Oxford Cambridge and RSA

Tuesday 17 May 2022 – Morning

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 **16** pages.

ADVICE

- Read each question carefully before you start your answer.

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 ion has the same electron configuration as Ca^{2+}?

A Al^{3+}

B Br^{-}

C K^{+}

D Mg^{2+}

Your answer ☐ **[1]**

2 Sodium has a lower melting point than magnesium.

What is a reason for this?

A Magnesium has more delocalised electrons per atom.

B Magnesium is more ionic.

C Melting points decrease across Period 3.

D Sodium has a covalent structure.

Your answer ☐ **[1]**

3 Which row is correct for the properties of the solids shown?

	Solid	**Melting point**	**Electrical conductivity**
A	graphite	high	poor
B	iodine	high	poor
C	iron	low	good
D	sodium chloride	high	poor

Your answer ☐ **[1]**

4 Which compound is a saturated aliphatic hydrocarbon?

A benzene

B cyclohexane

C cyclohexene

D hexene

Your answer ☐ **[1]**

5 Which reaction has the **largest** atom economy for the formation of the organic product?

A $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

B $C_2H_5Br + Br_2 \rightarrow C_2H_4Br_2 + HBr$

C $C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$

D $C_2H_6 + Br_2 \rightarrow C_2H_5Br + HBr$

Your answer ☐ **[1]**

6 What is a correct property of hydrogen iodide gas?

A It has high thermal stability.

B It is neutral in solution.

C It is unreactive with ammonia.

D It reduces sulfuric acid to hydrogen sulfide.

Your answer ☐ **[1]**

7 Which statement correctly describes the reaction below?

$C_4H_9Cl + NH_3 \rightarrow C_4H_9NH_2 + HCl$

A Ammonia adds to a haloalkane to form an amine.

B Ammonia is displacing hydrogen chloride.

C An amine is formed in a substitution reaction.

D Chloropropane is reacting with ammonia.

Your answer ☐ **[1]**

8 Which of these compounds will have the highest boiling point?

A CH_3CHO

B CH_3CH_2OH

C $HOCH_2CH_2OH$

D CH_3OCH_3

Your answer ☐ **[1]**

9 What is the final stage in the purification of a liquid organic product?

A distillation

B drying

C neutralisation

D separation

Your answer ☐ **[1]**

10 What is a correct formula for an iron salt?

A $FeCO_3$

B $Fe_2(NO_3)_3$

C $FeNO_3$

D Fe_2SO_4

Your answer ☐ **[1]**

11 Which molecule has the largest bond angle?

A BF_3

B CHF_3

C NF_3

D PF_3

Your answer ☐ **[1]**

12 Ethene is reacted with the reagents shown below.

Which row correctly describes the products?

	Hydrogen and platinum	**Hydrogen bromide**	**Steam/phosphoric acid with heat and pressure**
A	ethane	1,2-dibromoethane	ethanal
B	ethane	bromoethane	ethanol
C	no reaction	1,2-dibromoethane	ethanol
D	no reaction	bromoethane	ethanal

Your answer ☐ **[1]**

13 What mass of Na_2CO_3 is needed to make up $250\,cm^3$ of a $0.100\,mol\,dm^{-3}$ solution?

(Na, 23; C, 12; O, 16)

A 2.65 g

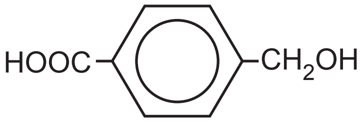
B 3.57 g

C 10.6 g

D 26.5 g

Your answer ☐ **[1]**

14 A compound has the structure shown.



What is a correct property of this compound?

A It fizzes with NaOH(aq).

B It gives a purple colour with neutral iron(III) chloride.

C It is neutral in solution.

D When it is heated with acidified dichromate(VI), a green solution is formed.

Your answer ☐ **[1]**

15 Silver nitrate solution, followed by ammonia solution, is added to solutions of the potassium halides.

What is correct?

