ST ANDREW'S JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS
HIGHER 1

CANDIDATE NAME	
CLASS	**2 3 S**

CHEMISTRY 8873/01

Paper 1 Multiple Choice **11 September 2024**
Candidate answer on the Optical Answer Sheet **1 hour**
Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

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 Optical Answer Sheet.

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 **13** printed pages (including this cover page).

1 Oxygen exist as two isotopes; ^{16}O and ^{18}O respectively. Which of the following particles contain more neutrons than protons and more protons than electrons respectively?

1 $^{12}C^{18}O_3^{2-}$

2 $^{1}H_3^{16}O^{+}$

3 $^{14}N^{18}O^{+}$

A 1, 2 and 3

B 1 and 2 only

C 2 and 3 only

D 3 only

2 The first seven successive ionisation energies for element **X** are as shown. **X** is found in Period 3.

	1st	2nd	3rd	4th	5th	6th	7th
Ionisation energy / kJ mol^{-1}	1010	1900	2900	5000	6300	21300	25400

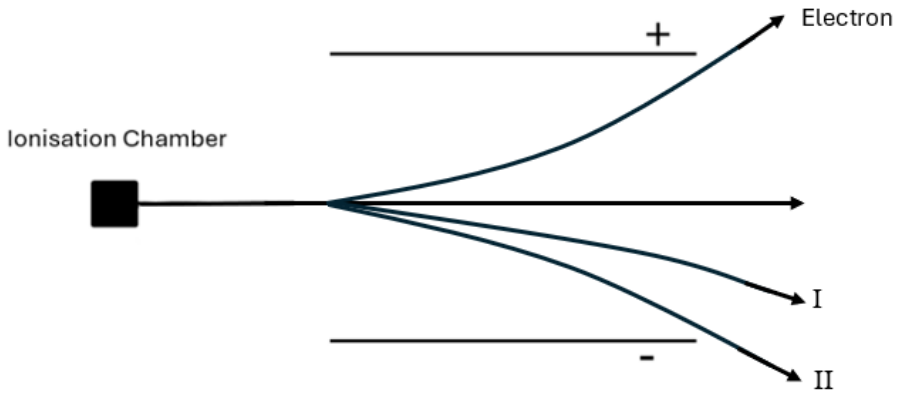
Which compound can be formed using **X**?

A **X**O **B** **X**O_2 **C** **X**O_3 **D** $\mathbf{X}_4O_{10}$

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

$^{204}_{81}Tl$ can undergo natural radioactive decay, where one of its electrons enters the nucleus to change a proton into a neutron, to form a new element **X**.

When **X** is put in an ionisation chamber, it emits a high energy α-particle (which is a ^{4}He nucleus).



What is the identity of the element **X** and the path of the emitted α-particle in an electric field?

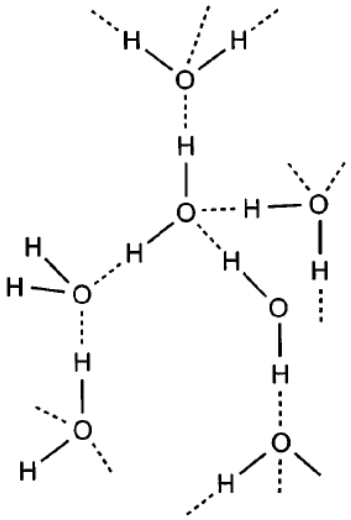
	X	Deflection Path
A	$^{204}_{80}X$	I
B	$^{204}_{82}X$	II
C	$^{205}_{80}X$	I
D	$^{205}_{82}X$	II

4 Which statements about cyanogen molecule, $(CN)_2$, are correct?

1 $(CN)_2$ is polar.
2 $(CN)_2$ is bent at the central carbon atoms.
3 A $(CN)_2$ molecule has 3 σ and 4 π bonds.
4 A $(CN)_2$ molecule has a total of 26 electrons.

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

5 The structure of ice is as shown.



Which statement is **incorrect**?

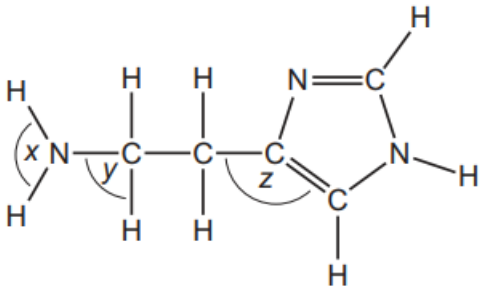
A The open structure causes ice to be less dense than liquid water.

