2009

Trial HSC Examination

Chemistry

General Instructions
Reading time – 5 minutes
Working time – 3 hours

* Write using blue or black pen
* Draw diagrams using pencil
* Approved calculators may be used
* Do NOT use liquid paper or white out on this exam paper. If you make a mistake, cross it out then continue writing.
* If you do use liquid paper/white out, anything written over it will NOT be remarked at a later date.
* A data sheet and periodic table are provided at the end of the paper and may be detached for your convenience.
* The multiple-choice answer sheet is provided on page 2 and should be detached for your convenience.

Write your student number on the front page of each section of the examination

Total marks 100
Section I
CORE MODULES
75 marks
This section has two parts, Part A and Part B.
Part A – 15 marks
Attempt Questions 1 – 15.
Allow about 30 minutes for this part.
Part B – 60 marks
Attempt Questions 16 – 30.
Allow about 1 hour and 45 minutes for this part.

Section II
OPTION MODULE
25 marks
Attempt ONE question only from this section.
Attempt Question 31 – Industrial Chemistry.
Allow about 45 minutes for this section.

Teacher-in-charge: Miss Jackson

Task Weighting: 40%

Multiple-choice Answer Sheet

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 change 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:

correct ↓

(A) ⊗ (B) ⊗ (C) ⬭ (D) ⬭

Part A

1.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
2.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
3.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
4.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
5.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
6.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
7.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
8.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
9.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
10.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
11.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
12.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
13.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
14.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
15.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭

Section I.

Part A.

15 marks

Attempt questions 1 - 15.
Allow about 30 minutes for this part.
Select the alternative A, B, C or D that best answers the question AND record your answer on the multiple-choice answer sheet.
The multiple-choice answer sheet is located on PAGE 2 and should be detached for your convenience.
Ensure you write your student number on the multiple-choice answer sheet.

1. If equal volumes of the following aqueous solutions are mixed, which one will have the highest pH?
   (A) 1 mol/L sodium hydroxide and 1 mol/L ethanoic (acetic) acid
   (B) 1 mol/L ammonia solution and 1 mol/L sulfuric acid
   (C) 1 mol/L sulfuric acid and 1 mol/L barium hydroxide
   (D) none - they will all be neutral and have a pH of 7

2. 25.0 mL of a solution of sulfuric acid that has a pH of 3.0 is pipetted into a 250.0 mL volumetric flask and distilled water added to make up exactly 250.0 mL of solution.
   What is the pH of the final solution?
   (A) 2.0
   (B) 3.7
   (C) 4.0
   (D) 4.3

3. What is produced when a basic oxide reacts with an acid?
   (A) hydrogen gas and a salt
   (B) water and a salt
   (C) oxygen and a salt
   (D) a salt only

4. Identify the conjugate acid of the polyatomic ion, HPO_4^{2-}.
   (A) PO_4^{3-}
   (B) H_3PO_4
   (C) $H_2PO_4^{1-}$
   (D) HPO_4^{1-}

5. Aluminium reacts with dilute sulfuric acid to form aluminium sulfate and hydrogen gas.
   What is the maximum mass of aluminium sulfate produced when 1.40 g of aluminium is added to 85.0 mL of 0.765 mol/L sulfuric acid?
   (A) 7.42 g
   (B) 11.1 g
   (C) 17.6 g
   (D) 22.2 g

6. Allan, a student, carries out an investigation to determine the pH of a variety of household substances using a pH probe.

Listed are seven features of experimental design that Allan used.

(1) calibrated the pH probe with a standard solution of 1.00 mol/L HCl
(2) repeated the measurements of each household substance several times
(3) compared his hypothesis with that of three other groups in the class
(4) compared his results with published results
(5) used the same volume of solution of each household substance
(6) compared his results with three other groups within the class
(7) rinsed the pH probe in distilled water several times between testing each household substance

Which list identifies features of experimental design that will primarily increase the reliability of the results Allan collects?

