Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/04**

Paper 4 Structured Questions A2 Core

October/November 2005

1 hour 15 minutes

Candidates answer on the Question Paper.
Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and candidate number in the spaces at the top of this page.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs, or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.
You may lose marks if you do not show your working or if you do not use appropriate units.
A Data Booklet is provided.
You may use a calculator.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

For Examiner's Use	
1	
2	
3	
4	
5	
TOTAL	

This document consists of **10** printed pages and **2** blank pages.

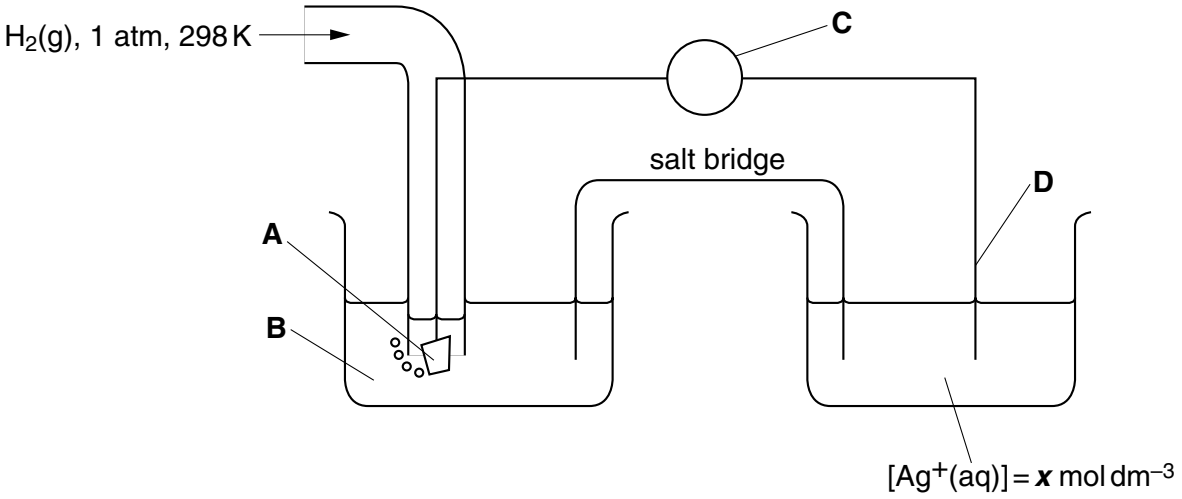
1 Silver bromide, AgBr, is widely used in photography. In a photographic film, AgBr crystals are precipitated into a gelatine base as 'grains' of diameter about 1×10^{-6} m.

(a) Calculate the approximate number of silver ions contained in a grain of AgBr of mass 2.5×10^{-12} g.

.....

..... [2]

(b) AgBr is only sparingly soluble in water. The $[Ag^+]$ in a saturated solution of AgBr can be estimated by measuring the E_{cell} of the following cell.



(i) In the spaces below, identify what the four letters **A** – **D** in the above diagram represent.

A ..... **C** .....

B ..... **D** .....

(ii) Predict how the potential of the right hand electrode might vary as $[Ag^+]$ is decreased.

.....

In its saturated solution, $[AgBr(aq)] = 7.1 \times 10^{-7}$ mol dm^{-3}.

(iii) Write an expression for the solubility product of AgBr, and calculate its value, including units.

.....

.....

[7]

(c) **(i)** Write a chemical equation representing the lattice energy of AgBr.

.....

(ii) Use the following data to calculate a value for the lattice energy of AgBr(s).

first ionisation energy of silver	=	+731 kJ mol^{-1}
electron affinity of bromine	=	–325 kJ mol^{-1}
enthalpy change of atomisation of silver	=	+285 kJ mol^{-1}
enthalpy change of atomisation of bromine	=	+112 kJ mol^{-1}
enthalpy change of formation of AgBr(s)	=	–100 kJ mol^{-1}

.....

(iii) How might the lattice energy of AgC*l* compare to that of AgBr? Explain your answer.

.....

.....

.....

[4]

In photography a bromide ion absorbs a photon and releases an electron which reduces a silver ion to a silver atom.

$$Br^- \longrightarrow Br + e^-$$

$$Ag^+ + e^- \longrightarrow Ag$$

(d) Predict whether it would require **more** energy or **less** energy to initiate this process in a AgC*l* emulsion, compared to a AgBr emulsion. Explain your answer.

