INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2
in preparation for General Certificate of Education Advanced Level
Higher 2

CHEMIST	RY		9647/01
CLASS		INDEX NUMBER	
NAME			

CHEINISTRY

Paper 1 Multiple Choice

9647/01

1 hour

11 September 2012

Additional Materials:

Multiple Choice Answer Sheet Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name and class on all the work you hand in. Write in soft pencil. Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **forty** questions on 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 **17** printed pages and **1** blank page.



Section A

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

1 Methane was burned in an incorrectly adjusted burner. The methane was converted into a mixture of carbon dioxide and carbon monoxide in the ratio of 98:2, together with water vapour.

What will be the volume of oxygen consumed when $y \, dm^3$ of methane is burned?

- **A** $1.99y \, dm^3$ **C** $0.995y \, dm^3$
- **B** $1.995y \, dm^3$ **D** $0.99y \, dm^3$
- **2** To identify an oxide of nitrogen, 0.10 mol of the oxide was mixed with 10 dm³ of hydrogen gas and passed over a heated catalyst. At the end of the reaction, 0.4 dm³ of hydrogen gas remained. The ammonia produced required 125 cm³ of 1.6 mol dm⁻³ HC*l* for neutralisation. All gasoues volumes were measured at room temperature and pressure.

What is the formula of the oxide of nitrogen?

Α	NO	С	NO_2
В	N ₂ O	D	N_2O_4

3 A 2 g sample of hydrogen at temperature *T* and of volume *V* exerts a pressure of *p*. Deuterium, ${}^{2}_{1}$ H is an isotope of hydrogen.

Which of the following would also exert a pressure *p* at the same temperature?

- **A** 2 g of deuterium of volume V
- **B** 4 g of deuterium of volume $\frac{1}{2}V$
- **C** a mixture of 1 g of hydrogen and 2 g of deuterium of total volume *V*
- **D** a mixture of 2 g of hydrogen and 1 g of deuterium of total volume 2*V*
- 4 Which atom has the highest ratio of unpaired electrons to paired electrons in its ground state?
 - A boron C nitrogen
 - B carbon D oxygen
- 5 Which one of the following pairs consist of a planar molecule and a polar molecule?
 - **A** $C_6H_5CH_3$ and CO_2 **C** $CH_2=CHCHO$ and CH_3OCH_3
 - **B** C_6H_{12} and H_3PO_4 **D** C_6H_6 and CCl_4

- **6** Which of the following statements describe a phenomenon which can be explained by intermolecular hydrogen bonding?
 - A The melting points of the Group I hydroxides increase with increasing relative molecular mass.
 - **B** CH_3OCH_3 (M_r = 46) as a higher boiling point than $CH_3CH_2CH_3$ (M_r = 44)
 - **C** Ice has a lower density than water at 0°C.
 - **D** Glycine, NH₂CH₂COOH has a higher solubility in water than butane.
- 7 The kinetics of the reaction between H^+ (aq) and $S_2O_3^{2-}$ can be invesitgated experimentally by varying the volumes of HCl(aq) and $Na_2S_2O_3(aq)$ used and determining the time taken, **t**, for the formation of sulfur to completely obscure the cross as shown in the diagram.

$$S_2O_3^{2-}(aq) + 2H^+(aq) \longrightarrow S(s) + SO_2(g) + H_2O(l)$$

$$HC_1(aq) + Na_2S_2O_3(aq)$$
cross

The table below shows the experimental results obtained.

Experiment	Volume used / cm ³			t/s
	1.0 mol dm ⁻³ 0.040 mol dm ⁻³ $H_2O(I)$			
	HCl(aq)	$Na_2S_2O_3(aq)$		
1	10.0	5.0	25.0	170
2	15.0	5.0	20.0	170
3	15.0	10.0	15.0	85
4	20.0	20.0	0.0	X

What is the value of **x** in Experiment 4?

Α	21	С	85
В	43	D	170

8 A simple decomposition reaction is shown below.

 $AB(g) \longrightarrow A(g) + B(g)$

The rate equation was found to be as follows.

Rate = k[AB] where rate constant, $k = 0.2 \text{ s}^{-1}$

Estimate the time taken for AB(g) to reach one eighth of its initial concentration of 1.5 mol dm^{-3} .

