

## SERANGOON JUNIOR COLLEGE General Certificate of Education Advanced Level Higher 2

Candidate Name	
Class	

## CHEMISTRY

# 9647/01

Preliminary Examination Paper 1 Multiple Choice 29 August 2014 1 hour

Additional Materials: Data Booklet Optical Mark Sheet (OMS)

### **READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid. Write your name, FIN/NRIC number and class on the OMS in the spaces provided. Shade correctly FIN/NRIC number and your class. Eg. If your NRIC is S9306660Z, shade <u>S9306660Z</u> for the item "index number".

There are **forty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the one you consider correct and record your choice using a **soft pencil** on the separate OMS.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this question paper.

This document consists of 22 printed pages and 2 blank pages.

#### **Section A**

For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the one you consider to be correct.

1 The hydrolysis of  $S_2Cl_2$  proceeds by two reactions.

Reaction 1  $S_2Cl_2 + 2H_2O \longrightarrow H_2S + SO_2 + 2HCl$ 

Reaction 2  $2H_2S + SO_2 \longrightarrow \frac{3}{8}S_8 + 2H_2O$ 

Which of the following correctly describe the reactions?

- A weakly acidic solution is formed in Reaction 1.
- **B** Reverse disproportionation occurs in Reaction 2.
- **C** The oxidation state of chlorine and oxygen changes in both reactions.
- **D** The products of Reaction 1 require 2 mol of NaOH for complete neutralisation.
- **2** Sodium carbonate peroxyhydrate with the formula  $(Na_2CO_3)_x$ .  $y H_2O_2$  is used in eco-friendly cleaning products and as a laboratory source of anhydrous hydrogen peroxide.

When 20.0 cm<sup>3</sup> of 0.100 mol dm<sup>-3</sup> sodium carbonate peroxyhydrate is titrated with 0.200 mol dm<sup>-3</sup> acidified KMnO<sub>4</sub>, it requires 12.0 cm<sup>3</sup> of acidified KMnO<sub>4</sub> before the first pink colour appears.

$$2MnO_4^- + 6H^+ + 5H_2O_2 \longrightarrow 2Mn^{2+} + 8H_2O + 5O_2$$

When an identical sample is acidified, it releases 96.0 cm<sup>3</sup> of carbon dioxide at room conditions.

What is the ratio of x:y?

- **A** 1:3
- **B** 2:3
- **C** 2:1
- **D** 3:1

**3** The successive ionisation energies, in kJ mol<sup>-1</sup>, of an element **E** are given below.

578 1820 2750 11600 14800 18400

Which of the following could be the electronic configuration of the outermost shell in  $\ensuremath{\text{E}}\xspace?$ 

- **D**  $ns^2 np^3$
- 4 The diagram represents the melting points of four consecutive elements in the third period of the Periodic Table.



The sketches below represent another two properties of the elements.



Which of the following represents the properties F and G?

	property <b>F</b>	property <b>G</b>
Α	third ionisation energy	electronegativity
в	number of valence electrons	boiling point
с	ionic radius	effective nuclear charge
D	electrical conductivity	atomic radius

5 Two identical bulbs at the same temperature contain ideal gases J and K separately. The density of gas J is twice that of gas K and the molecular mass of gas J is half that of gas K.

What is the ratio of the pressure of gas J to that of gas K?

- **A** 1:2 **B** 1:1
- **C** 2:1
- **D** 4:1
- 6 Which of the following statements about an ideal gas are correct?
  - A One mole of any ideal gas occupies the same volume under the same conditions of temperature and pressure.
  - **B** The density of an ideal gas at constant pressure is directly proportional to the temperature.
  - **C** The volume of a given mass of an ideal gas is doubled when its temperature is raised from 25 °C to 50 °C.
  - **D** The temperature of a given mass of an ideal gas is doubled when its volume is raised from 0.05 cm<sup>3</sup> to 0.1 dm<sup>3</sup>.

7 The type of bonding between two elements can be rationalised and even predicted using a van Arkel triangle. The triangle is based on electronegativity values. Difference in electronegativity is plotted along the y-axis and average electronegativity is plotted along the x-axis.



What is the type of bonding present at each of these bonding extremes, labelled L, M and N on the triangle?

	L	Μ	Ν
Α	covalent	metallic	ionic
В	metallic	covalent	ionic
С	covalent	ionic	metallic
D	ionic	covalent	metallic

**8** Lead is the final product formed by a series of changes in which the rate-determining stage is the radioactive decay of uranium-238. This radioactive decay is a first-order reaction with a half-life of 4.5 x 10<sup>9</sup> years.