.....

.....

..... [1]

[Total: 14]

2 **(a)** What do you understand by the term *standard electrode potential*?

.....

..... [2]

(b) By reference to relevant $E^{\ominus}$ data in the *Data Booklet*, explain how the halogen/halide electrode potentials relate to the relative reactivity of the halogens as oxidising agents.

.....

.....

..... [2]

(c) Use data from the *Data Booklet* to construct redox equations, and calculate the standard cell potentials, for the reactions between

(i) Acidified H_2O_2(aq) and KI(aq),

.....

(ii) Cl_2(aq) + SO_2(aq).

.....

[4]

(d) Use data from the *Data Booklet* to predict the likely product of the reaction between I_2(aq) and tin metal, writing a balanced equation for the reaction.

..... [2]

[Total: 10]

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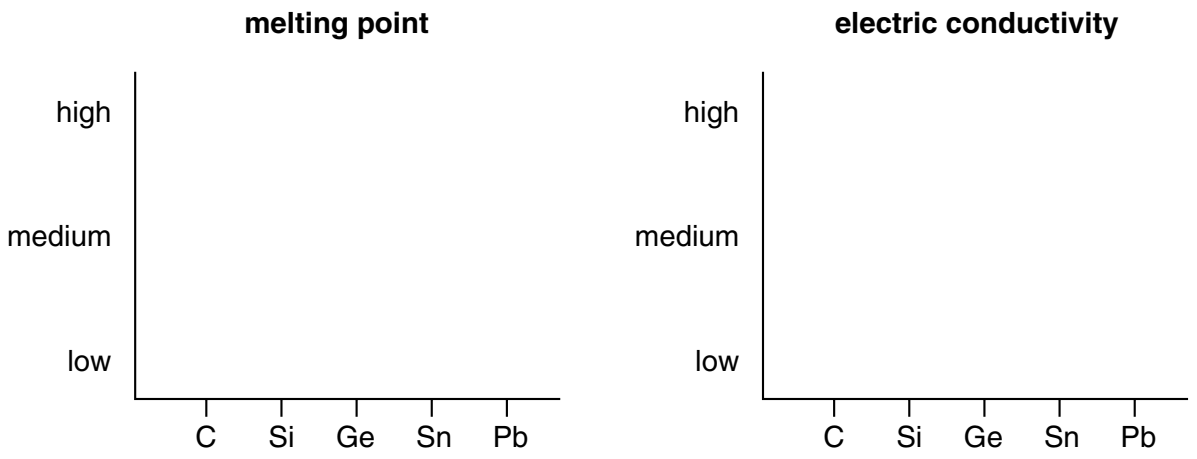
3 (a) (i) Use the following sets of axes to sketch graphs of the variations in the melting points and the electrical conductivities of the Group IV elements.



(ii) Explain how the variation in conductivity is related to the structure and bonding in the elements.

.....

.....

.....

[6]

(b) Going down Group IV there is a variation in the relative stabilities of the higher and lower oxidation states of the elements in their oxides.

Illustrating your answers with balanced chemical equations, in each of the following cases suggest **one** piece of chemical evidence to show that

(i) CO is less stable than CO_2,

.....

.....

(ii) PbO is more stable than PbO_2.

.....

.....

[3]

(c) Name **one** ceramic based on silicon(IV) oxide, and explain what properties of the oxide make it suitable for this use.

.....

..... [1]

(d) Tin(II) oxide reacts with both acids and alkalis.

(i) What name is given to this property of an oxide?

.....

(ii) Write suitable equations to show these two reactions of tin(II) oxide.

.....

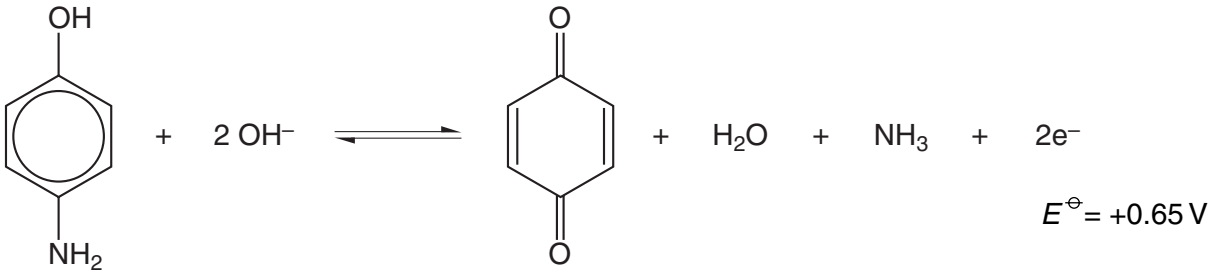
.....

