Mark Scheme - C1.6 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) $Q(g) \rightarrow Q^+(g) + e$ / 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) $K_c = \frac{[HI]^2}{[H_2][I_2]}$ must be square brackets **[1]**

(ii) $K_c = \frac{0.11^2}{3.11^2} = 1.25 \times 10^{-3}$ 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 = $\frac{80 \times 0.20}{1000}$ = 0.016 (1)

Number of moles of calcium needed = 0.008 (1)

Number of moles of calcium actually used = $\frac{0.40}{40}$ = ~ 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 × 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

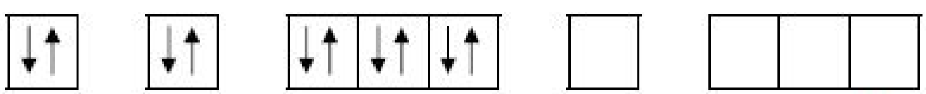
- no credit for 'so that *atoms* can be deflected...'

[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 $BaSO_4 = \frac{2 \times 233.1}{137} = 3.4$ (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]