Abbreviations, annotations and conventions used in the Mark Scheme	/	= alternative and acceptable answers for the same marking point
	;	= separates marking points
	NOT	= answers which are not worthy of credit
	( )	= words which are not essential to gain credit
	___	= (underlining) key words which **must** be used to gain credit
	ecf	= error carried forward
	AW	= alternative wording
	ora	= or reverse argument

Question	Expected Answers	Marks
1 (a)	<table><tr><td>isotope</td><td>protons</td><td>neutrons</td><td>electrons</td></tr><tr><td>^{12}C</td><td>6</td><td>6</td><td>6</td></tr><tr><td>^{13}C</td><td>6</td><td>7</td><td>6</td></tr></table> ✓ ✓	[2]
(b) (i)	mass spectrometry ✓	[1]
(ii)	mass of an isotope compared with carbon-12 ✓ 1/12th of mass of carbon-12/on a scale where carbon-12 is 12 ✓ *mass of 1 mole of the isotope/mass of 1 mole of carbon-12 is equivalent to the first mark* *"mass of the isotope that contains the same number of atoms as are in 1 mole of carbon-12" ⟶ 1 mark (mark lost because of mass units)*	[2]
(iii)	12 x 95/100 + 13 x 5/100 OR 12.05 ✓ = 12.1 (mark for significant figures) ✓ (12.1 scores both marks)	[2]
(c)	$1s^2 2s^2 2p^2$ ✓	[1]
(d)	CO_2: correct covalent bonds around carbon ✓ outer shell electrons correct ✓ (must be 'dot AND cross' or electron source clearly shown (different coloured for source?)	[2]
(e) (i)	calcium hydroxide/$Ca(OH)_2$ ✓	[1]
	$Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$ ✓✓ 1st mark for $CaCO_3(s)$ State symbol essential here 2nd mark for rest of equation. Ignore state symbols	[2]
(f)	$CaCO_3 \longrightarrow CaO + CO_2$ ✓ state symbols not required	[1]
(g) (i)	moles CO_2 = 1000 /44 mol = 22.7 mol ✓ volume CO_2 in 2000 = 22.7 x 24 = 545 dm^3 ✓	[3]
(ii)	reduction = 545 x 60/100 = 327 dm^3 ✓	
		Total: 17

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Question		Expected Answers	Marks
2	(a)	......$Ca(s)$ + ...2 ✓ $HCl(aq)$ ....$CaCl_2(aq)$ + .$H_2(g)$. ✓ (g) not required for H_2	[2]
	(b)	In Ca, oxidation state = 0 ✓ and In $CaCl_2$, oxidation state = +2 ✓ <u>Oxidation number increases from Ca to $CaCl_2$</u>	 [2]
	(c)	correct dot and crosses ✓ correct charges ✓	[2]
	(d) (i)	white precipitate/goes white ✓	[1]
	(ii)	$Ag^+ + Cl^- \longrightarrow AgCl$ ✓ *state symbols not required*	[1]
	(e) (i)	moles HCl = 2.0 x 50/1000 = 0.10 ✓	[1]
	(ii)	moles Ca = ½ x moles HCl = 0.050 ✓ mass Ca = 40.1 x 0.050 = 2.00 g / 2.005 g ✓ (accept 40 x 0.050 = 2.0 g) (mass Ca of 4.0 g would score 1 mark as 'ecf' as molar ratio has not been identified)	 [2]
	(iii)	Ca has reacted with water ✓ $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$ ✓✓ *state symbols not required* 1st mark for H_2 2nd mark is for the rest of the balanced equation	 [3]
			Total: 14

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Question			Expected Answers	Marks
3	(a)	(i)	O ✓	[1]
		(ii)	Al ✓	[1]
		(iii)	P ✓	[1]
		(iv)	C/Si ✓	[1]
		(v)	N/P ✓	[1]
		(vi)	Mg ✓	[1]
		(vii)	Na ✓	[1]
		(viii)	Si ✓	[1]
	(b)	(i)	Energy change when each atom in 1 mole ✓ of gaseous atoms ✓ loses an electron ✓ (to form 1 mole of gaseous 1+ ions).	[3]
		(ii)	increasing nuclear charge/number of protons ✓ electrons experience greater attraction or *pull* / atomic radius decreases / electrons added to same shell /same or similar shielding ✓	[2]
		(iii)	In B, electron being removed is at a higher energy / In Be, electron being removed is at a lower energy ✓ An s electron is lost in Be AND a p electron is lost in B ✓	[2]
		(iv)	IE (of Na): 100 - 500 kJ mol^{-1} ✓ electron is in a different shell /further from nucleus/new shell/ more shielding ✓ (*not sub-shell or orbital*) /	[2]
				Total: 17

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Question	Expected Answers	Marks
4 (a)	uneven distribution of electrons ✓ instantaneous /oscillating/changing/temporary/transient/ dipole on one atom ✓ causes an induced/resultant dipole on another molecule/atom ✓ chlorine gas; bromine liquid; iodine solid/ volatility decreases from $Cl_2 \longrightarrow Br_2 \longrightarrow I_2$/ boiling point increases from $Cl_2 \longrightarrow Br_2 \longrightarrow I_2$/ stronger forces are broken from $Cl_2 \longrightarrow Br_2 \longrightarrow I_2$ ✓ number of electrons increases down group ✓ greater/more van der Waals' forces / induced dipole-dipole interactions / forces between the molecules ✓	[6]

(b)	Reactivity decreases down group/ $Cl_2 > Br_2 > I_2$ /
	
	 Cl_2 displaces Br_2 AND Br_2 displaces I_2 ✓
	
	 chlorine: Cl_2 + bromide $\longrightarrow$ yellow ..../ orange .... ✓
	 bromine: Br_2 + iodide $\longrightarrow$ darker orange/brown ✓
	                    or purple in organic solvent
	 $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ ✓
	 $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ ✓
	       (*or full equations*)
	
	 Cl_2 is stronger oxidising agent than Br_2
	 AND Br_2 is stronger oxidising agent than I_2 /
	
	 Cl_2 has greater attraction for electrons than Br_2
	 AND Br_2 has greater attraction for electrons than I_2 ✓
		[5 max]

QoWC:	**At least two sentences** that show legible text with accurate spelling, punctuation and grammar so that the meaning is clear. ✓ (Mark this from anywhere within Q4)	[1]
		Total: 12