OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY B (SALTERS) F335 MS

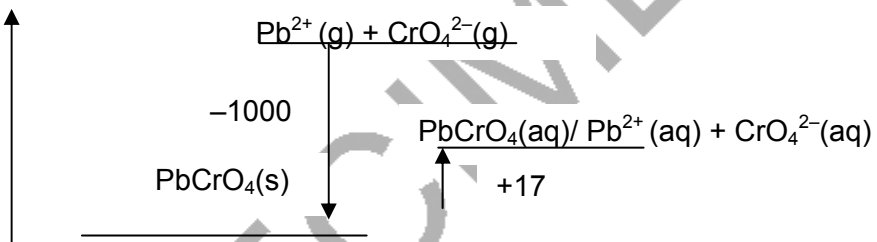
Unit F335: *Chemistry by Design*

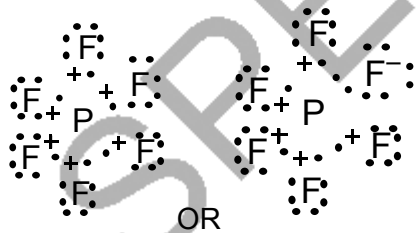
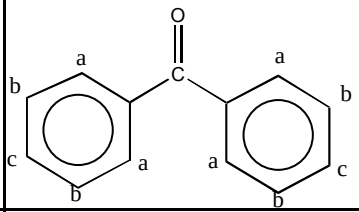
Specimen Mark Scheme

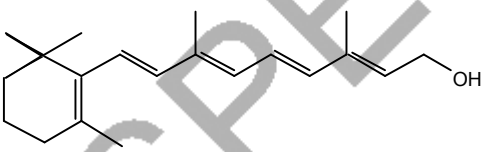
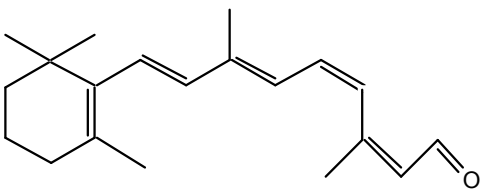
The maximum mark for this paper is **120**.

This document consists of **8** printed pages.

Question Number	Answer	Max Mark
1(a)(i)	Air allow atmosphere	[1]
(ii)	M_r NH_4NO_3 = 80(.0) (1); % = 28 x 100/80 = 35(.0) % (1)	[2]
(iii)	$(NH_4)_2SO_4$	[1]
(iv)	Advantage: provide nutrients/ return nitrogen to soil/ make plants grow (1); Disadvantage: washed away/ eutrophication (AW)/ waste of resources	[2]
(b)(i)	$[H_2]3$ x $[CO]$/ $[H_2O]$ x $[CH_4]$ (2) award (1) if one error (except addition, scores zero)	[2]
(ii)	292 x 5 x 5/1728 = 4.22 (2) ecf from 1bi (unless addition); award (1) if one error; 3sf scores (1) independently, provided some correct calculation shown.	[3]
(c)(i)	higher yield (1); more molecules on right than left (1); equilibrium position moves in direction of higher pressure (AW) (1) NB firming up on equilibrium position	[3]
(ii)	(compromise) with rate (of setting up equilibrium)	[1]
(d)(i)	$CO + H_2O \rightarrow CO_2 + H_2$	[1]
(ii)	two from: toxic gas; can be burnt as a fuel; produces more hydrogen	[2]
(e)(i)	positive because more (gas) molecules on right (1)	[1]
(ii)	393 + 198 – 189 – 186 = +216 (1) for products – reactants; (1) for 3 x 131; (1) for sign with ecf from a calculation shown	[3]
(iii)	–1784 = +216 – $\Delta H/T$, thus ΔH = +1 x 10^6 (J mol^{-1})(1) ΔS = +216 – ΔH *value*/1000 = –784 J K^{-1} mol^{-1}(1)	[2]
	Total	[24]

Question Number	Answer	Max Mark
2(a)	(6) is the oxidation state/number of the <u>chromium</u>	**[1]**
(b)	$Pb^{2+}(aq) + CrO_4^{2-}(aq) \rightarrow PbCrO_4(s)$ (1) for correct equation (1) for correct state symbols *provided equation shows ions forming compound* or *correct full equation for lead nitrate and sodium chromate.*	**[2]**
(c)	C (1); it reflects in the yellow/ yellow light is in centre of spectrum/ around 600 nm (1)	**[2]**
(d)(i)	3d	**[1]**
(ii)	the (presence of the) ligands (at different orientations to the orbitals)	**[1]**
(e)(i)	iron(III) oxide *ignore gaps*	**[1]**
(ii)	diagram with minimum three levels, getting closer at higher energy (1); *allow from diagram or written account:* levels are electron energy levels (1); electron falling emits light (1); *only award if in terms of energy levels* frequency depends on <u>gap</u> between energy levels/ (Δ)$E = hv$ (1)	**[4]**
(iii)	Cd (1); cadmium(II) sulfide (1); *allow cadmium sulfide*	**[2]**
(f)(i)	 solution enthalpy above solid and correctly labelled (1); top line in place and correctly labelled (1); numbers in correct places (1)	**[3]**
(ii)	–983 (1) *sign essential*	**[1]**
(iii)	broken: ionic (bonds) in lattice (1); hydrogen bonds in water (1); made: ion-dipole bonds (1); QWC - *do not award mark for first spelling error in bond description* bonds broken stronger than bonds made (AW) (1)	**[4]**
	Total	**[22]**
3(a)(i)	–C=O | Cl	**[1]**
(ii)	electrophilic (1); substitution (1) *mark separately*	**[2]**
(b)	shape: regular hexagon/ flat/ all bonds equal length (1); properties: no/few addition reactions/ substitution reactions (1)	**[2]**

