National Qualifications 2019

X713/77/02

Chemistry
Section 1 — Questions

FRIDAY, 10 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.

SQA ©

SECTION 1 — 30 marks
Attempt ALL questions

1. In an emission spectrum of mercury, the line at 310 nm is due to

   A   energy from the ultraviolet region of the electromagnetic spectrum being absorbed

   B   energy from the ultraviolet region of the electromagnetic spectrum being released

   C   energy from the visible region of the electromagnetic spectrum being absorbed

   D   energy from the visible region of the electromagnetic spectrum being released.

2. In which of the following changes would heating to constant mass allow the mass of water produced to be determined?

   A $CH_3CH_2OH(\ell) \rightarrow C_2H_4(g) + H_2O(\ell)$

   B $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$

   C $KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(\ell)$

   D $Na_2CO_3.10H_2O(s) \rightarrow Na_2CO_3(s) + 10H_2O(\ell)$

3. Which of the following reagents would be most suitable for the gravimetric determination of magnesium ions in water?

   A   Sodium nitrate

   B   Silver(I) nitrate

   C   Sodium carbonate

   D   Silver(I) carbonate

4. Hund's rule states that

   A   electrons occupy degenerate orbitals singly with parallel spins before pairing

   B   no two electrons in an atom can have the same set of four quantum numbers

   C   electrons occupy orbitals in order of increasing energy

   D   the energy of an electron in an atom is quantised.

5. Which of the following molecules contains the smallest bond angle?

    A $BeCl_2$

    B BCl_3

    C CCl_4

    D PCl_5

6. Iron forms both Fe^{2+} and Fe^{3+} ions.

Which of the following statements is correct?
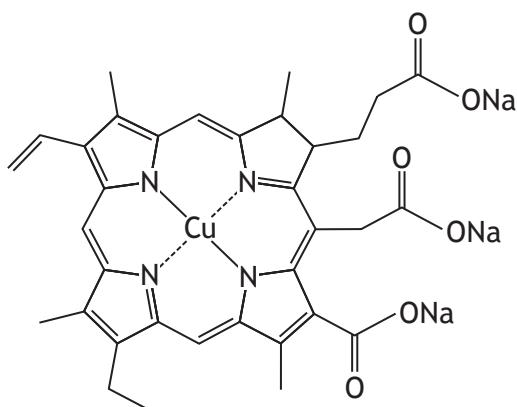
    A Fe^{2+} ions have more occupied energy levels than Fe^{3+} ions

    B Fe^{2+} ions have more unpaired electrons than Fe^{3+} ions

    C Fe^{3+} ions are a better reducing agent than Fe^{2+} ions

    D Fe^{3+} ions are more stable than Fe^{2+} ions

7. Which metal in the following ions has the highest oxidation state?

    A $Cr_2O_7^{2-}$

    B MnO_4^{-}

    C VO^{2+}

    D Sn^{4+}

[Turn over

8. The copper complex shown can be used as a green food colouring.

Which line in the table is correct for this complex?
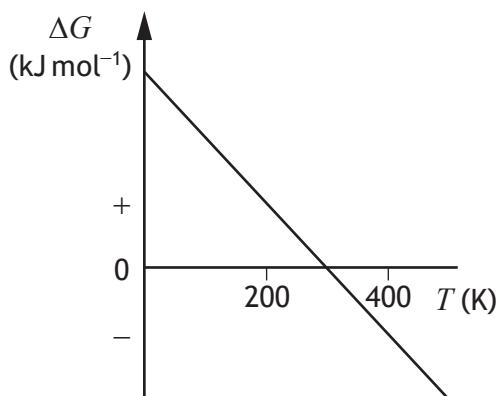
	Co-ordination number of copper	Classification of ligand
A	2	monodentate
B	2	tetradentate
C	4	monodentate
D	4	tetradentate

9. $2X(g) \rightleftharpoons Y(g)$ $\quad\quad \Delta H = -220\,kJ\,mol^{-1}$

Which of the following changes will cause the equilibrium constant to increase?
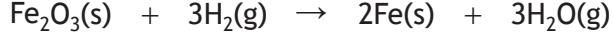
A Decrease in temperature

B Increase in temperature

C Decrease in pressure

D Increase in pressure

10. The following graph shows the variation in ΔG with temperature (T) for a reaction.

Which of the following statements is true?

