National Qualifications 2017

X713/77/02

Chemistry
Section 1 — Questions

MONDAY, 8 MAY

9:00 AM – 11:30 AM

Instructions for the completion of Section 1 are given on *Page 02* of your question and answer booklet X713/77/01.

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.

SECTION 1 — 30 marks

Attempt ALL questions

1. All noble gases are characterised by the completion of the outermost orbital.
This orbital is

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

2. The electronic configuration of an atom of X, in its ground state, is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^2$.
X is an atom of

A calcium
B scandium
C titanium
D vanadium.

3. Which line in the table could represent the four quantum numbers of an outer electron in an Mg^{2+} ion?

	n	*l*	*m*	*s*
A	2	1	−2	−½
B	2	0	0	+½
C	2	1	−1	+½
D	3	0	0	−½

4. The coordination number of an ionic lattice can be determined by using the following equation.

$$\text{radius ratio} = \frac{\text{radius of positive ion}}{\text{radius of negative ion}}$$

Radius ratio	*Coordination number*
less than 0·23	3
0·23–0·42	4
0·42–0·73	6
greater than 0·73	8

What is the coordination number in zinc(II) sulfide?

A 3
B 4
C 6
D 8

5. What is the formula for the diaquatetrachlorocobaltate(II) ion?

A $[CoCl_4(H_2O)_2]^{2-}$
B $[CoCl_2(H_2O)_4]^{2-}$
C $[CoCl_4(H_2O)_2]^{2+}$
D $[CoCl_2(H_2O)_4]^{2+}$

6. Which of the following indicators is most suitable to use in a titration of dilute hydrochloric acid solution with dilute ammonia solution?

A Bromothymol blue
B Phenolphthalein
C Methyl orange
D Phenol red

7. The pH of a solution of benzoic acid with concentration 0·01 mol l^{-1} is

A 1·1
B 2·0
C 3·1
D 5·2.

8. A reaction must be exothermic if

A both $\Delta G°$ and $\Delta S°$ are negative

B both $\Delta G°$ and $\Delta S°$ are positive

C $\Delta G°$ is negative

D $\Delta S°$ is positive.

9. For the reaction

$A + B \rightarrow C$

the following data were obtained.

Experiment	*Initial concentration of A* (mol l^{-1})	*Initial concentration of B* (mol l^{-1})	*Initial rate of formation of C* (mol l^{-1} s^{-1})
1	0·1	0·1	0·05
2	0·2	0·1	0·05
3	0·1	0·2	X

Given that the rate equation is

$\text{Rate} = k[B]^2$

the value of X will be

A 0·05

B 0·10

C 0·15

D 0·20.

10. The rate equation for the reaction between nitrogen monoxide and chlorine is

$\text{rate} = k[NO]^2[Cl_2]$

The units for the rate constant, k, in this reaction are

A s^{-1}

B mol l^{-1} s^{-1}

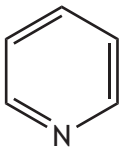
C l mol^{-1} s^{-1}

D l^2 mol^{-2} s^{-1}.

11. Which of the following describes the bonding in ethane?

A sp^2 hybridisation with sigma bonds only.
B sp^3 hybridisation with sigma bonds only.
C sp^2 hybridisation with sigma and pi bonds.
D sp^3 hybridisation with sigma and pi bonds.

12. Pyridine has the following structure.



The number of sigma bonds in a molecule of pyridine is

A 3
B 6
C 11
D 12.

13. A racemic mixture is defined as

A a mixture of two enantiomers
B a pair of enantiomers mixed in equal proportions
C a mixture of two geometric isomers
D a pair of geometric isomers mixed in equal proportions.

