

APOLLO

The covalent model

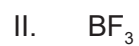
HL

Chemistry

First assessment 2025

28 questions | questions

9. In which of the following molecules do all atoms obey the octet rule?



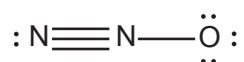
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

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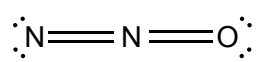
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2220-0201

10. Nitrogen(I) oxide, N_2O , can be represented by two Lewis formulas.



Structure X



Structure Y

Which row correctly identifies the formal charges and the more stable structure?

	Structure X $:\text{N} \equiv \text{N} - \ddot{\text{O}}:$			Structure Y $\cdot\ddot{\text{N}} = \text{N} = \ddot{\text{O}}\cdot$			More stable
A.	0	+1	-1	-1	+1	0	X
B.	-1	+1	0	+1	0	-1	X
C.	0	+1	-1	-1	0	+1	Y
D.	-1	0	+1	0	+1	-1	Y

11. Which row puts these molecules in order of decreasing bond angle?

A. NH_3 , H_2O , C_2H_4 , CH_4

B. H_2O , C_2H_4 , CH_4 , NH_3

C. C_2H_4 , CH_4 , NH_3 , H_2O

D. CH_4 , NH_3 , H_2O , C_2H_4

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2220-0201

13. Kekulé suggested a structure of benzene with alternating single and double bonds. Which piece of evidence disproves this structure?

- A. Benzene has the formula C_6H_6 .
- B. Benzene is an unsaturated molecule.
- C. All C–C bonds have the same length.
- D. Benzene can be hydrogenated.

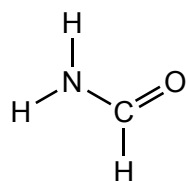
7. Which molecule is polar?

- A. CH_4
- B. C_6H_6
- C. SO_2
- D. CO_2

9. What are the electron domain and molecular geometries of XeCl_4 ?

	Electron domain geometry	Molecular geometry
A.	octahedral	tetrahedral
B.	octahedral	square planar
C.	tetrahedral	tetrahedral
D.	tetrahedral	square planar

10. What are the hybridizations of the N, C and O atoms in this molecule?



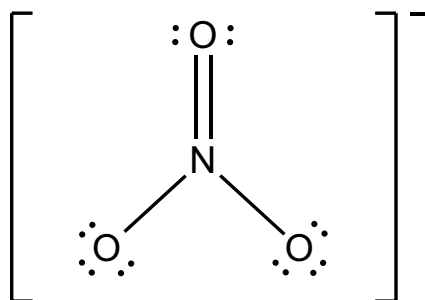
	N	C	O
A.	sp^3	sp^3	sp^2
B.	sp^3	sp^2	sp^2
C.	sp^2	sp^2	sp
D.	sp^2	sp^3	sp

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Turn over
4445-0219

8. Which forces of attraction cause the boiling point of ammonia, NH_3 , to be significantly higher than that of phosphine, PH_3 ?
- A. Covalent bonds
 - B. Dipole–dipole forces
 - C. London (dispersion) forces
 - D. Hydrogen bonds

9. What is the formal charge of the nitrogen atom in NO_3^- ?



- A. -3
B. -1
C. +1
D. +3

— 5 —

2220-0219

10. What is the hybridization of carbon and oxygen in CO_3^{2-} ?

	C	O
A.	sp^2	sp^3
B.	sp^2	sp^2
C.	sp^3	sp^2
D.	sp^3	sp

1. Iron(II) sulfide can be produced by heating powdered iron and sulfur together.

(a) Describe the difference between an element and a compound.

[2]

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(b) Outline why solid iron(II) sulfide is a polar covalent compound. Use sections 9 and 17 of the data booklet.

[1]

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(c) Contrast **one** physical property of iron and iron(II) sulfide.

[1]

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(d) Calculate the wavelength, in m, for the limit of convergence observed in the line spectrum of iron. Use sections 1, 2 and 9 of the data booklet.

[3]

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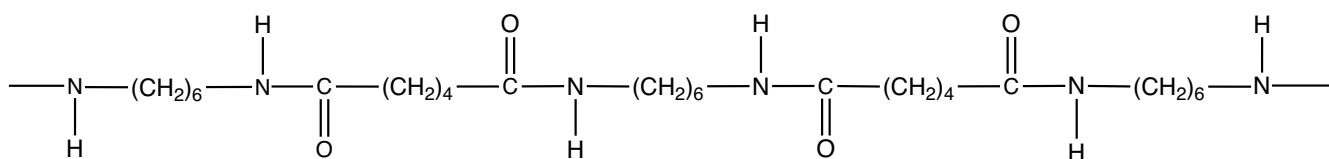


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4425-0209

7. Nylon 6,6 is a polyamide used in many things, such as fishing lines.

A section of the polymer chain of nylon 6,6



- (a) Nylon 6,6 is formed by condensation polymerisation.

