



**General Certificate of Education**

**Chemistry 5421**

**CHM2 Foundation Physical and Inorganic  
Chemistry**

**Mark Scheme**

*2007 Examination – January series*

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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1	a	Heat Energy change at constant pressure	1 1
	b	$\text{N}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g})$	1
	c	i	$\Delta H = \Sigma \text{ bonds broken} - \Sigma \text{ bonds made}$
			$\frac{1}{2} (945) + 3/2 (159) - 3(278)$
			$- 123 \text{ kJmol}^{-1}$
			$+ 123 \text{ kJmol}^{-1}$ scores 1 mark
			Accept no units
		ii	The N-F bond energy is an average taken from several compounds
	d	i	It is an element
		ii	$\Delta H = \Sigma \Delta H_f \text{ products} - \Sigma \Delta H_f \text{ reactants}$ (or correct cycle)
			$-114 + 3(-467) - 4(-46) - 0$
			$- 1331 \text{ kJmol}^{-1}$
			$+1331 \text{ kJmol}^{-1}$ scores 1 mark
			Accept no units
2	a	i	+1
			0
			+5
		ii	HClO is simultaneously oxidised and reduced
	b	i	$2\text{HClO} + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{Cl}_2 + 2\text{H}_2\text{O}$ or $2\text{ClO}^- + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{Cl}_2 + 2\text{H}_2\text{O}$
		ii	$\text{HClO} + 2\text{H}_2\text{O} \rightarrow \text{ClO}_3^- + 5\text{H}^+ + 4\text{e}^-$ or $\text{ClO}^- + 2\text{H}_2\text{O} \rightarrow \text{ClO}_3^- + 4\text{H}^+ + 4\text{e}^-$
3	a	i	Decreases from fluorine to iodine
		ii	$\text{Cl}_2 + 2\text{KBr} \rightarrow \text{Br}_2 + 2\text{KCl}$ Accept ionic equations
	b	J	NaF, accept $\text{F}^-$ or correct name.
		K	NaI, accept $\text{I}^-$ or correct name.
		L	NaBr, accept $\text{Br}^-$ or correct name.
		M	$\text{Br}_2$ / bromine
		N and Q	HBr /hydrogen bromide
			$\text{SO}_2$ /sulphur dioxide

4	a	Rate of the forward reaction = rate of the backward reaction Concentrations are constant	1 1
	b	Increase There are 3 moles on the LHS and 2 moles on the RHS so the system moves to the right to decrease the pressure/ oppose the increase in pressure	1 1 1
	c	Negative allow exothermic the equilibrium shifts to decrease the temperature/ oppose the increase in temperature	1 1
5	a	Resists corrosion Abundant ore Lightweight	1 1
		} any two	
	b i	Molten or dissolved in cryolite	1 1
		$\text{Al}^{3+} + 3\text{e}^{-} \rightarrow \text{Al}$	1
		$2\text{O}_2^{-} \rightarrow \text{O}_2 + 4\text{e}^{-}$	1
	ii	Reduction	1
	c	$2\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe}$ Reducing agent	1 1
	d	$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$ or $\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$ or $2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$	1
		1500 C (or in range 1-2000C ) accept high temperatures	1
	e	Blast furnace process is continuous Coke/ CO is a cheaper reducing agent than Aluminium	1 1
		QoL	

6	a	Y axis labelled as number/ fraction/ % of molecules X axis labelled energy Both axes must be correctly labelled for 1 mark	}	1
		Curve starts at origin		1
		Curve skewed to the left and has a decreasing gradient to a maximum		1
		Curve after maximum decreases in steepness, never touches x axis, levels out at <10% of the maximum height		1
		W is displaced to the right and is flatter/ lower		1 1
	b	The <u>change in concentration</u> per unit of time	QoL	1
		<i>Both axes must be labelled to gain marks for graph. y axis conc NO<sub>2</sub> and x axis time</i>		
		Curve starts at origin and levels off		1 1
		<i>If candidates graph does not level off then second mark can be scored for a curve with a continuously decreasing gradient.</i>		
		Initial rate can be found by finding the gradient at t = 0 <i>Candidates may score this mark if they have shown this on their graph</i>		1
	c	$2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$ <i>accept multiples</i>		1
		NO is a catalyst		1
		it is regenerated at the end of the reaction		1
		provides an alternative route		1
		of lower activation energy		1