B The open structure gives ice a larger mass than liquid water.

C Four electrons from each oxygen are involved in forming hydrogen bonds.

D Each oxygen atom in a water molecule is tetrahedrally bonded to 4 hydrogen atoms.

6 The structure of histamine is as shown.



histamine

Which is the correct order of bond angle from smallest to largest?

	Smallest bond angle ⟶		Largest bond angle
A	x	y	z
B	z	y	x
C	y	z	x
D	x	z	y

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

Copper metal, copper(II) ions and water are formed when dilute sulfuric acid is added to copper(I) oxide.

Which option is correct?

	number of moles of Cu^{+} reacted	number of moles of Cu formed	number of moles of Cu^{2+} formed
A	1	1	1
B	1	2	1
C	2	1	1
D	2	2	1

8 *Use of the Data Booklet is relevant to this question.*
Which statement is correct?

A 2.00g of hydrogen gas contains 3.00×10^{23} atoms.
B 4.00g of helium gas contains 6.00×10^{23} molecules.
C 28.0g of carbon monoxide gas contains 6.00×10^{23} molecules.
D 88.0g of carbon dioxide gas contains 2.40×10^{24} atoms.

9 Which compound has the same empirical formula as its molecular formula?

A dinitrogen tetraoxide
B ethanoic acid
C propanone
D tetrafluoroethene

10 *Use of the Data Booklet is relevant to this question.*
Which compound contains 54.1% by mass of calcium?

A Calcium oxide
B Calcium nitrate
C Calcium sulfate
D Calcium hydroxide

11 10.0 cm^3 of 0.30 mol dm^{-3} thallium nitrate, $Tl NO_3$, required 20.00 cm^3 of 0.10 mol dm^{-3} acidified NH_4VO_3 for oxidation to Tl^{3+}. Vanadium is the only element which is reduced.

What is the final oxidation state of vanadium?

A 0
B +2
C +3
D +4

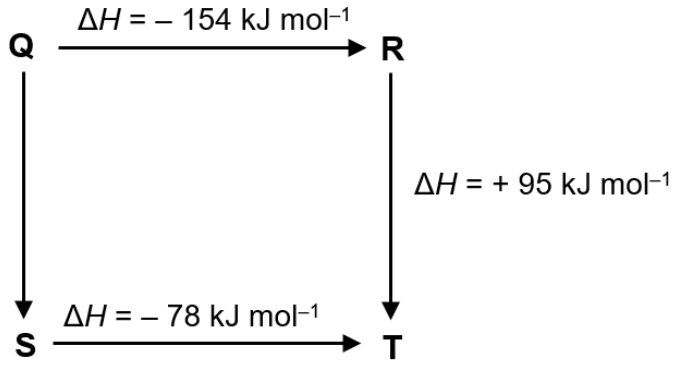
12 *Use of the Data Booklet is relevant to this question.*

In an energetics experiment, 2.00 g of a fuel is completely burnt. 55% of the energy released is absorbed by 200 g of water and the temperature rose from 18 °C to 66 °C.

What is the energy released per gram of fuel burnt?

A 20 064 J **B** 36 480 J **C** 36 845 J **D** 72 960 J

13 The following diagram illustrates the enthalpy changes for a set of reactions.



Which statements are correct?

1 Δ*H* for the conversion of **S** to **R** is + 17 kJ mol^{-1}

2 Δ*H* for the conversion of **Q** to **S** is + 19 kJ mol^{-1}.

3 The energy level of **T** is lower than the energy level of **Q**.

A 1, 2 and 3

B 1 and 2 only

C 2 and 3 only

D 2 only

14 Cs-137 is a radioactive isotope with a half-life of 30 years. It was reported that about 9.6 kg of Cs-137 was released into the sea following the Japan nuclear disaster in 2011.

What is the mass of Cs-137 left in the sea after 150 years?