Α	3.0 s	С	10.4 s
В	7.5 s	D	13.9 s

9 Hydrogen iodide dissociates into its elements according to the following equation.

$$2HI(g) \Longrightarrow H_2(g) + I_2(g)$$
 $\Delta H = +9 \text{ kJ mol}^{-1}$

A mixture of $H_2(g)$, $I_2(g)$ and HI(g) rapidly comes to equilibrium in a 2.0 L container. After the reaction has been at equilibrium for 10 minutes, the volume of the container is suddenly reduced to 1.3 L at constant temperature.

Which one of the following graphs best represents the effect of this decrease in volume on the concentration of the gases in the mixture?



10 Phosphorus(V) chloride, PCl_5 , decomposes to form phosphorus(III) chloride, PCl_3 , and chlorine, Cl_2 according to the equation

$$PCl_5(g) \implies PCl_3(g) + Cl_2(g)$$

Four different flasks, **1**, **2**, **3** and **4**, at the same temperature, contain a mixture of PCl_5 , PCl_3 and Cl_2 . The concentration, in mol dm⁻³, of these components in each of the flasks is shown below. In three of the four flasks, the mixture of gases is at equilibrium.

	Flask	$[PCl_5(g)]$	[PC <i>l</i> ₃ (g)]	$[Cl_2(g)]$
Α	1	0.15	0.20	0.30
В	2	0.20	0.15	0.15
С	3	0.10	0.10	0.40
D	4	0.30	0.80	0.15

In which one is the mixture of gases not at equilibrium?

11 Two titrations were performed as shown below



Which of the following statements is true?

- A The weak acid will require a greater volume of NaOH solution than the strong acid to reach the equivalence point.
- **B** The weak acid will require a smaller volume of NaOH solution than the strong acid to reach the equivalence point.
- **C** The weak acid will require the same amount of NaOH as the strong acid to reach the equivalence point.
- **D** The equivalence point in a titration of a weak monoprotic acid with NaOH solution cannot be determined.

12 Strontium hydride is an ionic compound. The standard enthalpy changes, ΔH_1 and ΔH_2 are known.

$$Sr(s) \longrightarrow Sr^{2+}(g) + 2e^{-} \qquad \Delta H_1$$
$$H_2(g) + 2e^{-} \longrightarrow 2H^{-}(g) \qquad \Delta H_2$$

What additional data is needed to determine the lattice energy of strontium hydride?

- **A** The first ionisation energy of hydrogen.
- **B** The standard enthalpy change of atomisation of hydrogen.
- **C** The standard enthalpy change of atomisation of strontium.
- **D** The standard enthalpy change of formation of strontium hydride.
- **13** Four half cells are constructed as follows.

Half cell I: an electrode of metal **P** in a 1.0 M solution of $P^+(aq)$ ions

Half cell II: an electrode of metal \mathbf{Q} in a 1.0 M solution of $\mathbf{Q}^+(aq)$ ions

Half cell III: an electrode of metal **R** in a 1.0 M solution of $\mathbf{R}^+(aq)$ ions

Half cell IV: an electrode of Cu(s) metal in a 1.0 M solution of Cu²⁺(aq) ions

The half cells are connected in pairs, as shown below, to form a series of galvanic cells. For each cell, the polarity of the electrodes and the voltage generated are recorded.

Half cells used	Positive electrode	Negative electrode	Voltage (V)
I and IV	Р	Cu	0.46
II and IV	Cu	Q	0.57
III and IV	Cu	R	1.10
II and III	Q	R	0.53

Which one of the following alternatives lists the metals in order of **increasing** strength as reducing agents?

Α	R, Q, Cu, P	С	P, Cu, R, Q
в	Cu, P, Q, R	D	P, Cu, Q, R

14 Aqueous sodium chloride (brine) is electrolysed by using inert electrodes in a cell which is stirred so that the products of electrolysis are able to react. The cell is kept cold.

Which one of the following pairs of substances is among the major products?

- A Hydrogen and sodium chlorate(I)
- **B** Hydrogen and sodium chlorate(V)
- C Hydrogen and chlorine only
- **D** Sodium hydroxide and chlorine only

15 The structure of compound **X** is given below.



Compound **X**

How many chiral centres are there in the product when compound ${\bf X}$ is hydrogenated with sodium boron hydride?

Α	2	С	6
В	4	D	8

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

Based on bond energies listed in the *Data Booklet*, what are the possible products of the following reaction?

•CH₃ + CH₃CH₂Cl
$$\longrightarrow$$

Α	CH ₄ + CH ₃ CHC <i>l</i>	C CI	$H_3CH_2CH_3 + Cl$
в	$CH_3CH_2CH_2 + HCl$	D Cł	$H_3CH_2CH_2Cl + H_{\bullet}$

17 An organic compound **Y** undergoes the following reactions:

- (i) It decolourises a solution of bromine in tetrachloromethane.
- (ii) It reacts with sodium bromide in concentrated sulfuric acid.

