Oxford Cambridge and RSA

Tuesday 06 October 2020 – Afternoon

AS Level Chemistry B (Salters)

H033/01 Foundations of chemistry

Time allowed: 1 hour 30 minutes

You must have:
- the Data Sheet for Chemistry B

You can use:
- a scientific or graphical calculator
- an HB pencil

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **20** pages.

ADVICE
- Read each question carefully before you start your answer.

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SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

Write your answer to each question in the box provided.

1 Which particles join in a fusion reaction?

A Atoms

B Electrons

C Elements

D Nuclei

Your answer ☐ **[1]**

2 How many π bonds and σ bonds are there in a molecule of propene?

	π bonds	**σ bonds**
A	1	8
B	1	7
C	2	8
D	2	7

Your answer ☐ **[1]**

3 Which is the correct systematic name that matches the formula?

	Formula	**Systematic name**
A	$Cu(OH)_2$	copper hydroxide
B	$Fe_2(SO_4)_3$	iron(III) sulfate(VI)
C	$Pb(NO_3)_2$	lead(II) nitrate(III)
D	$NaHCO_3$	sodium hydrogencarbonate(I)

Your answer ☐ **[1]**

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4 Which equation represents the first ionisation enthalpy of magnesium?

A $Mg(s) \rightarrow Mg^{+}(g) + e^{-}$

B $Mg(s) \rightarrow Mg^{2+}(g) + 2e^{-}$

C $Mg(g) \rightarrow Mg^{+}(g) + e^{-}$

D $Mg^{+}(g) \rightarrow Mg(g) + e^{-}$

Your answer ☐ **[1]**

5 Why is calcium carbonate more thermally stable than magnesium carbonate?

A Mg^{2+} ions distort carbonate ions more than Ca^{2+} ions do.

B The charge density of Mg^{2+} ions is smaller than Ca^{2+} ions.

C Magnesium is less electronegative than calcium.

D Mg^{2+} ions are larger than Ca^{2+} ions.

Your answer ☐ **[1]**

6 A solution of **X** gives a green flame colour and a white precipitate with aqueous silver nitrate.

What is **X**?

A Barium chloride

B Barium sulfate

C Iron(II) chloride

D Iron(II) sulfate

Your answer ☐ **[1]**

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7 A student wants to make a pure sample of insoluble lead chloride.

Which substance should the student react with hydrochloric acid?

A Lead

B Lead carbonate

C Lead nitrate solution

D Lead oxide

Your answer ☐ **[1]**

8 Which statement about cracking a liquid alkane in the laboratory is correct?

A No alkanes remain in the products.

B The alkane is mixed with a catalyst and heated.

C The M_r of the product is the same as that of the reactant.

D The products can be collected over water.

Your answer ☐ **[1]**

9 What is a **disadvantage** of using biofuels, compared to fossil fuels?

A Biofuels are more toxic.

B Biofuels give off CO_2 when they burn.

C Biofuels give off SO_2 when they burn.

D The land used to grow biofuels could be used for crops.

Your answer ☐ **[1]**

10 Which reaction has the **lowest** atom economy for making an ester?

A Reacting butan-1-ol with butanoic acid.

B Reacting ethanol with ethanoic acid.

C Reacting methanol with methanoic acid.

D Reacting propan-1-ol with propanoic acid.

Your answer ☐ **[1]**

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11 **Y** is a hydrogen halide. It reduces sulfuric(VI) acid to hydrogen sulfide, H_2S.

What is **Y**?

A HF

B HC*l*

C HBr

D HI

Your answer ☐ **[1]**

12 Iodopropane has a higher boiling point than chloropropane.

What is a reason for this?

A Iodopropane has more hydrogen bonds than chloropropane.

B Iodopropane has stronger covalent bonds than chloropropane.

C Iodopropane has stronger instantaneous dipole-induced dipole bonds than chloropropane.

D Iodopropane has stronger permanent dipole-permanent dipole bonds than chloropropane.

Your answer ☐ **[1]**

13 Which statement about UV radiation is correct?

A It causes the bonds in molecules to vibrate more.

