RECOGNISING ACHIEVEMENT

GCE

Chemistry (Salters)

Advanced GCE **A2 7887**

Advanced Subsidiary GCE **AS 3887**

Combined Mark Schemes and Reports on the Units

June 2005

3887/7887/MS/R/05

Oxford Cambridge and RSA Examinations

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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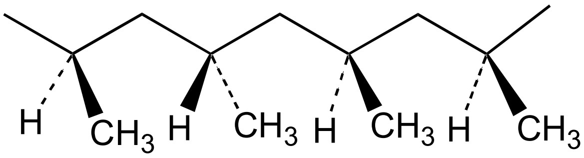
Mark Scheme 2848
June 2005

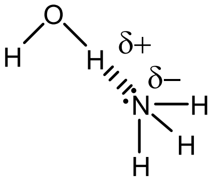
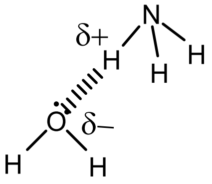
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ____ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument

Mark Scheme	**Unit Code**	**Session**	**Year**	**Version**
	2848	**Jun**	**2005**	**Final**

Question	**Expected Answers**	**Marks**
1 a i	rock/earth/gangue/silicates/soil/unwanted minerals *Not waste/impurities/dust*	1
1 a ii	$PbS + 1.5O_2 \rightarrow PbO + SO_2$ (*or doubled*) species (1); balancing (1)	2
1 a iii	lead(II) oxide	1
1 b	M_r PbS = 239 *stated or implied* (1); 58 x 207/239 *ecf* = 50.23% (1) Answer to 2sf = 50 (1) (allow 2sf for any number 40 – 60)	3
1 c i	silver *NOT Ag*	1
1 c ii	0.01% impurity (1); x 10^4 = 100 ppm(1)	2
1 d i	0, +3 *NOT 3+*	2
1 d ii	redox	1
1 d iii	hydrogen is flammable/explosive (1); no sources of ignition/sparks/flames (AW) or alternative suitable industrial precaution (1) *or* antimony (compounds) toxic (1); avoid breathing dust (AW) or wear gloves (1) **precaution linked to hazard**	2
1 d iv	$6p^2$ 6(1) p^2(1) *mark separately*	2
1 d v	p (block) *Allow "P"*	1
1 d vi	+5 ; *ACCEPT 5+ IF 3+ not awarded in 1(d)(i) allow -3; if mark not awarded in (d)(i) then allow +3;* Group or period comparisons (1) [*Other numbers (e.g. nitrogen oxidation states) can score ONLY if justified]*	2
1 e	funnel connected without leaks to side-arm flask (1); lead shown on filter paper in funnel (1) Any label in a sensible place from vacuum/ pump/buchner funnel/side arm flask/buchner flask (1). *Not filter paper*	3
		23

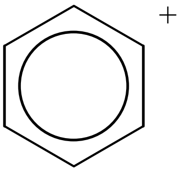
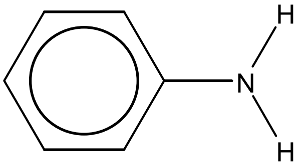
2 a i	chlorofluorocarbon *ALLOW small spelling errors if meaning is clear*	1
2 a ii	any saturated carbon compound with chlorine and fluorine only	1
2 a iii	*two from:* aerosol (propellants); blowing agents; cleaning agents; refrigerants (aw); coolant in air conditioning units; fire extinguishers	2
2 a iv	2 from in the stratosphere/upper atmosphere (1); uv light (1); causes break down/photodissociation / homolytic fission (1); Plus to chlorine atoms/chlorine radicals/ Cl (1); these catalyse the breakdown of ozone (aw) (1) QWC: two sentences; spelling (*1 error allowed*), punctuation and grammar correct	4 1
2 b i	δ+ on carbon, δ– on fluorine(s) (1)	1
2 b ii	mention of electronegativity or explanation (1); comparison of <u>fluorine</u> and <u>carbon</u>(1)	2
2 b iii	Yes, the charges/dipoles do not balance (1); shape is tetrahedral (1)	2
2 c i	uv/radiation (1); does not have high enough energy/ does not have high enough frequency (1) *REJECT for second mark answers which imply intensity of radiation* **"C–F is strong/stronger than C–Cl" scores (1) only if no other mark awarded**	2
2 c ii	$467/6.02 \times 10^{23}$ (1) $\times 1000 = 7.75(7)/7.76 \times 10^{-19}$ J (1)	2
2 c iii	7.757×10^{-19} *ecf*/6.63×10^{-34} (1) = 1.17×10^{15} (1) Hz or s^{-1}(1)	3
2 c iv	homolytic (fission) (*ignore photodissociation)*	1
2 d	uv/visible/<u>near</u> ir (from sun) (1) *not sunlight* (warms) the <u>Earth</u> which radiates ir (1) NOT reflects this increases (1) <u>vibrational</u> energy of the <u>bond</u>s (1) QWC: Two sentences, logical, correct use in context of at least three terms below: uv; visible; ir; radiates; radiation; bonds; vibrate	4 1
		27

