

Question 39**(15 marks)**

Ethanol can be produced either from plant materials or from petrochemical sources.

- (a) When ethanol is produced from plant sources, the material is ground up. The starches and cellulose in the material are then converted into sugars. Yeast or zymase is mixed with the sugars at 25 to 37 °C and a pH of between 3 and 5 at atmospheric pressure. The products of the fermentation process are ethanol and carbon dioxide.

- (i) Justify the conditions used for fermentation. (2 marks)

- (ii) Write an equation for the fermentation process, using $C_6H_{12}O_6$ as the sugar. Use condensed structures in your equation. (2 marks)

Ethanol can also be produced by the endothermic hydration of ethene. This is carried out at 250 to 300 °C and 6000 to 7000 kPa in the presence of an acid catalyst.

- (b) (i) Write an equation for the hydration of ethene. Use condensed structures in your equation. (3 marks)

(ii) Justify the temperature and pressure used for the hydration of ethene. (5 marks)

(c) State **three** reasons why the fermentation process to produce ethanol is more common than the hydration of ethene. (3 marks)

One:

Two:

Three:
