

Particles, Substances and Thermochemistry AS 91390

SPD Configuration (A sometimes M)

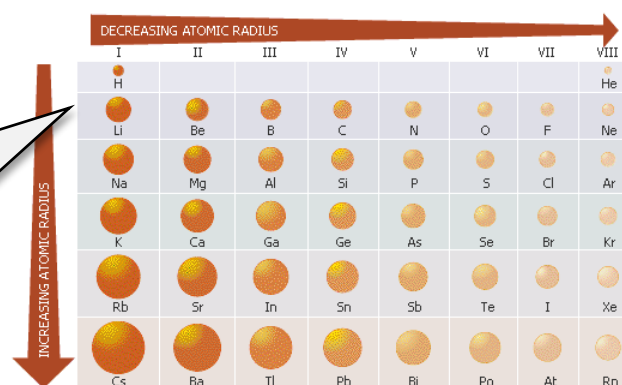
Year	Atoms/ions	Grade
2013	Se V V ³⁺	A
2014	K Cr As	M
2015	Al Cu ²⁺ Se	A
2016	Cl Zn Cr ³⁺	A
2017	Cl Ca ²⁺ Mn ²⁺	A
2018	V Cu ⁺ Br ⁻	A
2019	Cr Fe ³⁺ Ge	A

- ❑ Usually need 2/3 correct for Achieved.
- ❑ Focus on atoms – then ions
- ❑ Count back electrons to match atomic number
- ❑ Don't spend more than a few minutes
- ❑ Leave a difficult ion configuration

quick tip

Periodic trends (E1 – can often be 2E or M + E)

- ❑ Always include both NUCLEAR CHARGE (across) and ENERGY LEVELS (down) as part of your discussion
- ❑ Also include attraction (+/-) /repulsion (-/-) to explain NET attractive force



- ❑ Make sure you can write an ionisation equation (with states!)
- ❑ Use the equation to remember your definitions

quick tip

Periodic trends Summary

	Electronegativity	1 st ionisation energy	Atomic radii
Across a Period	The greater the nuclear charge, the easier it is to obtain more electrons from other atoms > more p+ to pull with INCREASES	As the nuclear charge is larger it requires more energy to remove an electron as they are stronger attracted (and closer) to the nucleus INCREASES	Across a period, the energy level numbers stay the same, but proton numbers increase attraction of the valence electrons DECREASES
Down a group	The larger the number of energy levels the less net electrostatic attraction so the less ability an atom has to remove the valence electrons of another atom (and further away) DECREASES	As the energy level numbers increase the easier it is to remove electrons as the valence electrons are further from the 'pull' of the protons and more electron repulsion by other electrons in inner energy levels DECREASES	Down a group the energy levels become further away from the nucleus therefore the valence electrons repel more, less attraction to nucleus, taking up more space and increasing the size INCREASES

Year		Atomic Radii		Electronegativity	1 st Ionisation Energy	
		atoms	atom/ion		atoms	equation
2013	E x 2		Cl/Cl ⁻	O Se	Li Cl	
2014	E		K/K ⁺		arrange	
2015	E x 2			definition	Definition Trend across 3 rd Period	
2016	M + E		Cl/Cl ⁻	Trend down	Trend down	
2017	M + E x 2			Definition Cl/P	Definition Trend down Grp 2.	Ca
2018	E	Trend across 2 nd period			Trend across 2 nd period	
2019	M + E		S/S ²⁻	O Na S		

Lewis Diagrams (tends to be M Question)

Year	Atoms/ions	Grade
2013	BrF ₃ /PCl ⁻	A
2014	SiF ₆ ²⁻	M
2015	AsF ₅ /SeF ₆	A x 2
2016	ICl ₄ ⁻ /ClF ₃	M
2017	I ₃ ⁻ + explain shape	M
2018	AsF ₅ /BrF ₅	M
2019	SF ₄ /SF ₃ ⁻	M

- ☐ In table - usually 2 to draw and name shape
- ☐ Only one name + diagram required for the mark.
- ☐ It is highly likely the Lewis structure will be an expanded Octet (more than 4 pairs around the central atom) so "L3" names can be used for shapes.
- ☐ YX₆ indicates octahedral
- ☐ Don't forget charge and [] for ions!

quick tip

Molecular Shapes and Polarity (E2)

Key phrases to use:

- ☐ The electron clouds repel as far apart as possible; this produces the x shape – **VSEPR**
- ☐ repulsions between x bonding regions and x non-bonding region of charge – **REPLUSIONS**
- ☐ difference in electronegativity between X and Y, so the X-Y bonds are polar covalent - **ELECTRONEGATIVITY**
- ☐ Shape x which is asymmetric therefore the polarities/dipoles do not cancel - **SYMMETRY**

Year	Atoms/ions	Grade
2013	SF ₄ and XeF ₄	E
2014	Polarity of Bonds	E
2015	XeO ₂ F ₂ and GeH ₄	E
2016	SeF ₆ linked to solubility	E
2017	IF ₅	E
2018	XeF ₄	E
2019	ClF ₅	E

- ☐ Link shape to symmetry
- ☐ Shapes with non-bonding pairs (except linear and square planar) are **unsymmetrical**
- ☐ In recent years only one shape is used
- ☐ Bond angles not needed (except at Schol level)

quick tip

Weak-Intermolecular Forces (E3)

Year	compounds	Grade
2013	N ₂ H ₄ (HB) CH ₃ F (P) C ₁₀ H ₂₂ (NP)	E
2014	NH ₃ (HB) F ₂ (NP) HCl(P)	A + E
2015	C ₅ H ₁₂ O isomers branched straight	A + E
2016	NaCl HCl (P) CH ₃ Cl(P)	A + E
2017	N ₂ H ₄ (HB) CH ₃ I(P) C ₁₀ H ₂₂ (NP) and solubility comparison and comparison of states	E + M x 2
2018	CH ₃ OH(HB) CH ₃ CH ₂ CH ₂ OH (HB) CH ₃ CH ₂ COH (P)	A + E
2019	NH ₃ (HB) C ₂ H ₆ (NP) CH ₃ NH ₂ (HB)	A + E

- ☐ Always check if question has reference to Molar mass – as this will be then required in answer
- ☐ If molar mass and bonding type is the same, then check for branched and straight chain molecules
- ☐ Data table will be given with melting/boiling point OR $\Delta_{\text{vap}}H^\circ$
- ☐ Sometimes a table is required first, but use ALL information in question – use as a guide
- ☐ Watch for ionic solids – no intermolecular bonding!
- ☐ There is not always 1 of each type
- ☐ Use information and terms from filled in chart in long answer

quick tip

Non-Polar Temporary (Instantaneous) dipole ID - ID	Polar Permanent dipole + Instantaneous dipole PD – PD + ID - ID	Polar (H-O, H-N, H-F) Hydrogen Bonding + Instantaneous dipole HB – HB + ID - ID
<p>The (...) molecular solid is non-polar and so the only intermolecular forces would be due to temporary dipole interactions.</p> <p>This type of intermolecular bonding is the weakest of the three so these molecular solids will have the lowest boiling point.</p> <p>Generally, as the molar mass increases, there are more electrons and more instantaneous dipole-dipole interactions so all things being equal, the boiling points would increase.</p>	<p>The (.....) molecular solid is polar and contains both Permanent dipole and instantaneous dipole interactions.</p> <p>The permanent dipole is generally the stronger force and will be the dominant force found in the molecular solid and therefore these substances tend to have a higher boiling point than the non-polar substances.</p> <p>The instantaneous dipole forces will become more significant if the molar mass of the molecule becomes greater.</p>	<p>The (...) molecular solid has the highest boiling point of the three. This is because it has hydrogen bonds, which are very strong intermolecular forces. The electronegativity difference between the H-.... Bond creates a very polar molecule, which takes large amounts of energy to break the intermolecular bond between molecules hence a high boiling point.</p> <p>These molecular substances also contain instantaneous dipoles, which only become significant when the molar mass is large.</p>

Enthalpy (E4 – sometimes E but mostly M)

Year	Type	Grade
2013	1. Definition $\Delta_{\text{vap}}H$ 2. What occurs at BP	A + M
2014	1. Graph – what occurs at each point	E
2015	1. Write the equation for $\Delta_c H^\circ$ 2. explain why $\Delta_c H^\circ$ (H_2) and $\Delta_f H^\circ$ (H_2O) have the same value 3. compare $\Delta_f H^\circ$ ($\text{H}_2\text{O}_{(g)}$) for liquid and gas	E + A x 2
2016	1. Define $\Delta_{\text{fus}}H^\circ$ 2. Why is $\Delta_{\text{vap}}H^\circ(\text{NaCl})$ greater than $\Delta_{\text{fus}}H^\circ(\text{NaCl})$?	M
2017	1. equation for the sublimation 2. Define the enthalpy of sublimation	A
2018	1. equation for $\Delta_{\text{fus}}H^\circ$ 2. compare $\Delta_c H^\circ$ for liquid and gas	M x 2
2019	1. identify vapourisation as endo or exo	M

- ❑ Make sure you know all the definitions
- ❑ Label a S/L/G graph with MP and BP and notes at each point
- ❑ Combustion and Formation equations will be used in Hess's law as well – so make sure you can do these!