Deduce the structures of the two monomers that form the polyamide nylon 6,6.

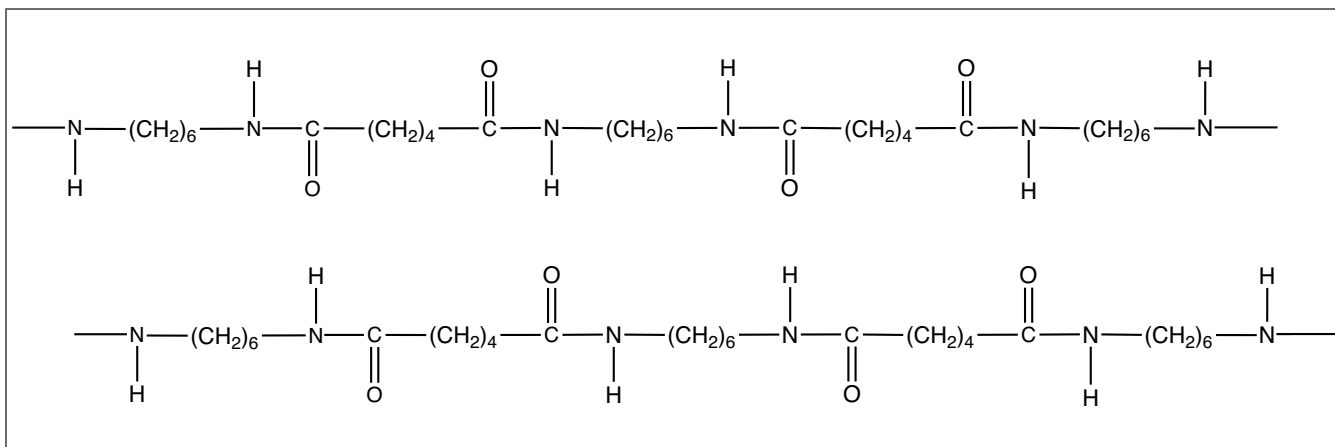
[2]

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- (b) (i) The strength of nylon 6,6 is due to the hydrogen bonding between the polymer chains.

Annotate the diagram to show a hydrogen bond between the sections of the polymer chains. Use a dotted line to represent the hydrogen bond.

[1]



- (ii) Outline how a hydrogen bond is formed.

[2]

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(Question 7 continued)

- (c) Discuss the following data in terms of the bonding **and/or** intermolecular forces in each substance.

[3]

Substance	Melting point / K
Silicon	1683
Poly(ethene)	393

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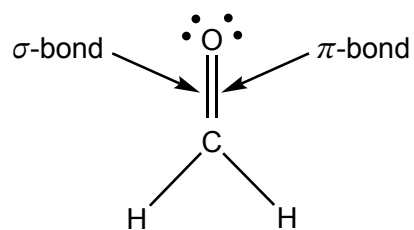
7. What are the electron domain and molecular geometries of IF_4^+ ion?

	Electron domain geometry	Molecular geometry
A.	Trigonal bipyramidal	Seesaw
B.	Tetrahedral	Tetrahedral
C.	Tetrahedral	Seesaw
D.	Trigonal bipyramidal	Tetrahedral

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0020-0207

8. Which orbitals overlap to form σ -bond and π -bond between carbon and oxygen in methanal?



	σ -bond	π -bond
A.	sp^2 and sp^3	p and p
B.	sp^2 and sp^2	p and sp^2
C.	sp^2 and sp^2	p and p
D.	sp^2 and sp^3	p and sp^2

