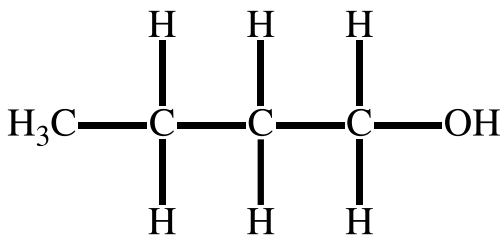
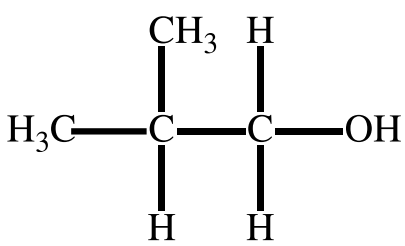
Butanol Dehydration

A Level

The four different isomers of butanol (**1** - **4**) can be dehydrated to give four isomers of butene (**A** - **D**)



1



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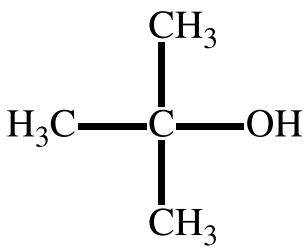

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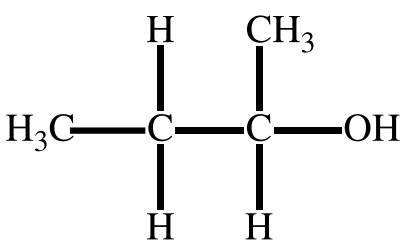

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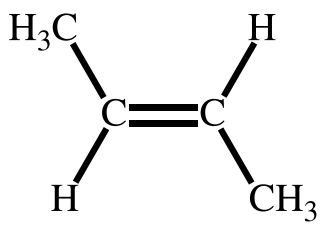
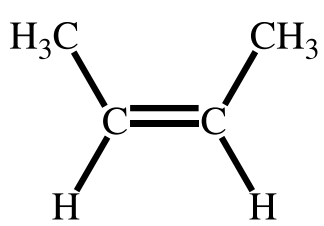
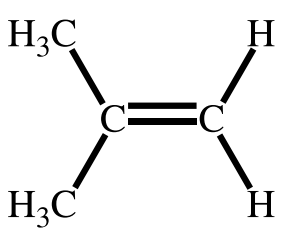


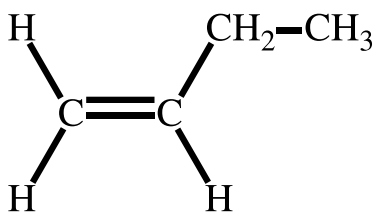
A



B



C



D

Figure 1: Isomers of butanol and butene

Part A A

Which isomer(s) of butanol could give rise to butene **A**?

- **1** only
- **2** only
- **3** only
- **4** only
- **1** and **2** only
- **2** and **3** only
- **3** and **4** only
- **1** and **4** only

Part B B

Which isomer(s) of butanol could give rise to butene **B**?

- **1** only
- **2** only
- **3** only
- **4** only
- **1** and **2** only
- **2** and **3** only
- **3** and **4** only
- **1** and **4** only

Part C C

Which isomer(s) of butanol could give rise to butene **C**?

- **1** only
- **2** only
- **3** only
- **4** only
- **1** and **2** only
- **2** and **3** only
- **3** and **4** only
- **1** and **4** only

Part D D

Which isomer(s) of butanol could give rise to butene **D**?

- **1** only
- **2** only
- **3** only
- **4** only
- **1** and **2** only
- **2** and **3** only
- **3** and **4** only
- **1** and **4** only

Part E Reaction type

What type of reaction is this? e.g. addition, elimination, substitution, oxidation, reduction etc.