B It has a longer wavelength than IR radiation.

C It is the principal radiation from the Earth's surface.

D It promotes electrons to higher energy levels in molecules.

Your answer ☐ **[1]**

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14 Which statement about the reactions of methanol is correct?

A It cannot be oxidised to methanal.

B It reacts with acid anhydrides to form methyl esters.

C It reacts with ethanoic acid to form $HCOOC_2H_5$.

D It undergoes dehydration to an alkene.

Your answer ☐ **[1]**

15 Which colour change is correct?

A Acidified dichromate(VI) changes from orange to green when reduced.

B Alkenes turn bromine from colourless to brown.

C Chloropropane gives a yellow precipitate when shaken with aqueous silver nitrate.

D Phenols react with iron(III) chloride to give a yellow colour.

Your answer ☐ **[1]**

16 Which statement about the purification of a solid by recrystallisation is correct?

A Insoluble impurities are removed in the last stage of the process.

B Soluble impurities remain in solution when the crystals are filtered off.

C The production of the purified solid can be speeded up by evaporating all the solvent.

D The solid must be soluble in the solvent used at all temperatures.

Your answer ☐ **[1]**

17 What is the shape of an s-orbital?

A Circle

B Dumbbell

C Oval

D Sphere

Your answer ☐ **[1]**

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18 What is the outer-shell electron configuration of antimony, Sb?

A $4d^{10}$

B $4p^3$

C $5p^3$

D $6s^2$

Your answer ☐ **[1]**

19 A student measures a volume of 200 cm^3.

What is the best way to express the number 'two hundred' to two significant figures?

A 200

B 200.00

C 2.0×10^2

D 2.00×10^2

Your answer ☐ **[1]**

20 A student is doing a titration. The student measures a titre of 21.5 cm^3.

How can the student decrease the uncertainty in the burette readings?

A Repeat the titrations and take an average.

B Use a burette with more graduations per cm^3.

C Use an indicator with a more gradual colour change.

D Dilute the solution in the burette to get a larger titre.

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

21 In 1930 Thomas Midgeley used the chlorofluorocarbon (CFC), CCl_2F_2, to blow out a candle. This demonstrated that CFCs were non-toxic and non-flammable. Their unreactivity made them apparently ideal for refrigerants.

It was discovered later that these CFCs were causing depletion of the ozone layer. CFCs also absorb infrared radiation emitted by the Earth.

(a) Give the systematic name for CCl_2F_2.

..... **[1]**

(b) **(i)** Ozone absorbs high-energy UV radiation in the stratosphere.

State **one** effect that this radiation has on life on Earth.

.....

..... **[1]**

(ii) Why is ozone a pollutant in the troposphere?

.....

..... **[1]**

(iii) Describe what happens to molecules when they absorb IR radiation.

.....

..... **[1]**

(c) **Table 21** shows how CCl_2F_2 causes depletion of ozone in the stratosphere.

	Equation	Type
21.1	$CCl_2F_2 \rightarrow CClF_2 + Cl$	initiation
21.2	$Cl + O_3 \rightarrow ClO + O_2$	
21.3		
21.4		termination

Table 21

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In **Table 21**:

(i) Write **equation 21.3** in the box to show how chlorine atoms are regenerated. **[1]**

(ii) Write **equation 21.4** in the box to show a possible termination reaction. **[1]**

(iii) Write the **types** of reaction in **equations 21.2** and **21.3** in the empty boxes in the 'Type' column. **[1]**

(d) In **equation 21.1**, a C–C*l* bond is broken. This has a bond strength of +346 kJ mol^{-1}.

(i) Use 'half curly arrows' to show how the bond breaks and describe the type of bond breaking process.

C – C*l*

type of bond breaking process ..... **[1]**

(ii) Calculate the wavelength of radiation required, in cm, to break the C–C*l* bond.

wavelength = ...cm **[4]**

(e) CFCs can react with nucleophiles such as hydroxide ions.

(i) What is meant by the term **nucleophile**?

.....

..... **[1]**

(ii) Draw the mechanism for the nucleophilic substitution of hydroxide ions on the C–C*l* bond shown below.

