



EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

2002

XVIII

1583

Time allowed
73 Minutes

Score

/61

Percentage

%

CHEMISTRY

**OCR
AS & A LEVEL**

Mark Scheme

Module 3: Periodic table and energy

www.exampaperspractice.co.uk



EXAM PAPERS PRACTICE

Question	Answer	Mark	Guidance
1 (a)	<p>M1 <i>Trend AND nuclear charge mark</i> (from Li to F) atomic radius decreases AND nuclear charge increases or number of protons increases ✓</p> <p>M2 <i>same shell/shielding mark</i> (outer) electrons are in same shell OR (outer) electrons experience similar or same shielding ✓ OR same number of shells</p> <p>M3 <i>nuclear attraction mark</i> Greater nuclear attraction on (outer) electrons or shells OR (Outer) electrons or shells are attracted more strongly to the nucleus ✓</p>	3	<p>ALLOW ORA throughout if it is clear that the Period is being crossed right to left</p> <p>ALLOW 'proton number increases' IGNORE 'atomic number increases' IGNORE 'nucleus gets bigger' IGNORE 'effective nuclear charge increases' DO NOT ALLOW 'charge increases' without reference to nuclear'</p> <p>IGNORE there is shielding DO NOT ALLOW sub-shells OR orbitals DO NOT ALLOW 'electrons are at a similar distance' This will also contradict M1 ALLOW 'there is no change in shielding' IGNORE 'shielding has no effect' DO NOT ALLOW 'there is no shielding'</p> <p>Quality of written communication 'nucleus' OR 'nuclear' spelled correctly once and used in context for third marking point</p> <p>ALLOW pull for attraction IGNORE for M3, 'electrons are pulled closer to nucleus' as this is a re-statement of the trend mark. DO NOT ALLOW 'greater nuclear charge' for 'greater nuclear attraction' for M3</p>



Question		Answer	Mark	Guidance
	(b) (i)	$(1s^2) 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ ✓	1	ALLOW ... $4s^2 3d^{10} 4p^6$ ALLOW subscripts AND 3D IGNORE $1s^2$ seen twice
	(b) (ii)	Cream AND precipitate ✓	1	ALLOW solid OR ppt for precipitate IGNORE 'does not dissolve' OR 'partially dissolves'
	(b) (iii)	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ ✓	1	Equation AND state symbols required
	(c) (i)	Equation $2NaOH + Cl_2 \rightarrow NaCl + NaClO + H_2O$ ✓ Conditions cold AND dilute (sodium hydroxide) ✓	2	ALLOW correct multiples IGNORE state symbols ALLOW room temperature OR $\leq 20^\circ C$ for cold



Question	Answer	Mark	Guidance
(c) (ii)	<p><i>Definition of disproportionation mark</i></p> <p>M1 (Disproportionation) is the (simultaneous) oxidation and reduction of the same element (in the same redox reaction) ✓</p> <p>M2 Assigning of oxidation numbers</p> <p>Cl in Cl₂ is 0 AND Cl in NaCl is -1 AND Cl in NaClO₃ is +5 ✓</p> <p>M3</p> <p>Chlorine has been oxidised from 0 to +5 AND Chlorine has been reduced from 0 to -1 ✓</p> <p>'Chlorine has been oxidised from 0 in Cl₂ to +5 in NaClO₃ and chlorine has been reduced from 0 in Cl₂ to -1 in NaCl' would secure M2 and M3</p> $\begin{array}{ccccccc} 3\text{Cl}_2 & + & 6\text{NaOH} & \rightarrow & 5\text{NaCl} & + & \text{NaClO}_3 & + & 3\text{H}_2\text{O} \\ & & & & \begin{array}{c} \uparrow \\ -1 \end{array} & & \begin{array}{c} \uparrow \\ +5 \end{array} & & \\ & & \text{reduction} & & & & \text{oxidation} & & \end{array}$ <p>This diagram, along with a correct definition, would secure all three marks.</p>	3	<p>ALLOW 'an element' OR 'a species' for 'the same element' Assume 'it' means disproportionation M1 can be awarded for 'chlorine is oxidised and reduced and this is disproportionation'</p> <p>ALLOW oxidation numbers written above the equation if not seen in the text but IGNORE oxidation numbers written above the equation if seen in the text ALLOW 1- AND 5 AND 5+ DO NOT ALLOW chloride in place of chlorine except for NaCl DO NOT ALLOW Cl⁻ in NaCl AND Cl⁵⁺ in NaClO₃ (ie do not allow ionic charges for oxidation numbers) ALLOW Cl OR Cl₂ for chlorine DO NOT ALLOW M2 if incorrect oxidation numbers of other elements are seen in the text eg H = +2 ALLOW ECF for third marks if ONE incorrect oxidation number is assigned but directional changes are correct eg Cl = 0 and -1 and +3 instead 0 and -1 and +5</p> <p>DO NOT ALLOW ECF if two oxidation numbers are incorrectly assigned</p> <p>IGNORE references to electron loss/gain</p> <p>If oxidation numbers are correct ALLOW third mark for: chlorine is oxidised to form NaClO₃ AND chlorine is reduced to form NaCl</p>
		Total	11