[Turn over

14. $CH_3CH_2Br + NH_3 \rightarrow CH_3CH_2NH_2 + HBr$

$CH_3Br + OH^- \rightarrow CH_3OH + Br^-$

The nucleophiles in these two reactions are

A CH_3Br and NH_3

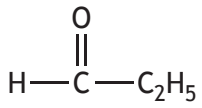
B OH^- and CH_3CH_2Br

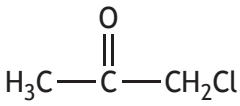
C CH_3CH_2Br and CH_3Br

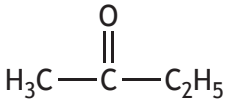
D NH_3 and OH^-.

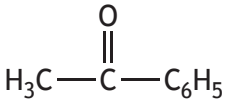
15. A compound X has a GFM of less than 100 g.
Complete combustion of compound X produces carbon dioxide and water only.
Reduction of compound X produces a secondary alcohol.

Compound X is most likely to be

A 

B 

C 

D 

16.

Amine	*Boiling point* (°C)
$C_2H_5N(CH_3)_2$	37·5
$(C_2H_5)_2NH$	56·3
$C_4H_9NH_2$	77·8

Based on the information in the table,

A the tertiary amine has the highest boiling point

B the secondary amine has the lowest boiling point

C the primary amine has a lower boiling point than the tertiary amine

D the secondary amine has a lower boiling point than the primary amine.

17. Compound Y reacts with the product of its own oxidation to form an ester.

Compound Y could be

A propanal

B propan-1-ol

C propan-2-ol

D propanoic acid.

18. Which of the following statements about benzene is correct?

A The benzene molecule is planar.

B Benzene does not react with electrophiles.

C Benzene readily undergoes nucleophilic attack.

D The benzene molecule contains carbon to carbon bonds of two different lengths.

19. Chlorine has two isotopes, ^{35}Cl and ^{37}Cl.

These isotopes are present in a sample of 1,1,1-trichloroethane, $C_2H_3Cl_3$. The number of molecular ion peaks expected in the mass spectrum of 1,1,1-trichloroethane is

A 6

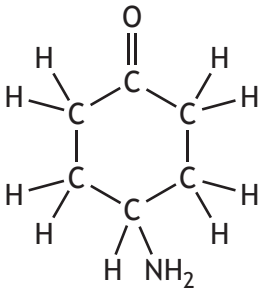
B 4

C 3

D 2.

[Turn over

20. The following substance was analysed using an infrared spectrometer.



The spectrum produced would **not** have a significant peak in the wave number range

A 1700–1680 cm^{-1}

B 2962–2853 cm^{-1}

C 3100–3000 cm^{-1}

D 3500–3300 cm^{-1}.

21. Antisense drugs are a group of medicines that act by binding to DNA to block the synthesis of some proteins.

Which line in the table is correct for antisense drugs?

	Classification	*Receptor*
A	antagonist	DNA
B	antagonist	protein
C	agonist	DNA
D	agonist	protein

22. Which of the following would be most suitable as a reagent in the gravimetric analysis of silver ions?

A Sodium nitrate

B Potassium sulfate

C Barium carbonate

D Ammonium chloride

23. Using colorimetry, the most appropriate filter for determining the concentration of green nickel ions, $Ni^{2+}(aq)$, in a solution, would be

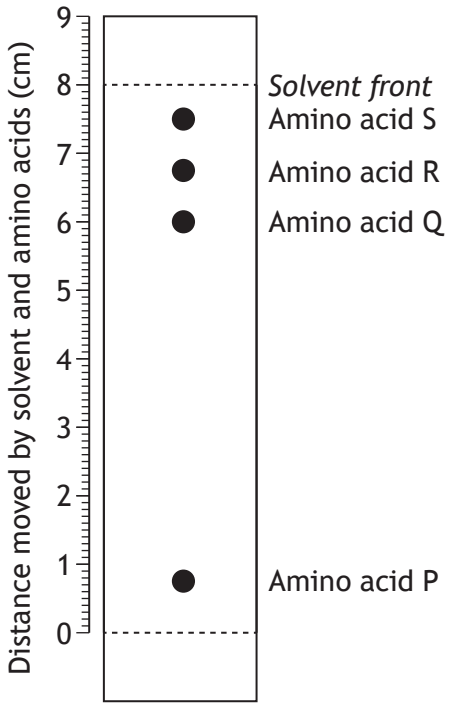
A 390 nm

B 490 nm

C 540 nm

D 680 nm.