Use 'curly arrows' and full and partial charges. Show the products.

C – C*l*

[2]

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22 Naturally-occurring carbon consists of two isotopes, carbon-13 and carbon-12. The presence of these can be shown by mass spectrometry.

(a) Give the number of protons and neutrons in an atom of carbon-13.

protons ..... neutrons..... **[1]**

(b) Naturally-occurring carbon has 1.1% of carbon-13.

(i) Calculate the relative atomic mass of naturally-occurring carbon.

Give your answer to **2** decimal places.

relative atomic mass = ... **[2]**

(ii) A molecule consists of two carbon atoms. It has a visible 'M+1' peak but no visible 'M+2' peak in its mass spectrum.

Suggest why.

.....

..... **[1]**

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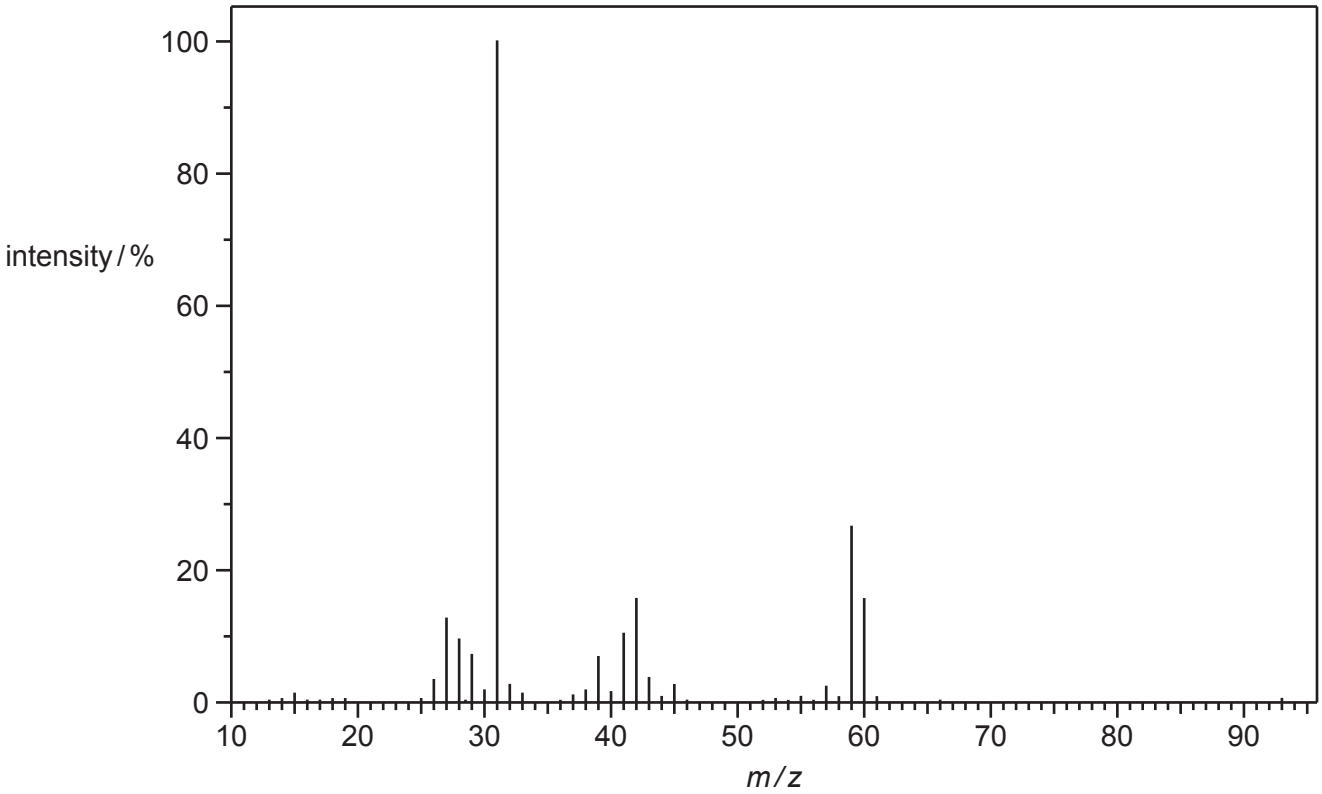
(c) The mass spectrum of an alcohol is given below.

