



National  
Qualifications  
2024

**X813/77/02**

**Chemistry**  
**Section 1 — Questions**

THURSDAY, 23 MAY

9:00 AM – 12:00 NOON

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. The outermost occupied orbital in a noble gas is

- A an s orbital
- B a p orbital
- C a d orbital
- D an s or p orbital.

2. The common ions of copper are  $\text{Cu}^+$  and  $\text{Cu}^{2+}$ .

Which of the following electronic configurations does **not** represent an atom or ion of copper in its ground state?

- A  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$
- B  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
- C  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9 4s^2$
- D  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$

3.  $\text{VO}^{2+}$  can react to form  $[\text{V}(\text{OH}_2)_6]^{2+}$  as shown.



Which line in the table is correct for this reaction?

	Oxidation number of vanadium in $\text{VO}^{2+}$	Type of reaction
A	+2	reduction
B	+4	reduction
C	+2	oxidation
D	+4	oxidation

4. Compounds containing transition metal ions can form coloured solutions when dissolved in water.

Transition metal ion	Colour of solution
$\text{Ti}^{3+}$	purple
$\text{Ni}^{2+}$	green
$\text{Cu}^{2+}$	blue-green
$\text{Co}^{2+}$	red

Using the information in the table, the transition metal ion with the greatest energy gap between split d orbitals is

- A  $\text{Ti}^{3+}$   
B  $\text{Ni}^{2+}$   
C  $\text{Cu}^{2+}$   
D  $\text{Co}^{2+}$
5. The name of the complex ion  $[\text{CoCl}_2(\text{NH}_3)_4]^+$  is
- A dichloridotetraamminecobalt(I)  
B dichloridotetraamminecobalt(III)  
C tetraamminedichloridocobalt(I)  
D tetraamminedichloridocobalt(III).
6. Which line in the table is correct for a molecule of xenon difluoride,  $\text{XeF}_2$ ?

	Arrangement of electron pairs around xenon atom	Shape of molecule
A	linear	linear
B	tetrahedral	angular
C	trigonal bipyramidal	linear
D	trigonal bipyramidal	angular

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7. Propanoic acid partially dissociates into ions in aqueous solution and an equilibrium is established.

Which of the following decreases in concentration when potassium propanoate is added to this equilibrium?

- A Propanoate ions
- B Hydronium ions
- C Hydroxide ions
- D Propanoic acid molecules

8. The ionic product of water,  $K_w$ , is  $5.48 \times 10^{-14}$  at 50 °C.

The pH of water at 50 °C is

- A 5.48
- B 6.63
- C 7.00
- D 13.3

9. Excess calcium carbonate was added to 100 cm<sup>3</sup> of 1 mol l<sup>-1</sup> hydrochloric acid.

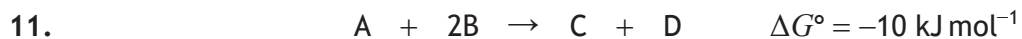
The experiment was repeated using the same mass of calcium carbonate and 100 cm<sup>3</sup> of 1 mol l<sup>-1</sup> methanoic acid.

Which of the following was the same for both experiments?

- A The mass of unreacted calcium carbonate at the end of the reaction.
- B The time taken for the reaction to be completed.
- C The pH of the mixture at the end of the reaction.
- D The initial rate of the reaction.

10. The pH of a buffer solution made by mixing equal volumes of 0.100 mol l<sup>-1</sup> ethanoic acid and 0.100 mol l<sup>-1</sup> sodium ethanoate is

- A 2.38
- B 2.88
- C 3.76
- D 4.76



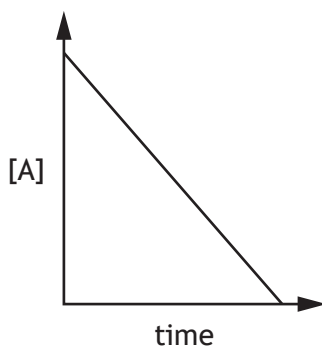
Which of the following can be concluded from the above information?

- A The reaction is feasible.
- B The reaction is exothermic.
- C The reaction is third order overall.
- D The reaction has a low activation energy.

12. Which line in the table shows the correct changes in entropy for the spontaneous formation of a snowflake?

	$\Delta S$ formation of snowflake	$\Delta S$ surroundings
A	+	+
B	+	–
C	–	+
D	–	–

13. The graph shows the change in concentration of reactant A as a reaction proceeds.



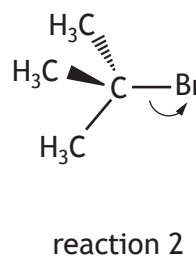
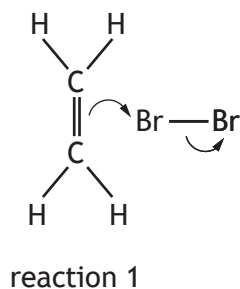
The order of reaction with respect to A is

- A zero
- B first
- C second
- D third.

