

VICTORIA JUNIOR COLLEGE JC 2 PRELIMINARY EXAMINATIONS Higher 2

# CHEMISTRY

9647/0

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Paper 1 Multiple Choice

19 September 20

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 NRIC/FIN number, name and CT group on the Answer Sheet.

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

Choose the **one** you consider correct and record your choices in **soft pencil** on the separat 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 20 printed pages.

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#### Section A

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

1 The hardness present in a water sample due to dissolved calcium ions can determined by using an ion-exchange column as shown in the diagram.



A 50 cm<sup>3</sup> sample of a solution containing calcium sulfate was passed through ion-exchange resin. The calcium ions in the sample were quantitatively exchanged hydrogen ions. The sample collected in the flask required 25 cm<sup>3</sup> of  $1.0 \times 10^{-2}$  mol d potassium hydroxide for complete neutralisation.

What was the concentration of the calcium sulfate in the original sample?

- A 2.5 x 10<sup>-3</sup> mol dm<sup>-3</sup>
- **B** 1.0 x 10<sup>-2</sup> mol dm<sup>-3</sup>
- **C** 2.0 x 10<sup>-2</sup> mol dm<sup>-3</sup>
- **D** 4.0 x  $10^{-2}$  mol dm<sup>-3</sup>
- 2 The bombardment of polonium atoms, Po, with atoms of an isotope of a Group element, **X**, may bring about a new element with proton number 115 via the follow reaction.

$$^{209}_{84}$$
Po + **X**  $\rightarrow$  [new element] + 5 neutrons

What is the identity of X?

A thallium B indium C gallium D aluminium

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3 The successive ionisation energies (IE) of two elements, **Q** and **R**, are given below.

IE / kJ mol <sup>-1</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8 <sup>th</sup>
Q	1090	2350	4610	6220	37800	47000	-	-
R	1251	2298	3822	5158	6542	9362	11018	33604

What is the likely formula of the compound that is formed when Q reacts with R?

Α	QR	в		С	<b>QR</b> ₄	D	Q₄R
	~	_	-23	•	<b>4</b> . 4	_	

4 The diagrams P, Q, R and S show how a change in conditions affects the Maxw Boltzmann distribution of molecular energies for gas G. In each case, the origi distribution is shown by a solid line and the distribution after a change has been ma is shown by a dashed line.



Which statement about the change made is correct?

- A The change shown in diagram P occurs when the temperature is decreased.
- **B** The change shown in diagram **Q** occurs when a catalyst is used.
- **C** The change shown in diagram **R** occurs when the temperature is increased.
- **D** The change shown in diagram **S** occurs when the pressure of **G** is decreased constant temperature.

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**5** The numerical value of the solubility product of calcium fluoride is  $3.9 \times 10^{-11}$ . Give that HF is a weak acid, which diagram shows how the solubility of CaF<sub>2</sub> will vary wight pH at constant temperature?



**6** The dissociation of dinitrogen tetroxide into nitrogen dioxide is represented by equation below.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g); \quad \Delta H = +52.7 \text{ kJ mol}^{-1}$$

If the temperature of an equilibrium mixture of these gases is increased at const pressure, the volume of the mixture will

- A decrease, because a shift in position of equilibrium towards the left would methan counteract any thermal expansion.
- **B** decrease, because a shift in position of equilibrium towards the right would a produce cooling and hence thermal contraction.
- C increase, but only because of a shift in position of equilibrium towards the right
- **D** increase, both because of a shift in position of equilibrium towards the right a because of thermal expansion.
- 7 1600 J of energy is required to vaporise 40 cm<sup>3</sup> of a pure liquid **Q**. The  $\Delta S$  vaporisation of liquid **Q** is found to be +100 J mol<sup>-1</sup> K<sup>-1</sup>. Given that the molar density **Q** is 1.0 mol dm<sup>-3</sup>, what is the boiling point of liquid **Q** at 1 atm?
  - **A** 200 K
  - **B** 400 K
  - **C** 600 K
  - D Cannot be determined from the above data

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A direct current is passed through the apparatus shown in the diagram below.



After a few minutes, what colours would be observed on the paper at the three point X, Y and Z?

	X	Y	Ζ
A	red	white	blue
в	blue	purple	red
С	blue	purple	white
D	blue	red	white

9 When a dilute sulfate solution of a metal J was electrolysed, the metal J and diatomic gas K were produced at the cathode and anode respectively in the molar ra 2:1.

In another experiment, the same quantity of electricity was used to electrolyse saturated sodium chloride solution and a gas L was evolved at the anode.

What is the molar ratio of **J** : **K** : **L**?

