9. The Periodic Table: Chemical Periodicity

9.1 Periodicity of physical properties

Paper 1

Question Paper

1 X and Y are elements in Period 3 of the Periodic Table.

Y has a greater atomic number than X.

The stable ion formed by Y has a greater radius than the stable ion formed by X.

The stable ion formed by Y has 18 electrons.

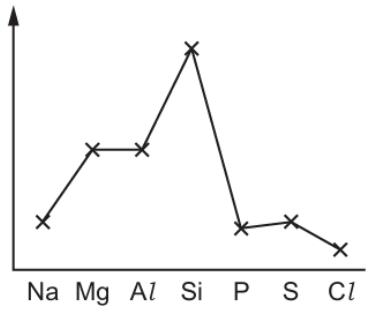
Which row is correct?

	number of electrons in the stable ion of X	element with the greater atomic radius
A	10	X
B	10	Y
C	18	X
D	18	Y

2 The graphs show trends in four physical properties of elements in Period 3, excluding argon.

Which graph has electronegativity on the *y*-axis?

A



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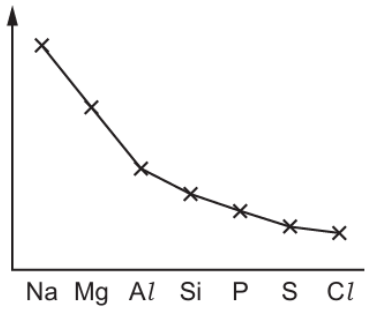

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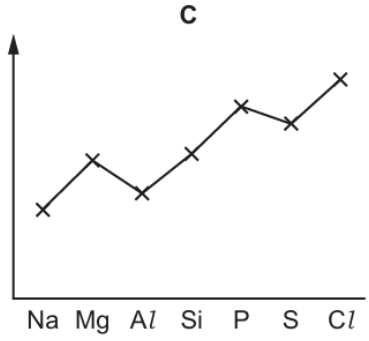

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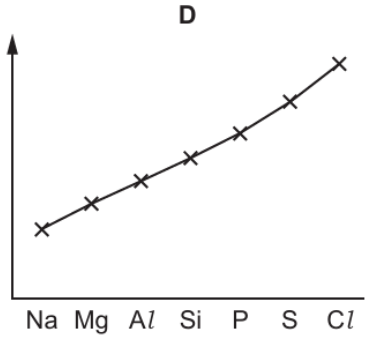


3 Which statement is correct?

A The atomic radius of silicon is larger than that of aluminium.

B The boiling point of chlorine is higher than that of silicon.

C The first ionisation energy of sulfur is greater than that of phosphorus.

D The electrical conductivity of magnesium is greater than that of sodium.

4 Which statement is correct?

A Adding sodium oxide to water gives a lower pH solution than adding silicon oxide to water.

B The oxidation state of sodium in its chloride is higher than the oxidation state of silicon in its chloride.

C The atomic radius of sodium is larger than that of silicon.

D The melting point of the chloride of sodium is lower than the melting point of the chloride of silicon.

5 Which row about silicon, Si, and magnesium, Mg, and their ions is correct?

	comparison of silicon and magnesium	explanation
A	Si has a greater atomic radius than Mg.	Si has electrons in 3p orbitals. Mg has electrons in the 3s orbital only.
B	Si has a lower electrical conductivity than Mg.	Si has 4 delocalised electrons per atom. Mg only has 2 delocalised electrons per atom.
C	Si has a lower melting point than Mg.	Si has covalent bonding. Mg has metallic bonding.
D	The radius of Si^{4+} is smaller than the radius of Mg^{2+}.	Si has a greater nuclear charge than Mg.

6 Which row gives the best description of the variations in the melting points and the first ionisation energies of the elements in Period 3 from sodium to argon?

	melting points	first ionisation energies
A	increase up to a peak at aluminium then decrease	generally decrease
B	increase up to a peak at aluminium then decrease	generally increase
C	increase up to a peak at silicon then decrease	generally decrease
D	increase up to a peak at silicon then decrease	generally increase

7 X and Y are atoms of different elements in Period 3 of the Periodic Table. Neither X nor Y is argon.

X is a non-metal.

X has a greater atomic radius than Y.

Which statement is correct?

A X has more occupied electron shells than Y.

B X has more protons in each atom than Y.

