JURONG PIONEER JUNIOR COLLEGE JC2 PRELIMINARY EXAMINATION 2021

CHEMISTRY

Higher 2

9729/01

Paper 1 Multiple Choice

24 September 2021 1 hour

Candidates answer on separate paper.

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 exam index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** or **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.

This document consists of **16** printed pages.

1 Some isotopes are unstable and undergo nuclear (radioactive) reactions. In one type of reaction, an unstable nucleus assimilates an electron from an inner orbital of its electron cloud. The net effect is the conversion of a proton and an electron into a neutron.

Which of the following describes this type of reaction?

- A
 ${}^{11}C \rightarrow {}^{12}C$ B
 ${}^{111}I \rightarrow {}^{111}Te$

 C
 ${}^{76}Br \rightarrow {}^{75}Br$ D
 ${}^{76}Kr \rightarrow {}^{75}Br$
- 2 **Figure 1** shows the first six ionisation energies of an element **P**. **Figure 2** shows the <u>second</u> ionisation energies of eight consecutive elements (including **P**).



With reference to **Figure 2**, which of the options, **A**, **B**, **C** or **D**, corresponds to the <u>second</u> ionisation energy of element **P**?

3 Which of the following has the largest bond angle?

A SiC l_4 **B** SO₂ **C** IF₂ **D** CH₃⁺

4 Molecular dimerisation can be described as the process in which two identical molecules combine to give a single product.

Examples of dimers are N_2O_4 and $(CH_3CO_2H)_2$.

Which of the following descriptions about the above dimers is incorrect?

- A Hydrogen bonds hold the CH₃CO₂H molecules together in the dimer.
- **B** There is one nitrogen-nitrogen single bond in N_2O_4 .
- **C** $(CH_3CO_2H)_2$ is a non-planar molecule.
- **D** The nitrogen-oxygen bonds in N_2O_4 are of different length.
- **5** Naturally-occurring silicon is a mixture of three isotopes, ²⁸Si, ²⁹Si and ³⁰Si. The relative atomic mass of silicon is 28.109.

What could be the relative abundance of each of the three isotopes?

- A 91.1% ²⁸Si, 7.9% ²⁹Si and 1.0% ³⁰Si
- B 92.2% ²⁸Si, 4.7% ²⁹Si and 3.1% ³⁰Si
- C 95.0% ²⁸Si, 3.2% ²⁹Si and 1.8% ³⁰Si
- D 96.3% ²⁸Si, 0.3% ²⁹Si and 3.4% ³⁰Si
- 6 A tube filled with 50 cm³ of methane and 150 cm³ of oxygen at room temperature was inverted over a vessel containing KOH (aq) as shown in the diagram.

The hydrocarbon was ignited for the following reaction to take place.



When the setup is cooled to room temperature, at which level will the liquid be?

7 An experiment was conducted to determine the efficiency of the heating of a can of water using a spirit burner.



Which expression below gives the efficiency of this heating process?

A	$\frac{300 \times c \times \Delta T \times 46.0}{m \times 1371 \times 1000} \times 100\%$	В	$\frac{m \times c \times \Delta T \times 46.0}{300 \times 1371 \times 1000} \times 100\%$
С	$\frac{300 \times c \times \Delta T \times 46.0}{m \times 1371} \times 100\%$	D	$\frac{m \times 1371 \times 1000}{300 \times c \times \Delta T \times 46.0} \times 100\%$

8 In 1944, T. Ellingham published plots of ΔG against temperature T for a number of reactions. Today, such plots are called Ellingham diagrams.

An Ellingham diagram for three reactions involving the oxidation of C and CO is shown below.



Which of the following shows correctly the three reactions corresponding to I, II and III in the above Ellingham diagram?

	I	II	III
Α	$2CO + O_2 \rightarrow 2CO_2$	$C + O_2 \rightarrow CO_2$	$2C + O_2 \rightarrow 2CO$
в	$2C + O_2 \rightarrow 2CO$	$2CO + O_2 \rightarrow 2CO_2$	$C + O_2 \rightarrow CO_2$
С	$C + O_2 \rightarrow CO_2$	$2CO + O_2 \rightarrow 2CO_2$	$2C + O_2 \rightarrow 2CO$
D	$2C + O_2 \rightarrow 2CO$	$C + O_2 \rightarrow CO_2$	$2CO + O_2 \rightarrow 2CO_2$

9 The graphs below show how the percentage of gaseous products present at equilibrium vary with temperature and pressure.



