

Atoms, elements and compounds

30 questions: 15 multiple choice, 15 structured.

1 Core Elements, compounds and mixtures [1]

Which statement correctly describes a compound?

- A A pure substance made of only one type of atom
- B A pure substance made of two or more elements chemically combined in a fixed ratio
- C Two or more substances mixed together in variable proportions, without any chemical bonds between them
- D A substance made of only one type of molecule, which can be separated into simpler substances by physical means alone

2 Core Atomic structure and the Periodic Table [1]

In which region of an atom are protons and neutrons found?

- A The nucleus
- B The electron shells
- C The outer shell only
- D Spread evenly throughout the whole volume of the atom

3 Core Atomic structure and the Periodic Table [1]

Which row correctly gives the relative charge and the relative mass of a neutron?

Option	Relative charge	Relative mass
A	+1	1
B	-1	1
C	0	very small (about 1/1840)
D	0	1

4**Core**

Atomic structure and the Periodic Table

[1]

An atom of phosphorus has a mass number of 31 and contains 16 neutrons. What is its proton (atomic) number?

- A 47
 - B 16
 - C 15
 - D 31
-

5**Core**

Atomic structure and the Periodic Table

[4]

An atom of aluminium has a proton (atomic) number of 13 and a mass (nucleon) number of 27.

- (a) State the number of neutrons and the number of electrons in this atom. [2]

- (b) Give the electronic configuration of this atom. [1]

- (c) State the number of occupied electron shells in this atom, and identify the period of the Periodic Table in which aluminium is found. [1]

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Core

Atomic structure and the Periodic Table

[5]

- (a) Describe the structure of an atom, including the location of protons, neutrons and electrons, and explain why an atom has no overall electrical charge.

[3]

- (b) Complete the table to give the relative charge and the relative mass of each particle.

Particle	Relative charge	Relative mass
proton		
neutron		
electron		

[2]

A sulfur atom (proton number 16) gains two electrons to form a sulfide ion, S^{2-} .

- (a) Deduce the number of protons and the number of electrons in the S^{2-} ion, giving a reason for your answer. [3]

- (b) Give the electronic configuration of the S^{2-} ion. [1]

- (c) A calcium atom (proton number 20) loses two electrons to form a Ca^{2+} ion. Give the electronic configuration of the Ca^{2+} ion, and state how many occupied electron shells it has. [2]

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Core

Isotopes

[1]

Which statement correctly defines isotopes?

- A Atoms of the same element that have the same number of protons but different numbers of neutrons
 - B Atoms of different elements that have the same mass number
 - C Atoms of the same element that have different numbers of protons
 - D Molecules with the same molecular formula but different structures
-

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Supplement

Isotopes

[1]

Chlorine has two common isotopes, ^{35}Cl and ^{37}Cl . Both isotopes have identical chemical properties. Which statement explains why?

- A They have the same number of neutrons
 - B They have the same relative atomic mass
 - C They have the same number of protons, and therefore the same number of electrons
 - D They are found in different groups of the Periodic Table
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Isotopes

[4]

Potassium has two isotopes, which can be written as $^{39}_{19}\text{K}$ and $^{41}_{19}\text{K}$.

- (a) For the isotope $^{39}_{19}\text{K}$, state the number of protons, the number of neutrons and the number of electrons.

[3]

- (b) Explain, in terms of subatomic particles, why $^{39}_{19}\text{K}$ and $^{41}_{19}\text{K}$ are both isotopes of potassium.

[1]

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11**Supplement**

Isotopes

[5]

A sample of chlorine gas contains two isotopes: 75% of the atoms are ^{35}Cl (relative isotopic mass 35) and 25% of the atoms are ^{37}Cl (relative isotopic mass 37).

- (a) Calculate the relative atomic mass of this sample of chlorine. Give your answer to 3 significant figures.

[3]

- (b) The relative atomic mass of chlorine given in the Periodic Table is 35.5. State, with a reason, whether your answer to (a) is consistent with this value.

[2]

12**Core**

Ions and ionic bonds

[1]

A magnesium atom loses two electrons when it reacts. What type of ion is formed, and what is its charge?

- A An anion with charge 2-
B A cation with charge 2+
C An anion with charge 2+
D A cation with charge 2-

13 **Core** Ions and ionic bonds

[1]

Which statement correctly defines an ionic bond?

- A A shared pair of electrons between two atoms
 - B The attraction between a nucleus and its own electrons
 - C A weak attraction between neighbouring molecules
 - D A strong electrostatic attraction between oppositely charged ions
-

14 **Core** Ions and ionic bonds

[1]

Which pair of properties is typical of an ionic compound such as sodium chloride?

- A High melting point; conducts electricity when molten or in aqueous solution
 - B Low melting point; conducts electricity when molten or in aqueous solution
 - C High melting point; conducts electricity only when solid
 - D Low melting point; does not conduct electricity in any state
-

15 **Supplement** Ions and ionic bonds

[1]

Which statement best describes the structure of solid sodium chloride?

