NAME _____ CLASS **23S**

JURONG PIONEER JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2024

CHEMISTRY 9729/01

Higher 2

Paper 1 Multiple Choice Questions

16 September 2024
1 hour

Candidates answer on the Question 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 **12** printed pages.

1 Which statement about relative atomic mass is correct?

A It is the average of the masses of all the isotopes of that element.

B It is the sum of the relative masses of the neutrons and protons in each atom.

C It is the ratio of the average mass of one atom of an element to the mass of one ^{1}H atom.

D It is the ratio of the mass of one mole of atoms of an element to one-twelfth the mass of one mole of ^{12}C atoms.

2 The ionisation energies, IE, in kJ mol^{-1}, of five elements are given in the table.

element	2nd ionisation energy / kJ mol^{-1}	3rd ionisation energy / kJ mol^{-1}	4th ionisation energy / kJ mol^{-1}
F	3370	6040	8410
Ne	3950	6150	9290
Na	4560	6940	9540
Mg	1450	7740	10500
A*l*	1820	2740	11600

Which statement about these ionisation energies is correct?

A The 2nd IE of F is greater than the 3rd IE of A*l* because Al^{2+} ions have more outer shell electrons than F^{+} ions.

B The 3rd IE of all the elements in the table involves the removal of an electron from the same shell.

C The 4th ionisation energy of Na is greater than the 3rd IE of Ne because the nuclear charge of Na is greater than that of Ne.

D The successive ionisation energies of these elements increase as these electrons are being taken from the same shell.

3 Why is the molecule of BCl_3 planar, whereas the molecule of PH_3 is pyramidal?

A The boron atom has no d-orbitals available for bonding.

B The covalent radius of chlorine is greater than that of hydrogen.

C The repulsion between chlorine atoms is greater than that between hydrogen atoms.

D The boron atom in BCl_3 has six electrons in its valence shell, whereas the phosphorus atom in PH_3 has eight.

4 After an oil spillage at sea, a liquid hydrocarbon layer floats on the surface of the water.
Which statements help to explain this observation?

1 Hydrocarbon molecules are not solvated by water.

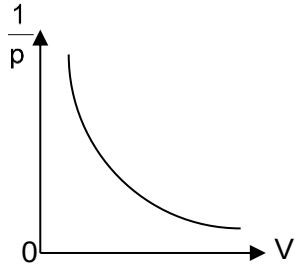
2 There are only instantaneous dipole–induced dipole interactions between hydrocarbon molecules.

3 Hydrogen bonding between water molecules causes water molecules to be packed closely together.

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

5 Which diagram correctly describes the behavior of a fixed mass of an ideal gas at constant *T* (measure in K)?

A



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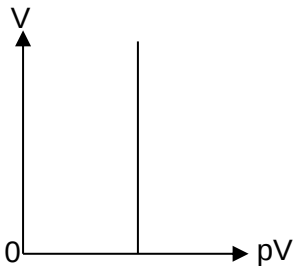

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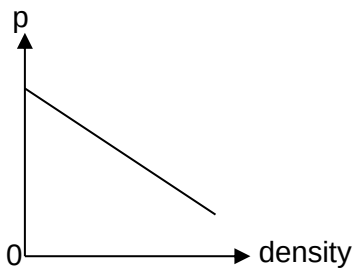
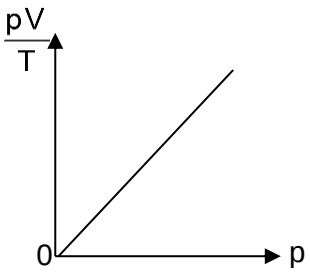


D



6 A mixture of the three gases, oxygen, nitrogen and argon, is at a total pressure of 500 kPa. There is a total of 1.2 moles of gases in the mixture.

If the oxygen gas alone occupied the entire volume of the mixture, it would exert a pressure of 150 kPa.

