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Molecular Geometry & VSEPR

Exam — Chemical Bonding

Pre-med/IB-style questions on VSEPR: electron domains vs molecular shape, lone pair effects, bond angles, trigonal bipyramidal and octahedral structures, polarity from geometry, and basic hybridization mapping.

70 items — Printable Exam

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1 In VSEPR theory, what counts as ONE electron domain (electron region) around a central atom?



- A Only lone pairs on the central atom
- B Only single bonds to surrounding atoms
- C Any region of electron density: a single bond, multiple bond, or a lone pair
- D Each shared electron counts as one domain
- E Each atom attached to the central atom counts as one domain, regardless of bonding

2 When counting electron domains for VSEPR, a double bond between the central atom and an outer atom counts as:



- A Two electron domains because it contains two shared electron pairs
- B One electron domain because it is one region of electron density
- C Zero electron domains because the electrons are shared
- D Three electron domains because a double bond is 'bigger' than a single bond
- E It depends on electronegativity, not bonding

3 What is the molecular geometry (shape) of CO₂?



- A Bent
- B Trigonal planar
- C Tetrahedral
- D Linear
- E Trigonal pyramidal





4 What is the molecular geometry around carbon in HCN (H–C N)?



- A Bent
- B Trigonal planar
- C Tetrahedral
- D Linear
- E Seesaw

5 What is the molecular geometry of BF₃?



- A Trigonal planar
- B Trigonal pyramidal
- C Tetrahedral
- D Bent
- E Linear

6 What is the molecular geometry of CH₄?



- A Trigonal planar
- B Tetrahedral
- C Linear
- D Trigonal pyramidal
- E Square planar





7 Which pair correctly describes the electron-domain geometry and the molecular geometry of NH_3 ?



- A Electron geometry trigonal planar; molecular geometry trigonal planar
- B Electron geometry tetrahedral; molecular geometry trigonal pyramidal
- C Electron geometry trigonal bipyramidal; molecular geometry trigonal pyramidal
- D Electron geometry tetrahedral; molecular geometry tetrahedral
- E Electron geometry linear; molecular geometry trigonal pyramidal

8 Which pair correctly describes the electron-domain geometry and the molecular geometry of H_2O ?



- A Electron geometry linear; molecular geometry linear
- B Electron geometry tetrahedral; molecular geometry bent
- C Electron geometry trigonal planar; molecular geometry trigonal planar
- D Electron geometry tetrahedral; molecular geometry tetrahedral
- E Electron geometry trigonal planar; molecular geometry bent

9 Which repulsion is strongest in VSEPR (largest electron-pair repulsion)?



- A Bonding pair–bonding pair (BP–BP)
- B Bonding pair–lone pair (BP–LP)
- C Lone pair–lone pair (LP–LP)
- D All repulsions are equal in strength
- E Repulsion depends only on atom size, not on lone pairs





10 Which order of bond angles is generally correct?



- A $\text{H}_2\text{O} > \text{NH}_3 > \text{CH}_4$
- B $\text{CH}_4 > \text{NH}_3 > \text{H}_2\text{O}$
- C $\text{NH}_3 > \text{CH}_4 > \text{H}_2\text{O}$
- D $\text{CH}_4 > \text{H}_2\text{O} > \text{NH}_3$
- E All are exactly 109.5°

11 NH_3 has a bond angle slightly less than 109.5° mainly because:



- A Nitrogen has too few protons to make tetrahedral geometry
- B A lone pair on nitrogen repels bonding pairs more strongly, compressing the H–N–H angle
- C Hydrogen atoms repel each other less than electron pairs do
- D NH_3 is linear, so the angle must be near 180°
- E The N–H bonds are ionic, so angles are not defined