The peak at 31 is caused by the fragment CH_2OH^+.



Draw the **skeletal** formula of the alcohol.

Give reasons for the skeletal formula that you have drawn.

Skeletal formula

Reasons .....

.....

.....

.....

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.....

..... **[4]**

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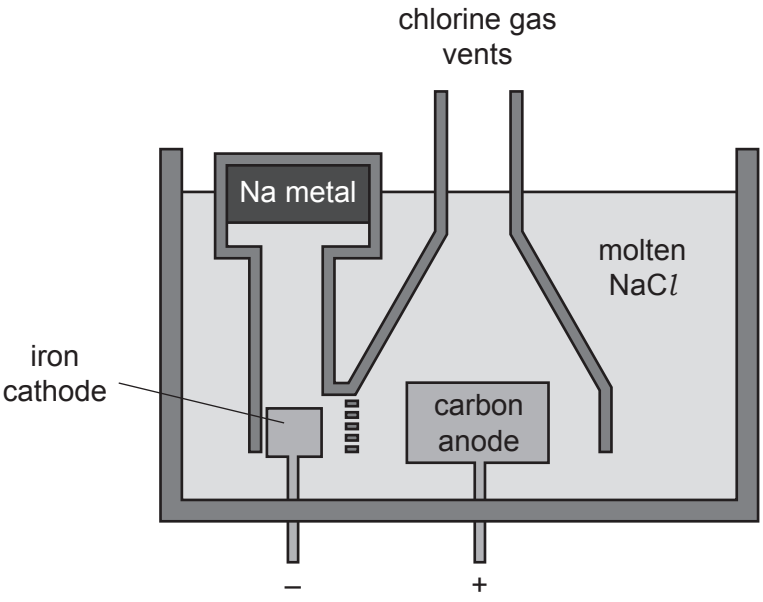
23 Sodium metal is made by the electrolysis of molten sodium chloride. The electrolysis takes place in a Downs Cell as shown in the diagram.



(a) Suggest why it is necessary to separate the products in the cell.

.....

..... **[1]**

(b) Sodium is produced at the cathode, shown by the half-equation:

$Na^+ + e^- \rightarrow Na$ **Equation 23.1**

(i) What is reduced in **equation 23.1**? Explain your answer.

.....

..... **[1]**

(ii) Write the half-equation for the production of chlorine gas in the cell.

[1]

(iii) Give **one** safety precaution that must be taken when working with chlorine gas.

.....

..... **[1]**

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(iv) 1.0 tonne of sodium is made in a cell.

What volume (in m^3) of chlorine will be produced at the same time, measured at 600 °C and 1.1 kPa?

Give your answer to a **suitable** number of significant figures and in **standard form**.

volume = ...m^3 **[5]**

(c) Calcium chloride is added to lower the melting temperature of sodium chloride.
The electrolyte often contains 33% $NaCl$ and 67% $CaCl_2$ by mass.

Calculate the number of moles of Ca per mole of Na in this mixture.

moles of Ca per mole of Na = ... **[2]**

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(d) Sodium and sodium chloride are both solids at room temperature.

Describe the structure and bonding in both solids.

.....

.....

.....

.....

.....

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.....

.....

..... **[5]**

(e) **(i)** Some students mix a solution of chlorine with a solution of sodium iodide.

Describe what they would **observe** and write an equation for the reaction.

Observation .....

Equation

[2]

(ii) A halogen is formed in part **(e)(i)**.

Suggest a test that would confirm which halogen it is and state the result of the test.

.....

..... **[1]**

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24 Carbon monoxide often occurs as an impurity in industrial gases. It can be removed by the reaction shown in **equation 24.1**.