(A) 1, 2, 3, 4, 5, 6, 7
(B) 1, 3, 4, 5
(C) 2, 3, 6, 7
(D) 2, 6

7. The table below shows the pH of 0.1 mol/L solutions of three monoprotic acids, X, Y and Z.

Acid	**Concentration (mol/L)**	**pH**
X	0.1	2.1
Y	0.1	2.9
Z	0.1	1.0

The degree of ionisation of these acids can be calculated and would be:-

	Degree of ionisation (%)		
	Acid X	**Acid Y**	**Acid Z**
(A)	21	29	10
(B)	80	13	100
(C)	4.8	3.4	10
(D)	7.9	1.3	100

8. Which of the following is most likely to be a stable isotope?

(A) hydrogen-3
(B) oxygen-18
(C) chlorine-36
(D) calcium-40

9. Consider the following reaction.

$$Ca_{(s)} + 2Fe^{3+}_{(aq)} \rightarrow Ca^{2+}_{(aq)} + 2Fe^{2+}_{(aq)}$$

Determine the standard cell voltage.
(A) -2.10 V
(B) +2.10 V
(C) +3.64 V
(D) +4.41 V

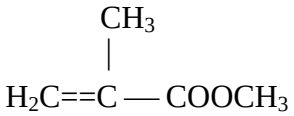
10. Consider the reaction:

$$Ca_{(s)} + H_2O_{(l)} \rightarrow H_{2(g)} + Ca^{2+}_{(aq)} + 2OH^-_{(aq)}$$

Which statement about this reaction is correct?
(A) water molecules are reducing agents
(B) oxygen atoms in water are oxidised to hydroxide ions
(C) hydrogen atoms in water are reduced to hydrogen gas
(D) this is not a redox reaction

11. Which polymer is made by the polymerisation of methyl methacrylate?

Methyl methacrylate



(A)

(B)

(C)

(D)

12. The structures of two commercially significant monomers are shown.

A **B**

Identify the correct statement.

(A) monomer A has the IUPAC name ethenyl chloride and forms the polymer, poly vinyl chloride
(B) monomer B forms the polymer polystyrene through addition polymerisation
(C) monomer A forms the polymer poly vinyl chloride through condensation polymerisation
(D) monomer B has the IUPAC name ethenyl benzene and forms a polymer via condensation polymerisation

13. How many isomers of the compound C_4H_9Cl exist?

(A) 2
(B) 4
(C) 6
(D) 8

14. Identify the element most likely to cause heavy metal water pollution.

(A) calcium
(B) iron
(C) lead
(D) sodium

15. Water treatment plants in Sydney carry out the following basic procedures, but not in the sequence listed.

1. sand filtration
2. sedimentation
3. flocculation
4. aeration
5. chlorination
6. screening

What is the correct order of these procedures?

(A) 4, 1, 6, 2, 3, 5
(B) 6, 4, 3, 2, 1 ,5
(C) 1, 6, 3, 2, 5, 4
(D) 4, 6, 2, 3, 1, 5

Section I (continued)

Part B.

60 marks

Attempt questions 16 – 28.
Read the whole of each question before commencing it.
Answer the questions in the spaces provided.
Allow about 1 hour and 45 minutes for this part.

Question 16. (2 marks)

Describe TWO factors that contribute to contamination of water in catchment areas. 2M

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Question 17. (3 marks)

A full bottle of 2.5 mol/L sulfuric acid was dropped in a laboratory accident. Solid sodium hydrogen carbonate was used to neutralise the spilled acid.

Justify the choice of solid sodium hydrogen carbonate to clean up the spill. Include relevant equation(s). 3M

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Question 18. (5 marks)

Citrus fruits have a sharp, sour taste that is due to the presence of citric acid.

(a) Draw the structural formula of citric acid. 1M

(b) Identify citric acid by its IUPAC name. 1M

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(c) "*When equal volumes of 0.01 mol/L solutions of citric acid and hydrochloric acid are neutralised using a standard solution of sodium hydroxide, the volume of sodium hydroxide used to neutralise the citric acid solution will be three times the volume used to neutralise the hydrochloric acid solution.*"
Critically assess this statement. 3M

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Question 19. (4 marks)
Sulfuric acid was classified as an acid by the theories proposed by Bronsted-Lowry, Lavoisier and Davy.
Explain why each of these three theories classified sulfuric acid as an acid. Use equations, where appropriate, in your response. 4M

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Question 20. (2 marks)
Ethanol can be used as a fuel extender added to petrol.
Explain why ethanol forms a solution with petrol (octane). 2M

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Question 21. (5 marks)
A student decarbonated a sample of soda water by opening the bottle it was in and leaving it for a period of time, weighing it at regular intervals. She also used a non-carbonated sample of water as a control, recording its mass at the same time intervals.

