QATs
Quality Assessment Tasks

Student Number

2008
YEAR 11
FINAL EXAMINATION

Chemistry

General Instructions

1. Reading time – 5 minutes

- Working time – 2 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Use the data sheet and Periodic Table provided
- Use the multiple-choice answer sheet provided
- Write your Student Number at the top of this page, page 9 and page 23, the multiple-choice answer sheet.

Total marks – 75

This paper 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 16-25
- Allow about 1 hour and 30 minutes for this part

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Part A – 15 marks
Attempt Questions 1-15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet provided for Questions 1-15.

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1 The correct formula for ammonium carbonate is

(A) $(NH_3)_2CO_3$
(B) $(NH_4)_2CO_3$
(C) NH_3CO_2
(D) NH_4CO_3

2 A student was asked to separate a sample of ethanol (BP 78°C) from a mixture of ethanol and water. Which of the following techniques would be used?

(A) Filtration, followed by condensation
(B) Evaporation, followed by filtration
(C) Decanting, followed by evaporation
(D) Evaporation, followed by condensation

3 Which of the following shows the atomic structure of an isotope of potassium?

	protons	*electrons*	*neutrons*
(A)	39	39	19
(B)	19	19	20
(C)	19	19	39
(D)	20	20	19

4 The list containing pure substances only is

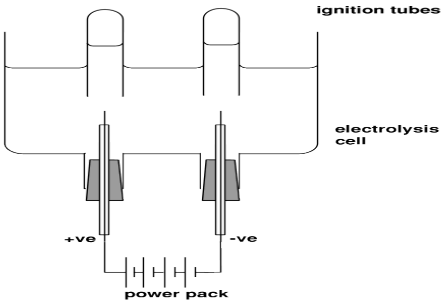
(A) water, petrol, ice, air

(B) air, ice, water, steam

(C) diamond, iodine, sodium chloride, zinc

(D) magnesium, calcium, iron, bauxite

5 The apparatus below was used to electrolyse water into its elements.



Which of the following is a correct statement about this process?

(A) The hydrogen-oxygen bonds in water will be broken by this process

(B) The heating of water to 200°C, under high pressure, can achieve the same result as electrolysis

(C) A physical process to separate the water molecules from each other will occur

(D) Bubbles of hydrogen and oxygen form at one electrode, while no bubbles are produced at the other electrode

6 Which of the following substances contains atoms bonded by the sharing of electrons?

(A) Magnesium carbonate

(B) Calcium chloride

(C) Copper oxide

(D) Helium

7 Methane gas (CH_4) was burnt with a limited supply of oxygen in a sealed container. One of the products was solid carbon (soot). The solid carbon was carefully scraped from the inside of the container and was found to weigh 54 g. Assume the carbon is pure $^{12}_{6}C$. How many carbon atoms would there be in the weighed sample?

(A) 4.5 atoms

(B) 5.4×10^2 atoms

(C) 2.7×10^{23} atoms

(D) 2.7×10^{24} atoms

8 Photosynthesis can be represented by the equation:

$$6CO_2\,(g) + 6H_2O\,(l) + \text{energy} \rightarrow C_6H_{12}O_6\,(aq) + 6O_2\,(g)$$

Calculate the mass of glucose produced when 54 g of water reacts with excess carbon dioxide during photosynthesis.

(A) 30 g

(B) 90 g

(C) 180 g

(D) 1080 g

9 The volume of water that needs to be added to 100 mL of 0.4 mol/L HCl to dilute it to a concentration of 0.04 mol/L is:

(A) 90 mL

(B) 100 mL

(C) 900 mL

(D) 1000 mL

10 A hot nail was dropped into 100 g of water, initially at 25°C. The temperature rose to 37.5°C. The amount of energy absorbed by the 100 g of water was closest to

(A) 0.418 kJ

(B) 5.225 kJ

(C) 1250 kJ

(D) 5255 kJ

11 Which of the following lists elements in order of increasing electronegativity?

(A) Li, Na, K

(B) C, Mg, Na

(C) K, Mg, F

(D) F, Cl, Br

12 The five elements listed below are found in the same period of the Periodic Table.

Na Mg Al Si P

Which of the following is a correct statement about their properties?

(A) They are all good conductors of electricity

(B) Their melting points decrease across the Periodic Table from left to right

(C) Their chemical reactivities increase across the Periodic Table from left to right

(D) Their first ionisation energies increase across the Periodic Table from left to right

13 A 146 g sample of sodium chloride was dissolved in 500 mL of pure water. The concentration of the solution is closest to:

(A) 2.5 mol/L

(B) 5.0 mol/L

(C) 7.5 mol/L

(D) 10.0 mol/L

14 Which of the following processes will require the most energy?

(A) $Al^{+} \rightarrow Al^{4+}$

(B) $Al^{+} \rightarrow Al^{2+}$

(C) $Al^{2+} \rightarrow Al^{3+}$

(D) $Al^{+} \rightarrow Al^{3+}$

15 The reaction between nitrogen and hydrogen to produce ammonia gas is represented by the equation:

$N_2(g) \; + \; 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92$ kJ/mol $N_2(g)$

If 170 tonnes (170 x 10^3 kg) of ammonia are produced from nitrogen and hydrogen, the amount of energy released is:

(A) 460 kJ

(B) 920 kJ

(C) 4.60 x 10^8 kJ

(D) 9.20 x 10^8 kJ

End of Part A

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QATs
Quality Assessment Tasks

2008 YEAR 11 FINAL EXAMINATION

Chemistry

Student Number

Part B – 60 marks
Attempt Questions 16-25
Allow about 1 hour and 30 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 16 (6 marks) **Marks**

The element carbon is present both in the living and non-living environment on Earth. It has also been detected in asteroids entering our solar system.

