



Oxford Cambridge and RSA

AS Level Chemistry B (Salters)

H033/01 Foundations of chemistry

Friday 26 May 2017 – Morning

Time allowed: 1 hour 30 minutes



You must have:

- the Data Sheet for Chemistry B (Salters)
(sent with general stationery)

You may use:

- a scientific or graphical calculator



| | | | | | | | | | | |
|---------------|--|--|--|--|--|------------------|--|--|--|--|
| First name | | | | | | | | | | |
| Last name | | | | | | | | | | |
| Centre number | | | | | | Candidate number | | | | |

INSTRUCTIONS

- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION

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

2
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 How many hydrogen atoms are there in 1 mol of methanol?

- A 3
- B 4
- C 1.8×10^{24}
- D 2.4×10^{24}

Your answer

[1]

2 Which row could be correct for **solids** with the structure type named?

| | Structure type | Melting point | Solubility in water | Electrical conductivity |
|---|----------------|---------------|---------------------|-------------------------|
| A | ionic | high | soluble | high |
| B | metallic | high | insoluble | high |
| C | ionic | low | soluble | high |
| D | metallic | low | insoluble | low |

Your answer

[1]

3 What is a correct measure of percentage atom economy?

- A mass of useful products \times 100/mass of reactants
- B amount of products \times 100/amount of reactants
- C M_r of products \times 100/ M_r of reactants
- D M_r of useful products \times 100/ M_r of reactants

Your answer

[1]

4 What is correct about hydrogen bromide?

- A It reacts with concentrated sulfuric acid to form Br_2 and H_2S .
- B It forms white fumes with ammonia.
- C Its M_r is 79.9.
- D It does **not** decompose on heating.

Your answer

[1]

5 For which purpose is distillation used?

- A to allow a liquid to boil without the loss of vapour
- B to purify a liquid product
- C to remove an involatile impurity
- D to allow further reaction without the loss of product

Your answer

[1]

6 What is correct about a 'green chemistry' process?

- A It makes waste products that are easier to separate.
- B It makes processes cheaper.
- C It uses organic solvents.
- D It reduces the number of steps necessary.

Your answer

[1]

7 A sample of gas, volume V , has its temperature raised from 0°C to 20°C . The pressure remains constant.

What is the new volume?

- A $0.005V$
- B $0.93V$
- C $1.07V$
- D $20V$

Your answer

[1]

8 Which row is correct for the silver halide shown?

| | Halide | Colour | Solubility in ammonia |
|----------|-----------------|--------|-----------------------|
| A | silver chloride | white | soluble |
| B | silver bromide | yellow | insoluble |
| C | silver iodide | yellow | soluble |
| D | silver iodide | cream | partially soluble |

Your answer

[1]

9 CH_3Cl can be converted to CH_3NH_2 in one step.

What is correct about this process?

- A** The reaction is substitution of Cl by NH_3 .
- B** The product is an amide.
- C** The reagent is NH_4^+ .
- D** The reagent is a nucleophile.

Your answer

[1]

10 CH_3Cl and CH_3I both react with hydroxide ions.

What is correct about these reactions?

- A** CH_3Cl reacts faster because the $\text{C}-\text{Cl}$ bond is more polar than the $\text{C}-\text{I}$ bond.
- B** CH_3I reacts faster because the $\text{C}-\text{Cl}$ bond is stronger than the $\text{C}-\text{I}$ bond.
- C** Both form ethanol.
- D** In each case, homolytic bond fission occurs.

Your answer

[1]

11 What will react with a phenol?

- A sodium carbonate
- B sodium hydroxide
- C ethanoic acid
- D acidified potassium dichromate

Your answer

[1]

12 When are insoluble impurities removed during recrystallisation?

- A when the hot solution is filtered
- B as the solution cools
- C when the crystals are filtered off
- D when the crystals are washed

Your answer

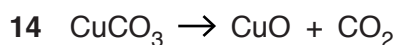
[1]

13 Which of these is classified as an elimination reaction?

- A $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \rightarrow \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$
- B $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} \rightarrow \text{CuSO}_4 + 5\text{H}_2\text{O}$
- C $\text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
- D $\text{C}_{17}\text{H}_{36} \rightarrow \text{C}_{10}\text{H}_{22} + \text{C}_7\text{H}_{14}$

Your answer

[1]



0.618 g of copper carbonate ($M_r = 123.5$) is heated.

What is the volume of CO_2 produced at room temperature and pressure?

- A 120 cm^3
- B 1.2 dm^3
- C 240 cm^3
- D 12 dm^3

Your answer

[1]

15 What is correct about a sodium chloride lattice?

- A There are attractions between ions of different charge.
- B The sodium ions are larger than the chloride ions.
- C The numbers of sodium ions and chloride ions are not equal.
- D Each sodium ion is surrounded by four chloride ions.

Your answer

[1]

16 What is correct about an exothermic reaction?

- A Heat is taken in.
- B More bonds are made than broken.
- C The sign of ΔH is positive.
- D It is represented by a downwards arrow on an enthalpy profile diagram.

