

Periodic Table: Chemical Periodicity – 2023 AS Chemistry 9701

1. Nov/2023/Paper_9701/11/No.16

X, Y and Z are elements all found within Groups 13, 14 and 15 of the Periodic Table.

X is in the same group in the Periodic Table as Y.

Y and Z are in Period 3.

The first ionisation energy of X is greater than the first ionisation energy of Y.

The melting point of Z is less than the melting point of Y.

Y and Z both form chlorides which are white solids. These white solids react with water to produce solutions with a pH of less than 4.

Which row of the table shows the possible identities of X and Y?

| | X | Y |
|---|----|----|
| A | B | Al |
| B | Ge | Si |
| C | As | P |
| D | N | P |

2. Nov/2023/Paper_9701/11/No.17

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. |

3. Nov/2023/Paper_9701/11/No.18

Bromocresol green is an acid-base indicator. Below a pH of 3.8 it is yellow. Above a pH of 5.4 it is blue. Between these values it is green.

Bromocresol green is added to the aqueous solution formed when the chloride of element T is added to water. The colour becomes yellow.

When an excess of the solid oxide of element U is slowly added to this yellow solution, the indicator turns green then blue.

Which row could identify element T and element U?

| | element T | element U |
|---|-----------|------------|
| A | silicon | sodium |
| B | silicon | phosphorus |
| C | magnesium | sodium |
| D | magnesium | phosphorus |

4. Nov/2023/Paper_9701/12/No.18

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 |

5. Nov/2023/Paper_9701/12/No.19

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?

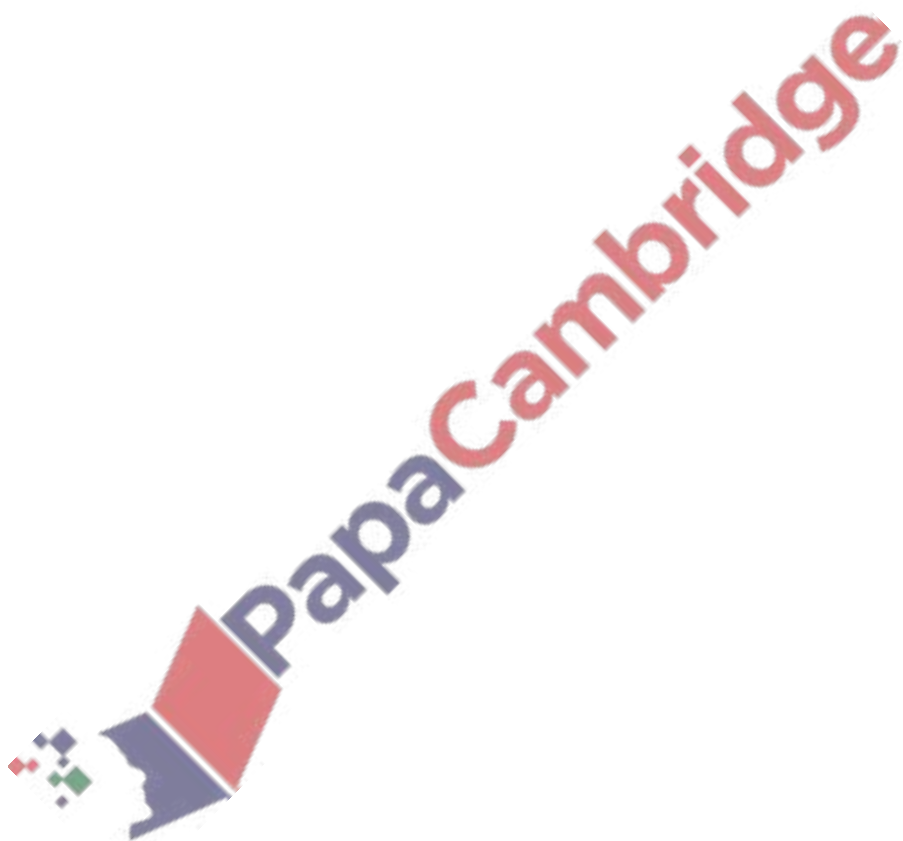
- A X has more occupied electron shells than Y.
- B X has more protons in each atom than Y.
- C X has the same number of outer electrons in each atom as Y.
- D Y is a non-metal.