Which one of the following reactions could the graph represent?

AN₂O₄(g)
$$\ll$$
 2NO₂(g) $\Delta H = +57 \text{ kJ mol}^{-1}$ BH₂(g) + I₂(g) \ll 2HI(g) $\Delta H = +53 \text{ kJ mol}^{-1}$ CN₂(g) + 3H₂(g) \ll 2NH₃(g) $\Delta H = -92 \text{ kJ mol}^{-1}$ DC(s) + O₂(g) \ll 2CO(g) $\Delta H = -99 \text{ kJ mol}^{-1}$

10 At a temperature T K, 0.80 mol of SO₂ and 0.40 mol of O₂ were introduced into a 10 dm³ vessel and allowed to come to equilibrium.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H < 0$$

The graph below shows the variations in the amounts of SO_2 and SO_3 in the system with time. A change was made to the system at time t.



Which of the following statements are correct?

- **1** A catalyst was added at time t
- 2 Temperature was decreased at time t
- 3 An inert gas was added at constant volume at time t
- 4 The value of K_c before time t is 14.4

Α	1 and 2	В	1 and 3	С	2 and 3	D	2 and 4

7

11 At body temperature of 37 °C, K_w has a value of 2.4 x 10⁻¹⁴. What is the concentration of OH⁻ if the pH of blood is 7.4 under these conditions?

Α	7.00 x 10 ⁻⁷	В	2.51 x 10 ⁻⁷
С	6.03 x 10 ⁻⁷	D	3.98 x 10 ^{−8}

12 A 0.100 mol dm⁻³ solution of lead(II) nitrate is added, with stirring, into an equal volume of a solution containing a mixture of Cl^- , Br⁻, and I⁻ ions, each with the same concentration of 1.0 x 10⁻² mol dm⁻³.

Given the following data:

Compound	Numerical value of K _{sp} (at 25 °C)
Lead(II) chloride	1.7 x 10 ^{−5}
Lead(II) bromide	6.6 x 10 ⁻⁶
Lead(II) iodide	9.8 x 10 ⁻⁹

Which one of the following statements is correct?

- A No precipitate will form.
- **B** Only PbI₂ precipitate will form.
- **C** A mixture of PbI₂ and PbBr₂ precipitates will form.
- **D** All three precipitates, PbI₂, PbBr₂, and PbC*l*₂, will form.
- **13** When the gases dinitrogen tetroxide and nitrogen monoxide are mixed in a 1:2 ratio, the two gases slowly react to form the blue compound dinitrogen trioxide according to the following equilibrium.

 $N_2O_4(g) + 2NO(g) \implies 2N_2O_3(g) \quad \Delta H = -26 \text{ kJmol}^{-1}$

The forward and backward rate constants are given as k_1 and k_2 respectively.

What happens to the equilibrium constant K_p , k_1 , and k_{-1} if at equilibrium, the temperature of the reaction mixture is increased?

	k 1	k _1	Kp
Α	Increases	Decreases	Increases
в	Unchanged	Increases	Unchanged

С	Increases	Increases	Decreases
D	Decreases	Increases	Decreases

14 Consider one mole of ideal gas at a given pressure.

Which processes will increase the number of molecules which have an energy greater than a particular value?

- 1 increasing the temperature
- 2 introducing more of the same gas into the same volume at the same temperature
- **3** compressing the gas at constant temperature
- A 1, 2 and 3 B 1 and 2 C 2 and 3 D 1 only
- 15 Which statements about the properties of a catalyst are correct?
 - 1 A catalyst increases the average kinetic energy of the reacting particles.
 - **2** A catalyst increases the rate of the reverse reaction.
 - **3** A catalyst has no effect on the enthalpy change ΔH .
 - A 1, 2 and 3 B 1 and 2 C 2 and 3 D 1 only
- **16** The use of Data Booklet is relevant to this question.

