Mark Scheme - AS 1.6 The Periodic Table

1.
(a)   same number of protons and electrons (1)

0, 1 and 2 neutrons (1)   [2]

(b)   (i)   3 energy levels between n = 2 and n = ∞
becoming closer together
first gap must be < that between n = 1 and n = 2   [1]

(ii)   any arrow pointing upwards (1)

from n = 1 to n = ∞ (1)   [2]

(c)   (i)   visible   [1]

(ii)   (not correct because) Balmer series corresponds to energy transitions
involving n = 2 (1)

for ionisation energy need Lyman series / energy transitions involving
n = 1 (1)   [2]

(d)   (i)   Q(g) → Q⁺(g) + e / accept any symbol   [1]

(ii)   Group 6   [1]

(iii)   In T there is more shielding (1)

The outer electron is further from the nucleus (1)

The increase in shielding outweighs the increase in nuclear
charge / there is less effective nuclear charge (1)   [3]

*Legibility of text; accuracy of spelling, punctuation and grammar;
clarity of meaning QWC*   [1]

Total [14]

2.

(a) (i) Energy required to remove one mole of electrons from one mole of
atoms / to form one mole of positive ions from one mole of atoms (1)
in the gaseous state (to form 1 mol of gaseous ions) (1)
(Accept correct equation)   [2]

(ii) Cross between Na and Mg crosses   [1]

(iii) P only has unpaired electrons, S has a pair of electrons in 3p
orbital (1)
Repulsion between the paired electrons makes it easier to remove
one of the electrons (1)   [2]

(b) (i) Effective nuclear charge is greater / electron being removed from a
positive ion   [1]

(ii) Accept from 6000 to 9000   [1]

(c) Lines are formed from electron being excited and jumping up to a higher
energy level (1)
Falling back down to the n = 2 level (1)
Emitting energy / photon of light (1)
Lines become closer since the electron energy levels of a hydrogen atom
become closer (1)   [4]

QWC Selection of a form and style of writing appropriate to purpose and to
complexity of subject matter   [1]

Total [12]

3.

(a) Weighing bottle would not have been washed / difficult to dissolve solid in volumetric flask / final volume would not necessarily be 250 cm^3 [1]

(b) Pipette [1]

(c) To show the end point / when to stop adding acid / when it's neutralised [1]

(d) So that a certain volume of acid can be added quickly before adding drop by drop / to save time before doing accurate titrations / to give a rough idea of the end point [1]

(e) To obtain a more reliable value [1]

(f) (i) Moles = 0.730/36.5 = 0.0200 (1)

Concentration = 0.02/0.1 = 0.200 mol dm^{-3} (1) [2]

(ii) Moles = 0.2 x 0.0238 = 0.00476 [1]

(iii) 0.00476 [1]

(iv) 0.00476 x 10 = 0.0476 [1]

(v) M_r = 1.14/0.0476 = 23.95 [1]

(vi) Lithium [1]

  - mark consequentially throughout (f)

Total [12]

4.

nitrogen / phosphorus (or any other Group 5 element)   [1]

5.

(a)   Name of any commercially/ industrially important chlorine containing compound e.g.
       (sodium) chlorate(I) as bleach/ (sodium) chlorate(V) as weedkiller/ aluminium chloride as
       catalyst in halogenation
                          - do not accept CFCs   [1]

(b)   (i) $K_c = \dfrac{[HI]^2}{[H_2][I_2]}$ must be square brackets   [1]

       (ii) $K_c = \dfrac{0.11^2}{3.11^2} = 1.25 \times 10^{-3}$ follow through error (ft)   [1]

       (iii) K_c has no units   ft   [1]

       (iv)   when temperature increases K_c increases (1)

              this means equilibrium has moved to RHS
              / increasing temperature favours endothermic reaction (1)

              therefore ΔH for forward reaction is +ve (1)
              (mark only awarded if marking point 2 given)   [3]

(c)   (i)   +2   [1]

       (ii)   co-ordinate/ dative (covalent)   [1]

       (iii) pink is $[Co(H_2O)_6]^{2+}$ **and** blue is $[CoCl_4]^{2-}$ (1)

              (ligand is) Cl^- (1)

              (addition of HCl sends) equilibrium to RHS (1)   [3]

       (iv) $[Co(H_2O)_6]^{2+}$ shown as octahedral [with attempt at 3D] (1)

              $[CoCl_4]^{2-}$ shown as tetrahedral/ square planar (1)   [2]

                                                                            Total [14]

6.

