Chemical Bonding (Advanced)

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer 8 × 1 = 8 marks

1. How many dots surround the symbol Be in the Lewis symbol of beryllium (atomic number 4)?

(a) 4 **(b)** 2 **(c)** 3 **(d)** 6

2. How many electrons are there in the valence shell of the central silicon atom in SiH_4?

(a) 8 **(b)** 6 **(c)** 4 **(d)** 10

3. The total number of valence electrons in one molecule of NH_3 is:

(a) 9 **(b)** 7 **(c)** 8 **(d)** 10

4. Calcium (Z = 20) combines with fluorine (Z = 9). The formula of the compound is:

(a) Ca_2F **(b)** CaF **(c)** CaF_2 **(d)** Ca_3F_2

5. The octet rule says that atoms tend to bond until they have:

(a) no valence electrons **(b)** two electrons in every shell
(c) eight electrons in their valence shell **(d)** eight shells

6. What kind of bonding holds potassium and oxygen in their compound?

(a) metallic bonding **(b)** ionic bonding (transfer of electrons)
(c) covalent bonding (sharing of electrons) **(d)** no bonding: the atoms stay separate

7. Steel is stretched into thin wire for cables. The electron sea model explains this because:

(a) layers of ions slide over one another when hammered, while the electron sea keeps holding them, so it spreads into sheets
(b) free electrons drift through the metal when a voltage is applied
(c) ions slide past one another when pulled and the non-directional bonds hold, so it can be drawn out into a wire
(d) fast-moving free electrons and vibrating ions pass the energy along quickly

8. Assertion (A): In OF_2, the central O atom has 8 electrons in its valence shell.
Reason (R): Hydrogen is stable with two electrons, like helium.

(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. For magnesium (atomic number 12), write (a) its electron configuration and (b) the number of dots in its Lewis symbol.

10. How many pairs of electrons are shared between the two nitrogen atoms in N_2?

11. How many lone pairs of electrons are there on the central B atom in BCl_3?

12. (a) Find the total number of valence electrons in O_2. (b) Is it an odd-electron molecule? (Yes or No)

13. Oxygen has atomic number 8. To reach a stable configuration, (a) how many electrons does its atom transfer, and (b) does it lose or gain them?

14. In SF_6, how many electrons more than an octet does the central S atom have?

15. How many chlorine atoms must bond with one nitrogen atom (atomic number 7) so that nitrogen completes its octet by sharing?

16. A tiny crystal of aluminium (atomic number 13) has 72 thousand atoms. In the electron sea model each atom gives up its valence electrons to the sea. How many electrons are in the sea?

Section C — Word problems — 4 × 4 = 16 marks

17. Work out the Lewis structure of BH_3. For the central B atom, find (a) the number of shared pairs, (b) the number of lone pairs and (c) the electrons in its valence shell. (d) Does it obey the octet rule? (Yes or No)

18. For a molecule of BCl_3, find (a) the total number of valence electrons and (b) the number of electrons around the central B atom. (c) Which exception to the octet rule is it: an incomplete octet or an expanded octet?

19. Element X has atomic number 12 and element Y has atomic number 15. (a) Write the electron configuration of X. (b) Write that of Y. (c) What type of bond forms between them? (d) Write the formula of the compound, using the symbols Mg and P.

20. Why does boron form compounds with only six electrons around it, as in BF_3?

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Answer key

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Q	Answer	Working
1	**(b) 2**	configuration 2, 2: 2 valence electrons, one dot each
2	**(a) 8**	4 shared pairs and 0 lone pairs: 2 × 4 = 8
3	**(c) 8**	1 × 5 (N) + 3 × 1 (H) = 8
4	**(c) CaF_2**	valency of Ca = 2 (configuration 2, 8, 8, 2), of F = 1 (configuration 2, 7); cross the valencies and simplify
5	**(c) eight electrons in their valence shell**	by losing, gaining or sharing electrons
6	**(b) ionic bonding (transfer of electrons)**	a metal gives electrons to a non-metal
7	**(c) ions slide past one another when pulled and the non-directional bonds hold, so it can be drawn out into a wire**	ductility
8	**(b) Both A and R are true, but R is not the correct explanation of A.**	A is true: 2 shared and 2 lone pairs: 8. R is true but does not explain A.
9	**(a) 2, 8, 2; (b) 2**	fill 2, 8, 8 …; the outer shell has 2
10	**3**	a triple bond
11	**0**	B has 3 valence electrons; 3 are used in bonds, 0 left = 0 pairs
12	**(a) 12; (b) No**	2 × 6 = 12
13	**(a) 2; (b) gain**	configuration 2, 6: gain 2 to make 8
14	**4**	6 shared + 0 lone pairs = 12 electrons; |12 − 8|
15	**3**	nitrogen has 5 valence electrons and needs 3 more; each chlorine atom shares one
16	**216,000**	configuration 2, 8, 3: 3 per atom × 72,000
17	**(a) 3; (b) 0; (c) 6; (d) No**	B has 3 valence electrons; 2 × (3 + 0) = 6
18	**(a) 24; (b) 6; (c) incomplete octet**	(a) 1 × 3 + 3 × 7; (b) 2 × (3 + 0); (c) 6 is fewer than 8
19	**(a) 2, 8, 2; (b) 2, 8, 5; (c) ionic bond; (d) Mg_3P_2**	X loses 2 and Y gains 3; balance the charges: Mg_3P_2
20	**Boron has only 3 valence electrons, so it can form only 3 bonds; with no lone pairs, its octet stays incomplete at 6 electrons, yet the molecule is stable.**	marking: each point in the model answer

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