(a) TWO common isotopes of carbon exist; carbon-12 and carbon-14. Use these examples to explain the meaning of the term 'isotopes'. Identify the composition of BOTH isotopes of carbon. **2**

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Question 16 continues on the next page

Question 16 (continued) **Marks**

(b) Write the electronic configuration of an atom of carbon. **1**

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(c) (i) Define the term ‘allotropes’. **1**

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(ii) Would you expect the physical properties of allotropes to be similar or different? Explain your answer, including an example of a physical property of the allotropes of carbon in your response. **2**

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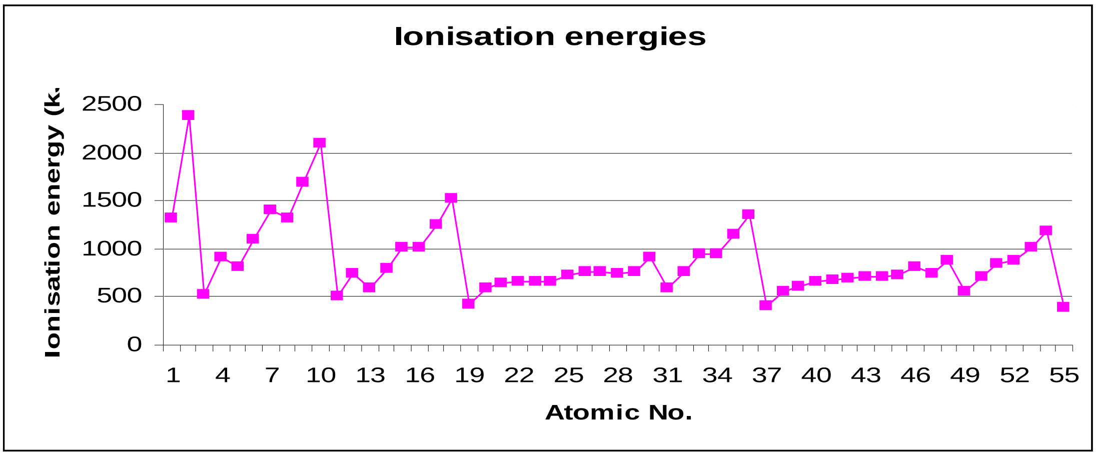
Question 17 (6 marks) **Marks**

The graph below shows the 1st ionisation energies of the first 55 elements.



(a) Outline why the shape of the graph varies in this way. **1**

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(b) Explain why the elements with Atomic Numbers 3, 11, 19, 37 and 55 have much lower 1st ionisation energies than the elements immediately preceding them (atomic numbers 2, 10, 18, 36 and 54). **3**

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(c) Explain why the Periodic Table developed by Mendeleev in 1869 was more widely accepted by chemists than earlier models of the periodic table. **2**

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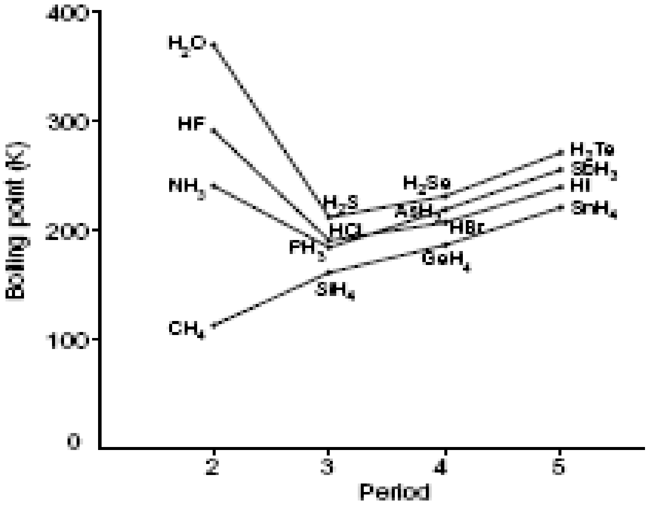
Question 18 (4 marks) **Marks**

The graphs below show the boiling points of hydrogen compounds of the Group 4, 5, 6 and 7 elements.



(a) Explain why you would expect the boiling points of the hydrogen compounds to increase as the period number increases. **2**

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(b) Explain why the boiling points of water, hydrogen fluoride and ammonia are abnormally high. **2**

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Question 19 (4 marks) **Marks**

The metal zinc reacts with hydrochloric acid to produce hydrogen gas.

