ANGLO-CHINESE JUNIOR COLLEGE DEPARTMENT OF CHEMISTRY Preliminary Examination

CHEMISTRY Higher 2

9647/01

Paper 1 Multiple Choice

12 September 2012

1 hour

Additional Materials:

Multiple Choice Answer Sheet Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid. Write your name, Centre number and candidate number on the answer sheet in the spaces provided unless this has been done for you.

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 in **soft pencil** on the separate answer sheet.

Read the instructions on the Answer Sheet very carefully.

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 booklet.

This document consists of 18 printed pages.

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ANGLO-CHINESE JUNIOR COLLEGE Department of Chemistry

[Turn over

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 relative atomic mass of antimony, which consists of the isotopes ¹²¹Sb and ¹²³Sb, is 121.8. What is the percentage of ¹²³Sb in the isotopic mixture?
 - **A** 40%
 - **B** 45%
 - **C** 50%
 - **D** 55%
- 20 cm³ of a gaseous unknown hydrocarbon was combusted in 100 cm³ (an excess) of oxygen. After the combustion, the mixture was left to cool and the gaseous volume was 90 cm³. Upon treatment with potassium hydroxide, the volume was decreased to 50 cm³.

What is the molecular formula of the unknown hydrocarbon?

- **A** CH₄
- **B** C₂H₂
- **C** C₂H₆
- \mathbf{D} C_3H_6
- **3** Species with unpaired electrons exhibit a property known as paramagnetism, that is, it is attracted by an external magnetic field which is directly proportional to the number of unpaired electrons present in the species.

Which of the following species is **not** paramagnetic?

- A Fe³⁺
- **B** Ti²⁺
- **C** Cu²⁺
- **D** Ca²⁺

4 The empirical formula of a fluorocarbon is CF₂. At the same temperature and pressure, 1 dm³ of the fluorocarbon weighs 8.93 g while 1 dm³ of fluorine gas weighs 1.80 g.

What is the molecular formula of the fluorocarbon?

- A CF₂
- **B** C₂F₄
- **C** C₄F₈
- **D** C₅F₁₀
- 5 Which of the following molecules will **not** form a hydrogen bond with another of its own molecules?
 - A CH₃NH₂
 - B CH₃COCH₃
 - **C** CH_3CONH_2
 - D CH₃OH
- 6 Adrenaline is a hormone which, when secreted directly into the bloodstream, acts as a stimulant. The structure of adrenaline is given below.



What are the values of the angles *x*, *y* and *z* in a molecule of adrenaline?

	X	У	Z
Α	120º	105º	107º
В	109º	180º	90º
С	120º	105º	120º
D	180º	120º	107º

7 Propene burns completely in oxygen to give carbon dioxide and water.

 $CH_3CH=CH_2 + 9/2 O_2 \longrightarrow 3 CO_2 + 3 H_2O$

Using the Data Booklet, calculate the enthalpy change of the reaction.

- A 890 kJ mol⁻¹
- **B** 1548 kJ mol⁻¹
- C 2569 kJ mol⁻¹
- **D** 2890 kJ mol⁻¹
- **8** Which graph correctly represents an auto-catalytic reaction (reaction in which one of the products catalyses the reaction)?



9 0.12 g of graphite was added to a vessel that contained CO₂ (g) at a pressure of 0.824 atm at 400K. The total pressure reached an equilibrium value of 1.366 atm after a period of time.

 $C(graphite) + CO_2(g) \implies 2 CO(g)$

Given that the temperature did not change, what is the value of the equilibrium constant K_p ?

- **A** 0.239
- **B** 0.260
- **C** 3.84
- **D** 4.17
- **10** What is the pH of the final solution formed when V cm³ of dilute sulfuric acid of pH 2.0 is mixed with V cm³ of dilute sulfuric acid of pH 4.0 followed by the addition of 2V cm³ of water?
 - **A** 2.3
 - **B** 2.6
 - **C** 3.0
 - **D** 3.6

11 When 5.00 cm³ of a 0.100 mol dm⁻³ base is titrated against 0.100 mol dm⁻³ of ethanoic acid, CH₃COOH, the following titration curve is obtained.



Which of the following correctly identifies the base used and the point on the curve at which $pH = pK_a$?