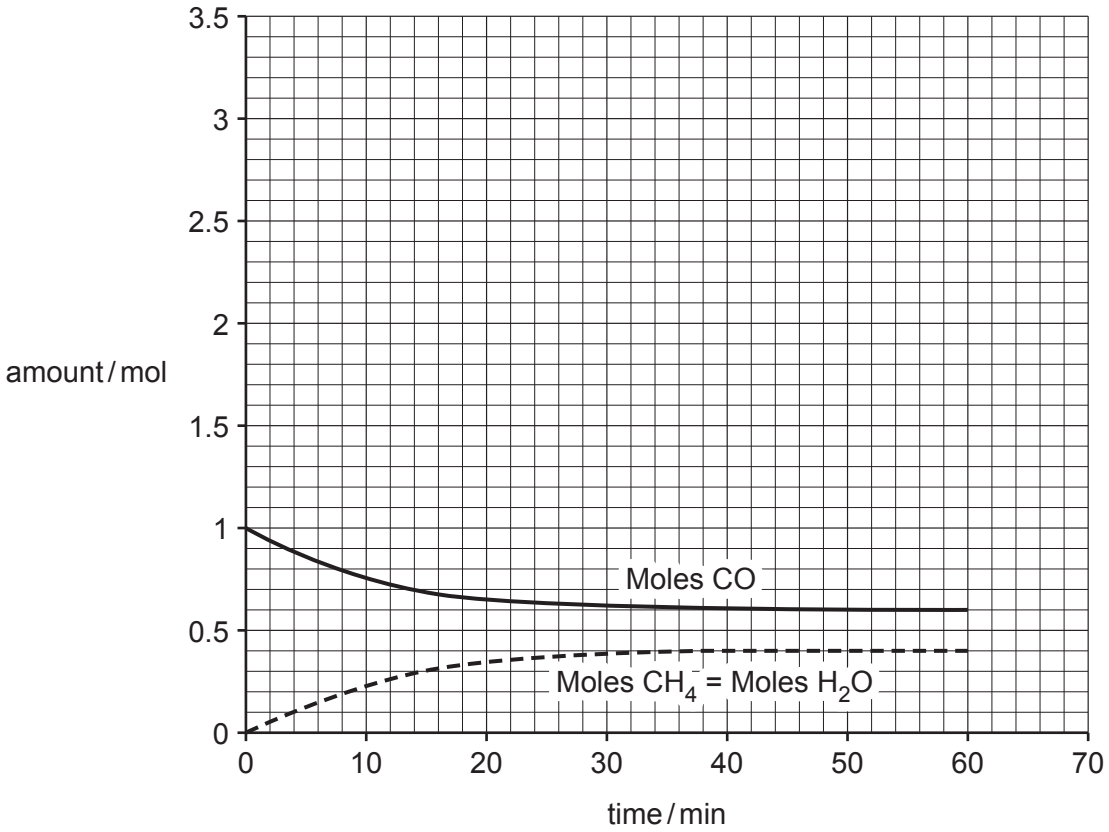
$$CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g) \quad \Delta_r H = -206\,kJ\,mol^{-1}$$ **Equation 24.1**

A group of students find data for this reaction.
Some of their data are given in the table. Other data have already been plotted on the graph below.

Time / min	Amount H_2 / mol
0.0	3.00
5.0	2.50
10.0	2.30
15.0	2.20
20.0	1.95
30.0	1.85
40.0	1.80
50.0	1.80
60.0	1.80

(a) Plot the data in the table on the axes below.

Draw a line of best fit. Label this line 'Moles H_2'. **[2]**



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(b) The graphs show that the reaction has reached equilibrium after 40 minutes.

The volume of the container for the experiment is 1.0 dm^3.

Use data from the graph to work out the value of K_c for the equilibrium in **equation 24.1**.

value of K_c = ... **[3]**

(c) The pressure is increased on the equilibrium in **equation 24.1**. The volume remains the same.

Sketch on the graph, on page 16, a line for 'moles CO at a higher pressure'. **[2]**

(d) A nickel catalyst is used with the reaction in **equation 24.1**.

State with a reason whether this is a heterogeneous or a homogeneous catalyst.

.....

..... **[1]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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