9. Which species contain a coordination bond?



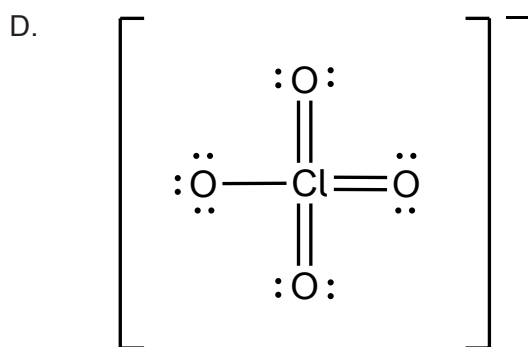
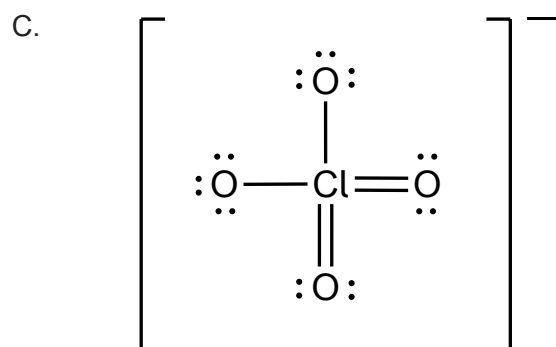
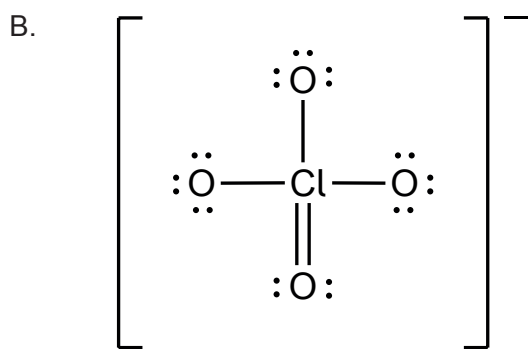
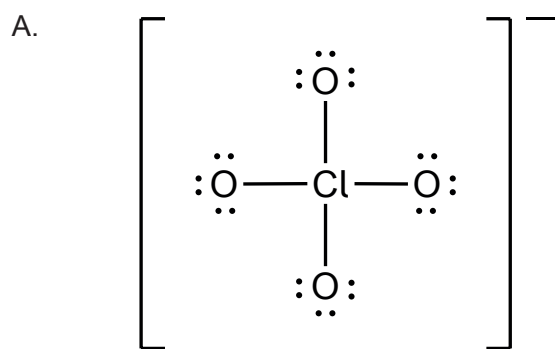
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

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Turn over

0020-0207

10. What is the preferred Lewis formula for chlorate(VII), ClO_4^- , ion based on formal charges?



12. Which material is a good electrical conductor?

- A. Diamond
- B. Graphite
- C. Fullerene
- D. Silicon

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0020-0201

39. Which statements are correct for the complex ion $[\text{FeCl}_4]^{2-}$?

- I. Chloride ions are behaving as ligands.
 - II. The oxidation state of iron is +3.
 - III. Iron ion forms coordination bonds with chloride ions.
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

6. What are the electron domain and molecular geometries of thionyl chloride, SOCl_2 ?

	Electron domain geometry	Molecular geometry
A.	Tetrahedral	Tetrahedral
B.	Tetrahedral	Trigonal pyramidal
C.	Trigonal planar	Trigonal planar
D.	Trigonal planar	Bent

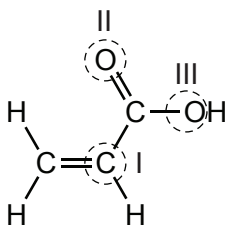
7. Which molecule is most polar?

- A. CF_4
- B. CO_2
- C. NBr_3
- D. NH_3

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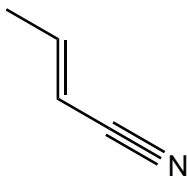
0025-0219

9. What is the hybridization of each circled atom I, II and III?



	I	II	III
A.	sp^3	sp	sp^2
B.	sp^3	sp	sp^3
C.	sp^2	sp^2	sp^2
D.	sp^2	sp^2	sp^3

11. How many π (pi) and σ (sigma) bonds are there in but-2-enenitrile, CH_3CHCHCN ?



	π , pi	σ , sigma
A.	5	2
B.	5	7
C.	3	4
D.	3	9

16. Which compound has the highest boiling point?

- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- C. $(\text{CH}_3)_3\text{CCH}_2\text{CH}_3$
- D. $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$

7. In which group of ions and molecules are electrons delocalized in all species?

- A. CH_3COOH , O_3 , C_{60}
- B. CH_3COO^- , NO_2^- , C(graphite)
- C. C_2H_2 , $(\text{COOH})_2$, C(diamond)
- D. C_2H_4 , NO_2^+ , SiO_2

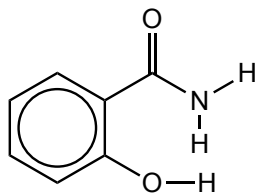
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8. What is the molecular geometry of the central atom in SF_4Cl_2 ?
- A. linear
 - B. tetrahedral
 - C. hexagonal
 - D. octahedral

9. Which is the preferred Lewis formula of nitrous oxide, N_2O , as deduced by formal charges?

- A. $\ddot{\text{N}}=\text{N}=\ddot{\text{O}}$
- B. $:\text{N}\equiv\text{N}-\ddot{\text{O}}:$
- C. $:\ddot{\text{N}}-\text{N}\equiv\text{O}:$
- D. $\ddot{\text{N}}=\text{O}=\ddot{\text{N}}$

10. Which pair of statements about electrons in this molecule is correct?



	Number of non-bonding pairs of electrons	Number of electrons in π bonds
A.	3	6
B.	3	8
C.	5	6
D.	5	8

- 17.** What do all greenhouse gases have in common?
- A. They are emitted by the burning of fossil fuels.
 - B. They absorb ultraviolet radiation.
 - C. They are symmetrical molecules with no polar bonds.
 - D. They absorb infrared radiation.