[3]

[Total: 13]

[Turn over

4 Rodinol is used as a photographic developer. In alkaline solution it is a mild reducing agent, providing electrons according to the following half equation.



rodinol

Rodinol 'develops' a latent photographic image by reducing activated silver bromide grains to silver metal and bromide ions.

(a) Construct a balanced equation for the reaction between rodinol and AgBr.

..... [1]

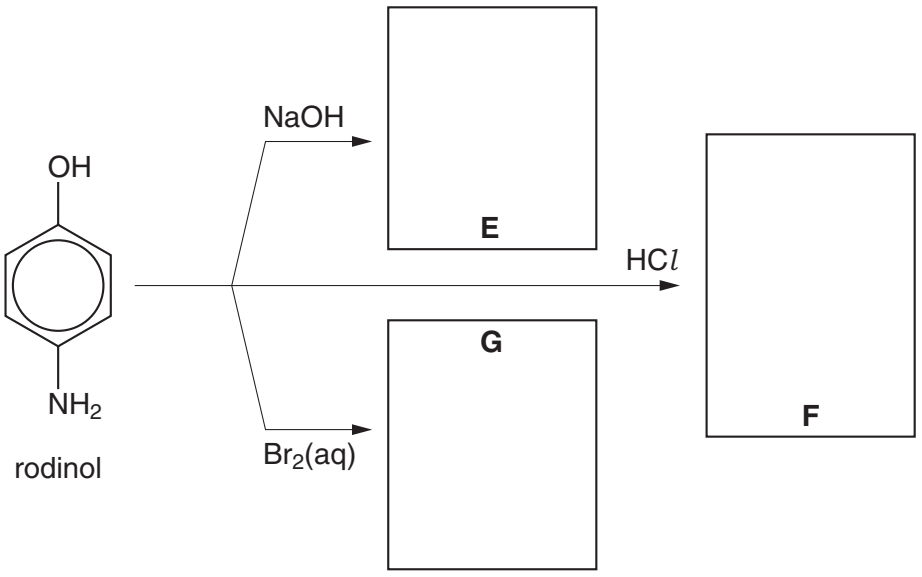
(b) Suggest, with a reason, how the basicity of rodinol might compare to that of ammonia.

.....

.....

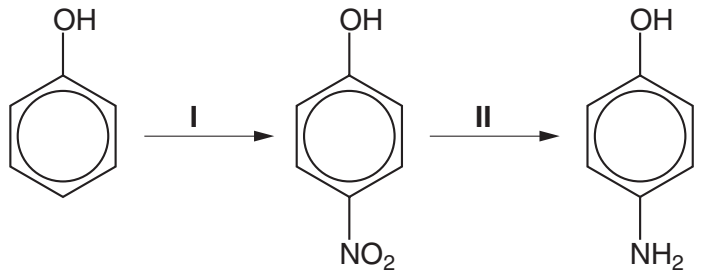
..... [2]

(c) Suggest structural formulae for the compounds **E**, **F** and **G** in the following chart of the reactions of rodinol.



[3]

(d) Rodinol can be synthesised from phenol by the following route.



(i) Suggest reagents and conditions for step **I**.

.....

(ii) What type of reaction is step **II**?

.....

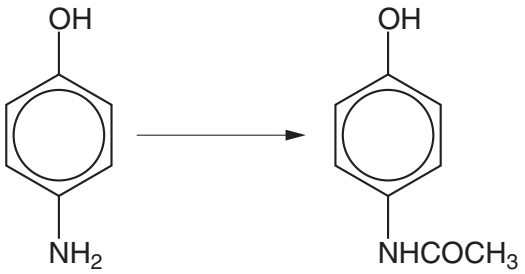
(iii) Place a tick in the box by the most suitable reagent for step **II**.

