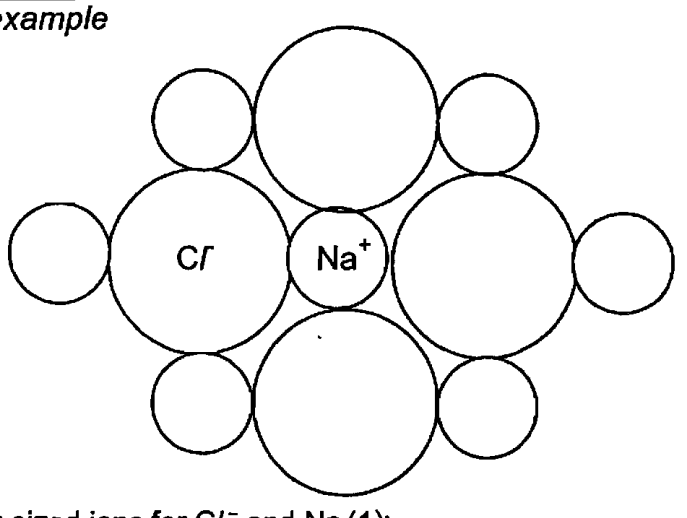
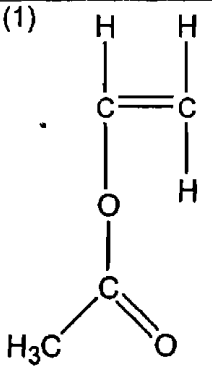
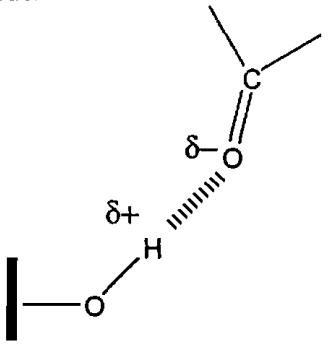
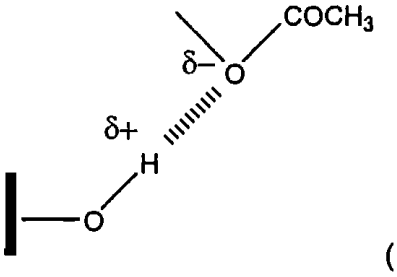
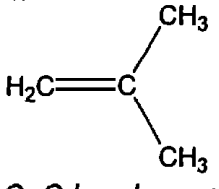
Question	Expected answers	Marks
1 (a) (i)	Volatile/gas (1); toxic (to humans)/causes respiratory diseases/choking gas (1).	2
1 (a) (ii)	Green colour (1). *Allow (pale) greenish yellow/ yellowish green & all shades in between.*	1
1 (b) (i)	Hydrogen ions/ H^+ /protons are present (1).	1
1 (b) (ii)	*1 mark for point in bold and 3 from 4 other points:* NaCl contains chloride ions/ chloride added/ sodium chloride dissolves AW (1); Increase in (chloride ion) (1); **concentration** (1); will cause equilibrium (position) to move to the left AW (1); (molecular) chlorine/Cl_2 (concentration) increases (1). *QWC* 1 mark for two sentences / 2 bullet points including correct use of **two** of the following words: *ion, molecule, equilibrium, counteract/oppose.*	4 1
1 (b) (iii)	*For example*  correct sized ions for Cl^- and Na (1); correct charges for Cl^- and Na^+ (1); 4 oppositely charged ions or atoms around each type of ion/atom (1).	3
1 (c) (i)	Cl_2 = 0 (1); HOCl = +1 (1).	2
1 (c) (ii)	Oxidation/ redox (1) *NOT ecf*	1
1 (c) (iii)	Oxidation state of Cl has increased *or* Cl has lost electron(s) (1) *ecf.*	1
1 (d)	$2HOCl \rightarrow O_2 + 2Cl^- + 2H^+$ or 2HCl in equation formulae correct (1); correct formulae balanced (1); hν above → (1).	3
	Total mark	19

Question	Expected answers	Marks
2 (a) (i)	*allow* $-COCH_3$ (1) 	1
2 (a) (ii)	Softens/flows/melts (1); when heated/warmed (1).	2
2 (a) (iii)	Addition *accept additional* (1).	1
2 (b) (i)	M_r of monomer = 86 (1); n = 43,000 / 86 = 500 *ecf* (1).	2
2 (b) (ii)	More intermolecular forces/attractions between chains / chains get tangled /entwined (1); chains/molecules can not move as easily AW (1).	2
2 (c) (i)	Hydrogen bonding (1).	1
2 (c) (ii)	 or  (1) *accept non-linearity of the O-H....O atoms;* bond (1); correct partial charges (1).	3
2 (d) (i)	(Shake with/add) bromine (in solvent) (1) orange/brown (1); turns colourless (1) *do not accept* clear.	3
2 (d) (ii)	C=C restricts bond rotation AW (1); substituent groups mean two different arrangements possible AW (1).	2
	Total mark	**17**

