

IB Chemistry HL - S2.2

The covalent model

Exercises + Practice questions

Official answers appended at the end

Exercise

Q1. Which is the best definition of a covalent bond?

- A** the attraction between positively charged ions and a shared pair of electrons
- B** the attraction between pairs of shared electrons
- C** the attraction between positively charged nuclei and a shared pair of electrons
- D** the attraction between a pair of positively charged nuclei

Q2. Which best describes the octet rule?

- A** the tendency of atoms to gain a valence shell with a total of 8 electrons
- B** the tendency of atoms to lose 8 electrons
- C** the tendency of atoms to gain 8 electrons
- D** the tendency of atoms to form bonds with 8 other atoms

Q3. Draw the Lewis formulas of the following molecules:

- | | | | |
|------------------------------|--|--|----------------------------|
| (a) HF | (b) CF ₃ Cl | (c) PCl ₃ | (d) OF ₂ |
| (e) SeCl ₂ | (f) C ₂ H ₆ | (g) N ₂ H ₄ | |

Q4. How many valence electrons are in the following molecules?

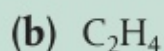
- | | | |
|------------------------------|-----------------------------|-----------------------------|
| (a) BeCl ₂ | (b) BCl ₃ | (c) CCl ₄ |
| (d) PH ₃ | (e) SCl ₂ | (f) NCl ₃ |

Q5. Draw Lewis formulas of the following ions:

- | | | |
|---|--|----------------------------|
| (a) NH ₄ ⁺ | (b) H ₃ O ⁺ | (c) HS ⁻ |
|---|--|----------------------------|

Exercise

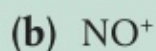
Q6. Draw the Lewis formulas of the following molecules:



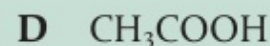
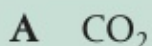
Q7. Suggest which of the following molecules would have the shortest carbon–carbon bond length.



Q8. Draw Lewis formulas of the following ions:



Q9. Which of the following molecules contains the shortest bond between carbon and oxygen?



Q10. Which of the following best describes the general trend in bond length and bond strength?

	Bond strength	Bond length
A	triple > double > single	single > double > triple
B	triple > double > single	triple > double > single
C	single > double > triple	triple > double > single
D	single > double > triple	triple > double > single

Exercise

Q11. Which best describes a coordination bond?

- A** A covalent bond containing a shared pair of electrons.
- B** A covalent bond in which each atom shares one electron.
- C** A covalent bond involving a transition metal.
- D** A covalent bond in which both the electrons of the shared pair originate from the same atom.

Q12. Which of the following are features of a coordination bond?

- I. Contains a shared pair of electrons.
- II. Both shared electrons originate from the same atom.
- III. Shorter in length than a normal covalent bond.

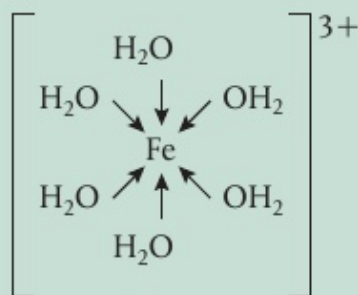
A I and II **B** I and III **C** II and III **D** I, II and III

Q13. Which of the following species contain a coordination bond?

- I. H_3O^+ II. NH_3 III. CO

A I and II **B** I and III **C** II and III **D** I, II and III

Q14. **HL** Which of the following statements are true about the transition element complex below?



- I. The iron ion accepts pairs of electrons.
- II. Six coordination bonds are formed.
- III. Water molecules donate pairs of electrons.

A I and II **B** I and III **C** II and III **D** I, II and III

Q15. Ammonia, NH_3 , can react with boron trifluoride, BF_3 , to form ammonia boron trifluoride, NH_3BF_3 . Draw a Lewis formula of ammonia boron trifluoride and show the coordination bond using an arrow.

in the table on page 251.

Exercise

Q16. Predict the geometry and bond angles of the following molecules:

- | | | | |
|--------------------------|----------------------------|-------------------|-------------------|
| (a) H_2S | (b) CF_4 | (c) HCN | (d) NF_3 |
| (e) BCl_3 | (f) NH_2Cl | (g) OF_2 | |

Q17. Predict the geometry and bond angles of the following ions:

- | | | | |
|---------------------|---------------------|----------------------|-----------------------|
| (a) NO_2^+ | (b) NO_2^- | (c) ClF_2^+ | (d) SnCl_3^- |
|---------------------|---------------------|----------------------|-----------------------|

Q18. How many electron domains are there around the central atom in molecules that have the following shapes?

- | | | |
|------------------------|-----------------------|------------|
| (a) tetrahedral | (b) bent | (c) linear |
| (d) trigonal pyramidal | (e) triangular planar | |

Exercise

Q19. Which substance contains only ionic bonds?

- A** NaNO_3 **B** H_3PO_4 **C** NH_4Cl **D** CaCl_2

Q20. For each of these molecules, identify any polar bonds and label them using δ^+ and δ^- appropriately.

- (a)** HBr **(b)** CO_2 **(c)** ClF **(d)** O_2 **(e)** NH_3

Q21. Use the electronegativity values in Section 9 of the data booklet to predict which bond in each of the following pairs is more polar.

- (a)** C-H or C-Cl **(b)** Si-Li or Si-Cl **(c)** N-Cl or N-Mg