Rate of Reaction

Question Paper

Level	Pre U
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Rate of Reaction- Gases and kinetics
Booklet	Question Paper

Time Allowed: **40 minutes**

Score: **/33**

Percentage: **/100**

Grade Boundaries:

1. **(a)** Write an expression that represents the relationship defined by Charles's law.

..... [1]

(b) The graph in Fig. 2.1 shows the variation of pV with increasing pressure for an ideal gas and four 'real' gases at 273 K.

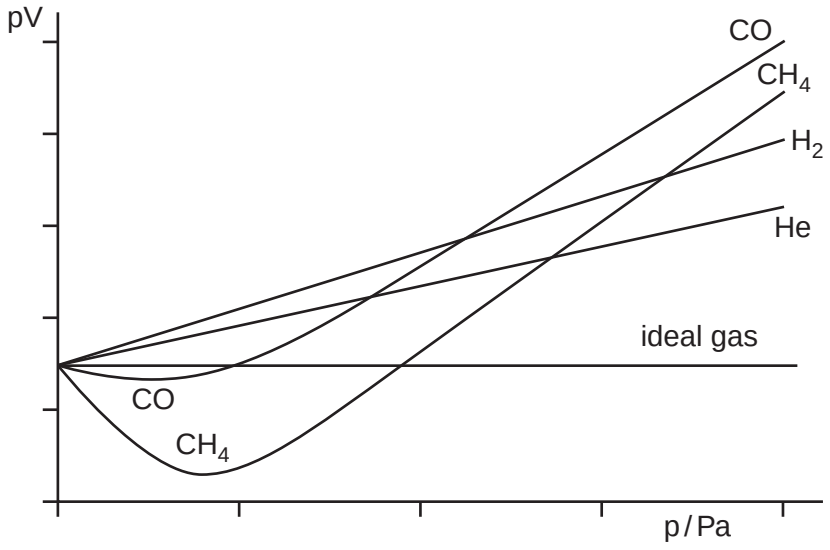

Fig. 2.1

(i) State the two properties of real gases that explain the deviations from ideal behaviour that are shown in Fig. 2.1.

1 .....

.....

2 .....

..... [2]

(ii) Calculate the volume, in dm^3, of one mole of an ideal gas at 10^5 Pa and 273 K.

..... dm^3 [2]

(iii) Explain the positive deviation from ideal behaviour that is shown by all four real gases at high pressures.

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..... [2]

(iv) Explain why the positive deviations at high pressures are in the order shown above, i.e. $CO > CH_4 > H_2 > He$.

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..... [1]

(c) At lower temperatures, the negative deviation from ideal behaviour shown by CH_4 becomes greater. Explain why this is so.

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..... [2]

[Total: 10]

2. 2-bromobutane reacts with potassium hydroxide by either elimination or nucleophilic substitution depending on a combination of factors.

(a) State the conditions needed to bring about each of these reactions.

(i) elimination

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(ii) nucleophilic substitution

.....

.....[3]

(b) 2-bromobutane is a *chiral* molecule and, when it is prepared by the reaction between but-1-ene and hydrogen bromide, a *racemate* is formed. The enantiomers in the *racemate* can be converted to *diastereoisomers* by covalent derivatisation with suitable *chiral* reagents. Pure samples of each of the enantiomers can then be obtained by simple separation techniques as the *diastereoisomers* have different physical and chemical properties.

Give definitions of each of the words in italics.

(i) *chiral* .....

.....

.....[1]

(ii) *racemate* .....

.....

.....[1]

(iii) *diastereoisomers* .....

.....

.....[1]

(iv) Draw suitable diagrams of the two different enantiomers of 2-bromobutane.

[2]

(c) When R-(–)-2-bromobutane undergoes nucleophilic substitution with potassium hydroxide under appropriate conditions the reaction proceeds predominantly by the S_N2 mechanism. When the progress of the reaction is followed in a polarimeter the optical activity is seen to change gradually from –23.1° via zero to +13.5°.

(i) Draw a curly-arrow mechanism for the reaction that is taking place. Show the 3-D structures of the reactant and product clearly.

[4]

(ii) Give the systematic name of the organic product.

.....[2]

(d) The kinetics of the reaction of a different bromoalkane (RBr) with aqueous alkali were investigated at 323 K. The results are shown in Table 2.1.

Table 2.1

experiment	[RBr] / mol dm^{-3}	[OH$^-$] / mol dm^{-3}	initial rate / mol dm^{-3} s^{-1}
1	0.05	0.10	4.0×10^{-4}
2	0.15	0.10	1.2×10^{-3}
3	0.10	0.20	1.6×10^{-3}

(i) Deduce the order of reaction with respect to RBr and with respect to the hydroxide ion, OH$^-$.

Give reasons for each of your answers.

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.....

.....[4]

(ii) Write the rate equation for the reaction.

.....[1]

(iii) Calculate the value of the rate constant, *k*, at 323 K and give its units.

.....[3]

(iv) Draw the skeletal formula of RBr, which is an isomer of 2-bromobutane.

[1]

[Total: 23]