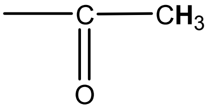
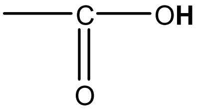
3 a	CH_3CHCH_2 *or more fully structured*	1
3 b i	organometallics/Al joined to an organic molecule	1
3 b ii	poly(ethene)/ldpe/hdpe/conducting polymers/poly(ethyne)/Teflon	1
3 c i	*e.g.*  1, 2 or 3 carbons changed from original	1
3 c ii	instantaneous (dipole) – induced dipole Van der Waals *allow small spelling errors*	1
3 c iii	*two from:* its structure is more organised/(stereo)regular (1); fits/packs together closer/ more points of contact (1); stronger imfs *(not bonds)* hold the chain in position (allow more in this context) (1)	2
3 c iv	the chains move over each other less easily (1) stronger imf (allow more)(1)	2
3 d i	brown/orange/yellow (1); colourless (*NOT clear*) (1)	2
3 d ii	(partially) positively charged/electron deficient reagent/attracted to areas of high electron density (1) ; bonds by accepting a pair of electrons (can be shown via mechanism) (1); two molecules react to form <u>one</u> product (aw) (1) (*accept <u>correct</u> explanation of mechanism)*	3
3 e i	HBr/hydrogen bromide/hydrobromic acid	1
3 e ii	2-bromopropane *ignore commas, dashes and spaces*	1
3 e iii	secondary	1
3 e iv	elimination	1
3 f i	NaOH (1); aqueous *depends on first mark* (1); (just “water” / aqueous OH^- scores 1) reflux *only if any mention of above* (1)	3
3 f ii	more collisions <u>per unit time</u> (allow more frequent collisions)	1
3 f iii	1 from molecules have more kinetic energy or more speed (1); more particles *(not atoms)* collide (1); plus with energy greater than <u>activation energy</u> (1)	2
		24

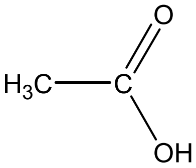
4 a	nitrogen/N	1
4 b	at least three bent water molecules (1) ; *(can be* ∧ *or triangle)* 2 x H and 1 x O with the O facing the ion (1); δ+ on at least one H, δ– on at least one O (1)	3
4 c i	H^+ (is acidic)	1
4 c ii	NH_3 / H_2O	1
4 d i	**N**: (very) electronegative N atom/ lone pair on the nitrogen (1); **H**: a delta positive H / H attached to a more electronegative atom(1)	2
4 d ii	 or  correct atoms hydrogen bonded with a dashed/dotted line (1); lone pair on relevant N or O (1); partial charges shown for relevant atoms (1) *N–H–O straight NOT required*	3
4 e i	(graduated/volumetric) pipette *ALLOW burette*	1
4 e ii	Use indicator/pH probe	1
4 f	concentration of $(NH_4)_2SO_4$ = 0.01 mol dm^{-3} (*half* $[NH_4^+]$) (1); M_r $(NH_4)_2SO_4$ = 132 (*stated or implied*) (1); concentration = molarity x M_r = 1.3(2) g dm^{-3} (1) 2.6(4) scores (2) overall.	3
		16

