

**4** Fritz Haber, a German chemist, first manufactured ammonia in 1909. Ammonia is very soluble in water.

**4 (a)** State the strongest type of intermolecular force between one molecule of ammonia and one molecule of water.

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(1 mark)

**4 (b)** Draw a diagram to show how one molecule of ammonia is attracted to one molecule of water. Include all partial charges and all lone pairs of electrons in your diagram.

(3 marks)

**4 (c)** Phosphine ( $\text{PH}_3$ ) has a structure similar to ammonia.

In terms of intermolecular forces, suggest the main reason why phosphine is almost insoluble in water.

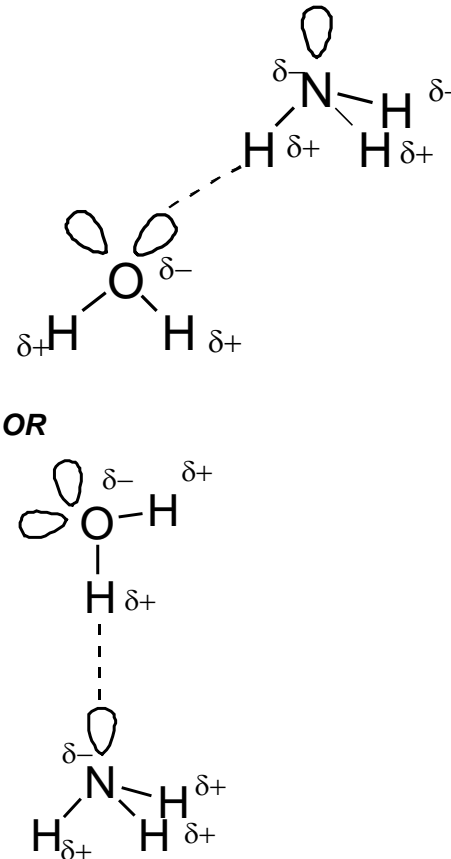
.....  
.....  
(1 mark)

5
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Turn over ►





Question	Marking Guidance	Mark	Comments
4(a)	Hydrogen bonding / hydrogen bonds / H-bonding / H-Bonds	1	Not just hydrogen.
4(b)	 <p>OR</p>	3	<p>One mark for minimum of 4 correct partial charges shown on the N-H and O-H</p> <p>One mark for the 3 lone pairs.</p> <p>One mark for H bond from the lone pair on O or N to the H<sup>δ+</sup></p> <p>The N-H-O should be linear but can accept if the lone pair on O or N hydrogen bonded to the H<sup>δ+</sup></p> <p>If wrong molecules or wrong formula, CE = 0/3</p>

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4(c)	(Phosphine) does not form hydrogen bonds (with water)	1	
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