1. Atomic Structure

1.4 Ionisation energy

Paper 1

Question Paper

1 Which factor causes helium to have a higher first ionisation energy than hydrogen?

A In the 1s orbital in helium, electrons are paired.

B The lowest energy level in helium is filled.

C The nuclear charge in helium is higher than in hydrogen.

D There is less shielding of the outer shell in helium.

2 Z is a compound of two elements, X and Y.

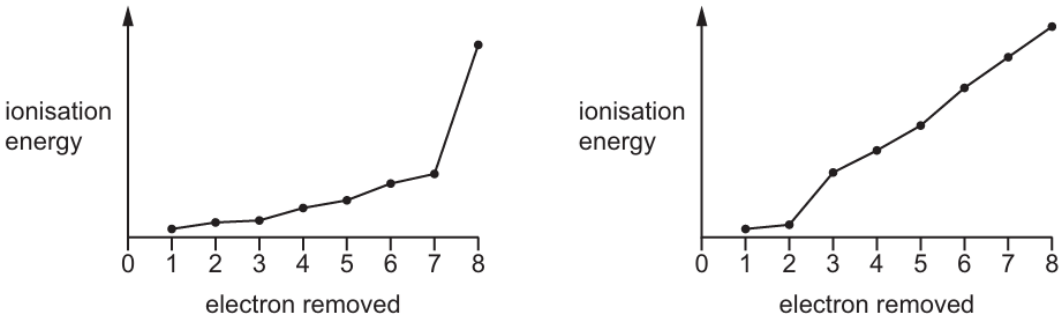
Element X shows a very large increase between its 5th and 6th ionisation energies. It has the second largest 1st ionisation energy in its group.

Element Y shows a very large increase between its 6th and 7th ionisation energies. It has the largest 1st ionisation energy in its group.

What is compound Z?

A NO_2 **B** PCl_5 **C** P_4O_{10} **D** SF_6

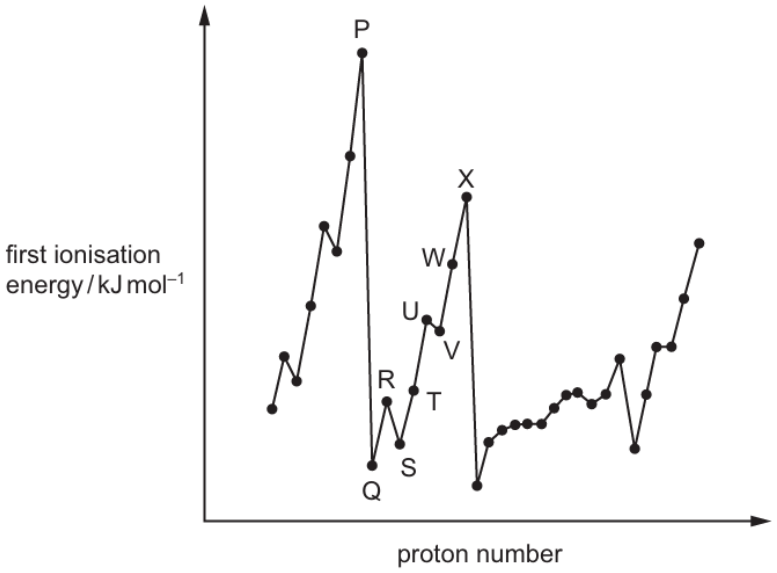
3 The first eight successive ionisation energies for two elements of Period 3 of the Periodic Table are shown in the graphs.



What is the formula of the ionic compound formed from these elements?

A $MgCl_2$ **B** $CaBr_2$ **C** Na_2S **D** K_2Se

4 The graph shows the variation of the first ionisation energy with proton number for some elements. The letters used are **not** the actual symbols for the elements.



Which statement about the elements is correct?

A P and X are in the same period in the Periodic Table.

B The general increase from Q to X is due to increasing atomic radius.

C The small decrease from R to S is due to decreased shielding.

D The small decrease from U to V is due to repulsion between paired electrons.

5 The second ionisation energy of oxygen is greater than the second ionisation energy of fluorine.

Which factor explains this difference?

A The atomic radius of an oxygen atom is smaller than that of fluorine.

B The covalent bond in a fluorine molecule is weaker than the bond in an oxygen molecule.

C A spin-paired electron is removed from fluorine but **not** from oxygen.

D Fluorine has more electrons in total than oxygen. This causes a greater shielding of the nuclear attraction in fluorine.

6 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

7 Which statement is correct?

A The first ionisation energy of chlorine is more than the first ionisation energy of argon.

B The second ionisation energy of calcium is more than the second ionisation energy of magnesium.

C The second ionisation energy of sulfur is equal to the first ionisation energy of phosphorus.

D The eighth ionisation energy of chlorine is more than the first ionisation energy of neon.

8 For the element sulfur, which pair of ionisation energies has the largest difference between them?

A third and fourth ionisation energies

B fourth and fifth ionisation energies

C fifth and sixth ionisation energies

D sixth and seventh ionisation energies

9 Why is the first ionisation energy of phosphorus greater than the first ionisation energy of silicon?

A A phosphorus atom has one more proton in its nucleus.

B The atomic radius of a phosphorus atom is greater.

C The outer electron in a phosphorus atom is more shielded.

D The outer electron in a phosphorus atom is paired.