quick tip

Entropy (E5)

Year	Type	Grade
2013	Spontaneous $\Delta H < 0$ $\Delta S < 0$	E
2014	Spontaneous $\Delta H > 0$ $\Delta S > 0$ System/surrounds increase/decrease	M + E
2015	Spontaneous $\Delta H > 0$ $\Delta S > 0$ System/surrounds increase/decrease	M + E
2016	System/surrounds increase/decrease Spontaneous $\Delta H > 0$ $\Delta S > 0$	E + M
2017	System/surrounds increase/decrease Spontaneous $\Delta H > 0$ $\Delta S > 0$	E + M
2018	Spontaneous $\Delta H > 0$ $\Delta S > 0$ AND system/surrounds	E
2019	Spontaneous $\Delta H < 0$ $\Delta S < 0$ AND system/surrounds	E

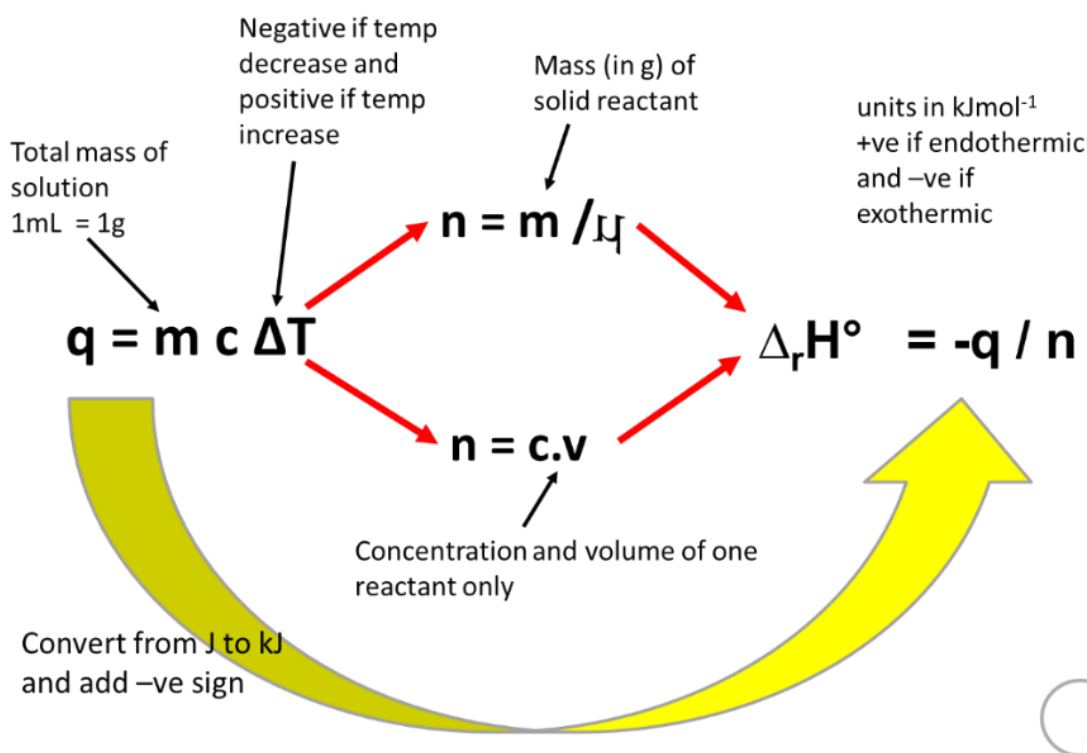
- ❑ Questions have combined spontaneous and system/surrounds for past 2 years
- ❑ Make sure you identify How enthalpy and entropy have increased or decreased
- ❑ Drawing a simple diagram can help as well

quick tip

Specific Heat Capacity (E6)

Year	Mass (given g)	Concentration (given v)	Conditions	Grade
2013		HCl + NH ₃ solution	yes	E
2014				
2015				
2016	Methanol combusted		yes	E + M
2017				
2018	NH ₄ Cl			E
2019	C ₆ H ₁₄ combusted		Yes	E + M

- ❑ Not given every year, but a quick calculation to do if it is
- ❑ Make sure you convert from J to kJ
- ❑ Also remember to change sign (as a temperature increase is -ve enthalpy value)



Enthalpy of Formation (E7 -sometime E Usually M)

