

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY

2815/05

Gases, Liquids and Solids

Tuesday

28 JUNE 2005

Morning

50 minutes

Candidates answer on the question paper.

Additional materials:

Data Sheet for Chemistry

Scientific calculator

Candidate Name	Centre Number	Candidate Number										
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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	14	
3	12	
4	10	
TOTAL	45	

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

Answer **all** the questions.

1 This question is concerned with the different states of matter.

(a) Describe, in terms of the kinetic molecular model

- **one** similarity and **one** difference between a solid and a liquid;
- the limitations to ideal behaviour of gases at low temperatures and high pressures.

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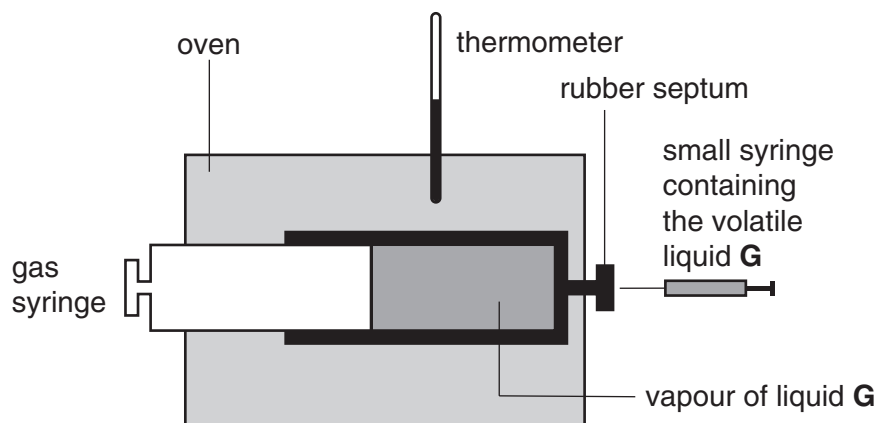
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..... [4]

(b) A student carried out an experiment to find the relative molecular mass of a volatile liquid **G**. The student injected a small amount of the liquid into a syringe placed in an oven at 100 °C and measured the volume of vapour produced. The apparatus used is shown below.



In the experiment, the mass of liquid **G** used was 0.275 g and this produced 96.0 cm³ of vapour at 100 °C and at a pressure of 101 kPa.

- (i) Use the Ideal Gas Equation to show how you could obtain the relative molecular mass of liquid **G**.

[1]

- (ii) Use the data to determine the relative molecular mass, M_r , of liquid **G**.

$$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$$

[2]

- (iii) Suggest why this method gives a more accurate value for M_r of a hydrocarbon such as cyclohexane than an alcohol such as ethanol.

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..... [2]

[Total: 9]

2 This question is about interpreting phase diagrams.

(a) The phase diagram for the tin-lead system is shown in Fig. 2.1.

