

**Modified Enlarged 24pt**  
**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**

**Tuesday 17 May 2022 – Morning**

**AS Level Chemistry B (Salters)**

**H033/01 Foundations of chemistry**

**Time allowed: 1 hour 30 minutes**  
**plus your additional time allowance**

**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.**

**Centre number**

|  |  |  |  |  |
|--|--|--|--|--|
|  |  |  |  |  |
|--|--|--|--|--|

**Candidate number**

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|

**First name(s)** \_\_\_\_\_

**Last name** \_\_\_\_\_

**READ INSTRUCTIONS OVERLEAF**



## **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 [ ].**

## **ADVICE**

**Read each question carefully before you start your answer.**

**BLANK PAGE**

## SECTION A

You should spend a maximum of 25 minutes plus your additional time allowance 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  $\text{Ca}^{2+}$ ? [1]

A  $\text{Al}^{3+}$

B  $\text{Br}^-$

C  $\text{K}^+$

D  $\text{Mg}^{2+}$

Your answer

**2 Sodium has a lower melting point than magnesium.**

**What is a reason for this? [1]**

**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**

**3 Which row is correct for the properties of the solids shown? [1]**

|          | <b>Solid</b>    | <b>Melting point</b> | <b>Electrical conductivity</b> |
|----------|-----------------|----------------------|--------------------------------|
| <b>A</b> | graphite        | high                 | poor                           |
| <b>B</b> | iodine          | high                 | poor                           |
| <b>C</b> | iron            | low                  | good                           |
| <b>D</b> | sodium chloride | high                 | poor                           |

**Your answer**

**4 Which compound is a saturated aliphatic hydrocarbon? [1]**

**A benzene**

**B cyclohexane**

**C cyclohexene**

**D hexene**

**Your answer**

**5 Which reaction has the LARGEST atom economy for the formation of the organic product? [1]**



**Your answer**

**6 What is a correct property of hydrogen iodide gas? [1]**

**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**

**7 Which statement correctly describes the reaction below? [1]**



- 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**



**8 Which of these compounds will have the highest boiling point? [1]**

**A  $\text{CH}_3\text{CHO}$**

**B  $\text{CH}_3\text{CH}_2\text{OH}$**

**C  $\text{HOCH}_2\text{CH}_2\text{OH}$**

**D  $\text{CH}_3\text{OCH}_3$**

**Your answer**

**9 What is the final stage in the purification of a liquid organic product? [1]**

**A distillation**

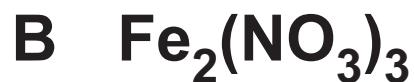
**B drying**

**C neutralisation**

**D separation**

**Your answer**

**10 What is a correct formula for an iron salt? [1]**



**Your answer**

**11 Which molecule has the largest bond angle? [1]**



**Your answer**

**BLANK PAGE**

**12 Ethene is reacted with the reagents shown on the following page.**

**Which row correctly describes the products? [1]**

**Your answer**

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

**13 What mass of  $\text{Na}_2\text{CO}_3$  is needed to make up  $250\text{ cm}^3$  of a  $0.100\text{ mol dm}^{-3}$  solution? [1]**

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

**A 2.65 g**

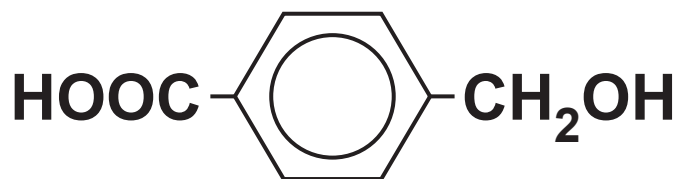
**B 3.57 g**

**C 10.6 g**

**D 26.5 g**

**Your answer**

**14 A compound has the structure shown.**



**What is a correct property of this compound? [1]**

- 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**

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

**What is correct? [1]**

- 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**



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

**What is a correct expression for the density? [1]**

**A  $p/RT$**

**B  $M_r p/RT$**

**C  $RT/p$**

**D  $p/M_r RT$**

**Your answer**

**17 How many UNSATURATED structural and *E/Z* isomers of butene are there? [1]**

**A 3**

**B 4**

**C 5**

**D 6**

**Your answer**

**18 The mass spectrum of  $(\text{C}_3\text{H}_7)_2\text{O}$  has peaks at  $m/z$  103, 102, 43 and other values.**

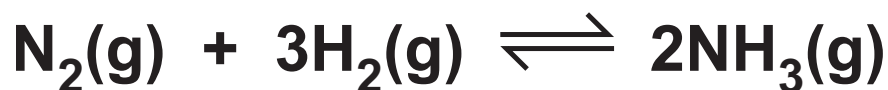
**What is correct? [1]**

- A 102 is caused when the molecule gains an electron in the mass spectrometer.**
- B 103 is caused by the presence of  $^2\text{H}$  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**