Question			Answer	Mark	Guidance
2	(a)	(i)	$\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g}) \checkmark$	1	
	(a)	(ii)	BaCO_3 OR $\text{RaCO}_3 \checkmark$	1	ALLOW formula if seen as reactant in an equation IGNORE name
	(b)		<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = $\text{SrCl}_2 \cdot 2\text{H}_2\text{O}$ award 3 marks</p> <p>M1 Correctly calculates Mol of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O} = (5.332 / 266.6) = 0.02 \text{ mol} \checkmark$</p> <p>M2 Correctly calculates Mol of water given off $[(5.332 - 3.892)/18] = 0.08 \text{ mol} \checkmark$</p> <p>M3 Correctly calculates $0.08/0.02 = 4$ mol of water lost from one mol of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ Therefore Answer = $\text{SrCl}_2 \cdot 2\text{H}_2\text{O} \checkmark$</p>	3	<p>Allow alternative methods eg M1 Correctly calculates mol of $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ as $5.332/266.6 = 0.02(00) \text{ mol}$ DO NOT ALLOW M1 if a second mass is divided by 266.6</p> <p>M2 Correctly calculates molar mass of partially hydrated product as $3.892/0.02(00) = 194.6$</p> <p>M3 Correctly calculates mass of H_2O present as $194.6 - 158.6 = 36.0$ AND product is $\text{SrCl}_2 \cdot 2\text{H}_2\text{O}$</p> <p>ALLOW ECF for the third mark for showing 158.6 taken from an incorrect stated molar mass leading to an ECF formula OR ALLOW $266.6 - 194.6 = 72.0$ to find amount of water lost</p>
	(c)	(i)	<p>Reaction 1: $\text{Ba} + 2\text{H}_2\text{O} \rightarrow \text{Ba}(\text{OH})_2 + \text{H}_2 \checkmark$</p> <p>Reaction 2: $\text{Ba}_3\text{N}_2 + 6\text{H}_2\text{O} \rightarrow 3\text{Ba}(\text{OH})_2 + 2\text{NH}_3$ Correct products \checkmark Balancing \checkmark</p>	3	Ignore state symbols
	(c)	(ii)	Giant ionic (lattice) \checkmark	1	ALLOW 'Giant lattice with ionic bonds' ALLOW 'Giant ionic bonds' DO NOT ALLOW 'atoms or molecules or dipoles'



Question	Answer	Mark	Guidance
(iii)	<p> $\left[\begin{array}{c} x x \\ x Ba x \\ x x \end{array} \right]^{2+} \left[\begin{array}{cc} \bullet \bullet & \bullet \bullet \\ x \bigcirc & \bullet \bigcirc x \\ \bullet \bullet & \bullet \bullet \end{array} \right]^{2-}$ </p> <p>OR</p> <p> $\left[\begin{array}{c} x x \\ x Ba x \\ x x \end{array} \right]^{2+} \left[\begin{array}{ccc} \bullet \bullet & & \bigcirc \bigcirc \\ x \bigcirc & \bullet & \bigcirc x \\ \bullet \bullet & & \bigcirc \bigcirc \end{array} \right]^{2-}$ </p> <p>OR</p> <p> $\left[\begin{array}{c} x x \\ x Ba x \\ x x \end{array} \right]^{2+} \left[\begin{array}{ccc} \bullet \bullet & & \bigcirc \bigcirc \\ x \bigcirc & \bullet & \bigcirc \bigcirc \\ \bullet \bullet & & \bigcirc \bigcirc \end{array} \right]^{2-}$ </p> <p>OR</p> <p> $\left[\begin{array}{c} x x \\ x Ba x \\ x x \end{array} \right]^{2+} \left[\begin{array}{cc} \bullet \bullet & \bullet \bullet \\ x \bigcirc & \bullet \bigcirc \\ \bullet \bullet & \bullet \bullet \end{array} \right]^{2-}$ </p>	1	<p>Ba must have a 2+ charge Ba can be with or without octet. IGNORE lack of charge on O₂²⁻ ion</p> <p>O₂²⁻ ion to have 12 electrons belonging to O atoms + 2 other electrons of another symbol. The 2 other electrons must match Ba if Ba has an octet.</p> <p>If O electrons are shown as 6 of one symbol and 6 of another, each O must have six electrons of the same symbol</p> <p>ALLOW</p> <p> $\left[\begin{array}{c} x x \\ x Ba x \\ x x \end{array} \right]^{2+} \left[\begin{array}{cc} \bullet \bullet & \bullet \bullet \\ \bullet \bigcirc & x \bigcirc x \\ \bullet \bullet & \bullet \bullet \end{array} \right]^{2-}$ </p> <p>OR</p> <p> $\left[\begin{array}{c} x x \\ x Ba x \\ x x \end{array} \right]^{2+} \left[\begin{array}{cc} \bullet \bullet & \bullet \bullet \\ \bullet \bigcirc & x \bigcirc \\ \bullet \bullet & \bullet \bullet \end{array} \right]^{2-}$ </p>
	Total	10	



