VIRILE AGITUR

2009

PRELIMINARY COURSE EXAMINATION

Chemistry

Tuesday 8 September, 1.00–3.00pm

General Instructions

- Reading time – 5 minutes

- Working time – 2 hours

- Write using black or blue pen

- Draw diagrams using pencil

- Approved calculators may be used

- Write your student number at the top of every page.

Mr Hunter
Mr Weeding
Mr Hargis
Mr Glucina
78 students

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 16-27
- Allow about 1 hour and 30 minutes for this part

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

Use the 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 the correct answer by writing the word **correct** and drawing an arrow as follows.

A ⬤   B ⨂   C ◯   D ◯

correct

1   Crystalline hematite is used as a gemstone and has the formula Fe_2O_3. What is the systematic (IUPAC) name for this mineral?

(A)   iron(II) oxide

(B)   iron(III) oxide

(C)   diiron trioxide

(D)   iron(II,III) oxide

2   Listed below are the electron energy levels for four different elements. Which of these elements would form an ion with a charge -2?

(A)   2,2

(B)   2,6

(C)   2,8,4

(D)   2,8,8

3   Which metal requires the greatest amount of energy in its extraction?

(A)   copper

(B)   iron

(C)   magnesium

(D)   zinc

4   Which mixture is best separated using the apparatus below?

(A)   oil and water

(B)   ethanol and water

(C)   sugar and salt (both in solid states)

(D)   sand and water

5 In which group do all the species have the same number of electrons?

(A) Li, Na, K

(B) Mg^{2+}, Ca^{2+}, Sr^{2+}

(C) F^-, Ne, Na^+

(D) O, F, Ne

6 Which number is closest to the total number of atoms in 10 moles of water?

(A) 30

(B) 2×10^{24}

(C) 6×10^{24}

(D) 2×10^{25}

7 Heating water to boil it simply separates its molecules, BUT electrolysis separates its atoms to form new substances. Which statement best explains this difference?

(A) Water is ionic and the ions move to opposite electrodes.

(B) Electrolysis provides more energy per molecule than boiling.

(C) The polar water molecules respond to the applied electrical field.

(D) Only electrolysis can break the hydrogen bonds in water.

8 Identify the compound which has a molecular formula different to its empirical formula?

(A) ammonia

(B) carbon dioxide

(C) ethane

(D) magnesium fluoride

9   Which statement best explains the inability of water to dissolve iodine?

(A)   Iodine is a dense brown liquid.

(B)   Iodine has a macromolecular structure.

(C)   Iodine has low chemical reactivity.

(D)   Iodine consists of non-polar molecules.

10   White precipitates are formed when sodium hydroxide is added to magnesium chloride solution and when sulphuric acid is added to barium nitrate solution. Predict the result of adding together equal volumes of 0.05 mol/L barium hydroxide and magnesium sulphate solutions.

(A)   No reaction.

(B)   A precipitate of barium sulphate only.

(C)   A precipitate of magnesium hydroxide only.

(D)   A mixed precipitate of barium sulphate and magnesium hydroxide.

11   Identify the main type of forces between hydrocarbon molecules.

(A)   dispersion forces.

(B)   dipole – dipole forces

(C)   hydrogen bonds

(D)   covalent bonds

12   What is the total mass of products formed when a piece of magnesium is burned in air?

(A)   Less that the total mass of the initial reactants.

(B)   Equal to the total mass of the initial reactants.

(C)   Greater than the total mass of the initial reactants.

(D)   Could be any of the above depending on the atmospheric pressure at the time.

13 A 10mL volume of 0.15 mol/L aluminium chloride solution is diluted to a final volume of 50mL. What is the chloride ion concentration in the diluted solution?

(A) 9.0×10^{-2} mol/L

(B) 4.5×10^{-2} mol/L

(C) 3.0×10^{-2} mol/L

(D) 1.5×10^{-2} mol/L

14 Which characteristic is the same for different members of the same homologous series?

(A) boiling points

(B) molecular formula

(C) molar masses

(D) functional group

15 Identify the IUPAC name for the hydrocarbon with the chemical formula C_4H_{10}.

(A) propane

(B) propene

(C) butane

(D) 1-butene

Part B
Attempt questions 16-27
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.

_____

Marks

Question 16 (6 marks)

Egg laying hens are fed a calcium supplement in the form of shell grit, consisting of crushed sea shells and sand.

