**1** Halogenoalkanes react with hot ethanolic potassium cyanide.

The reaction mechanism is either $S_N1$ or $S_N2$.

Which statement is correct?

**A** All secondary halogenoalkanes react by the $S_N2$ mechanism only.

**B** Both the halogenoalkane and the cyanide ion are involved in the initial step of the $S_N1$ mechanism.

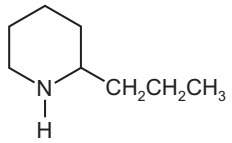
**C** Chloroethane reacts with cyanide ions by the $S_N1$ mechanism only.

**D** The $S_N2$ mechanism involves a short-lived negatively charged transition state.



**2** The structure of coniine is shown.

coniine



Coniine can be synthesised by reacting ammonia with a dibromo compound, X.

X

$$NH_3 + C_8H_{16}Br_2 \rightarrow \text{coniine} + 2HBr$$

What is compound X?

**A** 1,1-dibromo-2-propylcyclopentane

**B** 1,2-dibromo-2-propylcyclopentane

**C** $Br(CH_2)_3CHBr(CH_2)_3CH_3$

**D** $Br(CH_2)_4CHBr(CH_2)_2CH_3$

**3** Which reaction is a redox reaction?

**A** ethanenitrile heated under reflux with dilute hydrochloric acid

**B** ethanoic acid reacted with aqueous sodium hydroxide

**C** ethanoic acid reacted with sodium

**D** ethyl ethanoate heated under reflux with dilute hydrochloric acid



**4** Which reaction will form a strong organic base?

**A** ethanol and acidified sodium dichromate

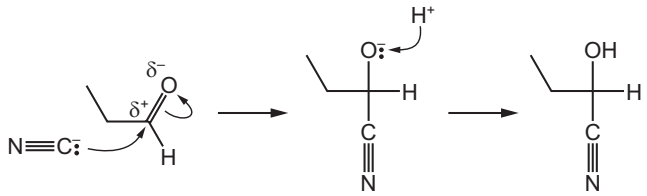
**B** ethanol and hot aluminium oxide

**C** ethanol and sodium

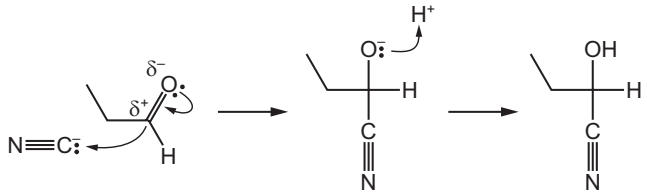
**D** ethanol and hydrogen chloride

**5** Which reaction mechanism for the formation of $C_2H_5CH(OH)(CN)$ is correct?

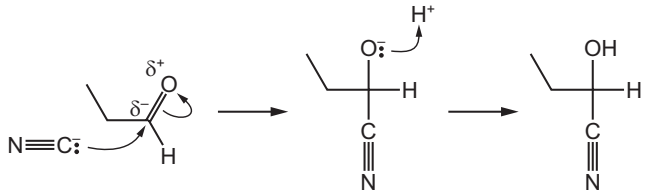
**A**



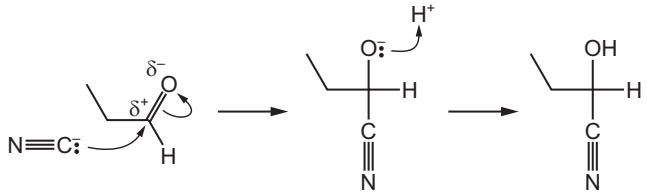
**B**



**C**



**D**

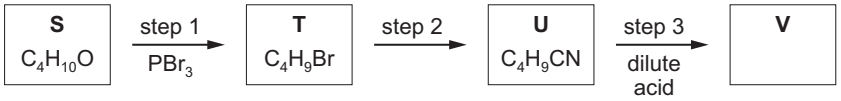


**6** **S** is a secondary alcohol with molecular formula $C_4H_{10}O$.

**(a)** Draw the displayed formula of **S**.

[1]

**(b)** **S** is converted to **V** in a three-step reaction sequence.




In step 1, the secondary alcohol **S** reacts with $PBr_3$ to produce **T**, which has molecular formula $C_4H_9Br$.

**(i)** Give the systematic name of **T**.

..... [1]

**(ii)** Name the type of reaction that occurs in step 1.

..... [1]

**(iii)** State the reagent(s) and conditions for step 2.

.....

..... [2]

**(iv)** Step 3 involves heating $C_4H_9CN$ with dilute acid to form **V**.

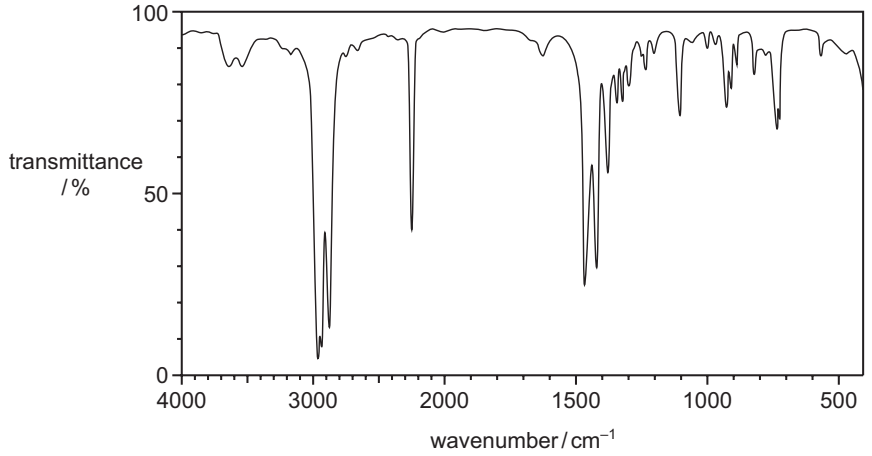
Complete the equation for this reaction.

.....$C_4H_9CN$ + .....$H^+$ + .....$H_2O$ → ..... [2]



**(v)** An unlabelled sample contains either **S**, **T** or **U**.

The sample produces the infrared spectrum shown.




Explain how this spectrum confirms that the unknown sample contains **U**.

In your answer identify **one** relevant absorption in the infrared spectrum and the bond that corresponds to this absorption in the region above 1500 $cm^{-1}$.

.....

..... [1]

[Total: 8]