Student Number……...

CHELTENHAM GIRLS' HIGH SCHOOL

2009

MID COURSE EXAMINATION

Chemistry

Total marks – 66

General Instructions
- Reading time – 5 minutes
- Working time – 2 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 at the back of this paper
- Write your student number where required

This paper contains two parts, Part A and Part B

Part A – 12 marks
- Attempt Questions 1-12
- Allow about 22 minutes for this part

Part B – 54 marks
- Attempt Questions 13 – 21
- Allow about 1 hour and 38 minutes for this part

This examination is weighted 15% of your final school-based assessment mark

Part A – 12 marks
Attempt Questions 1-12
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.
Allow approximately 22 minutes for this part.

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1 Which of the following radiations can be used to destroy cancer cells?

(A) Beta

(B) Gamma

(C) Infrared

(D) Microwave

2 What are the volumes of two moles of helium, He, and one mole of ozone, O_3, at 0°C and 100 kPa?

	Volume (litres)	
	He	O_3
(A)	22.71	68.13
(B)	22.71	22.71
(C)	45.42	22.71
(D)	45.42	68.13

3 A 20mLvolume of 0.010 mol L^{-1} nitric acid solution is diluted to 100mL. Its pH changes:

(A) From 2.0 to 2.5

(B) From 4.0 to 9.0

(C) From 1.7 to 1.0

(D) From 2.0 to 2.7

4 Which of the following changes will always shift this equilibrium reaction to the right?

$$CO(g) + Cl_2(g) \leftrightarrow COCl_2(g) \qquad \Delta H = -9.93 \text{ kJ mol}^{-1}$$

(A) Adding a catalyst

(B) Increasing the pressure

(C) Increasing the temperature

(D) Adding more of the product

5 According to the Davy concept of acids and bases, an acid is a substance that

(A) tastes sour.

(B) contains replaceable hydrogen.

(C) is capable of donating a hydrogen ion.

(D) increases the concentration of hydrogen ions in an aqueous solution.

6 Which of the following oxides is the most strongly acidic?

(A) Carbon dioxide

(B) Silicon dioxide

(C) Sodium oxide

(D) Sulfur trioxide

7 The molar heat of combustion of ethanol is 1367 kJ mol^{-1}.
What quantity of ethanol must be combusted to release 500kJ of energy?

(A) 17.2 g

(B) 29.7 g

(C) 125.5 g

(D) 300 g

8 Identify which of the following is the conjugate base of HPO_4^{2-}.

(A) HPO_4^{1-}

(B) $H_2PO_4^{1-}$

(C) H_3PO_4

(D) PO_4^{3-}

9 Plutonium-242 decays to produce Uranium-238. Identify the other product that is released in this reaction.

(A) an alpha particle

(B) a beta particle

(C) a gamma ray

(D) a neutron

10 Some reactions of the metals Q, R and S are given below.

Metal	*Reaction in air*	*Reaction with water*	*Reaction with dilute hydrochloric acid*
Q	Burns to form metallic oxide	Reacts with steam to form hydrogen	Hydrogen is formed
R	Reacts slowly to form metallic oxide	Does not react	Does not react
S	Reacts to form metallic oxide	Does not react	Hydrogen is formed

Which combination of metals when used in a galvanic cell would produce the highest potential difference?

(A) Q and R

(B) Q and S

(C) R and S

(D) Q and Q

11 Sulfuric acid (H_2SO_4), nitric acid (HNO_3) and ethanoic acid (CH_3COOH) were each titrated separately with a 0.10 M solution of sodium hydroxide (NaOH). All three acids had a concentration of 0.10 M and the same amount (20.00 mL) of acid was used in each titration.
In order to completely neutralize the acid present:

(A) all three acids would require the same amount of NaOH.

(B) HNO_3 would require more NaOH than CH_3COOH but less than H_2SO_4.

(C) H_2SO_4 and HNO_3 would require the same amount of NaOH but CH_3COOH would require less.

(D) CH_3COOH and HNO_3 would require the same amount of NaOH but H_2SO_4 would require more.

