Strathfield Girls High School

Student Name

2011

Preliminary Final Examination

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper and can be detached
- The Multiple Choice answer sheet is attached at the back of this paper and should be detached.
- All questions should be answered on this paper.
- All papers should be submitted at the end of the examination. Place multiple choice sheet inside the cover of this paper.

Exam Requirements

- Examination paper containing multiple choice answer sheet, data sheet and periodic table

Pages 2 – 14

Total marks (**75**)

This paper has two parts, Part A and Part B

Part A
Total marks (**20**)

- Attempt questions 1 – 20
- Allow about 35 minutes for this part

Part B
Total marks (**55**)

- Attempt questions 21 – 34
- Allow about 1 hour and 25 minutes for this part.

PART A: 20 MULTIPLE CHOICE questions. Allow about 35 minutes for this part.

Place a X in the correct space on the MULTIPLE CHOICE answer sheet.

1. What is the main reason for recycling aluminium?

(A) Aluminium is a rare metal in the Earth's crust

(B) Aluminium corrodes easily, so aluminium articles need constant replacement

(C) It takes much less energy to recycle it than to extract it from its ore

(D) Aluminium is difficult to extract from its ore because it is highly unreactive

2. How are the bonds formed in strontium chloride?

(A) By sharing electrons

(B) By delocalised electrons attracted to positive ions

(C) By the attraction between two nuclei and a shared pair of electrons

(D) By the attraction between positive and negative ions

3. Which of the following statements about minerals and ores is correct?

(A) An ore may be separated using physical processes to obtain a mineral, from which a metal is then extracted using chemical processes.

(B) A mineral is a source of one or more metals, but the concentrations of metals in a mineral mean that it is uneconomical to mine.

(C) A mineral may be separated through physical processes to obtain an ore, from which a metal is then extracted using chemical processes.

(D) An ore is a mixture of uncombined metals, which can be separated by physical processes.

4. The table below shows the densities of some metals.

Metal	Density (g/mL)
Lithium	0.53
Sodium	0.97
Potassium	0.86
Rubidium	1.53

Benzene and nitrobenzene are liquids at room temperature. The density of benzene is 0.88 g/mL, and that of nitrobenzene is 1.2 g/mL.

Which metal sinks in benzene, but floats in nitrobenzene?

(A) Lithium

(B) Sodium

(C) Potassium

(D) Rubidium

5. Which of the following statements is correct?

(A) The more reactive an element is, the less energy is required to extract it

(B) The more reactive an element is, the less chance of its occurring uncombined in nature

(C) The more reactive an element is, the more chance of its being found in the atmosphere

(D) The more reactive an element is, the more chance of its being discovered early in human history

6. Particle 'X' is made up of 13 protons, 10 electrons and 14 neutrons. Which symbol correctly identifies this particle?

(A) Al^{3+}

(B) Al

(C) Si^{4+}

(D) Si

7. Which statement correctly identifies the Bronze Age?

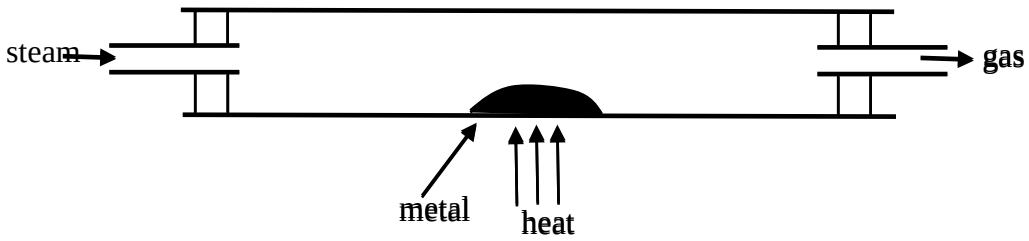
(A) It was the period before the Stone Age, when copper and its alloy bronze were used to make weapons and other implements

(B) It was the period before the Iron Age, when copper and its alloy bronze were used to make weapons and other implements

(C) It was the period before the Iron Age, when iron and its alloy bronze were used to make weapons and other implements

(D) It was the period after the Iron Age, when copper and its alloy bronze were used to make weapons and other implements

8. The diagram below shows how a metal can be reacted with steam.



Which of the following metals will react with steam to produce hydrogen gas?