A Potassium bromide gives a yellow precipitate, soluble in ammonia.

B Potassium chloride gives a white precipitate, soluble in ammonia.

C Potassium iodide gives a purple precipitate, insoluble in ammonia.

D Potassium iodide gives a white precipitate, partially soluble in ammonia.

Your answer ☐ **[1]**

16 The density of a gas is given by mass/volume.

What is a correct expression for the density?

A p/RT

B M_rp/RT

C RT/p

D p/M_rRT

Your answer ☐ **[1]**

17 How many **unsaturated** structural and *E*/*Z* isomers of butene are there?

A 3

B 4

C 5

D 6

Your answer ☐ **[1]**

18 The mass spectrum of $(C_3H_7)_2O$ has peaks at *m*/*z* 103, 102, 43 and other values.

What is correct?

A 102 is caused when the molecule gains an electron in the mass spectrometer.

B 103 is caused by the presence of ^2H in the molecule.

C The peaks at other values are caused by fragments of the molecule.

D The peak at 43 is caused by impurities.

Your answer ☐ **[1]**

19 Ammonia is made by the following reaction.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

40 cm^3 of hydrogen is reacted with excess nitrogen.
10 cm^3 of ammonia is found in the equilibrium mixture.
All volumes are measured at the same temperature and pressure.

What volume of hydrogen remains?

A 15 cm^3

B 20 cm^3

C 25 cm^3

D 30 cm^3

Your answer ☐ **[1]**

20 What represents the enthalpy change of neutralisation of sulfuric acid?

A $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

B $\frac{1}{2}H_2SO_4 + NaOH \rightarrow \frac{1}{2}Na_2SO_4 + H_2O$

C $H_2SO_4 + 2Na \rightarrow Na_2SO_4 + H_2$

D $\frac{1}{2}H_2SO_4 + Na \rightarrow \frac{1}{2}Na_2SO_4 + \frac{1}{2}H_2$

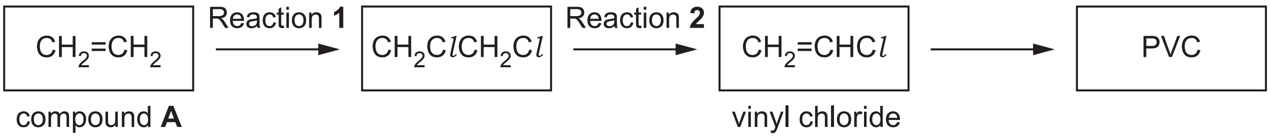
Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

21 Vinyl chloride, CH_2CHCl, is an important industrial chemical as it can be polymerised to make the polymer polyvinyl chloride, PVC.

The flowchart below shows how PVC is made.



(a) **(i)** Give the systematic names for compound **A** and vinyl chloride.

compound **A** ....

vinyl chloride ....
[2]

(ii) Draw a dot-and-cross diagram for vinyl chloride.

[2]

(iii) Give the reagent for Reaction **1**.

.... **[1]**

(iv) Draw the repeating unit of the structure of PVC.

[1]

(b) Vinyl chloride reacts with HBr in an electrophilic addition reaction. Possible products are CH_2BrCH_2Cl and $CH_3CHBrCl$.

There is not an equal mix of products. The carbocation with more hydrogen atoms on one of its carbon atoms is the more stable.

Predict the **main** product of the reaction, giving your reasons.

....

....

....

.... **[2]**

(c) Both compound **A** and vinyl chloride have instantaneous dipole-induced dipole intermolecular bonds. Vinyl chloride also has permanent dipole-permanent dipole intermolecular bonds.

Explain how both these types of intermolecular bonds arise and predict, with a reason, which of compound **A** and vinyl chloride has the higher boiling point.

....

....

....

....

....

....

....

....

....

....

....

....

....

.... **[5]**

22 The American Environmental Protection Agency (EPA) describes ozone as ‘Good up high, bad nearby’.

(a) **(i)** State **two** polluting effects of ozone in the **troposphere**.

