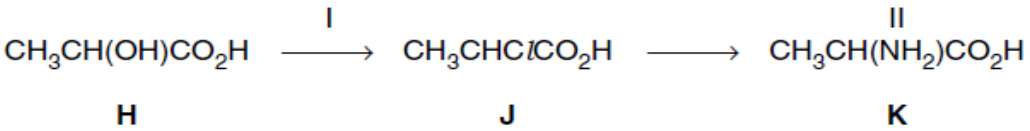
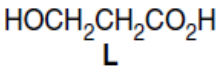
Q1 The amino acid alanine, **K**, can be obtained from 2-hydroxypropanoic acid, **H**, by the following route.



(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 $ClCH_2CO_2H$.

.....

.....

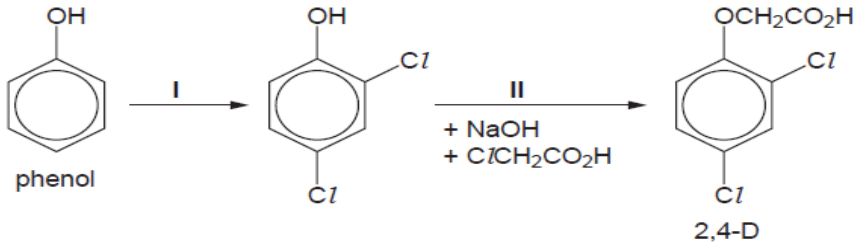
.....

(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**.

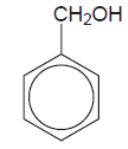
.....

(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**

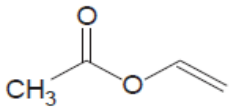
reagents .....

observation with phenol .....

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

(June 2005 Q5)

Q3 **(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**.

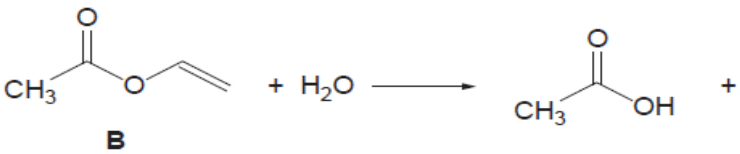


B

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.



B

C (C_2H_4O)

(ii) Use this information to suggest a possible structure for **C** and draw it in the box above.

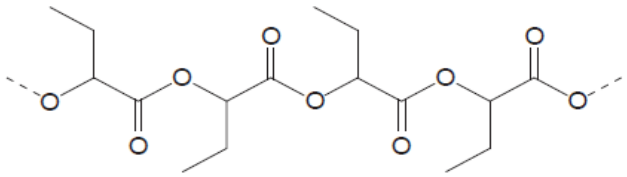
When substance **C** is extracted from the product mixture, it is found that it does **not** decolourise $Br_2(aq)$, but it **does** form a pale yellow precipitate with alkaline aqueous iodine.

(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**.

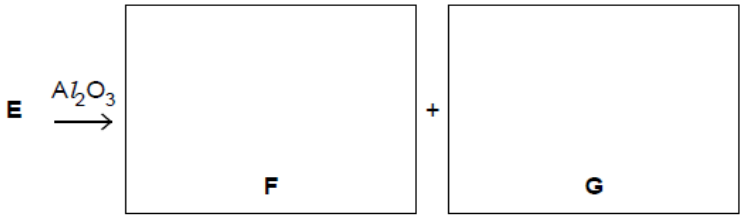
.....
(iii) Suggest and draw the structure of the monomer, **E**, that could form this polymer.

(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)

Q4 (a) Describe and explain how the acidities of $CHCl_2CO_2H$ and CH_2ClCO_2H compare to each other, and to the acidity of ethanoic acid.

.....

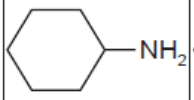
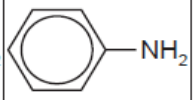
.....

.....

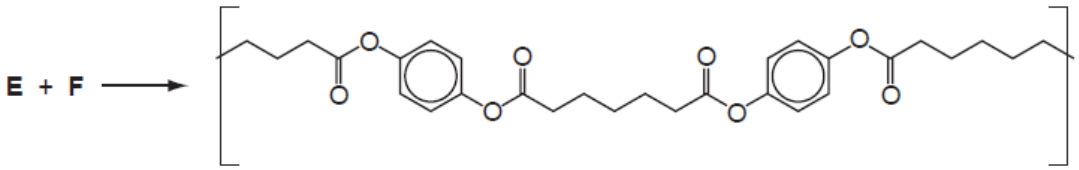
.....

.....[3]

(b) For each of the following pairs of compounds, suggest one chemical test (reagents and conditions) that would distinguish between them.
State the observations you would make with each compound, writing 'none' if appropriate.

first compound	second compound	test (reagents and conditions)	observation with first compound	observation with second compound
				
CH_3CH_2COCl	CH_3COCH_2Cl			
CH_3CH_2CHO	CH_3COCH_3			

(c) The following diagram shows a section (not a repeat unit) of a polymer, **G**, that can be made from the two monomers **E** and **F**.



polymer **G**

(i) What *type of polymerisation* made this polymer?

.....

(ii) Draw the structures of the two monomers **E** and **F**.

E **F**

(iii) Suggest the conditions needed to make polymer **G** from **E** and **F** in the laboratory.

.....

