FOUNDATION

P4F Atomic Structure: Foundation Tier Practice

Total Marks

AQA 8463 · Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 An atom is made of protons, neutrons and electrons.

(a) Give the name of the particle that has a negative charge in an atom. **(1)**

(Total for Question 1 is 1 mark)

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2 An isotope is an atom of the same element with a different number of neutrons.

(a) State which subatomic particle is different in isotopes of the same element. **(1)**

(Total for Question 2 is 1 mark)

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3 An atom of element X has atomic number 11 and mass number 23.

(a) Calculate the number of protons in the atom. **(1)**

.....

(b) Calculate the number of neutrons in the atom. **(1)**

.....

(Total for Question 3 is 2 marks)

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4 A neutral atom has equal numbers of protons and electrons.

(a) Explain why a neutral atom has no overall electrical charge. **(2)**

(Total for Question 4 is 2 marks)

5 Chlorine has two common isotopes: chlorine-35 and chlorine-37. A neutral chlorine atom has atomic number 17.

(a) Calculate the number of neutrons in chlorine-35. **(1)**

.....

(b) Calculate the number of neutrons in chlorine-37. **(1)**

.....

(Total for Question 5 is 2 marks)

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6 Sodium atoms (Na) can form ions by losing one electron to become Na^+.

(a) State how many electrons a neutral sodium atom has. (Sodium atomic number = 11) **(1)**

(b) State the number of electrons in a Na^+ ion. **(1)**

(Total for Question 6 is 2 marks)

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7 Relative atomic mass Ar can be estimated from isotope abundances. Neon has two isotopes: Ne-20 (90% abundance) and Ne-21 (10% abundance).

(a) Calculate the relative atomic mass Ar of neon using the abundances given. Show the calculation. **(2)**

.....

(Total for Question 7 is 2 marks)

8 Radioactive decay can reduce the activity of a source over time. After one half-life the activity halves.

(a) A sample has initial activity 80 counts per minute (cpm). Calculate the activity after one half-life. **(1)**

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(b) Calculate the activity after two half-lives. **(1)**

.....

(c) Calculate the activity after three half-lives. **(1)**

.....

(Total for Question 8 is 3 marks)

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9 Alpha, β and γ radiation differ in penetration and ionising ability.

(a) State which type of radiation is the least penetrating. **(1)**

(b) State which type of radiation is the most penetrating. **(1)**

(c) Give one example of a material that will stop β radiation. **(1)**

(Total for Question 9 is 3 marks)

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10 When an unstable nucleus emits α radiation its atomic number and mass number change.

(a) A nucleus has atomic number 92 and mass number 238. Calculate the atomic number after it emits one α particle. **(1)**

.....

(b) Calculate the mass number after emission of one α particle. **(1)**

.....

(Total for Question 10 is 2 marks)

11 In a classroom demonstration a teacher places a radioactive source 2.0 m from a detector and measures count rate 200 counts per minute (cpm). The teacher then moves the source to 1.0 m from the detector.

(a) Predict whether the count rate will increase, decrease or stay the same when the source is moved from 2.0 m to 1.0 m. **(1)**

(b) Explain why the count rate changes in that way in terms of distance and detection of particles. **(2)**

(Total for Question 11 is 3 marks)

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12 Choose the correct statement about electrons in atoms.

(a) Select which of the following is true and give a brief reason: **(2)**
A: Electrons are found in the nucleus. B: Electrons orbit the nucleus in shells. C: Electrons have positive charge.

- ☐ A
- ☐ B
- ☐ C

(Total for Question 12 is 2 marks)

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13 A Geiger counter is used to measure the activity of a small source. The teacher reminds students about safety when working with radioactivity.

(a) Give one safety measure to protect against exposure to a weak classroom source of α radiation. **(1)**

(b) Give one additional safety measure for handling a radioactive source in class. **(1)**

(Total for Question 13 is 2 marks)

14 The early model of the atom described atoms as 'plum pudding', later replaced by Rutherford's nuclear model.

(a) Explain briefly how the α scattering experiment led Rutherford to propose a nuclear model of the atom. **(3)**

(Total for Question 14 is 3 marks)

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15 Extended response: Explain how the structure of an atom determines its identity, its common isotopes, and how an ion forms. Support your answer with clear reasons and examples.

Explain how the structure of an atom determines its identity, its common isotopes, and how an ion forms. Support your answer with clear reasons and examples.

