



IB Chemistry – SL

Topic 4 Answers

1. D [1]
2. B [1]
3. B [1]
4. D [1]
5. C [1]
6. A [1]
7. B [1]
8. B [1]
9. B [1]
10. B [1]
11. B [1]
12. C [1]
13. A [1]
14. D [1]
15. B [1]
16. B [1]
17. D [1]
18. B [1]



- | | | |
|-----|---|-----|
| 19. | B | [1] |
| 20. | D | [1] |
| 21. | C | [1] |
| 22. | D | [1] |
| 23. | B | [1] |
| 24. | B | [1] |
| 25. | D | [1] |
| 26. | C | [1] |
| 27. | D | [1] |
| 28. | B | [1] |
| 29. | A | [1] |
| 30. | C | [1] |
| 31. | A | [1] |
| 32. | D | [1] |
| 33. | B | [1] |
| 34. | C | [1] |
| 35. | A | [1] |
| 36. | B | [1] |
| 37. | D | [1] |



38. A [1]
39. B [1]
40. B [1]
41. (i) as molecules become larger/heavier/have higher M_r values/
number of electrons increases; van der Waals'/London/
dispersion forces increase; 2
- (ii) hydrogen bonding **between molecules** in H_2O ; this bonding is stronger
(than van der Waals' forces); 2
Must be an implied comparison with (i) [4]
42. (i) tetrahedral (*accept correct 3-D diagram*);
bent/V-shape/angular (*accept suitable diagram*); 2
- (ii) 105° (*accept 103 – 106°*);
lone pairs **repel** each other more than bonding pairs; 2
Do not accept repulsion of atoms. [4]
43. bonds are polar as Cl more electronegative than Si;
Allow "electronegativities are different"
- molecule is symmetrical, hence polar effects cancel out/*OWTTE*; 2 [2]
44. (a) (i) A – sodium iodide, B – sodium, C – iodine (*three correct [1]*); 1
Accept correct formulas.
- (ii) A – ionic bonding;
B – metallic bonding;
C – van der Waals' forces (and covalent bonding); 3
- (b) (i) (for Na) (lattice of) positive ions/atoms;
delocalized/free electrons/sea of electrons;
(for NaI) oppositely charged ions/positive and negative ions;
free to move (only) in molten state; 4
- (ii) forces between I_2 molecules are weak;
ionic/metallic bonding strong(er); 2 [10]
45. (i) $\begin{array}{c} \times\times \\ O :: C :: O \\ \times\times \end{array} ;$ 2
- $\begin{array}{c} \times\times \\ H \times S \times H \\ \times\times \end{array} ;$
- Accept dots, crosses, a combination of dots and crosses or a line to represent a pair of electrons.*



- (ii) CO_2 is linear;
two charge centres or bonds and no lone pairs (around C);
 H_2S is bent/v-shaped/angular;
two bond pairs, two lone pairs (around S); 4
- (iii) CO_2 is non-polar, H_2S is polar;
bond polarities cancel CO_2 but not in H_2S ; 2

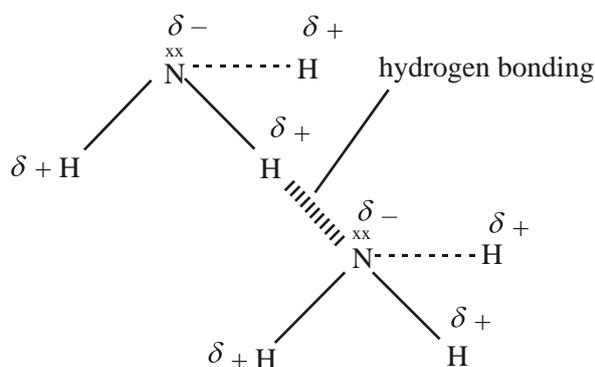
[8]

46. CH_3Cl – dipole-dipole attractions;
 CH_4 – van der Waals’/dispersion/London forces;
 CH_3OH – hydrogen bond; 3

[3]

47. (a) (i) (relative) measure of an atom’s attraction for electrons; in a bond; 2

(ii)



Suitable diagram indicating
dipoles;
lone pairs of electrons;
hydrogen bonding; 3

- (iii) 107° ; 1
Accept answer in range 107 to 109° .

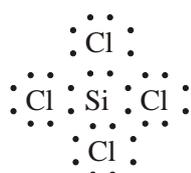
- (iv) molecule is asymmetrical/OWTTE; 1

- (b) (i) 109.5° ; 1

- (ii) NH_4^+ has four bonding pairs
(around central atom so is a regular tetrahedron);
 NH_3 has three bonding pairs (of electrons) and one non-bonding pair;
non-bonding pairs (of electrons) exert a greater repulsive force; 3
Accept suitable diagrams.

[11]

48. Si—Cl bonds are covalent; 3



Accept lines for electron pairs.

Award [1] for covalent bonds and [1] for lone pairs.

[3]

49. find number of electron pairs/charge centres in (valence shell of) central atom;
electron pairs/charge centres (in valence shell) of central atom repel each other;
to positions of minimum energy/repulsion/maximum stability;
pairs forming a double or triple bond act as a single bond;
non-bonding pairs repel more than bonding pairs/*OWTTE*;

3 max

Do not accept repulsion between bonds or atoms.

Award [1] each for any three points.

[3]

50. (i) SCl_2 two bonding pairs, two non-bonding pairs;
angular/bent/non-linear/V-shaped;
Both these marks can be scored from a diagram.
 $90^\circ < \text{angle} < 107^\circ$;

C_2Cl_2 two charge centres around each C;
linear;

Both these marks can be scored from a diagram.

angle = 180° ;

6

- (ii) SCl_2 is polar;
 C_2Cl_2 is non-polar;
No net dipole movement for C_2Cl_2 but angular SCl_2 has a resultant dipole / *OWTTE*;

3

Mark can be scored from a diagram.