A   The reaction is never feasible

B   The reaction is always feasible

C   The reaction is feasible above 300 K

D   The reaction is feasible below 300 K

11. Iron(III) oxide can be reduced to iron using hydrogen.

$$Fe_2O_3(s) \ + \ 3H_2(g) \ \rightarrow \ 2Fe(s) \ + \ 3H_2O(g)$$

Substance	ΔH_f° (kJ mol^{-1})
$Fe_2O_3(s)$	−822
$H_2(g)$	0
$Fe(s)$	0
$H_2O(g)$	−242

The enthalpy change, ΔH°, in kJ mol^{-1}, for the reduction of iron(III) oxide using hydrogen is

A   −580

B   −96

C   +96

D   +580.

[Turn over

12. Which line in the table is correct for water condensing?

	ΔH	ΔS
A	positive	negative
B	negative	negative
C	positive	positive
D	negative	positive

13. The results in the table were obtained for the reaction

$$X + 2Y \rightarrow Z$$

Experiment	[X] (mol l^{-1})	[Y] (mol l^{-1})	Initial rate (mol l^{-1} s^{-1})
1	0·030	0·030	0·0064
2	0·060	0·030	0·0128
3	0·030	0·015	0·0064

From these results, the rate equation is
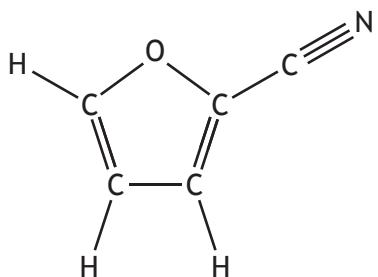
A   rate = k[X]

B   rate = k[Y]

C   rate = k[X][Y]

D   rate = k[X][Y]^2.

14. The rate of a chemical reaction is second order overall.

The units for the rate constant, k, are

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

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

C   l^2 mol^{-2} s^{-1}

D   l^{-2} mol^2 s^{-1}.
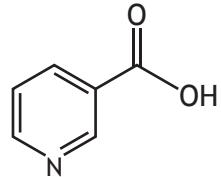
15. The structure of 2-furonitrile is shown.

The number of pi bonds in 2-furonitrile is

A   2

B   3

C   4

D   7.
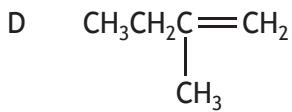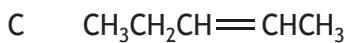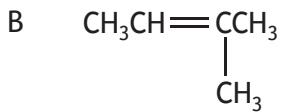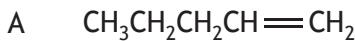
**16.** The structure of one form of vitamin B3 is shown.

The molecular formula of this structure is
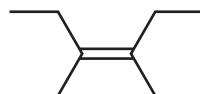
A $C_6H_5O_2N$

B $C_6H_6O_2N$

C $C_7H_5O_2N$

D $C_7H_6O_2N$.

17. Which of the following compounds exhibits geometric isomerism?

A $CH_3CH_2CH_2CH{=}CH_2$

B $CH_3CH{=}CCH_3$
                     $|$
                  CH_3

C $CH_3CH_2CH{=}CHCH_3$

D $CH_3CH_2C{=}CH_2$
                $|$
 CH_3

[Turn over
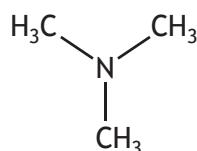
18.
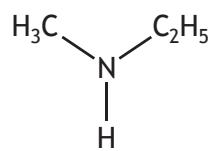
The systematic name of the molecule shown above is

A   *cis*-2,3-diethylbut-2-ene

B   *trans*-2,3-diethylbut-2-ene

C   *cis*-3,4-dimethylhex-3-ene

D   *trans*-3,4-dimethylhex-3-ene.

