Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **February/March 2018**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

8057470051

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** 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 Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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.
Electronic calculators may be used.

This document consists of **12** printed pages.

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Section A

For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

Use of the Data Booklet may be appropriate for some questions.

1 What are the shapes of the molecules of water and boron trifluoride?

	H_2O	BF_3
A	linear	pyramidal
B	linear	trigonal
C	non-linear	pyramidal
D	non-linear	trigonal

2 The electronic configuration of the two outermost shells of an atom is $3s^2 3p^6 3d^5 4s^2$.

What is this atom?

A manganese

B phosphorus

C strontium

D vanadium

3 Drinking water may contain dissolved calcium hydrogencarbonate, $Ca(HCO_3)_2$.

How many electrons are present in a hydrogencarbonate anion?

A 30 **B** 31 **C** 32 **D** 33

4 Which molecule contains a nitrogen atom with sp hybridised orbitals?

A $CH_3CH_2NH_2$ **B** HNO_3 **C** HCN **D** NH_3

5 Which mass of solid residue is obtained from the thermal decomposition of 4.10 g of anhydrous calcium nitrate?

A 0.70 g **B** 1.00 g **C** 1.40 g **D** 2.25 g

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6 Sodium hydroxide neutralises acid.

$$H^+ + OH^- \rightarrow H_2O$$

In a 11 000 dm^3 sample of an aqueous solution, the concentration of acid, $[H^+]$, is 1.26×10^{-3} mol dm^{-3}.

Which mass of solid sodium hydroxide neutralises the acid?

A 0.0214 g **B** 0.0504 g **C** 236 g **D** 554 g

7 The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

0.960 g of oxygen gas is contained in a vessel of volume 7.00×10^{-3} m^3 at a temperature of 30 °C.

Assume that the gas behaves as an ideal gas.

What is the pressure in the vessel?

A 1.07 kPa **B** 2.14 kPa **C** 10.8 kPa **D** 21.6 kPa

8 Which equation represents the standard enthalpy change of formation of water?

A $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g)$

B $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$

C $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

D $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

9 Hess' Law and bond energy data can be used to calculate the enthalpy change of a reaction.

Bromoethane, CH_3CH_2Br, can be made by reacting ethene with hydrogen bromide.

$$CH_2{=}CH_2 + HBr \rightarrow CH_3CH_2Br$$

What is the enthalpy change for this reaction?

A -674 kJ mol^{-1}

B -64 kJ mol^{-1}

C $+186$ kJ mol^{-1}

D $+346$ kJ mol^{-1}

10 Which reaction is **not** a redox reaction?

A $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$

B $2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$

C $SO_2 + NO_2 \rightarrow SO_3 + NO$

D $SO_3 + H_2O \rightarrow H_2SO_4$

11 The reaction between sulfur dioxide and oxygen is reversible.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \qquad \Delta H^{\ominus} = -196\,kJ\,mol^{-1}$$

Which conditions of pressure and temperature favour the **reverse** reaction?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

12 Which statement about the effect of a catalyst on a reversible reaction is correct?

A The activation energy of the forward reaction stays the same.

B The composition of the equilibrium mixture stays the same.

C The rate of the backward reaction stays the same.

D The value of the equilibrium constant changes.

13 Which oxide is insoluble in aqueous sodium hydroxide?

A MgO **B** Al_2O_3 **C** P_4O_{10} **D** SO_2

14 X, Y and Z are three elements in the third period.

- X reacts with chlorine to give a liquid product.
- Y reacts with chlorine to give a solid product that dissolves in water to give a solution of pH 7.
- Z reacts with chlorine to give a solid product that dissolves in water to give a solution of pH 6.

Which elements are good conductors of electricity?

A X and Y **B** Y and Z **C** Y only **D** Z only

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15 A solution contains both $Mg^{2+}(aq)$ and $Sr^{2+}(aq)$ at the same concentration.

The solution is divided into two equal portions. Aqueous sodium hydroxide is added dropwise to one portion. Dilute sulfuric acid is added dropwise to the other portion.

Which row is correct?

	precipitate seen first when NaOH(aq) is added	precipitate seen first when $H_2SO_4(aq)$ is added
A	magnesium hydroxide	magnesium sulfate
B	magnesium hydroxide	strontium sulfate
C	strontium hydroxide	magnesium sulfate
D	strontium hydroxide	strontium sulfate

16 The volatility of the Group 17 elements, chlorine, bromine and iodine, decreases down the group.

What is responsible for this?

