

# CHEMISTRY MULTIPLE CHOICE QUESTIONS

---

Organic Chemistry Carboxylic  
acids and derivatives

---

2002 -2009

---

1.

2-Bromopropane,  $(\text{CH}_3)_2\text{CHBr}$ , may be used as the starting point for making  $(\text{CH}_3)_2\text{CHCO}_2\text{H}$ .

Which of the following sequences would be most suitable?

- A  $(\text{CH}_3)_2\text{CHBr} \rightarrow (\text{CH}_3)_2\text{CHOH} \rightarrow (\text{CH}_3)_2\text{CHCO}_2\text{H}$
- B  $(\text{CH}_3)_2\text{CHBr} \rightarrow (\text{CH}_3)_2\text{CHCN} \rightarrow (\text{CH}_3)_2\text{CHCO}_2\text{H}$
- C  $(\text{CH}_3)_2\text{CHBr} \rightarrow (\text{CH}_3)_2\text{CHOH} \rightarrow (\text{CH}_3)_2\text{CHCN} \rightarrow (\text{CH}_3)_2\text{CHCO}_2\text{H}$
- D  $(\text{CH}_3)_2\text{CHBr} \rightarrow (\text{CH}_3)_2\text{CHCN} \rightarrow (\text{CH}_3)_2\text{CHOH} \rightarrow (\text{CH}_3)_2\text{CHCO}_2\text{H}$

[2002 M/J (23)]

2.

A compound X has all of the following properties:

it is a liquid at room temperature and atmospheric pressure;

it does not mix completely with water;

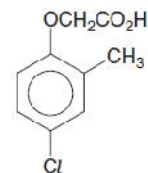
it does not decolorise acidified potassium manganate(VII).

What could X be?

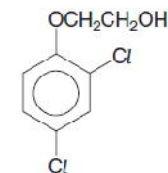
- A ethane
- B ethanoic acid
- C ethanol
- D ethyl ethanoate

[2002 M/J (27)]

MCPA and 2,4-D are two widely-used selective weedkillers.



MCPA



2,4-D

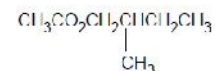
Which reagent will distinguish MCPA from 2,4-D?

- A acidified  $\text{AgNO}_3(\text{aq})$
- B Fehling's solution
- C Na
- D  $\text{Na}_2\text{CO}_3(\text{aq})$

[2002 M/J (29)]

4.

An ester with an odour of banana has the following formula.



In which of the following do the substances react together, under suitable conditions, to produce this ester?

- A  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CO}_2\text{H} + \text{CH}_3\text{OH}$
- B  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{OH}$
- C  $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$
- D  $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{Cl}_2$

[2002 O/N (30)]

5.

A compound **X** has all of the properties below.

- It is a liquid at 25°C.
- It mixes completely with water.
- It reacts with aqueous sodium hydroxide.

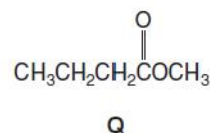
What could **X** be?

- A ethanoic acid  
 B ethanol  
 C ethene  
 D ethyl ethanoate

[2003 O/N (30)]

6.

The flavour of pineapples is partly due to the compound **Q**.

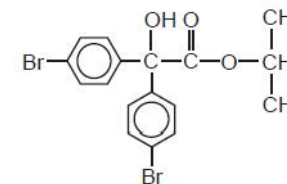


When **Q** is heated under reflux with NaOH(aq) and the mixture distilled, what compounds will be found in the distillate?

- 1 CH<sub>3</sub>OH  
 2 CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CO<sub>2</sub>Na  
 3 CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH

[2003 O/N (40)]

*Acarol* is sold as an insecticide for use on fruit and vegetables.



*Acarol*

The final stage of its manufacture is an esterification.