Question	Answer	Marks	Guidance
3 (a)	<p>Reactivity increases (down the group) ✓</p> <p><i>Increasing size mark</i> Atomic radius increases OR There are more shells ✓</p> <p><i>Increased shielding mark</i> There is more shielding ✓</p> <p><i>Nuclear attraction (to electron) mark</i> Nuclear attraction (to electron) decreases OR (outermost) electrons experience less attraction (to nucleus) OR Increased nuclear charge is outweighed by increased shielding/distance ✓</p> <p><i>Ease of electron loss mark</i> Easier to remove (outer) electron(s) OR Ionisation energy decreases ✓</p> <p>Quality of written communication <i>electron(s) OR ionisation OR ionization OR oxidise OR oxidize spelled correctly at least once for last marking point</i></p>	5	<p>FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED</p> <p>'Down the group' is not required ORA throughout</p> <p>ALLOW alternative phrases for 'reactivity increases'</p> <p>ALLOW 'there are more energy levels' ALLOW 'electrons are in higher energy levels' ALLOW 'electrons are further from the nucleus' IGNORE there are more orbitals OR more sub-shells ALLOW 'different shell' OR 'new shell'</p> <p>There must be clear comparison ie 'more shielding' OR 'increased shielding' ALLOW there is more electron repulsion from inner shells DO NOT ALLOW responses which have no comparative eg 'there is shielding'</p> <p>ALLOW 'there is less nuclear pull' OR 'electrons less tightly held' IGNORE there is less effective nuclear charge IGNORE 'nuclear charge' for 'nuclear attraction'</p> <p>If question is answered in terms of only Group 7, then ONLY marks 2, 3 and 4 can be awarded</p> <p>ALLOW easier to oxidise</p>



Question		Answer	Marks	Guidance
	(b)	(i) $\text{AgNO}_3(\text{aq})$ OR silver nitrate OR AgNO_3 ✓	1	ALLOW $\text{Ag}^+(\text{aq})$
		(ii) Yellow AND precipitate ✓	1	ALLOW shades of yellow but not creamy yellow ALLOW ppt or solid for precipitate
		(iii) $\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$ ✓	1	ALLOW correct multiples
		(iv) concentrated (aqueous) NH_3 ✓	1	
Total			9	

Question			Answer	Marks	Guidance
4	(a)	(i)	<p><i>Nuclear charge mark</i> (Across the period) number of protons increases OR greater nuclear charge ✓</p> <p>Quality of written communication – nuclear OR proton(s) OR nucleus spelled correctly ONCE for the first marking point</p> <p><i>Distance / shielding mark</i> (Outermost) electrons are in the same shell OR (Outermost) electrons experience the same shielding OR Atomic radius decreases ✓</p> <p><i>Nuclear attraction (to electron) mark</i> Greater nuclear attraction (on outermost electrons) OR (outer) electrons are attracted more strongly (to the nucleus) ✓</p>	3	<p>FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED</p> <p>Comparison should be used for each mark</p> <p>IGNORE atomic number increases, but ALLOW proton number increases IGNORE nucleus gets bigger IGNORE 'effective nuclear charge increases' DO NOT ALLOW 'charge' increases without reference to nuclear</p> <p>ALLOW shielding is similar BUT IGNORE 'there is shielding' DO NOT ALLOW sub-shells OR orbitals</p> <p>ALLOW greater nuclear pull for greater nuclear attraction DO NOT ALLOW use of greater nuclear charge for greater nuclear attraction for third mark</p>
		(ii)	(Diamond and graphite form) gaseous atoms (of carbon when they are ionised) ✓	1	ALLOW the atoms are in the gaseous state