A bond length in the halogen molecule

B bond strength in the halogen molecule

C electronegativity of the halogen

D number of electrons in the halogen molecule

17 Bromine is extracted from sea-water.

In the final stages of the process two redox reactions take place.

$$Br_2(aq) + SO_2(g) + 2H_2O(l) \rightarrow 2HBr(aq) + H_2SO_4(aq)$$

$$2HBr(aq) + Cl_2(g) \rightarrow Br_2(g) + 2HCl(aq)$$

Which row is correct?

	strongest oxidising agent	⟶	weakest oxidising agent
A	Br_2	SO_2	Cl_2
B	Cl_2	Br_2	SO_2
C	Cl_2	SO_2	Br_2
D	SO_2	Br_2	Cl_2

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18 When burned, sulfur forms a gaseous product X which can be oxidised to produce a gas Y.

Gas Y reacts with water to produce a product Z.

Which row correctly shows the oxidation states of sulfur in X, Y and Z?

	X	Y	Z
A	–2	+4	+4
B	–2	+4	+6
C	+4	+6	+4
D	+4	+6	+6

19 One molecule of ammonia reacts with one molecule of ethyl methanoate, $HCO_2C_2H_5$, to produce one molecule of methanamide, $HCONH_2$, and only one other molecule, X.

One molecule of methanamide decomposes on heating strongly to produce one molecule of ammonia and only one other molecule, Y.

What could be the identities of X and Y?

	X	Y
A	ethanoic acid	carbon monoxide
B	ethanoic acid	hydrogen cyanide
C	ethanol	carbon monoxide
D	ethanol	hydrogen cyanide

20 Which types of stereoisomerism are shown by 2,4-dimethylhex-2-ene?

A both cis-trans isomerism and optical isomerism

B cis-trans isomerism only

C neither cis-trans isomerism nor optical isomerism

D optical isomerism only

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21 An organic ion containing a carbon atom with a negative charge is called a carbanion.

An organic ion containing a carbon atom with a positive charge is called a carbocation.

The reaction between aqueous sodium hydroxide and 1-bromobutane proceeds by an S_N2 mechanism.

What is the first step in the mechanism?

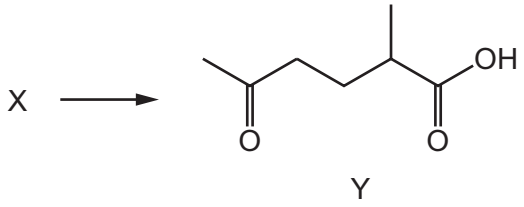
A attack by a nucleophile on a carbon atom with a partial positive charge

B heterolytic bond fission followed by attack by an electrophile on a carbanion

C heterolytic bond fission followed by attack by a nucleophile on a carbocation

D homolytic bond fission followed by attack by a nucleophile on a carbocation

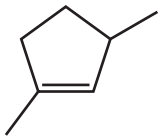
22 Compound X can be converted into compound Y in a single step.



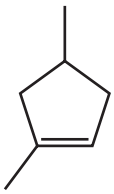
Y

What could be the identity of X?

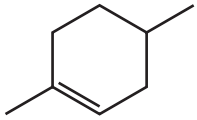
A



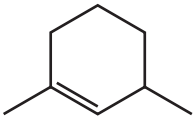
B



C



D



23 Which compound reacts with 2,4-dinitrophenylhydrazine reagent but does **not** react with Tollens' reagent?

A CH_3COCO_2H

B $CH_3CH(OH)CHO$

C CH_3COCHO

D $CH_3CH(OH)CH_3$

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24 Structural isomerism and stereoisomerism should be considered when answering this question.

The molecular formula of compound X is $C_5H_{12}O$.

Compound X:

- reacts with alkaline aqueous iodine
- can be dehydrated to form two alkenes only.

What could be the identity of compound X?

A $CH_3CH_2CH(CH_3)CH_2OH$

B $CH_3CH_2CH(OH)CH_2CH_3$

C $(CH_3)_2CHCH(OH)CH_3$

D $CH_3CH_2CH_2CH(OH)CH_3$

25 Which volume of hydrogen, measured under room conditions, is produced when 0.160 g of methanol reacts with an excess of sodium?

A 60 cm^3 **B** 120 cm^3 **C** 240 cm^3 **D** 480 cm^3

26 Compound X produces a carboxylic acid when heated under reflux with acidified potassium dichromate(VI). Compound X does not react with sodium metal.

What could be the identity of compound X?

