



National  
Qualifications  
2023

X813/77/02

**Chemistry  
Section 1 — Questions**

FRIDAY, 12 MAY

9:00 AM – 12:00 NOON

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Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X813/77/01.

Record your answers on the answer grid on *page 03* of your question and answer booklet.

You may refer to the Chemistry Data Booklet for Higher and Advanced Higher.

Before leaving the examination room you must give your question and answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.



\* X 8 1 3 7 7 0 2 \*

**SECTION 1 — 25 marks**

**Attempt ALL questions**

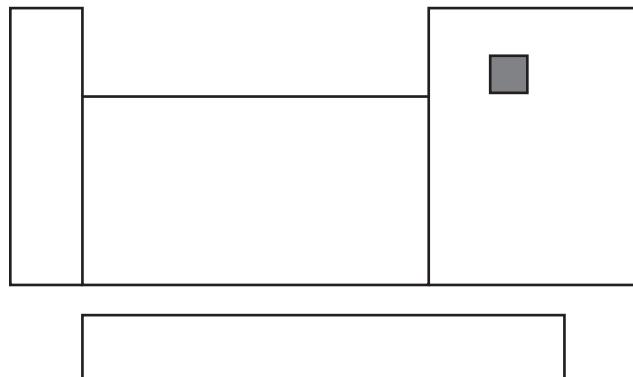
1. Which of the following electronic configurations shows the ground state arrangement of electrons in the 3d and 4s subshells of an atom?

	3d	4s
A	$\begin{array}{ c c c c c }\hline 1&1&1&1&\\ \hline\end{array}$	$\boxed{\phantom{0}}$
B	$\begin{array}{ c c c c c }\hline 1&1&1&1&1\\ \hline\end{array}$	$\boxed{\phantom{0}}$
C	$\begin{array}{ c c c c c }\hline 1&1&1&1&1\\ \hline\end{array}$	$\boxed{1}$
D	$\begin{array}{ c c c c c }\hline 1&1&1&1&1\\ \hline\end{array}$	$\boxed{1}$

2. Which of the following shapes can only be formed by compounds that contain non-bonding electron pairs?

- A Linear
- B Tetrahedral
- C Trigonal pyramidal
- D Trigonal bipyramidal

3.



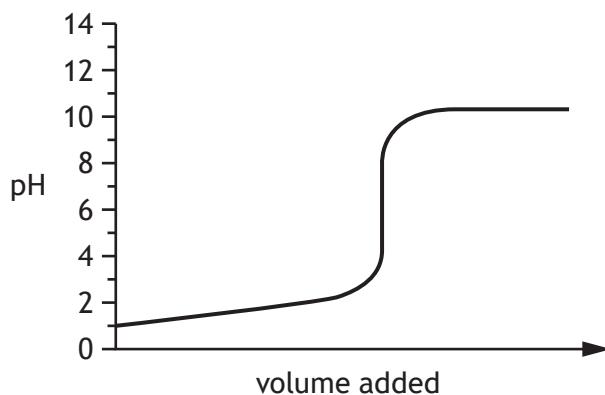
In which block of the periodic table is the shaded element?

- A s
- B p
- C d
- D f

4. Which line in the table is correct for transition metal catalysts?

	Heterogenous catalyst	Homogeneous catalyst
A	adsorption onto active sites	same state as reactants
B	full d subshell	different state to reactants
C	same state as reactants	can change oxidation state
D	different state to reactants	adsorption onto active sites

5.



The titration curve above shows how the pH changes when a

- A weak acid is added to a strong alkali
- B strong alkali is added to a weak acid
- C strong acid is added to a weak alkali
- D weak alkali is added to a strong acid.

6. Which line in the table is correct for an acidic buffer?

	Species absorbing excess $\text{H}_3\text{O}^+$ ions	Species providing $\text{H}_3\text{O}^+$ ions
A	weak base	conjugate acid
B	conjugate base	conjugate acid
C	weak base	weak acid
D	conjugate base	weak acid

[Turn over

7. Which of the following statements is correct for a feasible reaction under standard conditions?
- A The standard free energy change is negative and the equilibrium favours products.
  - B The standard free energy change is negative and the equilibrium favours reactants.
  - C The standard free energy change is positive and the equilibrium favours products.
  - D The standard free energy change is positive and the equilibrium favours reactants.