	Mass (g)					
	Initial (0 hours)	**After 12 hours**	**24 hours**	**36 hours**	**48 hours**	**60 hours**
soda water	385.0	382.6	381.1	380.7	380.3	380.0
plain water	385.0	384.7	384.2	383.7	383.4	383.0

(a) Identify the dependent variable in this investigation. 1M

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(b) Graph the information shown for each water sample on the same graph. 2M

This question continues on the next page.

(c) Interpret the trends shown by the graph. 2M

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Question 22. (3 marks)
Biopolymer carry bags are increasingly being used in place of bags made from polyethylene.
Discuss the benefits and problems associated with the use of biopolymer carry bags. 3M

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Question 23. (2 marks)
Outline TWO technologies used by scientists to collect data on ozone levels in the atmosphere. 2M

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Question 24. (4 marks)
(a) Identify the origins of CFCs in the atmosphere. 1M

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(b) Discuss, using relevant equations, the problems associated with the use of CFCs. 3M

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Question 25. (5 marks)
The smelting of chalcopyrite ($CuFeS_2$) during the production of copper can be represented by the reaction:-

$$2CuFeS_{2(s)} + 5O_{2(g)} + 2SiO_{2(s)} \rightarrow 2Cu_{(l)} + 4SO_{2(g)} + 2FeSiO_{3(l)}$$

(a) Calculate the volume (at 25 ^oC and 100 kPa) of sulfur dioxide that would be released into the atmosphere from the smelting of 1 tonne of chalcopyrite (assume the sulfide mineral is pure). 2M

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(b) The release of sulfur dioxide pollutes the atmosphere resulting in acid rain.
(i) Define the term "acid rain". 1M

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(ii) Outline one impact of acid rain on the environment. 1M

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(iii) Outline one impact of acid rain on society. 1M

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Question 26. (6 marks)
During your practical work, you performed a first-hand investigation to distinguish between an alkane and its corresponding alkene.

(a) Name the alkene used in your investigation. 1M

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(b) Identify a potential hazard in your investigation and outline how you addressed this hazard. 2M

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(c) Describe the procedure you used for your first-hand investigation. 3M

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Question 27. (3 marks)
Earlier this year a new transuranic element, *ununbium*, was produced. It existed for 0.05 seconds.

(a) Define the term transuranic element. 1M

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(b) Outline how transuranic elements such as ununbium are produced. 2M

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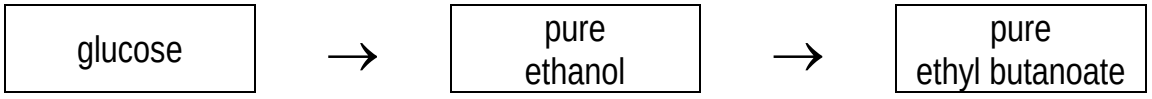
Question 28. (7 marks)
The flowchart shows a series of steps involved in the production of ethyl butanoate.



Describe the chemistry and procedures involved in each step, using labelled diagrams where appropriate. 7M

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Question 29. (4 marks)
Explain the need for monitoring the products of a chemical reaction such as combustion. 4M

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Question 30. (5 marks)
The Haber process is used to synthesise ammonia from its elements.

(a) Write a balanced equation for the reaction (include states). 1M

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(b) Explain the impacts of increased temperature on the reaction system. 4M

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Section II

25 marks

Attempt Question 31 – **Industrial Chemistry**.

Answer the questions in the separate writing booklet provided.
Ensure that you clearly identify each answer [eg. (a) (i) ….].
You may ask for additional writing booklets if required.
Allow about 45 minutes for this part.

Question 31 - Industrial Chemistry.