	Magnesium	**Gold**	**Silver**
(A)	Yes	Yes	Yes
(B)	Yes	Yes	No
(C)	Yes	No	No
(D)	No	No	No

9. Some reactions of metals W, X, Y and Z are shown below.

Metal	Reaction with cold water	Reaction with dilute acid
W	Slow formation of bubbles.	Gas bubbles form vigorously.
X	Gas bubbles form vigorously.	Not attempted. Explosive.
Y	No reaction.	No reaction.
Z	No reaction.	Steady, gentle fizzing.

What is the order of reactivity of the metals in order from *most* reactive to *least* reactive.

(A) X W Z Y

(B) Y W X Z

(C) X W Y Z

(D) Y Z W X

10. Which of the metals below will form an oxide requiring the most energy to decompose?

(A) copper

(B) magnesium

(C) iron

(D) lead

11. A student heated 1g blocks of four substances in the same hot water bath for 10 minutes.

The temperature change of each substance is shown below.

Substance	Temperature change (^{0}C)
A	7.3
B	12.5
C	15.0
D	25.0

Which one of the substances has the lowest specific heat capacity?

(A) A

(B) B

(C) C

(D) D

12. What is the number of water molecules in 3.6 g of ice?

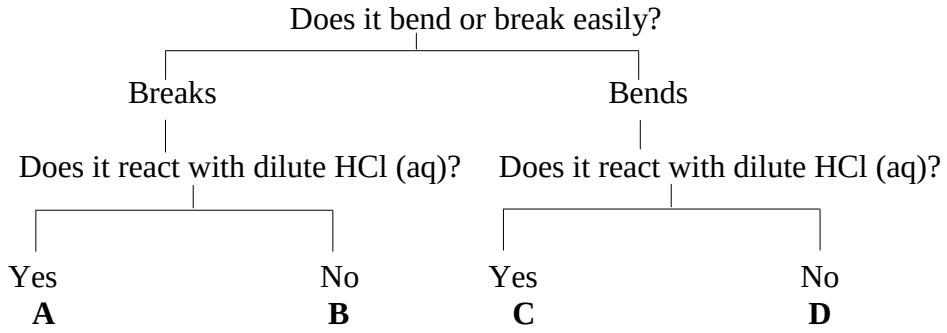
(A) 0.2

(B) 1.2×10^{23}

(C) 3.6×10^{23}

(D) 6.02×10^{23}

13. Use the key below to determine which substance is copper.



(A) A

(B) B

(C) C

(D) D

14. What is the best explanation for the ability of many insects to walk across the surface of a pond?

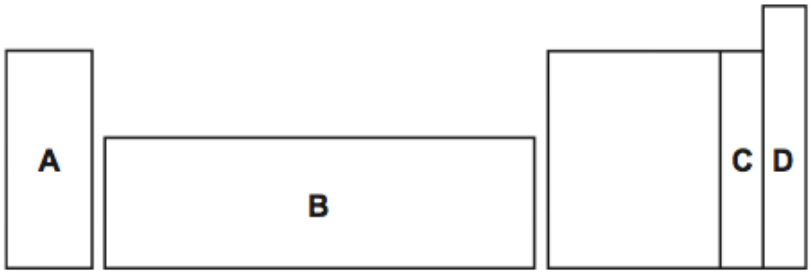
(A) The insects have a lower density than the water

(B) The surface tension of the water supports them

(C) The viscosity of the water is so high that the insects cannot move through it

(D) The heat capacity of the water is too high

15. An element 'X' exists as diatomic molecules, is a solid at room temperature, and does not conduct electricity. Where in the periodic table would it be found?



(A) A

(B) B

(C) C

(D) D

16. Sodium thiosulfate and scandium oxide are ionic compounds. Their formulae are $Na_2S_2O_3$ and Sc_2O_3 respectively.

What is the most likely formula of scandium thiosulfate?

(A) ScS_2O_3

(B) $Sc(S_2O_3)_2$

(C) $Sc_2(S_2O_3)_3$

(D) $Sc_2S_2O_3$

17. Which atoms, in the compounds NH_3, CH_4 and HF, use all of their outer shell electrons in bonding?

(A) C and H

(B) N and H

(C) C and N

(D) F and H

18. Iron (II) oxide reacts with aluminium to form iron and aluminium oxide.

What is the correct balanced equation for this reaction?