10 Which of these elements has the highest fifth ionisation energy?

A C **B** N **C** P **D** Si

11 Why is the first ionisation energy of oxygen less than that of nitrogen?

A The nitrogen atom has its outer electron in a different subshell.

B The nuclear charge on the oxygen atom is greater than that on the nitrogen atom.

C The oxygen atom has a pair of electrons in one p orbital that repel one another.

D There is more shielding in an oxygen atom.

12 Which equation represents the first ionisation energy of iodine?

A $\frac{1}{2}I_2(g) + e^- \rightarrow I^-(g)$

B $I(g) + e^- \rightarrow I^-(g)$

C $\frac{1}{2}I_2(g) \rightarrow I^+(g) + e^-$

D $I(g) \rightarrow I^+(g) + e^-$

13 The electronic arrangement for atoms of four elements is given.

Which element is the strongest oxidising agent?

A $1s^2 2s^2 2p^5$

B $1s^2 2s^2 2p^6 3s^2$

C $1s^2 2s^2 2p^6 3s^2 3p^5$

D $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

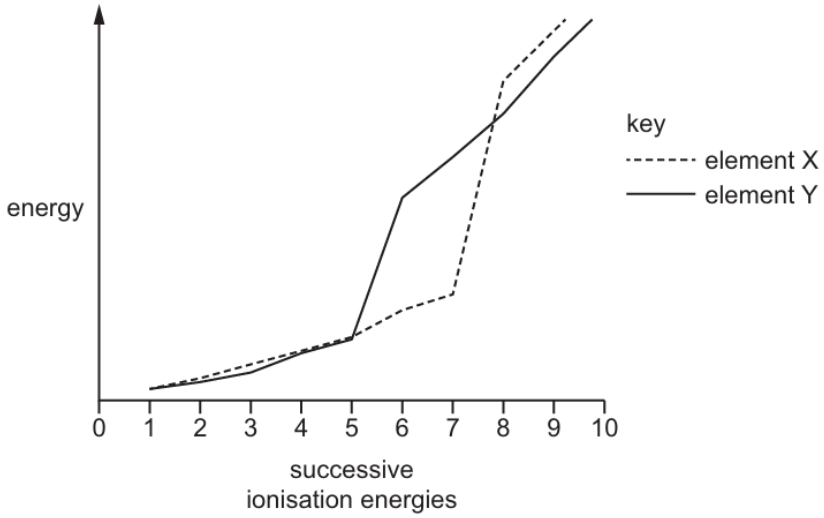
14 The fifth to eighth ionisation energies of four elements in Period 3 of the Periodic Table are shown.

Which row refers to chlorine?

	ionisation energies / kJ mol^{-1}			
	fifth	sixth	seventh	eighth
A	6280	21 200	25 900	30 500
B	6990	8 490	27 100	31 700
C	6540	9 330	11 000	33 600
D	7240	8 790	12 000	13 800

15 The graph shows the successive ionisation energies of element X and element Y.

Both elements are in Period 3.



Which statement is correct?

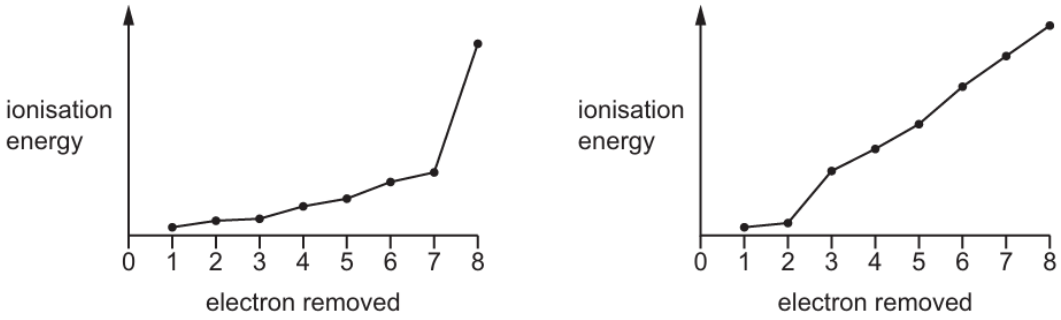
A An atom of element X needs one extra electron for a full outer shell; an atom of element Y needs three extra electrons for a full outer shell.

B An atom of element Y has five electrons in the 3p subshell.

C Element X has an oxidation number of +7 in most of its compounds.

D When element X combines with element Y, the bonding is ionic.

16 The first eight successive ionisation energies for two elements of Period 3 of the Periodic Table are shown in the graphs.



What is the formula of the ionic compound formed from these elements?

A $MgCl_2$ **B** $CaBr_2$ **C** Na_2S **D** K_2Se

17 The first four ionisation energies for element X are shown in the table.

ionisation energy	1st	2nd	3rd	4th
value / kJ mol^{-1}	577	1980	2960	6190

Which ion of X is produced by removing an electron from a filled shell?

A X^{+} **B** X^{2+} **C** X^{3+} **D** X^{4+}

18 Element X has a higher first ionisation energy than element Y.

Two students state what they believe is one factor that helps to explain this.

student 1 "X has a higher first ionisation energy than Y because an atom of X has more protons in its nucleus than an atom of Y."

student 2 "X has a higher first ionisation energy than Y because X has a smaller atomic radius than Y."

Only **one** of the two students is correct.

What could X and Y be?

	X	Y
A	carbon	boron
B	magnesium	aluminium
C	oxygen	nitrogen
D	oxygen	sulfur