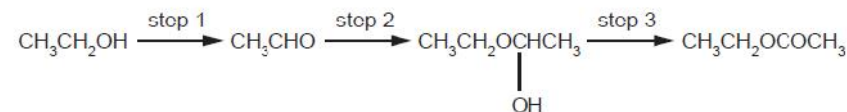
Which alcohol is used to form the ester?

- A di(4-bromophenyl)methanol  
 B methanol  
 C propan-1-ol  
 D propan-2-ol

[2004 O/N (30)]

8.

Ethyl ethanoate is a very important solvent in industry. Currently, researchers are investigating ways of producing the ester from cheap, low grade ethanol by the following process.



What types of reaction are steps 1 and 3?

	step 1	step 3
A	elimination	esterification
B	elimination	isomerisation
C	oxidation	esterification
D	oxidation	oxidation

[2005 M/J (25)]

9. Which compound reacts with its own oxidation product (an oxidation which involves no loss of carbon) to give a sweet-smelling liquid?

- A propanal
- B propanoic acid
- C propanone
- D propan-1-ol

[2005 M/J (27)]

10. Ibuprofen is an anti-inflammatory drug.



ibuprofen

What reaction would lead to its formation?

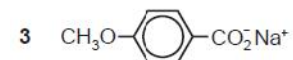
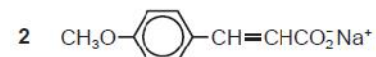
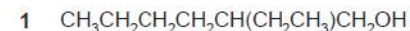
- A  $(\text{CH}_3)_2\text{CHCH}_2$ -C<sub>6</sub>H<sub>4</sub>-C(CH<sub>3</sub>)=CH<sub>2</sub> + hot concentrated KMnO<sub>4</sub>
- B  $(\text{CH}_3)_2\text{CHCH}_2$ -C<sub>6</sub>H<sub>4</sub>-CH(CH<sub>3</sub>)CHO + warm acidified K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>
- C  $(\text{CH}_3)_2\text{CHCH}_2$ -C<sub>6</sub>H<sub>4</sub>-CH(CH<sub>3</sub>)COCH<sub>3</sub> + warm H<sub>2</sub>SO<sub>4</sub>(aq)
- D  $\text{CH}_2=\text{C}(\text{CH}_3)\text{CH}_2$ -C<sub>6</sub>H<sub>4</sub>-C(=O)OCH<sub>3</sub> + H<sub>2</sub>/Pt catalyst

[2005 M/J (29)]

A sun protection cream contains the following ester as its active ingredient.

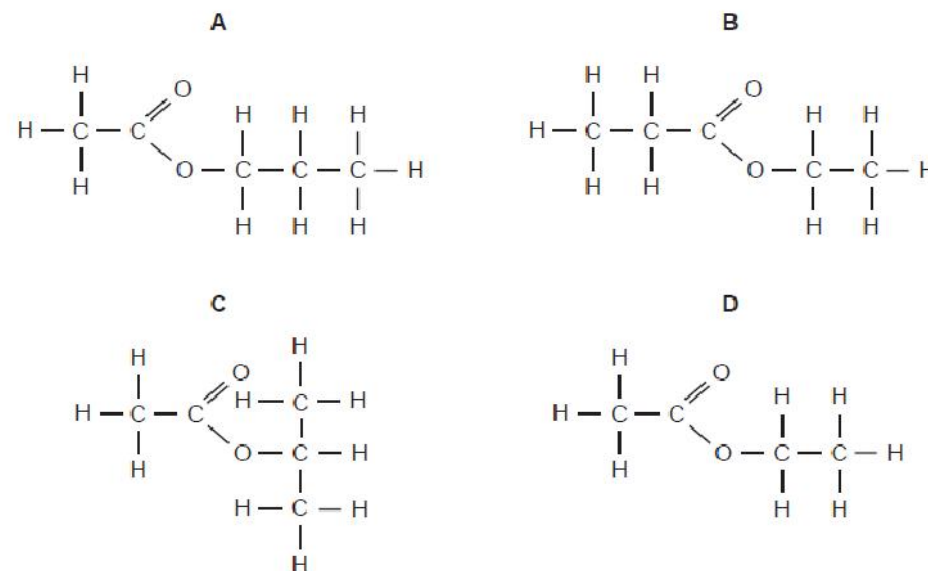


What are the products of its partial or total hydrolysis by aqueous sodium hydroxide?