(A) $FeO\ (s) + Al\ (s) \rightarrow Fe\ (s) + AlO\ (s)$

(B) $Fe_2O_3\ (s) + 2Al\ (s) \rightarrow 2Fe\ (s) + AlO_3\ (s)$

(C) $Fe_2O\ (s) + 2Al\ (s) \rightarrow 2Fe\ (s) + AlO\ (s)$

(D) $3FeO\ (s) + 2Al\ (s) \rightarrow 3Fe\ (s) + Al_2O_3\ (s)$

19. Given the overall chemical reaction:

$$2A(g) + B(g) \rightarrow 2C(g) + D(g)$$

Examine the three following statements about this reaction:

I C is produced at double the rate of D.

II B is consumed at double the rate of A.

III The rate at which B disappears is equal to the rate at which D appears.

Which of these statements are correct?

(A) I only

(B) I and III only

(C) II and III only

(D) I, II and III

20. Which of the following is a polar molecule?

(A) Br_2

(B) C_2H_6

(C) BaF_2

(D) HI

Part B – 55 marks

Attempt Questions 21 – 34
Allow about 1 hour and 25 minutes for this part

Answer the questions in the spaces provided.

Marks

Question 21 (7 marks)

In the 18th century balloonists filled their balloons with gas by dissolving iron in dilute sulfuric acid, forming iron (II) sulfate solution.

(a) Write a balanced equation for this reaction. **2**

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(b) Describe a test that could be done to identify the gas produced in this reaction. **1**

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(c) Write the half-equation for the electron transfer reaction of iron in this process. **1**

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(d) Calculate the volume of gas that this reaction would produce by dissolving 1.0 kg of iron. **3**

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Question 22 (3 marks)

The specific heat capacity of water is relatively high, at 4.18 $JK^{-1}g^{-1}$.

Explain the importance for marine organisms of the high specific heat capacity of water. **3**

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Marks

Question 23 (4 marks)

One method of producing nitric acid (HNO_3) industrially is to carry out a series of reactions using ammonia (NH_3), represented by the overall equation:

$$NH_3(g) + 2O_2(g) \rightarrow HNO_3(aq) + H_2O(l)$$

In one experiment 10.5 g of ammonia was used. This gas occupied 48 L at 500°C.

(a) Calculate the mass of nitric acid produced in this reaction. **3**

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(b) Determine the volume of oxygen gas used in this reaction when measured at 500°C and the same pressure as was used for ammonia. Show your working. **1**

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Question 24 (4 marks)

Magnesium and magnesium oxide both conduct electricity in the molten state, however, magnesium also conducts electricity in the solid state whereas magnesium oxide does not.

Explain the electrical conductivity of magnesium and magnesium oxide in terms of their structure and bonding. **4**

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Marks

Question 25 (6 marks)

(a) Calculate the mass of sodium chloride (NaCl) that would be required to make up 250.0 mL of 0.500 mol L^{-1} solution. **2**

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(b) Describe the procedure you would follow to make up this solution, naming all essential equipment you would use. **3**

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(c) Describe how you could make 250 mL of 0.05 mol L^{-1} solution from the solution in part (a)

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Question 26 (2 marks)

Describe and explain how first ionisation energy changes across Period 3 (Na to Ar) in the Periodic Table. **2**

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Marks

Question 27 (2 marks)

Chalcopyrite is known as 'mixed sulfide'; it contains iron, copper and sulfur. A 50.0 g sample of chalcopyrite contains 17.4 g of copper, and 15.2 g of iron. The remainder is sulfur.

Calculate the empirical formula of chalcopyrite. **2**

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Question 28 (4 marks)

A 'cold pack' is used for the treatment of soft tissue injuries at sporting events. It can be made by mixing solid ammonium nitrate (NH_4NO_3) with water in a plastic bag.

A student carries out an investigation to test this idea by dissolving 1.0 g of ammonium nitrate in 50.0 g of water in a foam cup. She collected the following data:

Mass of foam cup	2.0 g
Mass of water in cup	50.0 g
Mass of ammonium nitrate	1.0 g
Initial temperature of water	19.4^{o}C
Final temperature of water	17.9^{o}C

(a) Calculate the molar heat of solution of ammonium nitrate. **3**

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(b) Is this reaction exothermic or endothermic? Justify your answer. **1**

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Marks

Question 29 (2 marks)

The information in the table below shows the solubility rules for common salts.