Year	Type	Grade
2013	$C_{10}H_{22}(l) + 15.5O_{2(g)} \rightarrow 10CO_{2(g)} + 11H_2O(l)$	M
2014	$NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$	M
2015	$C_5H_{12}O(l) + 7\frac{1}{2} O_{2(g)} \rightarrow 5CO_{2(g)} + 6H_2O(l)$	M
2016	$CH_3OH(l) + 3/2 O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O(l)$	E
2017	$C_{10}H_{22}(l) + 15\frac{1}{2} O_{2(g)} \rightarrow 10CO_{2(g)} + 11H_2O(l)$	E
2018	$C_3H_7OH(l) + 4.5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O(l)$	M
2019	$CH_{4(g)} + NH_{3(g)} \rightarrow HCN_{(g)} + 3H_{2(g)}$	M

- ❑ Check for $\Delta_c H^\circ = \Delta_f H^\circ$
- ❑ All elements $\Delta_f H^\circ = 0$
- ❑ Do calculation twice as easy to make mistake
- ❑ 3 s.g.f.
- ❑ Don't forget units kJ mol⁻¹
- ❑ don't forget sign - or +

$$\Delta_r H^\circ = \sum n \Delta_f H^\circ_{products} - \sum n \Delta_f H^\circ_{reactants}$$

Hess's Law (E8)

Year	Type	Grade
2013	Calculate $\Delta_f H^\circ$ (H ₂ O(l)),	M
2014	Calculate the standard enthalpy of formation of liquid ethanol	E
2015	Calculate the $\Delta_f H^\circ$ for B ₂ H _{6(g)} ,	E
2016		
2017		
2018	enthalpy change, $\Delta_r H^\circ$ 2Al(s) + 3Cl _{2(g)} → Al ₂ Cl _{6(s)}	E
2019	Calculate the standard enthalpy of formation for liquid hexane, $\Delta_f H^\circ$ (C ₆ H _{14(l)}),	E

- ☐ Check the question first to make sure you can't use enthalpy of formation method (which is quicker)
- ☐ Self-checking – as your final equation must match starting equation
- ☐ Add up enthalpies twice! This is where mistakes can be made, and quickly fixed
- ☐ Make sure you can expand out equations -both $\Delta_f H$ and $\Delta_c H$
- ☐ Again, 3 s.g.f. for answers and units (kJ mol⁻¹) and -ve or +ve sign
- ☐ Underline final answer to make it obvious

Good luck – You can do it!

Summary of grade boundaries

Year	Question	Grade Boundaries for each question										To get overall E
		N0	N1	N2	A3	A4	M5	M6	E7	E8		
2013	1	/	1a	2a	3a	4a	2m	3m	2e Minor error	2e Trends Shape/polarity	19+	
	2	/	1a	2a	3a	4a	2m	3m	1e + 1M	2e Hess's Specific heat		
	3	/	1a	2a	3a	4a	2m	3m	2e minor error	2e Intermolecular entropy		
2014	1	/	1a	2a	3a	4a	3m	4m	2e minor error	2e Trends x 2	19+	
	2	/	partial	1a	3a	4a	2m	3m	1e minor error	2e Intermolecular enthalpy		
	3	/	1a	2a	3a	4a	3m	4m	1e with minor error	2e Entropy Hess's		
2015	1	/	1a	2a	3a	4a	2m	3m	1e + 1m	2e Trends x 2	19+	
	2	/	1a	2a	3a	4a	1m + 3a	2m	1e + 1m	2e Enthalpy Hess's		
	3	/	1a	2a	3a	4a	2m	3m	2e	2e + 1m Shape/polarity intermolecular		
2016	1	/	1a	2a	3a	4a	3m	4m	1e	2e Trends Shape/polarity	20+	
	2	/	1a	2a	3a	4a	2m	3m	1e	2e Intermolecular entropy		
	3	/	1a	2a	3a	4a	2m	3m	2e	3e Hess's Specific heat entropy		
2017	1	/	1a	2a	3a	4a	2m	3m	2e minor error	2e Trends X 2	19+	
	2	/	1a	2a	3a	4a	4m	5m	2e	3e Intermolecular x 2 Hess's entropy		
	3	/	1a	2a	3a	4a	3m	4m	2e minor error	2e Entropy Shape/polarity		
2018	1	/	1a	2a	3a	4a	2m	3m	1e	2e minor error Trends Shape/polarity	20+	
	2	/	1a	2a	3a	4a	3m	4m	2e minor error	2e Intermolecular Hess's		
	3	/	1a	2a	3a	4a	2m	3m	1e	2e minor error Specific heat entropy		
2019	1	/	1a	2a	3a	5a	3m	4m	1e + 2M	2e Trends Shape/polarity	20+	
	2	/	1a	2a	3a	5a	3m	4m	1e + 2m	2e Hess's Heat capacity		
	3	/	1a	2a	3a	5a	3m	4m	1e + 2m	2e Intermolecular entropy		