ANDERSON SERANGOON JUNIOR COLLEGE



2021 JC 2 PRELIMINARY EXAMINATION

| NAME:_ | (|) | CLASS: 21 / |
|--------|-------|---|-------------|
| | | | |

CHEMISTRY

Paper 1 Multiple Choice

9729/01 22 September 2021 1 hour

Additional Materials:

Multiple Choice Answer Sheet Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil Do not use staples, paper clips, glue or correction fluid. Write your name, class and register number on the Answer Sheet.

There are **thirty** 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.

The use of an approved scientific calculator is expected, where appropriate.

Multiple Choice Answer Sheet

Write your name, class and NRIC / FIN number, including the reference letter.

Shade the NRIC / FIN number.

Exam Title: JC2 PRELIM

Exam Details: <u>H2 Chemistry / Paper 1</u>

Date: <u>22/09/2021</u>

¹ Two particles, \mathbf{A}^+ and \mathbf{B}^{3+} are fired with equal velocity into an electric field. The information on two particles are given in the table below.

| particle | number of electrons | number of neutrons | angle of deflection in an electric field |
|------------------------|------------------------|-----------------------|---|
| A^+ | 10 | 12 | 2.0° |
| B ³⁺ | ? | 14 | 5.1° |
| | | | |

What is the number of electrons for \mathbf{B}^{3+} ?

| A 10 B 11 C 12 D | 13 |
|--|----|
|--|----|

2 A to **H** are consecutive elements with atomic numbers less than 20. The graph below shows their second ionisation energies (2nd I.E.).



Which of the following statements is correct?

- **A** The 2nd I.E. of **G** is lower than that of **F** due to the inter–electronic repulsion between its paired s electrons.
- **B C** exists as diatomic molecules at room temperature.
- **C** The compound formed between **A** and **E** has a low melting point.
- **D** Element **B** is from Group 17.

3 The graph shows the logarithm of the first twelve ionisation energies (I.E.) for element **J**.



What can be deduced about element J from the graph?

- 1 It can form a compound with oxygen with the formula J_2O_3 .
- **J** is likely to have a lower first I.E. than the element preceding it in the same period.
- 3 It is in the second period (Li to Ne) of the Periodic Table.
- 4 J has a half–filled p–subshell.
- A 1, 2 and 3
- **B** 1, 2 and 4
- **C** 1 and 2 only
- **D** 3 and 4 only
- 4 Acrylonitrile, CH₂=CHCN is a monomer used to made polyacrylonitrile.

Which row correctly describes the number of $\boldsymbol{\pi}$ bonds and hybridisation in a molecule of acrylonitrile?

| | Number of π bonds | Number of sp C atoms | Number of sp ² C atoms |
|---|-----------------------|----------------------|-----------------------------------|
| Α | 2 | 2 | 1 |
| В | 3 | 1 | 2 |
| С | 1 | 1 | 2 |
| D | 1 | 2 | 1 |

5 The mechanism for a certain reaction is given below.

step 1
$$(CH_3)_3 COH + HCl$$
 \xrightarrow{fast} $(CH_3)_3 COH_2 + Cl^-$
step 2 $(CH_3)_3 COH_2$ \xrightarrow{slow} $(CH_3)_3 COH_2 + Cl^-$
step 3 $(CH_3)_3 COH_2$ \xrightarrow{fast} $(CH_3)_3 COH_2 + H_2O$

Which of the statements are correct?

- 1 There is a decrease in the bond angle with respect to O atom in step 1.
- 2 The shape with respect to C atom in bold, changes from tetrahedral to trigonal planar and back to tetrahedral in the mechanism.
- 3 Dative bond is formed in step 1 and 3.
- 1 and 3 Α
- В 1 and 2 only

step 3

- С 2 and 3 only
- D 2 only
- 6 In which of the following does Statement II give a correct explanation for Statement I?

| | Statement I | Statement II |
|---|--|--|
| 1 | Magnesium has a higher melting point than sodium. | Magnesium has more delocalised valence electrons which results in stronger metallic bonds. |
| 2 | Glycine, H ₂ NCH ₂ COOH, has a higher melting point than 2–hydroxyethanoic acid, HOCH ₂ COOH. | Glycine can form more extensive hydrogen bonds than 2-hydroxyethanoic acid. |
| 3 | Chloromethane undergoes nucleophilic substitution more easily than fluoromethane. | The C–C <i>l</i> bond in chloromethane is weaker than the C–F bond in fluoromethane. |

- Α 2 and 3 only
- В 1 and 2 only
- С 1 and 3 only
- 1, 2, and 3 D

7 The amount of carbon monoxide present in air can be determined by its reaction with iodine pentoxide, I_2O_5 , to form carbon dioxide and iodine in the reaction below.

$$5\text{CO} + \text{I}_2\text{O}_5 \rightarrow \text{I}_2 + 5\text{CO}_2$$

The amount of iodine liberated is then determined by titration with a standard solution of sodium thiosulfate.

$$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$$

A 100 cm³ sample of polluted air is passed over solid iodine pentoxide and the iodine produced required 20.0 cm³ of 0.20 mol dm⁻³ of sodium thiosulfate for complete reaction.