To investigate shell grit for calcium carbonate content a 10.0 g sample is mixed with excess hydrochloric acid. The mass of the reaction mixture is monitored using an electronic balance, initially set (tared) to zero.
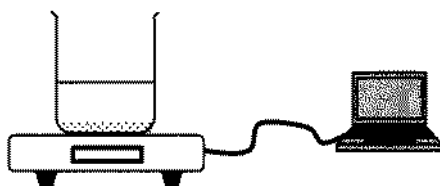
The output of the computer monitor is shown below:
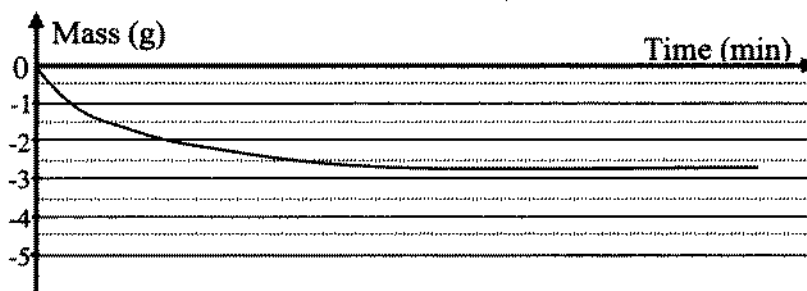
(a) Account for the change in mass of the reaction mixture

.... **1**

....

(b) Calculate the mass AND percentage by mass of calcium carbonate in the sample.

Marks

3

....

....

....

....

....

(c) Describe a suitable procedure to obtain a dried sample of the unreacted residue from the reaction for further analysis.

2

....

....

....

....

Question 17 (6 marks)

Both hydrogen and sodium react violently with chlorine.

With the aid of electron dot diagrams, compare and contrast the changes which occur at the atomic level in these two reactions, and the type of bonding in the resulting compounds.

6

....

....

....

....

....

....

....

....

....

....

....

Question 18 (3 marks)

The diagrams below show the structures of three different substances.   **Marks**

Substance I   Substance II   Substance III
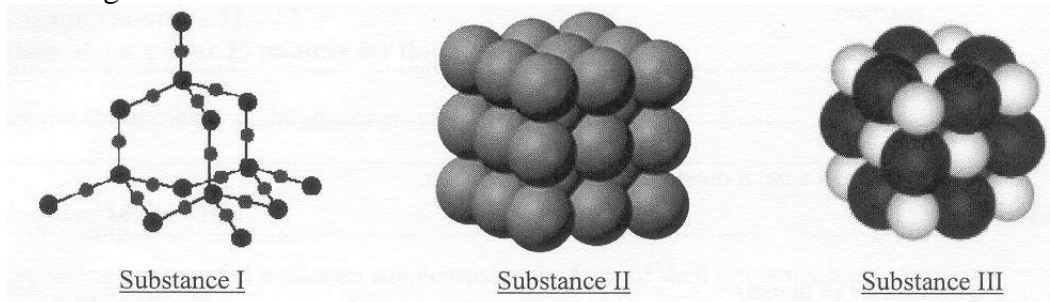
Complete the last two columns of the table below to:

(a) Show which of the above substances has those properties.   **1**

(b) Identify an example of a substance matching those properties.   **2**

Melting Point	Conductivity		Effect of water	Substance I,II,III	Possible Identity
	Solid	Molten			
High	0	high	Dissolves		
High	0	0	None		
Medium	high	high	H_2 gas		

Marks

Question 19 (7 marks)

You have performed a first-hand investigation of the reactions of a range of metals with dilute acid. Choose a metal which reacts more slowly than magnesium, but more rapidly than lead to answer the following questions.

(a) Describe your procedure and the observations you made.

2

....

....

....

....

....

....

(b) Identify the products of the reaction, by name and formula.

....

2

....

(c) Construct half equations to demonstrate the role of electron transfer in this reaction.

....

2

....

(d) Construct a net ionic equation for the reaction.

....

1

....

Marks

Question 20 (4 marks)

Pure iron is a soft silvery metal with low strength and no carbon.

Outline the difference between iron and steel, and explain why steels can be made with a range of properties, including hardness and strength.

4

....

....

....

....

....

....

....

....

Question 21 (3 marks)

For the sequence of elements from nitrogen to silicon in the Periodic Table, identify the trend in each of the properties below.

(a) First ionisation energy.

1

....

....

(b) Valency

1

....

....

(c) Electrical conductivity

1

....

....