Your answer

[1]

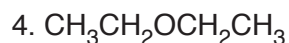
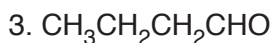
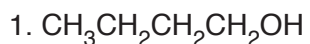
17 What is the functional group in the compound $\text{CH}_3\text{COOCOC}_2\text{H}_5$?

- A carboxylic acid
- B ester
- C acid anhydride
- D ketone

Your answer

[1]

18 This question concerns four compounds each with four carbon atoms.



What is the order of their boiling points, largest first?

A 1 2 3 4

B 1 2 4 3

C 4 3 1 2

D 3 4 2 1

Your answer

[1]

19 Which has the largest bond angle?

A BF_3

B CF_4

C NF_3

D OF_2

Your answer

[1]

20 Nitrogen monoxide, NO , reacts instantaneously in air to form NO_2 .

What is an explanation for this?

A NO is a radical taking part in a termination reaction.

B the activation enthalpy for the reaction is low.

C oxygen is a very reactive gas.

D NO_2 is less stable than NO .

Your answer

[1]

SECTION B

Answer **all** the questions.

- 21 The presence of chlorine in organic compounds can be seen from their mass spectra. Chlorine has two isotopes in the proportions as shown.



- (a) (i) Give the number of protons, neutrons and electrons in an atom of ${}^{35}\text{Cl}$.
- protons
- neutrons
- electrons [1]
- (ii) Give the electron configuration, using sub-shells and atomic orbitals, of an atom of ${}^{37}\text{Cl}$.
- [1]
- (iii) Draw a diagram to show the shape of a p-orbital and indicate how many electrons it can hold.

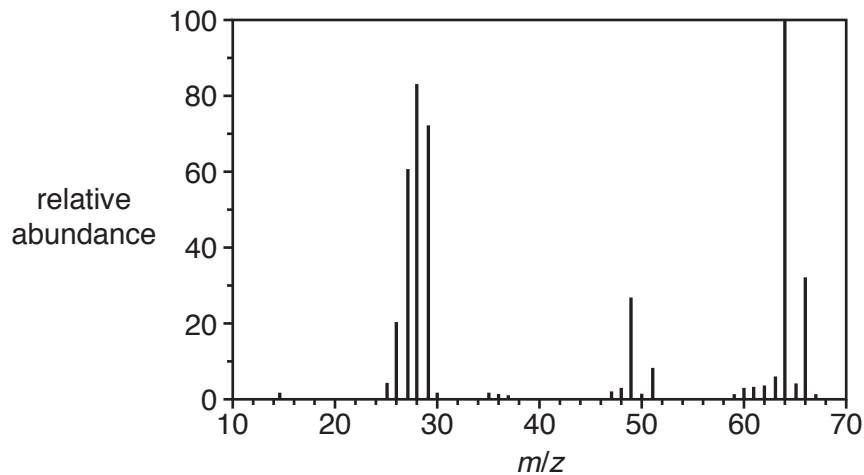
number of electrons: [1]

- (b) Calculate a value for the A_r of chlorine.

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

$A_r = \dots\dots\dots$ [2]

- (c) The mass spectrum of chloroethane, C_2H_5Cl , is shown below. The presence of chlorine isotopes causes two 'mass peaks'.



- (i) Give the formula of the ion responsible for the peak at m/z 64.

..... [1]

- (ii) Explain the ratio of the heights of the peaks at m/z 64 and m/z 66.

.....

 [2]

- (iii) Suggest the formula of the ion that gives the peak at m/z 65.

..... [1]

- (d) Chloroethane can be converted to ethanol.

The infrared spectrum of ethanol has some absorptions that are not present in the infrared spectrum of chloroethane.

Give the range of **one** of these absorptions and the corresponding bond.

Absorption

Bond [1]

22 Some students carry out experimental work involving salts.

Salt **A** is used as a fertiliser. The students are given a sample of salt **A** to analyse.

They carry out a flame test. The result is a lilac flame.

They dissolve salt **A** in water and add hydrochloric acid followed by barium chloride solution. The result is the formation of a white precipitate.

(a) Name salt **A**.

..... [1]

(b) The lilac flame colour is from a prominent line in the atomic emission spectrum of salt **A**.

(i) Describe the appearance of an atomic emission spectrum.

.....
 [1]

(ii) The lilac line in the spectrum of the salt occurs at 405 nm.

Calculate the energy associated with this wavelength in kJ mol^{-1} .
 (1 nm = 10^{-9} m)

energy = kJ mol^{-1} [3]

(c) The students are then asked to make a pure dry sample of lead chloride, an insoluble salt. They suggest mixing lead nitrate solution and sodium chloride solution, then filtering and drying the solid formed.

(i) Write a **full** equation for the reaction that occurs.

[1]

- (ii) The students' method would not produce a pure dry sample of lead chloride.

State how to improve the method.

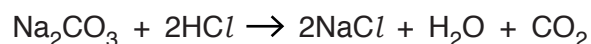
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..... [2]

- (d) The students are given a $0.150 \text{ mol dm}^{-3}$ solution of Na_2CO_3 . They titrate this against a solution of hydrochloric acid.