1. ....

....

2. ....

....
[2]

(ii) According to the EPA, exposure to 0.07 ppm of ozone for 8 or more hours is dangerous.

A scientist measures the ozone concentration in the air of a town as 1.0×10^{-6} %.

Is this a dangerous ozone concentration? Show your calculation.

[1]

(b) In the stratosphere, ozone acts as a sunscreen, blocking out high-energy UV radiation.

Give **one** way in which high-energy UV is harmful to humans.

....

.... **[1]**

(c) Chloroalkanes decompose to chlorine radicals in the stratosphere.

(i) Chlorine radicals catalyse the breakdown of ozone.

The catalytic process can be shown by two equations. Write the equation for **reaction 22.2**.

$Cl + O_3 \rightarrow ClO + O_2$ **Reaction 22.1**

Reaction 22.2

[1]

(ii) Give the equation for a possible termination reaction to end this sequence.

[1]

(d) CH_3CH_2Cl is a chloroalkane that decomposes in the stratosphere.

$CH_3CH_2Cl \rightarrow CH_3CH_2 + Cl$ **Reaction 22.3**

The bond energy of the C–Cl bond is +346 kJ mol^{-1}.

Calculate the frequency of radiation required to break this bond.

frequency = ... Hz **[3]**

(e) CH_3CH_2Cl reacts with hydroxide ions as shown in **reaction 22.4**.

$CH_3CH_2Cl + OH^- \rightarrow CH_3CH_2OH + Cl^-$ **Reaction 22.4**

Compare **reactions 22.3**, in part **(d)**, and **22.4** in terms of their mechanisms and the way the C–Cl bond is broken.

....

....

....

....

....

....

....

.... **[4]**

23 Sodium hypochlorite, NaOC*l*, is a chemical present in chlorine bleaches.

It acts as a bleach by oxidising stains to colourless compounds.

(a) Give the systematic name for NaOC*l*.

.... **[1]**

(b) Sodium hypochlorite is made by electrolysing brine, NaC*l*(aq), and allowing the products to mix.

(i) Give the half-equation for the reaction at the **positive** electrode when NaC*l*(aq) is electrolysed.

[1]

(ii) Give the half-equation for the production of hydroxide ions (and a gas) at the **negative** electrode when NaC*l*(aq) is electrolysed.

[1]

(iii) Suggest the equation for the two electrode products reacting to give OC*l*$^-$ ions.

[1]

(c) The concentration of a bleach in solution can be measured by reacting the bleach with acidified iodide ions. The iodine that is formed is then titrated with sodium thiosulfate solution.

$OCl^- + 2I^- + 2H^+ \rightarrow Cl^- + I_2 + H_2O$ **Equation 23.1**

$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$ **Equation 23.2**

(i) State which atoms are being oxidised in **equation 23.2** and give their change in oxidation state.

.... is being oxidised from .... to ....**[2]**

(ii) A group of students measure out 25 cm^3 of a bleach solution in a measuring cylinder and pour it into a conical flask. The students add excess hydrochloric acid and excess potassium iodide solution. They are supplied with 1.60 mol dm^{-3} sodium thiosulfate solution.

Describe how the students should go on to obtain the results to calculate the average titre of sodium thiosulfate needed. They add starch solution near the end point.

....

....

....

....

....

.... **[3]**

(iii) The students find that 25 cm^3 of the bleach solution needs 20.3 cm^3 of 1.60 mol dm^{-3} sodium thiosulfate.

Calculate the concentration of NaOCl in the bleach solution in g dm^{-3}.

Give your answer to an **appropriate** number of significant figures.

concentration of NaOCl = ... g dm^{-3} **[4]**

(iv) The students are told that they should have used a volumetric pipette rather than a measuring cylinder to measure out 25 cm^3 of bleach.

What effect would this have on your answer to **part (iii)**?

....