[2005 M/J (40)]

12. What is the structure of the ester formed from propanoic acid and ethanol?

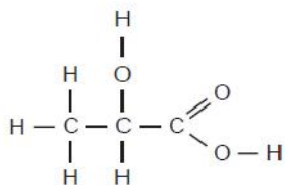


[2005 O/N (28)]

13.

Lactic acid occurs naturally, for example in sour milk.

Its displayed formula is shown.



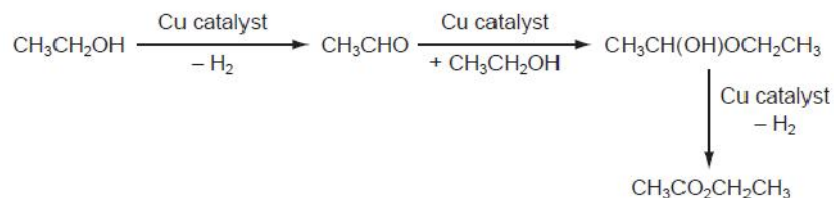
Which reaction occurs with lactic acid?

- A It decolourises aqueous bromine rapidly.
- B It is insoluble in water.
- C It reduces Fehling's reagent.
- D Two molecules react with each other in the presence of a strong acid.

[2005 O/N (29)]

14.

A new industrial preparation of ethyl ethanoate has been developed using cheap sources of ethanol.



Which process is involved at some stage in this reaction sequence?

- A disproportionation
- B electrophilic addition
- C nucleophilic addition
- D reduction

[2006 M/J (20)]

15.

Which compound is a product of the hydrolysis of  $\text{CH}_3\text{CO}_2\text{C}_3\text{H}_7$  by boiling aqueous sodium hydroxide?

- A  $\text{CH}_3\text{OH}$
- B  $\text{C}_3\text{H}_7\text{OH}$
- C  $\text{C}_3\text{H}_7\text{CO}_2\text{H}$
- D  $\text{C}_3\text{H}_7\text{CO}_2\text{Na}^+$

[2006 M/J (30)]

16.

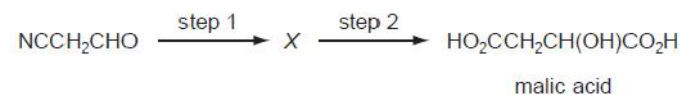
Which statements about lactic acid,  $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$ , are correct?

- 1 Lactic acid forms optical isomers.
- 2 Two hydrogen atoms per lactic acid molecule can be involved in hydrogen bonding.
- 3 Lactic acid would form an aldehyde when oxidised by acidified potassium dichromate(VI).

[2006 M/J (40)]

17.

Apples, the fruit of trees of the genus *Malus*, are rich in malic acid. Malic acid may be synthesised in the laboratory in two steps.



Which reagents could be used for this synthesis?

	step 1	step 2
A	HCl(aq)	HCN(g)
B	HCN, NaCN(aq/alcoholic)	H <sub>2</sub> SO <sub>4</sub> (aq)
C	H <sub>2</sub> SO <sub>4</sub> (aq)	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> /H <sub>2</sub> SO <sub>4</sub> (aq)
D	KCN(aq/alcoholic)	HCl(aq)

[2006 O/N (29)]

18.

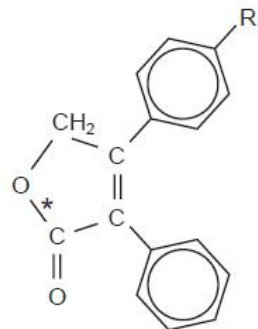
Which pair of compounds is formed when the ester  $C_2H_5CO_2CH_3$  is boiled with aqueous sodium hydroxide?