(a) (i) Number of moles of HCl $= \dfrac{80 \times 0.20}{1000} = 0.016$ (1)

Number of moles of calcium needed $= 0.008$ (1)

Number of moles of calcium actually used $= \dfrac{0.40}{40} = \sim 0.010$ (1)

($\therefore$ calcium is present in excess)

[Calculation could be carried out in grams] [3]

(ii) gas bubbles / effervescence / some calcium 'dissolves' /
colourless solution produced [1]

(b) Mass of E in solution at 0 °C $= 0.13 \times 2 = 0.26\,g$ (1)

$\therefore$ Quantity precipitated $= 1.50 - 0.26 = 1.24\,g$ (1) [2]

(c) (i) Brick red / orange-red [1]

(ii) Cream precipitate (accept off-white precipitate) [1]

(iii) $Ag^{+} + Br^{-} \rightarrow AgBr$ [1]

(iv) Red / brown solution [1]

(v) Calcium bromide is an ionic compound (1)
and contains Ca^{2+} and Br^{-} ions (1)
Chlorine reacts with the bromide ions in a redox /
displacement reaction (1)
Chlorine is a more powerful oxidising agent / has a greater affinity for
electrons than bromine (1)
$2Br^{-} + Cl_{2} \rightarrow Br_{2} + 2Cl^{-}$ (1) [5]

QWC: *ensure that text is legible and that spelling, punctuation and
grammar are accurate so that the meaning is clear* [1]

Total [16]

7. (a) (i)

	magnesium nitrate	barium chloride	sodium hydroxide
potassium carbonate	white precipitate	white precipitate	no visible change
sodium hydroxide	WHITE PRECIPITATE	NO VISIBLE CHANGE	
barium chloride	NO VISIBLE CHANGE		

All three correct for 2 marks, two correct for 1 mark [2]

(ii) Name of precipitate: Magnesium carbonate (1)
Ionic equation: $Mg^{2+} + CO_3^{2-} \rightarrow MgCO_3$ (1) [2]

(b) (i) Sodium hydroxide solution would turn blue/purple
[Ignore references to potassium carbonate] [1]

(ii) Potassium carbonate would give a lilac flame
Sodium hydroxide would give a golden yellow flame
Barium chloride would give an apple green flame
(2 for all correct, 1 mark for 2 correct)
1 max if any reference to white flame for magnesium [2]

(iii) Barium chloride (1) White precipitate (1) [2]

(c) (i) Sodium **ions** surrounded by δ– on oxygen atoms of water (1)
Bromide **ions** surrounded by δ+ on hydrogen atoms of water (1)
Marks can be obtained from a labelled diagram – must show minimum of two oxygen/hydrogen atoms around sodium/bromide ions [2]

(ii) *Observation with sodium bromide*   cream precipitate (1)

*Observation with sodium iodide*   yellow precipitate (1) [2]

(iii) Reagent: (dilute) ammonia solution (1)
Observation with sodium bromide: precipitate dissolves in part
Observations with sodium iodide: precipitate does not change
both observations required for (1)
[If concentrated ammonia (1) used then sodium bromide
will dissolve completely] [2]

(iv) $2NaI + Br_2 \rightarrow 2NaBr + I_2$ allow ionic equation [1]

Total [16]

8.