What would be the age of a rock sample, originally lead–free, in which the molar proportion of uranium to lead is now 1:31?

- **A** 2.25 x 10<sup>10</sup> years
- **B** 2.70 x 10<sup>10</sup> years
- **C** 3.15 x 10<sup>10</sup> years
- **D** 3.60 x 10<sup>10</sup> years

**9** When 0.1 mol of bismuth chloride is added to 2 dm<sup>3</sup> of water, it reacts to form 0.02 mol of white precipitate of bismuth oxychloride and a solution of hydrochloric acid:

$$BiCl_3(aq) + H_2O(l) \implies BiOCl(s) + 2HCl(aq)$$

What is the correct expression for the equilibrium constant  $K_c$ ?

A 
$$\frac{(2 \times 0.02)^2}{0.08}$$
  
B  $\frac{(0.02)(2 \times 0.02)^2}{0.08}$   
C  $\frac{(\frac{2 \times 0.02}{2})^2}{\frac{0.08}{2}}$   
D  $\frac{(\frac{0.02}{2})(\frac{2 \times 0.02}{2})^2}{\frac{0.08}{2}}$ 

**10** What is the pH of the resultant solution when 100 cm<sup>3</sup> of 0.10 mol dm<sup>-3</sup> of aqueous NH<sub>3</sub> and 80 cm<sup>3</sup> of 0.15 mol dm<sup>-3</sup> aqueous NH<sub>4</sub>C*l* are mixed at 25 °C? (p $K_b$  of NH<sub>3</sub> = 4.75)

**A** 9.07 **B** 9.17 **C** 9.32 **D** 9.35

11 Instant 'cold packs' are often used by athletes to conveniently treat injuries. One type of 'cold pack' is composed of powdered ammonium nitrate and water separated by a thin plastic membrane. When the pack is squeezed, the membrane breaks and ammonium nitrate dissolves in water spontaneously.

Which line in the table gives the signs of  $\Delta H$ ,  $\Delta S$  and  $\Delta G$  for the overall process?

	$\Delta H$	$\Delta S$	$\Delta G$
Α	—	+	-
В	_	_	+
С	+	-	+
D	+	+	_

**12** Use of the Data Booklet is relevant to this question.

The half-cells for four metals: Mg, **P**, **Q** and **R** were in turn connected in pairs and the potential difference was recorded.

#### Temperature = 25°C



The results obtained are as shown in the table below.

Positive electrode	Negative electrode	e.m.f /V
Р	Mg	+2.10
Q	Mg	+2.72
Mg	R	+0.33

Rank the four metals in the order of decreasing reducing power.

- **A Q** > **P** > Mg > **R**
- **B P** > **Q** > Mg > **R**
- $C \qquad R > Mg > P > Q$
- $\mathbf{D}$   $\mathbf{R} > Mg > \mathbf{Q} > \mathbf{P}$

13 W, X, Y and Z are four elements in Period 3.

**W** is a conductor of electricity and does not react with water. **Z** forms a chloride,  $\mathbf{Z}Cl_5$  which reacts with water and dissolves in organic solvent. **Y** forms a solid oxide  $\mathbf{Y}O_2$ . **X**OH is a strong alkali.

Arrange the above elements in order of increasing proton number.

- **A X**, **W**, **Y**, **Z**
- B X, Y, Z, W
- C W, Y, X, Z
- D W, X, Y, Z
- **14** The graph below show the variation in the molar enthalpy change of vapourisation,  $\Delta H_{vap}$  for 8 consecutive elements in the Periodic Table, all with atomic number  $\leq 20$ .





Atomic number

What can be deduced from the above graph?

- A Element A forms amphoteric oxides.
- **B** Element **F** exists as diatomic molecules.
- **C** Element **G** forms an oxide which is acidic in aqueous solution.
- **D** Element **C** is in the same group as boron in the Periodic Table.

**15** Radium is the last element in Group II in the Periodic Table.

Which of the following is **not** true for radium?