12 Acid *X* and acid *Y* are both monoprotic weak acids of equal concentration. Acid *X* is a stronger acid than acid *Y*. Which statement about acid X and acid Y is correct?

(A) Acid *Y* is completely ionised in solution.

(B) The solution of acid *X* is less ionised than the solution of acid *Y*.

(C) The solution of acid *X* has a lower pH than the solution of acid *Y*.

(D) 1 mole of acid *Y* requires a greater volume of 1.0 mol L^{-1} NaOH for neutralisation than 1 mole of acid *X*.

Part B – 54 marks

Attempt Questions 13-21
Write your answers in the spaces provided, showing working for calculations.
Allow approximately 1 hour and 38 minutes for this part.

Question 13 (3 marks)

Marks

Indicators are often used in everyday situations. Identify and describe the everyday use of an indicator. **3**

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Question 14 (3 marks)

142.0 g of an unknown gas has a volume of 49.6 L at 100 kPa and 25°C.

(a) Calculate the molar mass of the gas. **2**

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(b) If the gas is diatomic, identify the gas. **1**

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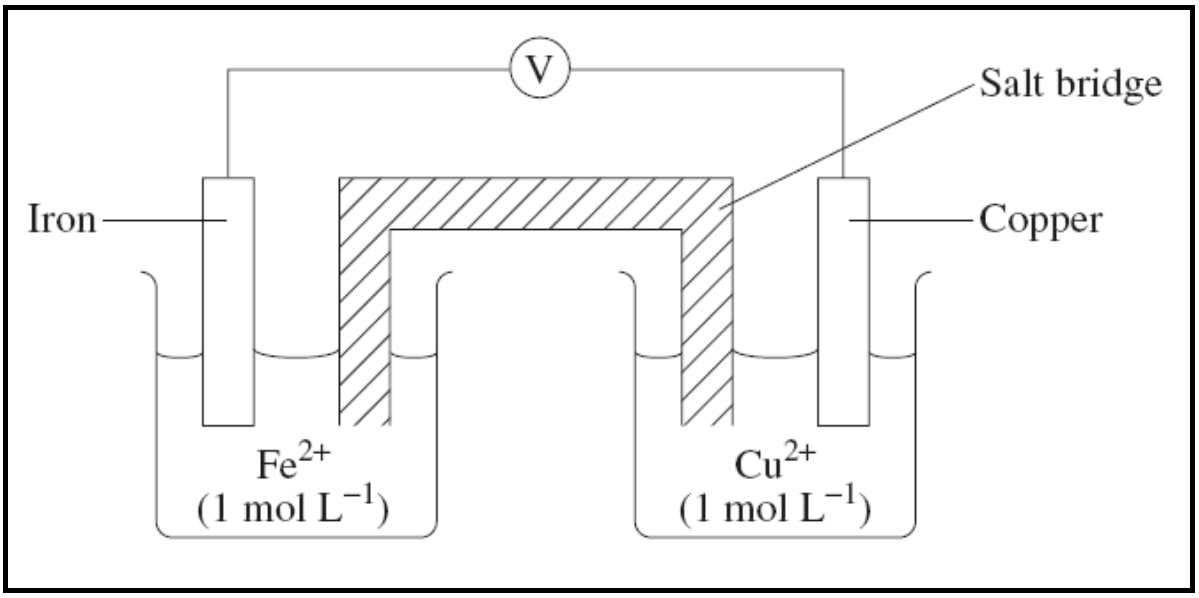
Marks

Question 15 (7 marks)

A galvanic cell under standard conditions is represented below.



(a) On the diagram, clearly label the anode, the cathode and the direction of electron flow. **1**

(b) Write a balanced net ionic equation for the overall cell reaction. **1**

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(c) Calculate the standard cell potential (E°). **1**

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(d) Explain any colour changes observed in this cell as the reaction proceeds. **2**

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(e) Identify how the solutions should be disposed of at the conclusion of the experiment. **2**

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Marks

Question 16 (4 marks)

(a) Complete the table below by naming a salt example for each classification. **2**

Classification of solution	*Salt name*
Acidic	
Basic	
Neutral	

(b) Write equations to illustrate the acidic and basic natures of the salts you have chosen. **2**

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Question 17 (4 marks)

Discuss the benefits and problems associated with the use of ONE radioactive isotope in medicine. **4**

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Marks

Question 18 (9 marks)

The table shows four fuels and their various properties.

