SCIENCE FOUNDATIONS

Lewis structures

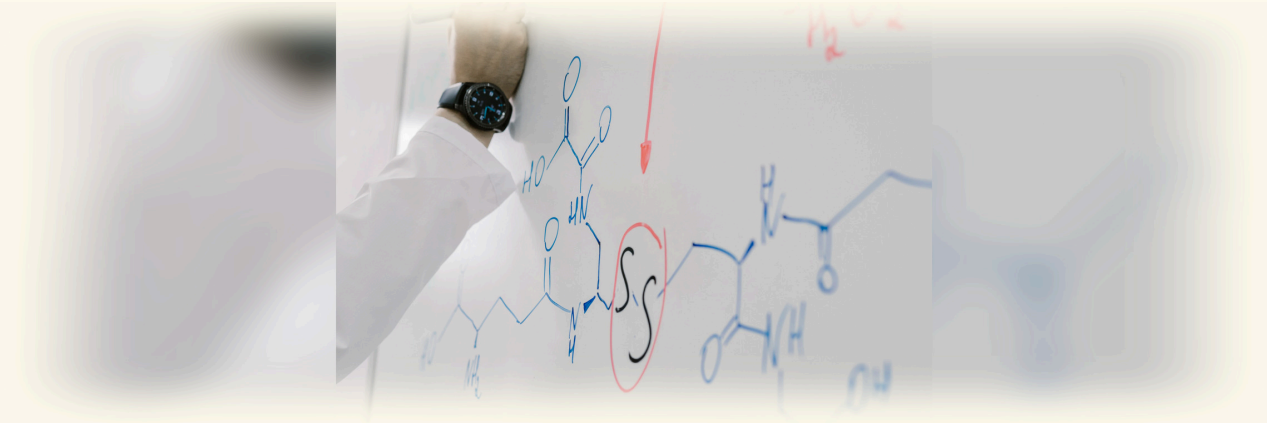
Difficulty level: Intermediate

Science Foundations

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Overview of the concept

This is how a chemist draws a molecule on paper so you can see at a glance which atoms share electrons and which have spare pairs left over. A student drawing water can see the two spare pairs on the oxygen that give the molecule its bent shape. A pharmacist sketching a drug molecule checks the drawing to see which parts can bond and which parts are free. Knowing Lewis structures tells you how a molecule is put together before you ever mix anything in a flask.

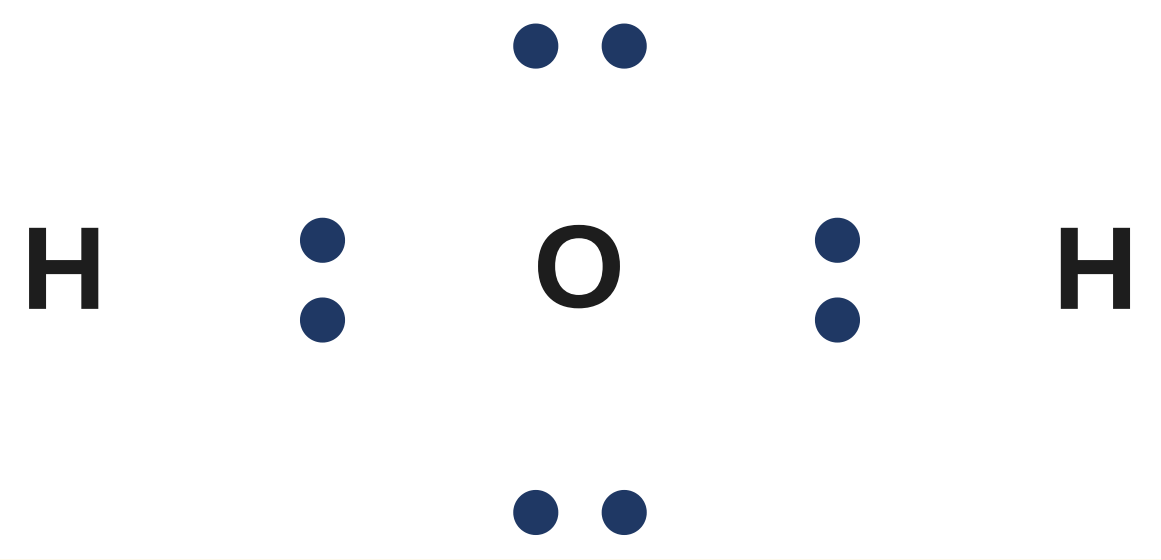


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Worked examples

EXAMPLE 1

Q Draw the Lewis structure of water, H_2O.