Created for isaacphysics.org by R. Less

Alcohol Dehydration

A Level

P P P

Part A Preparation of ethene

In a preparation of ethene, ethanol is added a drop at a time to a heated reagent **Y**. The impure ethene is washed by being bubbled through a solution **Z** and then collected. What are reagent **Y** and solution **Z** likely to be?

	reagent Y	solution Z
A	acidified $\mathrm{K_2Cr_2O_7}$	dilute NaOH
B	concentrated $\mathrm{H_2SO_4}$	dilute $\mathrm{H_2SO_4}$
C	concentrated $\mathrm{H_2SO_4}$	dilute NaOH
D	ethanolic NaOH	concentrated $\mathrm{H_2SO_4}$
E	ethanolic NaOH	dilute NaOH

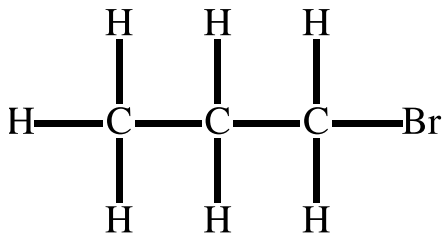
- **A**
- **B**
- **C**
- **D**
- **E**

Part B Dehydration of propan-1-ol

Propan-1-ol, C_3H_7OH, is dehydrated by passing its vapour over hot aluminium oxide to give a hydrocarbon.

Which structural formula represents the product obtained when the hydrocarbon reacts with bromine?

A



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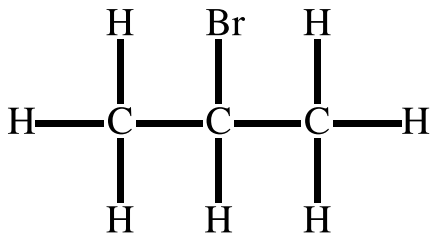

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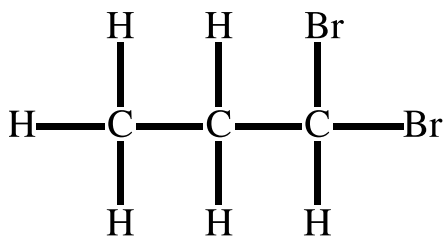

D

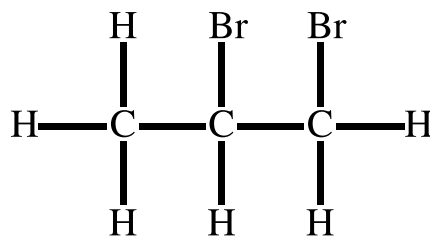

Figure 1: Possible structures after dehydration and bromination of propan-1-ol

- A
- B
- C
- D

Part A adapted with permission from UCLES, A-Level Chemistry, June 1990, Paper 1, Question 27;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1996, Paper 3, Question 21

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Butanol Oxidation

A Level

Dilute acidified sodium dichromate(VI) is used to distinguish between primary, secondary and tertiary alcohols. Draw full structural formulae of the final organic products (if any) when the following alcohols are treated with this reagent under reflux.

Use the structure editor to generate a SMILES string.

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

Using the structure editor

Part A $CH_3CH_2CH(OH)CH_3$

$CH_3CH_2CH(OH)CH_3 \longrightarrow$

Part B $(CH_3)_3COH$

$(CH_3)_3COH \longrightarrow$

Adapted with permission from UCLES, A-Level Chemistry, June 1990, Paper 2, Question 3

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Aldehyde and Alcohol Reactions

A Level

Part A Bioluminescence

The production of light by animals and plants is known as bioluminescence. It sometimes involves the following reaction:

$$\mathrm{CH_3(CH_2)_8CHO} \xrightarrow{\text{enzyme}} \mathrm{CH_3(CH_2)_8COOH}$$

What type of reaction is this?

- Substitution
- Elimination
- Oxidation
- Reduction
- Addition

Part B Butan-2-ol with potassium dichromate(VI)

Which of the following are produced when an aqueous solution of butan-2-ol is refluxed with potassium dichromate(VI) in dilute sulfuric acid?

1 butanal
2 butanoic acid
3 butanone

- **1**, **2** and **3** are correct
- **2** and **3** only are correct
- **1** and **2** only are correct
- **3** only is correct
- **1** only is correct

Part A adapted with permission from UCLES, A-Level Chemistry, November 1994, Paper 4, Question 25;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1993, Paper 3, Question 38

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Alcohol Reactions

A Level

The compound C_3H_8O has two isomers that are alcohols. These isomers can undergo a series of reactions with the reagents shown giving organic products.