(iii) It reacts with hot alkali to produce a compound with two alcohol functional groups.

Which compound could be **Y**?

- **A** $HOH_2CCH=CHCH=CHCH_2Cl$
- **B** $Cl_2CHCH=CHCH_2COOH$
- **C** BrCH₂CH₂CHClCH₂COCl
- **D** $C_lCH_2CH_2CH=CHCH(C_l)CH_2OH$

18 Ibuprofen is an anti-inflammatory agent.



ibuprofen

Which of the following could be part of a sequence for synthesizing ibuprofen?



19 In which of the following sequences does the value of pK_a decrease continuously?

- $\textbf{A} \quad CH_3CO_2H \quad > CCl_3CO_2H \quad > C_2H_5OH \quad > C_6H_5OH$
- $\textbf{B} \quad CCl_3CO_2H > CH_3CO_2H > C_6H_5OH > C_2H_5OH$
- $\textbf{C} \qquad C_2H_5OH \qquad > C_6H_5OH \qquad > CH_3CO_2H \qquad > CCl_3CO_2H$
- $\textbf{D} \qquad C_6H_5OH \qquad > C_2H_5OH \qquad > CH_3CO_2H \qquad > CCI_3CO_2H$

20 The production of 4-chloro-3-nitrobenzoic acid from methylbenzene is as follows:



Which of the following shows the correct intermediates for **1** and **2** with the highest yield of the final product?



21 An account in a student's notebook read:

'An excess of aqueous bromine was added to aqueous phenol in a test tube, 2,4,6-tribromophenol was produced as a creamy-white precipitate suspended in a yellow alkaline solution.'

Which statement in this account must have been incorrect?

- A The precipitate is not 2,4,6-tribromophenol, but a mixture of 2- and 4-bromophenol.
- **B** The precipitate obtained is not creamy-white, but yellow.
- **C** The resultant solution is not alkaline, but acidic.
- **D** The resultant solution is not yellow, but purple.
- 22 Ethanoic acid can be made by direct carbonylation of methanol, in presence of a rhodium catalyst.

$$CH_3OH + CO \xrightarrow{\text{rhodium}} CH_3COOH$$

Using a similar method, which of the following could be expected to produce compound W?





Compound W

23 The amino acids glutamine and glutamic acid can react with each other to form amide linkages.



What is the maximum number of different compounds, each containing one amide linkage, that can be formed from one molecule of glutamine and one molecule of glutamic acid?

- A 2 C 4 B 3 D 5
- **24 B** is synthetic nonapeptide that is resynthesised from the amino acids found in honey bee venom. To investigate the sequence of amino acids in **B**, the nonapeptide was first hydrolysed by two enzymes. The protein fragments were then separated and their sequence determined.

The following protein fragments were obtained from the first enzyme which hydrolysed the peptide chain at the carboxylic end of the amino acid isoleucine, lle.

Arg-Ile Ser-Lys-Trp-Ile Lys-Leu-Arg

The second enzyme, which hydrolysed the peptide chain at the carboxylic end of the amino acid lysine, Lys, yielded the following fragments

Arg-Ile-Ser-Lys Trp-Ile-Lys Leu-Arg

Which of the following is the correct primary structure of the nonapeptide B?

- A Lys-Leu-Arg-Ile-Ser-Lys-Trp-Ile-Lys
- **B** Trp-Ile-Lys-Leu-Arg-Ile-Ser-Lys-Trp
- **C** Arg-Ile-Ser-Lys-Trp-Ile-Lys-Leu-Arg
- **D** Ser-Lys-Trp-Ile-Lys-Leu-Arg-Ile-Ser
- **25** Haemoglobin is the oxygen carrying pigment in red blood cells. It contains two α -sub-units and two β -sub-units. What are the **main** forces responsible for holding the four subunits together?
 - A van der Waals' forces C peptide bonds
 - B electrostatic forces D hydrogen bonds

26 Two properties of non-metallic elements and their atoms are as follows.

property 1	has an oxide that can form a strong acid in water
property 2	has no paired 3p electrons

Which properties do phosphorus and sulfur have?

	phosphorus	sulfur
Α	1 and 2	1 only
В	1 only	1 and 2
С	1 and 2	1 and 2
D	2 only	1 only

27 At 900 0 C, CaCO₃ decomposes producing CO₂ and the metal oxide. At 1100 0 C, CaSO₄ decomposes producing SO₃ and the metal oxide.