(Total for Question 15 is 6 marks)

Mark scheme · P4F Atomic Structure: Foundation Tier Practice

Question 1

- (a) **B1** electron cao
- **(a) Answer: Electron**

Question 2

- (a) **B1** neutron cao
- **(a) Answer: Neutron**

Question 3

- (a) **B1** 11 protons cao
- **(a) Answer: 11 protons**
- (b) **B1** neutrons = mass number - atomic number = 23 - 11 = 12
- **(b) Answer: 12 neutrons**

Question 4

- (a) **B1** number of protons equals number of electrons
- (a) **B1** positive charges from protons are balanced by negative charges from electrons so charges cancel out, oe
- **(a) Answer: Because the number of protons equals the number of electrons, so positive and negative charges balance and cancel out.**

Question 5

- (a) **B1** 35 - 17 = 18 neutrons
- **(a) Answer: 18 neutrons**
- (b) **B1** 37 - 17 = 20 neutrons
- **(b) Answer: 20 neutrons**

Question 6

- (a) **B1** 11 electrons cao
- **(a) Answer: 11 electrons**
- (b) **B1** 10 electrons (lost one electron) cao
- **(b) Answer: 10 electrons**

Question 7

- (a) **M1** uses weighted average: (0.90 x 20) + (0.10 x 21)
- (a) **A1** 20.1 Ar cao
- **(a) Answer: 20.1 Ar**

Question 8

- (a) **B1** 40 cpm cao
- **(a) Answer: 40 cpm**
- (b) **B1** 20 cpm cao
- **(b) Answer: 20 cpm**
- (c) **B1** 10 cpm cao
- **(c) Answer: 10 cpm**

Question 9

- (a) **B1** α radiation cao
- **(a) Answer: Alpha radiation**
- (b) **B1** γ radiation cao
- **(b) Answer: Gamma radiation**
- (c) **B1** thin sheet of metal such as aluminium or a few millimetres of aluminium cao
- **(c) Answer: A few millimetres of aluminium**

Question 10

- (a) **B1** 92 - 2 = 90
- **(a) Answer: 90**
- (b) **B1** 238 - 4 = 234
- **(b) Answer: 234**

Question 11

- (a) **B1** increase cao
- **(a) Answer: Increase**
- (b) **M1** states that closer distance means more particles reach the detector per unit time
- (b) **A1** because intensity falls with distance so halving distance gives more counts at 1.0 m than at 2.0 m, oe
- **(b) Answer: Increase, because moving the source closer means more of the emitted particles reach the detector per minute; intensity falls with distance so halving the distance gives a higher count rate.**

Question 12

- (a) **B1** selects B
- (a) **B1** gives reason such as: electrons are outside the nucleus in shells or energy levels, oe
- **(a) Answer: B; electrons orbit the nucleus in shells outside the nucleus.**

Question 13

- (a) **B1** use tongs or a long handling tool to keep distance from the source, oe
- **(a) Answer: Use tongs or a long handling tool to keep distance from the source.**
- (b) **B1** store the source in a shielded container when not in use or minimise time near the source, oe
- **(b) Answer: Store the source in a shielded container when not in use.**

Question 14

- (a) **M1** states that most α particles passed straight through the foil
- (a) **M1** states that some α particles were deflected or scattered at large angles
- (a) **A1** concludes that atoms have a small dense positively charged nucleus that caused the deflections, with electrons around it, oe
- **(a) Answer: Most α particles passed straight through, but some were strongly deflected; this showed atoms have a small dense positively charged nucleus that deflects particles, with electrons outside.**

Question 15

- **Level 3** (5-6): Detailed explanation that links atomic structure to identity, isotopes and ion formation. Uses correct examples and shows clear reasoning.
- **Level 2** (3-4): Partial explanation covering two of the three ideas with some correct reasoning and at least one example.
- **Level 1** (1-2): Basic statements about atoms with limited or missing links between structure and the three topics; may include factual errors.
- **Indicative content:**
  - Identity: atomic number equals number of protons; changing protons changes element; example: carbon proton number 6 so element is carbon.
  - Isotopes: same atomic number (same protons) but different neutrons; give example such as carbon-12 and carbon-14; explain that isotopes have similar chemical properties but different mass and some are radioactive.
  - Ion formation: ions form when atoms lose or gain electrons; losing electrons makes positive ions and gaining makes negative ions; example: sodium atom Na (11 electrons) loses one electron to form Na+; chloride atom gains one electron to form Cl-.
  - Linking ideas: show how electron arrangement affects chemical behaviour and ion formation; mention conservation of protons when making isotopes and ions.