Deduce the identity of each of the organic products **A** to **D**. Use the structure editor to generate SMILES strings as your answers.

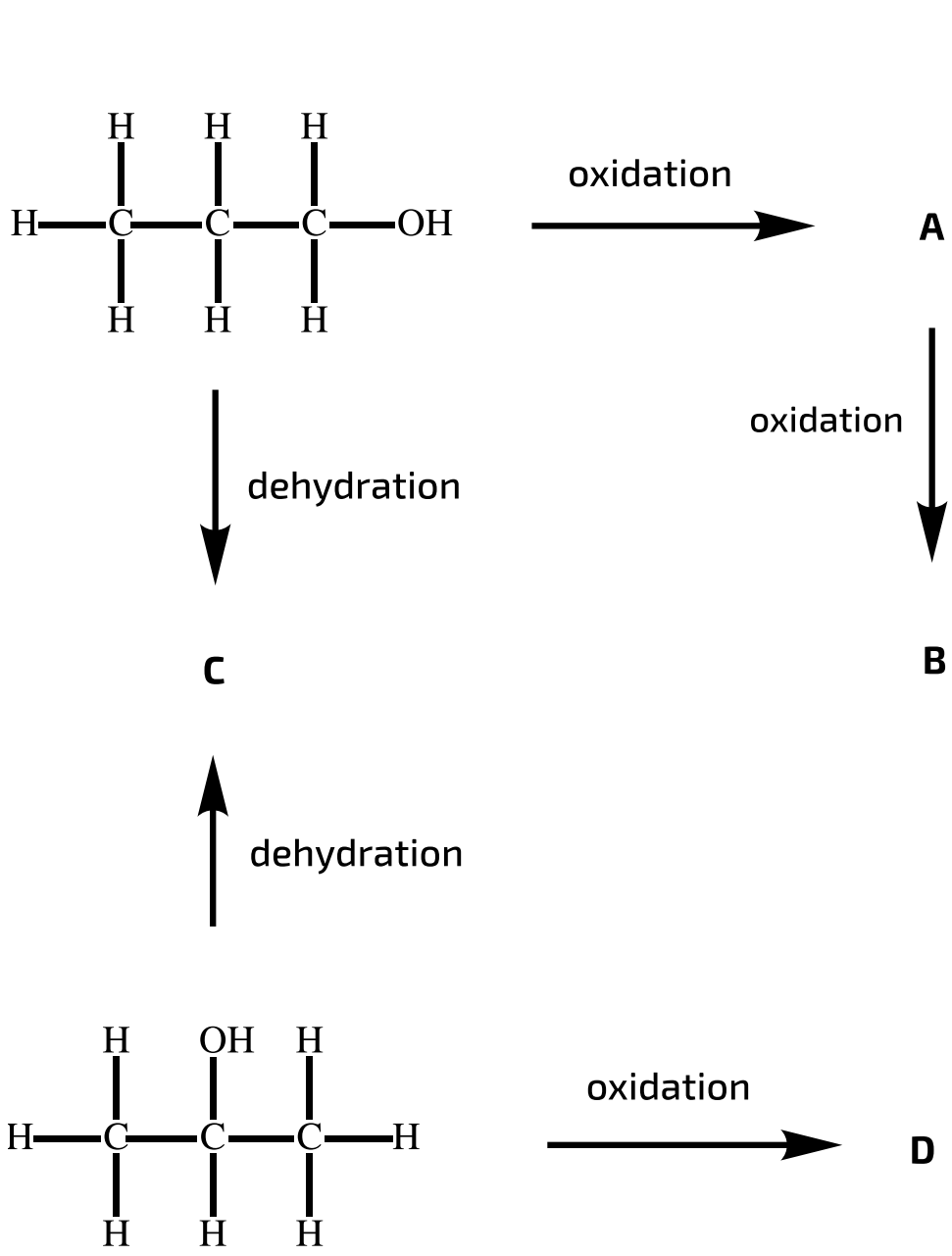

Figure 1: Reactions of alcohols

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

Using the structure editor

Part A **A**

A is:

Part B **B**

B is:

Part C **C**

C is:

Part D **D**

D is:

Adapted with permission from UCLES, A-Level Modular Sciences, November 1996, Chains and Rings, Question 3

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Reactions of $C_4H_{10}O$

A Level

Part A Elimination

A compound $C_4H_{10}O$ reacts with sodium, is not affected by warm acidified potassium dichromate(VI) solution, and eliminates water when warmed with concentrated sulfuric acid. What could the compound be?

