GCSE AQA Chemistry: Topic 1

Atomic structure and the periodic table.

Mark Scheme:

Q1

(a) Sub-atomic particles (3)

- Proton (1 mark)
- Neutron (1 mark)
- Electron (1 mark)

(b) Charge of a proton (1)

- +1 (1 mark)

Total: 4 marks

Q2

(a) Relative mass of a proton (1)

- 1 (1 mark)

(b) Relative charge of a neutron (1)

- 0 (neutral) (1 mark)

Total: 2 marks

Q3

(a) Arrangement of elements (2)

- In order of atomic number (1 mark)
- In rows (periods) and groups showing similar properties (1 mark)

(b) Vertical columns name (1)

- Groups (1 mark)

Total: 3 marks

Q4

(a) Maximum electrons in first shell (1)

- 2 (1 mark)

(b) Electronic structure of oxygen (1)

- 2,6 (1 mark)

Total: 2 marks

Q5

(a) Similarity of isotopes (1)

- Same number of protons / same atomic number (1 mark)

(b) Difference of isotopes (1)

- Different number of neutrons (1 mark)

Total: 2 marks

Q6

(a) Atomic number (1)

- Number of protons in the nucleus (1 mark)

(b) Mass number (1)

- Number of protons + neutrons (1 mark)

Total: 2 marks

Q7

(a) Mendeleev's improvement (2)

- Left gaps for undiscovered elements (1 mark)
- Arranged mainly by atomic mass but considered properties (1 mark)

(b) Why accepted (2)

- Predicted properties of undiscovered elements correctly (1 mark)
- When new elements were discovered, they fitted his table (1 mark)

Total: 4 marks

Q8

(a) Trend in Group 1 reactivity (1)

- Reactivity increases down the group (1 mark)

(b) Observation with sodium + water (1)

- Fizzes / moves on water surface / melts into a ball (any one) (1 mark)

Total: 2 marks

Q9

(a) Trend in Group 7 reactivity (1)

- Reactivity decreases down the group (1 mark)

(b) Fluorine more reactive (2)

- Outer electrons are closer to nucleus (1 mark)
- Stronger attraction makes it easier to gain an electron (1 mark)

Total: 3 marks

Q10

(a) Transition metal property (1)

- High melting point / form coloured compounds / good conductor of heat and electricity (any one) (1 mark)

(b) Reactivity difference (2)

- Transition metals less reactive than Group 1 metals (1 mark)
- Group 1 react violently with water/oxygen, transition metals do not (1 mark)

Total: 3 marks

Q11

$^{23}_{11}Na$

(a) Protons (1)

- 11 (1 mark)

(b) Neutrons (1)

- 23 – 11 = 12 (1 mark)

Total: 2 marks

Q12

(a) Noble gases unreactive (2)

- Full outer shell (1 mark)
- So do not need to gain/lose electrons (1 mark)

(b) Use of noble gas (1)

- Helium in balloons / Argon in lightbulbs / Neon in signs (any one) (1 mark)

Total: 3 marks

Q13

(a) J. J. Thomson model (1)

- Plum pudding model (1 mark)

(b) Rutherford's experiment (2)

- Gold foil experiment showed atom mostly empty space (1 mark)
- Nucleus is small, dense and positively charged (1 mark)

Total: 3 marks

Q14

(a) Property of metals (1)

- Conduct electricity / malleable / ductile (any one) (1 mark)

(b) Property of non-metals (1)

- Poor conductor / brittle / low melting points (any one) (1 mark)

Total: 2 marks

Q15

(a) Similar properties in groups (2)

- Same number of electrons in outer shell (1 mark)
- Means they react in similar ways (1 mark)

(b) Example (1)

- Sodium and potassium / chlorine and bromine (any one correct pair) (1 mark)

Total: 3 marks

Q16

(a) Proton properties (2)

- Relative mass = 1 (1 mark)
- Relative charge = +1 (1 mark)

(b) Compare protons and neutrons (2)