Marks

Question 22 (4 marks)

Industrially, the main reaction used to produce hydrogen gas is by heating steam with methane (natural gas) over a metal catalyst.

$$CH_{4\,(g)} + 2H_2O_{(g)} + 250\ kJ \rightarrow CO_{2\,(g)} + 4H_{2\,(g)}$$
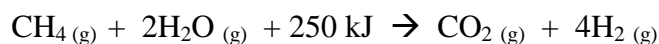
(a) Calculate the volume of hydrogen produced from 100L of methane, measured under standard conditions.

1

....

....

(b) Explain the endothermic nature of the reaction.

1

....

....

(c) Referring to activation energy, explain the role of the metal catalyst in this process

1

....

....

(d) Suggest a practicable method for separating carbon dioxide from hydrogen in the reaction products.

1

....

....

Marks

Question 23 (4 marks)

Sucrose (cane sugar) and cellulose (eg cotton wool) are both carbohydrates with the general formula $C_x(H_2O)_y$. Sucrose is very soluble in water while cellulose is quite insoluble.

(a) Account for the difference in solubility, referring to their molecular properties.　　**2**

....

....

....

....

(b) Contrast the changes at the molecular/ionic level when sodium chloride and sucrose dissolve in water.　　**2**

....

....

....

....

Marks

Question 24 (3 marks)

Heat energy is released when anhydrous calcium chloride is dissolved in water.

$$CaCl_{2\ (s)} \rightarrow CaCl_{2\ (aq)} + 83kJ$$

Calculate the final temperature when 0.01 mol of calcium chloride is dissolved into 100 mL of water initially at a temperature of $18.0°C$.

3

....

....

....

....

....

....

Marks

Question 25 (7 marks)

(a) Calculate the concentration of chloride ions when 0.010 mol of calcium chloride is dissolved in water to form 100 mL of solution.

2

....

....

....

....

(b) Calculate the mass of silver chloride precipitate formed when 20mL of 0.010 mol/L silver nitrate solution is added to the calcium chloride solution.

2

....

....

....

....

(c) More silver nitrate solution is added in 20 mL portions until no further reaction occurs. Construct a graph of the mass of silver chloride precipitate against the volume of silver nitrate solution.

3

Marks

Question 26 (7 marks)

Candle wax is largely composed of long chain hydrocarbon molecules with a typical molecular formula of $C_{30}H_{62}$.

(a) Using this formula, write an equation to represent the complete combustion of candle wax.

1

....

(b) Explain why another flame is needed to ignite a candle.

2

....

....

....

....

(c) Identify the changes of state involved in combustion of a burning candle and where these changes occur.

2

....

....

....

....

(d) The bright yellow colour of the candle flame is mainly due to the incandescent solid carbon (soot) present in the flame. Explain what is meant by the term *incomplete combustion* and why it would lead to the production of solid carbon.

2

....

....

....

....

Marks

Question 27 (6 marks)

Photosynthesis is one of the most important chemical processes to the existence of life on Earth.

(a) Write a chemical equation to represent photosynthesis. **1**

....

(b) Predict the effect on the rate of photosynthesis of increased carbon dioxide concentration from human activities, and increased temperatures caused by the enhanced greenhouse effect. **2**

....

....

....

....

(c) Outline the role of photosynthesis to explain its importance to life on Earth. **3**

....

....

....

....

....

....

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

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

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

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79	← Symbol of element
Atomic Weight	Au	
	197.0	
	Gold	← 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 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 72.61 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 [98.91] 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 Lanthanides	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 [210.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon	
87 Fr [223.0] Francium	88 Ra [226.0] Radium	89–103 Actinides	104 Rf [261.1] Rutherfordium	105 Db [262.1] Dubnium	106 Sg [263.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [265.1] Hassium	109 Mt [268] Meitnerium	110 Uun [?] Ununnilium	111 Uuu [?] Unununium	112 Uub [?] Ununbium	113	114 Uuq [?] Ununquadium	115	116 Uuh [?] Ununhexium	117	118 Uuo [?] Ununoctium	

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [146.9] 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

Actinides

89 Ac [227.0] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237.0] Neptunium	94 Pu [239.1] Plutonium	95 Am [241.1] Americium	96 Cm [244.1] Curium	97 Bk [249.1] Berkelium	98 Cf [252.1] Californium	99 Es [252.1] Einsteinium	100 Fm [257.1] Fermium	101 Md [258.1] Mendelevium	102 No [259.1] Nobelium	103 Lr [262.1] Lawrencium

Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ^{237}Np and ^{99}Tc.