- A  $C_2H_5CO_2H$        $CH_3OH$   
 B  $C_2H_5CO_2Na$      $CH_3ONa$   
 C  $C_2H_5CO_2Na$      $CH_3OH$   
 D  $C_2H_5OH$          $CH_3CO_2Na$

[2006 O/N (30)]

19.

Rofecoxib, an efficient drug against arthritis, has the following structure. R is an inert group.



Which reactions are possible with this structure?

- The bond marked \* is hydrolysed by heating with aqueous sodium hydroxide.
- Aqueous bromine is decolourised.
- An orange precipitate is formed with 2,4-dinitrophenylhydrazine reagent.

[2006 O/N (40)]

20. Which reagent could be used to convert  $CH_3CO_2CH_3$  into  $ClCH_2CO_2CH_3$ ?

- A concentrated hydrochloric acid at  $100^\circ C$   
 B phosphorus pentachloride at room temperature  
 C sulphur dichloride oxide (thionyl chloride,  $SOCl_2$ ) at  $50^\circ C$   
 D chlorine in bright sunlight at  $100^\circ C$

[2007 M/J (21)]

21.

Which formula represents the organic compound formed by the reaction of propanoic acid with methanol in the presence of concentrated sulphuric acid as a catalyst?

- A  $CH_3CH_2COCH_3$   
 B  $CH_3CH_2CO_2CH_3$   
 C  $CH_3CO_2CH_2CH_3$   
 D  $CH_3CH_2CH_2CO_2CH_3$

[2007 M/J (30)]

22.

Fats and grease that build up on pans used in cooking are esters. Pans which are dirty from fats or grease may be cleaned by heating them with a reagent that will react with the ester group.

What may be used to clean such pans by this reaction?

- vinegar - aqueous ethanoic acid,  $CH_3CO_2H$
- alcohol - ethanol,  $C_2H_5OH$
- baking powder - sodium hydrogencarbonate,  $NaHCO_3$

[2007 M/J (40)]

23.

The ester  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_3$  is responsible for the aroma of apples.

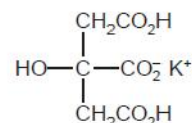
When this ester is hydrolysed by acid in the stomach, what is the empirical formula of the organic acid produced?

- A  $\text{CH}_4\text{O}$       B  $\text{C}_2\text{H}_4\text{O}$       C  $\text{C}_2\text{H}_4\text{O}_2$       D  $\text{C}_3\text{H}_7\text{O}_2$

[2007 O/N (30)]

24.

Monopotassium citrate is used as an emulsifying agent in powdered milk and in powdered soups. It may be represented by the formula shown.



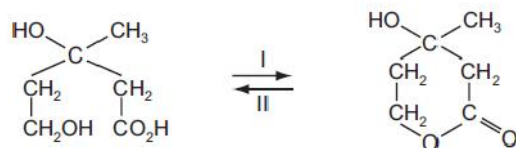
Which statements about monopotassium citrate are correct?

- 1 It can form optical isomers.
- 2 It can act as a dibasic acid.
- 3 It can form esters with both acids and alcohols.

[2007 O/N (40)]

25.

Mevalonic acid, 3,5-dihydroxy-3-methylpentanoic acid, is involved in cholesterol formation in the body. It is an oil that occurs as a mixture of the two interchanging molecules shown in the diagram.

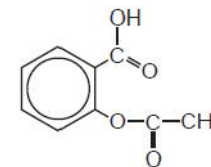


What names are used to describe the pair of interchanging reactions I and II?

- A condensation and addition  
B dehydrogenation and hydrogenation  
C esterification and hydrolysis  
D neutralisation and acidification

[2008 M/J (24)]

Aspirin is a widely-available pain-killer, whose properties have been known for centuries. The structure of aspirin is shown.