A propanal

B propanone

C propan-1-ol

D propan-2-ol

27 A reaction occurs when a sample of 1-chloropropane is heated under reflux with sodium hydroxide dissolved in ethanol.

Which row is correct?

	type of reaction	name of product
A	elimination	propan-1-ol
B	elimination	propene
C	substitution	propan-1-ol
D	substitution	propene

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28 Ethanedioic acid has the formula HO_2CCO_2H.

What is the formula of aluminium ethanedioate?

A $Al C_2O_4$ **B** $Al(C_2O_4)_3$ **C** $Al_2C_2O_4$ **D** $Al_2(C_2O_4)_3$

29 Alcohols, aldehydes and nitriles can each be converted into carboxylic acids.

Which descriptions of their conversions into carboxylic acids are correct?

	alcohols	aldehydes	nitriles
A	hydrolysis	hydrolysis	hydrolysis
B	hydrolysis	hydrolysis	oxidation
C	oxidation	oxidation	hydrolysis
D	oxidation	oxidation	oxidation

30 How many **structural** isomers with the molecular formula $C_4H_{10}O$ give infra-red absorptions both at approximately 1200 cm^{-1} and at approximately 3400 cm^{-1}?

A 2 **B** 4 **C** 6 **D** 7

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

Use of the Data Booklet may be appropriate for some questions.

31 Compound Q contains 40% carbon by mass.

What could Q be?

1 glucose, $C_6H_{12}O_6$

2 starch, $(C_6H_{10}O_5)_n$

3 sucrose, $C_{12}H_{22}O_{11}$

32 A container is partially filled with hot water, sealed and left to cool.

Which statements are correct?

1 As the temperature decreases, water molecules lose kinetic energy.

2 As the temperature decreases, more water molecules move from vapour to liquid.

3 As the temperature decreases, the vapour pressure of the water decreases.

33 Ammonia and chlorine react together in the gas phase.

$$8NH_3 + 3Cl_2 \rightarrow N_2 + 6NH_4Cl$$

Which statements are correct?

1 Ammonia behaves as a reducing agent.

2 Ammonia behaves as a base.

3 The oxidation number of hydrogen changes.

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34 In which reactions does NH_3 behave as a Brønsted-Lowry acid?

1 $2NH_3 \rightarrow NH_2^- + NH_4^+$

2 $HSO_4^- + NH_3 \rightarrow SO_4^{2-} + NH_4^+$

3 $Ag^+ + 2NH_3 \rightarrow [Ag(NH_3)_2]^+$

35 Chlorine reacts with **hot** aqueous sodium hydroxide.

Which oxidation states does chlorine show in the products of this reaction?

1 –1

2 +3

3 +1

36 In which different forms does nitrogen exist in compounds?

1 bonded by a triple covalent bond

2 as part of a cation

3 in an oxidation state of +5

37 Poly(ethene) and PVC are examples of addition polymers.

Which statements are correct?

1 On combustion, PVC can produce carbon monoxide, carbon dioxide and hydrogen chloride.

2 When poly(ethene) is buried in a landfill site, it will not significantly biodegrade.

3 The empirical formula of an addition polymer is the same as that of the monomer.

38 Organic compound X gives a precipitate when warmed with aqueous silver nitrate. This precipitate dissolves when concentrated aqueous ammonia is added.

What could X be?

1 1-bromopropane

2 2-chlorobutane

3 2-iodo-2-methylpropane

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The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

39 Propanal reacts with hydrogen cyanide to form 2-hydroxybutanenitrile. A suitable catalyst for this reaction is sodium cyanide.

$$CH_3CH_2CHO + HCN \overset{NaCN}{\rightleftharpoons} CH_3CH_2CH(OH)CN$$

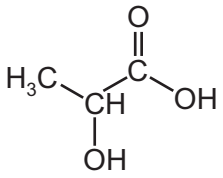
Which statements about the reaction of propanal with hydrogen cyanide are correct?

1 HCN is a weaker nucleophile than the nucleophile provided by NaCN.

2 The reaction mechanism involves two steps.

3 The product of the reaction has a chiral carbon atom.

40 The structure of lactic acid is shown.

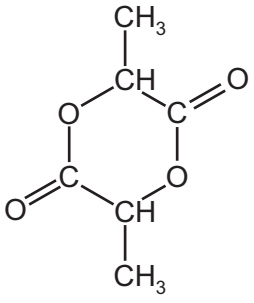


lactic acid

Which esters might form when lactic acid is heated?

1 $CH_3CH(OH)CO_2CH(CH_3)CO_2H$

2



3 $CH_3CH(OH)CO_2CH(OH)CH_3$

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