



RECOGNISING ACHIEVEMENT

Mark Scheme 2854
June 2003

1	(a)	(i)	Crude oil / oil/ petroleum (oil);	1
		(ii)	Impurity binds to / bonds to / attaches to / reacts with / is adsorbed on catalyst surface; (not absorbed) prevents reactants reaching catalyst surface / blocks active sites/reduces active area/makes catalyst inactive (or wtte);	2
	(b)		Surface / active area of the catalyst; is reduced;	2
	(c)	(i)	Formation of methanol / forward reaction is <u>exothermic</u> ; Cooling shifts equilibrium in favour / direction of the exothermic change; (thus) increasing the yield; (or reverse argument)	3
		(ii)	$K_p = \frac{p_{\text{CH}_3\text{OH}} \times p_{\text{H}_2\text{O}}}{p_{\text{CO}_2} \times p_{\text{H}_2^3}}$ (1 for top; 1 for bottom;) (Wrong way up OR square brackets [even if Kp used] scores 1) (correct expression for <i>equation 1.1</i> scores 1)	2
		(iii)	Higher yield / shifts equilibrium to the right; faster / higher rate;	2
		(iv)	Lower energy requirements/high pressure costly to create or maintain/stronger plant required/thick-walled pipes or plant required/more health and safety systems required;	1
	(d)	(i)	$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$ correct equation; correct state symbols;	2
		(ii)	25-250 atm; 400 to 500 °C / 650K to 800K; iron or rhenium catalyst; (allow any temperature range within the stated range)	3
	(e)		$2\text{KHCO}_3(\text{aq}) \rightarrow \text{K}_2\text{CO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ formulae of reactant and products correct; balanced; (ignore state symbols)	2

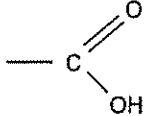
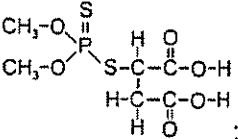

[Total: 20]

2	(a)	(i)	$\begin{array}{ccccccc} \text{H} & \times & \text{C} & \begin{array}{l} \times\text{O} \\ \times\text{O} \\ \times\text{O} \end{array} & \text{C} & \times & \text{H} \end{array}$ <p>triple bond; rest of molecule; (allow same symbol [o or x] throughout)</p>	2
		(ii)	Two regions of electrons / electron density / negative charge / bonds around each carbon atom; <u>repel</u> as far apart as possible / to a position where minimum repulsion exists / get as far away from each other as possible;	2
	(b)	(i)	Electrons are not localised / located / placed between / bonded to / fixed between / (all) carbon atoms (stated or implied); spread out (evenly) / free to move along the carbon chain / between carbon atoms;	2
		(ii)	Ignore everything outside visible spectrum Maximum absorption in red-orange region :- 2 marks some absorption in the red-orange region :- 1 mark	2
		(iii)	NO CHOICE POINTS: reference to <u>energy levels</u> / <u>energy states</u> ; <u>electrons need/absorb energy/light</u> to be excited/to move to higher energy levels; <u>absorbed</u> from visible light / radiation in visible spectrum; <u>complementary colour transmitted/reflected</u> ; (emitted disqualifies this mark) (allow "if blue absorbed, red reflected" or reverse argument) THEN 2 FROM: absorption in visible region because excitation energy in poly(ethyne) is low; difference in energy gap (between cis and trans forms); cis form has greater gap / excitation energy of cis form is higher; (greater gap corresponds to) blue light/radiation or light of higher energy/frequency/lower wavelength; (or reverse argument)	6
	(c)		EITHER: add functional group / side chain; example (eg NH ₂ , OH, SO ₃ H) / to change the conjugation OR: add more double bonds; to extend the conjugation/conjugated system; OR: change orientation of benzene ring/position of side chains; to 1:2 or 1:3; OR: change configuration of C=C; to make the cis form; (NB: two first 'general points' can gain 2 marks)	2

[Total: 16]