(a) (i)   12   [1]

     (ii)   14   [1]

     (iii)   Percentage / abundance / ratio / proportion of
each isotope   [1]

(b) (i)   0.125 g   [1]

     (ii)   e.g. Cobalt-60 (1) in radiotherapy (1) / Carbon-14 (1) in
radio carbon dating (1) / Iodine-131 (1) as a tracer in
thyroid glands (1)   [2]

(c) (i)   Atoms are hit by an electron beam / electrons fired from
an electron gun (and lose electrons)   [1]

     (ii)   To be able to accelerate the ions (to high speed) / so that
they can be deflected by a magnetic field
          - no credit for 'so that *atoms* can be deflected...'
       [1]

     (iii)   They are deflected by a magnetic field / according to the
m/z ratio   [1]

(d)

1s	2s	2p	3s	3p

       [1]
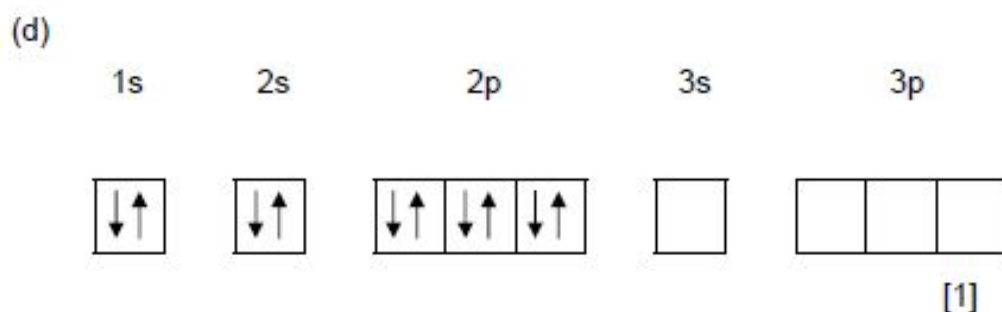
(e) (i) $Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$ [1]

     (ii)   moles $Mg(OH)_2$ = 1.75/58.32 = 0.0300 (1)

        moles Mg_3N_2 = 0.0100 (1)

        mass Mg_3N_2 = 0.01 x 100.9 = 1.01 g (1)   [3]

        - must be **3 significant figures** to gain third mark

                 Total [14]

9.

(a) apparatus in which reaction can occur, e.g. flask/ test tube, and delivery/ rubber tube (1)

apparatus in which to measure volume of gas, e.g. over water with measuring cylinder/ gas syringe (1)   [2]

(b) (i) fewer **moles** of barium used / barium has a higher A_r [1]

(ii) reaction faster/ more vigorous/ less cloudy solution formed with barium (1)

because ionisation energy of barium is less/ electrons lost more easily from barium/ barium is lower in the group/ barium hydroxide is more soluble (1)   [2]

(c) flame test (1) brick red for calcium **and** (apple) green for barium (1)

OR

add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

white precipitate with Ba^{2+}, less precipitate/ no precipitate with Ca^{2+} (1)   [2]

(d) electrons correct – oxide ion clearly shows that 2 electrons originated from calcium atom (1)

charges correct (1)   [2]

(e) (i) add sulfuric acid/ sodium sulfate solution/ potassium sulfate solution (1)

filter (1)

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ (1)

- state symbols ignored   [3]

(ii) moles Ba = 2/137 (1)

mass $BaSO_4$ = $\dfrac{2 \times 233.1}{137}$ = 3.4 (g) (1)   [2]

Total [14]

10.

(a) (i)   Potassium bursts into flames sodium does not / potassium darts about
           surface **more** vigorously than sodium   [1]

     (ii) 1st ionisation energy decreases as group is descended / as element
           has higher A_r (1)

           (Atom) becomes larger / outer electron further from nucleus /
           more shielding / less effective nuclear charge (1)   [2]

     (iii) As group descended outer electron more easily lost   [1]

(b) (i)   Electronegativity (difference between the atoms) (1)

           The bigger the difference the more likely is an ionic bond / ORA for
           covalent (1)   [2]

     (ii) Ionic: high electron density centred round ions / shown on diagram (1)

           Covalent: high electron density between nuclei/atoms / shown on
           diagram (1)

           Intermediate: high electron density between nuclei/atoms but higher
           nearer one of them / ions with electron distortion of negative ion (1) [3]

(c) (i)   Calcium   [1]

     (ii) Calcium chloride/ $CaCl_2$ – error carried forward (ecf) from (i)   [1]

     (iii) White precipitate/ solid – ecf from (i)   [1]

     (iv) $Ca^{2+} + 2OH^- \rightarrow Ca(OH)_2$ (ignore state symbols) – ecf from (i) [1]

           Penalise incorrect metal once only in (c)

                                                                      Total [13]