Anion or cation present	General Solubility Rule	Exceptions
Group I metals	Soluble	No exceptions
Ammonium	Soluble	No exceptions
Nitrate	Soluble	No exceptions
Chloride	Soluble	Lead(II); mercury(II), silver
Sulfate	Soluble	Lead(II); mercury(II), silver, barium
Carbonate	Insoluble	Group I and ammonium
Hydroxide	Insoluble	Group I and ammonium, barium

A student wants to prepare copper (II) hydroxide by precipitation from solutions of two salts. Identify two salts which would be appropriate to use and write an equation for the reaction. **2**

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Question 30 (3 marks)

A student was given a mixture of the three chemicals listed in the table below.

Substance	Density (g/mL)	Melting Point (^{o}C)	Boiling Point (^{o}C)	Solubility in water	Solubility in octane
Paraffin wax	0.9	60	370	insoluble	soluble
Octane	0.7	-57	126	insoluble	_
Water	1.0	0	100	_	insoluble

Describe and justify the process the student should use to separate this mixture. **3**

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Question 31 (4 marks) **Marks**

Explain the differences between the interaction with water of a soluble ionic compound and a soluble molecular compound, using one example of each type of compound. **4**

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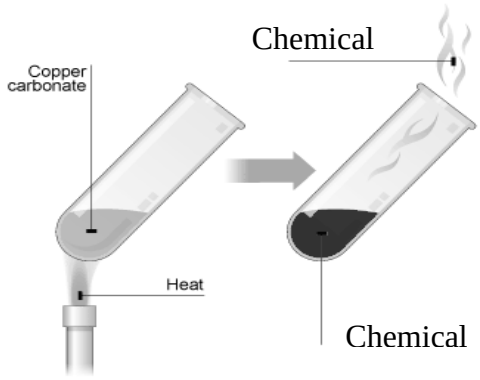
Question 32 (4 marks)

A student carried out the following procedure.



(a) Write a balanced chemical equation to represent the reaction shown in the diagram. **1**

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(b) Describe how you could modify the procedure to allow you to perform the same reaction but also collect chemical X and confirm its identity. **3**

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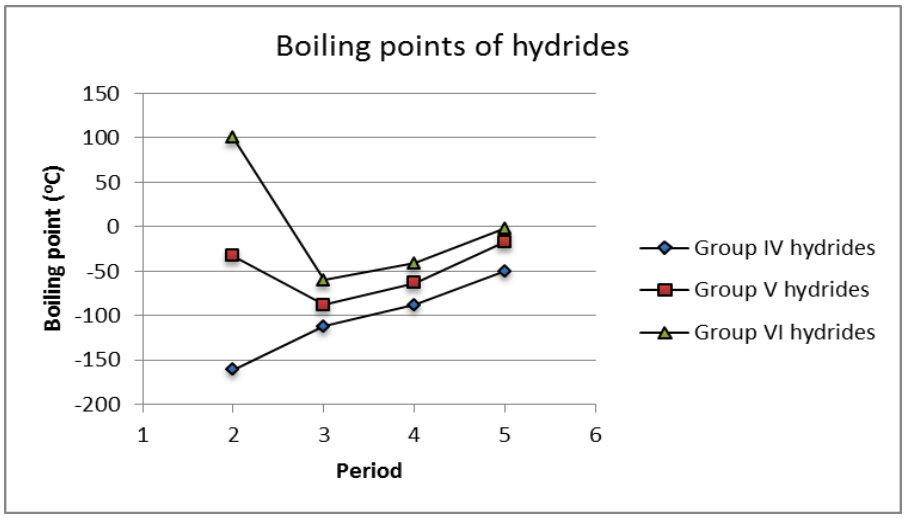
Question 33 (5 marks) **Marks**

a) Draw a Lewis electron dot diagram of ammonia, a group V hydride **1**

b) The graph below shows how the boiling points of the hydrides of elements in Groups IV, V and VI vary, moving down each group. **4**



Explain TWO trends, and ONE anomaly (something which does not fit the trend) in these data.