(place a tick in one box only)

H_3O^+ + heat	☐
$OH^-(aq)$ + heat	☐
$Cr_2O_7^{2-} + H^+$ + heat	☐
$HNO_3(aq)$	☐
Sn + HCl(aq)	☐
NH_3 in ethanol + heat/pressure	☐

[3]

(e) Rodinol is also an important intermediate in the commercial production of the analgesic drug *paracetamol*.



paracetamol

(i) Name **two** functional groups in *paracetamol*.

.....

.....

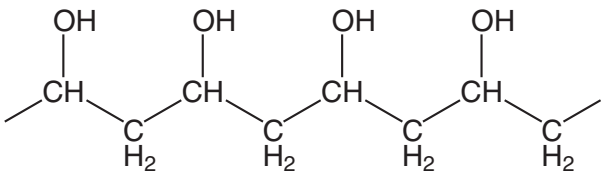
(ii) Suggest a reagent to convert rodinol into *paracetamol*.

.....

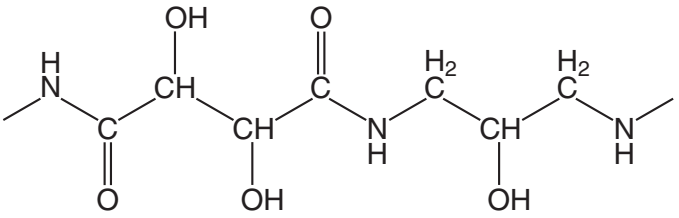
[3]

[Total: 12]

5 Hydrophilic polymers find important uses in the manufacture of contact lenses and wound dressings. Their chemical structures allow them to bond with water molecules, which keeps them soft and flexible. Sections of two hydrophilic polymers are shown below.



H



J

(a) What type of polymerisation has produced

(i) polymer **H**? .....

(ii) polymer **J**? .....

[2]

(b) What type of attractions might occur between these polymers and molecules of water?

..... [1]

(c) Chains of polymer **H** can be 'cross-linked', i.e. joined together, by reaction with a small bifunctional molecule.

(i) Which one of the following molecules would be most suitable for such cross-linking?

(place a tick in one box only)

$HOCH_2CH_2OH$	☐
$H_2NCH_2CH_2NH_2$	☐
$HOCH_2CH_2CO_2H$	☐
$HO_2CCH_2CH_2CO_2H$	☐
$H_2NCH_2CH_2CO_2H$	☐

(ii) What type of bond would be formed during the cross-linking?

.....

[2]

(d) **(i)** Suggest the reagents and conditions needed to hydrolyse polymer **J** into its monomers.

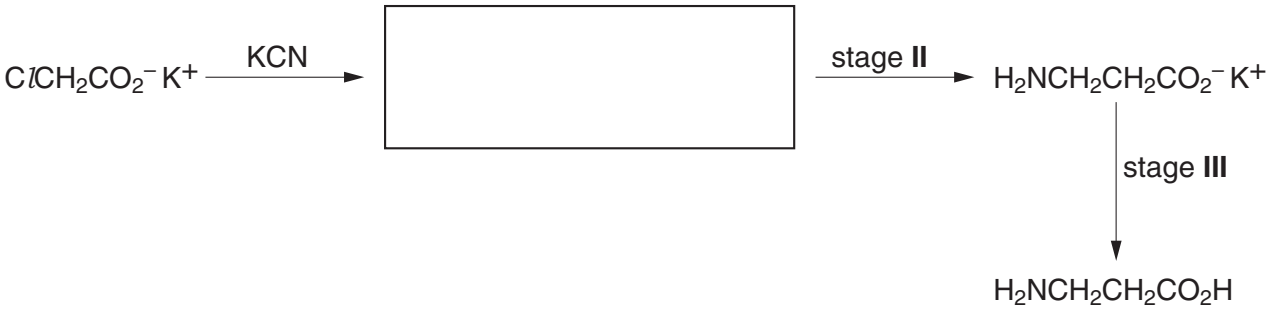
.....

(ii) Draw the structural formulae of the two products of this hydrolysis reaction.

.....

[3]

(e) The last compound in the list in **(c)(i)** above is 3-aminopropanoic acid. This can be made from potassium chloroethanoate by the following 3-stage route.



(i) In the box above write the structure of the intermediate in this route.

(ii) Suggest reagents and conditions for

stage **II** .....

stage **III** .....

[3]

[Total: 11]

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