12 Which molecule has trigonal planar electron-domain geometry but a bent molecular shape?



- A CO_2
- B BF_3
- C SO_3
- D SO_2
- E CH_4





13 Which statement about SO_3 is correct (treating it with VSEPR/resonance)?



- A SO_3 is bent and polar because sulfur has one lone pair
- B SO_3 is trigonal planar and nonpolar because the three S–O bond dipoles cancel by symmetry
- C SO_3 is tetrahedral because sulfur forms three double bonds
- D SO_3 is linear because it has three oxygen atoms
- E SO_3 must be square planar because it has 3 electron domains

14 What is the molecular geometry of the nitrate ion, NO_3^- ?



- A Trigonal planar
- B Trigonal pyramidal
- C Bent (tetrahedral electron geometry)
- D Linear
- E T-shaped

15 What is the molecular geometry of the nitrite ion, NO_2^- ?



- A Linear
- B Trigonal planar
- C Bent (with trigonal planar electron geometry)
- D Tetrahedral
- E Square planar





16 What is the molecular geometry of the carbonate ion, CO_3^{2-} ?



- A Tetrahedral
- B Trigonal planar
- C Bent
- D Trigonal pyramidal
- E Linear

17 What is the molecular geometry of PCl_5 ?



- A Tetrahedral
- B Trigonal bipyramidal
- C Square pyramidal
- D Octahedral
- E Seesaw

18 In an ideal trigonal bipyramidal molecule like PF_5 , what is the bond angle between two equatorial bonds?



- A 90°
- B 109.5°
- C 120°
- D 180°
- E 60°





19 In trigonal bipyramidal electron geometry, lone pairs usually occupy equatorial positions because:



- A** Equatorial positions have fewer 90° interactions than axial positions
- B** Equatorial positions always have stronger bonds than axial positions
- C** Axial positions do not allow lone pairs
- D** Equatorial positions are closer to the nucleus
- E** Lone pairs prefer 180° angles only

20 SF_4 has one lone pair on sulfur (AX_4E). What is its molecular geometry and where is the lone pair located in the trigonal bipyramidal arrangement?



- A** Tetrahedral; lone pair is axial
- B** Seesaw; lone pair is equatorial
- C** Trigonal planar; lone pair is equatorial
- D** Square planar; lone pair is axial
- E** T-shaped; lone pair is axial

21 ClF_3 has the formula AX_3E_2 around chlorine. What is its molecular geometry (shape)?



- A** Trigonal planar
- B** Trigonal pyramidal
- C** T-shaped
- D** Seesaw





E Octahedral

22 Which statement correctly describes XeF₂?



- A** XeF₂ is bent because xenon has two lone pairs
- B** XeF₂ is linear with trigonal bipyramidal electron geometry (AX₂E₃)
- C** XeF₂ is trigonal planar because it has three electron domains
- D** XeF₂ is tetrahedral because xenon has four electron domains
- E** XeF₂ is square planar because it has six electron domains

23 The ion I₃⁻ is best described as:



- A** Bent with two lone pairs on the central iodine
- B** Linear with three lone pairs on the central iodine (AX₂E₃)
- C** Trigonal planar with one lone pair on the central iodine
- D** Tetrahedral because there are three iodine atoms
- E** Octahedral because it is an ion

24 What is the molecular geometry of SF₆?



- A** Trigonal bipyramidal
- B** Octahedral
- C** Square planar





- D Seesaw
- E Trigonal pyramidal

25 What is the molecular geometry of BrF_5 (AX_5E)?



- A Trigonal bipyramidal
- B Square pyramidal
- C Square planar
- D Octahedral
- E Seesaw

26 What is the molecular geometry of XeF_4 (AX_4E_2)?



- A Tetrahedral
- B Square planar
- C Trigonal planar
- D Trigonal bipyramidal
- E Square pyramidal

27 In XeF_4 , the two lone pairs on xenon are arranged:



- A Adjacent in the square plane
- B Opposite each other (trans) in an octahedral arrangement





- C Both in axial positions of a trigonal bipyramidal arrangement
- D On different atoms, not on xenon
- E Randomly; VSEPR cannot predict lone pair positions