☐

**19 Ammonia is made by the following reaction.**



**40 cm<sup>3</sup> of hydrogen is reacted with excess nitrogen.**

**10 cm<sup>3</sup> of ammonia is found in the equilibrium mixture.**

**All volumes are measured at the same temperature and pressure.**

**What volume of hydrogen remains? [1]**

**A 15 cm<sup>3</sup>**

**B 20 cm<sup>3</sup>**

**C 25 cm<sup>3</sup>**

**D 30 cm<sup>3</sup>**

**Your answer**

**20 What represents the enthalpy change of neutralisation of sulfuric acid? [1]**



**Your answer**

## SECTION B

Answer ALL the questions.

**21 Vinyl chloride,  $\text{CH}_2\text{CHCl}$ , is an important industrial chemical as it can be polymerised to make the polymer polyvinyl chloride, PVC.**

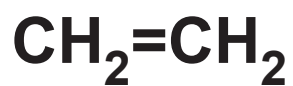
**The flowchart opposite shows how PVC is made.**

**(a) (i) Give the systematic names for compound A and vinyl chloride. [2]**

**compound A** \_\_\_\_\_

**vinyl chloride** \_\_\_\_\_

**compound A**



**Reaction 1**



**Reaction 2**



**vinyl chloride**



**PVC**

**(ii) Draw a dot-and-cross diagram for vinyl chloride.  
Use the space below. [2]**

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

\_\_\_\_\_ **[1]**

**(iv) Draw the repeating unit of the structure of PVC.  
Use the space below. [1]**



**(b) Vinyl chloride reacts with HBr in an electrophilic addition reaction. Possible products are  $\text{CH}_2\text{BrCH}_2\text{Cl}$  and  $\text{CH}_3\text{CHBrCl}$ .**

**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  $1.0 \times 10^{-6}$  %.**

**Is this a dangerous ozone concentration? Show your calculation.  
Use the space below. [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.**

---

---

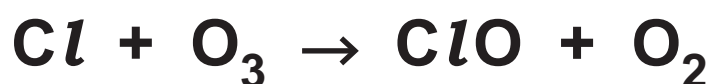
**[1]**

**(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. [1]**

**REACTION 22.1**



**REACTION 22.2**

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

**Use the space below. [1]**

(d)  $\text{CH}_3\text{CH}_2\text{Cl}$  is a chloroalkane that decomposes in the stratosphere.

**REACTION 22.3**



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

Calculate the frequency of radiation required to break this bond.

frequency = \_\_\_\_\_ Hz [3]

(e)  $\text{CH}_3\text{CH}_2\text{Cl}$  reacts with hydroxide ions as shown in REACTION 22.4.

**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]



**BLANK PAGE**

**23 Sodium hypochlorite,  $\text{NaOCl}$ , is a chemical present in chlorine bleaches.**

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

**(a) Give the systematic name for  $\text{NaOCl}$ .**

\_\_\_\_\_ [1]

**(b) Sodium hypochlorite is made by electrolysing brine,  $\text{NaCl(aq)}$ , and allowing the products to mix.**

**(i) Give the half-equation for the reaction at the POSITIVE electrode when  $\text{NaCl(aq)}$  is electrolysed.**

**Use the space below. [1]**

**(ii) Give the half-equation for the production of hydroxide ions (and a gas) at the NEGATIVE electrode when  $\text{NaCl(aq)}$  is electrolysed.  
Use the space below. [1]**

**(iii) Suggest the equation for the two electrode products reacting to give  $\text{OCl}^-$  ions.  
Use the space below. [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.**

**EQUATION 23.1**



**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  $25\text{ cm}^3$  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  $1.60\text{ mol dm}^{-3}$  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  $25\text{ cm}^3$  of the bleach solution needs  $20.3\text{ cm}^3$  of  $1.60\text{ mol dm}^{-3}$  sodium thiosulfate.