(a) Write TWO half-equations and an overall ionic equation to represent this reaction. **2**

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(b) Calculate the mass of zinc required to produce 7.5 g of hydrogen. **2**

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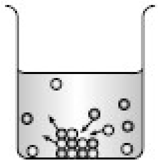
Question 20 (4 marks) **Marks**

Magnesium chloride was added to water until no more would dissolve and lumps of solid remained in the beaker.



(a) Write an equation to represent the reversible reactions which are occurring in the beaker. **1**

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(b) Explain why magnesium chloride will dissolve in water. **1**

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(c) Explain why a solution of magnesium chloride will conduct electricity whereas solid magnesium chloride will not. **2**

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Question 21 (11 marks) **Marks**

During your study of metals, you performed a first-hand investigation to place metals in order of their activity.

(a) Explain how the student would carry out an investigation to determine the relative activities of the metals calcium, iron and copper. **2**

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(b) Explain the results and conclusions of the investigation, including balanced equations for reactions you describe. **4**

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Question 21 continues on the next page

(c) 'The methods used to extract metals from their ores depend, to a large extent, on the activity of the metal'. **5**
Assess this statement, referring to the methods used for extraction of aluminium and copper.

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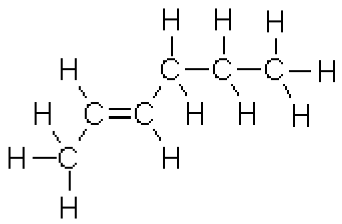
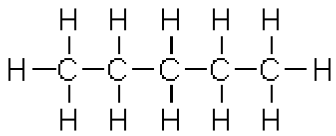
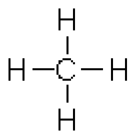
Question 22 (12 marks) **Marks**

The structural formulae of THREE compounds are shown below.


Compound 1


Compound 2


Compound 3

(a) Use IUPAC nomenclature to identify the THREE compounds. **3**

Compound 1 =

Compound 2 =

Compound 3 =

(b) Do these THREE compounds belong to the same homologous series? Explain your answer, identifying the homologous series into which these compounds are classified. **2**

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(c) Explain why these THREE compounds are all insoluble in water. **2**

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Question 22 continues on the next page

(d) Compare, qualitatively, the melting points of the THREE compounds with the melting points of other compounds such as sodium chloride and silicon dioxide (silica) and explain your answer in terms of structure and bonding. **5**

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Question 23 (2 marks) **Marks**

The table shows the simplified solubility rules for a range of substances.

Anion	***Formula***	***Cation***	
		Soluble	***Insoluble***
nitrates	NO_3^-	all	
acetates	CH_3COO^-	all	
chlorides	Cl^-	most	Ag^+, Pb^{2+}
sulfates	SO_4^{2-}	most	Ba^{2+}, Ca^{2+}, Pb^{2+}, Ag^+
sulfides	S^{2-}	Group 1, NH_4^+, Group 2	most
hydroxides	OH^-	Group 1, NH_4^+, Ba^{2+}	most
carbonates	CO_3^{2-}	Group 1, NH_4^+	most

Write ionic equations to represent precipitation reactions which occur when the following solutions are mixed. If no reaction occurs, write 'NO REACTION'.

(a) Solutions of copper sulfate and sodium hydroxide are mixed. **1**

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(b) Solutions of sodium carbonate and potassium nitrate are mixed. **1**

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Question 24 (6 marks) **Marks**

Combustion reactions are all exothermic reactions.

(a) Draw an energy profile for a combustion reaction, identifying the heat of reaction and the activation energy. **2**

(b) Explain the exothermic nature of combustion reactions in terms of the breaking and making of chemical bonds. **2**

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(c) Identify a pollutant formed during combustion of organic compounds and outline why it is regarded as a pollutant. **2**

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Question 25 (5 marks) **Marks**

The rate of a reaction can be influenced by the presence of a catalyst.

(a) Explain how a named catalyst affects the reaction rate in a specified reaction. **2**

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(b) (i) Identify TWO factors (apart from the use of a catalyst) which will increase the reaction rate. **1**

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(ii) Explain how EACH of these factors influences the rate of reaction. **2**

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End of Paper

Student Number

YEAR 12 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION 2008

CHEMISTRY– 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 have changed your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

A ⊗ B ⊗ ← *correct* C ○ D ○

ATTEMPT ALL QUESTIONS

Question				
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 ○

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

$\mathrm{pH} = -\log_{10}[\mathrm{H}^+]$ $\Delta H = -m\,C\,\Delta T$

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

KEY

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

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							

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.