At room conditions, the amount of nitrogen gas in the mixture would occupy a volume of 5.76 dm^3.

Using the data from above, what is the partial pressure of the argon gas in the mixture?

A 150 kPa
B 200 kPa
C 250 kPa
D 300 kPa

7 When aqueous ammonia is added to a solution containing hexaaquairon(III) ions, $[Fe(H_2O)_6]^{3+}$, a red-brown precipitate is formed which does not dissolve when excess ammonia is added.

Which of the following states the role of ammonia in this reaction?

1 Brønsted-Lowry base
2 Ligand
3 Lewis acid
4 Reducing agent

A 1 only
B 4 only
C 1 and 2 only
D 2 and 3 only

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

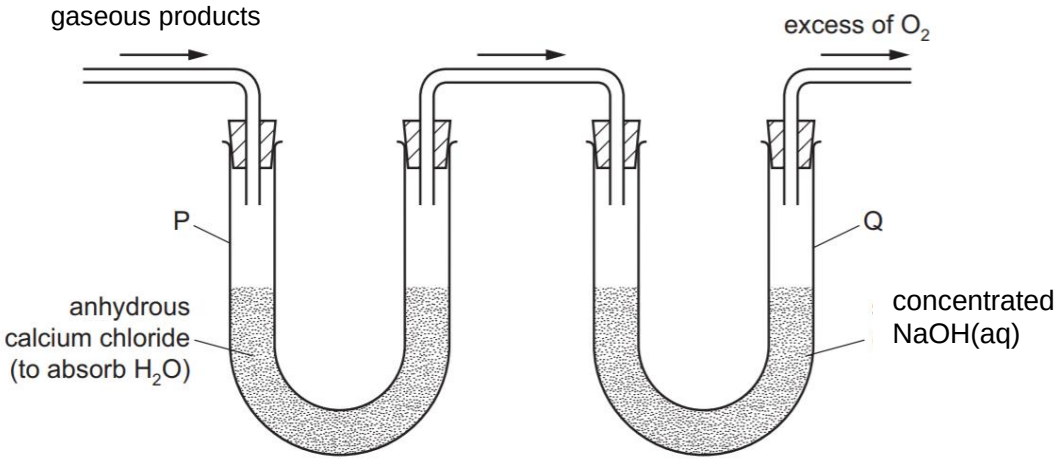
An element **M** can exist in a few oxidation states.

15.00 cm^3 of an aqueous solution of 0.100 mol dm^{-3} of $\mathbf{M}^{n+}$ required 20.00 cm^3 of 0.0250 mol dm^{-3} of acidified $K_2Cr_2O_7$ solution for a complete reaction.

What is the change in oxidation state of **M**?

A 2 **B** 3 **C** 4 **D** 5

9 A sample of the hydrocarbon C_6H_{12} is completely burned in excess dry oxygen and the gaseous products collected as shown.



The increases in mass of the collecting vessels P and Q are M_P and M_Q respectively.
What is the ratio of M_P / M_Q?

A 0.41 **B** 0.82 **C** 1.2 **D** 2.4

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

A butane burner is used to heat water. The M_r of butane is 58.

- ΔH_c of butane is –2877 kJ mol^{-1}.
- 250 g of water is heated from 12 °C to 100 °C.
- The burner transfers 47% of the heat released from the burning fuel to the water.

Assume that the butane undergoes complete combustion and none of the water evaporates.
What is the minimum mass of butane that must be burnt?