C X has the same number of outer electrons in each atom as Y.

D Y is a non-metal.

8 Element X has six more protons than element Y.

Which statement **must** be correct?

A Atoms of element Y are smaller than atoms of element X.

B Element X has a full shell of electrons.

C Element X and element Y are in the same group.

D Element X and element Y are in the same period.

9 Three statements about potassium and chlorine and their ions are listed.

1 The atomic radius of a potassium atom is greater than the atomic radius of a chlorine atom.

2 The first ionisation energy of potassium is greater than the first ionisation energy of chlorine.

3 The ionic radius of a potassium ion is greater than the ionic radius of a chloride ion.

Which statements are correct?

A 1 only **B** 2 only **C** 1 and 3 **D** 2 and 3

10 Element X has the second largest atomic radius in its period. An atom of X has three occupied electron shells only.

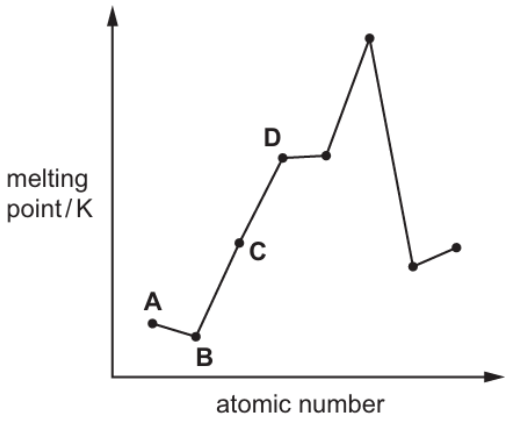
The oxide of X is shaken with water.

What could be the pH of the resulting solution?

A 5 **B** 7 **C** 9 **D** 14

11 The diagram shows the melting points of eight elements with consecutive atomic numbers.

Which element could be sodium?



12 L, M and N are three different elements from Period 3 of the Periodic Table.

L is the element whose atoms have three unpaired electrons in its 3p sub-shell.

M is the element with the highest electrical conductivity in the period.

N is the element with the highest melting point in the period.

Which statement about element L is correct?

A L has a higher atomic number than M and a lower atomic number than N.

B L has a lower atomic number than M and a higher atomic number than N.

C L has a lower atomic number than both M and N.

D L has a higher atomic number than both M and N.

13 Which row describes the relative sizes of the ionic radii of Na^+, Mg^{2+} and S^{2-}?

	smallest →		largest
A	Na^+	Mg^{2+}	S^{2-}
B	Mg^{2+}	Na^+	S^{2-}
C	S^{2-}	Na^+	Mg^{2+}
D	S^{2-}	Mg^{2+}	Na^+

14 The melting points of the Period 3 elements sodium to aluminium are shown in the table.

element	Na	Mg	Al
melting point / K	371	923	932

Which factor explains the **increase** in melting points from sodium to aluminium?

A the change in first ionisation energy from sodium to aluminium

B the increase in electronegativity from sodium to aluminium

C the increase in the A_r of the elements from sodium to aluminium

D the increase in the number of outer electrons in each atom from sodium to aluminium