24. The diagram shows a thin layer chromatogram for a mixture of amino acids.



Which amino acid has an R_f value of approximately 0·75?

A Amino acid S

B Amino acid R

C Amino acid Q

D Amino acid P

[Turn over

25. Which line in the table shows the properties of the most suitable solvent to extract caffeine from an aqueous solution of tea?

A	Caffeine is more soluble in the solvent than it is in the tea solution.	The solvent is immiscible in the tea solution.
B	Caffeine is more soluble in the solvent than it is in the tea solution.	The solvent is miscible in the tea solution.
C	Caffeine is less soluble in the solvent than it is in the tea solution.	The solvent is miscible in the tea solution.
D	Caffeine is less soluble in the solvent than it is in the tea solution.	The solvent is immiscible in the tea solution.

26. A series of titrations was performed to determine the concentration of vitamin C in a brand of fruit juice. A standard solution of the fruit juice was prepared and titrated with iodine solution.

Which of the following would be a suitable control experiment for this analysis?

A Titrate more samples from the same carton of fruit juice.

B Titrate a solution of pure vitamin C of known concentration.

C Titrate more samples from the standard solution of fruit juice.

D Titrate a sample from a different carton of the same brand of fruit juice.

27. $Ba(OH)_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaOH(aq)$

$50\,cm^3$ of $0{\cdot}010\,mol\,l^{-1}$ barium hydroxide solution were added to $50\,cm^3$ of $0{\cdot}010\,mol\,l^{-1}$ sodium sulfate solution.

The concentration of sodium hydroxide, in $mol\,l^{-1}$, in the resulting solution is

A 0·0010

B 0·010

C 0·020

D 0·10.

28. $1{\cdot}06 \times 10^{-2}$ moles of phenylamine, $C_6H_5NH_2$, react with 5·16 g of bromine.

Which equation shows the correct stoichiometry for this reaction?

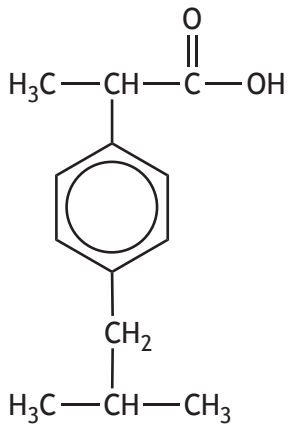
A $C_6H_5NH_2 + Br_2 \rightarrow C_6H_4BrNH_2 + HBr$

B $C_6H_5NH_2 + 2Br_2 \rightarrow C_6H_3Br_2NH_2 + 2HBr$

C $C_6H_5NH_2 + 3Br_2 \rightarrow C_6H_2Br_3NH_2 + 3HBr$

D $C_6H_5NH_2 + 4Br_2 \rightarrow C_6HBr_4NH_2 + 4HBr$

29. Ibuprofen is used for the relief of pain, fever and inflammation. A structural formula for ibuprofen is shown below.



If one tablet contains 300 mg of ibuprofen, approximately how many tablets can be manufactured from 1 mole of ibuprofen?

A $6{\cdot}73 \times 10^{2}$

B $6{\cdot}87 \times 10^{2}$

C $6{\cdot}73 \times 10^{-1}$

D $6{\cdot}87 \times 10^{-1}$

[Turn over for next question

30. The term accuracy is used to describe how close an experimental result is to the theoretical value. The term precision is used to describe how close a set of duplicate results are to each other.

Four students determined the percentage by mass of chlorine in $BaCl_2.2H_2O$.

Which of the following sets of results is both accurate and precise?

A 29·0%, 29·0%, 29·1%

B 29·1%, 28·2%, 29·9%

C 34·0%, 34·1%, 34·0%

D 34·0%, 34·3%, 33·8%

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