(a) (i) Outline one industrial use of sulfuric acid. 1M

(ii) Describe the Frasch process for extracting sulfur from mineral deposits. Illustrate your answer using a labelled diagram. 3M

(iii) One of the intermediate products in the synthesis of sulfuric acid is oleum.
Identify its formula. 1M

(iv) One step in the industrial production of sulfuric acid involves the conversion of sulfur dioxide into sulfur trioxide.
Justify the choice of reaction conditions used in the industrial conversion of sulfur dioxide into sulfur trioxide to optimise the yield in the shortest time possible. 6M

(b) You performed a first-hand investigation to qualitatively analyse an equilibrium reaction.

(i) Write a balanced equation to describe the equilibrium reaction you analysed. 1M

(ii) Describe the qualitative feature of this reaction that allowed you to analyse the effects of changes imposed on the equilibrium reaction. 2M

(c) (i) Compare anionic and cationic detergents in relation to their chemical structure. 2M

(ii) Account for the ability of a detergent molecule to cause the emulsification of water and oil when a mixture of water, oil and detergent is agitated. 3M

This question continues on the next page.

(d) Over a nickel catalyst, at a high temperature and in a closed container, ethane and steam react to form carbon monoxide and hydrogen.

$$C_2H_{6(g)} + 2H_2O_{(g)} \leftrightarrow 2CO_{(g)} + 5H_{2(g)} \qquad \Delta H = -200 \text{ kJ/mol}$$

The equilibrium constant has a value of 0.0060 at a temperature of 727 °C and a pressure of 202 kPa.

(i) Write the equilibrium constant expression for this reaction. 1M

(ii) Predict what will happen to the value of K in each of the following cases.
Your answer should be in terms of "*increases, decreases or remains the same*".

(x) temperature is increased
(y) pressure is increased
(z) a catalyst is added 2M

(iii) In a mixture of ethane, steam, carbon monoxide and hydrogen the concentrations of species are :-

species	**$C_2H_{6(g)}$**	**$H_2O_{(g)}$**	**$CO_{(g)}$**	**$H_{2(g)}$**
concentration (mol/L)	0.055	0.037	0.021	0.100

Evaluate whether this mixture is at equilibrium. 3M

HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

DATA SHEET

Avogadro constant, N_A ..... 6.022×10^{23} mol^{-1}

Volume of 1 mole ideal gas: at 100 kPa and

at 0°C (273.15 K) ..... 22.71 L

at 25°C (298.15 K) ..... 24.79 L

Ionisation constant for water at 25°C (298.15 K), K_w ..... 1.0×10^{-14}

Specific heat capacity of water ..... 4.18×10^3 J kg^{-1} K^{-1}

Some useful formulae

$$pH = -\log_{10}[H^+] \qquad \Delta H = -mC\Delta T$$

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2.94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2.91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2.87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2.71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2.36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1.68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1.18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0.83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0.76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0.34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0.80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

PERIODIC TABLE OF THE ELEMENTS

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.41 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [97.91] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po [209.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223] Francium	88 Ra [226] Radium	89–103 Actinoids	104 Rf [261] Rutherfordium	105 Db [262] Dubnium	106 Sg [266] Seaborgium	107 Bh [264] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

KEY

Atomic Number
79
Au
Symbol of element
Atomic Weight
197.0
Gold
Name of element

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [145] Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac [227] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237] Neptunium	94 Pu [244] Plutonium	95 Am [243] Americium	96 Cm [247] Curium	97 Bk [247] Berkelium	98 Cf [251] Californium	99 Es [252] Einsteinium	100 Fm [257] Fermium	101 Md [258] Mendelevium	102 No [259] Nobelium	103 Lr [262] Lawrencium

For elements that have no stable or long-lived nuclides, the mass number of the nuclide with the longest confirmed half-life is listed between square brackets.

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (October 2005 version) is the principal source of data. Some data may have been modified.

Marking Guidelines THSC Exam 2009
Year 12 CHEMISTRY

Multiple choice

Question	Answer		Question	Answer
1	A		9	C
2	C		10	C
3	B		11	B
4	C		12	B
5	A		13	B
6	D		14	C
7	D		15	B
8	D			

16.

Marking criteria	*Marks*
Identifies TWO factors and provides their main features	2
Identifies ONE factor and provides its main features OR Identifies TWO factors	1

17.