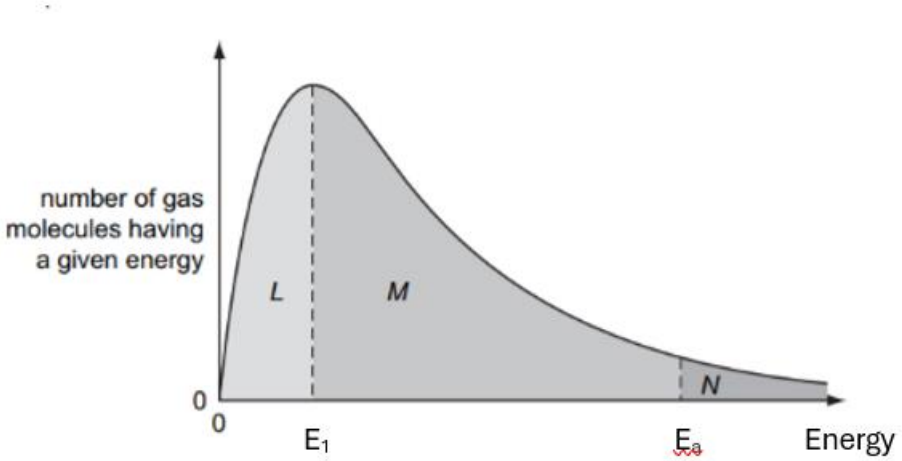
A 0.30 kg

B 0.60 kg

C 1.92 kg

D 3.84 kg

15 The Boltzmann distribution shows the number of molecules having a particular energy at constant temperature.



L refers to the area under the curve from 0 to E_1.

M refers to the area under the curve from E_1 to E_a.

N refers to the area under the curve after E_a.

If the temperature is increased by 10 °C, what happens to the size of the areas labelled **L**, **M** and **N**?

	L	**M**	**N**
A	increase	decrease	decrease
B	decrease	increase	increase
C	decrease	decrease	increase
D	increase	increase	decrease

16 1.00 mol of N_2O_4 and 0.200 mol of NO_2 were added to a sealed vessel of fixed volume of 2.00 dm^3 at 298 K. When the system reached equilibrium, 0.680 mol of NO_2 was present in the vessel.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

Which statements are true about this equilibrium?

1 0.760 mol of N_2O_4 are present at equilibrium.
2 The value for the equilibrium constant, K_c, is 0.608.
3 The pressure in the vessel at equilibrium is lower than the pressure in the vessel before the reaction started.

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

17 What is true about an equilibrium system whose K_c is independent of temperature?

A The number of moles of gaseous particles on both sides are equal.
B The system is a homogenous equilibrium system.
C The enthalpy change of the reaction is 0 kJ mol^{-1}.
D Its K_c has no units.

18 Which reaction involves both Arrhenius acid and Arrhenius base?

A $HCl\,(g) + NH_3\,(g) \rightarrow NH_4Cl\,(s)$
B $2HCl\,(aq) + Zn\,(s) \rightarrow ZnCl_2\,(s) + H_2\,(g)$
C $HNO_3\,(aq) + CaCO_3\,(s) \rightarrow Ca(NO_3)_2\,(aq) + CO_2\,(g) + H_2O\,(l)$
D $2HNO_3\,(aq) + Ca(OH)_2\,(aq) \rightarrow Ca(NO_3)_2\,(aq) + 2H_2O\,(l)$

19 What is the final pH of a solution formed by mixing equal volumes of aqueous hydrochloric acid at pH 1.0 and at pH 2.0?

A 0.96 **B** 1.26 **C** 1.50 **D** 3.00

20 The oxide of element **Z** has a giant structure. The chloride of **Z** reacts with water to give a solution with a pH less than 5. Which pairs shows two elements which could be **Z**?

A Aluminium, Phosphorus
B Aluminium, Silicon
C Phosphorus, Sodium
D Sodium, Silicon

21 Which property increases steadily down Group 1 elements?

A Melting point
B Electronegativity
C Charge density
D Reducing power

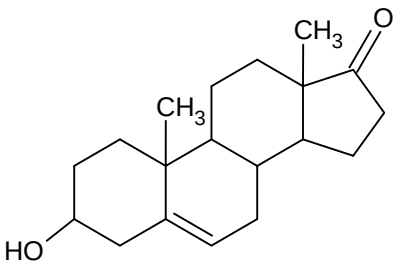
22 Which statement best explains the trend of volatility of hydrogen halides from HC*l* to HI?