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14. Which of the following formulae could only represent an aldehyde?
- A  $\text{CH}_2\text{O}$
  - B  $\text{C}_2\text{H}_4\text{O}$
  - C  $\text{C}_2\text{H}_6\text{O}$
  - D  $\text{C}_3\text{H}_6\text{O}$
15. Propanoic acid would **not** be produced by the reaction of
- A  $\text{C}_2\text{H}_5\text{CHO}$  and acidified permanganate
  - B  $\text{C}_3\text{H}_7\text{OH}$  and Fehling's solution
  - C  $\text{C}_2\text{H}_5\text{COOC}_2\text{H}_5$  and  $\text{H}^+/\text{H}_2\text{O}$
  - D  $\text{C}_2\text{H}_5\text{CN}$  and  $\text{H}^+/\text{H}_2\text{O}$
16. The formula  $\text{C}_3\text{H}_8\text{O}$  could represent an alcohol or an ether.  
Which of the following statements is **not** correct?
- A They are both used as solvents.
  - B They can both form hydrogen bonds with water.
  - C They can both be made by nucleophilic substitution of a haloalkane.
  - D They both produce a peak between  $3600\text{ cm}^{-1}$  and  $3200\text{ cm}^{-1}$  in an infrared spectrum.
17. Which of the following compounds reacts with both dilute hydrochloric acid and dilute sodium hydroxide solution?
- A  $\text{H}_2\text{NCH}_2\text{CHO}$
  - B  $\text{HOCH}_2\text{COOH}$
  - C  $\text{H}_2\text{NCH}_2\text{COOH}$
  - D  $\text{HOCH}_2\text{CH}_2\text{NH}_2$

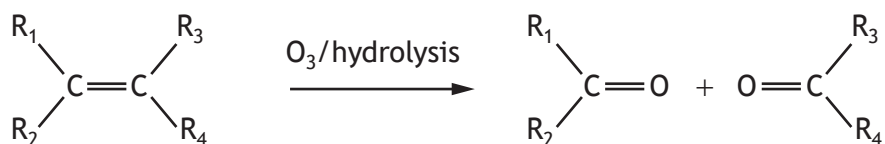
18. The first step in the mechanisms of two different reactions are shown below.



Both reaction mechanisms involve

- A the formation of a cyclic ion intermediate
- B the formation of a carbocation
- C breaking a pi bond
- D heterolytic fission.

19. Alkenes react with ozone,  $O_3$ , to form carbonyl compounds.

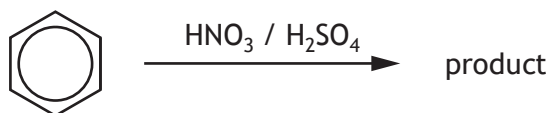


Which of the following alkenes would react with ozone to produce a mixture of propanone and ethanal?

- A  $(CH_3)_2C=CH_2$
- B  $CH_3CH=C(CH_3)_2$
- C  $CH_3CH=CHCH_2CH_3$
- D  $CH_3CH=CHCH_3$

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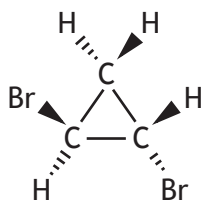
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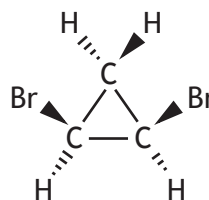
Which line in the table is correct for the substitution reaction above?

	Type of substitution reaction	Product
A	electrophilic	
B	electrophilic	
C	nucleophilic	
D	nucleophilic	

21. X and Y are isomers.



X



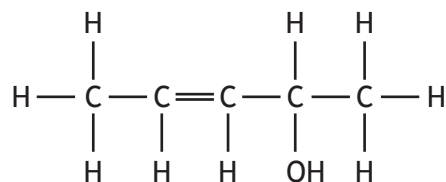
Y

Which line in the table shows the correct names for X and Y?

	X	Y
A	<i>cis</i> -1,2-dibromocyclopropane	<i>trans</i> -1,2-dibromocyclopropane
B	<i>trans</i> -2,3-dibromocyclopropane	<i>cis</i> -2,3-dibromocyclopropane
C	<i>trans</i> -1,2-dibromocyclopropane	<i>cis</i> -1,2-dibromocyclopropane
D	<i>cis</i> -2,3-dibromocyclopropane	<i>trans</i> -2,3-dibromocyclopropane



22.