- A Its oxide is basic with water.
- **B** It is the least reactive element in Group II.
- **C** It reacts with water to release hydrogen gas.
- **D** Its compounds conduct electricity when molten.
- **16** Which of the following factors best explains why magnesium sulfate has a higher solubility than barium sulfate?
  - **A** Barium is more electropositive than magnesium.
  - The charge density of magnesium ions is greater than that of the barium ions.
  - Magnesium sulfate has numerically larger lattice energy than barium **C** sulfate.
  - The hydration of barium ions is more exothermic than that of magnesium **D** ions.
- **17** Concentrated sulfuric acid reacts differently with each of the sodium halides, NaC*l*, NaBr and NaI due to their differing chemical properties.

Which of the following statements about their respective reactions is **not** true?

- A Sodium halides may act as reducing agents.
- **B** White fumes are produced in the reactions involving sodium bromide and sodium iodide only.
- **C** Redox reaction occurred with concentrated sulfuric acid only for sodium bromide and sodium iodide.
- **D** There is a difference in the extent of the reduction of the sulfuric acid when the reactions of bromide and iodide with concentrated sulfuric acid are compared.

**18** Consider the following reaction route.

T (aq)  
hot aqueous KOH  

$$\downarrow$$
 AgNO<sub>3</sub> (aq)  
precipitate  $\rightarrow$  colourless solution  
dilute NH<sub>3</sub> (aq)

What could solutions **T**, **U** and **V** be?

	т	U	V
Α	$Cl_2$	KC <i>l</i>	KC <i>l</i> O
В	$Cl_2$	KC <i>l</i>	KClO <sub>3</sub>
С	Br <sub>2</sub>	KBr	KBrO
D	Br <sub>2</sub>	KBr	KBrO <sub>3</sub>

**19** Use of the Data Booklet is relevant to this question.

Peroxodisulfate(VI),  $S_2O_8^{2^2}$ , is capable of oxidising the tartrate ion,  $[CH(OH)CO_2]_2^{2^2}$  to carbon dioxide and methanoate as shown in the following reaction.

 $[CH(OH)CO_2]_2^2 + 3S_2O_8^2 + 2H_2O \longrightarrow 2CO_2 + 2HCO_2^- + 6H^+ + 6SO_4^2$ 

The reaction can be catalysed by a homogenous catalyst. Given that the electrode potential for the tartrate ion is

 $2CO_2 + 2HCO^{2-} + 6H^+ + 6e$  [CH(OH)CO<sub>2</sub>]<sub>2</sub><sup>2-</sup> + 2H<sub>2</sub>O  $E^{\theta} = + 0.56 V$ Which metal ion is **not** a suitable catalyst for this reaction?

- **A** Co<sup>3+</sup>
- B Fe<sup>3+</sup>
- C Mn<sup>2+</sup>
- **D** V<sup>2+</sup>

**20** Covalent bonds are formed by orbital overlap. The shape of unsaturated hydrocarbon molecules can be explained in terms of hybridisation of orbitals.

Which bond is **not** present in  $CH_2=C=CHCH_2CH_3$ ?

- **A**  $\pi$  bond formed by sp sp<sup>2</sup> overlap
- **B**  $\sigma$  bond formed by sp<sup>3</sup> sp<sup>2</sup> overlap
- **C**  $\sigma$  bond formed by s sp<sup>3</sup> overlap
- **D**  $\sigma$  bond formed by sp<sup>3</sup> sp<sup>3</sup> overlap
- 21 In which reaction will the oxidation number of carbon show the smallest change?

$$CH_3CH(OH)CH_3 \xrightarrow{MnO_4^- / H^+}$$
  
heat

Note: refer to the C atom bonded to the -OH group

$$\mathbf{B} \qquad \begin{array}{c} H \\ H \\ -C \\ H \\ H \\ H \\ \end{array} \qquad \begin{array}{c} \mathsf{K}_2 \mathsf{Cr}_2 \mathsf{O}_7 / \mathsf{H}^+ \\ \hline \mathsf{heat} \\ \mathsf{heat} \\ \end{array} \\ \begin{array}{c} \mathsf{O} \\ \mathsf{excess} \mathsf{O}_2 \\ \hline \mathsf{O} \\ \mathsf{$$

**D** 
$$CH_2=CH_2 \xrightarrow{H_2, Ni}$$
 heat

22 Methylcyclopentane can react with chlorine via free radical substitution to produce a mixture of four monochlorinated products, two of which are shown below.



For methylcyclopentane, the order of reactivity of tertiary and primary hydrogen atoms follows a 5 : 1 ratio.

What is the likely ratio of tertiary RCl : primary RCl formed?