A Covalent bonds between atoms become stronger.
B Electron cloud size of the molecules increases.
C Permanent dipole – permanent dipole (pd-pd) interactions become weaker.
D Instantaneous dipole – induced dipole (id-id) interactions become stronger.

23 How many saturated constitutional (structural) isomers are there with the formula of $C_5H_{12}O$ are alcohols?

A 5
B 6
C 7
D 8

24 Androstenolone, $C_{19}H_{28}O_2$, is a steroid secreted by the adrenal cortex.



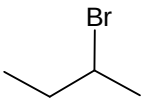
Androstenolone

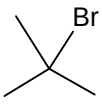
When it is heated with hydrogen gas and nickel catalyst, it forms compound **Z**.

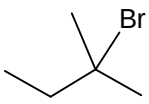
Which row identifies the number of cis-trans isomers in Androstenolone and the molecular formula of **Z?**

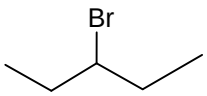
	number of cis-trans isomers	molecular formula of **Z**
A	2	$C_{19}H_{30}O_2$
B	0	$C_{19}H_{30}O_2$
C	2	$C_{19}H_{32}O_2$
D	0	$C_{19}H_{32}O_2$

25 Which halogenoalkane gives the greatest number of different alkenes (including stereoisomers) on elimination?

A 

B 

C 

D 

26 Ethyl acetate is a widely used solvent for paints and perfumes and has a sweet and fruity odor. It has the molecular formula of $C_4H_8O_2$.

After heating under reflux with dilute sulfuric acid, it forms **P** ($C_2H_4O_2$) and **Q** (C_2H_6O).

What is the structure formula of ethyl acetate?

A CH_3COCH_2CHO

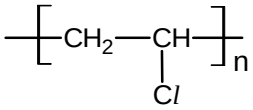
B $CH_3CH_2OCOCH_3$

C $CH_3CH_2CH_2COOH$

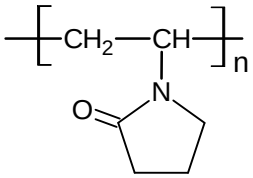
D $CH_3CH_2COOCH_3$

27 Which polymer is used in waterproof fabrics for mattresses and outdoor furniture?

A



B



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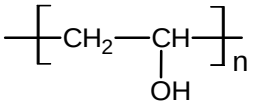

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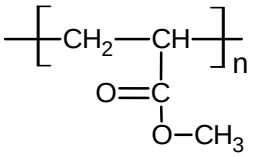
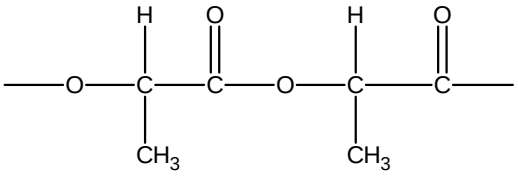


28 *Use of the Data Booklet is relevant to this question.*

A short section of the polymer, poly(lactic acid), is shown.



The relative molecular mass of poly(lactic acid) is approximately 240 000.

How many monomers are present in poly(lactic acid)?

A 1000 **B** 1600 **C** 2600 **D** 3300

29 In recent times, silver nanoparticles were widely utilised as catalyst in a diverse range of organic reactions. However, it was found that presence of sulfur in the reaction mixture will reduce the catalytic efficiency of silver nanoparticles.

Which statement about silver nanoparticles is **incorrect**?

A The efficiency of silver nanoparticles as a catalyst is greatly improved due to its large surface area to volume ratio.
B Sulfur poisons the catalyst by coating the surface of the silver nanoparticles, preventing the metal from coming into contact with the reactants.
C Silver nanoparticles can be easily inhaled and become a potential health hazard.
D Silver nanoparticles are particles with all dimensions between 1 to 10 nm.

30 A gecko can climb vertical walls and hang from the ceiling with its feet above its head.

Recent research has resulted in the invention of “gecko tape”, a reusable adhesive that has a structure which is similar to the feet of geckos. This gecko tape can stay sticky even under extreme temperatures.

Which features likely enable the tape to stick to a surface in a similar way to that of how a gecko hangs on the ceiling?

1 The surface of the tape possesses many finely divided nanostructures.
2 The tape has a large surface area of contact with any surface.
3 Hydrogen bonds exist between the tape and the surface.

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

END OF PAPER