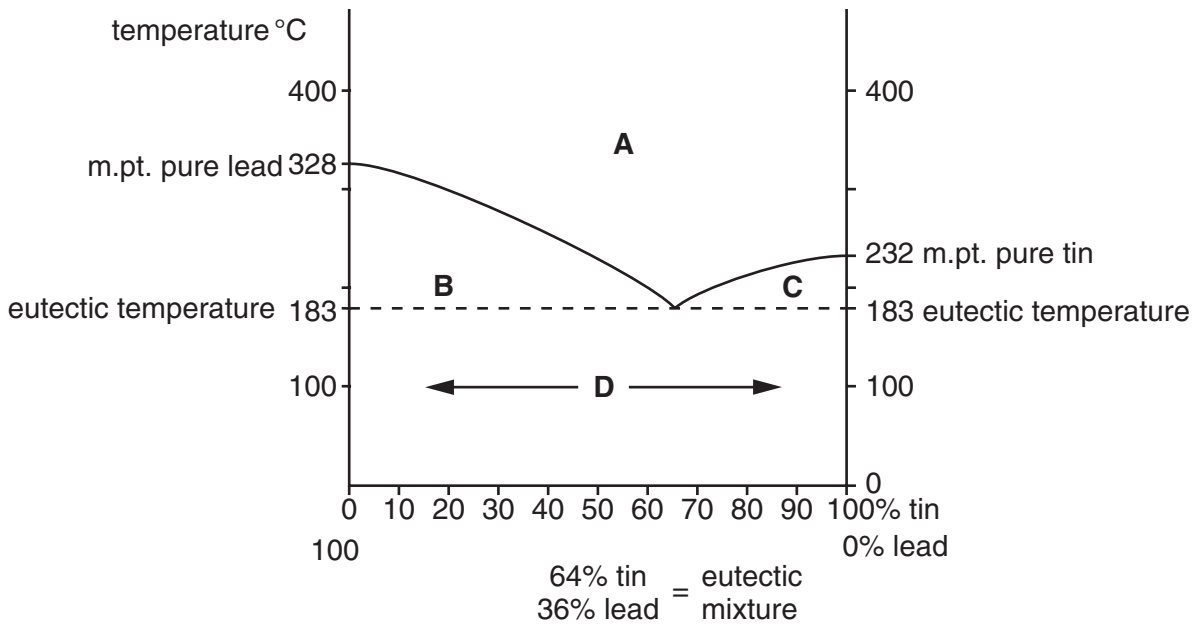


Fig. 2.1

(i) What do the areas **A**, **B**, **C** and **D** represent?

A

B

C

D

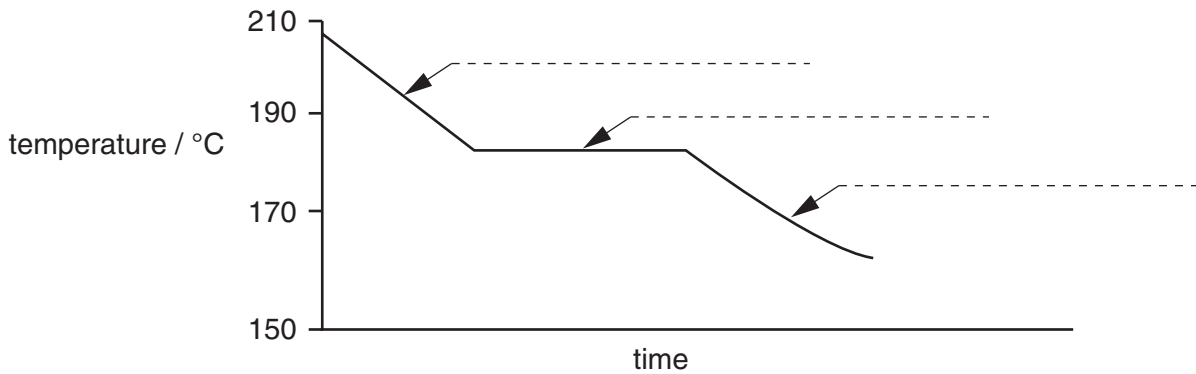
[2]

(ii) State what is meant by the term *eutectic*.

.....

..... [1]

(b) The cooling curve for the eutectic mixture in Fig. 2.1 on Page 4 is shown below.



(i) Label the cooling curve, indicating what is occurring in each section. [3]

(ii) In this question, one mark is available for the quality of use and organisation of scientific terms.

Use Fig. 2.1 to suggest how the cooling curve for a mixture of 40% tin and 60% lead, initially at 300 °C, would differ from that of the eutectic mixture.

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..... [5]

Quality of Written Communication [1]

(c) Explain simply why the hardness of an alloy can differ from that of a pure metal.

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..... [2]

[Total: 14]

3 This question concerns the distribution of substances between different phases.

(a) State *Henry's law*.

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..... [2]

(b) Air contains approximately 20% of oxygen and 80% of nitrogen by volume. Fish in an aquarium would die if they were kept in water containing this proportion of oxygen.

(i) Calculate, in mol dm^{-3} , the concentrations of the two gases in the water of an aquarium in equilibrium with air at a temperature of 300 K and a pressure of 100 kPa.

The Henry's law constants for oxygen and nitrogen at this temperature and pressure are $1.3 \times 10^{-5} \text{ mol dm}^{-3} \text{ kPa}^{-1}$ and $6.5 \times 10^{-6} \text{ mol dm}^{-3} \text{ kPa}^{-1}$ respectively.

[3]

(ii) Explain why, in prolonged spells of hot weather, owners of commercial trout farms sometimes need to aerate the water in which the fish are kept.

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..... [2]

- (c) State what is meant by the *partition coefficient* of a substance in a two liquid system.