- Both have similar mass ≈ 1 (1 mark)
- Protons are positively charged, neutrons have no charge (1 mark)

Total: 4 marks

Q17

(a) Definition of isotope (2)

- Atoms of the same element (1 mark)
- With different numbers of neutrons (1 mark)

(b) Relative atomic mass of chlorine (3)

- (35 × 75) + (37 × 25) = 2625 + 925 = 3550 (1 mark)
- ÷ 100 = 35.5 (1 mark)
- Correct final answer with working (1 mark)

Total: 5 marks

Q18

(a) Plum pudding model (2)

- Atom is a ball of positive charge (1 mark)
- With electrons embedded in it (1 mark)

(b) Rutherford's experiment → nuclear model (3)

- Most alpha particles passed straight through → atom mostly empty space (1 mark)
- Some deflected → nucleus is positively charged (1 mark)
- Very small, dense nucleus (1 mark)

Total: 5 marks

Q19

(a) Electronic configuration of phosphorus (1)

- 2,8,5 (1 mark)

(b) Explanation of group & period (2)

- 5 electrons in outer shell → Group 5 (1 mark)
- 3 shells → Period 3 (1 mark)

Total: 3 marks

Q20

(a) Mendeleev arrangement (2)

- By increasing atomic mass (1 mark)
- Elements placed in groups with similar properties (1 mark)

(b) Why accepted (2)

- Left gaps and predicted properties (1 mark)
- New elements discovered matched predictions (1 mark)

Total: 4 marks

Q21

(a) Group 1 reactivity trend (2)

- Reactivity increases down the group (1 mark)
- Reactions become more vigorous (1 mark)

(b) Explanation of trend (2)

- Outer electron further from nucleus (1 mark)

- Weaker attraction, easier to lose (1 mark)

Total: 4 marks

Q22

(a) Boiling point trend (1)

- Increases down the group (1 mark)

(b) Reactivity trend (2)

- Decreases down the group (1 mark)
- Because outer electrons are further from the nucleus, less attraction (1 mark)

(c) Balanced symbol equation (2)

- $Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$ (1 mark)
- Correct state symbols optional (1 mark if included correctly)

Total: 5 marks

Q23

(a) Transition vs Group 1 properties (2)

- Transition metals have higher melting points (1 mark)
- Transition metals are stronger/harder (1 mark)
  (accept: less reactive / form coloured compounds / higher densities)

(b) Industrial use (1)

- Catalyst (e.g. iron in Haber process) / construction (any one correct) (1 mark)

Total: 3 marks

Q24

(a) Ar of magnesium (3)

- (24 × 79) + (25 × 10) + (26 × 11) = 1896 + 250 + 286 = 2432 (1 mark)
- ÷ 100 (1 mark)
- = 24.32 (accept 24.3) (1 mark)

(b) Not whole number (1)

- Because it is an average of isotopes (1 mark)

Total: 4 marks

Q25

(a) Noble gases unreactive (2)

- Have full outer electron shell (1 mark)
- Do not need to gain/lose electrons (1 mark)

(b) Boiling point trend (2)

- Increases down the group (1 mark)
- Because atoms are larger → stronger intermolecular forces (1 mark)

Total: 4 marks

Q26

$^{27}_{13}Al$

(a) Subatomic particles (2)

- Protons = 13 (1 mark)
- Neutrons = 14, Electrons = 13 (1 mark for both correct)

(b) Aluminium ion Al^{3+} (2)

- Loses 3 electrons (1 mark)
- So has more protons than electrons (1 mark)

Total: 4 marks

Q27

(a) Scientist (1)

- James Chadwick (1 mark)

(b) Importance of discovery (2)

- Explained existence of isotopes (1 mark)
- Isotopes have same protons but different neutrons (1 mark)

Total: 3 marks

Q28

(a) Ionic equation (2)

- $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$ (1 mark)
- Balanced correctly (1 mark)

(b) Explanation (2)

- Chlorine is more reactive than iodine (1 mark)