Property	*Petrol*	*Kerosene*	*Hydrogen*	*Ethanol*
Heat of combustion (kJ mol^{-1})	5 500	10 000	285	1371
Boiling point (°C)	126	300	–253	78
Density (g mL^{-1})	0.69	0.78	n/a	0.78
Average molar mass (g mol^{-1})	114	210	2	46
Heat of combustion (kJ g^{-1})			142.5	
Heat of combustion (kJ L^{-1})			11.5*	

*at 25 °C

(a) Calculate the heat of combustion of per gram and per litre for each of the above three fuels.
Show your working in the space below, and transfer your answers to complete the table above. **4**

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Question 18 is continued over the page

Marks

(b) Use the information ***in the table in part(a)*** to assess each of the other three fuels on their suitability as a petrol replacement. **5**

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Question 19 (8 marks)

A standard solution was prepared by dissolving 15.992 g of sodium carbonate in water. The solution was made up to a final volume of 500.0 mL.

(a) Calculate the concentration of the sodium carbonate solution. **2**

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The student then used her standard solution to determine the concentration of a nitric acid solution.

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

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(c) Identify the indicator that she should use for her titration and justify your choice. **2**

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Question 19 is continued over the page

Marks

(d) 38.2mL of nitric acid was needed to neutralise 25.0mL of the sodium carbonate solution. Calculate the concentration of the nitric acid. **3**

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Question 20 (7 marks)

Many acids and bases occur naturally. A large number of acidic and basic compounds are industrially produced and these compounds are found in daily use within our homes.

(a) Identify an example of a naturally occurring acid and a naturally occurring base. Include both their names and their chemical formulae in your answer. **3**

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(b) Acids are widely used as food additives. Acids can be included in foods for various reasons. Explain the use of acids as food additives, illustrating your answer with examples of **TWO DIFFERENT** reasons for their use. **4**

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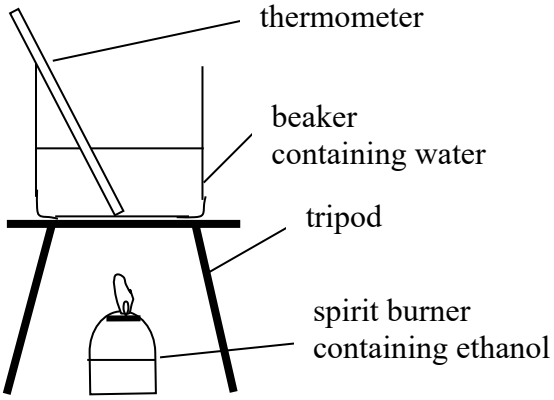
Marks

Question 21 (9 marks)

(a) A student set up the apparatus shown below to determine the molar heat of combustion of ethanol.



Using the apparatus, the following laboratory data was obtained.

Mass of water	200 g
Initial temperature of water	18.5°C
Final temperature of water	60.5°C
Initial mass of spirit burner	180.6 g
Final mass of spirit burner	179.3 g

(i) Calculate the molar heat of combustion of ethanol using the student's data. **3**

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(ii) The result the student obtained did not agree with the value found in the data booklet. Assuming the calculations had been done correctly, suggest ONE main reason for this AND modifications to the experimental method that could be used to overcome this issue. **2**

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Marks

Question 21 (continued)

(b) (i) Write a balanced equation for the complete combustion of butanol. **2**

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(ii) A mass of 86.0 g of butanol was burnt completely in air. Calculate the volume of carbon dioxide produced at 25°C and 100 kPa. **2**