28 Which molecule is nonpolar mainly because its molecular geometry causes bond dipoles to cancel?



- A NH₃
- B H₂O
- C SF₄
- D XeF₄
- E CH₂Cl₂

29 Which molecule is expected to be polar?



- A CO₂
- B BF₃
- C SF₆
- D CCl₄
- E SF₄

30 What is the hybridization of the central carbon in CO₂ using the basic electron-domain model?





- A sp
- B sp²
- C sp³
- D sp³d
- E sp³d²

31 What is the hybridization of boron in BF₃ in the basic VSEPR/hybridization model?



- A sp
- B sp²
- C sp³
- D sp³d
- E sp³d²

32 What is the hybridization of nitrogen in NH₃ in the basic model?



- A sp
- B sp²
- C sp³
- D sp³d
- E sp³d²





33 Using the common high-school hybridization mapping, what hybridization is assigned to sulfur in SF₆?



- A sp
- B sp²
- C sp³
- D sp³d
- E sp³d²

34 In the basic hybridization mapping, sp³d hybridization corresponds to a central atom with:



- A 2 electron domains (linear)
- B 3 electron domains (trigonal planar)
- C 4 electron domains (tetrahedral)
- D 5 electron domains (trigonal bipyramidal)
- E 6 electron domains (octahedral)

35 How many electron domains are around sulfur in SO₂ (according to VSEPR counting)?



- A 2
- B 3
- C 4
- D 5
- E 6





36 What is the geometry around each carbon atom in ethene, C_2H_4 ($H_2C=CH_2$)?



- A Tetrahedral (sp^3)
- B Trigonal planar (sp^2)
- C Linear (sp)
- D Trigonal bipyramidal (sp^3d)
- E Octahedral (sp^3d^2)

37 What is the geometry around each carbon atom in ethyne, C_2H_2 ($HC\equiv CH$)?



- A Trigonal planar (sp^2)
- B Tetrahedral (sp^3)
- C Linear (sp)
- D Seesaw (sp^3d)
- E Square planar

38 In ethanol (CH_3CH_2OH), what is the approximate molecular geometry around the oxygen atom?



- A Linear
- B Trigonal planar
- C Bent (from tetrahedral electron geometry)
- D Trigonal pyramidal
- E Octahedral





39 CO₂ has polar C=O bonds, yet the molecule is nonpolar. The best explanation is:



- A Oxygen is not electronegative enough to make a dipole
- B CO₂ is linear, so the two equal bond dipoles cancel
- C Double bonds cannot be polar
- D Carbon has no valence electrons, so it cannot be polar
- E CO₂ is nonpolar because it has no lone pairs on oxygen

40 Which molecule has a net dipole moment (is polar)?



- A CO₂
- B BF₃
- C SO₃
- D SF₆
- E SO₂

41 Which statement about BF₃ is correct?



- A BF₃ is polar because B–F bonds are polar
- B BF₃ is nonpolar because trigonal planar symmetry cancels the three bond dipoles
- C BF₃ is bent because boron has a lone pair
- D BF₃ is linear because boron forms three bonds
- E BF₃ is square planar because fluorine has lone pairs





42 What is the geometry around carbon in formaldehyde, CH_2O ($\text{H}_2\text{C}=\text{O}$)?



- A Tetrahedral
- B Trigonal planar
- C Linear
- D Trigonal pyramidal
- E Octahedral

43 What is the molecular geometry of NH_4^+ (ammonium)?



- A Trigonal pyramidal
- B Tetrahedral
- C Square planar
- D Bent
- E Linear

44 What is the molecular geometry of H_3O^+ (hydronium)?



- A Trigonal planar
- B Tetrahedral
- C Trigonal pyramidal
- D Bent
- E Linear





45 What is the molecular geometry of sulfate, SO_4^{2-} , around sulfur?



- A Trigonal planar
- B Tetrahedral
- C Square planar
- D Trigonal pyramidal
- E Octahedral