19. The structures shown below are isomeric amines.


trimethylamine   ethylmethylamine
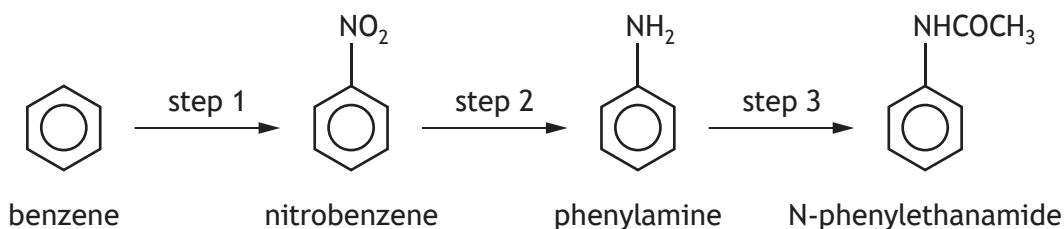
Which line in the table is correct for trimethylamine when compared to ethylmethylamine?

	Boiling point	Solubility in water
A	higher	higher
B	higher	lower
C	lower	higher
D	lower	lower

20. The reaction of butanone with lithium aluminium hydride produces

A   butanoic acid

B   butan-2-ol

C   butan-1-ol

D   butanal.

21.

benzene → step 1 → nitrobenzene → step 2 → phenylamine → step 3 → N-phenylethanamide

Which line in the table is correct for the types of reaction taking place at steps 1, 2 and 3?

|	Step 1	Step 2	Step 3
A	addition	reduction	condensation
B	electrophilic substitution	nucleophilic substitution	neutralisation
C	electrophilic substitution	reduction	condensation
D	addition	nucleophilic substitution	neutralisation

22. Carboxylic acids can be prepared in different ways.
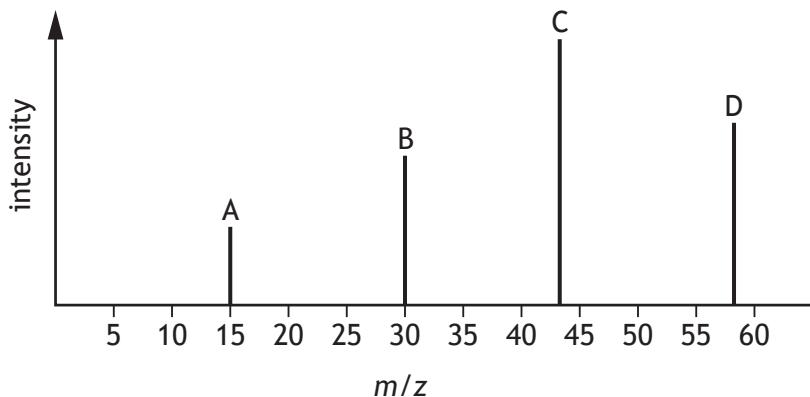
Which of the following is a suitable method for preparing a carboxylic acid in one reaction?

A   Addition to an alkene

B   Hydrolysis of a nitrile

C   Reduction of an aldehyde

D   Substitution of a haloalkane

[Turn over

23. A student attempted to predict the mass spectrum of propanone.

The predicted spectrum is shown below.

The actual mass spectrum of propanone contains only three main peaks.

Which of the above peaks would **not** appear in the actual mass spectrum?
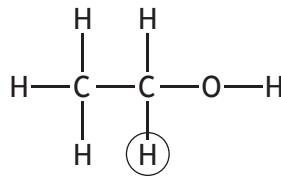
24. Analysis of a compound shows the following percentage composition by mass.