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Question 34 (5 marks)

Assess the significance of the process of photosynthesis to all life on earth and in the formation of important sources of energy. Include a relevant chemical equation in your answer. **5**

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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 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 [209.0] 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 [266.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [144.9] 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 [244.1] Plutonium	95 Am [243.1] Americium	96 Cm [247.1] Curium	97 Bk [247.1] Berkelium	98 Cf [251.1] 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.

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

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

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.

Strathfield Girls High School

2011 Preliminary Chemistry

Multiple Choice Answer Sheet

Name:.....

	A	B	C	D
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Preliminary Chemistry Final Marking Scheme 2011

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Answer	C	D	A	B	B	A	B	C	A	B	D	B	D	B	C	C	A	D	B	D

Question 21 (a)

Criteria	Marks
Writes a correct balanced equation, including states	2
Writes an unbalanced equation, or a correct balanced equation but states missing or incorrect	1

Sample answer:

$Fe_{(s)} + H_2SO_{4\,(aq)} \rightarrow FeSO_{4\,(aq)} + H_{2\,(g)}$

(b)

Criteria	Marks
Describes an appropriated test, including the expected result	1

Sample answer:

Place an ignited stick near gas. If a popping sound occurs, hydrogen is present.

(c)

Criteria	Marks
Writes a correct half-equation	1

Sample answer:

$Fe_{(S)} \rightarrow Fe^{2+} + 2e^-$

(d)

Criteria	Marks
Correctly calculates the volume of gas with correct units	3
Correctly performs two steps in the calculation	2
Correctly performs one step in the calculation	1

Sample answer:

Moles of Fe = 1000/ 55.85 = 17.905 thus moles of H= 17.905 (1:1 mole ratio)

Volume of H = 17.905 X 24.79 = 443.86L or 444L (at 25˚C) OR

= 17.905 X 22.71 = 406.62L or 406L (at 0˚C)

Question 22

Criteria	Marks
Explains the importance of water having a high specific heat capacity to marine organisms as creating a stable environment AND explains how this affects the solubility of gases AND relates this to marine organisms suffocating with temperature increase.	3
Only two of the above mentioned	2
Only one of the above mentioned	1

Sample answer:

The high specific heat capacity of water allows for very stable temperatures of marine environments. Thus significant rises of temperature in the ambient environment has little effect of the temperature of marine environments. As a result marine organisms do NOT need complex temperature control mechanisms. This stable temperature allows for the solubility of gases like oxygen into water to

maintain survival. An increase in temperature would decrease the solubility of gases such as oxygen in water, suffocating marine organisms.

Question 23 (a)

Criteria	Marks
Correctly calculates the mass of nitric acid to 3 significant figures	**3**
Correctly calculates the mass of nitric acid with incorrect significant figures	**2**
Correctly calculates the moles of ammonia	**1**

Sample answer:

Moles of HNO_3 = moles of NH_3= 10.5/17.034 = 0.6164

Mass of HNO_3 = 0.6164 x 63.08 = 38.8g (3 sig. fig)

(b)

Criteria	Marks
Correctly determines the volume of oxygen using Guy Lussac's Law	**1**

Sample answer:

48 L x 2 = 96 L

Question 24

Criteria	Marks
Explains the electrical conductivity of magnesium and magnesium oxide in terms of bonding AND structure	**4**
Explains the electrical conductivity of both compounds in terms of bonding OR structure	**3**
Explains the electrical conductivity of ONE of the compounds using both bonding AND structure	**2**
Explains the electrical conductivity of one of the compounds with either structure OR bonding	**1**

Sample answer:

MgO is an ionic compound where each positive and negative ion is held together by strong electrostatic forces in an ionic lattice. Solid magnesium oxide cannot conduct electricity because there are no mobile ions or electrons present in its rigid ionic lattice. When MgO is dissolved in liquid or is in its molten state, it CAN conduct electricity with the mobile ions that are dissociated.

Mg is a metal and thus has metallic bonding where each atom is a positive ion surrounded by a 'sea' of electrons. It is this mobile sea of electrons that allows an electric current to be carried readily through the metal to conduct electricity in both solid and molten state.

Question 25 (a)

Criteria	Marks
Calculates the moles AND mass of NaCl correctly	**2**
Calculate ONLY the moles of NaCl correctly	**1**

Sample answer:

n = c/v = 0.500 mol L^{-1} x 0.2500L = 0.1250 mol

mass = n x M = 7.31g (3 sig. fig.)

