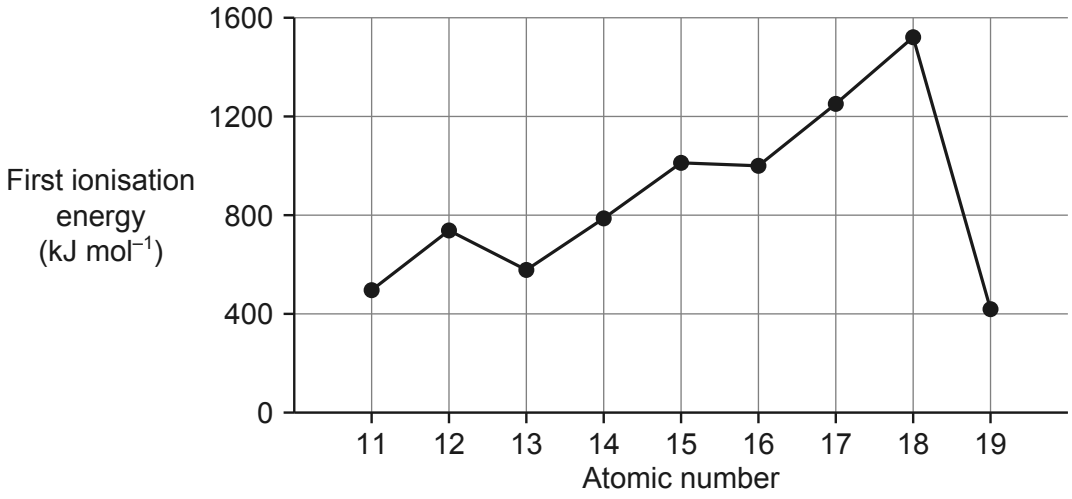
Elements and the periodic table

Student name _____ Answer all questions in the spaces provided.

Question 1 (4 marks)

The graph shows the first ionisation energy of each of the elements with atomic numbers from 11 to 19.

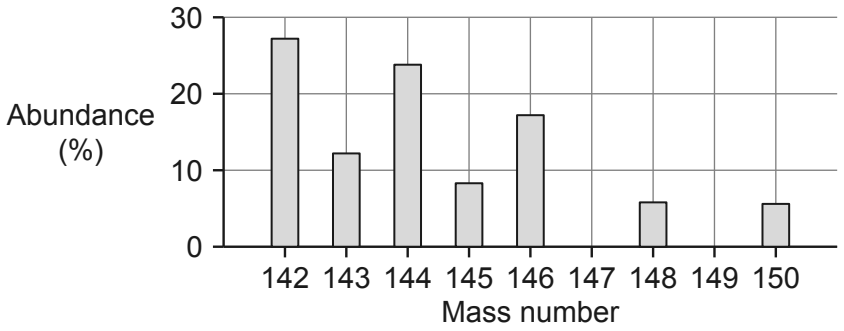


a. Explain the general increase in first ionisation energy that the graph shows from atomic number 11 to atomic number 18. 2 marks

b. The element with atomic number 19 reacts with water more rapidly than the element with atomic number 11. Each element forms 1+ ions. Explain this difference between the two elements. Refer to the graph and the electronic configuration of each element. 2 marks

Question 2 (6 marks)

Neodymium, atomic number 60, is a rare-earth element. It is required for the strong magnets found inside wind turbines, electric cars and mobile phones. The graph shows the percentage abundance of each isotope in a sample of neodymium.



a. Complete the table for two different particles of this element. 2 marks

Particle	Protons	Neutrons	Electrons
An atom of the most abundant isotope	60		60
A 3+ ion with a mass number of 146	60	86	

b. Explain why the atoms represented in the graph are isotopes, and why they undergo the same chemical reactions. 2 marks

c. Neodymium is a critical element, but very little of it is recycled. Each phone contains less than 1 g of this element. A company manager states: “Recovering neodymium from old phones is not worth the cost.” Evaluate this statement. 2 marks