Α	2:1:1	в	2:1:2	С	4:2:1	D	4:2:3

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10 The reaction between substances A and B is found to follow the rate law

where *k* is the rate constant and has units of  $mol^{-2} dm^6 s^{-1}$ .

Two experiments to study the kinetics of this reaction were carried out and the d obtained are tabulated below.

Experiment	Initial [ <b>A</b> ] / mol dm <sup>-3</sup>	Initial [ <b>B</b> ] / mol dm <sup>-3</sup>	Initial rate / mol dm <sup>-3</sup> s <sup>-1</sup>
1	0.040	0.080	S
2	0.020	У	S/2

What is the value of y in experiment 2?

Α	0.020	в	0.040	С	0.160	D	0.320

11 Which is the correct statement about the following reaction?

$$\mathbf{P}(g) + \mathbf{Q}(g) \stackrel{\mathbf{M}(s)}{=\!\!=\!\!=} \mathbf{R}(g) \qquad \Delta H < 0$$

- A The rate constant decreases with increasing temperature.
- **B** The solid **M** will lower the activation energy of both forward and backw reactions.
- **C** Increasing temperature will lower the activation energy of the reaction.
- **D** The activation energy of the forward reaction is equal to the activation energy the backward reaction.
- **12** The following diagrams show the structures of an element, its principal oxide and halide.



What could the element be?

Α	aluminium	в	carbon	С	silicon	D	phosphorus
		_		-		_	p

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- **13** Which statement about A/Cl<sub>3</sub> is correct?
  - **A**  $A/Cl_3$  is pyramidal.
  - **B** A/C $l_3$  has a higher melting point than A $l_2O_3$ .
  - **C** The  $Al_2Cl_6$  dimer contains two co-ordinate bonds.
  - **D** The A/Cl<sub>3</sub> catalyst acts as an electron pair donor in the acylation of benzene.
- 14 For the elements (Na to S) in the third period, the oxide of element U has the high melting point and the pH of the chloride of element V is around 2. Which eleme could U and V be?

	U	V
Α	magnesium	silicon
в	aluminium	silicon
С	silicon	aluminium
D	silicon	phosphorus

15 The diagram represents an unsuccessful attempt to prepare and collect sulfur dioxid



Which modification would make the experiment successful?

- A omitting flask P entirely
- B omitting flask Q entirely
- C using dilute sulfuric acid instead of hydrochloric acid
- **D** collecting by upward delivery

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- 16 Which one of the statements of the Group II elements (magnesium to barium) or the compounds is correct?
  - A The stability of the carbonate to heat decreases on descending the group.
  - **B** The volume of acidic gas evolved from the decomposition of 1 mol of barium is two times that of the neutral gas evolved.
  - **C** Reactivity of Group II elements with oxygen increases down the group.
  - **D** Solubility of the Group II sulfates increases on descending the group.
- 17 Which of the following is incorrect for chlorine, bromine, iodine and their compound
  - A Thermal stability of hydrogen halides decreases down the group.
  - **B** The halogens react with aqueous sodium hydroxide to form oxo-anions.
  - **C** Volatility of the halogens decreases down the group
  - **D** The halogens can be obtained by the reaction of concentrated sulfuric acid w halide salts.
- **18** For the first row transition elements, which of the following three elements display increase in **both** their second and third ionisation energies?
  - A V, Cr, Mn
  - B Cr, Mn, Fe
  - C Mn, Fe, Co
  - D Fe, Co, Ni
- **19** Assuming that only mono-bromination takes place, which of the following is the corricombination of the products obtained when limited bromine is reacted with 2 dimethylbutane in the presence of *uv* light?
  - **A** 5 possible products in the ratio 3:3:3:3:2
  - **B** 4 possible products in the ratio 6:3:3:2
  - C 3 possible products in the ratio 9:3:2
  - **D** 3 possible products in the ratio 3:3:1

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- 20 Compound A has the following characteristic.
  - It decolourises aqueous bromine.
  - It changes acidified potassium dichromate(VI) from orange to green.
  - It gives a yellow precipitate with alkaline aqueous iodine.

Which of the following compounds best represents A?



- 21 When bromine reacts with propene in the presence of concentrated aquer potassium nitrate, which of the following form the bulk of the products formed?
  - A CH<sub>3</sub>CHBrCH<sub>2</sub>ONO<sub>2</sub>
  - B CH<sub>3</sub>CH(OH)CH<sub>2</sub>Br
  - C CH<sub>3</sub>CHBrCH<sub>2</sub>OH
  - D CH<sub>3</sub>CH(ONO<sub>2</sub>)CH<sub>2</sub>Br

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**22** What is the structure of the compound formed when compound **W** was heated v aqueous sodium hydroxide, followed by acidification and PC*l*<sub>5</sub> was added?