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END OF EXAMINATION

CHELTENHAM GIRLS' HIGH SCHOOL 2009 CHEMISTRY MID COURSE EXAMINATION

Marking guidelines and specimen answers

Part A. Total : **12** marks

1. **B** 2. **C** 3. **D** 4. **B** 5. **B**

6. **D** 7. **A** 8. **D** 9. **A** 10. **A**

11. **D** 12. **C**

Part B. Total : **52** marks

13

MARKING GUIDELINES (3 marks)

Criteria	Marks
Correctly identifies an everyday use of indicators AND Correctly describes how the indicator is used	2 - 3
Correctly identifies an everyday use of indicators	1

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14

(a) **MARKING GUIDELINES** (2 marks)

Criteria	Marks
Correctly calculates the molar mass of the gas	2
Correctly calculates the number of moles of the gas	1

Specimen Answer

n = 49.6 / 24.79 = 2.00 moles

Molar mass = m/n = 142 / 2 = 71g

(b) **MARKING GUIDELINES** (1 mark)

Criteria	Marks
Correctly identifies the gas	1

Specimen Answer

Chlorine gas or Cl_2

15

(a) **MARKING GUIDELINES** (1 mark)

Criteria	Marks
Correctly labels the anode, the cathode and the direction of electron flow.	1

(b) **MARKING GUIDELINES** (1 mark)

Criteria	Marks
Writes correctly balanced net ionic equation	1

Specimen Answer

$Fe_{(s)} + Cu^{2+}_{(aq)} \rightarrow Fe^{2+}_{(aq)} + Cu_{(s)}$

(c) **MARKING GUIDELINES** (1 mark)

Criteria	Marks
Correctly calculates standard potential of cell	1

Specimen Answer

0.78V

(d) **MARKING GUIDELINES** (2 marks)

Criteria	Marks
Correctly identifies colour change and links it to the reaction that occurs	2
Correctly identifies a colour change	1

Specimen Answer :

The blue colour of the copper solution decreases in intensity as the reaction proceeds, due to the loss of $Cu^{2+}_{(aq)}$ ions in the half-cell.

15 (continued)

(e) **MARKING GUIDELINES** (2 marks)

Criteria	Marks
Correctly identifies the correct disposal of both solutions	2
Correctly identifies the correct disposal of one solution	1

Specimen Answer :

The copper solution must be collected for disposal as a heavy metal, the iron solution can be disposed of down the sink.

16

(a) **MARKING GUIDELINES** (2 marks)

Criteria	Marks
Correctly identifies all three salts correctly	2
Correctly identifies at least one salt correctly	1

Specimen Answer

Classification of solution	*Salt name*
Acidic	Ammonium nitrate
Basic	Sodium carbonate
Neutral	Sodium chloride

(b) **MARKING GUIDELINES** (2 marks)

Criteria	Marks
Correctly writes two balanced equations that illustrates both acid and basic salts	2
Correctly writes a balanced equation that illustrates either the acidic or basic nature of salts	1

Specimen Answer

$$NH_4^+{}_{(aq)} + H_2O_{(l)} \rightarrow NH_{3\,(aq)} + H_3O^+{}_{(aq)}$$

$$CO_3^{2-} + H_2O_{(l)} \rightarrow HCO_3^- + OH^-{}_{(aq)}$$

17

MARKING GUIDELINES (4 marks)

Criteria	Marks
Provides points for and/or against both the benefits and problems associated with the use of a named radioisotope in medicine	4
Describes a benefit and/or problem(s) associated with the use of a named radioisotope in medicine OR Describes benefits and problems in medicine for an incorrect isotope of the element (for 2 marks maximum)	2 - 3
Identifies a benefit of a named radioisotope in industry/medicine OR Identifies a problem of a named radioisotope in industry/medicine OR Identifies a use of a named radioisotope in industry/medicine	1

18

(a) **MARKING GUIDELINES** (4 marks)

Criteria	Marks
Calculates all heats of combustion correctly, showing all working	4
Calculates most heats of combustion correctly, showing all working	3
Calculates all/most heats of combustion correctly, without showing all working	2
Correctly calculates at least one heat of combustion	1

