$

$$2NO(g) + O_2(g) \rightarrow N_2O_4(g) \qquad \Delta H = ?$$

• **Correctly rearrange the first equation** $2NO_2(g) \rightarrow N_2O_4(g)$ $\Delta H = -57.93$ kJ	**1**
• **Correctly adding the equation together and find ΔH = -171.07 kJ, with the correct unit**	**1**
*** Lose 1 mark if there is no correct unit provided**	


2NO(g) + O2(g) → 2NO2(g) -113.14kJ +
2NO2(g) → N2O4(g) -57.93kJ
2NO(g) + O2(g) → N2O4(g) -171.07kJ

END OF PART C