Mark Scheme 2849
June 2005

Mark Scheme	Unit Code 2849	Session June	Year 2005	FINAL

Question	Expected answers	Marks
1 (a) (i)	(Secondary) amide (1).	1
1 (a) (ii)	Ethanoyl chloride (CH_3COCl) / ethanoic anhydride ($(CH_3CO)_2O$) (1).	1
1 (b) (i)	93 (1).	1
1 (b) (ii)	16 (1) *ecf for 92 then 15.*	1
1 (b) (iii)	NH_2 (1) *ecf* CH_3*.*	1
1 (b) (iv)	$C_6H_5^+$ *allow*  *Correct structure/molecular formula for phenyl group (1);* *positive charge on structural formula (1).*	2
1 (b) (v)	 *NH_2 group on molecule (1);* *phenyl group (1).*	2
1 (b) (vi)	Amino group (NH_2) reacts with/accepts H^+ ions/protons (1); Resulting ion attracts water molecules/salt formed is soluble / ion formed can interact with other species in solution (1).	2

<table>
<tr><td>1 (c)</td><td>
<table>
<tr><th>chemical shift</th><th>type of proton</th></tr>
<tr><td>2.1</td><td>
$-\underset{\underset{\displaystyle O}{\Vert}}{C}-C\mathbf{H}_3$</td></tr>
<tr><td>11.4</td><td>
$-\underset{\underset{\displaystyle O}{\Vert}}{C}-O\mathbf{H}$</td></tr>
</table>

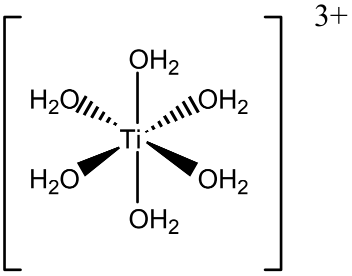
1 mark each for type of proton (2);

(1).</td><td>3</td></tr>
<tr><td>1 (d)</td><td>***One mark each for points in bold** and then any **three** others up to a total of 6 marks:*

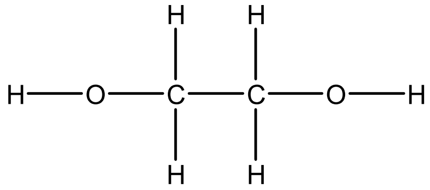
<u>Pencil</u> line near bottom;
of plate;
dissolve acetanilide in <u>ethanol</u>;
spot sample of mixture on line;
solvent in beaker below sample *not ethanol***;**
cover beaker (with lid/film);
leave until solvent front nears top of plate;
remove and dry plate;
(UV light or iodine) to locate *(use of locating agent)*;
use of a standard compound to identify acetanilide/ R_f values the same / spots the same height.

QWC
Award the mark if there is only one error in spelling, punctuation or grammar in **any two relevant sentences**.</td><td>6

1</td></tr>
<tr><td>1 (e)</td><td>*2 marking points from*

Synthesis (1);
modification of structure/change properties *e.g. solubility* /make more effective *e.g. increase time when effective* (1);
analysis/identification(1)
checking purity (1)
scaling-up processes (1)
formulation of preparation *e.g. tablets, solution, spray etc.* (1).
Do NOT allow testing alone or testing for safety etc. or on animals.</td><td>2</td></tr>
<tr><td></td><td>**Total mark**</td><td>**23**</td></tr>
</table>