Marking criteria	*Marks*
Provides an equation for the neutralisation reaction between an acid and a metal carbonate AND Outlines TWO advantages of using $NaHCO_3$ with an acid spill	3
Provides an equation for the neutralisation reaction between an acid and a metal carbonate AND Outlines ONE advantage of using $NaHCO_3$ with an acid spill	2
Identifies TWO properties of $NaHCO_3$ that make it useful when dealing with an acid spill	1

18. a.

Marking criteria	*Marks*
Presents a structural formula that shows the correct number and type of each atom, their correct spatial arrangement and all covalent bonds drawn	1

18. b.

Marking criteria	*Marks*
Correctly identifies citric acid by its IUPAC name as 2-hydroxypropane-1,2,3-tricarboxylic acid	1

18. c.

Marking criteria	*Marks*
Provides a judgment about the correctness of the statement – "the statement is correct". AND Outlines TWO reasons for this judgement → (1) NaOH is a strong base so even though citric acid is a weak acid whereas HCl is a strong acid, both acids will be fully consumed in the neutralisation reaction with NaOH. (2) Citric acid is triprotic whereas hydrochloric acid is monoprotic, thus the neutralisation of citric acid will requires three times the volume of NaOH.	3
Provides a judgment about the correctness of the statement – "the statement is correct". AND Outlines ONE reason for this judgement →see above for an appropriate reason.	2
Identifies that NaOH is a strong base, HCl is a strong acid and citric acid is a weak acid OR Identifies that HCl is a strong, monoprotic acid and citric acid is a weak, triprotic acid.	1

19.

Marking criteria	*Marks*
Outlines the theory put forward by each of the THREE scientists, relating H_2SO_4 to each AND Provides an equation that demonstrates H_2SO_4 acting as a proton donor	4
Outlines the theory put forward by each of the THREE scientists, relating H_2SO_4 to each	3
Outlines the theory put forward by TWO of the scientists	2
Outlines the theory put forward by ONE of the scientists	1

20.

Marking criteria	*Marks*
Identifies that ethanol has a non-polar component AND Identifies that petrol (octane) is also a non-polar molecule AND Outlines that dispersion forces will form between them, allowing a solution to form (like dissolves like)	2
Identifies that ethanol has a non-polar component AND Identifies that petrol (octane) is also a non-polar molecule AND Outlines that this will allow a solution to from	1

21.a.

Marking criteria	*Marks*
Identifies the dependent variable as the mass of bottle and the liquid it contains	1

21.b.

Marking criteria	*Marks*
Graph shows TWO line graphs that have accurately plotted points and lines of best fit for each AND Provides a key that distinguishes between the soda water and the plain water lines	2
Graph shows TWO line graphs that have accurately plotted points and lines of best fit for each	1

21.c.

Marking criteria	*Marks*
Identifies that both soda water and plain water loss	2

mass as time progresses AND Identifies that the soda water loses mass at a decreasing rate whereas the plain water losses mass at a constant rate	
Identifies that both soda water and plain water loss mass as time progresses OR Identifies that the soda water loses mass at a decreasing rate whereas the plain water losses mass at a constant rate	1

22.

Marking criteria	*Marks*
Outlines TWO benefits and TWO problems associated with the use of biopolymer carry bags	3
Outlines TWO benefits and ONE problem associated with the use of biopolymer carry bags OR Outlines ONE benefit and TWO problems associated with the use of biopolymer carry bags	2
Outlines ONE benefit and ONE problem associated with the use of biopolymer carry bags	1

23.

Marking criteria	*Marks*
Identifies TWO technologies and give the main features of each	2
Identifies ONE technology and give its main features	1

24.a.

Marking criteria	*Marks*
Identifies TWO sources of CFCs	1

24.b.

Marking criteria	*Marks*
(1) Provides a series of equations to show how a CFC eventually decomposes ozone (2) Relates the destruction of ozone to the increased levels of ultraviolet radiation reaching the Earth's surface (3) Outlines one problem that results from this increased level of UV radiation	3
Provides TWO of the three points outlined above	2
Provides ONE of the three points outlined above	1

25.a.