	Base used	Point where $pH = pK_a$
Α	NaOH(aq)	М
B	Ba(OH)2(aq)	Ν
С	NaOH(aq)	Р
D	Ba(OH)₂(aq)	Р

12 A sparingly soluble salt, cobalt(II) hydroxide, dissociates in aqueous solution according to the equation below.

 $Co(OH)_2$ (s) $\implies Co^{2+}$ (aq) + 2 OH⁻ (aq)

What is the concentration of OH^{-} at equilibrium given that the solubility product of cobalt(II) hydroxide is 1.6 x 10⁻¹⁵ mol³ dm⁻⁹?

- A 7.37 x 10⁻⁶ mol dm⁻³
- **B** 9.28 x 10⁻⁶ mol dm⁻³
- **C** 1.47 x 10⁻⁵ mol dm⁻³
- **D** 2.34 x 10⁻⁵ mol dm⁻³

13 The following reaction has a negative E_{cell}^{θ} so it does not occur under standard conditions.

 $2NO_{3}(aq) + 8H^{+}(aq) + 6Cl^{-}(aq) \longrightarrow 2NO(g) + 4H_{2}O(l) + 3Cl_{2}(g)$

However, the reaction may be made to proceed under non-standard conditions. Which of the following changes will **not** aid the reaction to proceed?

- A Addition of NaCl
- **B** Addition of HC*l*
- **C** Addition of KNO₃
- **D** Addition of AgC*l*
- 14 Use of the Data Booklet is relevant to this question.

Sacrificial protection is a common method used to prevent the rusting of large steel objects such as underground pipes, oil tankers or ships.

A piece of metal that is more reactive than iron is connected to the object made of iron. Over time, the more reactive metal will corrode in place of the iron and hence "sacrificed".

Which metal can be used in the above mentioned method to prevent rusting?

- A Copper
- B Zinc
- **C** Cobalt
- D Lead
- 15 Which of the following species has the smallest radius?
 - **A** S²⁻
 - **B** C*l*⁻
 - **C** K⁺
 - **D** Ca²⁺

16 A mixture of the oxides of two elements in the third period is dissolved in water. The resultant solution is acidic.

What could be the constituents of the mixture?

- A Na₂O and MgO
- B Na₂O and Al₂O₃
- **C** Al_2O_3 and SiO_2
- **D** SO₃ and P_4O_{10}
- **17 X**, **Y** and **Z** are Group II elements. They form compounds with the following properties:
 - $Y(NO_3)_2$ has a higher thermal decomposition temperature than $Z(NO_3)_2$.
 - XSO₄ has a more exothermic lattice energy than ZSO₄.

Which of the following statements is correct?

- **A** On heating, $Y(NO_3)_2$ decomposes to the nitrite and oxygen while $Z(NO_3)_2$ decomposes to the oxide, nitrogen dioxide and oxygen.
- **B X** Cl_2 has a more covalent character than **Y** Cl_2 .
- **C Z** is more reducing than **Y**.
- **D X** is Mg and **Z** is Ba.
- **18** 0.03 mol of chlorine gas was bubbled into 100 cm³ of hot aqueous sodium hydroxide of concentration, 1.5 mol dm⁻³.

Which of the following statement is correct regarding the above reaction?

- A 0.03 mol of sodium chlorate (I) was formed.
- **B** 0.03 mol of sodium chlorate (V) was formed.
- **C** The excess sodium hydroxide required 0.06 mol of dilute hydrochloric acid for complete neutralization.
- **D** The chloride produced required 0.05 mol of silver nitrate for complete precipitation.

- **19** Transition metals like platinum and rhodium are found in catalytic converters fitted into cars. Which of the following statements best explains the role of transition metals in this use?
 - **A** Transition metals can exhibit variable oxidation states in their compounds as 3d and 4s electrons have similar energies.
 - **B** Transition metals have available and partially filled 3d orbitals for the adsorption of reactant molecules.
 - **C** Transition metals have very high melting points because both 3d and 4s electrons are involved in forming strong metallic bonds.
 - **D** Transition metals form coloured ions due to absorption of energy in the visible light region to promote an electron from a lower to a higher energy 3d orbitals.
- **20** The table shows the electronic configuration of the three d-block elements in the Periodic table.

Element	Electronic Configuration
Р	[Ar]3d ⁶ 4s ²
Q	[Ar]3d ⁸ 4s ²
R	[Ar]3d ¹⁰ 4s ¹

Which one of the following statements is incorrect?