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23 Chlorofluoroalkanes are commonly used as aerosol propellents. However, they can depletion to the ozone layer when they rise into the stratosphere. It has thus be suggested that fluoroalkanes should be used instead.

Which of the following could be a possible reason for the suggestion?

- A Fluoroalkanes are less volatile than chlorofluoroalkanes and making it m difficult to reach the stratosphere.
- **B** Fluorine radicals may be produced, but unlike chlorine radicals, do not re with ozone.
- **C** Fluorine radicals are not produced as the C-F bonds are stronger than the C bonds.
- **D** Fluorine radicals may be produced, but unlike chlorine radicals, are regenerated after reaction with ozone.
- 24 *Pravastatin* is a drug used to lower cholesterol in the blood.



Which of the following statements about the reactions of *pravastatin* is likely to **incorrect**?

- **A** 1 mol of pravastatin reacts with 4 mol of SOC*l*<sub>2</sub> to release 4 mol of HC*l* gas.
- **B** 1 mol of pravastatin reacts with sodium carbonate to release 2 mol of CO<sub>2</sub> ga
- C It reacts with acidified potassium manganate(VII) under reflux to form to organic products.
- **D** It reacts with liquid bromine in tetrachloromethane to form a compound with chiral centres.

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25 The structures of psilocin and cortisone are shown below.



psilocin

cortisone

Which of the following can be used to distinguish psilocin and cortisone?

- A PCl<sub>5</sub>
- B Na
- C Fehling's solution
- **D** Br<sub>2</sub> in CCl<sub>4</sub>

26 An organic compound undergoes the following reactions:

- (i) It decolourises a solution of bromine in tetrachloromethane.
- (ii) It reacts with phosphorus pentachloride giving copious white fumes of HC/.
- (iii) It reacts with hot alkali to give a compound with two hydroxyl groups.

Which of the following represents the organic compound?

- **A**  $C/CH_2CH_2CH=CHCH(C/)CH_2OH$
- B C/CH<sub>2</sub>CH<sub>2</sub>CH=CHCO<sub>2</sub>H
- $\textbf{C} \qquad BrCH_2CH_2CH_2CH_2CH_2Cl$
- **D** HOCH<sub>2</sub>CH=CHCH=CHCH<sub>2</sub>C*l*

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27 A sequence of reactions is shown below.



Which of the following shows the correct list of substances for the sequence?

	step 1	step 2	step 3	step 4
Α	CH <sub>3</sub> COC <i>l</i>	NaBH <sub>4</sub>	conc. H <sub>2</sub> SO <sub>4</sub>	Cl <sub>2</sub>
в	A/Cl <sub>3</sub>	HC <i>l</i>	NaOH	Cl <sub>2</sub>
С	A/Cl <sub>3</sub>	NaBH <sub>4</sub>	conc. $H_2SO_4$	HC <i>l</i>
D	AlCl <sub>3</sub>	NaBH <sub>4</sub>	conc. H <sub>2</sub> SO <sub>4</sub>	Cl <sub>2</sub>

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Deuterium, D, is an isotope of hydrogen, <sup>2</sup><sub>1</sub>H.
Which reaction will **not** yield a stable organic compound containing deuterium?



**29** Aspartic acid is found in many proteins and is common in young sugar cane and sug beets.

HO<sub>2</sub>CCH<sub>2</sub>CH(NH<sub>2</sub>)CO<sub>2</sub>H aspartic acid

Aspartic acid has  $pK_a$  values of 1.9, 3.7 and 9.6.

What is the structure of the major species in a solution of aspartic acid at pH 3?



14

30 A mixture of amino acids can be separated by electrophoresis.



The following information about glutamic acid and two other amino acids are given below.

Amino acid	glutamic acid	asparagine	valine
Structure	н 	H   H <sub>2</sub> N	H   H2N
lsoelectric point	3.1	5.6	6.0

Which of the following filter papers show a possible result of the separation of mixture of amino acids at pH 5?



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#### Section B

For each of the questions in this section, one or more of the three numbered statements  ${\bf 1}$   ${\bf 3}$  may be correct.

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

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

А	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

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

31 In which of the following compounds is the bond angle in molecule I greater than t in molecule II?

	Ι	II
1	BCl <sub>3</sub>	NCl <sub>3</sub>
2	$NO_3^-$	$ClO_2^-$
3	$SF_6$	SF4 <sup>2-</sup>

32 Nitrosyl chloride, NOC*l*, decomposes on heating according to the equation:

NOC
$$l(g) \implies$$
 NO(g) +  $\frac{1}{2}Cl_2(g) \quad \Delta H > 0 \text{ kJ mol}^{-1}$ 

100 cm<sup>3</sup> of NOC*l* was placed in a frictionless syringe at constant pressure and temperature of T K and allowed to reach equilibrium. The equilibrium mixt contained 20% by volume of  $Cl_2$ .