6. Nov/2023/Paper_9701/12/No.20

Four mixtures are added to four separate 50 cm^3 samples of water and stirred.

Which mixture results in a solution with the highest pH?

- A 1.0 g of aluminium oxide and 1.0 g of aluminium chloride
- B 1.0 g of magnesium oxide and 1.0 g of magnesium chloride
- C 1.0 g of phosphorus oxide and 1.0 g of phosphorus chloride
- D 1.0 g of silicon dioxide and 1.0 g of silicon chloride



The elements silicon, phosphorus and sulfur are in Period 3 of the Periodic Table.

- (a) (i) Describe the variation in atomic radius from silicon to sulfur.

..... [1]

- (ii) The melting point of silicon is 1410 °C. The melting point of sulfur is 113 °C.

Explain this difference.

.....

 [3]

- (b) Table 1.1 shows some properties of the elements Si to S.

The first ionisation energy of P is **not** shown.

Table 1.1

| property | Si | P | S |
|--|-------------------|------------------|------------------|
| total number of electrons in s subshells | | | |
| total number of electrons in p subshells | | | |
| first ionisation energy/kJ mol ⁻¹ | 786 | | 1000 |
| formula of most common chloride | SiCl ₄ | PCl ₅ | SCl ₂ |

- (i) Complete Table 1.1 to show the total number of s and p electrons in an atom of Si, P and S.



[2]

- (ii) Construct an equation to represent the first ionisation energy of Si.

..... [1]

(iii) Three possible values for the first ionisation energy of P are given.

619 kJ mol⁻¹

893 kJ mol⁻¹

1060 kJ mol⁻¹

Circle the correct value.

Explain your choice, including a comparison of your chosen value to those of Si and S.

.....

.....

.....

.....

.....

.....

..... [4]

(iv) SiCl₄ and PCl₅ each react with water, forming misty fumes.

Identify the chemical responsible for the misty fumes.

..... [1]

(v) Predict the shape of the SCl₂ molecule.

..... [1]

[Total: 13]



8. June/2023/Paper_9701/11/No.12

Four successive ionisation energies (IE) of element E are shown.

Element E is in Period 3 of the Periodic Table.

| fifth IE /kJ mol ⁻¹ | sixth IE /kJ mol ⁻¹ | seventh IE /kJ mol ⁻¹ | eighth IE /kJ mol ⁻¹ |
|-----------------------------------|-----------------------------------|-------------------------------------|------------------------------------|
| 16 000 | 20 000 | 24 000 | 29 000 |

In which group of the Periodic Table is E?

- A 14 B 15 C 16 D 17

9. June/2023/Paper_9701/11/No.18

SiO₂ has a melting point of 1713 °C. It reacts with hot NaOH(aq) to form sodium silicate, Na₂SiO₃, and water.

No reaction occurs when SiO₂ is added to hot H₂SO₄(aq).

What can be deduced from this information?

| | chemical behaviour of SiO ₂ | structure of SiO ₂ |
|---|---|----------------------------------|
| A | amphoteric | giant |
| B | amphoteric | simple |
| C | acidic | giant |
| D | acidic | simple |

10. June/2023/Paper_9701/11/No.19

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.