3	(a)	<p>Ca^{2+}; <u>surrounded by at least 3 water molecules</u>; at least one water molecule showing oxygen carrying δ^-; δ^- /oxygen adjacent to the metal ion; (representation of water molecule by a triangle allowed provided a key is added, showing what it represents : no key but δ^- shown in correct place loses the third marking point)</p>	4
	(b)		
	(i)	calcium ion has the higher charge density;; (ie 2 marks) OR small ion; high charge;	2
	(ii)	hydrated ion is bigger because it has more water molecules in it; hydrated ion has lower charge density;	2
	(c)		
	(i)	Ammonium ions attracted to the <u>negatively-charged</u> clay / soil; .. nitrate ions are negatively charged / are repelled by the clay;	2
	(ii)	-3; +5; (a sign is essential) (3- and 5+ earns one mark)	2
	(iii)	Hydrogen ions / protons released/formed; H^+ causes acidity / acid is proton donor; H_3O^+ is more acidic than NH_4^+ earns 2 marks	2
	(iv)	2 from: higher concentration of $\text{H}^+(\text{aq})$; hydrogen ions displace calcium ions; hydrogen ions have a greater affinity for the clay;	2
	(d)	products: all of Ca^{2+} , H_2O , CO_2 and no other component; balanced: $\text{CaCO}_3(\text{s}) + 2\text{H}_3\text{O}^+ \rightarrow \text{Ca}^{2+}(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$; state symbols; (allow state symbol mark if equation is wrong but substances are 'real')	3
	(e)		
	(i)	$\text{pH} = -\log[\text{H}^+(\text{aq})]$ (stated or implied); $\text{pH} = 6 - \log 2.5 / 0.4$ $= 5.6$; (allow 5.6 or 5.60 or 5.602)	2
	(ii)	$\text{SO}_x / \text{SO}_2 / \text{NO}_x / \text{NO}_2 / \text{H}_2\text{SO}_4$; more dissolved;	2

[Total: 23]

4	(a)	(i)	<p>Compound A: one carboxylic acid group shown:</p>  <p>CO₂H / COOH / CO₂⁻ and appropriate cation; rest correct, ie</p>  <p>Compound B: C₂H₅OH / CH₃.CH₂.OH / full structural formula;</p>	3
		(ii)	Ethanol; (allow ecf from (a)(i))	1
		(iii)	Reflux; with aqueous or dilute or moderately concentrated acid / H ⁺ / OH ⁻ / alkali / H ₂ SO ₄ / HCl / H ₃ PO ₄ / NaOH / Na ₂ CO ₃	2
	(b)		<p>NO CHOICE POINTS: water molecules linked by hydrogen bonds/IMF in water are hydrogen bonds; hydrogen bonds are strong; octan-1-ol forms weaker IMF with water; IMF between octan-1-ol and water not sufficiently strong to overcome IMF/hydrogen bonds between water molecules; AND THREE FROM: structure / formula of octan-1-ol: C₈H₁₇OH /  / full structural formula; hydrogen bonds are formed between O in one molecule and H in another; hydrogen bonds are formed because of the difference of electronegativity between hydrogen and oxygen; octan-1-ol is less polar than water; an effect of carbon chain;</p> <p>QWC for scientific and technical terms: at least two complete sentences containing TWO of polar, intermolecular forces, hydrogen bonds, electronegativity</p>	7 + 1
	(c)		Parathion more soluble in octan-1-ol than in water; because it cannot form strong hydrogen bonds with water / can form id-id or pd-pd intermolecular forces with octan-1-ol OR because Parathion is more soluble in fats OR octan-1-ol has low polarity or is non-polar; (Thus) concentration of Parathion in octan-1-ol is greater than the concentration in water;	3

[Total: 17]