A 0.071 g **B** 1.85 g **C** 3.94 g **D** 4.48 g

11 Hydrogen can be made from steam.

$$H_2O(g) + C(s) \rightarrow H_2(g) + CO(g)$$

The Gibbs free energy change of reaction at two different temperatures are shown.

$$\Delta G_1 = +78 \text{ kJ mol}^{-1} \text{ at } 378\text{K}$$
$$\Delta G_2 = -58 \text{ kJ mol}^{-1} \text{ at } 1300\text{K}$$

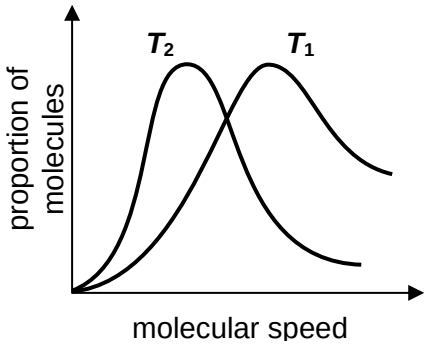
Which row of the table gives the correct signs of ΔH and ΔS for this reaction?

	ΔH	ΔS
A	–	–
B	–	+
C	+	–
D	+	+

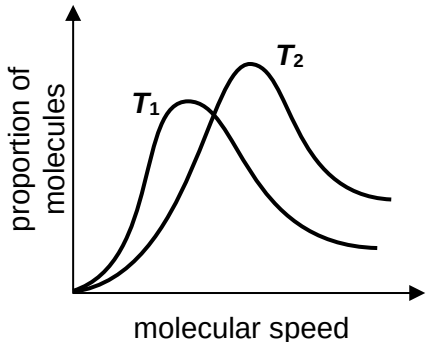
12 One mol of neon gas at temperature T_1 was added to another one mol of neon and the temperature was increased to T_2.

Which of the following diagrams correctly represents the Boltzmann distribution of molecular speeds before and after the changes were made?

A



B



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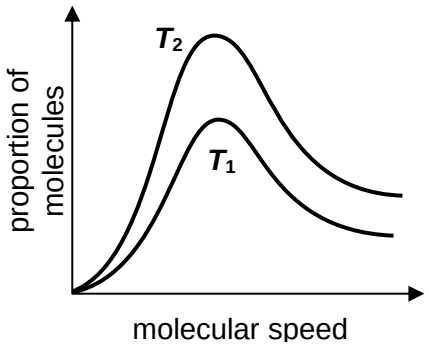
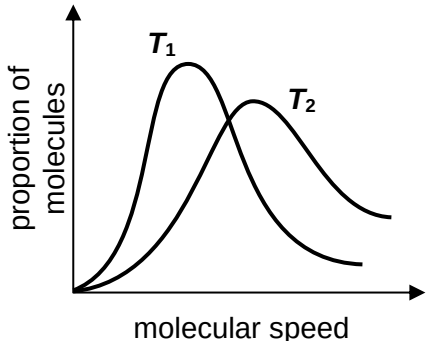
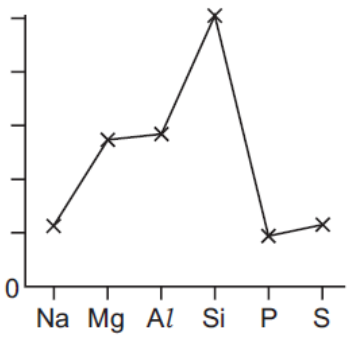


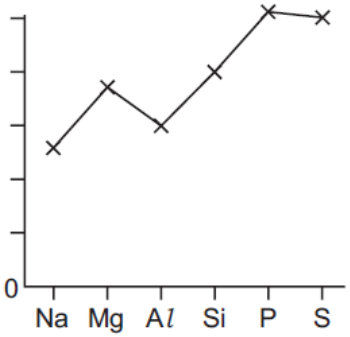
D



13 The trends in two physical properties of the elements Na, Mg, A*l*, Si, P and S are shown in the following graphs.



Graph 1



Graph 2

Which of the following illustrates the correct physical property for the corresponding graphs above?