SOLUTION

Count valence electrons: oxygen 6, each hydrogen 1, total 8.

Place oxygen in the centre, bond each hydrogen with a shared pair.

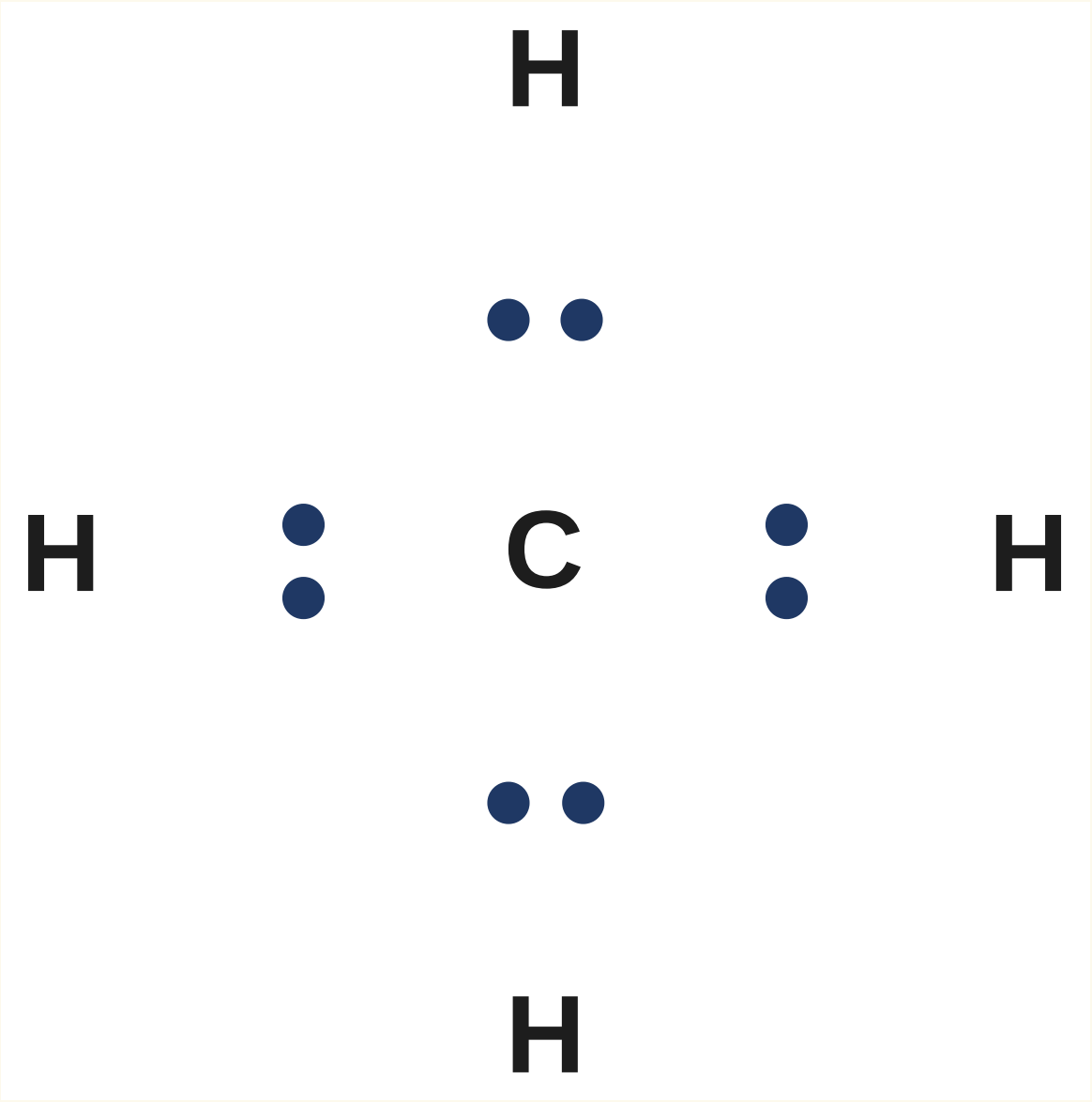
Add the remaining electrons as two lone pairs on oxygen.