15 Which statement for the element in Period 3 and Group 13 of the Periodic Table is correct?

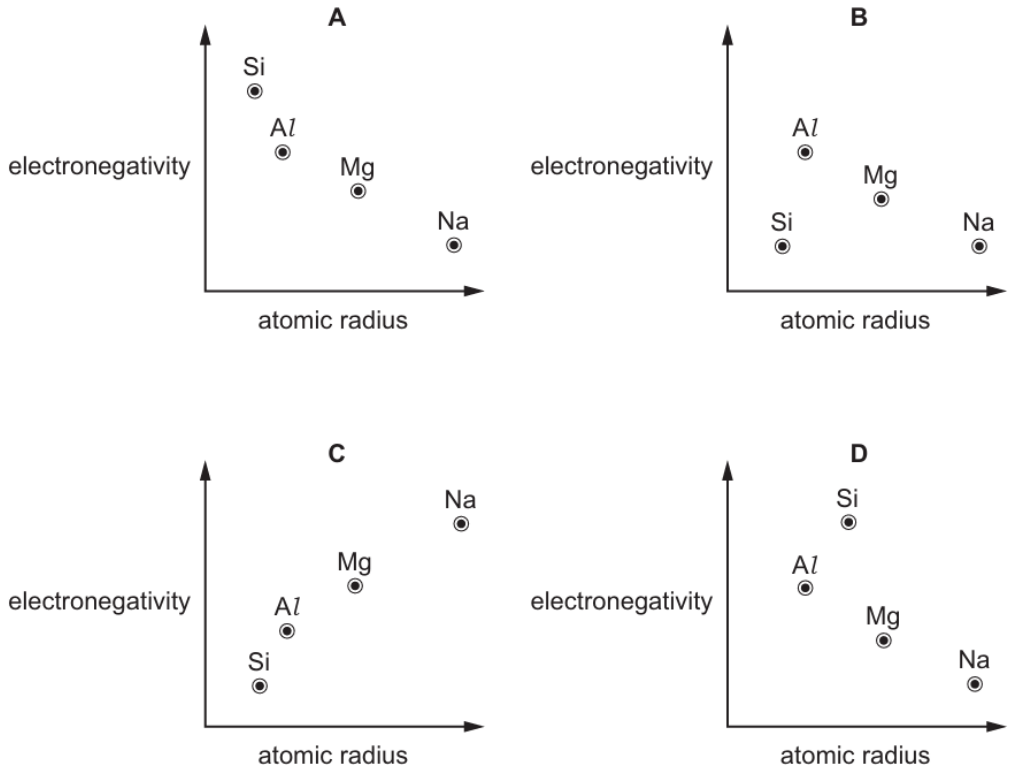
A It has the highest melting point of the elements in its period.

B It has exactly one electron in its shell with principal quantum number 3.

C It forms an oxide that reacts with aqueous sodium hydroxide.

D It forms a chloride that dissolves in water to give a neutral solution.

16 Which graph correctly shows relative electronegativity plotted against relative atomic radius for the elements Na, Mg, Al and Si?

