

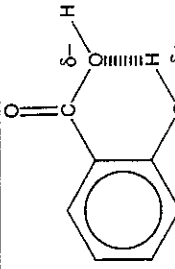
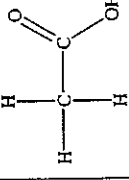
The following annotations may be used when marking:

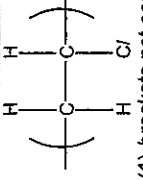
- X = incorrect response (errors may also be underlined)
 ^ = omission mark
 bod = benefit of the doubt (where professional judgement has been used)
 ecf = error carried forward (in consequential marking)
 con = contradiction (in cases where candidates contradict themselves in the same response)
 sf = error in the number of significant figures

Abbreviations, annotations and conventions used in the Mark Scheme:

- / = alternative and acceptable answers for the same marking point
 ; = separates marking points
 NOT = answers not worthy of credit
 () = words which are not essential to gain credit
 (underlining) = key words which must be used
 ecf = allow error carried forward in consequential marking
 AW = alternative wording
 ora = or reverse argument

Question	Expected answers	Marks
1 (a)(i)	For infrared: bond (1); vibrates (1); more (or faster) (1); or moves to higher (1) vibrational level (1); If IR not specified first two marks only (note marks are linked). For ultraviolet: three points max electron(s) (1); excited (1) or move to higher energy level (1); bonds are broken/form radicals (1); molecules are ionized (1); if UV not specified, one mark only for any effec (5) max QWC At least two readable and clear sentences with no more than one spelling, punctuation or grammatical error (1).	6
(ii)	Both peaks at same frequency (1); Winter peak smaller than summer peak (1).	2
(b)(i)	Atom or molecule (accept a chemical species, particle or ion) having at least one unpaired/spare/lone (NOT free, unshared, single) electron (1).	1
(ii)	Any 3 points from 4: Absorption/ $h\nu$ (1); of ultraviolet/high frequency radiation/light/energy (1); causes bonds to break or photodissociation (may be shown by an equation) (1); homolytically (AWY)(1).	3
(iii)	Bond enthalpy (1); of C-Cl is smaller than C-F (1). or C-Cl bond is weaker/longer (1) and bond breaks more easily, ora (1).	2
(iv)	Cl + O ₃ → ClO + O ₂ (1) ClO + O → O ₂ + Cl / ClO + O ₃ → O ₂ + Cl (1) Overall: O + O ₃ → 2O ₂ / 2O ₃ → 3O ₂ (1)	3
(c)(i)	Non-linear or bent triatomic molecule drawn (1); order of atoms is ClOC/ (1).	2
(ii)	Compares electronegativity (1); C-O bonds are polar/shown as correct partial charges (1); Dipoles of bonds do not cancel therefore molecule polar/has similar shape to water/molecule has a dipole (1)	3
	OR electronegativity difference is very small (1); bonds are not polar /do not have a dipole (1); therefore molecule is not polar (1); ecf for linear molecule in (c)(i) and stating that dipoles cancel.	
	Total mark	22

Question	Expected answers	Marks
2 (a)	Any 2 points: (these may be general or use a specific example) improve its activity/effect (1); widen its use (1); reduce side-effects (1); improve its properties (1); make it more specific (1). NOT cost.	2
(b)(i)		2
(ii)	B and C can form (1) or a hydrogen bonds between molecules /stronger intermolecular forces between molecules (1) or a more energy needed/harder to separate molecules or a(1).	3
(c)(i)	138 (1).	1
(ii)	18 (1).	1
(iii)	H ₂ O (1).	1
(iv)	H ₂ O molecule is lost from A (1) the groups are close enough in A /can interact/hydrogen bonds in the molecule, or a (1); but not in B and C (1).	3
(d)(i)	Ester (1).	1
(ii)	Flask + open vertical condenser (1); correct water and heating (1); contents indicated (may be line) and no leaks on reflux apparatus (1).	3
(iii)	 correct COOH group (allow -OH group) (1); methyl group correct (1) Purple/violet colour forms (1) Phenol, (allow hydroxy/yl/enol)(1).	2
(iv)		1
(v)		1