	Graph 1	Graph 2
A	melting point	1st ionisation energy
B	melting point	electrical conductivity
C	1st ionisation energy	electrical conductivity
D	1st ionisation energy	melting point

14 Which of the following statements are correct for a system at dynamic equilibrium?

1 The rate of both forward and backward reaction is the same.

2 The concentration of reactants is equal to the concentration of products.

3 The rate constant of forward reaction is equal to the rate constant of the backward reaction.

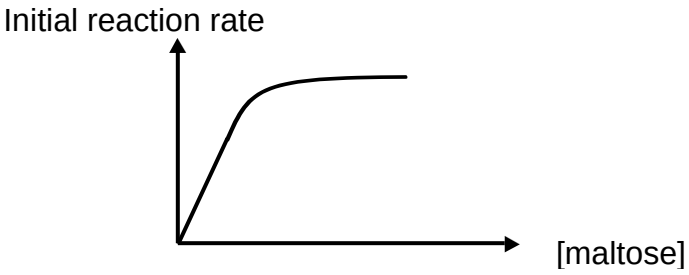
A 1 only

B 1 and 2 only

C 1 and 3 only

D 1, 2 and 3 only

15 The graph shows the result of an investigation of the initial rate of hydrolysis of maltose by the enzyme amylase. In the experiments, the initial concentration of maltose was varied, but that of amylase was kept constant.



Which conclusions can be deduced from these results?

A When [maltose] is low, the rate is zero order with respect to [maltose].

B When [maltose] is high, the rate is independent of [maltose].

C When [maltose] is low, the rate is independent of [amylase].

D When [maltose] is high, the rate is first order with respect to [amylase].

16 A saturated solution of $Ca(OH)_2$ is found to have a pH of 12.3 at 25 °C.
Which of the following statements is **incorrect**?

A The pH of the solution would increase when $Ca(NO_3)_2$ is added

B The solubility of $Ca(OH)_2$ would increase when temperature is raised to 35 °C.

C The solubility of $Ca(OH)_2$ will decrease when solid Na_2O is added.

D The K_{sp} of $Ca(OH)_2$ is 4×10^{-6} mol^3 dm^{-9}.

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

Which of the following solutions would result in a colour change when left to stand in the atmosphere?

A an acidified solution of tin(II) chloride

B an acidified solution of cobalt(II) nitrate

C a solution of potassium manganate(VII)

D an acidified solution of vanadium(II) sulfate

18 Adding concentrated HC*l*(aq) to $CuSO_4$(aq) causes the colour of the solution to change from blue to green.

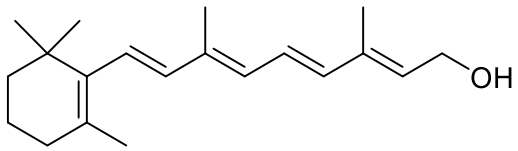
Which of the following row correctly shows the number of d-electrons and the energy gap between the d-orbitals, before and after the reaction?

	number of d-electrons	energy gap between the d-orbitals
A	changes	changes
B	remains the same	changes
C	changes	remains the same
D	remains the same	remains the same

19 How many structurally isomeric secondary alcohols are there with the molecular formula $C_5H_{12}O$?

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

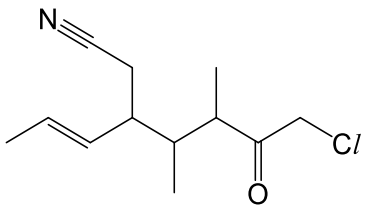
20 When retinol reacts completely with cold alkaline $KMnO_4$, it forms product **E**. How many stereoisomers do retinol and **E** have?



retinol

	retinol	**E**
A	2^4	2^8
B	2^5	2^8
C	2^4	2^{10}
D	2^5	2^{10}

21 Which of the following options about the structure below is correct?



	Number of *sp* hybridised C	Number of sp^2 hybridised C	Number of sp^3 hybridised C
A	1	3	8
B	1	3	6
C	0	4	8
D	0	4	6