- **A** 1:15
- **B** 1:3
- **C** 3:5
- **D** 5:3

**23** Tryptophan is an amino acid and is essential to the human diet. It also serves as a biological precursor to some chemicals associated with the nervous system of the human body. It has an isoelectric point of 5.89.



Tryptophan

What of the following statements is not true about tryptophan?

- **A** There are a total of 2 stereoisomers present.
- **B** It has a positive charge when placed in a solution at pH 3.
- **C** It reacts with lithium aluminium hydride to form:



**D** It reacts with aqueous bromine to form:



**24** 2–methylpropanoic acid can be synthesised from 1–chloropropane through a series of reactions.

Which set of reagents, used in sequential order, would be the most suitable for this synthesis?

- A ethanolic KCN, dilute HCl
- **B** PC $l_5$ , acidified KMnO<sub>4</sub>
- **c** aqueous KOH, HC*l*, ethanolic KCN, dilute HC*l*
- **D** ethanolic KOH, HBr, ethanolic KCN, dilute H<sub>2</sub>SO<sub>4</sub>
- 25 Compound J exhibits the following characteristics:
  - 1 mol of **J** reacts with excess sodium metal to form 1 mol of hydrogen gas.
  - Yellow precipitate is formed when **J** reacts with aqueous alkaline iodine.
  - Orange precipitate is formed when **J** reacts with 2,4-DNPH, but no reaction with alkaline silver diammine solution.

С

• J rotates plane-polarised light.

Which of the following could compound J be?









В

26 Ethanol reacts explosively with sodium metal to form a salt, sodium ethoxide.

What is the product of the reaction between 2-iodobutane and sodium ethoxide?

- **A**  $CH_3CH=CHCH_3$
- **B** (CH<sub>3</sub>)<sub>2</sub>CHCH<sub>2</sub>OCH<sub>2</sub>CH<sub>3</sub>
- C CH<sub>3</sub>CH<sub>2</sub>CH(OCH<sub>3</sub>)CH<sub>2</sub>CH<sub>3</sub>
- D CH<sub>3</sub>CH<sub>2</sub>CH(CH<sub>3</sub>)OCH<sub>2</sub>CH<sub>3</sub>
- **27** Deuterium, D, is the  ${}_{1}^{2}$ H isotope of hydrogen.

Which reaction could give an organic compound having deuterium incorporated into the molecule?



28 Safranal is a component of the yellow dyestuff saffron.



#### Safranal

What are the products of warming it with Tollens' reagent?

- A a precipitate of silver oxide and a carboxylate salt
- **B** a silver mirror and a carboxylate salt
- **C** a silver mirror and a carboxylic acid
- **D** a silver mirror and an alcohol

29 Ferulic acid is an abundant phytochemical found in plant cell walls.



Ferulic acid

Assume that  $CH_3O-$  group is inert. Which statement about ferulic acid is correct?

- A Ferulic acid can only undergo electrophilic addition with aqueous bromine. Ferulic acid forms an ester with ethanoic acid when heated with
- B concentrated sulfuric acid.
   One mole of ferulic acid can react with only one mole of phosphorous
- **C** pentachloride. Ferulic acid reacts with lithium aluminium hydride to form a product that
- **D** does not exhibit geometric isomerism.
- 30 Which of the following shows the correct order of increasing base strength?



#### Section B

For **questions 31 – 40**, one or more of the numbered statements **1** to **3** may be correct. Decide whether each of the statements is or is not correct. The responses **A** to **D** should be selected on the basis of

Α	В	С	D
1, 2 and 3	1 and 2 only	2 and 3 only	1 only
are correct	are correct	are correct	is correct

No other combination of statements is to be used as correct response.

- **31** Which of the following contain more intermolecular hydrogen bonds than ammonia?
  - 1  $H_2SO_4(l)$
  - 2  $CH_3COCH_3(l)$
  - **3**  $CH_3COOH(l)$
- 32 Consider the following mechanism.

L+M N	fast
L + N → P + Q	slow
$N + Q \longrightarrow M + P$	fast

What can be deduced from the mechanism?

- 1 The unit for rate constant, k, in the rate equation is  $mol^{-1} dm^3 s^{-1}$ .
- 2 The overall equation is  $2L + N \longrightarrow 2P$ .
- 3 **M** is a catalyst and **Q** is an intermediate.
- 33 Which of the following statements are false?
  - 1 When an inert gas is added at constant volume to an equilibrium mixture, the equilibrium position of the system will not shift.
  - **2** The magnitude of the equilibrium constant informs us of the relative proportion of products to reactants, providing us information on the reaction rate.
  - **3** When a change in conditions is introduced to an equilibrium system, both the concentration of reactants and products, as well as the equilibrium constant changes.