$C = 80·0\%$ $H = 9·3\%$ $O = 10·7\%$

The empirical formula for this compound is

A $C_{10}H_{14}O$

B $C_{14}H_{10}O$

C $C_{14}H_{20}O$

D $C_{20}H_{14}O$.

25.

Which of the following splitting patterns would be observed for the circled atom in the high resolution ^1H NMR spectrum of ethanol?

A   Doublet

B   Triplet

C   Quartet

D   Quintet

26. Pramipexole is a drug used to treat the symptoms of Parkinson's disease. Pramipexole acts like a natural compound in the body, dopamine, to stimulate nerve cells.

Buprenorphine is a drug used to treat heroin addiction. Buprenorphine stimulates receptors in the body but produces less of a response compared to heroin.

Which line in the table best describes pramipexole and buprenorphine?

	Pramipexole	Buprenorphine
A	agonist	agonist
B	agonist	antagonist
C	antagonist	agonist
D	antagonist	antagonist

27. The human nose can generally detect the toxic gas hydrogen sulfide at levels of 0·03 ppm.

If a person inhales 6 litres of air per minute, containing 0·03 ppm of hydrogen sulphide, what mass of hydrogen sulfide is inhaled in 10 minutes?

A 2 g

B 1·8 g

C 200 mg

D 1·8 mg

28. Which of the following techniques could be used to purify an impure sample of solid caffeine?

A Thin layer chromatography

B Heating under reflux

C Recrystallisation

D Distillation
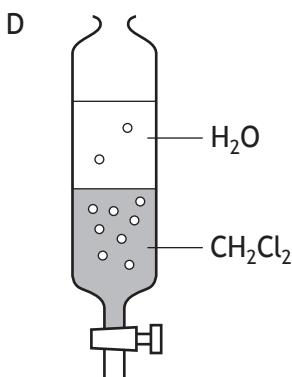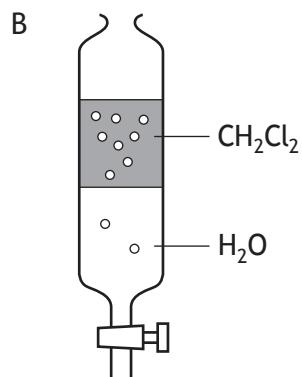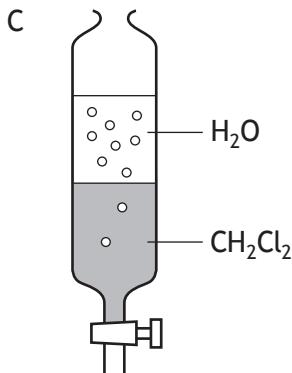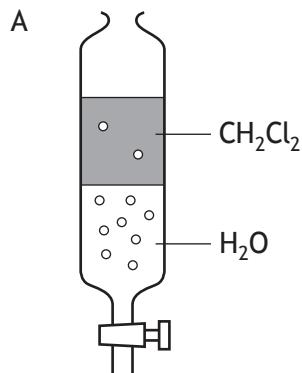
[Turn over

29. When substance **X** is distributed between equal volumes of two immiscible solvents, water and dichloromethane, an equilibrium will be established.

$$X(H_2O) \rightleftharpoons X(CH_2Cl_2) \qquad K = 4$$

In the diagrams below, the number of dots represents the relative distribution of **X** in the two solvents. Water is less dense than dichloromethane.

Which of the following shows the correct distribution of **X** between the two solvents at equilibrium?

A

CH_2Cl_2

H_2O

C

H_2O

CH_2Cl_2

B

CH_2Cl_2

H_2O

D

H_2O

CH_2Cl_2

30. A complexometric titration can be used to determine the concentration of

A calcium ions in milk

B chloride ions in sea water

C ethanoic acid in vinegar

D ethanol in wine.

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