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

Give your answer to an APPROPRIATE number of significant figures.

concentration of NaOCl = \_\_\_\_\_  $\text{g dm}^{-3}$  [4]

- (iv) The students are told that they should have used a volumetric pipette rather than a measuring cylinder to measure out  $25\text{ cm}^3$  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.**

**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** \_\_\_\_\_

\_\_\_\_\_

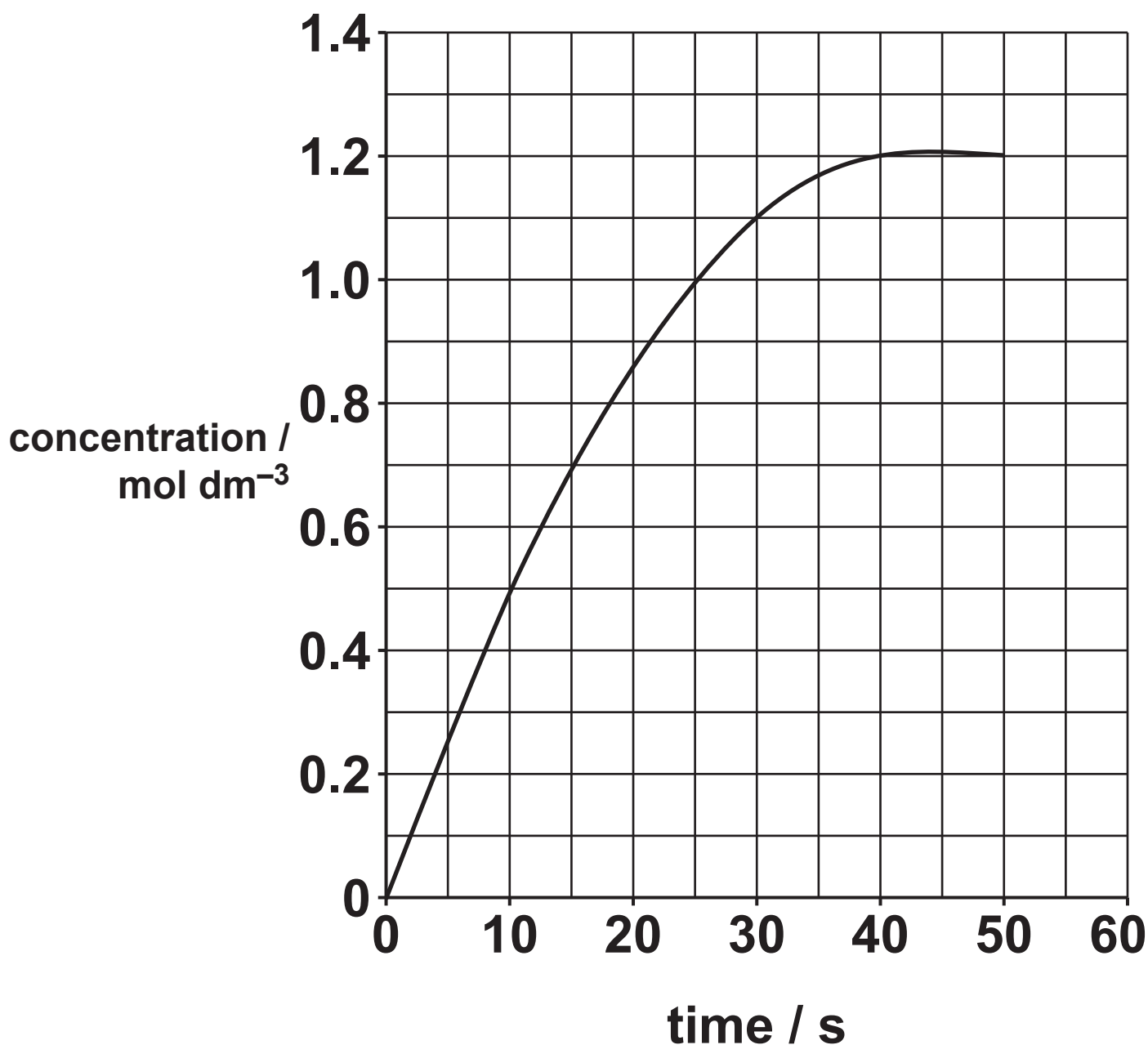
**[2]**

**At 298 K mostly  $\text{N}_2\text{O}_4$  is present in the equilibrium in EQUATION 24.1.**

**A  $1.0 \text{ dm}^3$  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  $\text{NO}_2$  concentration. They plot these on the graph below.



- (b) The concentration of  $\text{N}_2\text{O}_4$  starts at  $1.0 \text{ mol dm}^{-3}$  and reaches equilibrium again at  $0.40 \text{ mol dm}^{-3}$ .

Sketch a line on the axes above to show how the concentration of  $\text{N}_2\text{O}_4$  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  $\text{NO}_2$  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  $\text{NO}_2$  is  $0.60 \text{ mol dm}^{-3}$ .

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).**

|  |  |
|--|--|
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |



[illegible]

|  |  |
|--|--|
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |



**Copyright Information**

**OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website ([www.ocr.org.uk](http://www.ocr.org.uk)) after the live examination series.**

**If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.**

**For queries or further information please contact The OCR Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.**

**OCR is part of Cambridge University Press & Assessment, which is itself a department of the University of Cambridge.**