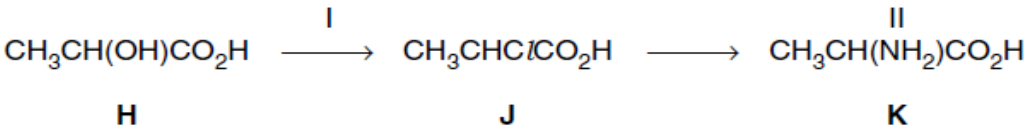
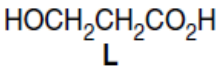
Q1 The amino acid alanine, **K**, can be obtained from 2-hydroxypropanoic acid, **H**, by the following route.



(a) Suggest a test you could use to distinguish **H** from its isomer 3-hydroxypropanoic acid, **L**.



L

reagents .....

observation with **H** .....

observation with **L** .....[2]

(b) How would the acidity of chloropropanoic acid, **J**, compare with that of propanoic acid? Briefly explain your answer.

.....

.....

.....[2]

(c) Alanine reacts with both acids and bases.
Write an equation for the reaction between alanine and sodium hydroxide, drawing the displayed formula of the organic product.

(d) In solution, alanine exists as a zwitterion. Draw the structure of this ion.

(e) Alanine is one of about 20 amino acids that make up proteins.
(i) What type of bond joins amino acids together in proteins?

.....

(ii) Draw the displayed formula of the compound formed when two alanine molecules are joined by this bond.

(f) An excess of benzoic acid in the body (present as a preservative in many foodstuffs, or formed by oxidation of aromatic compounds present in food) is excreted as hippuric acid, **M.**

M

(i) Suggest a reagent that could be reacted with glycine in the laboratory to form hippuric acid.

.....

(ii) Suggest the reagents and conditions needed to re-form glycine from hippuric acid.

.....

.....

(Nov 2003 Q5)

Q2 **(a)** Give an expression for K_a as applied to the weak acid RCO_2H.

.....

..... [1]

(b) The K_a values for three carboxylic acids are listed in the table below.

acid	K_a / mol dm^{-3}
CH_3CO_2H	1.8×10^{-5}
$ClCH_2CO_2H$	1.4×10^{-3}
Cl_2CHCO_2H	5.5×10^{-2}

(i) Describe and explain the trend in acid strength illustrated by these values.

.....

.....

.....

.....

(ii) Calculate the pH of a 0.100 moldm^{-3} solution of $ClCH_2CO_2H$.

.....

.....

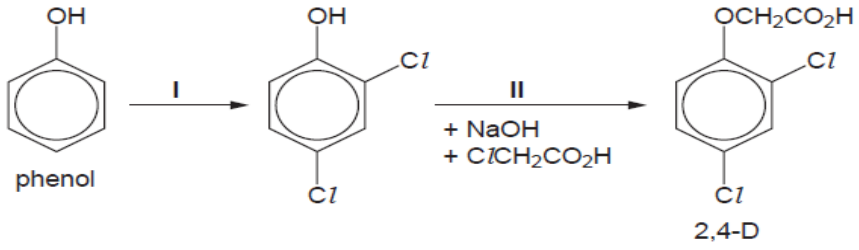
.....

(iii) Calculate the pK_a value for Cl_2CHCO_2H.

.....

.....

(c) The acid $ClCH_2CO_2H$ features in the industrial synthesis of the important weedkiller 2,4-D.



(i) Suggest a possible reagent for reaction **I**.

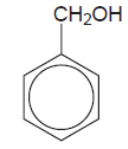
.....

(ii) What type of reaction is

reaction **I**, ...

reaction **II**? .....

(iii) Describe a test (reagents and observations) that would distinguish phenol from compound **A**.



compound **A**

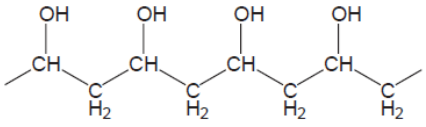
reagents .....

observation with phenol .....

