OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

CHEMISTRY 2815/05

Gases, Liquids and Solids

Friday **23 JANUARY 2004** Afternoon 50 minutes

Candidates answer on the question paper.
Additional materials:
Data Sheet for Chemistry
Scientific calculator

Candidate Name	Centre Number	Candidate Number

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	9	
2	12	
3	12	
4	12	
TOTAL	45	

This question paper consists of 10 printed pages and 2 blank pages.

Registered Charity Number: 1066969
[Turn over

For Examiner's Use

Answer **all** the questions.

1 This question is about the behaviour of ideal gases, real gases and vapours.

(a) State **two** assumptions made about ideal gases when explaining gaseous properties.

1 .....

.....

2 .....

..... [2]

(b) The Meteorological Office carries out studies of the upper atmosphere using balloons containing helium gas. These balloons have a capacity of 1 000 dm^3.

The balloons contain less than 500 dm^3 of helium when they are launched.

(i) State and explain what will happen to the gas in such a balloon as it rises through the atmosphere.

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..... [2]

(ii) Predict what would happen as the balloon rises if 1 000 dm^3 of helium was used to inflate the balloon.

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..... [1]

(c) **(i)** Rearrange the ideal gas equation, $pv = nRT$, to give the number of moles of a gas present at a known pressure and temperature in a given volume.

[1]

For Examiner's Use

(ii) A weather balloon contains 100 dm^3 of helium at 1.01×10^5 Pa and 293 K.
Calculate the number of moles of helium present in the balloon.
$R = 8.31\ J\ K^{-1}\ mol^{-1}$

[1]

(iii) As the balloon rises, it reaches a point where the temperature has dropped to 233 K, and the pressure has dropped to 1.01×10^4 Pa.
Calculate the volume of helium in the balloon at this point.

[2]

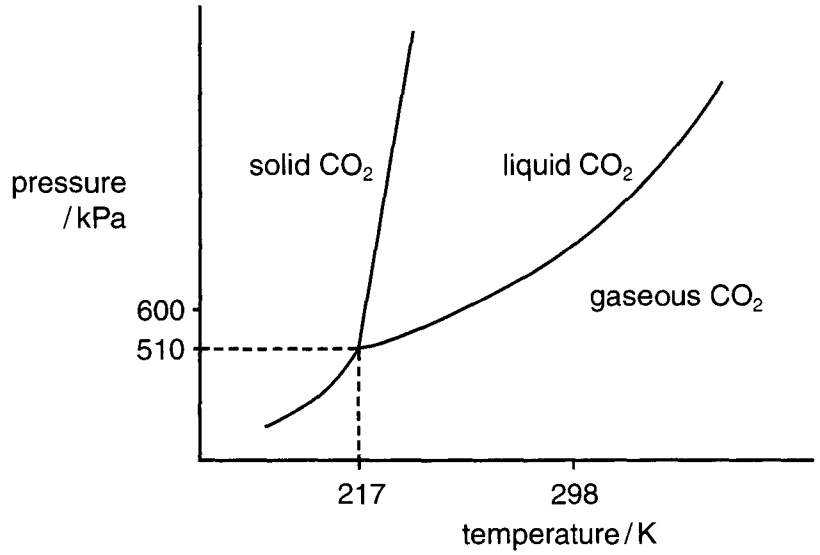
[Total: 9]

[Turn over

For Examiner's Use

2 This question concerns the behaviour of carbon dioxide and water in different states.

(a) The sketch below shows the phase diagram for carbon dioxide.



(i) Label the triple point of carbon dioxide on the sketch with a **T**. [1]

(ii) What does the triple point represent?

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..... [1]

(iii) Predict what would happen to carbon dioxide at 600 kPa when it is cooled from 298 K to 200 K at constant pressure.

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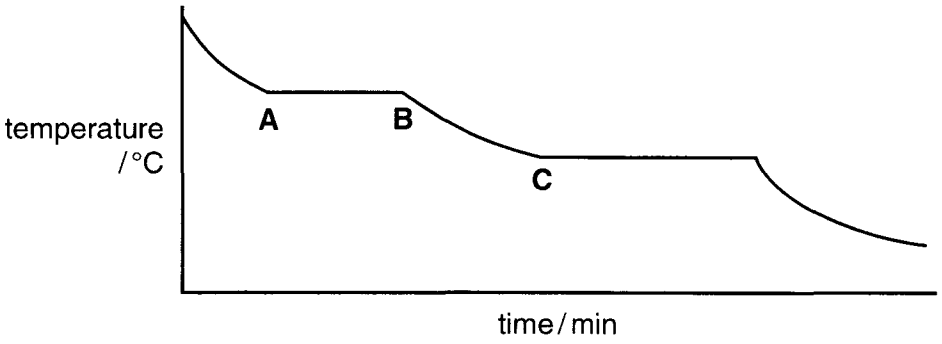
..... [2]

(b) The cooling curve for the change described in **(a)** is shown below.



(i) What is happening

along **AB** .....

along **BC**? ..... [2]

(ii) Why is **AB** horizontal? .....

..... [1]

(c) When used in stage productions and rock concerts, solid carbon dioxide is converted directly to a gas.
Use the phase diagram in **(a)** to suggest why, under these conditions, you would **not** expect liquid carbon dioxide to be formed.

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..... [2]

(d) The **shape** of the phase diagram for carbon dioxide differs from that of water in one important way.

(i) What is the difference in shape in the phase diagram for water?

.....