- A Individual NaCl molecules held together by weak intermolecular forces
- B A giant lattice of alternating Na^+ and Cl^- ions held together by strong electrostatic forces in all directions
- C A small cluster of six ions arranged randomly
- D A giant covalent structure with each atom bonded to four others

Potassium and fluorine react together to form the ionic compound potassium fluoride, KF. A potassium atom has the electronic configuration 2,8,8,1 and a fluorine atom has the electronic configuration 2,7.

- (a) Describe how a potassium atom and a fluorine atom form ions when they react together. [2]

- (b) State the electronic configuration of the K^+ ion and of the F^- ion. [2]

- (c) Explain why potassium fluoride is described as having an ionic bond. [1]

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Core

Ions and ionic bonds

[4]

- (a) State two physical properties of solid sodium chloride that are typical of ionic compounds. [2]

- (b) State whether solid sodium chloride conducts electricity, and state whether molten sodium chloride conducts electricity. [2]

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Magnesium (electronic configuration 2,8,2) reacts with oxygen (electronic configuration 2,6) to form magnesium oxide, MgO.

- (a) Describe how a magnesium atom and an oxygen atom form ions in this reaction. [2]

- (b) Give the electronic configuration of the Mg^{2+} ion and of the O^{2-} ion. [2]

- (c) Explain, in terms of electron transfer, why the ratio of magnesium ions to oxide ions in magnesium oxide is 1:1. [2]

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Ions and ionic bonds

[6]

Calcium oxide, CaO, is an ionic compound.

- (a) Describe the structure of calcium oxide as a giant ionic lattice.

[2]

- (b) Explain, in terms of structure and bonding, why calcium oxide has a high melting point.

[2]

- (c) Explain, in terms of structure and bonding, why calcium oxide conducts electricity when molten but not when solid.

[2]

20**Core**

Simple molecules and covalent bonds

[1]

What is a covalent bond?

- A An electrostatic attraction between oppositely charged ions
- B A pair of electrons transferred completely from one atom to another
- C A pair of electrons shared between two atoms
- D An attraction between a metal ion and a sea of delocalised electrons

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Simple molecules and covalent bonds

[1]

Which pair of properties is typical of a simple molecular compound such as water?

- A High melting point; good electrical conductivity
 - B High melting point; poor electrical conductivity
 - C Low melting point; good electrical conductivity
 - D Low melting point; poor electrical conductivity
-

22**Core**

Simple molecules and covalent bonds

[4]

Methane, CH₄, is a simple molecular compound.

- (a) State the number of covalent bonds formed by the carbon atom in a molecule of methane, and state the number of electrons shared in each of these bonds.

[2]

- (b) Describe, in terms of electron arrangement, how the covalent bonds in methane give both the carbon atom and each hydrogen atom a full outer shell of electrons.

[2]

In a molecule of carbon dioxide, CO_2 , the carbon atom forms a double covalent bond with each of the two oxygen atoms.

- (a) Describe, in terms of shared electrons, the covalent bonding between the carbon atom and each oxygen atom in a molecule of carbon dioxide. [3]

- (b) In a molecule of nitrogen, N_2 , the two nitrogen atoms share electrons so that each nitrogen atom has a full outer shell. State the number of electrons shared between the two nitrogen atoms, and name the type of covalent bond formed. [2]

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Simple molecules and covalent bonds

[6]

Iodine, I_2 , is a simple molecular substance.

- (a) Explain, in terms of structure and bonding, why simple molecular substances such as iodine have low melting points and low boiling points. [3]

- (b) Explain why simple molecular substances are poor conductors of electricity. [2]

- (c) State one way in which the covalent bond within a molecule of iodine differs from the forces between neighbouring molecules of iodine. [1]

25**Core**

Giant covalent structures

[1]

In which structure is each carbon atom covalently bonded to four other carbon atoms?

- A Diamond
- B Graphite
- C Carbon dioxide
- D Methane

26**Core**

Giant covalent structures

[1]

Which property of graphite makes it useful as an electrode in electrolysis?

- A It is very hard and resists scratching
 - B It conducts electricity and has a high melting point
 - C It is transparent and colourless
 - D It is soft and dissolves easily in water
-

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Giant covalent structures

[6]

- (a) Describe the structure and bonding in diamond.

[2]

- (b) Describe the structure and bonding in graphite, and explain how this structure allows graphite to be used as a lubricant.

[2]

- (c) State one other use of graphite and one use of diamond, and for each one link the use to a property of its structure.

[2]

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Giant covalent structures

[5]

Silicon(IV) oxide, SiO_2 , has a giant covalent structure similar to diamond.

(a) Describe the structure of silicon(IV) oxide.

[2]

(b) Explain why silicon(IV) oxide, like diamond, has a very high melting point and does not conduct electricity.

[3]

29**Supplement**

Metallic bonding

[1]

Which description best fits the structure of a metal such as copper?

- A A lattice of alternating positive and negative ions
- B Individual atoms held together by weak intermolecular forces
- C A giant lattice of positive ions surrounded by a sea of delocalised electrons
- D A lattice of neutral atoms joined by covalent bonds

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Supplement

Metallic bonding

[6]

- (a) Describe the structure of metallic bonding in a metal such as copper.

[2]

- (b) Explain, in terms of structure and bonding, why metals are good conductors of electricity.

[2]

- (c) Explain, in terms of structure and bonding, why metals can be bent and shaped without breaking.

[2]
