

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

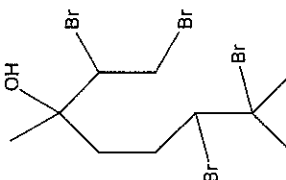
Abbreviations, annotations and conventions used in the Mark Scheme:

- / = 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)	Addition (allow additional/adding polymerisation (1)).	1
1 (a) (ii)	Initiation (1); propagation (1); termination (1).	3
1 (b) (i)	Chains are branched in hdpe(1); chains are (more) linear in hdpeless branching a comparison mark (1); chains cannot pack closely together / weaker attraction between chains/ more chains can fit in a given space ORA (1).	3
1 (b) (ii)	Areas in polymer may be inferred or show using a diagram (1); ordered / closely packed / chains more aligned / side by side (1).	2
1 (c) (i)	$TiCl_4 + 2H_2O \rightarrow TiO_2 + 4HCl$ Formulae correct each side (1); balanced (1).	2
1 (c) (ii)	Covalent (1); liquid at room temperature/ hydrolysed by water (1).	2
1 (d) (i)	d (block) (1).	1
1 (d) (ii)	d = 2 (1); s = 2 (1).	2
	Total mark	16

Question	Expected answers	Marks
2 (a)	Nitrogen (1); oxygen (1); argon (1) allow correct formulae.	3
2 (b)	$0.003/10^6 \times 100 = 3 \times 10^{-7}$ (1).	2
2 (c) (i)	$2\text{H}_2\text{O} + 2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{SO}_4$ Or half quantities etc. correct formulae each side (1); balanced (1).	2
2 (c) (ii)	NH_4^+ (1); $(\text{NH}_4)_2\text{SO}_4$ (1).	2
2 (c) (iii)	it gains/accepts (1) a proton/ H^+ (ion) (1). 1 mark only for 'it neutralises an acid' AW (1).	2
2 (d) (i)	Ultraviolet/high frequency/low wavelength (1).	1
2 (d) (ii)	It has an unpaired/one electron (1) do not allow 'free'.	1
2 (d) (iii)	$\text{NO}_2 + 4$ (1); $\text{HNO}_3 + 5$ (1). 1 mark only if no + sign and numbers correct.	2
2 (d) (iv)	Oxidation/ redox (1); (N) has lost an electron / oxidation state of (N) has increased/changed (watch for con)/ AW (N may be inferred) ecf from d(iii) (1).	2
2 (e)	Pipette NaOH into flask (1); fill burette with rain water (1); add indicator (1); (at end point) add rain water dropwise/slowly (1); repeat to get concordant readings AW (1). if NaOH & rain water reversed then allow 1 mark, hence max of 4.	6
2 (f)	QWC 1 mark for two sentences / 2 bullet points including correct use of two of the following words: pipette, burette, indicator, concordant, end-point.	3
2 (g) (i)	$\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$ or $\text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l})$ OH^- (1), rest correct (1); state symbols correct (1).	2
2 (g) (ii)	Volume x concentration (10.0 x 0.005/1000 (1); $= 5.0 \times 10^{-5}$ mol (1).	1
2 (g) (iii)	5.0×10^{-5} mol (1). 5.0×10^{-5} / volume (1); $= 5.0 \times 10^{-5} / 24.8/1000 = 2.0 \times 10^{-2}$ mol dm ⁻³ (1); 2 sig figs (1).	3
Total mark		32

Question	Expected answers	Marks
3 (a)	Ozone layer filters out/protects Earth from/ absorbs (high energy) radiation that is harmful to life/ damage will allow high energy/harmful radiation through to Earth (1).	1
3 (b) (i)	High energy/UV radiation (1); breaks (covalent) bond in oxygen (molecule)/photodissociation /homolysis of bond occurs (1).	2
3 (b) (ii)	Step 2; reaction is faster, activation enthalpy must be lower (1).	1
3 (c) (i)	Catalyst is in same phase/state as reactants (1).	1
3 (c) (ii)	NO is not used up in the reaction/ NO is reformed /chemically unchanged (1).	1
3 (d)	1 mark for point in bold and any 4 other points from 5: Infrared radiation is absorbed by NO/NO molecule excited by/ NO is given energy (1); NO bond/molecule (1); vibrates (1) more /may answer in terms of higher vibrational energy/ levels (1); at a specific frequency/wavelength/ allow in terms of 'characteristic absorption' (1); more IR absorbed by higher concentrations of NO / larger peak in IR spectrum/ relationship mark between absorbance and concentration (1). QWC At least two readable and clear sentences with no more than one spelling, punctuation or grammatical error (1).	6
3 (e) (i)	Trichlorofluoromethane (1); allow fluorotrichloromethane and ignore numbers if ones.	1
3 (e) (ii)	C-F bond (is more polar than C-Cl bond) since C-F has greater electronegativity difference (may be given as a number) ORA (1); correct partial charges: $\delta+$ on C & $\delta-$ on one halogen/F is more electronegative/F has the highest electronegativity (1).	2
3 (e) (iii)	CFCl_2 (1); Cl (1).	2
3 (e) (iv)	Bond strength/enthalpy/energy (1).	1
3 (e) (v)	CH_3^+ and Cl^- . 1 mark for correct charges (if molecules add up to CH_3Cl (1) & 1 mark for correct formulae (1).	2
Total mark		20

Question	Expected answers	Marks
4 (a)	Synthetic fragrances are not seasonal; Much less labour intensive/easier to manufacture; very low yield from natural sources/synthetic (or raw materials for) are more readily available/higher yield; synthetic fragrances are not weather dependant (1). (Pencil) line near bottom of plate/paper & spot small sample of mixture on line; solvent in beaker below line; plate; cover beaker with lid/film; leave until solvent front nears top of plate; remove and dry plate; use (UV light or iodine) to locate; at least two different spots (5). $C_{10}O$ (1); H_{18} (1). (1 mark only for $C_{10}H_{17}OH$)	1
4 (b)	1 mark for each point in bold, 1 mark for any of the other points listed: solvent in beaker below line; plate; cover beaker with lid/film; leave until solvent front nears top of plate; remove and dry plate; use (UV light or iodine) to locate; at least two different spots (5). $C_{10}O$ (1); H_{18} (1). (1 mark only for $C_{10}H_{17}OH$)	5
4 (c)	$C_{10}O$ (1); H_{18} (1). (1 mark only for $C_{10}H_{17}OH$)	2
4 (d) (i)	Linolol: tertiary (1); No H on C to which OH attached/ 3 alkyl groups on C (1); citronellol: primary (1); 2 Hs on C to which OH attached/ 1 alkyl group only on C/at end of chain (1).	4
4 (d) (ii)	Geraniol (1); restricted rotation around C=C (it has different groups which can be arranged in two ways/lack of symmetry around bond AW (1)). 3 from 4 points:	2
4 (e)	Hydrogen (1); 1 mol H_2 : 1 mol geraniol (1) unnamed catalyst & heat (and pressure)/Ni cat or Pt/Pd (1); at about 150 °C / room temperature (correct temperature for named catalyst) (1).	3
4 (f) (i)	 May use molecular formula $C_{10}H_{18}OBr_4$ If MF incorrect in part (c) then ecf. 4 bonded Br atoms (1); rest of molecule correct (1).	2
4 (f) (ii)	addition (1); electrophilic (1).	2
4 (f) (iii)	The C=C bond (1).	1
Total mark		22

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