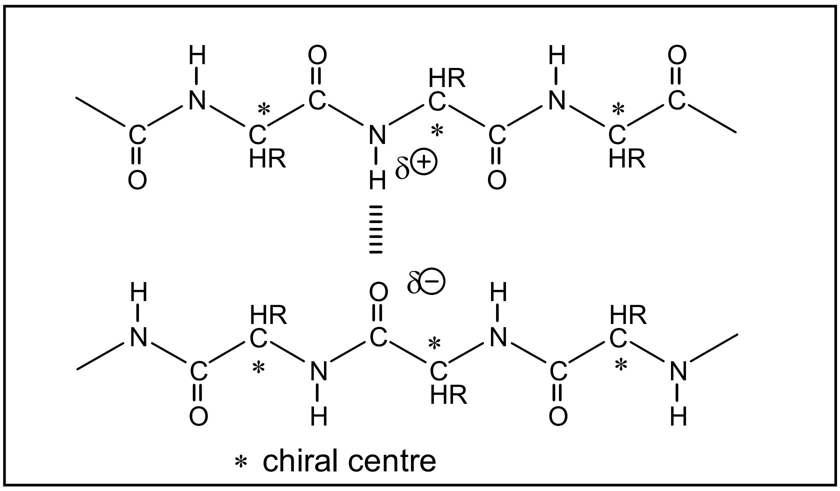
Question	**Expected answers**	**Marks**
2 (a)	Disrupts lattice/lattice less ordered AW (1). *Accept that layers in structure are no longer able to slide over one another as easily.*	1
2 (b) (i)	*Any* ***two*** *of the following* ***four*** *marking points:* Absorb light/in visible region (1); 3d energy shell/ energy levels split into 2 groups AW (1); electrons move up/promoted/excited to higher (energy) level (1); transmits (*or* reflects) the complementary colour/light not absorbed (1).	2
2 (b) (ii)	 6 water molecules around Ti in correct shape and charge correct (1); O shown bonded to Ti (1); octahedral shape (1).	3
2 (b) (iii)	Two different arrangements/isomers of ligands around central ion (1); show structures of the *cis* and *trans* isomers using diagrams/ describe the two isomers *e.g. chlorines may be adjacent or opposite or describe cis-trans isomers* (1).	2
2 (c) (i)	Mol dm^{-3} (1).	1
2 (c) (ii)	$1.300 \times 10^{-4} = [H^+(aq)]^2 / 0.010$ (1); $[H^+(aq)] = (1.3 \times 10^{-6})^{1/2}$ (1); $= 1.14 \times 10^{-3}$ *1 mark for answer if sig figs are correct .*	3
	Total mark	**12**

Question	Expected answers	Marks
3(a)	Full detail needed for 2 marks  $\mathrm{H{-}O{-}CH_2{-}CH_2{-}O{-}H}$ (2) Two –OH groups on C chain (1); correct C chain (1).	2
3 (b) (i)	1,6-diaminohexane (2); aminohexane/hexyldiamine (1); 1,6-di (1).	2
3 (b) (ii)	The two molecules add/react/join together and eliminate (1); a molecule of water (1).	2
3 (c)	**One mark for the point in bold** and then any **one** other: **Nylons have hydrogen bonding between the chains/nylons can hydrogen bond to polyester chains** (1); hydrogen bonding is much stronger than (permanent dipole-permanent dipole) forces between polyester chains AW (1); greater energy/force will be needed to separate polymer chains in nylons (1).	2
3 (d) (i)	*Burning:* no solid waste (which is expensive to dispose of) / no landfill needed / energy recycled (1); *burying:* no environmental issues with gas emissions from burning AW /non-biodegradable therefore no threat to environment AW (1).	2
3 (d) (ii)	(Heat under) reflux (1); (moderately concentrated) hydrochloric acid or sodium hydroxide *(accept sulphuric acid)* (1).	2
3 (d) (iii)	$BrO_3^-(aq) + 6H^+(aq) + 5Br^-(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$ correct chemical species (1); balanced may be x2 (1). *Ignore state symbols.*	2
3 (e)	*Any **four** of the following five marking points:* Dilute bromine solution to make a range of concentrations (1); select suitable filter for colorimeter (1); zero colorimeter with water (1); measure absorbance/transmittance of each bromine sample (1); plot absorbance/transmittance against concentration (1).	4