- Displaces iodine from potassium iodide (1 mark)

Total: 4 marks

Q29

(a) Similar group properties (2)

- Same number of electrons in outer shell (1 mark)
- Leads to similar chemical reactions (1 mark)

(b) Reactivity comparison (3)

- Group 1: reactivity increases down group (1 mark)
- Group 7: reactivity decreases down group (1 mark)
- Group 1 lose electrons, Group 7 gain electrons (1 mark)

Total: 5 marks

Q30

(a) Calcium electronic configuration (1)

- 2,8,8,2 (1 mark)

(b) Calcium ion explanation (2)

- Has 2 electrons in outer shell (1 mark)
- Loses them to form Ca^{2+} (1 mark)

Total: 3 marks

Q31

(a) Problems with early tables (2)

- Gaps / elements in wrong groups (1 mark)
- No understanding of isotopes (1 mark)

(b) Mendeleev solutions (2)

- Left gaps for undiscovered elements (1 mark)
- Re-ordered elements by properties, not just mass (1 mark)

Total: 4 marks

Q32

(a) Nucleus size (1)

- Very small compared to whole atom (1 mark)

(b) Alpha particles passed through (2)

- Atom mostly empty space (1 mark)
- Electrons do not stop alpha particles (1 mark)

(c) Few deflected back (2)

- Nucleus is positively charged (1 mark)
- Alpha particles repelled by positive charge (1 mark)

Total: 5 marks

Q33

(a) Physical property differences (2)

- Group 1 metals are softer (1 mark)
- Group 1 metals have lower melting points (1 mark)

(b) Coloured transition metal compound (1)

- Copper sulfate = blue (accept other correct examples) (1 mark)

Total: 3 marks

Q34

(a) Atomic number order (2)

- Shows number of protons (1 mark)
- Gives correct recurring properties (1 mark)

(b) Wrong order by mass (2)

- Some isotopes caused mis-ordering (1 mark)
- Atomic mass alone did not reflect proton number (1 mark)

Total: 4 marks

Q35

(a) Helium vs hydrogen in balloons (2)

- Helium is non-flammable (1 mark)
- Hydrogen is flammable, explosive (1 mark)

(b) Argon in filament lamps (2)

- Inert/unreactive (1 mark)

- Prevents filament burning/reacting (1 mark)

Total: 4 marks

Q36. The structure of the atom

(a) Compare protons, neutrons, electrons (3)

- Proton: relative mass 1, charge +1 (1 mark)
- Neutron: relative mass 1, charge 0 (1 mark)
- Electron: relative mass ≈ 0 (very small), charge –1 (1 mark)

(b) Atoms electrically neutral (2)

- Equal number of protons and electrons (1 mark)
- Charges cancel out → overall zero charge (1 mark)

Total: 5 marks

Q37. Development of atomic theory

(a) Bohr's adaptation (2)

- Electrons orbit the nucleus (1 mark)
- In fixed shells/energy levels (1 mark)

(b) Importance of new evidence (3)

- Rutherford's scattering showed atom mostly empty space (1 mark)
- Showed small, dense, positively charged nucleus (1 mark)
- New evidence meant models had to be updated to fit observations (1 mark)

Total: 5 marks

Q38. Isotopic calculations

(a) Ar of chlorine (3)

- (35 × 75) + (37 × 25) = 2625 + 925 = 3550 (1 mark)
- ÷ 100 = 35.5 (1 mark)
- Correct final answer with working (1 mark)

(b) Ar not whole number (2)

- It is an average of isotopes (1 mark)
- Weighted by abundance (1 mark)

Total: 5 marks

Q39. Electronic configurations

(a) Calcium (atomic number 20) (1)

- 2,8,8,2 (1 mark)

(b) Ca^{2+} ion (2)

- Has 2 outer electrons (1 mark)
- Loses them → forms a 2+ ion (1 mark)

Total: 3 marks

Q40. Periodic table trends

(a) Similar group properties (2)