Question	Expected answers	Marks
(e)(i)	(R-COO) ⁻ (1) (- between R & C not essential); Na ⁺ (1).	2
(ii)	Add indicator (may be named) (1); colour change (may give correct colour) (1). allow pH meter (1) reasonable observation (1)	2
(ii)	Moles = volume x concentration (1) = (27.5/1000 x 0.025); = 6.88 x 10 ⁻⁴ (1).	2
(iv)	6.88 x 10 ⁻⁴ (1) ecf from part (iii).	1
(v)	6.88 x 10 ⁻⁴ x 10 = 6.88 x 10 ⁻³ (1) ecf from part (iv).	1
(vi)	180 g (1).	1
(vii)	Mass in 250 cm ³ sample = 180 x 6.88 x 10 ⁻³ = 1.24 g (1).	1
(viii)	Ecfc from (iv), (v) & (vi). % = 1.24 x 100/1.45 = 85-86% (1) ecf from part (vii).	1
	Total mark	32
3 (a)	One from polythene (any version), light emitting polymers, conducting polymers, or 'bakelite' (1).	1
(b)	Addition (allow additional/adding polymerisation) (1).	1
(c)	Any 3 points from following 4: The initiator produces radicals (1); which cause a chain reaction/cycle of reactions (1); in which radicals are reformed/propagated/regenerated/reproduced (1); until terminated (1).	3
(d)	Particles/molecules collide (1); with energy (1); lower/greater than activation enthalpy/energy, AW (1); fewer/greater number of collisions are successful, AW (1).	5
(e)	QWC 1 mark for two sentences / 2 bullet points including correct use of two of the following words: activation enthalpy (energy), collisions/collide, (kinetic) energy, particles/molecules. 	1
(f)	(1) brackets not essential but spare bonds are. PTFE more flexible because polymer chains can slide over each other more easily (1); chains don't tangle/are stereoregular (1).	2

Question	Expected answers	Marks
(g)(i)	$\begin{array}{c} \text{H} & \text{Br} & & \text{H} & \text{Cl} \\ & & & & \\ \text{H}-\text{C}-\text{C}-\text{H} & & & \text{H}-\text{C}-\text{C}-\text{H} \\ & & & & \\ \text{H} & \text{Cl} & & \text{Br} & \text{H} \end{array}$ <p>1 mark for each structure.</p>	2
(ii)	(Thin layer) chromatography/(fractional) distillation (1).	1
Total mark		16
4 (a)(i)	5 ppm in $5 \times 10^5 \text{ dm}^3 = 5 \times 5 \times 10^5 / 10^6 = 2.5 \text{ dm}^3$ (1).	1
(ii)	molecules = $(2.5 / 24.0 \times 6.02 \times 10^{23}) = 6.27 \times 10^{22}$ (1) 1 mark for ratio of volumes (2.5/ 24.0)	2
(b)	(Permanent) dipole-(permanent) dipole forces (1) (accept <i>pd-pd</i>).	1
(c)(i)	1 mark for both full structural formulae (CH_3OH and CH_3Br) accept <i>-OH group</i> ; 1 mark for rest correct: $\text{CH}_3\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{Br} + \text{H}_2\text{O}$	2
(ii)	nucleophilic (1); substitution (1).	2
(d)(i)	Iodomethane because it is a liquid. (1).	1
(ii)	Iodomethane is a bigger molecule/has a higher boiling point/higher mass or it has more electrons (1).	1
(e)(i)	Any 3 points from 4: Ppt (1); yellowish-(green) for CH_3I (1); creamy/off-white for CH_3Br (1); yellow ppt. appears before cream ppt (AW) (1).	3
(ii)	Ethanol is a solvent (1) allows reactants to mix (1);	2
(iii)	$\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$ 1 mark for iodide ion, 1 mark for correct balanced equation, 1 mark for state symbols.	3
(iv)	Carbon-halogen bond is broken in the reaction (may be implied) (1); C-Br bond is stronger than a C-I bond or C-I is easier to break than C-Br bond (a comparison mark) (1).	2
Total mark		20