What is the concentration, in g dm⁻³, of carbon monoxide present in the sample of polluted air?

- **A** 0.100
- **B** 1.12
- **C** 2.80
- **D** 11.2
- 8 Two glass vessels **M** and **N** are connected by a closed valve.



M contains helium at 25 °C at a pressure of 1 x 10^5 Pa. **N** has been evacuated, and has three times the volume of **M**. In an experiment, the valve is opened and the whole set–up placed in boiling water at 100 °C.

What is the final pressure in the system?

9 Which of the following diagrams correctly describes the behavior of a fixed mass of an ideal gas at constant T?



10 30 cm³ of 0.1 mol dm⁻³ of sulfuric acid and 40 cm³ of 0.2 mol dm⁻³ sodium hydroxide were mixed in a Styrofoam cup.

Assume that the density and specific heat capacity of the final mixture are 1.0 g cm⁻³ and 4.2 J g⁻¹ K⁻¹ respectively.

What is the temperature change for the reaction given that the standard enthalpy change of neutralisation is -57.3 kJ mol⁻¹?

| A -1 | .6 °C | В | −1.2 °C | С | +1.2 °C | D | +1.6 °C |
|-------------|-------|---|---------|---|---------|---|---------|
|-------------|-------|---|---------|---|---------|---|---------|

11 An energy cycle is drawn for the following reaction.



The standard enthalpy of formation of $BrF_3(I) = -301 \text{ kJ mol}^{-1}$.

The enthalpy change of $BrF_3(I)$ to $BrF_3(g)$ is +44 kJ mol⁻¹.

What is the average bond energy of the Br-F bond in BrF_3 ?

- A 152 kJ mol⁻¹
- **B** 159 kJ mol⁻¹
- **C** 202 kJ mol⁻¹
- **D** 404 kJ mol⁻¹

12 Methanol can be synthesised from carbon monoxide and hydrogen according to the equation.

 $CO(g) + 2H_2(g) \implies CH_3OH(g)$

Higher yield of methanol can be achieved at a lower temperature.

Which graph corresponds to the forward process?



13 The kinetics of the following reaction is investigated under different conditions. The reaction is first order with respect to **G**.

 $G \longrightarrow H$

The table shows pairs of quantities that were plotted as graphs.

Which pairs gave the following graph?



| | <i>y</i> –axis | <i>x</i> –axis |
|---|---------------------------|--------------------|
| 1 | rate | concentration of G |
| 2 | half–life of G | rate constant |
| 3 | concentration of H | time |

- A 1 and 2 only
- B 1 only
- C 2 and 3 only
- D 1 and 3 only

| temperature / °C | $K_{ m w}$ / mol ² dm ⁻⁶ |
|------------------|--|
| 0 | $1.15 	imes 10^{-15}$ |
| 25 | $1.00 	imes 10^{-14}$ |
| 50 | $5.50 	imes 10^{-14}$ |
| | |

14 The ionic product of water, K_{w} , is affected by temperature.

What can be deduced from this information?

- **A** Only at 25 °C are $[H^+]$ and $[OH^-]$ equal.
- **B** The equilibrium lies more to the left as temperature increases.
- **C** The $[H^+]$ increases while the $[OH^-]$ decreases as temperature increases.
- **D** The pH of water at 50 °C is 6.6.
- 15 Which of the following reactions is the underlined reactant acting as a Bronsted–Lowry base?
 - 1 $\underline{NH_3} + CH_3Cl \rightarrow CH_3NH_3^+ + Cl^-$
 - 2 $OH^- + HSO_4^- \rightarrow H_2O + SO_4^{2-}$
 - $3 \qquad \underline{CH_3OH} + HC/O_4 \rightarrow CH_3OH_2^+ + C/O_4^-$
 - 4 $HNO_3 + H_2SO_4 \rightarrow H_2NO_3^+ + HSO_4^-$
 - A All the above
 - **B** 1 and 2 only
 - C 1 and 3 only
 - **D** 2, 3 and 4 only

16 A sealed vessel of fixed volume contains the following mixture at equilibrium.

 $H_2O(g) + C(s) \rightleftharpoons H_2(g) + CO(g)$ $\Delta H > 0$

At time *t*, the reaction mixture is subjected to a change. The graph below shows the partial pressure of CO against time.



Which changes, when carried out separately, could have given the graph above?