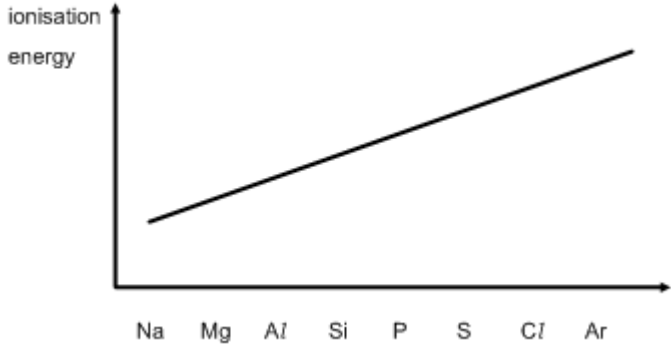
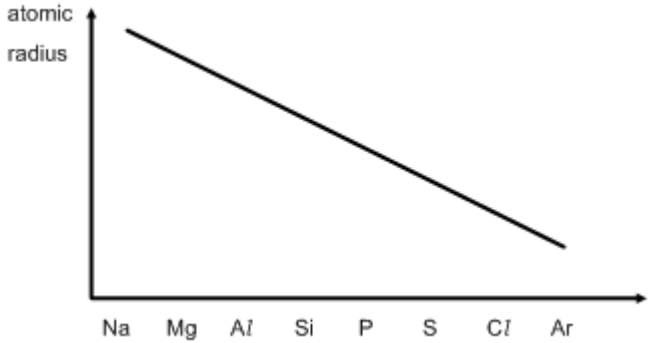


EXAM PAPERS PRACTICE

Question		Answer			Marks	Guidance
	(b)		Lithium	Carbon (diamond)	Fluorine	<p>ALLOW shared pair of electrons for covalent (bond)</p> <p>ALLOW vdw for van der Waals' ALLOW temporary–induced or instantaneous–induced for van der Waals'</p> <p>ALLOW Positive ions for Li⁺ ions IGNORE 'Lithium ions' but ALLOW 'Positive lithium ions' DO NOT ALLOW Li²⁺</p> <p>IGNORE C and IGNORE F₂ IGNORE diagrams but ALLOW names of particles if seen as a label on a diagram</p> <p>DO NOT ALLOW implication that covalent bonds are broken in fluorine for the <i>particles</i> mark of fluorine as this implies the particles are atoms</p>
		Structure	Giant	Giant ✓	Simple	
		Force or bond overcome on melting	Metallic bond	Covalent (bond) ✓	van der Waals' (forces) OR induced dipoles ✓	
		Particles between which the force or bond is acting	Li ⁺ ions and (delocalised) electrons ✓	Atoms ✓	Molecules ✓	
Total					10	



Question		Answer	Marks	Guidance
5	(a)	Periodicity ✓	1	ALLOW phonetic versions
	(b)	<p>Al bonding mark Al has metallic (bonding) OR has (electrostatic) attraction between positive ions and (delocalised) electrons ✓</p> <p>Si bonding mark Si has covalent (bonding) OR has shared pairs of electrons between atoms ✓</p> <p>P bonding mark P has induced dipoles OR has van der Waals' forces (between molecules) ✓</p> <p>Structure mark 1 Al AND Si are Giant ✓</p> <p>Structure mark 2 P is Simple molecular OR simple covalent ✓</p> <p>Bond strength mark Metallic AND covalent are stronger than vdWs OR Bonds broken in Al AND in Si are stronger than the forces broken in P OR More energy is needed to overcome bonds in Al AND Si than the forces in P ✓</p>	6	<p>Use annotations with ticks, crosses, ECF etc for this part</p> <p>DO NOT ALLOW marking point 1 if Al has dipoles OR intermolecular forces OR molecules OR atoms OR attraction between nuclei and electrons OR attraction between oppositely charged ions</p> <p>DO NOT ALLOW marking point 2 if Si has dipoles OR intermolecular forces OR molecules but IGNORE 'molecule'</p> <p>Must be induced dipoles ALLOW vdW for van der Waals' IGNORE P has covalent bonds for marking point 3</p> <p>Quality of Written Communication: 'giant' spelled correctly once and used in context for the fourth marking point</p> <p>DO NOT ALLOW covalent bonds are broken in phosphorus for marking point 6, but ALLOW answers that inform Al and Si are stronger than P, ignoring incorrect forces or bonds used above IGNORE 'heat' but ALLOW 'heat energy'</p>