Question	Expected answers	Marks
3 (a) (i)	$O_2 \rightarrow 2O$ (1); $O + O_2 \rightarrow O_3$ (1).	2
3 (a) (ii)	High frequency radiation only present in stratosphere AW (1); bonds are broken by this radiation AW (1).	2
3 (a) (iii)	(Intense) high frequency radiation/uv given off by firework reactions/(intense) heat/energy released (1).	1
3 (b) (i)	Increase its temperature/warm up the atmosphere (1).	1
3 (b) (ii)	Infrared (1) *do not allow* heat.	1
3 (b) (iii)	Makes it vibrate (faster)/increases its (kinetic) energy (1).	1
3 (c) (i)	Photodissociate / break down (to form oxygen molecules and atoms) (1).	1
3 (c) (ii)	E for 1 bond = 302 x 1000 (1) / 6.02×10^{23} (1) J = 5.02×10^{-19} J *ecf* (1).	3
3 (c) (iii)	$\nu = 5.02 \times 10^{-19} / 6.63 \times 10^{-34}$ (1) = 7.57×10^{14} Hz *ecf.* *1 mark for 3 sig. figs.*	2
	Total mark	**14**

Question	Expected answers	Marks
4 (a) (i)	$(3 / 1 \times 10^{6}) \times 100$ (1) $= 3 \times 10^{-4}$ % .	1
4 (a) (ii)	Froth flotation (1); *Any 2 points from 4:* grains are given water repellent coating (1); (air & detergent cause) the solution to froth (1); ore grains/metal are concentrated/AW in the froth (1); ore grains scooped/AW off with froth (1).	3
4 (b) (i)	Cu_2S (1).	1
4 (b) (ii)	$2p^6$, $3s^2$, $3p^4$ *12 electrons added (1);* *correct orbitals (1).*	2
4 (b) (iii)	$Cu_2S + O_2 \rightarrow 2Cu + SO_2$ *formulae correct, allow ecf from b(i) for copper(I) sulphide (1);* *balanced (1).*	2
4 (b) (iii)	SO_2 reacts in the atmosphere to form sulphuric/sulphurous acid / with water to form an acid (1); causes acid rain (1)	2
4 (c) (i)	hydrogen ions /protons (1).	1
4 (c) (ii)	S^{2-} (1).	1
4 (d) (ii)	Enthalpy of products lower than reactants in both cases (1); correct shape curve for reaction, single 'hump' (1); correct shape curve for catalysed reaction, two 'humps' (1); enthalpy change of reaction correct (1); both enthalpy changes of activation correct (1).	5
	Total mark	**18**

Question	Expected answers	Marks
5 (a) (i)	Cl_2 (1).	1
5 (a) (ii)	2-chloro-2-methylpropane *name (1);* *number for chlorine/methyl (1).*	2
5 (a) (iii)	room temperature (1) accept heat (under reflux) *alone.*	1
5 (b) (i)	OH^- (1); *must be ion.*	1
5 (b) (ii)	Cl and C have different electronegativities AW/ C-Cl bond is polar (1); the C is electron deficient/ slightly positive/ $\delta+$ (1).	2
5 (c) (i)	(Concentration x volume) 2.0 x 100/1000 (1); = 0.2 mol (1)	2
5 (c) (ii)	M_r(NaOH) = 40 (1); mass = 0.2 x 40 = 8 g (1). *ecf for* **5 (b) (i)** *and incorrect* M_r.	2
5 (d) (i)	Tertiary (1); no H atoms on C connected to OH (1)/only alkyl groups on C connected to OH / three carbon atoms bonded to C-OH (1).	2
5 (d) (ii)	 *C=C bond present (1); rest of molecule correct (1).*	2
5 (d) (iii)	Elimination (1).	1
5 (e) (i)	X in distillation head opposite condenser (1).	1
5 (e) (ii)	**2 defects from 3** Water connections need to be reversed (1); condenser water jacket will not be filled/ product will not condense (1); Delivery tube and distillate flask sealed (1); closed system is dangerous/pressure builds up on heating (1); No anti-bumping granules (1); liquid will boil over into condenser AW (1). *QWC* *At least two readable and clear sentences with no more than one spelling, punctuation or grammatical error* (1).	4 1
	Total mark	**22**