End of questions

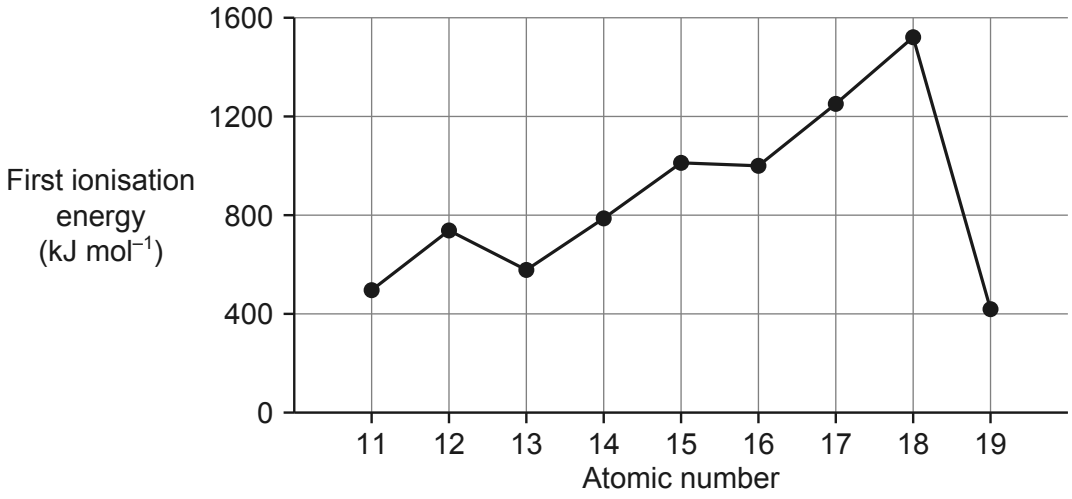
Elements and the periodic table

Solutions

Answer all questions in the spaces provided.

Question 1 (4 marks)

The graph shows the first ionisation energy of each of the elements with atomic numbers from 11 to 19.



a. Explain the general increase in first ionisation energy that the graph shows from atomic number 11 to atomic number 18. 2 marks

① From sodium to argon the core charge increases from +1 to +8, and the outer electrons are in the same shell (the third).

② The outer electrons are attracted more strongly to the nucleus, so more energy is needed to remove one.

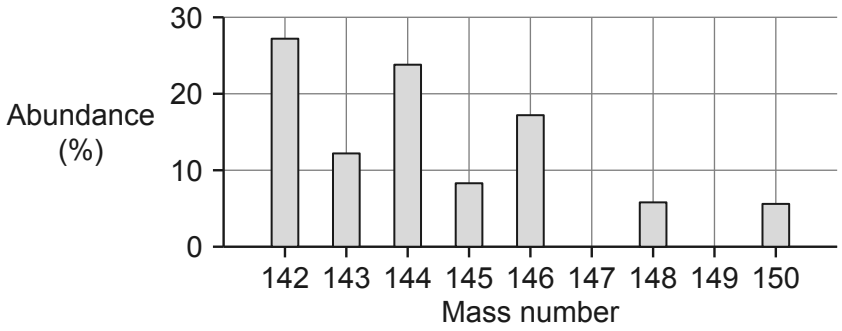
b. The element with atomic number 19 reacts with water more rapidly than the element with atomic number 11. Each element forms 1+ ions. Explain this difference between the two elements. Refer to the graph and the electronic configuration of each element. 2 marks

① Sodium is $1s^2 2s^2 2p^6 3s^1$ and potassium is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$: both have a core charge of +1, but the outer electron of potassium is in the fourth shell, further from the nucleus.

② This electron is attracted less strongly, as the lower first ionisation energy of potassium shows, so potassium loses it more easily when it reacts.

Question 2 (6 marks)

Neodymium, atomic number 60, is a rare-earth element. It is required for the strong magnets found inside wind turbines, electric cars and mobile phones. The graph shows the percentage abundance of each isotope in a sample of neodymium.



a. Complete the table for two different particles of this element. 2 marks

Particle	Protons	Neutrons	Electrons
An atom of the most abundant isotope	60	① 82	60
A 3+ ion with a mass number of 146	60	86	② 57

b. Explain why the atoms represented in the graph are isotopes, and why they undergo the same chemical reactions. 2 marks

① They are atoms of the same element, with the same number of protons, but they have different numbers of neutrons, so their mass numbers differ.

② They have the same number of electrons in the same arrangement, and it is the electrons that take part in reactions.

c. Neodymium is a critical element, but very little of it is recycled. Each phone contains less than 1 g of this element. A company manager states: “Recovering neodymium from old phones is not worth the cost.” Evaluate this statement. 2 marks

① The statement is not justified: neodymium is needed for important technologies, its supply is limited and demand is rising, and the very large number of discarded phones together holds a large mass of it.

② Recycling keeps this neodymium in use and reduces the need to mine more ore, although collecting and separating such small amounts takes energy and money.

End of questions