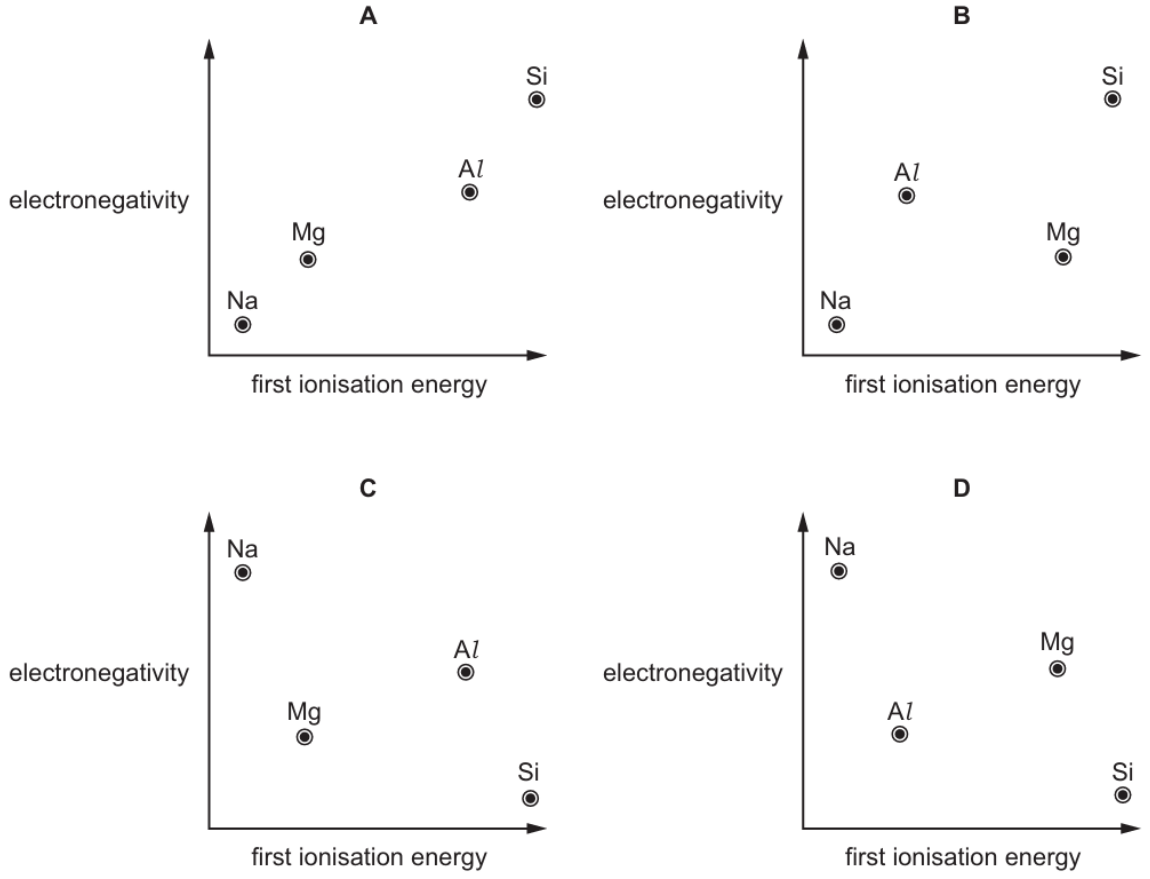


17 X, Y and Z are consecutive elements in Period 3 of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point of these three elements.

What are the identities of X, Y and Z?

	X	Y	Z
A	Na	Mg	Al
B	Mg	Al	Si
C	Al	Si	P
D	Si	P	S

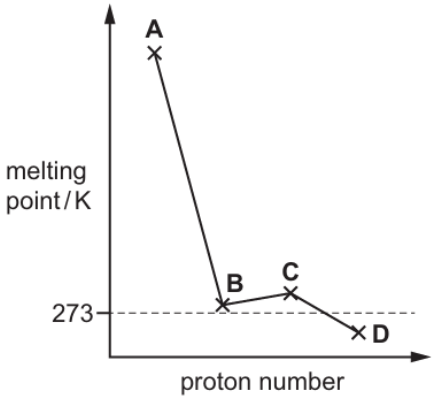
18 Which diagram correctly shows the electronegativity of the elements Na, Mg, Al and Si plotted against their first ionisation energies?



19 The relative melting points of four consecutive elements in the Periodic Table are shown in the graph.

The elements all have proton numbers less than 20.

Which element is in Group 16?



20 Elements D and E are both in Period 3. Element D has the smallest atomic radius in Period 3. There are only two elements in Period 3 which have a lower melting point than element E. Elements D and E react together to form compound L.

Which compound could be L?

A $MgCl_2$ **B** MgS **C** Na_2S **D** PCl_3

21 The melting points of the Period 3 elements phosphorus to argon are shown in the table.

element	P	S	Cl	Ar
mp/K	317	392	172	84

Which factor explains the changes in melting points from phosphorus to argon?

A the changes in electronegativity from phosphorus to argon

B the changes in first ionisation energy from phosphorus to argon

C the increase in the number of electrons in each atom from phosphorus to argon

D the number of atoms in each molecule of the element from phosphorus to argon

22 Which element has the **second** smallest atomic radius in its group and the **third** lowest first ionisation energy in its period?

A boron

B calcium

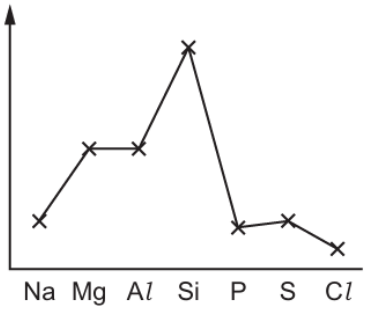
C magnesium

D sodium

23 The graphs show trends in four physical properties of elements in Period 3, excluding argon.

Which graph has electronegativity on the *y*-axis?

A



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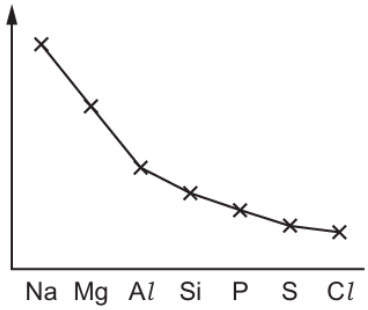

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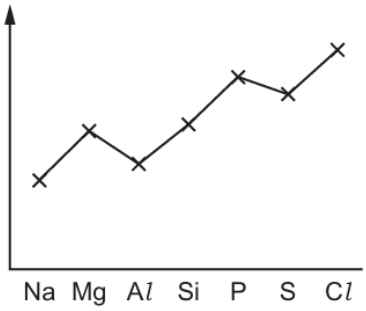

D