<table>
<tr><th>Question</th><th>Expected answers</th><th>Marks</th></tr>
<tr><td>3 (f) (i)</td><td><table><tr><th>reactant</th><th>order</th></tr><tr><td>bromide ion, Br^-</td><td>1</td></tr><tr><td>bromate ion, BrO_3^-</td><td>1</td></tr><tr><td>acid, H^+</td><td>2</td></tr></table>1 mark for each order correct (3).</td><td>3</td></tr>
<tr><td>3 (f) (ii)</td><td>Rate = $k \times [Br^-(aq)] \times [BrO_3^-(aq)] \times [H^+(aq)]^2$ (1) <i>ignore state symbols and note any ecf from f(i).</i>

$mol^{-3}\ dm^9\ s^{-1}$ <i>ecf</i> (1).</td><td>2</td></tr>
<tr><td colspan="2" align="right">Total mark</td><td>23</td></tr>
</table>

Question	**Expected answers**	**Marks**
4 (a) (i)	1.56 V (1) *ignore any sign*.	1
4 (a) (ii)	Non-standard conditions / not 1 mol dm^{-3} concentrations of correct ions / not 25 °C/incorrect ions in solution (1)	1
4 (a) (iii)	Zinc forms/goes into solution as zinc ions / Zn/Zn^{2+} has more negative electrode potential ora (1); electrons flow from zinc (into the wire)/Zn loses electrons (1).	2
4 (b)	(High resistance) voltmeter (*connected to metal electrodes*) (1); salt bridge (*dipping in both solutions*) (1); correct metal in solutions of correct ions (*in both half-cells*) (1); concentrations 1.0 mol dm^{-3} (1); temperature 25 °C/298 K (1).	5
4 (c)	$H_2 \rightarrow 2H^+ + 2e^-$ balanced equation, even if reverse direction (1); correct direction (1); $H \rightarrow H^+ + e^-$ 1 mark only.	2
4 (d)	$3s^2\ 3p^6\ 3d^{10}\ 4s^2$ (2); 20 electrons added (1); correct arrangement of orbitals, *allow if 3d written after 4s* (1). 3rd ionisation energy of Zn too high/too much energy needed to remove an electron from/break into 3rd shell AW (1)	3
	Total mark	**14**

Question	Expected answers	Marks
5 (a) (i)	 Bond correct (1) partial charges correct (1).	2
5 (a) (ii)	Mark any one chiral atom correct (*see above*) no mark awarded if a wrong atom is also marked (1); C atom is asymmetrical/bonded to four different atoms/groups (1).	2
5 (a) (iii)	(α-)helix (1); (β-) pleated/sheet (1).	2
5 (b)	*Any **two** marking points from the following:* Covalent/disulphide bridges/bonds (1); ionic (1); instantaneous dipole–induced dipole forces (1); permanent dipole–permanent dipole forces / permanent dipole–induced dipole forces (1).	2
5 (c) (i) 5 (c) (ii)	***One mark each for points in bold** and then any **three** others up to a total of 5 marks for both parts:* *Allow cross marking of points.* **c(i)** **Enzyme used to cut required gene** (1); from DNA of organism (1); plasmids/rings of DNA extracted from bacterial cells (1); enzyme used to cut plasmids (1); **c(ii)** **new gene spliced in using other enzymes** (1); modified plasmids replaced in bacterial cells (1); cells multiply in fermenter/ cultured (1); new gene causes synthesis of the required protein (1).	5
5 (d) (i)	Moderately concentrated acid/ HCl(aq) (1). *Do not allow dilute acid or sulphuric acid.*	1
5 (d) (ii)	Reaction mixture is boiled and vapours are cooled AW (EVAP & COND mark) (1) sealed top is a CON; liquid is returned to mixture / no loss of reactants or products AW (1).	2
5 (e)	Type of H atoms present AW (1); (relative) numbers of each type (1).	2
	Total mark	**18**