- 1 addition of $H_2(g)$
- 2 removal of some C(s)
- 3 decrease in temperature

| Α | 1, 2 and 3 | В | 1 and 2 only |
|---|--------------|---|--------------|
| С | 1 and 3 only | D | 3 only |

- **17** For the elements in the third period of the Periodic Table, which property decreases consistently from sodium to chlorine?
 - A melting point
 - **B** ionisation energy
 - **C** electrical conductivity
 - **D** radius of the atom
- 18 Which property generally increases down Group 2?
 - **A** sum of the first and second ionisation energies
 - **B** reactivity of metal with cold water
 - **C** polarising power of the cation
 - **D** oxidising power of the cation
- **19** Use of the Data Booklet is relevant to this question.

Two separate half-cells are connected and the following reaction was observed.

$$2I^{-}(aq) + H_2O_2(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(I)$$

Which statements about this cell are true?

- 1 E_{cell}^{o} = +1.23 V.
- 2 E_{cell} becomes more negative when $Br_2(aq)$ is added to the anode.
- 3 E_{cell} becomes more positive when water is added to the cathode.

| Α | 1 only | В | 1 and 2 |
|---|---------|---|------------|
| С | 2 and 3 | D | 1, 2 and 3 |

20 Aluminium is extracted from its ore by electrolysis.



Which of the following statements is correct?

- 1 Oxygen gas is produced.
- 2 Aluminium ions migrate to electrode **X**.
- 3 Electrons move from electrode **X** to electrode **Y** via the external circuit.

| Α | 1 and 2 only | В | 1 and 3 only |
|---|--------------|---|--------------|
| С | 2 and 3 only | D | 1 only |

21 How many possible enantiomers can be obtained when the following compound is heated with excess acidified KMnO₄?



| A 7 B 64 C 128 D 25 | C 128 D | 64 | В | A 7 | Α |
|---|---------|----|---|------------|---|
|---|---------|----|---|------------|---|

- P (CH₃)₂CHCH₂CH₂CH₃
- Q CH₃CH₂CH(CH₃)CH₂CH₃

P and **Q** react with chlorine to form monochloro compounds $C_6H_{13}Cl$.

How many possible **structural** isomers, each with formula $C_6H_{13}Cl$, could be produced by **P** and **Q**?

| | Number of isomers formed by P | Number of isomers formed by Q |
|---|--|--|
| Α | 5 | 3 |
| в | 5 | 4 |
| С | 6 | 3 |
| D | 6 | 4 |

23 One gram of each of the following compounds was heated with NaOH(aq), and then dilute HNO₃ and AgNO₃(aq) were added.

Which compound will produce the largest mass of AgBr(s)?



24 When 2–methylphenylamine reacts with an excess of $Br_2(aq)$, one of the intermediates is cation **R**.



What is the final product of this reaction?



25 Compound V, C₆H₁₃C*l*, reacts with aqueous sodium hydroxide to form W, C₆H₁₄O.
W reacts with alkaline aqueous iodine solution.

What could be the structure of V?



| | least acidic | | > most acidic |
|---|---------------------|---------------------|---------------------|
| A | H ₃ C OH | H ₂ N OH | O ₂ N OH |
| в | O ₂ N OH | H ₃ C OH | H ₂ N OH |
| с | H ₂ N OH | H ₃ C OH | O ₂ N OH |
| D | O ₂ N OH | H ₂ N OH | H ₃ C OH |

26 Which row correctly identify the order of acidity of the three compounds?

27 A mechanism for the reaction between ammonia and ethanoyl chloride is given below.



Which of the following statements are correct?

- 1 The ammonia behaves as a nucleophile in the mechanism.
- 2 The curly arrow showing the loss of proton in step 3 is incorrectly drawn.
- 3 The oxidation number of the carbonyl C atom in ethanoyl chloride and ethanamide are the same.

| Α | 1,2 and 3 | В | 1 and 2 only |
|---|--------------|---|--------------|
| С | 1 and 3 only | D | 2 and 3 only |

28 Which reaction gives the best yield of products?

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[(alc) indicates an alcoholic solution.]
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29 Esters can be reduced by LiA/H₄ in dry ether to give two alcohols as shown below.



Which of the following is a possible product formed when the following compound is reacted with LiA/H_4 in dry ether?



30 Chymotrypsin is an enzyme that hydrolyses protein into smaller peptides and amino acid. It specifically hydrolyses the peptide bond on the carboxylic end of Phe.

The structure of tetrapeptide **X** and M_r of selected amino acids are given below.

| Amino acid | Mr |
|------------|-----|
| Val | 117 |
| Lys | 146 |
| Phe | 165 |
| Arg | 174 |

tetrapeptide X: Val-Lys-Phe-Arg

What are the M_r of the two fragments obtained when tetrapeptide **X** is hydrolysed by chymotrypsin?

2

| | <i>M</i> _r of fragment 1 | <i>M</i> _r of fragment |
|---|-------------------------------------|-----------------------------------|
| Α | 428 | 174 |
| В | 392 | 174 |
| С | 339 | 263 |
| D | 321 | 245 |
| | | |

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