Which of the following statements are correct?

- 1 The total volume of gases in the equilibrium mixture decreases when reaction is carried out at temperature lower than T K.
- **2** The total volume of gases in the equilibrium mixture at T K is 125 cm<sup>3</sup>.
- **3** The volume of NOC*l* in the equilibrium mixture at *T* K remains unchanged the addition of an inert gas to the system.

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33 Which statements are correct for the electrochemical cell below?



- 1 Electrons flow from the left to the right.
- 2 The  $E_{cell}$  value decreases when NH<sub>3</sub>(aq) is added to the half-cell on the right.
- 3 The  $E_{cell}$  value remains the same when AgNO<sub>3</sub>(aq) is added to the half-cell the left.
- 34 When metal **A** is placed in a solution of metal ions  $B^{2+}$ , a reaction occurs between and  $B^{2+}$ , and metal ions  $A^{2+}$  appear in the solution. When metal **B** is placed in a solution, gas bubbles form on its surface. When metal **A** is placed in a solution metal ions,  $C^{2+}$ , no reaction occurs.

Which of the following would occur spontaneously?

- 1  $\mathbf{B}(s) + \mathbf{C}^{2+}(aq) \rightarrow \mathbf{C}(s) + \mathbf{B}^{2+}(aq)$
- **2**  $C(s) + A^{2+}(aq) \rightarrow A(s) + C^{2+}(aq)$
- **3**  $A(s) + 2H^{+}(aq) \rightarrow H_{2}(g) + A^{2+}(aq)$
- **35** Lime Mortar, used in building to join house bricks, is a paste made from lime (calcin hydroxide) and sand (silicon(IV) oxide) and water. After mixing, the paste sets a hardens.

Which processes take place during the setting?

- 1 Lime reacts with carbon dioxide.
- 2 Lime reacts with sand.
- 3 Lime and sand react with water.

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For each of the questions in this section, one or more of the three numbered statements  ${\bf 1}$   ${\bf 3}$  may be correct.

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

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

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

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

36 A coloured complex ion, X, is formed as follows:

 $\mathsf{Fe}(\mathsf{H}_2\mathsf{O})_6^{3^+} + \mathsf{SCN}^- \leftrightarrows [\mathsf{Fe}(\mathsf{SCN})(\mathsf{H}_2\mathsf{O})_5]^{2^+} + \mathsf{H}_2\mathsf{O}$ 

To determine the formula of **X**, 0.10 mol dm<sup>-3</sup> of Fe(H<sub>2</sub>O)<sub>6</sub><sup>3+</sup> and SCN<sup>-</sup> solutions mixed in varying proportions and the intensities of the colour produced measu using a colorimeter.

What are the observations made?

- 1 Ion X is red in colour.
- 2 The maximum colour intensity is achieved with equal volumes of the t solutions.
- 3 Low concentration of iron(III) ions can be estimated by this method.
- **37** Naphthalene, C<sub>10</sub>H<sub>8</sub>, is an aromatic compound with the following structure.



Which of the following statements about naphthalene and its derivatives are correct

- 1 Naphthalene will decolourise liquid bromine in the presence of iron(III) chlorid
- 2 The molecule of naphthalene is planar.
- $\label{eq:constraint} \textbf{3} \qquad \text{There are four aromatic isomers of molecular formula $C_{10}$H_7$Br}.$

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- 19
- 38 The diagram shows some laboratory apparatus.



Which preparations could this apparatus be used for?

- **1** Bromoethane, from ethanol, sodium bromide and concentrated sulfuric acid.
- 2 Ethanal, from ethanol, sodium dichromate(VI) and sulfuric acid.
- **3** 1,2–dibromoethane, from bromine and ethene.
- **39** The following compound, **Y**, is a by-product formed in the body that counteracts the effect of the drug administered to patients to treat herpes.



Which of the following statements about this compound are correct?

- 1 Y can undergo nucleophilic substitution with chloroethane.
- 2 1 mol of Y can be hydrolysed to produce 2 mol of amino acids.
- **3** When an aqueous solution of **Y** at pH 3 is analysed by electrophoresis, i found near the anode.

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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

Α	В	С	D
1, 2 and 3	1 and 2	2 and 3	<b>1</b> only
are correct	only are correct	only are correct	is correct

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

40 Which of the following reactions will most likely form a racemic mixture of products?

1 CH<sub>3</sub>CHO with HCN in trace amounts of alkali, 10-20 °C.



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