(b)

Criteria	Marks
Correctly describes the procedure as weighing solute AND transferring solution to a 250mL volumetric flask AND adding distilled water until the bottom of the meniscus of water is sitting on the mark of the volumetric flask AND inverting and mixing the flask to acquire a homogeneous solution.	**3**

Correctly describes TWO of the above procedures	**2**
Correctly describes ONE of the above procedures	**1**

Sample answer:

Weigh approx. 7.3g of NaCl in a **beaker**. Add **distilled water** to the beaker until all solute is dissolved. Transfer the solution to a **250ml volumetric flask.** Use a **wash bottle** to wash away any remaining solution in the beaker. Add distilled water into the volumetric flask until the bottom of the meniscus of water sits on the mark of the flask. The flask should then be stirred and inverted to acquire a homogeneous stock solution of NaCl.

(c)

Criteria	**Marks**
Describes the procedure using a pipette to transfer 25mL of stock solution into a 250mL volumetric flask AND describes the dilution with distilled water.	**1**

Sample answer:

Using a pipette, measure 25mL of the stock solution and transfer to a new 250mL volumetric flask. Dilute with distilled water until the bottom of the meniscus sits on the marked line of the volumetric flask.

Question 26

Criteria	**Marks**
Describes that there are more protons added to the nucleus going across the period AND relates this to the increasing nuclear force attracting valence electrons to the nucleus, requiring more energy to remove it	**2**
Describes the adding of protons to the nucleus WITHOUT relating it to an increase in nuclear force	**1**

Sample answer:

First Ionisation Energy (FIE) is the energy required to remove an electron from the valence shell of an atom in gas phase. The FIE increases as it goes across the period because there are more protons added to the nucleus moving across a period. Thus there is an increased nuclear force attracting the valence electron to the nucleus. This force requires more energy to overcome and so the ionisation energy increases.

Question 27

Criteria	**Marks**
Correctly calculates the empirical formula	**2**
Calculation contains one error	**1**

Sample answer:

Mass: Cu : Fe : S

17.4g : 15.2g : 17.4g

Moles: 17.4/63.55 : 15.2/55.85 : 17.4/32.06

Simplest ratio: 1:1:2 Thus empirical formula = $CuFeS_2$

Question 28 (a)

Criteria	**Marks**
Correctly calculates the heat of solution AND molar heat of solution	**3**
Correctly performs two steps in the calculation	**2**
Correctly performs one step in the calculation	**1**

Sample answer:

$\Delta H = -mc\Delta T = -50 \times 4.18 \times (-1.5) = 313.5J = 0.3135kJ$

Moles = 1/80.052 = 0.01249

Molar heat of solution = 0.3135/0.01249 = 25.1kJ mol $^{-1}$ (3 sig. fig.)

(b)

Criteria	Marks
Correctly states the reaction is endothermic AND justifies the answer based on the result.	**1**

Sample answer:

Endothermic because the ΔH_{SOL} is positive so energy is absorbed.

Question 29

Criteria	Marks
Correctly identifies two salts AND writes a balanced equation	**2**
Correctly writes a balanced equation OR identifies TWO salts	**1**

Sample answer:

Salts = copper (II) nitrate and sodium hydroxide

$Cu(NO_3)_{2\,(aq)} + 2NaOH_{\,(aq)} \rightarrow Cu(OH)_2 + 2NaNO_{3\,(aq)}$

Question 30

Criteria	Marks
Correctly describes the two separating techniques with justification	**3**
Correctly one technique with justification	**2**
Correctly describes one technique with no justification	**1**

Sample answer:

Use a separating funnel to separate water from the solution of octane and wax. This can occur due to the difference in density property. Distillation can then be used to separate octane from wax, based on the high differences in boiling points. Octane will boil off first, making it the distillate.

Question 31

Criteria	Marks
Correctly explains the interaction of both ionic and soluble molecular compounds with water AND identifies an example of each.	**4**
Correctly explains the interaction of both ionic and soluble molecular compounds with water and identifies an example of only one compound, OR Correctly explains or outlines the interaction of ionic and soluble molecular compounds with water and identifies an example of both	**3**
Correctly identifies an ionic OR soluble molecular compound AND explains its interaction with water.	**2**
Correctly identifies an example of the two compounds with no explanation on their interactions with water.	**1**

Sample answer:

When a soluble ionic compound such as NaCl is placed in water, the ions become hydrated, i.e. the positive (Na^+) ions at the edges of the crystal lattice are surrounded by the δ- (O) end of several water molecules, and the negative ions (Cl^-) are surrounded by the δ+ (H) end of other molecules, detaching them from the lattice.