- $CH_3CH_2CH_2OCH_3$
- $CH_3CH_2CH_2CH_2OH$
- $CH_3CH_2CH(OH)CH_3$
- $CH_3CH_2OCH_2CH_3$
- $(CH_3)_3COH$

Part B Oxidation

A compound **X**, $C_4H_{10}O$, gives the compound **Y**, C_4H_8O, on oxidation. **Y** does **not** give a silver mirror on the addition of Tollens' reagent. Which of the following could **X** be?

- $CH_3CH_2CH_2OCH_3$
- $CH_3CH_2CH_2CH_2OH$
- $CH_3CH_2CH(OH)CH_3$
- $(CH_3)_3COH$
- $CH_3CH_2OCH_2CH_3$

Part A adapted with permission from OCSEB, A-Level Chemistry, June 1995, Paper 1, Question 28;
Part B created for isaacphysics.org by R. Less

Tollens' Reagent

A Level

When propanal reacts with Tollens' reagent, what are the principal inorganic and organic products?

- Ag_2O and CH_3CH_2COOH
- Ag and CH_3CH_2COOH
- Ag and $CH_3CH_2CH_2OH$
- $AgNO_3$ and CH_3CH_2COOH

Adapted with permission from UCLES, A-Level Chemistry, June 1994, Paper 4, Question 24

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Ketones with KCN Mechanism

A Level

Part A Mechanism

In the reaction between a ketone and KCN followed by addition of acid, which of the following statements about the reaction mechanism are true?

1 A new carbon-carbon bond is formed.

2 In the intermediate, the oxygen carries a negative charge.

3 The last stage involves the formation of a hydrogen-oxygen bond.

- **3** only is correct
- **1**, **2** and **3** are correct
- **2** and **3** only are correct
- **1** and **2** only are correct
- **1** only is correct

Part B Why ketones not alkenes?

Why does the cyanide ion add to propanone but not to propene?

- Propanone is more susceptible to electrophilic attack than propene.
- The $C{=}C$ bond is more polar than the $C{=}O$ bond
- Propanone is more susceptible to free radical attack than propene.
- Propanone is more susceptible to nucleophilic attack than propene.
- The two methyl groups in propanone donate electron density more effectively than the single methyl group in propene.

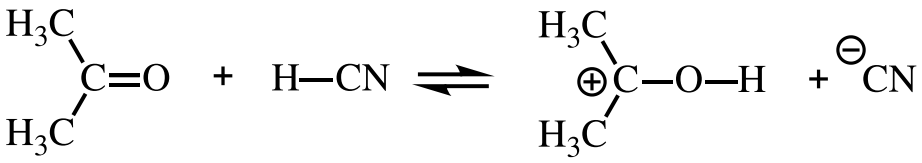
Ketones with HCN Steps

A Level

Part A Steps in mechanism

Hydrogen cyanide HCN adds to propanone most readily at a pH value between 9 and 10. Which of the following are likely steps in the reaction at this pH range?

1



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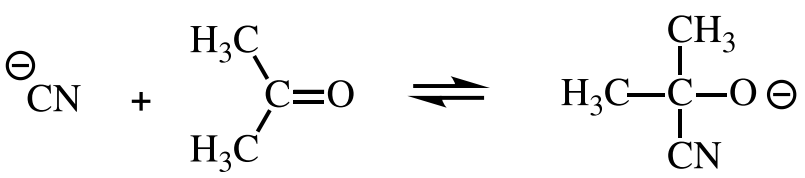

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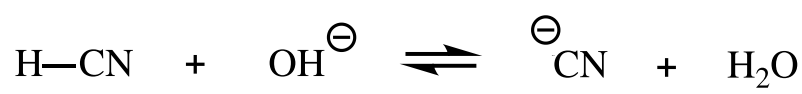

Figure 1: Possible steps in reaction of hydrogen cyanide with propanone at pH 9 - 10

- **1** and **2** only are correct
- **3** only is correct
- **1** only is correct
- **1**, **2** and **3** are correct
- **2** and **3** only are correct

Part B Rate at different pH values

Hydrogen cyanide adds to ketones. The table shows the relative rates of reaction in aqueous solutions under different conditions.

condition	relative rate
neutral solution	slow
acidified solution	virtually zero
alkaline solution	very rapid

Which of the following is likely to be involved in the rate-determining step of the reaction?