Specimen Answer

Property	*Petrol*	*Kerosene*	*Hydrogen*	*Ethanol*
Heat of combustion kJ g^{-1}	48.2	47.6	142.5	29.8
Heat of combustion kJ L^{-1}	33 800	37 413	11.5	23 550

18 (continued)

(b) **MARKING GUIDELINES** (5 marks)

Criteria	Marks
Discusses all of the appropriate physical properties of each fuel compared to petrol and provides an assessment of their suitability to replace petrol	5
Discusses most of the appropriate physical properties of each fuel compared to petrol and provides an assessment of their suitability to replace petrol OR Discusses all of the appropriate physical properties of each fuel compared to petrol	3 -4
Discusses some of the physical properties of each fuel compared to petrol AND/OR provides an assessment of their suitability to replace petrol	1 - 2

19

(a) **MARKING GUIDELINES** (2 marks)

Criteria	Marks
Correctly calculates the concentration of the sodium carbonate solution, including units	2
Correctly calculates the moles of sodium carbonate used	1

Specimen Answer

$$\text{Moles } Na_2CO_3 = \frac{15.992}{106.0} = \mathbf{0.1502 \text{ moles}}$$

$$\text{Concentration of } Na_2CO_3 \text{ solution} = \frac{0.1502}{0.500} = \mathbf{0.3004 \text{ mol L}^{-1}}$$

(b) **MARKING GUIDELINES** (1 mark)

Criteria	Marks
Writes correctly balanced equation	1

Specimen Answer

$$Na_2CO_{3(aq)} + 2HNO_{3(aq)} \rightarrow 2NaNO_{3\,(aq)} + H_2O_{(l)} + CO_{2(g)}$$

19 (continued)

(c) **MARKING GUIDELINES** (2 marks)

Criteria	Marks
Correctly identifies indicator needed AND Identifies that endpoint is acidic	2
Correctly identifies indicator needed OR Identifies that endpoint is acidic	1

Specimen Answer

Methyl orange should be used, as the endpoint of the titration will be an acidic solution.

(d) **MARKING GUIDELINES** (3 marks)

Criteria	Marks
Correctly calculates the concentration of acid, including units	3
Correctly calculates the concentration of acid, without units OR Correctly calculates the moles of acid needed	2
Correctly calculates the moles of base used	1

Specimen Answer :

Moles of $Na_2CO_{3(aq)}$ used $= \frac{0.3004 \times 25}{1000}$

$= \mathbf{0.0075\ moles}$

Moles of HCl needed $= 2 \times 0.0075$

$= \mathbf{0.0150\ moles}$

Concentration of HCl $= \frac{0.0150}{0.0382}$

$= \mathbf{0.393\ mol\ L^{-1}}$

20

(a) **MARKING GUIDELINES** (3 marks)

Criteria	Marks
Correctly names and writes formulae for a naturally occurring acid and a naturally occurring base	3
Correctly names and writes formulae for a naturally occurring acid and a naturally occurring base OR Correctly names a naturally occurring acid and a naturally occurring base OR Correctly writes formulae for a naturally occurring acid and a naturally occurring base OR Correctly names and writes formula for a naturally occurring acid OR a naturally occurring base	2
Correctly names OR writes formula for a naturally occurring acid OR a naturally occurring base	1

Specimen Answer

Methanoic acid (HCOOH) occurs in bull-ants and bees, it is used for their "stings". $CaCO_3$ (calcium carbonate) occurs in limestone and marble rock.

(b) **MARKING GUIDELINES** (4 marks)

Criteria	Marks
Explains the use of acids as food additives, including examples of TWO <u>different</u> reasons for their use	4
Explains the use of acids as food additives, including TWO examples of their use	3
Correctly describes ONE use of acids in foods OR Correctly identifies TWO uses of acids in foods	2
Correctly identifies ONE use of acids in foods	1

Specimen Answer :

Acids are added to food to lower the pH of the food so that the growth of bacteria and fungi is inhibited. Ethanoic acid and sulfur dioxide are commonly used for this purpose. Acids can also be added to food to give it a "sharp" or sour flavour. Jams, sauces and food drinks often have citric acid or ethanoic acid added to food for this reason.