The result is oxygen with two bonds and two lone pairs.

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EXAMPLE 2

Q Draw the Lewis structure of methane, CH_4.



SOLUTION

Count valence electrons: carbon 4, each hydrogen 1, total 8.

Place carbon in the centre, bond each hydrogen with a shared pair.

Check: carbon has 8 shared electrons, each hydrogen has 2.

The result is carbon with four bonds, no lone pairs.

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Practice questions

1 **A student draws hydrogen chloride, HCl. How many valence electrons are there in total, how many bonds does chlorine have, and how many lone pairs?**

- **A** 8 valence electrons, chlorine has 1 bond and 3 lone pairs
- **B** 8 valence electrons, chlorine has 2 bonds and 2 lone pairs
- **C** 7 valence electrons, chlorine has 1 bond and 3 lone pairs
- **D** 8 valence electrons, chlorine has 1 bond and 2 lone pairs

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2 **A chemist draws hydrogen sulfide, H_2S. How many valence electrons are there in total, how many bonds does sulfur have, and how many lone pairs?**

- **A** 8 valence electrons, sulfur has 2 bonds and 2 lone pairs
- **B** 8 valence electrons, sulfur has 2 bonds and 1 lone pair
- **C** 6 valence electrons, sulfur has 2 bonds and 2 lone pairs
- **D** 8 valence electrons, sulfur has 1 bond and 3 lone pairs

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3 **A student draws carbon dioxide, CO2. How many valence electrons are there in total, how many bonds does carbon have, and how many lone pairs?**

- **A** 16 valence electrons, carbon has 4 bonds and no lone pairs
- **B** 8 valence electrons, carbon has 4 bonds and no lone pairs
- **C** 16 valence electrons, carbon has 2 bonds and 2 lone pairs
- **D** 12 valence electrons, carbon has 4 bonds and no lone pairs

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4 **A pharmacist sketches ammonia, NH_3. How many valence electrons are there in total, how many bonds does nitrogen have, and how many lone pairs?**

- **A** 8 valence electrons, nitrogen has 3 bonds and 1 lone pair
- **B** 8 valence electrons, nitrogen has 3 bonds and no lone pairs
- **C** 10 valence electrons, nitrogen has 3 bonds and 1 lone pair
- **D** 8 valence electrons, nitrogen has 4 bonds and 1 lone pair

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In a Lewis structure, what do the dots stand for?

A Protons

B Valence electrons

C Neutrons

D Bonds

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In a Lewis structure, what does a line stand for?

A A shared pair of electrons, a bond

B A lone pair of electrons

C A proton in the nucleus

D A valence electron on its own

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7 How many valence electrons does sulfur have?

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8 In hydrogen fluoride, HF, how many lone pairs sit on the fluorine atom?

A 3 lone pairs

B 2 lone pairs

C 1 lone pair

D No lone pairs

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9

In water, H2O, how many electrons surround the oxygen atom, and how many surround each hydrogen?

A Oxygen 8, each hydrogen 2

B Oxygen 2, each hydrogen 8

C Oxygen 8, each hydrogen 8

D Oxygen 4, each hydrogen 2

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Explain why oxygen in water has two lone pairs, using its valence electron count.

A. Oxygen has 6 valence electrons, 2 are used in bonds, leaving 4, which is 2 lone pairs

B. Oxygen has 8 valence electrons, 2 are used in bonds, leaving 6, which is 3 lone pairs

C. Oxygen has 6 valence electrons, 4 are used in bonds, leaving 2, which is 1 lone pair

D. Oxygen has 4 valence electrons, 2 are used in bonds, leaving 2, which is 1 lone pair

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ANSWER KEY

1. 8 valence electrons, chlorine has 1 bond and 3 lone pairs

2. 8 valence electrons, sulfur has 2 bonds and 2 lone pairs

3. 16 valence electrons, carbon has 4 bonds and no lone pairs

4. 8 valence electrons, nitrogen has 3 bonds and 1 lone pair

5. Valence electrons

6. A shared pair of electrons, a bond

7. 6

8. 3 lone pairs

9. Oxygen 8, each hydrogen 2

10. Oxygen has 6 valence electrons, 2 are used in bonds, leaving 4, which is 2 lone pairs

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