The number of possible stereoisomers for the compound shown is

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

23. Which line in the table shows how the peaks in a  $^1\text{H}$  NMR spectrum are produced?

	Particles that flip	Peaks are produced when energy is
A	protons	emitted
B	electrons	emitted
C	protons	absorbed
D	electrons	absorbed

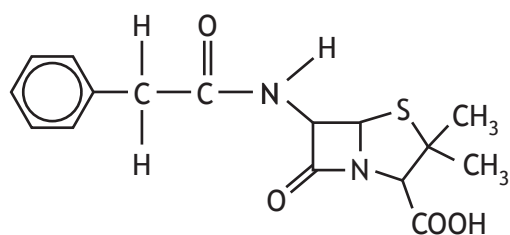
24. The empirical formula of a compound was found to be  $\text{H}_2\text{S}_2\text{O}_3$ . The total mass of sulfur in a sample of the compound was found to be 5.182 g.

What mass of oxygen was present in the sample?

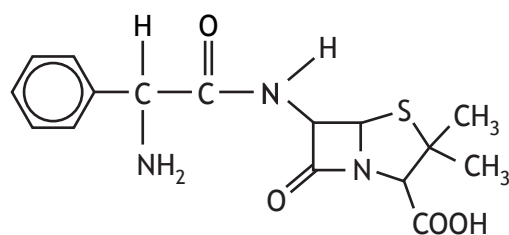
- A 1.291 g
- B 2.583 g
- C 3.874 g
- D 7.749 g

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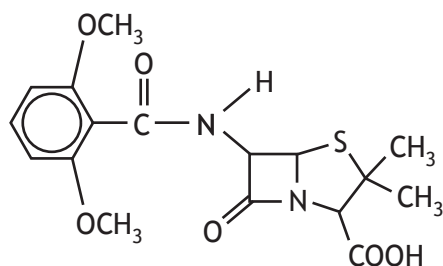
25. The structures of four antibiotic molecules are shown.



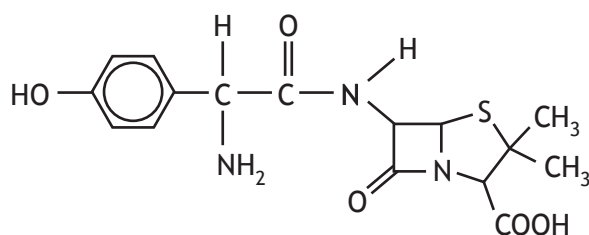
penicillin G



ampicillin

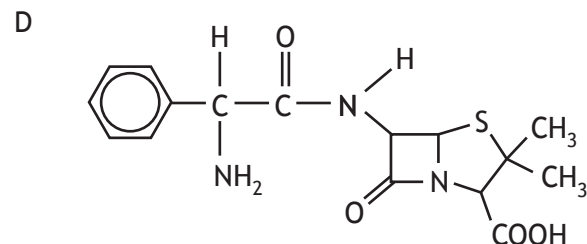
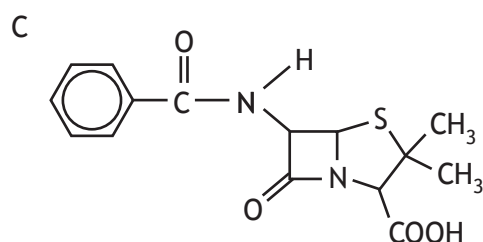
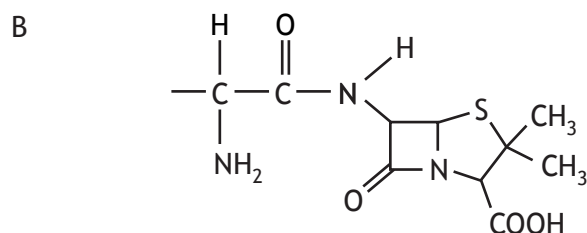
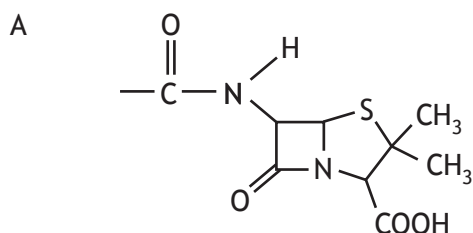


methicillin



amoxicillin

The structural fragment shared by these four antibiotic molecules is



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

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