QATs
Quality Assessment Tasks

2008 YEAR 11 FINAL EXAMINATION

CHEMISTRY – MAPPING GRID

Exam Section	Question	Marks	Syllabus/Course outcomes	Content	Targeted performance bands	Answer
Part A: Multiple Choice	1	1	P13	8.2.3	2-3	B
	2	1	P11	8.2.1	3-4	D
	3	1	P6	8.2.3	3-4	B
	4	1	P6	8.2.3	2-3	C
	5	1	P6, P8	8.2.4	3-4	A
	6	1	P6	8.2.3	5-6	A
	7	1	P10	8.3.4	4-5	D
	8	1	P10	8.3.4	4-5	B
	9	1	P10	8.4.4	4-5	C
	10	1	P7, P10	8.4.5	3-4	B
	11	1	P6	8.3.3	4-5	C
	12	1	P6	8.3.3	3-4	D
	13	1	P10	8.4.4	3-4	B
	14	1	P6	8.3.3	3-4	A
	15	1	P7, P10	8.5.4	5-6	C
Part B: Extended Response	16	6	P6, P13	8.2.3, 8.5.2	2-4	
	17	6	P1, P6, P13	8.3.4	2-5	
	18	4	P6, P14	8.4.2	3-5	
	19	4	P8, P10, P13	8.3.2, 8.3.4	3-5	
	20	4	P8, P13	8.2.5, 8.4.3	3-4	
	21	11	P8, P11, P13	8.3.2, 8.3.5	2-6	
	22	12	P6, P7, P9, P13	8.2.5, 8.4.3, 8.5.3	2-6	
	23	2	P8, P13	8.4.4	3-4	
	24	6	P4, P7, P10, P13	8.5.4	2-4	
	25	5	P4, P7, P8	8.5.5	2-5	

QATs
Quality Assessment Tasks

2008 YEAR 11 FINAL EXAMINATION

CHEMISTRY – MARKING GUIDELINES

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

Part A – 15 marks
Questions 1-15 (1 mark each)

Question	Correct Response	Outcomes Assessed	Targeted Performance Bands
1	B	P13	2-3
2	D	P11	3-4
3	B	P6	3-4
4	C	P6	2-3
5	A	P6, P8	3-4
6	A	P6	5-6
7	D	P10	4-5
8	B	P10	4-5
9	C	P10	4-5
10	B	P7, P10	3-4
11	C	P6	4-5
12	D	P6	3-4
13	B	P10	3-4
14	A	P6	3-4
15	C	P7, P10	5-6

Part B – 60 marks
Question 16 (6 marks)
16 (a) (2 marks)
Outcomes Assessed: P6, P13
Targeted Performance Bands: 2-3

Criteria	Marks
• Correctly explains the term 'isotopes', AND • Correctly identifies the composition of carbon-12 and carbon-14	2
• Correctly explains the term 'isotopes', OR • Correctly identifies the composition of carbon-12 and carbon-14	1

Sample answer
Isotopes are different atoms of the same element, which differ in their number of neutrons. Carbon-12 has 6 protons, 6 electrons and 6 neutrons while carbon-14 has 6 protons, 6 electrons and 8 neutrons.

16 (b) (1 mark)
Outcomes Assessed: P6
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct answer	1

Sample answer
2,4.

16 (c) (i) (1 mark)
Outcomes Assessed: P13
Targeted Performance Bands: 2-3

Criteria	Mark
• Defines 'allotropes'	1

Sample answer
Allotropes are different physical forms of the same element. The atoms in different allotropes of the same element are bonded into different structures.

Question 16 (continued)

16 (c) (ii) (2 marks)
Outcomes Assessed: P6, P13
Targeted Performance Bands: 2-4

Criteria	Marks
• Explains a different physical property of allotropes, AND • Explains a different physical property of diamond and graphite (or buckminsterfullerene)	2
• Explains a different physical property of allotropes, OR • Explains a different physical property of diamond and graphite (or buckminsterfullerene)	1

Sample answer
The allotropes of an element (e.g. carbon, which has 3 forms, diamond, graphite and buckminsterfullerene) have different physical properties because the atoms are bonded into different structures. Diamond is a non-conductor of electricity (because all the electrons are fixed in 3-D covalent bonding) whereas graphite conducts electricity (because the structure is layered, with delocalised electrons between the layers which are able to move to carry a current).

Question 17 (6 marks)
17 (a) (1 mark)
Outcomes Assessed: P6, P13
Targeted Performance Bands: 2-3

Criteria	Mark
• Outlines why the shape of the graph varies	1

Sample answer
The shape of the graph shows a periodic variation; ie: it varies according to the position of elements in the Periodic Table. For example, the noble gases are at the maxima in the graph, the Group 1 elements are at the minima.

Question 17 (continued)

17 (b) (3 marks)
Outcomes Assessed: P6
Targeted Performance Bands: 3-5

Criteria	Marks
• Identifies elements 3, 11, 19, 37 and 55 as the Group 1 elements and the elements 2, 10, 18, 36 and 54 as the noble gases, AND • Explains the relative 1st ionisation energies of atoms in terms of their size and force of attraction between the valency electrons and the nucleus, AND • Relates the 1st ionisation energies to stability of atomic structure	3
• Identifies elements 3, 11, 19, 37 and 55 as the Group 1 elements and the elements 2, 10, 18, 36 and 54 as the noble gases, AND • Explains the relative 1st ionisation energies of atoms in terms of their size and force of attraction between the valency electrons and the nucleus, OR • Relates the 1st ionisation energies to stability of atomic structure	2
• Identifies elements 3, 11, 19, 37 and 55 as the Group 1 elements and the elements 2, 10, 18, 36 and 54 as the noble gases, OR • Explains the relative 1st ionisation energies of atoms in terms of their size and force of attraction between the valency electrons and the nucleus, OR • Relates the 1st ionisation energies to stability of atomic structure	1

