4 Gaseous sulfur tetrafluoride, SF_4, reacts with steam in a reversible reaction.

$$SF_4(g) + 2H_2O(g) \rightleftharpoons SO_2(g) + 4HF(g) \qquad \Delta H = -54\,kJ/mol$$

(a) Complete the reaction pathway diagram in Fig. 4.1 for this reaction.

Include in your diagram:

- the position and the formulae of the products
- an arrow, labelled E_a, to show the activation energy
- an arrow, labelled ΔH, to show the enthalpy change of the reaction.

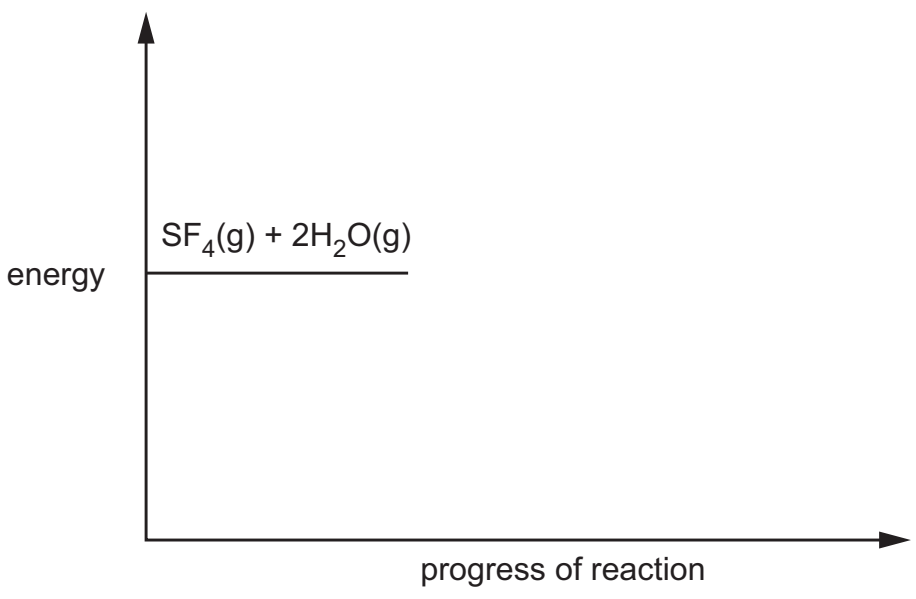

Fig. 4.1

[4]

(b) The equation for the reaction can be represented as shown in Fig. 4.2.

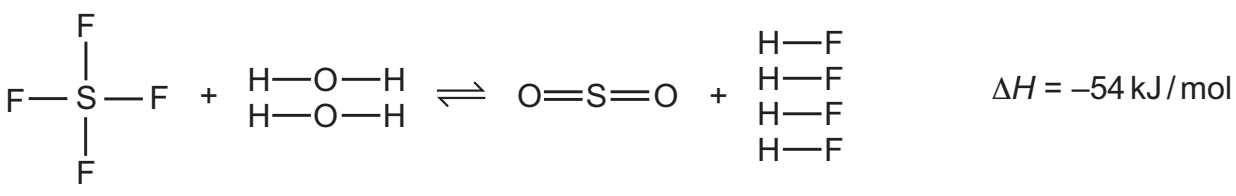

Fig. 4.2

Table 4.1 shows some bond energies.

Table 4.1

bond	S–F	O–H	H–F
bond energy in kJ/mol	330	460	570

Use the bond energies in Table 4.1 and the value of ΔH of the reaction to calculate the S=O bond energy in kJ/mol.

Use the following steps.

- Calculate the energy needed to break the bonds in the reactants.

..... kJ

- Calculate the energy released when the bonds in the products form.

..... kJ

- Calculate the S=O bond energy.

..... kJ/mol
[4]

(c) The equation for the reaction is shown.

$$SF_4(g) + 2H_2O(g) \rightleftharpoons SO_2(g) + 4HF(g) \qquad \Delta H = -54\,kJ/mol$$

State the effect, if any, on the position of equilibrium when the following changes are made.

Give a reason for each of your answers.

- The temperature is increased.

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- The pressure is increased.

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- A catalyst is added.

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.....
[5]

(d) Explain, in terms of collision theory, why reducing the temperature decreases the rate of the reverse reaction.

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..... [3]

[Total: 16]

Question 5 starts on the next page.