22 Which list contains all compounds that are made during the free radical substitution of chloromethane with chlorine?

A C_2H_6, CCl_4, CH_2Cl_2

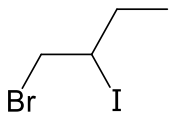
B CH_2CCl_2, CCl_4, $CHCl_3$

C HCl, CH_3CH_2Cl, $CHCl_3$

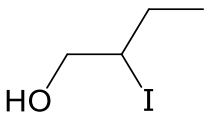
D CH_2ClCH_2Cl, CH_2Cl_2, $CHCl_3$

23 Which of the following **cannot** be formed as one of the products, when but–1–ene reacts with IBr(aq)?

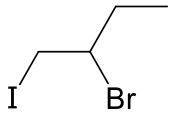
A



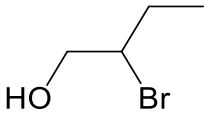
B



C



D



24 Which pair of reagents reacts to form a product with a chiral carbon atom?

A $CH_3CH_2CH_2Cl$ + NaOH in ethanol

B $(CH_3)_2C{=}O$ + $NaBH_4$

C CH_3CH_2CHO + HCN

D CH_3COCl + CH_3NH_2

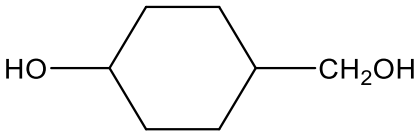
25 Heating compound **F**, $C_7H_{14}O_2$, under reflux with an excess of acidified potassium manganate(VII) produces compound **G**.

Compound **G** produces hydrogen gas with sodium metal and forms orange crystals with 2,4-DNPH reagent.

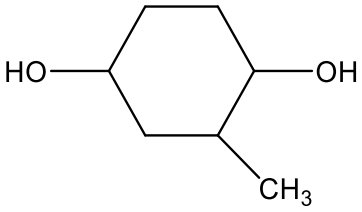
What could **F** be?

A $(CH_3)_2C(OH)CH_2CH_2CH_2CHO$

B



C



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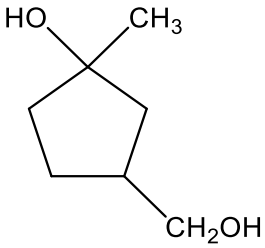
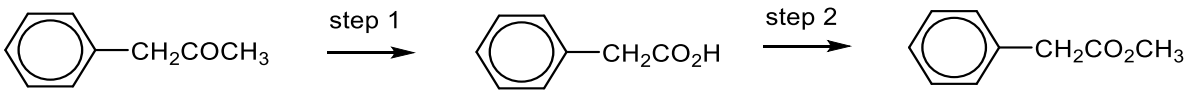


26 Methyl phenylacetate has a strong odour similar to honey. It is used in the flavour industry and in perfumes to impart honey scents.

The following pathway shows the synthesis of methyl phenylacetate via a 2-step pathway.



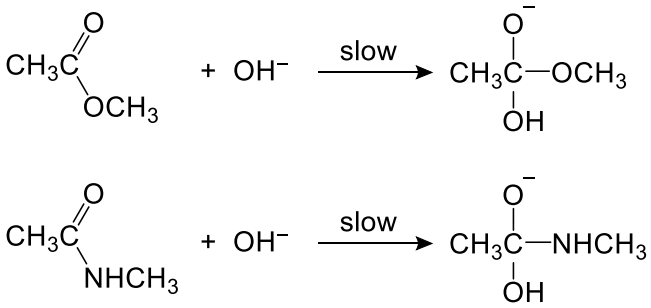
methyl phenylacetate

Which reagents can be used for step 1 and step 2?

	step 1	step 2
A	acidified $KMnO_4$	CH_3OH, concentrated H_2SO_4
B	H_2SO_4 (aq)	CH_3COOH, concentrated H_2SO_4
C	NaOH (aq), I_2	CH_3OH, concentrated H_2SO_4
D	acidified $K_2Cr_2O_7$	CH_3COOH, concentrated H_2SO_4

27 1 mol of an ester ($CH_3CO_2CH_3$) and 1 mol of an amide ($CH_3CONHCH_3$) underwent base hydrolysis separately and the initial rate of reaction was measured. It was found that the ester undergoes hydrolysis approximately three times faster than the amide.