- Same number of electrons in outer shell (1 mark)
- This causes similar chemical reactions (1 mark)

(b) Reactivity of Groups 1 & 7 (3)

- Group 1: reactivity increases down the group (1 mark)
- Group 7: reactivity decreases down the group (1 mark)
- Group 1 lose electrons; Group 7 gain electrons (1 mark)

Total: 5 marks

Q41. Transition metals

(a) Physical differences (2)

- Transition metals have higher melting points/densities (1 mark)
- Transition metals are stronger/harder (1 mark)
  (accept: Group 1 more reactive than transition metals)

(b) Catalyst usefulness (2)

- Provide alternative pathway/lower activation energy (1 mark)
- Increase reaction rate without being used up (1 mark)

Total: 4 marks

Q42. Transition metal compounds

(a) Colour (1)

- Blue (1 mark)

(b) Different charges (2)

- Transition metals can lose different numbers of electrons (1 mark)
- So form ions with different charges (1 mark)

(c) Industrial use (1)

- As catalysts (e.g. iron in Haber process) / construction / pigments (1 mark)

Total: 4 marks

Q43. Group 7 displacement reactions

(a) Balanced equation (2)

- $Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$ (1 mark)
- Correct balancing (1 mark)

(b) Displacement explanation (2)

- More reactive halogen displaces less reactive one (1 mark)
- Chlorine displaces bromine (1 mark)

Total: 4 marks

Q44. Group 0 elements

(a) Boiling points (2)

- Increase down the group (1 mark)
- Because larger atoms → stronger intermolecular forces (1 mark)

(b) Argon in lamps (2)

- Inert/unreactive (1 mark)
- Prevents filament reacting/burning (1 mark)

Total: 4 marks

Q45. Atomic models

(a) Problem with plum pudding (1)

- Could not explain scattering experiment results (1 mark)
  (accept: did not have nucleus / electrons in shells)

(b) Rutherford's experiment (3)

- Most alpha particles passed straight through → atom mostly empty space (1 mark)
- Some deflected → small, dense, positive nucleus (1 mark)
- Disproved "spread out positive charge" of plum pudding model (1 mark)

Total: 4 marks

Q46. Nuclear symbols ($^{25}_{12}Mg$)

(a) Protons (1)

- 12 (1 mark)

(b) Neutrons (1)

- 25 – 12 = 13 (1 mark)

(c) Mg^{2+} electrons (1)

- 10 (1 mark)

Total: 3 marks

Q47. Group 1 trends

(a) Lithium vs potassium (2)

- Lithium outer electron closer to nucleus (1 mark)

- Stronger attraction, harder to lose (1 mark)

(b) Observations with potassium (2)

- Lilac flame (1 mark)
- Explosive reaction / fizzing / hydrogen produced (1 mark)

Total: 4 marks

Q48. Predicting reactions

(a) Products of fluorine + sodium bromide (2)

- Sodium fluoride + bromine (1 mark)
- Correct identification of products (1 mark)

(b) Balanced equation (2)

- $F_2 + 2NaBr \rightarrow Br_2 + 2NaF$ (1 mark)
- Correct balancing (1 mark)

Total: 4 marks

Q49. Metals vs non-metals

(a) Metals conduct (2)

- Delocalised electrons (1 mark)
- Move and carry charge (1 mark)

(b) Non-metals don’t conduct (2)

- No delocalised electrons (1 mark)

- Electrons held tightly in bonds (1 mark)

Total: 4 marks

Q50. History of periodic table

(a) Problems before Mendeleev (2)

- Gaps / some elements in wrong groups (1 mark)
- Elements not arranged by properties (1 mark)

(b) Mendeleev overcame (2)

- Left gaps for undiscovered elements (1 mark)
- Re-ordered some elements by properties not just mass (1 mark)

(c) Isotopes supported Mendeleev (2)

- Explained why some elements didn't fit mass order (1 mark)
- Showed that arranging by atomic number made more sense (1 mark)

Total: 6 marks