In many areas, tap water becomes slightly acidic due to dissolved carbon dioxide.

By considering the relevant E values, which of the following metals will not be dissolved by tap water containing carbon dioxide?

Α	Chromium	В	Copper	С	Iron	D	Lead
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17 In an experiment, a cell was set up to obtain pure copper from a copper-silver alloy as shown below.



When a current of 40.0 A flows through the electrolyte for 26.8 minutes, the mass of the anode changes by 26.47 g.

Which of the following statements is correct?

- A Electrode **P** is pure copper and electrode **Q** is the copper-silver alloy.
- **B** The concentration of CuSO₄(aq) decreases during the experiment.
- **C** The mass of the cathode changes by 26.47 g during the experiment.
- **D** The copper-silver alloy contains 20% silver by mass.
- **18** The graph below shows the variation in the enthalpy change of vaporisation, ΔH_{vap} for eight consecutive elements in the Periodic Table, all with atomic number ≤ 20 .



What can be deduced from the above graph?

- **A E** is soluble in warm benzene whereas **F** is not.
- **B** The chlorides become less acidic from **A** to **C**.
- **C** The pH of the solution containing a mixture of oxide of **G** and oxide of **D** is greater

than 7.

- **D** The oxide of **A** reacts with excess aqueous sodium hydroxide to form a soluble complex.
- **19** Consider the following reaction route:



Which anion was present in each of the precipitates respectively?

	ppt A	ppt C	ppt D
Α	I—	SO4 ^{2—}	NO ₃ —
В	C <i>l</i> —	I—	NO ₃ —
С	SO4 ^{2—}	I—	C <i>l</i> -
D	SO4 ²	NO_3^{-}	C <i>l</i> —

20 In the preparation of ethene, ethanol was added to a drop of heated reagent **L**. The impure ethene was washed by being bubbled through a solution of **M** before collection.

What are the reagents L and M likely to be?

	Reagent L	Reagent M
Α	ethanolic NaOH	concentrated H ₂ SO ₄
в	dilute NaOH	concentrated H ₂ SO ₄
С	concentrated H ₂ SO ₄	ethanolic NaOH

D	concentrated H ₂ SO ₄	dilute NaOH

21 Deuterium, D, is the ${}_{1}^{2}$ H isotope of hydrogen.

Which of the following reactions yield a carbon compound containing deuterium?

11

1
$$CH_2=CH_2$$
 \xrightarrow{DCl}
2 CH_3CN $\xrightarrow{D_2SO_4, heat}$
3 CH_3CH_2OH $\xrightarrow{I_2, NaOD, heat}$
A 1, 2 and 3 B 1 and 2 C 2 and 3 D 1 only

22 The mechanism for a certain reaction is given below.

$$(CH_{3})_{3}COH + HCl \xrightarrow{fast} (CH_{3})_{3}COH_{2} + Cl^{-}$$

$$(CH_{3})_{3}COH_{2} \xrightarrow{slow} (CH_{3})_{3}COH_{2} + H_{2}O$$

$$(CH_{3})_{3}COH_{2} \xrightarrow{fast} (CH_{3})_{3}CCl$$

Which of the following statements is not true?

- A $(CH_3)_3CO^+H_2$ and $(CH_3)_3COH$ are conjugate acid-base pair.
- **B** The nucleophile in the reaction is HC*l*.
- **C** The overall reaction is $(CH_3)_3COH + HCl \rightarrow (CH_3)_3CCl + H_2O$
- **D** The above mechanism is a nucleophilic substitution reaction.

23 An optically pure enantiomer of butan-2-ol was found to rotate plane-polarised light clockwise by 13.5°.

When an optically pure enantiomer of 2-bromobutane was reacted with aqueous sodium hydroxide, under heating, the purified product obtained was found to rotate plane-polarised light clockwise by 5.5°.

Which of the following mechanisms could have taken place, assuming complete reaction?

- **A** $S_N 1$ only **B** $S_N 2$ only
- **24** Four drops of 1-chlorobutane, 1-bromobutane and 1-iodobutane were put separately into three test-tubes containing 1.0 cm³ of aqueous silver nitrate at 60 °C.

The following reaction occurred.