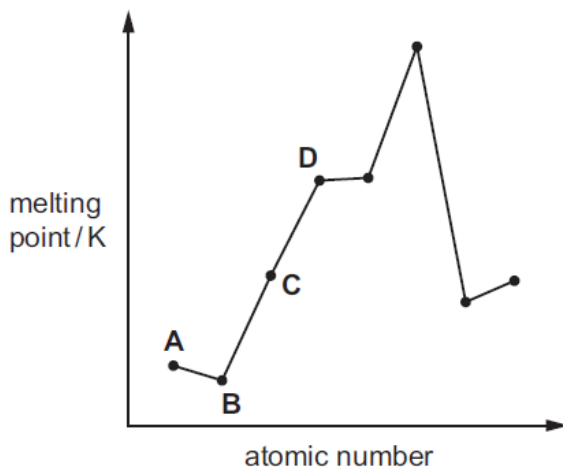
What could be the pH of the resulting solution?

- A 5 B 7 C 9 D 14

11. June/2023/Paper_9701/11/No.21

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

Which element could be sodium?



12. June/2023/Paper_9701/12/No.17

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.

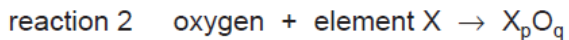
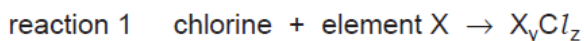
Which statement about element L is correct?

- 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. June/2023/Paper_9701/12/No.18

In reactions 1 and 2, X represents an element in Period 3.

In each reaction, X is forming a product where X is in its highest oxidation state.



Which ratios show a steady increase from sodium to phosphorus?

- A neither z : y nor q : p
- B z : y only
- C q : p only
- D both z : y and q : p

14. June/2023/Paper_9701/12/No.19

Sodium, magnesium, aluminium, silicon and phosphorus are all elements in Period 3 of the Periodic Table.

Three statements about the oxides and chlorides of these elements are given.

- 1 The ionicallly bonded oxides all react with dilute hydrochloric acid.
- 2 All metal chlorides produce neutral solutions when added to water.
- 3 The two most electronegative elements both form covalently bonded chlorides.

Which statements are correct?

- A 1, 2 and 3
- B 1 and 2 only
- C 1 and 3 only
- D 2 and 3 only

15.

The elements magnesium and phosphorus are reacted separately with an excess of oxygen to form their oxides. Each oxide is then added separately to water and the pH values of the resulting solutions are measured.

The same two elements are reacted separately with an excess of chlorine to form their chlorides. Each chloride is then added separately to water and the pH values of the resulting solutions are measured.

Which row is correct?

| | oxide giving the higher pH | chloride giving the higher pH |
|---|----------------------------|-------------------------------|
| A | magnesium | magnesium |
| B | magnesium | phosphorus |
| C | phosphorus | magnesium |
| D | phosphorus | phosphorus |

16. [March/2023/Paper_9701/12/No.19](#)

Two Period 3 elements, X and Y, burn separately in oxygen to form solid oxides.

The oxide of X is insoluble in water.

The oxide of Y dissolves in water to form a solution which dissolves the oxide of X.

What could X and Y be?

| | X | Y |
|---|-----------|------------|
| A | aluminium | sodium |
| B | magnesium | sodium |
| C | silicon | phosphorus |
| D | silicon | sulfur |

17. March/2023/Paper_9701/12/No.20

Which row describes the structure and bonding of SiO_2 and SiCl_4 ?

| | SiO_2 | | SiCl_4 | |
|----------|----------------|----------|-----------------|----------|
| | structure | bonding | structure | bonding |
| A | giant | covalent | giant | covalent |
| B | giant | covalent | simple | covalent |
| C | giant | ionic | giant | covalent |
| D | giant | ionic | simple | covalent |

18. March/2023/Paper_9701/12/No.22

V and Z are both elements in Period 3 of the Periodic Table. Each element forms one stable ion that does not contain another element.

The atomic radius of each element and the ionic radius of the ion described above is shown.

| element | atomic radius /nm | ionic radius /nm |
|---------|-------------------|------------------|
| V | 0.186 | 0.095 |
| Z | 0.099 | 0.181 |

Which statement is correct?

- A** Ions of V and Z have the same number of full electron shells.
- B** Ions of Z are positively charged.
- C** Z has a greater electronegativity than V.
- D** V has more outer electrons than Z.