Allow ECF based on the answers given to (i).

[9]

51.



Allow a combination of dots, crosses or lines.

bent/V shaped/angular
 104.5° ;

Accept answers in range 104° to 106° .

repulsion of the two non-bonding pairs of electrons forces bond angle to be smaller/non-bonding pairs repel more than bonding pairs;

4

[4]



52. butane < propanone < propanol;

butane has van der Waals' forces;

Accept vdW, dispersion or London forces or attractions between temporary dipoles.

propanone has dipole-dipole attractions;

propanol has (the stronger) H-bonding;

4

[4]

53. delocalized electrons;

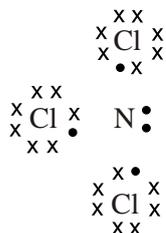
(attracted) to positive ions;

more delocalized/mobile/outer shell electrons/higher ionic charge;

3

[3]

54.



All electrons must be shown.

Accept molecular structures using lines to represent bonding and lone electron pairs.

bond angle: 107° – 109°

greater repulsion between lone pair and bonding pairs/OWTTE;

NOT between electron pairs and atoms.

Award [1 max] if lone pair missed on nitrogen, ECF for bond angle of 120° .

3

[3]

55. $\text{NH}_4^+ > \text{NH}_3 > \text{NH}_2^-$;

NH_4^+ has four bonded electron pairs (and no lone electron pairs);

NH_3 has three bonded electron pairs and one electron lone pair;

NH_2^- has two bonded electron pairs and two electron lone pairs;

Accept correct Lewis structures with lone electron pairs clearly shown.

lone pair-lone pair > lone pair-bonded pair > bonded pair-bonded pair/



lone pairs of electrons repel more than bonding pairs of electrons/*OWTTE*;
Do not accept repulsion between atoms.

5

[5]

56. (i) Find number of electron pairs/charge centres in (valence shell of) central atom;
electron pairs/charge centres (in valence shell) of central atom repel each other;

Any one of the following:

to positions of minimum energy/repulsion/maximum stability;

pairs forming a double or triple bond act as a single bond;

non-bonding pairs repel more than bonding pairs/*OWTTE*;

max

3

Do not accept repulsion between bonds or atoms.

(ii)

6

| Species | Lewis (electron-dot) structure | Shape | Bond angle(s) |
|------------------------|--------------------------------|--------------------------------|--|
| H_3O^+ | | Trigonal/triangular pyramidal; | Allow values in the range 106° to 109.5° ; |
| C_2H_4 | | Trigonal/triangular planar; | Allow values of approximately 120° ; |

Accept crosses and dots for electrons in Lewis structures also.

As the Lewis structures were asked for, and not 3D

representations, do not penalize incorrectly drawn geometries.

Do not accept structure of hydronium cation without lone pair on oxygen.

No penalty for missing charge.

- (iii) H_3O^+ : is polar and explanation either using a diagram or in words, involving the net dipole moment;
e.g. the three individual O-H bond dipole moments add as vectors to give a net dipole moment.

C_2H_4 : is non-polar and explanation either using a diagram or in words, involving no net dipole moment;

2

e.g. the vector sum of the individual bond dipole moments is zero.

For simple answers such as bond polarities do not cancel for H_3O^+ and do cancel for C_2H_4 , Award [1], only for the last two marking points.

- (iv) O-H is most polar;
O-H has greatest difference between electronegativities/calculation showing values of 1.4, 0.5 and 0.9 respectively;

2

[13]

57. BF_3 , N_2O , P_4O_6 and CBr_4 ;



Non-metals only/small difference in electronegativity values of the elements;

2

[2]

58. (i)

3

| Allotrope | Structure |
|---------------------------------|--|
| Diamond | 3D array/network involving tetrahedral carbons/each carbon atom joined to four others; |
| Graphite | layer structure involving trigonal (triangular) planar carbons/with each carbon atom joined to three others/with hexagonal (six-membered) rings of carbon atoms; |
| C₆₀ fullerene | truncated icosahedrons; <i>Accept carbon atoms form a 'ball' with 32 faces, of which 12 are pentagons and 20 are hexagons, exactly like a soccer ball. Do not accept soccer ball alone.</i> |

(ii) Diamond: covalent bonds (only);
Graphite: covalent bonds and the separated layers held together by (weak) London/van der Waals'/dispersion forces;

2

[5]

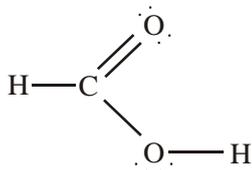
59. *Electrical conductivity:*
Bonding electrons are delocalised;
Current flow occurs without displacement of atoms within the metal/
able to flow within the metal;

Malleability:
Can be hammered into thin sheets;
atoms capable of slipping with respect to one another;

4

[4]

60. (a)



1

No mark without lone electron pairs.

Correct shape not necessary.

Do not award mark if dots/crosses and bond lines are shown.

Accept lone pairs represented as straight lines.

(b) $O - C - O = 120^\circ / H - C - O = 120^\circ$;
 $C - O - H = 109^\circ / < 109^\circ$;

2

No mark for 109.5°

Accept answer in range $100 - 109^\circ$



- (c) length: $C = O < C - O$;
strength: $C = O > C - O$;
greater number of electrons between nuclei pull atoms together and require greater energy to break;

Or

double bonds are shorter/single bonds are longer;
double bonds are stronger/single bonds are weaker;

3

Accept stronger attraction between nuclei and (bonding) electrons.

[6]