46 What is the molecular geometry of phosphate, PO_4^{3-} , around phosphorus?



- A Linear
- B Trigonal planar
- C Tetrahedral
- D Trigonal pyramidal
- E Octahedral

47 What is the molecular geometry of PCl_3 ?



- A Trigonal planar
- B Trigonal pyramidal
- C Tetrahedral
- D Linear
- E T-shaped





48 What is the molecular geometry of BeCl_2 (in the gas phase, as treated by VSEPR)?



- A Bent
- B Linear
- C Trigonal planar
- D Tetrahedral
- E Square planar

49 Which pair correctly describes the electron-domain geometry and molecular geometry of ozone, O_3 , around the central oxygen?



- A Electron geometry linear; molecular geometry linear
- B Electron geometry trigonal planar; molecular geometry bent
- C Electron geometry tetrahedral; molecular geometry bent
- D Electron geometry trigonal planar; molecular geometry trigonal planar
- E Electron geometry trigonal bipyramidal; molecular geometry linear

50 In formaldehyde ($\text{H}_2\text{C}=\text{O}$), which bond angle is expected to be larger, and why?



- A $\text{H}-\text{C}-\text{H}$ is larger, because H atoms repel more strongly than O does
- B $\text{O}-\text{C}-\text{H}$ is larger, because the $\text{C}=\text{O}$ double bond region repels more strongly than a single bond region
- C $\text{H}-\text{C}-\text{H}$ is larger, because a double bond counts as two domains





- D O–C–H is smaller, because oxygen pulls bonding electrons away and increases repulsion
- E All angles must be exactly 120° in any trigonal planar molecule

51 Which statement best describes CH_2Cl_2 ?



- A CH_2Cl_2 is trigonal planar and nonpolar
- B CH_2Cl_2 is tetrahedral around carbon and polar because bond dipoles do not cancel
- C CH_2Cl_2 is linear and polar
- D CH_2Cl_2 is tetrahedral and nonpolar because tetrahedral molecules always cancel dipoles
- E CH_2Cl_2 is square planar because it has four bonds

52 Which molecule has all its bonded atoms in a single plane around the central atom (planar around the central atom)?



- A CH_4
- B NH_3
- C BF_3
- D SF_4
- E H_2O

53 What is the electron-domain geometry around bromine in BrF_5 ?



- A Trigonal planar





- B Tetrahedral
- C Trigonal bipyramidal
- D Octahedral
- E Square planar

54 A central atom has VSEPR type AX₂E₃. What is the molecular geometry?



- A Bent
- B Trigonal planar
- C Linear
- D Seesaw
- E Square planar

55 How many lone pairs are on the central xenon atom in XeF₂ (in the VSEPR model)?



- A 0
- B 1
- C 2
- D 3
- E 4





56 Which molecule has the same molecular geometry as CO₂?



- A H₂O
- B NH₃
- C SO₂
- D BeCl₂
- E CH₄

57 Which molecule has the same electron-domain geometry as CH₄ but a different molecular geometry?



- A BF₃
- B CO₂
- C NH₃
- D PCI₅
- E SF₆

58 Which species has a bond angle closest to 109.5° (ideal tetrahedral)?



- A NH₄⁺
- B BF₃
- C CO₂
- D SO₂
- E ClF₃





59 Why is the H–O–H bond angle in water smaller than the H–N–H bond angle in ammonia?



- A Water is linear but ammonia is bent
- B Oxygen has two lone pairs, causing stronger repulsions that compress the bond angle more than in NH₃ (one lone pair)
- C Nitrogen cannot form tetrahedral electron geometry
- D Hydrogen atoms repel each other less when attached to oxygen
- E Water has more bonds than ammonia, so angles must be smaller

60 NF₃ has a smaller F–N–F bond angle than NH₃ has for H–N–H. Which explanation best matches the VSEPR reasoning taught at high-school level?