Α	В	С	D
1, 2 and 3	1 and 2 only	2 and 3 only	1 only
are correct	are correct	are correct	is correct

**34** Equal amounts of two organic compounds, **R** and **S**, were added to water and the pH values of both solutions were determined. It was found that the pH of the aqueous solution of **R** is higher.

Which pairs of compounds could be **R** and **S**?

	R	S
1	CH <sub>3</sub> CH <sub>2</sub> OH	CH <sub>3</sub> CO <sub>2</sub> H
2	$CH_3CH_2NH_2$	$C_6H_5NH_2$
3	C <sub>6</sub> H₅O⁻Na⁺	C <sub>6</sub> H₅CO₂ <sup>−</sup> Na <sup>+</sup>

**35** Iron (III) oxide can be reduced by hydrogen gas to form iron and water.

 $Fe_2O_3(s) + 3H_2(g) \longrightarrow 2 Fe(s) + 3H_2O(g)$   $\Delta H^{\theta} = +96 \text{ kJ mol}^{-1}$ 

The table below shows the  $\Delta S^{\theta}$  of the reactants and the products of the reaction.

	Fe <sub>2</sub> O <sub>3</sub>	H <sub>2</sub>	Fe	H <sub>2</sub> O
S <sup>θ</sup> ∕kJ mol⁻¹ K⁻¹	0.090	0.131	0.027	0.189

Which of the following conclusions can be made?

- 1 The rate of reaction can only be increased by increasing the temperature of the system.
- **2** The  $\Delta S^{\theta}$  is +0.138 kJ mol<sup>-1</sup> K<sup>-1</sup>.
- 3 The reaction is not spontaneous.

Α	В	С	D
1, 2 and 3	1 and 2 only	2 and 3 only	1 only
are correct	are correct	are correct	is correct

**36** During electrolysis of an aqueous solution of rhodium sulfate, 1.00 mol of rhodium ions was discharged at the cathode. This required  $2.90 \times 10^5$  C of electricity.

Which of the following conclusions can be drawn from the information above?

- 1 Effervescence will be observed at the anode.
- 2 The magnitude of the charge on the rhodium ions is three times the charge of an electron.
- **3** Rhodium is a transition element.
- 37 The hexa-aquairon (III) ion hydrolyses as shown.

 $[Fe(H_2O)_6]^{3+} (aq) + H_2O (l) \implies [Fe(H_2O)_5OH]^{2+} (aq) + H_3O^+ (aq)$ 

Which statements are correct?

- **1** The corresponding iron (II) ion,  $[Fe(H_2O)_6]^{2+}$  is less likely to undergo hydrolysis.
- 2 The iron undergoes a change in oxidation state.
- **3** This hydrolysis is favoured by low pH values.

Α	В	С	D
1, 2 and 3	1 and 2 only	2 and 3 only	1 only
are correct	are correct	are correct	is correct

38 Halogen-containing organic compounds can be hydrolysed under suitable conditions to produce the corresponding halide ions,  $X^-$ .

A student investigated the amount of C/ produced by hydrolysing CH<sub>3</sub>CH<sub>2</sub>Cl and another halogen-containing compound, W. In a given time the amount of  $X^{-}$  formed was greater with **W** than with CH<sub>3</sub>CH<sub>2</sub>Cl.



Which compound could be W?

- 1 CH<sub>3</sub>CHC*l*CH=CHC*l*
- 2  $CH_3CH_2COCl$
- 3  $ClCH_2CH_2Cl$

Α	В	С	D
1, 2 and 3	1 and 2 only	2 and 3 only	1 only
are correct	are correct	are correct	is correct

**39** Pethidine is a narcotic analgesic drug, used as a substitute for morphine in the treatment of acute severe pain.



Pethidine

Which pairs of compounds would produce pethidine when reacted together?



Α	В	С	D
1, 2 and 3	1 and 2 only	2 and 3 only	1 only
are correct	are correct	are correct	is correct

**40** Saccharin is an artificial sweetening agent. It can be synthesised from methylbenzene through a series of reactions as shown.



What types of reactions are involved in the series of reactions?

- 1 Condensation
- 2 Electrophilic substitution
- 3 Nucleophilic substitution

#### **END OF PAPER**

## **BLANK PAGE**

## **BLANK PAGE**