

2. This question is about atmospheric chemistry

- (a) $\text{H}_2\text{S} + \cdot\text{OH} \rightarrow \cdot\text{SH} + \text{H}_2\text{O}$ **1**

Dots marking radicals are not required.

- (b) $\text{FeS} + 2\text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2\text{S}$ **1**

- (c) rate of production of H_2S = rate of consumption of H_2S

$$7.65 \times 10^5 \text{ molecules cm}^{-3} \text{ s}^{-1} = k \times [\text{OH}] \times [\text{H}_2\text{S}]$$

$$7.65 \times 10^5 \text{ molecules cm}^{-3} \text{ s}^{-1} = 4.7 \times 10^{-12} \text{ cm}^3 \text{ s}^{-1} \times 1.1 \times 10^6 \text{ cm}^{-3} \times [\text{H}_2\text{S}]$$

$$[\text{H}_2\text{S}] = 1.48 \times 10^{11} \text{ molecules cm}^{-3}$$

$$[\text{H}_2\text{S}] = 1.5 \times 10^{11} \text{ molecules cm}^{-3}$$

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Please note that “molecules” can be omitted from the units. Correct answer with units scores full marks. One mark can be awarded if the following statement or equivalent is written: $7.65 \times 10^5 \text{ molecules cm}^{-3} \text{ s}^{-1} = k \times [\text{OH}] \times [\text{H}_2\text{S}]$

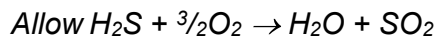
- (d) $[\text{H}_2\text{S}] = 1.48 \times 10^{11} \text{ cm}^{-3}$
 $[\text{H}_2\text{S}] = 1.48 \times 10^{17} \text{ m}^{-3}$
 $[\text{H}_2\text{S}] = 2.46 \times 10^{-7} \text{ mol m}^{-3}$
 $[\text{H}_2\text{S}] = 8.38 \times 10^{-6} \text{ g m}^{-3}$
 $[\text{H}_2\text{S}] = 8.38 \mu\text{g m}^{-3}$

$$[\text{H}_2\text{S}] = 8.4 \mu\text{g m}^{-3} \text{ (2 s.f.)}$$

1

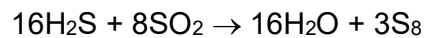
Correct answers scores mark. Intermediate steps in calculation not required.

- (e) (i) $2\text{H}_2\text{S} + 3\text{O}_2 \rightarrow 2\text{H}_2\text{O} + 2\text{SO}_2$ **1**

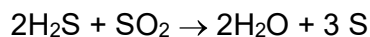


- (e) (ii) $2\text{H}_2\text{S} + \text{SO}_2 \rightarrow 2\text{H}_2\text{O} + \frac{3}{8} \text{S}_8$ **1**

or



or



- (f) Accept 3.7, 3.8 or 3.9 years 1
 One mark for correct reading of graph.

If said 3.7 years then 1.168×10^8 s 1

If said 3.8 years then 1.199×10^8 s

If said 3.9 years then 1.231×10^8 s

One mark for correct value in seconds. Conversion calculation not required. Allow ECF from their answer in years for the value in seconds.

1 year = 365.25 days/year \times 24 hours/day \times 60 minutes/hour \times 60 seconds/minute

1 year = 3.156×10^7 s. Therefore their value in seconds should be the value in years multiplied by 3.156×10^7

- (g) $[\text{OH}] = \ln 2 / (k_{2\text{nd}} \times t_{1/2})$
 $[\text{OH}] = 0.693 / (1.0 \times 10^{-14} \times t_{1/2})$
 $[\text{OH}] = 6.93 \times 10^{13} / t_{1/2}$

If they found $t_{1/2} = 3.7$ years, then
 $[\text{OH}] = 5.93 \times 10^5$ molecules cm^{-3} 2

If they found $t_{1/2} = 3.8$ years, then
 $[\text{OH}] = 5.78 \times 10^5$ molecules cm^{-3}

If they found $t_{1/2} = 3.9$ years, then
 $[\text{OH}] = 5.63 \times 10^5$ molecules cm^{-3}

Correct answer with units scores full marks. Please note that "molecules" can be omitted from the units. One mark may be awarded for obtaining the expression:

$[\text{OH}] = 6.93 \times 10^{13} / t_{1/2}$

Allow ECF from their answer to part (f) using the above formula.

Question Total 11