- A Fluorine is larger than hydrogen, so it always increases bond angles
- B Highly electronegative F pulls bonding electron density away from N, reducing bonding-pair repulsion near N and compressing the bond angle
- C NF₃ is trigonal planar while NH₃ is trigonal pyramidal
- D NF₃ has no lone pair while NH₃ does
- E Bond angles depend only on molar mass

61 Which molecule has the larger H–X–H bond angle?



- A H₂S
- B H₂O
- C They are equal because both have two lone pairs
- D Cannot be compared without knowing the pressure
- E H₂S is larger because sulfur is bigger





62 In a simple VSEPR model, the chlorate ion ClO_3^- is treated as having 4 electron domains around Cl (3 bonding regions + 1 lone pair). What is its molecular geometry?



- A Trigonal planar
- B Trigonal pyramidal
- C Tetrahedral
- D Bent
- E Linear

63 What is the geometry around carbon in phosgene, COCl_2 ($\text{O}=\text{CCl}_2$)?



- A Tetrahedral
- B Trigonal planar
- C Linear
- D Trigonal pyramidal
- E Seesaw

64 Which molecule is nonpolar because its tetrahedral geometry is perfectly symmetric with identical outer atoms?



- A CH_2Cl_2
- B CHCl_3
- C CCl_4
- D NH_3





E H₂O

65 Which molecule has octahedral electron-domain geometry but square planar molecular geometry?



- A SF₆
- B BrF₅
- C XeF₄
- D PCl₅
- E SF₄

66 A central atom has 6 electron domains: 4 bonding pairs and 2 lone pairs. If the lone pairs occupy opposite positions, what is the molecular geometry?



- A Tetrahedral
- B Square planar
- C Square pyramidal
- D Trigonal bipyramidal
- E Seesaw

67 A central atom has 5 electron domains: 3 bonding pairs and 2 lone pairs (AX₃E₂). What is the molecular geometry?



- A Trigonal planar





- B Trigonal pyramidal
- C T-shaped
- D Seesaw
- E Square planar

68 A central atom has 4 electron domains: 2 bonding pairs and 2 lone pairs (AX₂E₂). What is the molecular geometry?



- A Linear
- B Bent
- C Trigonal planar
- D Tetrahedral
- E Trigonal pyramidal

69 Which statement about CH₃⁺ and CH₃⁻ is correct (VSEPR/basic hybridization model)?



- A CH₃⁺ is trigonal planar; CH₃⁻ is trigonal pyramidal
- B CH₃⁺ is trigonal pyramidal; CH₃⁻ is trigonal planar
- C Both are tetrahedral because carbon always makes 4 bonds
- D Both are linear because they have only one carbon
- E Neither has a defined shape because they are charged





70 Which species has 5 electron domains around its central atom and NO lone pairs on the central atom?

- A** PF₅
- B** SF₄
- C** ClF₃
- D** XeF₂
- E** BrF₅







#	Ans	Answer Text
	C	
2	B	One electron domain because it is one region of electron density
	D	
4	D	Linear
	A	
6	B	Tetrahedral
	B	
8	B	Electron geometry tetrahedral; molecular geometry bent
	C	
10	B	$\text{CH}_4 > \text{NH}_3 > \text{H}_2\text{O}$
	B	
12	D	SO_2
	B	
14	A	Trigonal planar
	C	
16	B	Trigonal planar
	B	
18	C	120°
	A	
20	B	Seesaw; lone pair is equatorial
	C	
22	B	XeF_2 is linear with trigonal bipyramidal electron geometry (AX ₂ E ₃)
	B	
24	B	Octahedral
	B	
26	B	Square planar
	B	
28	D	XeF_4
	E	
30	A	sp
	B	
32	C	sp ³
	E	
34	D	5 electron domains (trigonal bipyramidal)
	B	
36	B	Trigonal planar (sp ²)
	C	
38	C	Bent (from tetrahedral electron geometry)