Marking criteria	*Marks*
Calculates and states the volume of SO_2 as 270132 L	2
Calculates the number of moles of $CuFeS_2$ as 5448 mol	1

25.b.(i).

Marking criteria	*Marks*
States that acid rain has a pH below 5 (or 5.5)	1

25.b.(ii).

Marking criteria	*Marks*
Outlines one impact of acid rain on the environment	1

25.b.(iii).

Marking criteria	*Marks*
Outlines one impact of acid rain on society	1

26.a.

Marking criteria	*Marks*
Identified an alkene that could be used in this experiment	1

26.b.

Marking criteria	*Marks*
Identifies one hazard and outlined how the hazard was addressed.	2
Identifies one hazard (*It is worth noting that a physical property is not necessarily a hazard. A link must be made to how this makes the substance a danger. It is worth going back and checking the MSDS information (easily found online) for the reagents you have encountered in this course.)*	1

26.c.

Marking criteria	*Marks*
Procedure is described thoroughly and could be followed to produce results that are both valid and reliable. (Includes – reagents, exact quantities, equipment, controlled variables, repetition and a logical and informative description)	3
Procedure is described well (but lacking one or more exact details) and could be used to produce results that are either valid or reliable	2
A method is outlined that has potential, if more detail was provided, to produce results that are valid and reliable.	1

27.a.

Marking criteria	*Marks*
States that a transuranic element is an element that occurs after uranium on the periodic table	1

27.b.

Marking criteria	*Marks*
Identifies TWO machines (or methods) and outlines how they both produce transuranic elements OR Identifies one machine and provides extensive details	2
Names ONE method of producing transuranic elements	1

28.

Marking criteria	*Marks*
Provides a detailed description, including reactions (chemistry) and conditions, for each of the following steps; → fermentation → purification of ethanol →esterification →purification of ethyl butanoate AND Includes ONE (6) or TWO (7) relevant, labelled diagrams	6 - 7
Provides a detailed description of 2 of the steps listed above AND outlines the other 2 steps AND includes 1 diagram	5
Provides a detailed description of 2 of the steps above AND includes 1 diagram	4
Outlines 2 of the steps identified above	3

Outlines 1 of the steps identified above	2
Includes one correct fact relevant to the process	1

29.

Marking criteria	*Marks*
(1) Displays a thorough knowledge of the possible different reaction products, either due to identified varying reaction conditions OR due to the presence of impurities in the reaction reactants, using an appropriate example. (2) Outlines ONE or TWO reasons why monitoring of the products is essential (reasons specifically related to the products of the reaction)	3 - 4
Describes a chemical reaction that can produce different products. AND Provides a reason why monitoring the reaction is needed.	2
Describes a chemical reaction that can produce different products. OR Provides a reason why monitoring the reaction is needed.	1

30.a.

Marking criteria	*Marks*
Correct, balanced equation for the equilibrium reaction between nitrogen gas, hydrogen gas and ammonia gas that includes states and an equilibrium arrow.	1

30.b.

Marking criteria	*Marks*
Outlines TWO cause and effect relationships of increasing temperature on the Haber process, specifically → (1) *Yield of ammonia is decreased* (effect) because the reverse endothermic reaction that absorbs heat will be favoured (Le Chatelier's Principle) (cause) (2) *Rate of reaction is increased* (effect) because the particles will have more kinetic energy and therefore will collide more frequently and with greater success (Collision Theory) (cause)	4
Outlines THREE of the cause/effect statements from those shown above	3
Outlines TWO of the cause/effect statements from those shown above	2
Outlines ONE of the cause/effect statements from those shown above	1

OPTION – Industrial Chemistry

a. (i).

Marking criteria	*Marks*
Identifies an *industrial use* of sulfuric acid and provides its main features.	1

a.(ii).

Marking criteria	*Marks*
(1) Draws a diagram that is accurately and correctly labelled. (2) Describes, thoroughly, the main features of the THREE principal steps of the Frasch process. In brief → • *Injection of superheated water → melts sulfur, forming a water/sulfur mixture* • *injection of hot, compressed air →forms an emulsion of water and sulfur AND lift the emulsion from the underground cavern to the surface of the ground* • *emulsion placed into a cooling pond →emulsion mixture cools on contact with the air, the sulfur solidifies at air temps (while the water remains liquid) and settles out of the mixture*	3
(1) Draws a diagram that is accurately and correctly labelled. (2) Describes, thoroughly, the main features of the TWO of the principal steps of the Frasch process.	2
Describes, thoroughly, the main features of the ONE of the principal steps of the Frasch process.	1

a.(iii).