..... [1]

(ii) Explain how this difference affects the physical properties of water in its solid state.

.....

.....

..... [2]

[Total: 12]

[Turn over

For Examiner's Use

3 **(a)** In this question, one mark is available for quality of written communication.

Carbon dioxide is used in a large number of soft drinks. Describe and explain how the solubility of carbon dioxide in water is affected by

(i) pressure

(ii) temperature

(iii) its reaction with water.

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..... [7]

Quality of Written Communication [1]

For Examiner's Use

(b) 500 cm^3 of cola drink is bottled at 298 K, with carbon dioxide gas at a pressure of 1 01 kPa.
The Henry's law constant for carbon dioxide at 298 K is 3.40×10^{-4} mol dm^{-3} kPa^{-1}.

(i) Calculate the amount of carbon dioxide that will dissolve in 500 cm^3 of cola under these conditions.

amount ..... mol [2]

(ii) Calculate the mass of carbon dioxide that will dissolve in 500 cm^3 of cola under these conditions.

mass ..... g [1]

(iii) What assumption has been made in your calculation?

.....

..... [1]

[Total: 12]

[Turn over

4 **(a)** State Raoult's law.

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..... [1]

(b) When a non-volatile solute is added to a liquid, the boiling point and freezing point of the solution differ from those of the pure solvent. State what differences occur and outline why these differences occur.

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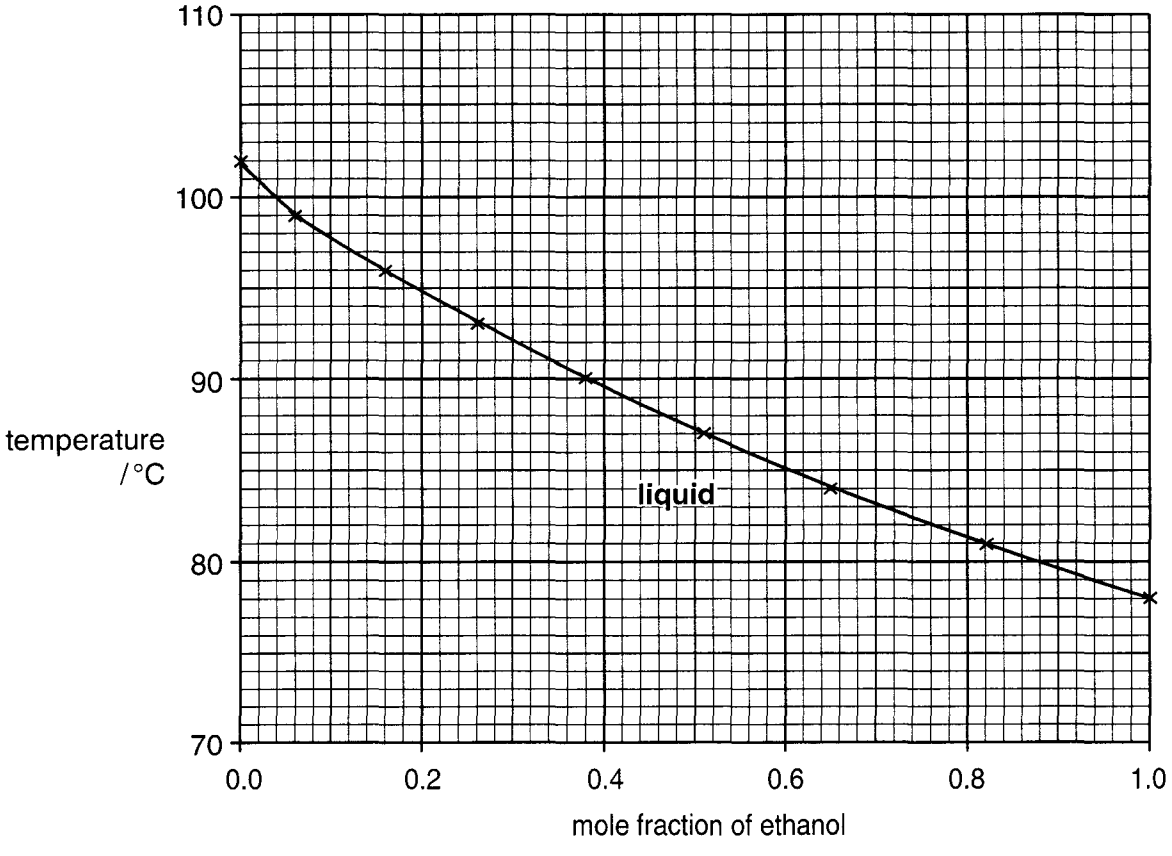
..... [4]

(c) The table below gives information for different mixtures of ethanol and pentan-2-one.

boiling point of liquid / °C	78	81	84	87	90	93	97	99	102
mole fraction of ethanol in vapour	1.00	0.92	0.83	0.72	0.60	0.45	0.30	0.20	0.00

(i) Use the data to plot the vapour curve for ethanol on the grid below, which already shows the liquid curve for ethanol.



[1]

(ii) Construct lines on your graph to determine how many theoretical plates would be needed to give a mixture containing at least 0.95 mole fraction of ethanol from a starting mixture containing 0.40 mole fraction of ethanol.

number of theoretical plates ..... [3]

(d) The technique known as steam distillation is often used to distil mixtures, such as natural products, in which components decompose close to their boiling points. Explain how the technique works, and why it is so useful for such mixtures.

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..... [3]

[Total: 12]

END OF QUESTION PAPER