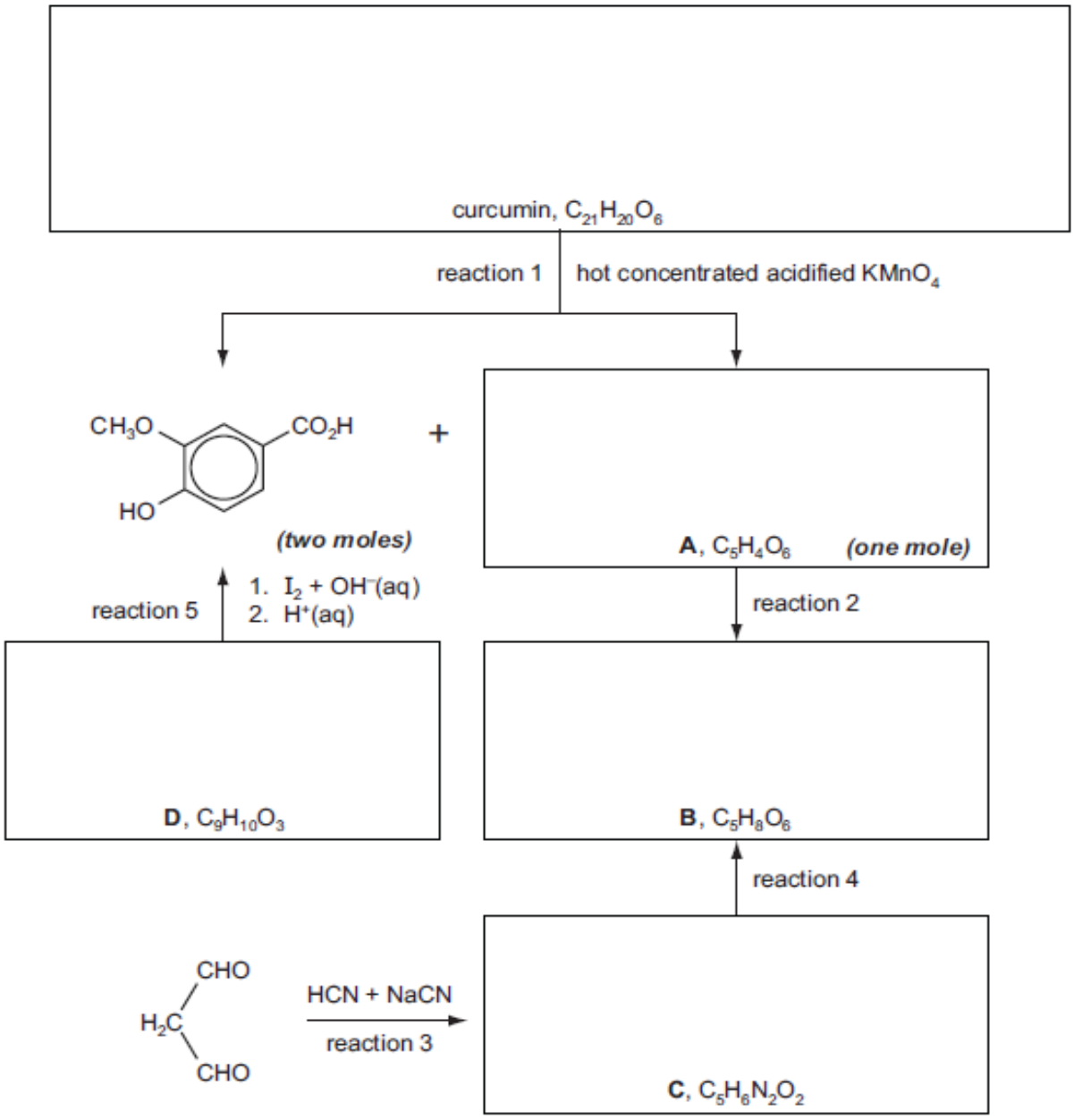
.....

.....

(iv) One of the monomers, **E** or **F**, could be changed to make a more rigid polymer of a similar chemical type to **G**.Suggest which of your two monomers could be changed, and suggest a structure for the new monomer.
Monomer to be changed (**E** or **F**) .....
Structural formula of the new monomer

(June 2012 42 Q5)

Q5 The compound responsible for the yellow colour of the spice turmeric is curcumin. Its molecular structure can be deduced from the following series of reactions.
The CH_3O – group that is present in curcumin may be regarded as unreactive.



Curcumin and compounds **A** and **D** all react with 2,4-dinitrophenylhydrazine reagent.
Compounds **A** and **B** effervesce with $Na_2CO_3(aq)$, but curcumin, and compounds **C** and **D**, do not. Curcumin reacts with $Br_2(aq)$ and with cold dilute acidified $KMnO_4$
(a) (i) Name the functional group common to curcumin and compounds **A** and **D**.

.....
(ii) Name the functional group common to compounds **A** and **B**.

.....[2]
(b) (i) Suggest the structures of compounds **B**, **C** and **D**, and draw their structural formulae in the relevant boxes opposite.
(ii) Suggest suitable reagents and conditions for reaction 4.

.....[4]

(c) (i) Name the *type of reaction* for reaction 2.

.....

(ii) Suggest a reagent for reaction 2.

.....

(iii) Suggest the structure of compound **A**, and draw its structural formula in the relevant box opposite.

[3]

(d) (i) Name the functional group in curcumin that reacts with cold dilute acidified $KMnO_4$.

.....

(ii) Name two functional groups in curcumin that react with $Br_2(aq)$.

.....[2]

(e) Suggest a structure for curcumin and draw its structural formula in the relevant box opposite.

[2]

(Nov 2012 P43 Q4)