- (i) 25.0 cm^3 of the Na_2CO_3 solution requires 23.6 cm^3 of HCl .

Calculate the concentration of the HCl .

concentration = mol dm^{-3} [2]

- (ii) A student says:
'There is no point writing $0.150 \text{ mol dm}^{-3}$ for the Na_2CO_3 solution. Writing 0.15 mol dm^{-3} means the same thing.'

Discuss whether or not the student's statement is correct.

.....

.....

.....

..... [2]

- (e) The students are then given some $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$.

The students dissolve the solid to make $\text{FeSO}_4(\text{aq})$.

- (i) Describe a test they can do on this solution to identify the cation.

Test and its result

..... [1]

- (ii) Write an **ionic** equation, with state symbols, for the reaction that occurs in this test.

[1]

- (f) The students then heat a sample of solid $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$.

They find that 9.45 g of $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ gives 5.16 g of solid after heating.

- (i) Describe how the students could ensure that all the water had been lost.

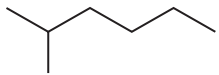
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- (ii) Calculate the value of x .

$x =$ [2]

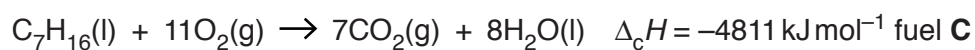
23 Some students are given samples of two liquid hydrocarbons, **B** and **C**, to test as fuels.

| Fuel | Name | Skeletal formula | Molecular formula | Aliphatic or aromatic? | Saturated or unsaturated? |
|----------|-------------|---|--------------------------------|------------------------|---------------------------|
| B | Cyclohexane | | | | |
| C | |  | C ₇ H ₁₆ | | |

(a) Complete the table above, filling the empty boxes.

[3]

(b) (i) Calculate a value for the $\Delta_f H$ of fuel **C** using the data below.



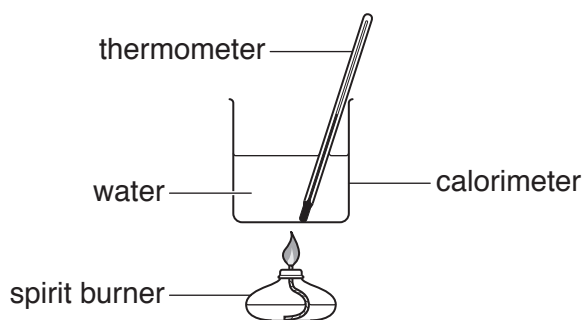
| Compound | $\Delta_f H / \text{kJ mol}^{-1}$ |
|---------------------|-----------------------------------|
| CO ₂ (g) | -394 |
| H ₂ O(l) | -286 |

$\Delta_f H = \dots\dots\dots \text{kJ mol}^{-1}$ [2]

- (ii) A sample of a fuel produces 46 g of carbon dioxide when burned.
Calculate the volume (in cm³) that this would occupy at 273 K and 150 kPa.
Give your answer to an **appropriate** number of significant figures.

volume = cm³ [3]

- (c) The students burn the fuels **B** and **C** separately in the apparatus shown below.
Their aim is to compare the energies produced on combustion.



- (i) State the measurements that the students would make to calculate a value for the energy produced. Show how these measurements would be used to calculate this energy.

.....
.....
.....
..... [2]

(ii) State and explain **two** improvements that could be made to increase the accuracy of the calculated value of the energy produced.

1

.....

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2

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..... [4]

(d) Both the fuels would produce NO if used in a car engine.

Explain how NO is produced in a car engine.

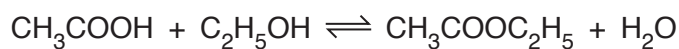
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.....

..... [1]

- 24 Ethyl ethanoate, $\text{CH}_3\text{COOC}_2\text{H}_5$, is an ester with many uses, including removing the caffeine from coffee.

(a) Ethyl ethanoate can be made in the laboratory by the reaction shown below.

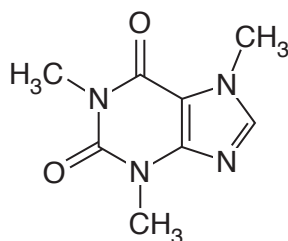


This reaction can reach dynamic equilibrium.

What can be said about the forward and back reactions once an equilibrium position has been reached?

.....
 [1]

(b) Ethyl ethanoate will dissolve caffeine since it has similar intermolecular bonds.



caffeine

(i) Caffeine contains some atoms that have greater electronegativity than carbon.

Explain the term *electronegativity*.

.....

 [1]

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).

A large area of lined paper for writing. It consists of a vertical solid line on the left side, creating a margin. To the right of this line, there are numerous horizontal dotted lines spaced evenly down the page, providing a guide for writing.

A large rectangular area consisting of numerous horizontal dashed lines, resembling a blank sheet of lined paper. The lines are evenly spaced and extend across the width of the page, leaving a small margin on the left side.

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines extending across the page, providing a grid for writing answers.



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