Sample answer
Elements with Atomic Numbers 3, 11, 19, 37 and 55 are Group 1 metals, which have large atoms and only 1 electron in the valency shell. The large size of these atoms means that there is only a weak force of attraction between this outermost electron and the positive charge in the nucleus and only a small amount of energy (the 1st ionisation energy) is needed to remove this electron.
Elements with Atomic Numbers 2, 10, 18, 36 and 54 are noble gases. These have very stable structures, with complete valency electron shells. Comparatively, they are much smaller atoms than the metals immediately following them in the Periodic Table. As a result of their small size and stability, the noble gases have higher 1st ionisation energies, as more energy is needed to remove an electron from a full shell and from close to the positive charge of the nucleus.

17 (c) (2 marks)
Outcomes Assessed: P1
Targeted Performance Bands: 3-5

Criteria	Marks
• Explains that Mendeleev's Periodic Table was more widely accepted because he was able to predict (correctly) the properties of as-yet-undiscovered elements	2
• Identifies some difference between Mendeleev's Periodic Table and those developed earlier	1

Question 17 (continued)

Sample answer
Mendeleev's table listed all the elements known in 1869 in order of their atomic weights and linked those elements with similar properties. Hence families of elements with similar properties or a regular change in properties (such as the Group 1 metals and halogens) were identified and linked together on the table. This allowed the prediction of properties of known elements but also the prediction of properties of as-yet-undiscovered elements.
Other chemists had developed lists or tables of elements which also recognised the existence of families of elements (such as Newland's Law of Octaves, Doebereiner's Triads and Meyer – whose table closely resembled Mendeleev's). It was Mendeleev's ability to predict both the physical and chemical properties of elements before they were discovered and the subsequent correctness of his prediction which led to his table achieving wider acceptance than those of the earlier chemists or that of Meyer.

Question 18 (4 marks)
18 (a) (2 marks)
Outcomes Assessed: P6, P14
Targeted Performance Bands: 3-5

Criteria	Marks
• Explains the prediction of increase in boiling point with increase in period number in terms of increased molecular mass and size, AND increased forces of attraction	2
• Relates the increase in boiling point to increased molecular mass and size, OR to increased forces of attraction	1

Sample answer
As the period number increases, the hydrogen compounds increase in mass (since the central atoms become heavier) and in size (since there are more shells of electrons, holding more electrons in total). More energy is required to boil a heavier molecule than a light molecule and more energy is required to overcome the stronger dispersion forces between molecules having greater number of electrons. Hence the increasing boiling points, as shown for the hydrogen compounds of the Group 4 elements, would be predicted for the boiling points of the other hydrogen compounds of the other 3 groups.

18 (b) (2 marks)
Outcomes Assessed: P6, P14
Targeted Performance Bands: 3-5

Criteria	Marks
• Explains the high boiling points in terms of hydrogen bonding	2
• Identifies hydrogen bonding as impacting on the boiling points	1

Question 18 (continued)
Sample answer
The compounds water, hydrogen fluoride and ammonia have abnormally high boiling points (even though they are comparatively low molecular mass molecules, with fewer electrons than those of the Period 3, 4 and 5 hydrides) because of hydrogen bonding.

Oxygen, fluorine and nitrogen are very electronegative atoms (much more electronegative than the atoms below them in the Periodic Table) so the bonds between these atoms and hydrogen are extremely polar. As a result, there are significant dipoles associated with the H-O, H-F and H-N bonds. This means neighbouring molecules attract each other very strongly, with the hydrogen being strongly attracted to the O, F or N in the neighbouring atom. This hydrogen bridging (or bonding) keeps neighbouring molecules together and means more energy must be put in to separate the liquid molecules into the gas (ie: a higher boiling temperature/point).

Question 19 (4 marks)
19 (a) (2 marks)
Outcomes Assessed: P8, P13
Targeted Performance Bands: 3-4

Criteria	Marks
• Writes TWO correct half-equations, AND a correct overall ionic equation	2
• Writes TWO correct half-equations, OR a correct overall ionic equation	1

Sample answer
$Zn\ (s) \rightleftharpoons Zn^{2+}\ (aq) + 2e^-$
$2H^+\ (aq) + 2e^- \rightleftharpoons H_2\ (g)$

Overall equation
$Zn\ (s) + 2H^+\ (aq) \rightarrow Zn^{2+}\ (aq) + H_2\ (g)$

19 (b) (2 marks)
Outcomes Assessed: P10
Targeted Performance Bands: 3-5

Criteria	Marks
• Correct answer determined, OR • Correct answer based on incorrect equation in part (a) above	2
• Correct moles of zinc determined, OR • Correct moles of zinc based on incorrect equation in part (a) above	1

Sample answer
1 mole hydrogen gas (H_2) is formed from 1 mole zinc
∴ 2.0 g hydrogen gas is formed from 1 mole zinc
∴ 7.5 g hydrogen gas is formed from 3.75 mole zinc
∴ 7.5 g hydrogen gas is formed from 3.75 x 65.41 g zinc = 245 g zinc = 2.5×10^2 g zinc