- **A** The electronic configuration of central metal ion for $[P(CN)_6]^{4-}$ is $[Ar]3d^6$.
- **B** Upon reduction from $\mathbf{R}Cl_2$ (aq) to $[\mathbf{R}Cl_2]^{-}$ (aq), the solution turned colourless.
- **C P** is likely to exist as KPO₄.
- **D** The E^{θ} value of P^{3+}/P^{2+} is less positive than that of Q^{3+}/Q^{2+} .
- **21** C₄H₈ decolourises aqueous bromine in the dark. How many isomers (including both structural and geometric isomers) are possible for the compound C₄H₈?
 - **A** 1
 - **B** 2
 - С 3
 - **D** 4

22 Which type of reaction is the following compound unlikely to undergo?



- A Nucleophilic substitution
- **B** Reduction
- **C** Electrophilic addition
- **D** Free radical substitution
- 23 Consider the compound **Y**, which has the structural formula as shown.



1 mole of compound **Y** is warmed with aqueous sodium hydroxide. The resulting solution is cooled and acidified with dilute nitric acid. How many moles of silver chloride will be precipitated out when excess aqueous silver nitrate is then added?

- **A** 1
- **B** 2
- **C** 3
- **D** 4

24 Thyroxine and Cyproterone are compounds that are often used in hormone therapy.



Thyroxine

Cyproterone

COCH₃

_`OH CH₃

Which of the following reagents could **not** be used to distinguish between the two compounds?

- A Neutral FeCl₃
- B Alkaline aqueous iodine
- **C** Aqueous silver nitrate
- D Sodium carbonate
- **25** Which process does **not** form $CH_3CO(CH_2)_3CO_2H$?



- TestObservationTollen's ReagentSilver mirror formedFehling's ReagentNo visible reactionAqueous sodium carbonateColourless gas evolved
- 26 Compound **G** gives the following observations:

What is compound **G**?



27 During frozen storage, white fish develops a typical "cold storage" flavour. One of the compounds contributing to this off-flavour has been isolated and identified as hept-4-enal.

CH₃CH₂CH=CHCH₂CH₂CHO

hept-4-enal

What is formed when hept-4-enal is reduced with **either** hydrogen and a nickel catalyst **or** lithium aluminum hydride?

	Reagent	Product
Α	With H ₂ /Ni	CH ₃ (CH ₂) ₅ CH ₂ OH
В	With H ₂ /Ni	$CH_3(CH_2)_5CH_3$
С	With LiA/H ₄	CH ₃ (CH ₂) ₅ CH ₂ OH
D	With LiA/H ₄	CH ₃ (CH ₂) ₅ CHO

28 The ester $CH_3CH_2CH_2CO_2CH_3$ is responsible for the aroma of apples.

When this ester is hydrolysed by acid in the stomach, what is the empirical formula of the organic acid produced?

- A CH₂O
- **B** C₂H₄O
- $C = C_2H_4O_2$
- **D** C₃H₇O₂
- **29** Which of the following is the correct order of compounds arranged in **decreasing** $K_{\rm b}$ values?



30 The reduction of a nitrile **Q** produced a compound of the formula $CH_3CH_2NH_2$. The same nitrile **Q** was then hydrolysed in acidic medium.

What would be formed if the products from the two reactions are mixed together?

- A CH₃CONHCH₂CH₃
- **B** CH₃CH₂CONHCH₂CH₃
- $\mathbf{C} \qquad (CH_3CH_2CO_2^{-})(CH_3CH_2NH_3^{+})$
- $\mathbf{D} \qquad (\mathrm{CH}_{3}\mathrm{CO}_{2}^{-})(\mathrm{CH}_{3}\mathrm{CH}_{2}\mathrm{NH}_{3}^{+})$

Section **B**

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	В	C	D
1, 2 and 3	1 and 2	2 and 3	1 only
are	only are	only are	is
correct	correct	correct	correct

No other combination of statements is used as a correct response.

31 Which change(s) in conditions would **not** increase the volume of a fixed mass of gas?

	Pressure / kPa	Temperature / K
1	Halved	Halved
2	Doubled	Halved
3	Halved	Doubled

32 Sodium hypochlorite is a chemical compound with the formula NaOC*l*. It is frequently used in household as a disinfectant or a bleaching agent.

What type(s) of bonding occur in NaOCl?

