Classification of Elements and Periodicity in Properties

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. The modern periodic law states that the properties of elements are a periodic function of their:

(a) densities **(b)** numbers of neutrons
(c) atomic masses **(d)** atomic numbers

2. The element with atomic number 15 lies in:

(a) period 3, group 15 **(b)** period 4, group 15
(c) period 2, group 15 **(d)** period 3, group 5

3. Which shows the correct order of increasing electronegativity?

(a) Na < Li < K **(b)** K < Li < Na **(c)** K < Na < Li **(d)** Li < Na < K

4. The IUPAC name and symbol of the element with atomic number 187 are:

(a) Unocthexium (Uoh) **(b)** Unseptoctium (Uso)
(c) Unoctseptium (Uos) **(d)** Unoctoctium (Uoo)

5. Which of these has the most negative electron gain enthalpy?

(a) Sodium **(b)** Selenium **(c)** Sulphur **(d)** Argon

6. The oxide SO_3 is:

(a) amphoteric **(b)** basic **(c)** acidic **(d)** neutral

7. Which species is isoelectronic with Al^{3+}?

(a) Sr^{2+} **(b)** Ca^{2+} **(c)** Mg^{2+} **(d)** He

8. Assertion (A): The atomic radius of sodium is smaller than that of chlorine.
Reason (R): Across a period, the nuclear charge increases while electrons enter the same shell, so they are pulled closer to the nucleus.

(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. Why is the first ionisation enthalpy of boron lower than that of beryllium?

10. Write the electronic configuration of the element with atomic number 35, and give its period, group and block.

11. Arrange these isoelectronic species in order of increasing size: Ca^{2+}, Cl^{-}, S^{2-}, K^{+}.

12. The IUPAC name of an element is Unhexhexium. What is its atomic number and its symbol?

13. Predict the formula and name of the compound formed by calcium and oxygen.

14. The successive ionisation enthalpies of an element are 590, 1,145, 4,912, 6,491 kJ/mol. In which group of the periodic table is it most likely to be?

15. How much energy is released when all the atoms in 48 g of gaseous sulphur atoms gain one electron each? (Electron gain enthalpy −200 kJ/mol; S = 32 u)

16. Among O, N, C, F, which has the largest atomic radius and which has the highest first ionisation enthalpy?

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

17. Explain how the electronic configuration of an element decides its period, group and block, with one example from each block.

18. Two elements X and Y have atomic numbers 11 and 15. (a) Write their electronic configurations. (b) Give the period and group of each. (c) Which has the higher first ionisation enthalpy? (d) Give the formula of the compound they form, and the type of bond.

19. The first ionisation enthalpies of C, N, O, F, Ne are 1086, 1402, 1314, 1681, 2080 kJ/mol. (a) State the general trend and give its reason. (b) Explain why the trend is broken.

20. Consider Ca^{2+}, Cl^{-}, K^{+}, S^{2-}. (a) How many electrons does each have? (b) Arrange them in order of increasing size. (c) Explain the order. (d) Which of them has the greatest nuclear charge?

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Answer key

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Q	Answer	Working
1	**(d) atomic numbers**	Moseley showed atomic number is the basis
2	**(a) period 3, group 15**	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$: p-block
3	**(c) K < Na < Li**	K 0.8, Na 0.9, Li 1.0
4	**(c) Unoctseptium (Uos)**	un + oct + sept + ium
5	**(c) Sulphur**	S −200, Se −195, Ar +96, Na −53 kJ/mol
6	**(c) acidic**	non-metal oxides are mostly acidic
7	**(c) Mg^{2+}**	both have 10 electrons
8	**(d) A is false, but R is true.**	A is false: Na 186 pm, Cl 99 pm. R is true.
9	**Boron's outer electron is in 2p, which is higher in energy and shielded by the 2s electrons, so it is removed more easily than a 2s electron of beryllium.**	—
10	**[Ar] $3d^{10}\ 4s^2\ 4p^5$; period 4, group 17 (p-block)**	period = highest n; block = subshell of the last electron; group from the outer electrons
11	**$Ca^{2+} < K^+ < Cl^- < S^{2-}$**	all have 18 electrons; more protons pull them closer
12	**166; Uhh**	nil 0, un 1, bi 2, tri 3, quad 4, pent 5, hex 6, sept 7, oct 8, enn 9
13	**CaO (calcium oxide)**	Ca forms Ca^{2+}; O forms O^{2-}; balance the charges
14	**Group 2**	the big jump comes after the 2nd electron, so it has 2 valence electrons (for example Ca)
15	**300 kJ**	moles = 1.5; energy = moles × 200
16	**Largest radius: C; highest ionisation enthalpy: F**	O: 66 pm, 1314 kJ/mol; N: 74 pm, 1402 kJ/mol; C: 77 pm, 1086 kJ/mol; F: 64 pm, 1681 kJ/mol
17	**Period = the highest principal quantum number n. Block = the subshell receiving the last electron. Group: s-block = number of ns electrons; p-block = 10 + (ns + np electrons); d-block = ns + (n − 1)d electrons. Examples: Na $3s^1$: period 3, group 1, s-block. Cl $3s^2\ 3p^5$: period 3, group 17, p-block. Fe $3d^6\ 4s^2$: period 4, group 8, d-block.**	—
18	**(a) X: $1s^2\ 2s^2\ 2p^6\ 3s^1$; Y: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$. (b) X: period 3, group 1 (s-block); Y: period 3, group 15 (p-block). (c) Y (phosphorus). (d) Na_3P (X_3Y); ionic**	X is sodium, a metal (loses 1); Y is phosphorus, a non-metal (gains 3)
19	**(a) It generally increases across the period, because the nuclear charge**	—

Q	Answer	Working
	increases while the electrons are added to the same shell. (b) O is lower than N: N has a stable half-filled p subshell, while in O one p orbital holds a pair of electrons that repel each other.	
20	**(a) 18 each (isoelectronic); (b) Ca^{2+} < K^{+} < Cl^{-} < S^{2-}; (c) the same number of electrons is held by more protons, so the cloud is pulled in more tightly; (d) Ca^{2+} (20 protons)**	—