The slow step of the base hydrolysis of the ester and amide is the same and shown below.



Which statements help to explain the faster rate of base hydrolysis of the ester?

1 Oxygen is more electronegative than nitrogen.

2 The lone pair of electrons on the nitrogen atom in the amide interacts more with the carbonyl group.

3 There are two lone pairs of electrons on the oxygen atom in the ester and only one lone pair of electrons on the nitrogen atom in the amide.

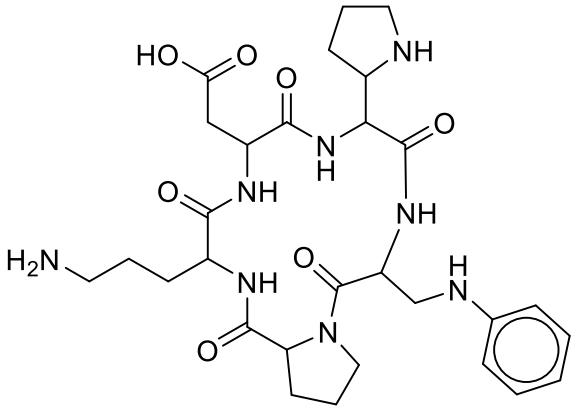
A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

28 Compound **W** is a cyclic oligopeptide.



W

How many amide linkages exist in compound **W**?

A 5 **B** 6 **C** 7 **D** 8

29 An octapeptide was analysed in the chemistry laboratory by treating it with enzymes. The following fragments were obtained after the partial hydrolysis that is catalysed by the enzymes.

ser-arg-pro
cys-pro
pro-ser
pro-ala-phe-gly

Which of the following is the correct sequence of the octapeptide?

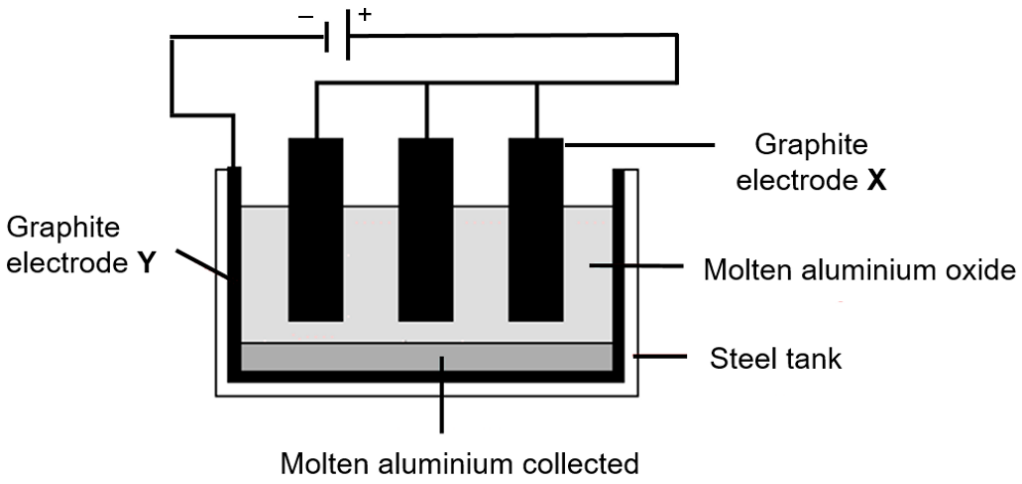
A ser-arg-pro-ala-phe-gly-cys-pro

B pro-ser-arg-pro-ala-phe-gly-cys

C cys-pro-ser-arg-pro-ala-phe-gly

D cys-pro-ala-phe-gly-ser-arg-pro

30 Aluminium is extracted from its ore by electrolysis.



Which of the following statements is correct?

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

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