Which statement explains the greater stability of CaSO₄?

- **A** CaCO₃ has a higher lattice energy than CaSO₄.
- **B** The CO_2 molecule is smaller than SO_3 .
- **C** The charge density of CO_3^{2-} is greater than that of SO_4^{2-} .
- **D** CO_3^{2} ions are more easily polarised than SO_4^{2} .
- **28 X** is a salt of one of the halogens chlorine, bromine, iodine, or astatine (proton number 85). The reaction scheme shows a series of reactions using a solution of **X** as the starting reagent.



- A as an acid only
- **B** as an acid and oxidising agent
- **C** as an oxidising agent only
- **D** as a reducing agent only
- 30 The diagram shows some reactions of salt Q.



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	С	D
1, 2 and 3 are correct	1 and 2 are correct	2 and 3 are correct	1 only is correct.

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

- **31** Which of the following quantities is equal to the Avogadro constant?
 - **1** The number of oxygen atoms in 49.9 g of allactite, $Mn_7(AsO_4)_2(OH)_8$, of molar mass 798 g mol⁻¹
 - 2 The number of aqueous chloride ions in a solution containing 0.5 mol of the complex, $[Cr(H_2O)_5Cl]Cl_2$
 - **3** The number of ions in 168 g of Reinecke's salt, NH₄[Cr(NH₃)₂(SCN)₄], of molar mass 336 g mol⁻¹
- 32 Which of the following is hydrogen bonded in the liquid state?
 - 1 CH_3NH_2
 - 2 CH₃CHO
 - **3** CH₂F₂
- **33** Which suggested mechanisms are consistent with the experimentally obtained rate equations?

1	Rate = $k[NO]^2[H_2]$	$2NO + H_2 \longrightarrow N_2O + N_$	+ H ₂ O (slow)
		$N_2O + H_2 \longrightarrow N_2 + I$	H₂O (fast)
2	Rate = $k[A]^2[B]$	$2A \Longrightarrow A_2$ (f	fast)	
		$A_2 + B \longrightarrow A_2B$ (s	slow)	
		$A_2B + A \longrightarrow A_3B$ (i	fast)	
3	Rate = k[HBr][O ₂]	2HBr + O₂ → 2HB	BrO	(slow)
		HBrO + HBr \longrightarrow H ₂	O + Br ₂	(fast)

$$S_2O_8^{2-}(aq) + 2I^{-}(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$$

The E^{Θ} , values for the half-reactions are:

 E^{Θ} , (I₂ / I⁻) = +0.54 V E^{Θ} , (S₂O₈²⁻ / SO₄²⁻) = +2.01 V

Which of the following transition metal ions can be used to catalyse this reaction?

- **2** Co³⁺
- **3** V³⁺
- **35** Which compounds could undergo elimination reaction when treated with hot ethanolic potassium hydroxide?







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

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

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

36 Which of the following statements is true for the compound below?



- **1** It is a non-planar compound.
- 2 When boiled with aqueous sodium hydroxide, it is converted to



- **3** It will react with 2,4-dinitrophenylhydrazine at room temperature.
- **37** Esters can be synthesized by reaction of a carboxylate anion with an alkyl halide.

 $\text{RCO}_2^- + \text{R'}-\text{X} \rightarrow \text{RCO}_2\text{R'} + \text{X}^-$ where X = Cl, Br or I

Which of the following esters can be prepared using this method?



- **38** Which of the following mixture produce ND_3 gas upon heating? [D = 2_1 H, an isotope of hydrogen]
 - 1 CaO (s) and ND_4Cl (s)
 - 2 CH_3CN and NaOD in D₂O
 - **3** CH_3CONH_2 and NaOD in D_2O
- **39** Which properties in the sequence hydrogen chloride, hydrogen bromide and hydrogen iodide steadily increase?
 - **1** thermal stability
 - 2 bond length
 - **3** ease of oxidation
- **40** The rock dolomite is a double carbonate of magnesium and calcium, CaCO₃.MgCO₃. When heated strongly, a product called *calcined dolomite* is formed which is used to line some furnaces for the production of metals.

Why is calcined dolomite used for this purpose?

- **1** It is a refractory material.
- 2 It will absorb acidic impurities in metallurgical processes.
- **3** It will reduce metallic oxides to metals.