Marking criteria	*Marks*
Identifies the formula of oleum as $H_2S_2O_7$	1

a.(iv).

Marking criteria	*Marks*
(1) Provides a correct, balanced equation for the conversion of sulfur dioxide into sulfur trioxide. (2) Outlines FOUR reaction conditions that are used in the industrial conversion of SO_2 into SO_3. (3) Provides specific details for TWO (5) OR THREE (6) of these conditions :- temp (^oC)= 550/600 → 400 → 400 → 400; pressure = 150 kPa; catalyst = V_2O_5; air:SO_2 ratio = 5:1 (4) Thoroughly justifies how each of the FOUR conditions increases yield &/or increases reaction rate.	5 - 6
(1)Outlines ONE (2 marks), TWO (3 marks) or THREE (4 marks) reaction conditions that are used in the conversion of SO_2 into SO_3. (2) Justifies the conditions by identifying whether each increases yield or increases reaction rate.	2 - 4
Identifies ONE reaction condition used in the conversion of SO_2 into SO_3.	1

b.(i)

Marking criteria	*Marks*
Provides a correct, balanced equation for an equilibrium reaction that could be monitored qualitatively (ie. macroscopic properties that are distinctive and observable.)	1

b.(ii).

Marking criteria	*Marks*
Identifies a qualitative feature of the equilibrium system described in (i) that could be used to monitor the system as changes are imposed on it (e.g. colour) AND provides the specific characteristics of this feature with respect to the reactants and the products of the reaction.	2
Identifies a qualitative feature that could be used to monitor the equilibrium system (e.g. colour)	1

c.(i).

Marking criteria	*Marks*
Provides TWO comparisons (similarities and/or differences) between the structure of an anionic and a cationic detergent. The correct text type must be used.	2
Provides ONE comparison (similarity and/or difference) between the structure of an anionic and a cationic detergent. The correct text type must be used.	1

c.(ii).

Marking criteria	*Marks*
Identifies the THREE relevant features of a detergent molecule that contribute to its ability to emulsify oil and water (namely, polar head, non-polar hydrocarbon tail, like-charged heads) AND Relates each feature to its role in the formation of an emulsion of oil and water when detergent is added and the mixture is agitated, specifically → *Upon agitation, the oil is broken up into very small droplets that are suspended throughout the water uniformly, each with the detergent molecules organised so that the hydrocarbon tail is buried into the oil while the like-charged polar heads are coating the surface of each droplet and interacting with water molecules.* (1) A detergent molecule has a polar head that is attracted to polar water molecules via dipole-dipole interactions. (2) A detergent molecule has a non-polar hydrocarbon tail that is attracted to non-polar oil via dispersion forces. (3) The like-charged polar heads surrounding each oil droplet repel preventing the oil droplets from recombining.	3
Outlines TWO of the features of a detergent molecule and relates each to its role in the emulsification process.	2
Outlines ONE of the features of a detergent molecule and relates it to its role in the emulsification process.	1

d.(i).

Marking criteria	*Marks*
Writes a fully detailed and correct equilibrium constant expression (must include K =)	1

d.(ii).

Marking criteria	*Marks*
Predicts the impact on the value of K for ALL THREE changes being imposed on the equilibrium system correctly → (x) value of K decreases (y) value of K remains the same (z) value of K remains the same	2
Predicts the impact on the value of K for ONE of the changes being imposed on the equilibrium system correctly → see above	1

d.(iii).

Marking criteria	*Marks*
Answer displays a thorough understanding of equilibrium constant calculations by showing → (1) The expression for the reaction quotient, Q (not K!!). (2) The calculated value of Q as 5.58×10^{-5}. (3) Makes the judgement that the system is NOT in equilibrium.	
Answer gives TWO of the three steps outlined above.	2
Answer gives ONE of the three steps outlined above.	1