Question		Answer	Marks	Guidance
(c)	(i)	Increasing straight line OR curve from Na to Ar ✓  <p>The graph shows ionisation energy on the y-axis and elements Na, Mg, Al, Si, P, S, Cl, Ar on the x-axis. A straight line starts at Na and increases steadily to Ar.</p>	1	ALLOW bar charts OR points IGNORE the standard of drawing as long as the trend is clear IGNORE decrease between Mg/Al and P/S Essentially the mark is for Na < Mg < Si < P < Cl < Ar AND Al < Si AND S < Cl
	(ii)	Decreasing straight line OR curve from Na to Ar ✓  <p>The graph shows atomic radius on the y-axis and elements Na, Mg, Al, Si, P, S, Cl, Ar on the x-axis. A straight line starts at Na and decreases steadily to Ar.</p>	1	ALLOW bar charts OR points IGNORE the standard of drawing as long as the trend is clear IGNORE Ar Essentially the mark is for Na > Mg > Al > Si > P > S > Cl
Total			9	



Question		Answer	Marks	Guidance
6	(a)	$(1s^2) 2s^2 2p^6 3s^2$ ✓	1	IGNORE $1s^2$ seen twice ALLOW subscripts
	(b) (i)	$Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$ Equation correct ✓ State symbols correct ✓	2	ALLOW $Mg^+(g) - e^- \rightarrow Mg^{2+}(g)$ for 2 marks The second mark is dependent upon the first mark except for the following close attempts for the first mark: ALLOW the following for one mark as states are correct $Mg(g) \rightarrow Mg^{2+}(g) + 2e^-$ $Mg(g) + e^- \rightarrow Mg^{2+}(g) + 2e^-$ ALLOW e for electron IGNORE states on electron
	(ii)	<i>Ionic radius mark</i> $Mg^{(+)}$ has smaller (ionic) radius OR has less shells ✓ <i>Shielding mark</i> (outermost electron) of $Mg^{(+)}$ experience less shielding ✓ <i>Nuclear attraction mark</i> More nuclear attraction on (outermost electrons) OR Outer electrons are attracted more strongly (to the nucleus) ✓ ORA throughout	3	Use annotations with ticks, crosses, ECF etc for this part ALLOW $Mg^{(+)}$ has less energy levels ALLOW $Mg^{(+)}$ has electrons in lower energy level ALLOW $Mg^{(+)}$ has electrons closer to nucleus IGNORE $Mg^{(+)}$ has less orbitals OR less sub-shells IGNORE atomic for ionic IGNORE 'different shell' ALLOW screening for shielding ALLOW $Mg^{(+)}$ has less electron repulsion from inner shells Quality of Written Communication: 'nuclear' OR 'nucleus' OR 'electron(s)' spelled correctly once and used in context for the third marking point ALLOW $Mg^{(+)}$ has more nuclear pull IGNORE $Mg^{(+)}$ has more effective nuclear charge DO NOT ALLOW more nuclear charge for more nuclear attraction for the third mark



Question		Answer	Marks	Guidance
(c)	(i)	Sr ²⁺ ✓ OH ⁻ ✓	2	ALLOW 2OH ⁻ ALLOW 2 marks for Sr(OH) ₂ → Sr ²⁺ + 2OH ⁻ ALLOW 1 mark for Sr ²⁺ + 2OH ⁻ → Sr(OH) ₂ IGNORE H ⁺
	(ii)	Sr has lost (two) electrons ✓	1	ALLOW Sr → Sr ²⁺ + 2e ⁻ IGNORE references to oxidation numbers
	(iii)	SrO AND H ₂ O ✓	1	ALLOW acceptable alternatives from Sr salts and alkalis eg SrC ₂ + NaOH
(d)	(i)	It shows the oxidation number of the sulfur OR the name without the IV is ambiguous ✓	1	DO NOT ALLOW 'the charge on sulfur' DO NOT ALLOW 'shows the oxidation number of the sulfate' ALLOW Otherwise it could be SrSO ₄ ALLOW Sulfur has different oxidation numbers AW
	(ii)	H ₂ SO ₃ ✓	1	
		Total	12	