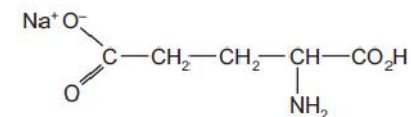
Which functional groups are present in aspirin?

- 1 alcohol
- 2 carboxylic acid
- 3 ester

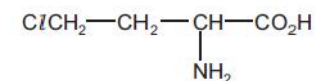
[2008 M/J (37)]

27.

The structure of monosodium glutamate, a flavour enhancer, is shown.



It may be prepared starting from the following compound.



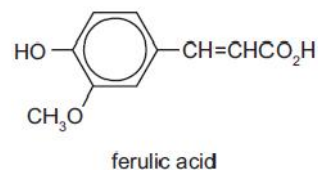
Which set of reagents and reaction conditions could be used to prepare monosodium glutamate?

- 1 Heat under reflux with ethanolic KCN followed by hydrolysis with  $\text{NaOH}(\text{aq})$ .
- 2 Heat with sodium methanoate,  $\text{HCO}_2^- \text{Na}^+$ .
- 3 Heat under reflux with  $\text{NaOH}(\text{aq})$ .

[2008 M/J (38)]

28.

Ferulic acid is an antioxidant that occurs widely in plants.



Which reagents can react with the  $-\text{CH}=\text{CHCO}_2\text{H}$  part of the molecule?

- 1 NaOH(aq)
- 2 acidified  $\text{KMnO}_4$
- 3 HBr

[2008 M/J (40)]

29.

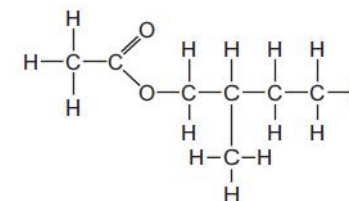
Ethyl phenylethanoate,  $\text{C}_6\text{H}_5\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$ , gives a characteristic flowery aroma to honey.

Which sequence of reagents, with heating in each case, leads to the preparation of  $\text{C}_6\text{H}_5\text{CH}_2\text{CO}_2\text{C}_2\text{H}_5$  from  $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$ ?

- A  $\text{C}_6\text{H}_5\text{CH}_2\text{Br} \xrightarrow{\text{NaOH(aq)}} \xrightarrow{\text{C}_2\text{H}_5\text{COCl}}$
- B  $\text{C}_6\text{H}_5\text{CH}_2\text{Br} \xrightarrow{\text{NaOH(aq)}} \xrightarrow{\text{C}_2\text{H}_5\text{CO}_2\text{H, conc. H}_2\text{SO}_4}$
- C  $\text{C}_6\text{H}_5\text{CH}_2\text{Br} \xrightarrow{\text{NaCN(alcoholic)}} \xrightarrow{\text{H}^+(\text{aq})} \xrightarrow{\text{C}_2\text{H}_5\text{OH, conc. H}_2\text{SO}_4}$
- D  $\text{C}_6\text{H}_5\text{CH}_2\text{Br} \xrightarrow{\text{NaOH(aq)}} \xrightarrow{\text{conc. MnO}_4^-, \text{H}^+(\text{aq})} \xrightarrow{\text{C}_2\text{H}_5\text{OH, conc. H}_2\text{SO}_4}$

[2008 O/N (26)]

Bees use 2-methylbutyl ethanoate as an 'alarm' pheromone. When disturbed, individual bees on guard will raise their abdomen and emit the alarm pheromone, fanning their wings to aid its dispersal. This alerts other bees to a danger and makes them ready to sting when required.



2-methylbutyl ethanoate

Which starting materials would be required to synthesise 2-methylbutyl ethanoate?