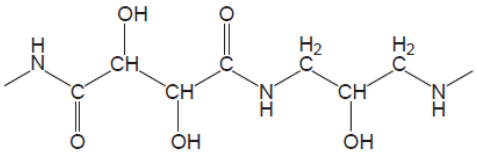
observation with compound **A** .....

(June 2005 Q5)

Q3 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**? .....

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

.....

(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 crosslinking?

(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?

.....

(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.

(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.

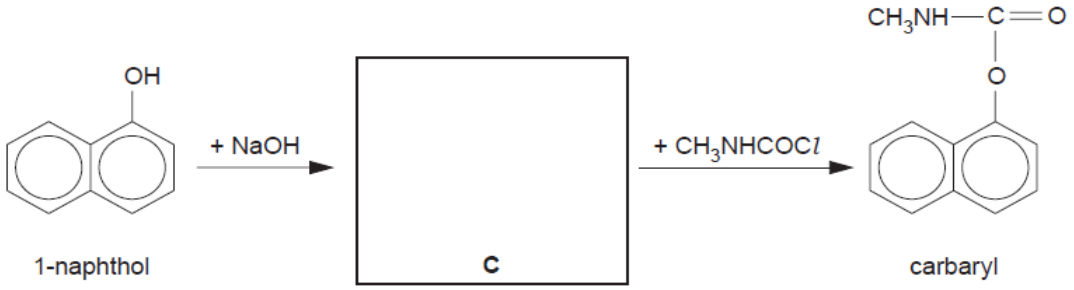
(i) In the box above write the structure of the intermediate in this route.
(ii) Suggest reagents and conditions for

stage **II** .....

stage **III** .....

(Nov 2005 Q5)

Q4 The phenol 1-naphthol is a starting point for the manufacture of carbaryl, an insecticide and a plant growth inhibitor.



(a) (i) Suggest a structure for the intermediate **C** and draw it in the box above.
(ii) Name the functional groups in carbaryl.

.....

.....

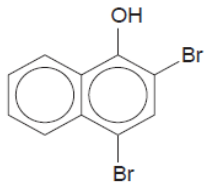
(iii) Suggest structures for the three products formed when carbaryl is hydrolysed.

(iv) What reagents and conditions would you use for this hydrolysis?

.....

(b) Suggest reagents and conditions for converting 1-naphthol into each of the following compounds.

(i)



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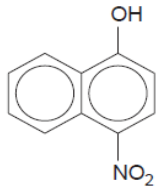
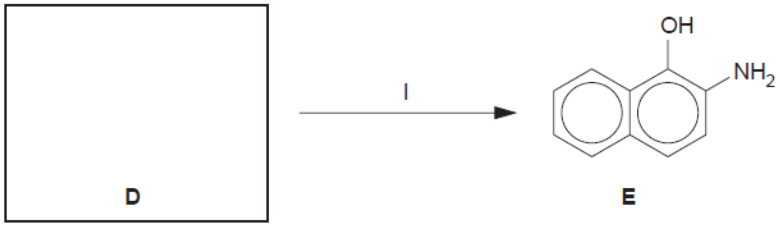
(ii)



.....

(c) Compound **D** is an isomer of 4-nitro-1-naphthol. **D** is formed as a by-product during the reaction in **b(ii)**. It can be converted into 2-amino-1-naphthol, **E**.



(i) Suggest the structural formula of the isomer **D**.

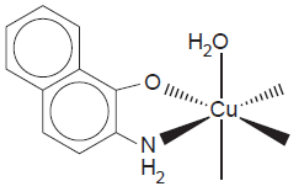
(ii) Suggest reagents needed for reaction I.

.....

(iii) Suggest the structural formula of the compound formed when compound **E** reacts with an excess of CH_3COCl.