Question Number	Answer	Max Mark
(c)	<u>electrons</u> are excited/ move to higher energy levels (1); freqency absorbed depends on energy level <u>gap</u>/ (∆)E = hv (1) frequency/ energy of uv > visible (1); to be coloured must absorb in visible (1) ✎ QWC mark and one from: needs more delocalisation to absorb in visible (AW) (1) transmits/reflects complementary colour	**[5]**
(d)	two marks for any correct pair (*mark for pollutant can be scored alone but NOT effect*) aluminium (compounds); forms toxic waste; HCl; toxic aluminium (compounds); wasted benzene; toxic/ carcinogenic	**[4]**
(e)(i)	an ionic substance that has a low enough melting point to be a liquid at room temperature	**[1]**
(ii)	M_r values C_6H_6 = 78, benzophenone = 182 (1); mass = 182 x 10/78 = 23/23.3 kg (1)	**[2]**
(iii)	FW of all atoms utilised/FW of all atoms used (1) *stated or implied* % atom economy = 182 x 100/(140.5 + 78) = 83(.3) % (1)	**[2]**
(iv)	catalyst/solvent recycled (1); no disposal of toxic products as with $AlCl_3$ (1) high atom economy (1); high percentage yield (1)	**[4]**
(v)	 OR 16 electrons round P (1); rest correct (1) octahedral(1) *ignore – sign*	**[3]**
(f)(i)	C=O at 1650/ C–H at 3000 (1)	**[1]**
(ii)	 all ten protons labelled in some way (1) correct letters (a,b,c in any order) (1) *score (1) if on one ring only*	**[2]**
4(a)(i)	alcohol/ hydroxy(l); carboxylic acid	**[2]**
(ii)	4-hydroxy (1); butanoic acid (1)	**[2]**
(b)(i)	ester /lactone	**[1]**
(ii)	hydrolysis	**[1]**
(c)(i)	circle round all except =O	**[1]**

Question Number	Answer	Max Mark
(ii)	–OH groups (1); hydrogen bond (1); indication that both molecules have same shape/ fit receptor site (1)	**[3]**
(d)(i)	computer modelling	**[1]**
(ii)	*two from:* no suitable alternatives; good sleeping pill – with reason, eg few side-effects; more stringent controls on release of GHB; beneficial uses outweigh problems (1)	**[2]**
(e)(i)	HA $\rightleftharpoons$ H^+ + A^- (*allow reaction with water to produce* H_3O^+)	**[1]**
(ii)	A^- is the conjugate base of HA (1); related by loss of proton (1)	**[2]**
(iii)	$[H^+] \times [A^-]/ [HA]$	**[1]**
(iv)	$[H^+] = 1.26 \times 10^{-3}$ mol dm^{-3} *stated or implied, units not essential* (1); $[A^-] = [H^+]$ stated or implied (1); $K_a = (1.26 \times 10^{-3})^2/10^{-1} = 1.59/1.58/1.6 \times 10^{-5}$ (1) mol dm^{-3} (1) *mark separately*	**[4]**
(v)	[HA] initial = [HA] at equilibrium (AW)/ $[A^-] = [H^+]$	**[1]**
(f)	minimises/resists change in (allow maintains) pH/ pH stays approximately constant(1) when <u>small amounts</u> (1); of <u>acid or alkali</u> added (1); need to maintain pH in body (1); e.g. for enzyme reactions/ blood (1)	**[5]**
(ii)	$[H^+] = K_a$ *stated or implied* (1); pH = –log (1.59×10^{-5}) = 4.8 *ignore sf* (1);	**[2]**
5(a)(i)	$C_{20}H_{28}O$ (1)	**[1]**
(ii)	 –OH (1) correct arrangements of bonds (1)	**[2]**
(ii)	alkene	**[1]**
(b)(i)	acidified/named acid/H^+ (1); (potassium/sodium) dicromate/ $Cr_2O_7^{2-}$ (1); <u>distil</u> (1)	**[3]**
(ii)	5	**[1]**
(c)(i)	 idea of *cis* (1); correct arrangement of bonds (1)	**[2]**
(ii)	lack of free rotation in C=C bonds	**[1]**
(d)(i)	amine	**[1]**
(ii)	nucleophilic (1); addition (1)	**[2]**

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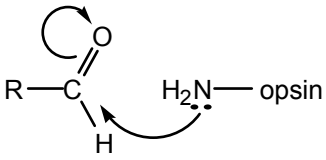
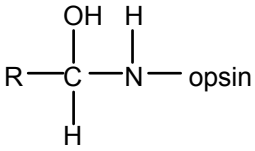
(iii)		[1]
(iv)		[1]
	Total	**[16]**
	Paper Total	**[120]**