 $H_2O(l) + C_4H_9X(l) + Ag^+(aq) \rightarrow C_4H_9OH(aq) + AgX(s) + H^+(aq)$ [X = Cl, Br, or I] The fastest to form cloudiness in the tube was C_4H_9I , followed by C_4H_9Br and finally C_4H_9Cl . Which of the following statement explains the above observation?

- A The C-X bond polarity decreases from C–Cl to C–I.
- **B** The solubility of AgX(s) decreases from AgCl to AgI.
- **C** The ionisation energy of the halogen decreases from C*l* to I.
- **D** The bond energy of C-X decreases from C-Cl to C-I.

25 The following synthesis can be carried out in three steps.



Which is the best method for this synthesis?

	Step 1	Step 2	Step 3
1	CH₃C/ anhydrous A/C/₃ heat	Concentrated HC <i>I</i> , Sn, heat	Dilute H ₂ SO ₄ , KMnO ₄ , heat
2	Concentrated HC <i>I</i> , Sn, heat	CH ₃ C/ anhydrous A/C/ ₃ heat	Dilute H ₂ SO ₄ , KMnO ₄ , heat
3	CH₃C/ anhydrous A/C/₃ heat	Dilute H ₂ SO ₄ , KMnO ₄ , heat	Concentrated HC <i>l</i> , Sn, heat followed by dilute NaOH
4	Concentrated HC <i>l</i> , Sn, heat followed by dilute NaOH	CH ₃ C/ anhydrous A/C/ ₃ heat	Dilute H ₂ SO ₄ , KMnO ₄ , heat

	Α	1 and 2	В	1 and 3	С	2 and 3	D	2 and
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26 In June 2011, a variety of Taiwanese food products were found to contain diisobutyl phthalate (DIBP), a plasticiser.



diisobutyl phthalate (DIBP)

Which of the following statements about DIBP are incorrect?

- 1 DIBP produces a pale yellow precipitate when heated with alkaline aqueous iodine.
- 2 When DIBP is heated with acidified potassium manganate(VII), the purple solution decolourises.
- **3** When DIBP is heated with dilute sulfuric acid, one of the products requires two molar equivalents of aqueous sodium hydroxide for complete neutralisation.
- A 1, 2 and 3 B 1 and 2 C 2 and 3 D 1 only
- 27 Which of the following compound has the lowest pK_b value?



28 *Psilocin* is a psychedelic mushroom alkaloid. It is the active compound that produces hallucinations from ingesting "magic mushrooms" and amplifies sensory experience. Compound **W** is a derivative of *Psilocin*.



Which of the following statements about compound W are correct?

- 1 The acidic group has a higher pK_a than that of ethanol.
- 2 It reacts with both aqueous acids and alkalis.
- 3 It gives white fumes with CH₃COC*l*.
- 4 It acts as a weaker nucleophile than ethanol when it forms an ester with an acyl chloride.
- A 1, 2 and 3 B 2, 3 and 4 C 1 and 2 D 3 and 4
- **29** Enalapril and Carvedilol are two compounds that are used in the treatment of heart failure and disease.



Which of the following can be used to distinguish between the two compounds? Assume the ether groups (C—O—C) in Carvedilol is inert.

- **1** Aqueous bromine
- 2 Aqueous sodium carbonate
- 3 Acidified potassium manganate(VII), heat

Α	1 and 2	В	2 and 3	С	1 onlly	D	2 only

16

30 In the study of a polypeptide structure of **Z**, it was digested using two different enzymes. The fragments obtained were then separated using electrophoresis. Analysis of the fragments from each digestion gave the following results:

Fragments using first enzyme:	tyr-leu-leu tyr-ala gly-asp-pro asp-pro
Fragments using second enzyme:	leu-tyr asp-pro-gly ala asp-pro-tyr-leu

Deduce the possible sequence of **Z**.

- A asp-pro-tyr-leu-ala-leu-tyr-asp-pro-gly
- B asp-pro-gly-asp-pro-tyr-leu-leu-tyr-ala
- **C** gly-asp-pro-asp-pro-tyr-ala-tyr-leu-leu
- **D** ala-asp-pro-gly-asp-pro-tyr-leu-leu-tyr