Question 20 (4 marks)
20 (a) (1 mark)
Outcomes Assessed: P8, P13
Targeted Performance Bands: 3-4

Criteria	Mark
• Correct answer	1

Sample answer
$MgCl_2\,(s) \rightleftharpoons Mg^{2+}\,(aq) + 2Cl^{-}\,(aq)$

20 (b) (1 mark)
Outcomes Assessed: P8
Targeted Performance Bands: 3-4

Criteria	Mark
• Correct answer	1

Sample answer
Magnesium chloride is an ionic solid. Water is a polar molecule. The electrical forces of attraction between polar water and the ions in the ionic solid are greater than the forces of attraction between the ions within the solid, so the solid will dissolve in water.

20 (c) (2 marks)
Outcomes Assessed: P8
Targeted Performance Bands: 3-4

Criteria	Marks
• Correct explanations BOTH of ions fixed (and hence not conducting) in the solid, AND of ions moving (and thus conducting) in the solution	2
• Correct explanation EITHER of ions fixed (and hence not conducting) in the solid, OR of ions moving (and thus conducting) in the solution	1

Sample answer
Magnesium chloride is an ionic solid. In the solid, the ions cannot move from place to place, even under the influence of an electric field, so the solid does not conduct electricity. In aqueous solution, the magnesium and chloride ions are able to move between electrodes in an electric circuit and so the circuit is closed and a current flows; i.e. the solution is an electrolyte and carries the current.

Question 21 (11 marks)
21 (a) (2 marks)
Outcomes Assessed: P11
Targeted Performance Bands: 2-4

Criteria	Marks
• Thorough explanation of the procedure and reagents used, AND how the conclusions would be reached	2
• Some correct information about the procedure and reagents used, OR how the conclusions would be reached	1

Sample answer
The 3 metals would each be reacted with water and with dilute hydrochloric acid, in order to observe the rate of reaction (as determined by the rate of production of bubbles of gas).

21 (b) (4 marks)
Outcomes Assessed: P8, P11, P13
Targeted Performance Bands: 2-4

Criteria	Marks
• Explanation of the results of the reactions, AND • Identification of calcium as the most active and copper as the least active of the 3 metals, AND • Correctly balanced equations for ALL reactions	4
• Identification of calcium as the most active and copper as the least active of the 3 metals, AND • Correctly balanced equations for SOME of the reactions	2-3
• Some correct comparison of the activity of the 3 metals and ONE correctly balanced chemical equation	1

Sample answer
When water was added to the 3 metals:
Calcium reacted vigorously, producing bubbles of gas. Iron and copper did not react, in that no bubbles of gas were noted within 5 minutes.
$Ca\ (s) + 2H_2O\ (l) \rightarrow Ca(OH)_2\ (aq) + H_2\ (g)$
Calcium was concluded to be the most active of the 3 metals.

When dilute hydrochloric acid was added to the 3 metals:
Calcium reacted vigorously (bubbles rapidly produced); iron reacted slowly (bubbles slowly produced); copper did not react (no bubbles).
$Ca\ (s) + 2HCl\ (aq) \rightarrow CaCl_2\ (aq) + H_2\ (g)$
$Fe\ (s) + 2HCl\ (aq) \rightarrow FeCl_2\ (aq) + H_2\ (g)$

Iron was concluded to be more active than copper. Hence the order of activity (most to least) was concluded to be calcium, iron, copper.

Question 21 (continued)
21 (c) (5 marks)
Outcomes Assessed: P11, P13
Targeted Performance Bands: 2-6

Criteria	Marks
• Assessment of the statement, AND • Discusses the different methods used for extraction of BOTH aluminium and copper, AND • Relates the methods of extraction to the activity of the metals	5
• Discusses the different methods used for extraction of BOTH aluminium and copper, AND • Relates the methods of extraction to the activity of the metals	3-4
• Discusses the different methods used for extraction of BOTH aluminium and copper	2
• Discusses the method used for extraction of EITHER aluminium OR copper	1

Sample answer
The more active the metal, the more stable the compounds it forms. As a result, aluminium, which is more active than copper, forms extremely stable compounds whereas copper, an inactive metal, forms compounds which can be easily decomposed.