- $\mathrm{H_2O}$
- $\mathrm{CN^-}$
- HCN
- $\mathrm{H^+}$

Part A adapted with permission from UCLES, A-Level Chemistry, June 1996, Paper 3, Question 37;
Part B adapted with permission from UCLES, A-Level Chemistry, June 1989, Paper 3, Question 37

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Nucleophilic Addition Mechanism

A Level

Aldehydes and ketones typically react by nucleophilic addition reactions.

Part A HCN with ketones first step

What is the sequence of curly arrows denoting movement of electrons in the first step of the reaction between propanone and HCN catalysed by KCN?

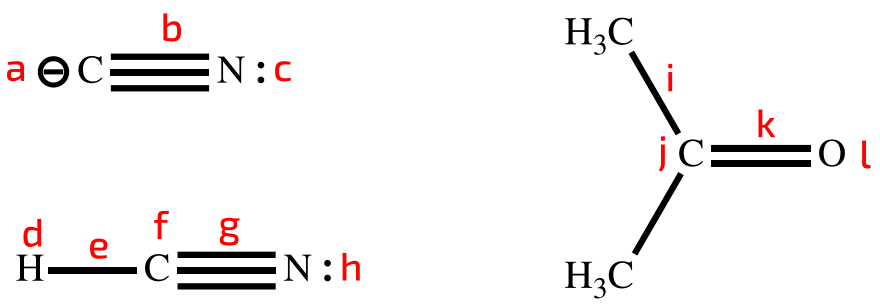

Figure 1: First step of HCN with propanone catalysed by KCN

For example in the reaction below, if you think the mechanism is as shown, your answer would be **cdef**.

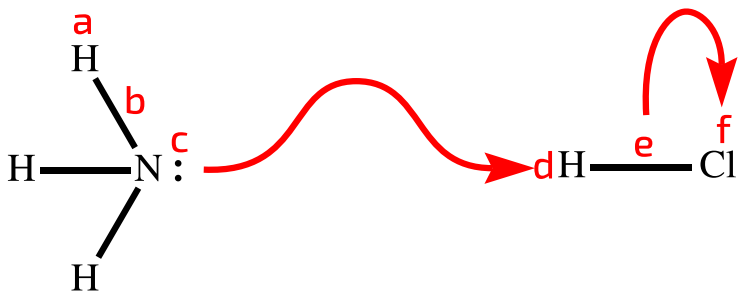

Figure 2: Sequence **cdef**

Part B HCN with ketones second step

What is the sequence of curly arrows denoting possible movement of electrons in the second step of the reaction between propanone and HCN catalysed by KCN that would regenerate the catalyst?

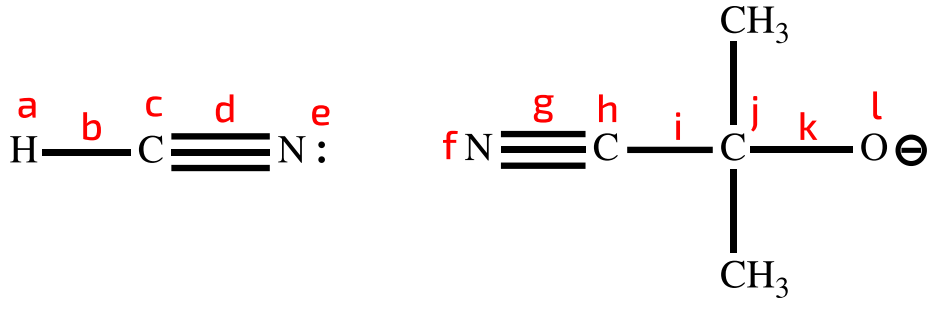

Figure 3: Second step of HCN with propanone catalysed by KCN