8. At 298 K,



What is the free energy change  $\Delta G^\circ$ , in  $\text{kJ mol}^{-1}$ , for the conversion of nitrogen dioxide to one mole of dinitrogen tetroxide?

- A -45.9
- B -5.9
- C +5.9
- D +45.9

9. Which of the following processes is endothermic and has a positive  $\Delta S$  value?

- A Carbon burning
- B Snowflakes forming
- C Ethoxyethane evaporating
- D Ammonia gas and hydrogen chloride gas forming solid ammonium chloride

10. The reaction  $\text{X} + 2\text{Y} \rightarrow \text{Z}$  has the rate equation shown below.

$$\text{rate} = k[\text{X}][\text{Y}]$$

Which of the following could represent the rate determining step?

- A  $\text{X} + \text{Y} \rightarrow$  intermediate
- B  $\text{Y} + \text{Y} \rightarrow$  intermediate
- C  $\text{X} + \text{Y} \rightarrow \text{Z}$
- D  $\text{XY} + \text{Y} \rightarrow \text{Z}$

11. Which line in the table is correct for a carbon-carbon single bond in an alkane?

	Overlap of atomic orbitals	Symmetry of molecular orbital
A	end-on	symmetrical
B	end-on	asymmetrical
C	side-on	symmetrical
D	side-on	asymmetrical

12. Which line in the table is correct for a chromophore that absorbs blue-green light?

	Movement of electrons	Colour observed
A	HOMO to LUMO	blue-green
B	LUMO to HOMO	blue-green
C	HOMO to LUMO	red
D	LUMO to HOMO	red

13. Which of the following compounds does **not** exhibit hydrogen bonding between its molecules?

- A Ethanol
- B Ethylamine
- C Ethanoic acid
- D Ethoxyethane

14. A haloalkane can be converted into a ketone by reaction with

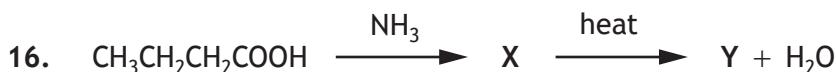
- A aqueous sodium hydroxide followed by oxidation
- B ethanolic potassium cyanide followed by hydrolysis
- C ethanolic sodium hydroxide followed by addition
- D potassium in ethanol followed by substitution.

[Turn over



The organic product X is

- A 2-methylbutanal
- B 2-methylbut-1-ene
- C 2-methylbutan-1-ol
- D 2-methylbutanoic acid.



The formula for Y will be

- A  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CN}$
- B  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CONH}_2$
- C  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$
- D  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COONH}_4$

17. Which of the following compounds is **not** an isomer of methoxypropane?

- A  $\text{CH}_3\text{CH}_2\text{COCH}_3$
- B  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$
- C  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$
- D  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$

18. Which of the following compounds can exhibit geometric isomerism?

- A  $\text{CH}_2\text{CHBr}$
- B  $\text{CHClCHCH}_3$
- C  $\text{CH}_3\text{CH}_2\text{CHCCl}_2$
- D  $\text{CH}_3\text{C}(\text{CH}_3)\text{CHCH}_3$

19. In which of the following techniques will the test compound always be destroyed?

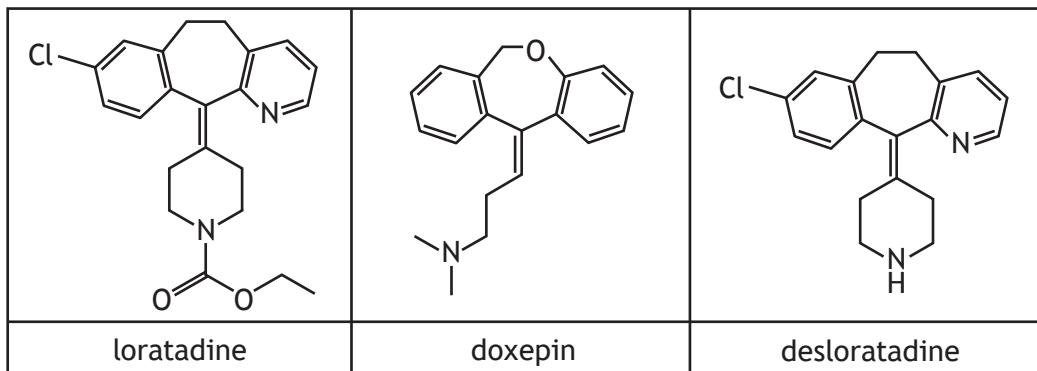
- A Mass spectrometry
- B Infrared spectroscopy
- C Melting point analysis
- D Proton NMR spectroscopy