(d) When an alkaline solution of compound **E** is added to a solution containing $Cu^{2+}(aq)$ ions, a pale green-blue precipitate **F** forms. Analysis of **F** shows that its formula is $Cu(C_{10}H_8NO)_2(H_2O)_2$.

(i) Complete the following structural formula of **F**.



When an excess of concentrated $NH_3(aq)$ is added to **F**, the precipitate dissolves to form a deep blue solution.

(ii) State the formula of the ion responsible for the deep blue colour.

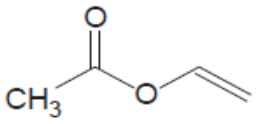
.....

(iii) What type of reaction is occurring here?

.....

(Nov 2007 Q6)

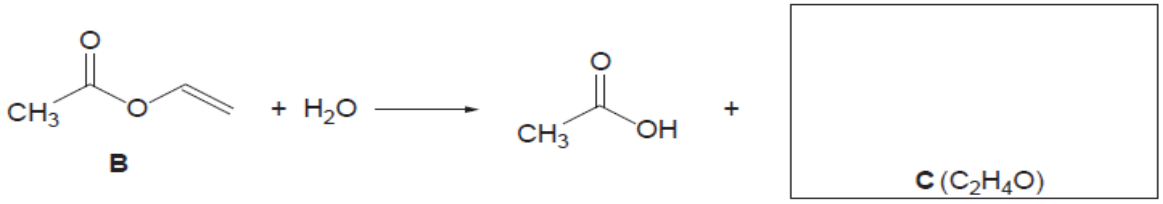
Q5 **(a)** Polyvinyl acetate, PVA, is a useful adhesive for gluing together articles made from wood, paper or cardboard. The monomer of PVA is ethenyl ethanoate, **B**.



B

PVA is formed from **B** by the process of addition polymerisation.
(i) Draw a section of the PVA molecule containing at least 2 monomer molecules, and identify clearly the repeat unit.

The ester **B** can be hydrolysed in the usual way, according to the following equation.

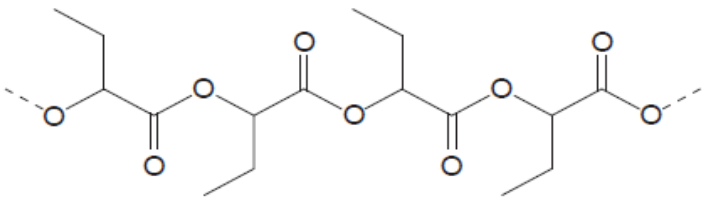


(ii) Use this information to suggest a possible structure for **C** and draw it in the box above.
When substance **C** is extracted from the product mixture, it is found that it does **not** decolourise $Br_2(aq)$, but it **does** form a pale yellow precipitate with alkaline aqueous iodine.
(iii) Suggest a structure for **C** that fits this new information.

(iv) Suggest a confirmatory test for the functional group in the structure you have drawn in **(iii)**. Your answer should include the reagent you would use and the observation you would make.

.....[6]

(b) The following diagram represents a section of another polymer.0



D

(i) On the above formula draw brackets, [ ], around the atoms that make up the repeat unit of this polymer.
(ii) Name the functional group in polymer **D**.

.....

(iii) Suggest and draw the structure of the monomer, **E**, that could form this polymer.

(iv) What *type of polymerisation* is involved in making polymer **D** from its monomer?

.....

(v) What is the relationship between the repeat unit of polymer **D** and the repeat unit of PVA?

.....

(c) Monomer **E** exists as two stereoisomers. Heating either isomer with Al_2O_3 gives a mixture of two unsaturated carboxylic acids **F** and **G**, which are stereoisomers of each other.

(i) Name the *type of stereoisomerism* shown by compound **E**.

.....

(ii) Suggest structures for **F** and **G**, and name the type of stereoisomerism they show.

type of isomerism .....

(June 2011 P42 Q4)