.... **[1]**

24 Some students study the equilibrium shown in **equation 24.1**.

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$ $\Delta H = +58\,kJ\,mol^{-1}$ **Equation 24.1**

(a) The reaction is in dynamic equilibrium.

Describe what is happening to the concentrations of the gases and the rates of the forward and back reactions at equilibrium.

concentrations ....

....

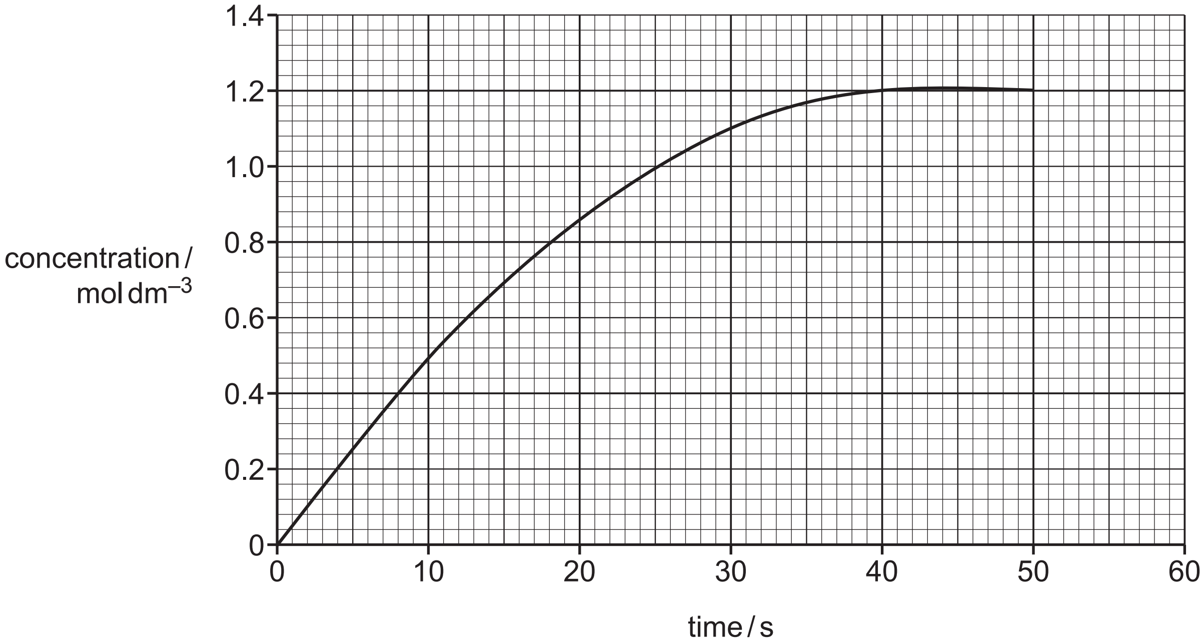
rates ....

.... **[2]**

At 298 K mostly N_2O_4 is present in the equilibrium in **equation 24.1**.

A 1.0 dm^3 flask contains the equilibrium mixture at 298 K.

The flask is placed in an oil bath at 600 K and the students find data for the changing NO_2 concentration. They plot these on the graph below.



(b) The concentration of N_2O_4 starts at 1.0 mol dm^{-3} and reaches equilibrium again at 0.40 mol dm^{-3}.

Sketch a line on the axes above to show how the concentration of N_2O_4 changes. **[2]**

(c) Use data from the graph to calculate the numerical value of K_c for the equilibrium in **equation 24.1** at 600 K.

K_c value = ... **[2]**

(d) Use **equation 24.1** to explain why more NO_2 is formed at 600 K, compared with 298 K.

....

....

....

....

....

.... **[2]**

(e) The students find data for repeating the experiment with the oil bath at 700 K.

They notice that after 10 s the concentration of NO_2 is 0.60 mol dm^{-3}.

Explain this observation with the relevant chemistry.

....

....

....

....

....

.... **[2]**

END OF QUESTION PAPER

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).