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..... [1]

- (d) 5.00 g of an organic compound, **J**, becomes contaminated with inorganic impurities. It is dissolved in 100 cm³ of water. **J** can be extracted from the inorganic impurities by shaking the solution with ethoxyethane. The partition coefficient for this ethoxyethane : water system is 20.0.

- (i) If 100 cm³ of ethoxyethane is used, calculate the mass of **J** extracted.

answer g [2]

- (ii) What mass of **J** could be extracted if, instead of using one portion of 100 cm³ of ethoxyethane, two 50 cm³ portions were used?

answer g [2]

[Total: 12]

4 This question is about vapour pressure and distillation.

- (a) Raoult's law can be expressed algebraically as $p_A = n_A \times p_A^o$. Explain in words what this means.

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..... [1]

(b) Raoult's law is not always obeyed.

- (i) State what is meant by a *positive deviation* from Raoult's law.

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..... [1]

- (ii) Explain, in terms of molecular interactions, why a mixture may show a positive deviation from Raoult's law.

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..... [1]

(c) Water and ethanol form an azeotropic mixture with a composition of 95.6% ethanol. The mixture has a boiling point of 78.2 °C, whereas pure ethanol boils at 78.5 °C.

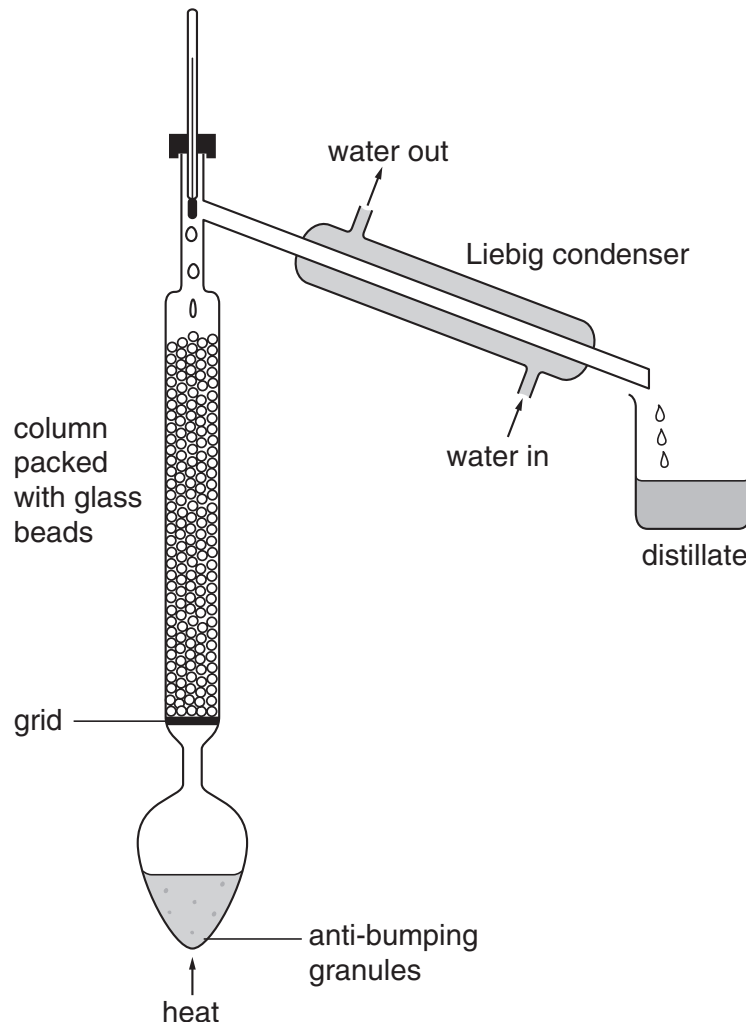
- (i) State what is meant by the term *azeotropic mixture*.

.....
..... [1]

- (ii) Comment on the feasibility of producing pure ethanol by distillation from a mixture of ethanol and water.

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..... [2]

- (d) In a laboratory, glass beads are often used in a fractionating column such as that shown below.



Explain how the beads help ensure efficient fractionation of a liquid mixture.

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..... [2]

- (e) Steam distillation is a technique often used when the boiling point of a natural product, such as a perfume, is close to the temperature at which it decomposes.

Explain how steam distillation is able to distil a liquid at a temperature lower than the boiling point of water or of the perfume.

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..... [2]

[Total: 10]

END OF QUESTION PAPER

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