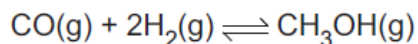


**AS Level Chemistry A**  
**H032/01 Breadth in chemistry**

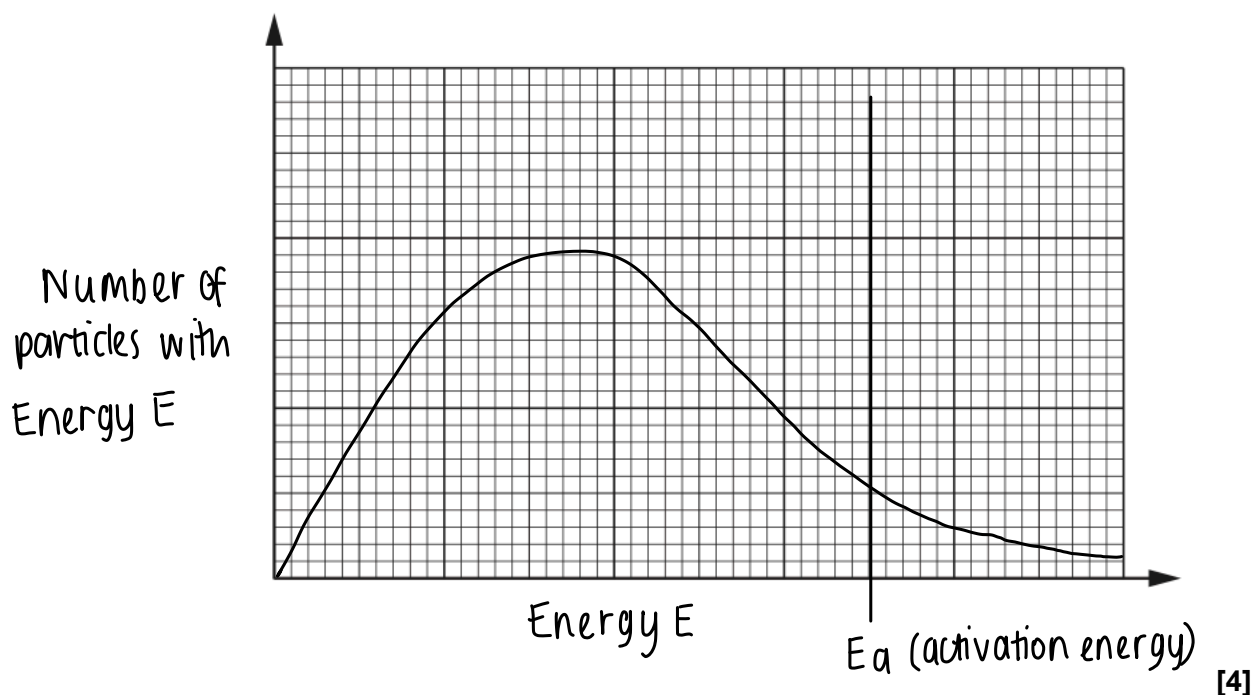
**Question Set 10**

1. Methanol can be prepared industrially by reacting carbon monoxide with hydrogen in the presence of a copper catalyst. This is a reversible reaction.



- (a) Using the Boltzmann distribution model, explain why the rate of a reaction increases in the presence of a catalyst.

You are provided with the axes below, which should be labelled.



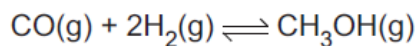
Only the particles under the curve to the right of the activation energy have enough energy to react; a catalyst moves the activation energy to the left, therefore more particles have  $E \geq E_a$  and so there are more frequent successful collisions so a faster rate of reaction because the activation energy has been lowered by the catalyst.

- (b) Explain why use of the catalyst reduces energy demand and benefits the environment.

A catalyst increases the rate of reaction by providing an alternative pathway for the reaction, one with a lower activation energy. A lower temperature is therefore required to be generated meaning less fossil fuels are burned and less  $\text{CO}_2$  is released into the atmosphere.

[2]

(c) A chemist investigates the equilibrium that produces methanol:



The chemist mixes CO(g) with H<sub>2</sub>(g) and leaves the mixture to react until equilibrium is reached.

The equilibrium mixture is analysed and found to contain the following concentrations.

Substance	Concentration /mol dm <sup>-3</sup>
CO(g)	0.310
H <sub>2</sub> (g)	0.240
CH <sub>3</sub> OH(g)	0.260

$$K_c = \frac{[\text{CH}_3\text{OH}]}{[\text{CO}][\text{H}_2]^2} \rightarrow \frac{\cancel{\text{mol dm}^{-3}}}{(\cancel{\text{mol dm}^{-3}})^3}$$
$$= \frac{0.260}{(0.310)(0.24)^2}$$
$$K_c = 14.6 \text{ mol}^{-2}\text{dm}^6$$

$\downarrow$   
 $\frac{1}{(\text{mol dm}^{-3})^2}$   
 $\downarrow$   
 $\text{mol}^{-2}\text{dm}^6$

Calculate the numerical value of  $K_c$  for this equilibrium.

Give your answer to an **appropriate** number of significant figures.

[2]

**Total Marks for Question Set 10: 8**

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