20. Which line in the table correctly describes the action of a drug?

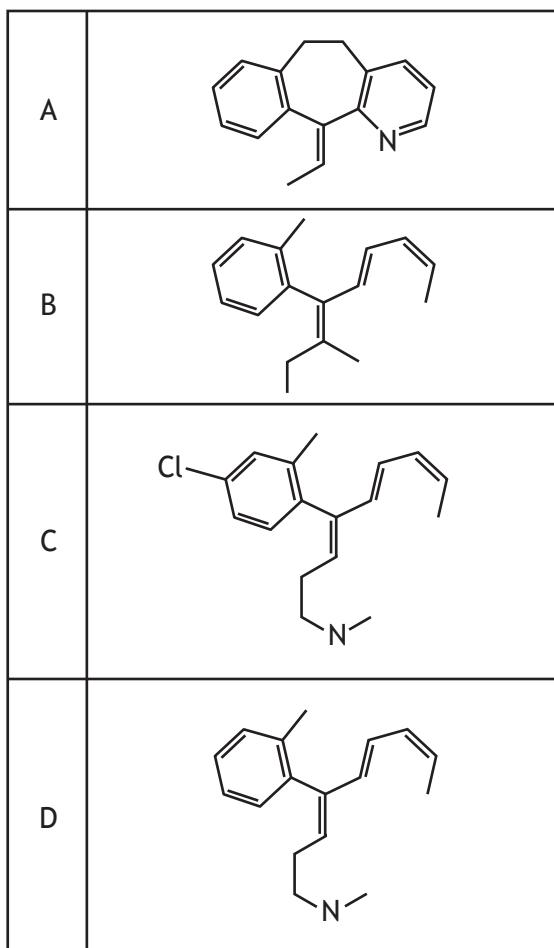
Type of drug	Binding site	Response
A antagonist	receptor binding site	produces a response similar to the body's natural response
B antagonist	enzyme active site	blocks the body's natural response
C enzyme inhibitor	receptor binding site	produces a response similar to the natural action of the enzyme
D enzyme inhibitor	enzyme active site	blocks the action of the enzyme

[Turn over

21. The structural formulae of three antihistamine drugs are shown.



Which of the following is the largest structural fragment that is common to all three molecules?



22. A compound was found to have the percentage composition by mass as shown below.

vanadium 61.4%      oxygen 38.6%

This compound has the formula

- A VO
- B VO<sub>2</sub>
- C V<sub>2</sub>O
- D V<sub>2</sub>O<sub>3</sub>

23. Which of the following compounds could be used as a primary standard?

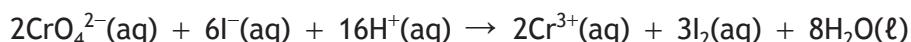
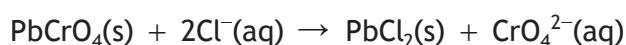
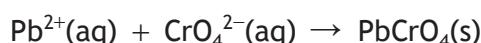
- A Calcium carbonate
- B Hydrochloric acid
- C Sodium carbonate
- D Sodium hydroxide

24. The total mass of the Earth's atmosphere has been determined to be  $5.1 \times 10^{18}$  kg.

What mass, in kg, of carbon dioxide is in the Earth's atmosphere if the concentration of carbon dioxide is 420 ppm?

- A  $1.2 \times 10^{13}$
- B  $2.1 \times 10^{15}$
- C  $1.2 \times 10^{16}$
- D  $2.1 \times 10^{18}$

25. The concentration of Pb<sup>2+</sup> ions in a solution can be determined using the following sequence of reactions:



How many moles of iodine are formed from one mole of Pb<sup>2+</sup> ions in the solution?

- A 0.75
- B 1.5
- C 3.0
- D 6.0

**[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF  
YOUR QUESTION AND ANSWER BOOKLET.]**

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