Soluble molecular compounds are those which form hydrogen bonds or are very polar, e.g. ethanol contains an -OH group which forms hydrogen bonds with water molecules, causing the ethanol molecules to separate, so the ethanol dissolves.

Question 32 (a)

Criteria	Marks
Correctly writes a balanced chemical equation	**1**

Sample answer:

$CuCO_{3\,(S)} \rightarrow CuO_{(S)} + CO_{2\,(g)}$

(b)

Criteria	Marks
Describes modifications needed to capture the CO_2 and test it	**3**
Identifies two modifications (e.g. side-arm test tube, limewater)	**2**
Identifies one modification (e.g. side-arm test tube, limewater)	**1**

Sample answer:

The copper carbonate should be heated in a closed test tube with a gas-delivery tube attached. The other end of the gas-delivery tube should be immersed in limewater in a second test tube. The gas (CO_2) will then bubble through the limewater and turn it milky if present.

Question 33 (a)

Criteria	Marks
Draws a correct electron-dot diagram for ammonia	**1**

Sample answer:

(b)

Criteria	Marks
Explains 2 trends and 1 anomaly in terms of intermolecular forces	**4**
Explains two trends OR 1 trend and 1 anomaly in terms of intermolecular forces	**3**
Outlines 1 trend or anomaly in the data, making limited reference to intermolecular forces, OR Outlines 2 trends and 1 anomaly	**2**
Outlines 1 trend or anomaly in the data	**1**

Sample answer:

Trend 1 – BP increases across a period from Group IV to VI. This is because group IV hydrides are **non-polar** and are held together by weak **dispersion forces**, while Group V and VI hydrides are **polar** and so have **dipole-dipole** interactions. These interactions are stronger than dispersion forces, especially in Group VI, so BP's are higher.

Trend 2 – Going down any group, BP, molecular mass increases, thus increasing the strength of the dispersion forces, so more energy is needed to separate molecules and therefore they have a higher BP.

Anomaly – BP's of nitrogen hydride (i.e. NH_3) and oxygen hydride (i.e. water) are much higher than expected based on their trend lines. This is because both ammonia and water have intermolecular hydrogen bonding, which is stronger than the dipole-dipole interactions between the other molecules in these groups. Thus more energy is needed to separate the molecules from each other, hence BP is higher.

Question 34

Criteria	Marks
• Outlines the process of photosynthesis in plants as a way to store energy in glucose, including a balanced equation • Outlines how this energy is transferred to animals • Outlines how this energy can be transferred to fossil fuels and how this energy is used in human societies • Provides an assessment of the importance of photosynthesis	**5**
• Outlines the process of photosynthesis in plants as a way to store energy in glucose • Outlines how this energy is transferred to animals OR how it is stored in fossil fuels • Assesses the importance of photosynthesis	**3-4**
• Outlines the process of photosynthesis in plants as a way to produce glucose and oxygen • Outlines the importance of oxygen to all living things • Assesses the importance of photosynthesis	**2**
• Gives some relevant information about the importance of photosynthesis	**1**

Sample answer:

Photosynthesis is the process in which plants absorb energy from sunlight and convert it into chemical energy. They do this by reacting CO_2 from air with water to form glucose and oxygen:

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

Glucose is then used to supply the energy which plants need to live, storing the excess in high-energy compounds such as starch. Animals (including humans) take in this energy by eating plants or plant-eating animals, so they too can have the energy they need to live.

Fossil fuels (coal, petroleum and natural gas) are formed by the slow decomposition of the buried remains of plants and animals, in which the energy from these compounds is transferred to bonds in the fuels. Almost all human technology, including manufacturing, modern forms of transport, and production of electricity for a multitude of purposes, relies on the release of the energy by combustion of fossil fuels.

Thus not only is photosynthesis essential to the survival virtually all life on earth, but also human society, at least in the way it has developed today, is totally dependent on the energy originally derived from photosynthesis.