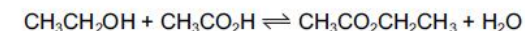
- A  $\text{CH}_3\text{CH}_2\text{OH}$  and  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CO}_2\text{H}$
- B  $\text{CH}_3\text{CO}_2\text{H}$  and  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$
- C  $\text{CH}_3\text{CH}_2\text{OH}$  and  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CO}_2\text{H}$
- D  $\text{CH}_3\text{CO}_2\text{H}$  and  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CO}_2\text{H}$

[2008 O/N (28)]

31.

Use of the Data Booklet is relevant to this question.

Ethyl ethanoate can be obtained from ethanoic acid and ethanol by the following reaction.



Ethanol (30 g) and ethanoic acid (30 g) are heated under reflux together, and 22 g of ethyl ethanoate are obtained.

What is the yield of the ester?

- A 25%
- B 38%
- C 50%
- D 77%

[2008 O/N (30)]



32.

Trichloroethanoic acid,  $\text{CCl}_3\text{CO}_2\text{H}$ , is used in cosmetic surgery to perform a 'chemical peel' to remove dead skin.

Trichloroethanoic acid can be made by reacting chlorine with ethanoic acid.

What is the mechanism of this reaction?

- A electrophilic addition
- B electrophilic substitution
- C free radical addition
- D free radical substitution

[2009 M/J (22)]

33.

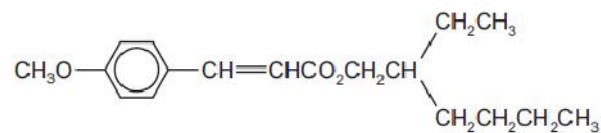
Which ester is formed when the alcohol  $\text{CH}_3\text{CH}_2\text{OH}$  is reacted with  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ ?

- A ethyl propanoate
- B ethyl butanoate
- C propyl ethanoate
- D butyl ethanoate

[2009 M/J (27)]

34.

A sun protection cream contains the following ester as its active ingredient.

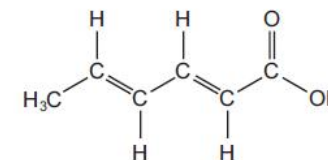


What are the products of its partial or total hydrolysis by aqueous sodium hydroxide?

- 1  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}_2\text{OH}$
- 2  $\text{CH}_3\text{O}-\text{C}_6\text{H}_4-\text{CH}=\text{CHCO}_2^- \text{Na}^+$
- 3  $\text{CH}_3\text{O}-\text{C}_6\text{H}_4-\text{CO}_2^- \text{Na}^+$

[2009 M/J (40)]

Sorbic acid is used as a food preservative because it kills fungi and moulds.



sorbic acid

Sorbic acid will react with

- hydrogen in the presence of a nickel catalyst,
- bromine in an organic solvent.

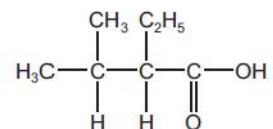
How many moles of hydrogen and of bromine will be incorporated into one mole of sorbic acid by these reactions?

	moles of hydrogen	moles of bromine
A	2	2
B	2	$2\frac{1}{2}$
C	3	2
D	3	$2\frac{1}{2}$

[2009 O/N-11 (24)]

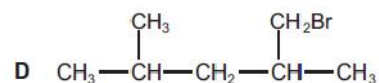
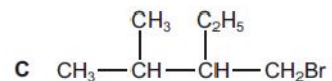
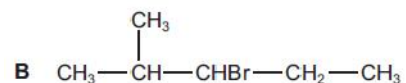
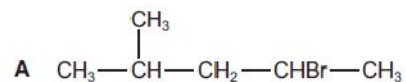
36.

The characteristic odour of rum is attributed to the compound 2-ethyl-3-methylbutanoic acid.



2-ethyl-3-methylbutanoic acid

Which compound will produce 2-ethyl-3-methylbutanoic acid by heating under reflux with alcoholic sodium cyanide and subsequent acid hydrolysis of the reaction product?



[2009 O/N-11 (29)]