The more active metal, aluminium, cannot be extracted from its ore bauxite (Al_2O_3) by heating, as its compound is very stable. Aluminium can only be extracted from its stable compound, aluminium oxide, by electrolysis and hence by significant input of energy. Alumina (Al_2O_3) is mixed with cryolite (Na_3AlF_6) to produce a mixture that will melt at 1000°C. The molten mixture is electrolysed using graphite anodes and iron cathode (the tank) to form molten aluminium and oxygen.
$2Al_2O_3\,(l) \rightarrow 4Al\,(l) + 3O_2\,(g)$

The less active metal, copper, can be extracted from its ores, chalcopyrite ($CuFeS_2$) or chalocite (Cu_2S) by strong heating or heating with carbon. Less energy is needed for this process than for the extraction of aluminium. The copper concentrate is heated with sand (silicon dioxide). The iron impurity is removed as iron silicate. The copper (I) sulfide remaining is heated strongly in air. Copper and sulfur dioxide are formed.
$2CuFeS_2\,(s) + 2SiO_2\,(s) + 4O_2\,(g) \rightarrow 2FeSiO_3\,(s) + Cu_2S\,(l) + 3SO_2\,(g)$
$Cu_2S\,(l) + O_2\,(g) \rightarrow 2Cu\,(s) + SO_2\,(g)$

Assessment
Hence the statement is correct in that 2 metals, which differ in their activity and hence in the stability of their compounds, require different amounts of energy to extract them from their ores. The more active metal (aluminium) requires a greater input of energy to extract it from its ore than does the less active metal (copper).

Question 22 (12 marks)
22 (a) (3 marks)
Outcomes Assessed: P9, P13
Targeted Performance Bands: 2-3

Criteria	Marks
• Identifies THREE compounds, using IUPAC nomenclature	3
• Identifies TWO compounds, using IUPAC nomenclature procedure	2
• Identifies ONE compound, using IUPAC nomenclature	1

Sample answer
Compound 1: 2-hexene
Compound 2: pentane
Compound 3: methane

22 (b) (2 marks)
Outcomes Assessed: P9, P13
Targeted Performance Bands: 3-4

Criteria	Marks
• Correct explanation AND correct classification of the THREE compounds into 2 different homologous series	2
• Correct explanation OR correct classification of the THREE compounds into 2 different homologous series	1

Sample answer
Compounds 2 and 3 are both classified into the same homologous series (the alkanes), as they are both hydrocarbons with single bonds only.
Compound 1 is an alkene, a different homologous series, as it is a hydrocarbon but also contains a double C=C bond.

22 (c) (2 marks)
Outcomes Assessed: P9
Targeted Performance Bands: 3-4

Criteria	Marks
• Correct explanation of the insolubility in terms of intermolecular forces between hydrocarbons AND between water molecules	2
• Some correct information about the intermolecular forces between hydrocarbons	1

Sample answer
Hydrocarbons (compounds 1, 2 and 3) are all non-polar molecules, so have only weak dispersion forces between neighbouring molecules. They do not possess permanent dipoles (charged regions) and so are not attracted to the dipoles of water molecules. Neighbouring water molecules are strongly attracted to each other by hydrogen bonding. As a result, the non-polar hydrocarbon molecules cannot separate the water molecules and therefore cannot form a solution. Compounds 1 and 2 are liquids at room temperature and these liquids would form a layer on top of a water layer. Compound 3 is a gas at room temperature and would not dissolve in the water layer.

Question 22 (continues)
22 (d) (5 marks)
Outcomes Assessed: P6, P7
Targeted Performance Bands: 3-6

Criteria	Marks
• Compares (qualitatively) the melting points of hydrocarbons, sodium chloride and silica • Discusses thoroughly the structures and bonding of molecules, ionic solids and covalent networks • Relates the structure and properties to the melting points	5
• Compares (qualitatively) the melting points of hydrocarbons, sodium chloride and silica • Discusses soundly the structures and bonding of molecules, ionic solids and covalent networks	3-4
• Compares (qualitatively) the melting points of hydrocarbons, sodium chloride and silica, AND • Identifies some correct information about the structures and bonding of hydrocarbons, sodium chloride OR silica	2
• Compares (qualitatively) the melting points of hydrocarbons, sodium chloride and silica, OR • Identifies some correct information about the structures and bonding of hydrocarbons, sodium chloride OR silica	1

Sample answer
The three hydrocarbon molecules would have the lowest melting points (significantly below room temperature) while sodium chloride and silicon dioxide (silica = quartz sand) have melting points significantly above room temperature. Silica has a much higher melting point than sodium chloride.

The three hydrocarbon molecules are held together in the solid by weak dispersion forces. When heated, the molecules separate from each other and change state to form the liquid. Only a small amount of heat energy is needed to overcome these intermolecular dispersion forces. The covalent bonds inside the molecules are NOT broken when melting occurs.

Sodium chloride is an ionic solid, held together by strong electrostatic forces of attraction between the oppositely charged ions. The solid must be heated to a temperature above a normal Bunsen flame (about 800°C) to overcome these strong forces holding the solid together and hence to form a molten liquid.

Silicon dioxide forms an infinite 3-D solid network, with extremely strong covalent bonds holding the atoms together. This structure is so strong that it does not melt until extremely high temperatures (over 1700°C).