- 1 covalent bond
- 2 ionic bond
- **3** Van der Waals forces
- **33** Which of the following reaction(s) has/have a positive enthalpy change of reaction?
 - 1 $H_2O(l) \longrightarrow H^+(aq) + OH^-(aq)$
 - **2** $\operatorname{Br}_2(g) \longrightarrow 2 \operatorname{Br}(g)$
 - **3** F (g) + e → F⁻ (g)

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

34 In a chemical reaction, **X** reacts with **Y** to form **Z**. The initial rates of the reaction are shown for the following experiments:

Experiment	[X]/ mol dm ⁻³	[Y]/ mol dm ⁻³	Initial rate/ mol dm ⁻³
1	0.150	0.250	2.80 x 10 ^{−5}
2	0.150	0.500	5.60 x 10 ^{−5}
3	0.075	0.500	2.80 x 10 ^{−5}
4	0.075	0.250	1.40 x 10 ^{−5}

The energy profile diagram for the reaction is as shown:



Which of the following is/are possible overall equation(s) of the above reaction?

- 1 $X + Y \rightarrow Z$
- $2 \qquad X+2Y \rightarrow Z$
- $3 \qquad 2X + Y \rightarrow Z$

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

35 At 200 °C, the value of K_c for the following reaction is 1.00 x 10¹⁰.

 $PCl_5 \implies PCl_3 + Cl_2$

Which factor(s) below can affect the magnitude of K_c?

- 1 Temperature
- 2 Pressure
- **3** Concentration of Cl₂ present
- **36** Which of the following statement(s) is/are true for period 3 elements and their compounds?
 - **1** The electronegativity decreases from sodium to chlorine.
 - 2 The pH of the chlorides decreases from sodium to chlorine
 - 3 The atomic radius decreases from sodium to chlorine.
- **37** The element astatine, At₂, is radioactive with a short half-life, hence its chemistry is not easily investigated. However, astatine is below iodine in the Periodic Table.

Which of the following prediction(s) is/are correct for astatine?

- 1 Chlorine is able to displace astatide from its aqueous solution.
- 2 Astatine reacts less readily with hydrogen than bromine.
- **3** Astatine oxidises thiosulfate to sulfate.

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

- **38** Which of the following reaction(s) will form a racemic mixture?
 - 1 CH₃CHO with HCN in trace amounts of NaOH at a temperature of 10 $^{\circ}$ C to 20 $^{\circ}$ C.
 - ² $CH_3CH_2CH_2C Cl$ with aqueous sodium hydroxide, heat under reflux. ³ $CH_3CH_2C - Cl$ with aqueous sodium hydroxide, heat under reflux. ⁴ C_6H_5 ⁴ CH_3CH_3 ⁴ $CH_3CH_2C - CCH_2CH_3$ with Br_2 dissolved in CCl_4 .
- **39** Thiols are organic compounds containing the –SH functional group. They are sulphur analogue of alcohols. Some common reactions undergone by thiols are shown as follows.
 - $\label{eq:ch_3CH_2SH} \textbf{I} \qquad \qquad \textbf{CH_3CH_2SH} \ \textbf{+} \ \textbf{CH_3CH_2Br} \ \rightarrow \ \textbf{(CH_3CH_2)_2S} \ \textbf{+} \ \textbf{HBr}$
 - $II \qquad CH_3CH_2SH + NaOH \rightarrow CH_3CH_2S^-Na^+ + H_2O$
 - $\label{eq:charged_scalar} \text{III} \qquad 2\text{CH}_3\text{CH}_2\text{SH} \ + \ \text{Br}_2 \ \rightarrow \ \text{CH}_3\text{CH}_2\text{-}\text{S}\text{-}\text{S}\text{-}\text{CH}_2\text{CH}_3 \ + \ 2\text{HBr}$

Which of the following statement(s) comparing thiols with alcohols is/are true?

- 1 Thiols are stronger nucleophiles than alcohols.
- 2 Thiols are stronger acids than alcohols.
- **3** Thiols are stronger reducing agents than alcohols.

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

40



Fumaric acid is generally used as a substitute for tartaric acid and occasionally in place of citric acid to add sourness to foods.

Which of the following statement(s) is/are correct?

- 1 It reacts with Br₂ (aq) to give 2 chiral centres.
- **2** It reacts with PCl_5 to give white fumes.
- **3** It reacts with two equivalents of phenol to form a sweet smelling compound.

END OF PAPER