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Name

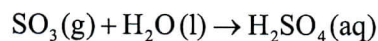
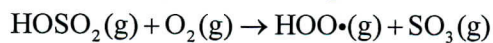
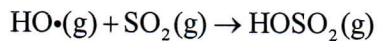
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SPEC/4/CHEMI/SP2/ENG/TZ0/XX

Key

2. One of the main constituents of acid deposition is sulfuric acid, H_2SO_4 . This acid is formed from the sulfur dioxide pollutant, SO_2 .

A mechanism proposed for its formation is:



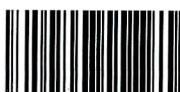
- (i) State what the symbol (\cdot) represents in the species shown in this mechanism. [1]

Radical or unpaired electron

- (ii) Draw one valid Lewis (electron dot) structure for each molecule below. [2]

Molecule	Lewis (electron dot) structure
SO_2	$\text{:}\ddot{\text{O}}-\ddot{\text{S}}=\ddot{\text{O}}\text{:}$
H_2O	$\text{H}-\ddot{\text{O}}-\text{H}$

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Turn over

(Question 2 continued)

- (iii) Deduce the name of the electron domain geometry and the molecular geometry for each molecule. [2]

	Electron domain geometry	Molecular geometry
SO ₂	Trigonal planar	Bent
H ₂ O	Tetrahedral	Bent

- (iv) Deduce the bond angles in SO₂ and H₂O. [1]

SO ₂ :	119° (115°-120° accepted)

H ₂ O:	104.5

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(Question 2 continued)

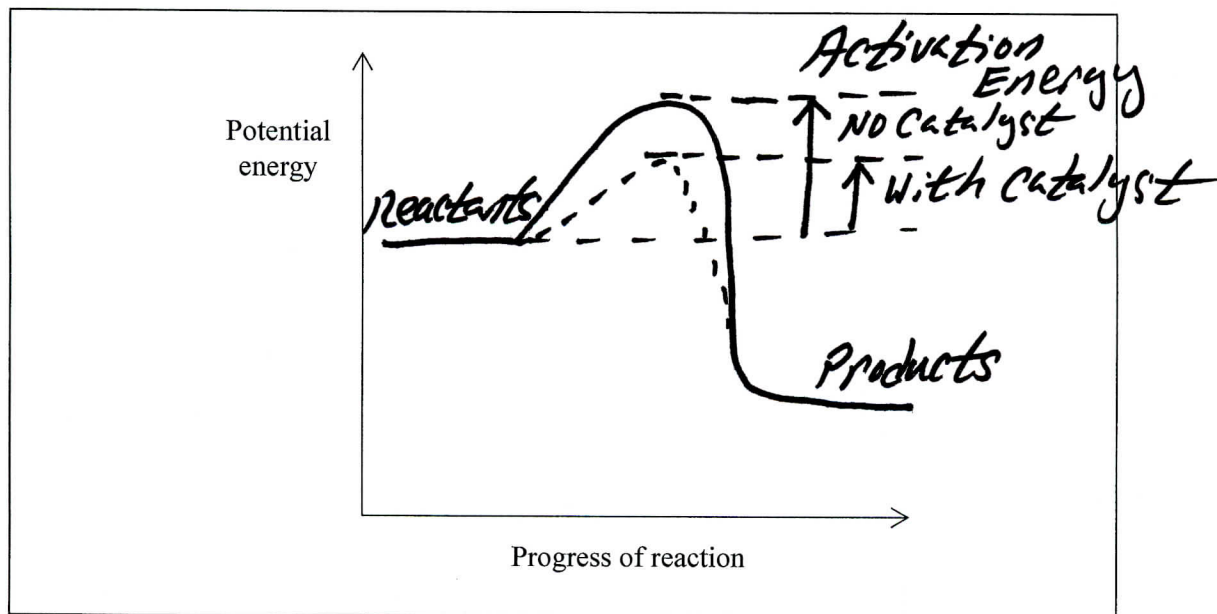
- (v) Consider the following equilibrium between the two oxides of sulfur, sulfur dioxide and sulfur trioxide:



Predict, with a reason, in which direction the position of equilibrium will shift for each of the changes listed below. [3]

Change	Shift	Reason
Increase in temperature	Left	Reaction is exothermic
Increase in pressure	Right	Fewer moles of gas ← must state!
Addition of a catalyst to the mixture	None	affects forward and reverse rates equally.

- (vi) Sketch the potential energy profile for the forward reaction in part (v) to show the effect of a catalyst on the activation energy, E_{act} . [2]



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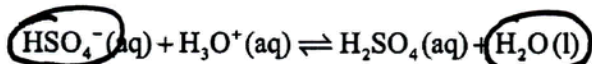


(Question 2 continued)

- (vii) Sulfuric acid, H_2SO_4 , can be described as a Brønsted–Lowry acid. State what you understand by this description. [1]

H_2SO_4 is a proton donor.

- (viii) The hydrogen sulfate anion, HSO_4^- , is amphiprotic, so can act as an acid or a base. In the reaction of HSO_4^- with the hydronium cation, H_3O^+ , identify the two species acting as bases. [1]



HSO_4^- and H_2O

- (ix) Other compounds present in acid rain are formed from nitrogen dioxide, NO_2 . Formulate an equation for the reaction of nitrogen dioxide with water. [1]



- (e) With reference to section 9 of the data booklet, explain the difference between the atomic radius and the ionic radius of nitrogen. [1]

Ionic radius is 146 pm which is greater than 71 pm for the atomic radius. This is due to the increased repulsion of electrons for N^{3-} .