Question 23 (2 marks)
23 (a) (1 mark)
Outcomes Assessed: P8, P13
Targeted Performance Bands: 3-4

Criteria	Mark
• Writes a correct, balanced ionic equation	1

Sample answer
Cu^{2+} *(aq)* + $2OH^{-}$ *(aq)* $\rightarrow$ $Cu(OH)_2$ *(s)*

23 (b) (1 mark)
Outcomes Assessed: P8, P13
Targeted Performance Bands: 3-4

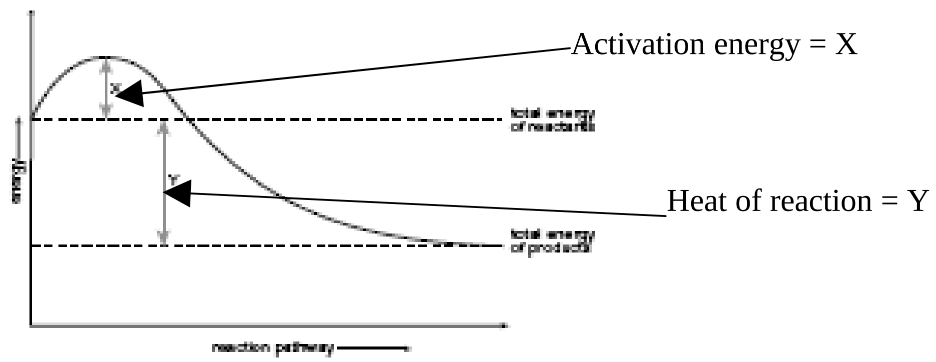
Criteria	Mark
• Correct answer	1

Sample answer
NO REACTION

Question 24 (6 marks)
24 (a) (2 marks)
Outcomes Assessed: P7, P13
Targeted Performance Bands: 2-3

Criteria	Marks
• Draws an energy profile, identifying the axes, the heat of reaction and the activation energy	2
• Draws an energy profile, identifying the axes AND the heat of reaction OR • Draws an energy profile, identifying the axes AND the activation energy	1

Sample answer



x axis = reaction pathway
y axis = energy (heat energy/enthalpy)

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Question 24 (continues)

24 (b) (2 marks)

Outcomes Assessed: P7, P13

Targeted Performance Bands: 2-3

Criteria	Marks
• Explains the exothermic nature of combustion in terms of the breaking and making of chemical bonds	2
• Outlines some correct information relating energy to EITHER the making or breaking of bonds	1

Sample answer

Combustion reactions always give out energy, as the sum of the exothermic steps (the bond-making steps) is always greater than the sum of the endothermic steps (the bond-breaking steps).

The bond-breaking steps involve breaking the covalent bonds in the fuel and in the oxygen molecules into gaseous atoms. These steps take in energy.

The bond-making steps involve converting the single atoms into new molecules of carbon dioxide and water. These bond-making steps give out energy.

The total energy given out is always greater than the energy required to break the bonds so the net reaction is exothermic.

24 (c) (2 marks)

Outcomes Assessed: P4, P10

Targeted Performance Bands: 2-4

Criteria	Marks
• Identifies a pollutant AND outlines why it is regarded as a pollutant	2
• Identifies a pollutant	1

Sample answer

Several possible answers involving carbon dioxide, oxides of nitrogen, unburnt hydrocarbons, soot, as well as carbon monoxide.

Carbon monoxide is a pollutant formed during combustion of organic compounds when insufficient oxygen is available. It is regarded as a pollutant because it is poisonous and in high concentrations can cause death, as it combines with the haemoglobin in the red blood cells and hence blocks out oxygen. This causes death as oxygen does not reach the brain and respiration stops.

Question 25 (5 marks)
25 (a) (2 marks)
Outcomes Assessed: P4, P8
Targeted Performance Bands: 3-5

Criteria	Marks
• Identifies a named catalyst AND explains how the catalyst affects the reaction rate in a specified reaction	2
• Identifies a named catalyst for a specified reaction OR explains how the catalyst affects the reaction rate in a specified reaction	1

Sample answer (Many possible answers)
Platinum wire acts as an inert catalyst in the gaseous reaction between methane gas and oxygen, to bring about activation of a combustion reaction (used in 'wands' to light gas-cooking hotplates).
The gas molecules hit the platinum wire and the electrons in the oxygen and methane molecules are attracted to the metal catalyst surface. As a result, the bonds between the atoms in the molecules are weakened and break, allowing new combinations of atoms and a chemical reaction to occur. The role of any catalyst is to provide a new, lower energy pathway for the reaction, so that the activation energy for the reaction is lowered and the reaction occurs at a faster rate than the un-catalysed reaction.

25 (b) (i) (1 mark)
Outcomes Assessed: P7, P8
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct answer	1

Sample answer
(1) Increase in the surface area of a solid reactant. (2) Increase in temperature.

25 (b) (ii) (2 marks)
Outcomes Assessed: P7, P8
Targeted Performance Bands: 3-4

Criteria	Marks
• Explains how BOTH factors from part (i) above increase the reaction rate	2
• Explains how ONE factor from part (i) above increases the reaction rate	1

Sample answer
Increasing the surface area (by dividing a solid into a powder, rather than large lumps) increases the area of contact between the solid and the other reactant, especially when the other reactant is a liquid or gas. The greater the area of interface between the reacting species, the greater the number of successful collisions and the faster the rate of reaction.
Increasing the temperature increases the kinetic energy of the reacting particles AND increases the proportion of reactant particles which have combined energies greater than the activation energy for a particular reaction. The greater the proportion of particles with energy greater than the activation energy, the faster the rate of reaction.