5	(a)	(i)	Number of moles of Ag^+ = $\frac{24.7 \times 0.05}{1000}$ = 1.235×10^{-3} or 1.24×10^{-3}	1
		(ii)	Number of moles of $\text{NaCl} \equiv$ Number of moles of Ag^+ = 1.235×10^{-3} (allow ecf)	1
		(iii)	Moles of chloride ion in 1 dm^3 = $1.235 \times 10^{-3} / 0.01 = 0.1235$; (ecf applies) Concentration = 0.1235×35.5 ; = 4.38 g dm^{-3} ; (sig fig rule to apply) (accept 4.40 if (a)(i) is 1.24×10^{-3}) (4.4 :- 2 max) (if (a)(i) gives 1.2×10^{-3} , 4.3 is necessary to earn the sig fig mark) (even if wrong answer shown but if sig fig correct - 1 mark)	3
	(b)	(i)	$K_{sp} = [\text{Ag}^+][\text{Cl}^-]$; (penalise wrong state symbols)	1
		(ii)	Concentration of Ag^+ = $\frac{0.1 \times 0.01}{0.2} = 5 \times 10^{-3} \text{ (mol dm}^{-3}\text{)}$; Concentration of Cl^- = $\frac{0.1 \times 0.001}{0.2} = 5 \times 10^{-4} \text{ (mol dm}^{-3}\text{)}$; $[\text{Ag}^+] \times [\text{Cl}^-] = 2.5 \times 10^{-6}$; which is greater than K_{sp} Therefore a precipitate formed; (has to be a reason to gain this mark : ecf can apply)	4
	(c)	(i)	(aq) and (aq) \rightarrow (s) and (aq) / a solid is formed; system becomes more ordered / solid has lower entropy / decrease in entropy / solid is more ordered;	2
		(ii)	Reaction spontaneous / "goes" / takes place; hence ΔS_{total} must be positive; Therefore ΔS_{surT} must be positive because ΔS_{sys} is negative;	3

[Total: 15]

6	(a)	(i)	3 from: ester; ether / methoxy-; alkene; arene / benzene ring;	3
		(ii)	Eugenol has a phenol / phenolic -OH group; add (neutral) iron(III) chloride solution / acid-base indicator; turns purple / takes up the acidic colour;	3
		(iii)	EITHER: (Anhydrous) ethanoyl chloride; room temperature; OR: ethanoic anhydride; reflux with concentrated sulphuric acid;	2
		(iv)	Esterification / condensation / <u>nucleophilic substitution</u> / acylation / ethanoylation;	1
	(b)	(i)	5 from: vanillin is more soluble in hot water than cold; vanillin crystallises when the hot solution cools; because the solution becomes saturated / amount / concentration in solution exceeds the solubility; impurities remain in solution or can be filtered; vanillin is highly soluble in ethanol at both high and low temperatures / at all temperatures; would not crystallise on cooling; QWC for spelling, grammar and punctuation: at least TWO complete and relevant sentences containing NO MORE THAN ONE spelling, punctuation or grammatical errors.	5 + 1
	(c)	(i)	Structural / position(al) isomerism;	1
		(ii)	Molecule of Y has a different shape; does not fit the same receptor / fits different receptors / active sites;	2
		(iii)	distillation / chromatography / fractional crystallisation / molecular sieve; (NOT crystallisation)	1
	(d)	(i)	7 points for vanillin (ora): (6 max if appropriate arguments applied to wrong compound) vanillin contains aldehyde group; infra-red : vanillin shows a peak at 1680-1750/1670-1690; because of C=O bond; nmr: peak at 10/9.8/9.7 (NOT 9.5); due to <u>proton/hydrogen</u> in CHO group; proton ratio in vanillin is 1:3:3:1 / proton ratio in guaiacol is 3:4:1; (therefore) 4 peaks in vanillin spectrum / 3 peaks in guaiacol spectrum; smaller peak at 7.2/7.5 in vanillin; due to fewer aryl hydrogens / protons; QWC: Logical presentation of evidence: at least two logical statements (ie of the sort <i>evidence, therefore conclusion</i>) (table/bullet points allowed);	7 + 1
		(ii)	C ₈ H ₈ O ₃ ;	1
		(iii)	Molecular (ion) peak / highest mass peak at 152;	1

[Total: 29]