Mark Scheme 2850
June 2005

Abbreviations, annotations and conventions used in the Mark Scheme

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

Mark Scheme	Unit Code 2850	Session Jun	Year 2005	Version TL

1 a i	Protons = 82(1); Neutrons = 124(1); Electrons(allow ecf with protons) = 82(1)	3
1 a ii	234 and 4 top line (1); 90 and 2 bottom (1); ($^{4}_{2}$)α /He$^{(2+)}$ (1) No ecf. Not α^{2+}	3
1 a iii	Time taken(qualified) to decay(1) but NOT half the time taken(CON) for amount/ count rate to drop by half (from starting point)/ half radioactivity decays/half the atoms decay/half radiation emitted/ half radioactive nuclei decay/half mass of original isotope (1) (AW)	2
1 a iv	β /beta(1) correct symbol(with 0 and -1) OK but wrong way round CON	1
1 b	Gas escapes (1); less final lead isotope, decay has not been going on so long /U:Pb ratio greater/ (1)(Idea that loss of a daughter product seems to suggest radioactive decay has not been going on as long as it really has.)	2
1 c i	Correct labels (4 x 1)clockwise from – sample inlet; ionization chamber; ion detector; deflecting magnetic field	4
1 c ii	Reduce/weaken/lessened/decreased (AW) field	1
1 d	Moles of U 88.1/238 (1) (= 0.37); moles of O 11.9/16 (1) (= 0.74); Formula = UO_2 (1) NB UO_2 on its own 3 marks. U_2O can score two if ratio clearly shown to be upside down (UrO_2 = 2.) Any whole number ratio that follows from working can score 1.	3
	Question 1 total 19	

Question	Expected answers	Marks
2 a i	200 x 4.2 x 20(= 16800 J)(1);=16.8/17 kJ(1)(second mark for correct conversion to kJ) Ignore signs	2
2 a ii	1.2/12 (1) (= 0.1 mole); ecf 0.1 x 394(=39.4) (1) Ecf 39 (1) mark sig figs independently Ignore sign 39.4 scores 2	3
2 a iii	17/39 x 100 = (44)(43.6)% or 16.8/39(39.4) x 100 = 43(42.6)(1) ignore sig figs (Marking process *i.e.* actual/theoretical x 100) but correct answer needed from candidate values.	1
2 b	Nitrogen(& O_2) from air/fuel/coal(1); react with O_2 /combust/oxidized/bond with O_2 (1) (ignore refs. to incomplete combustion)	2
2 c i	**A = Unbranched** alkane; B = **unbranched** alkene; C = cycloalkane; D = **branched** alkane (4 x 1)	4
2 c ii	Skeletal (1)	1
2 c iii	Low/reduced tendency. NOT no/doesn't/prevents/ autoignit(e)ion (1); to autoignite/pre-ignite/knock (1) Can get max one mark if talk in terms of composition (more branched/shorter molecules)	2
2 d i	Benzene(1)	1
2 d ii	2-methylpentane(1)	1
2 d iii	Hydrogen/H_2 (not "H") (1)	1
	Total question 2 = 18	

3 a i	$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ LHS(1); RHS(1); appropriate states (1)	3
3 b i	Lime water/$Ca(OH)_2$ /suitable indicator (*e.g*. bicarbonate/Universal Indicator/Methyl Orange) (1)	1
3 b ii	Goes cloudy/milky/white/ precipitate/appropriate indicator change (1) NOT bubbles/murky	1
3 b iii	Idea of fair test (*e.g.* same amount/mass of carbonate/heating conditions (1); $MgCO_3$/it causes lime water/indicator to change quicker/ more gas in a given time/bubbles faster (1) ORA must be an <u>input</u> variable for fair test	2
3 c i	Slaked lime more soluble/leached off more quickly (ora) (1)	1
3 c ii	Basic/alkaline/accepts H^+/pH > 7/contains OH^- /hydroxide <u>ions</u> NOT OH without – charge. (1)	1
3 c iii	$Ca(OH)_2(s) + \underline{2}HCl(aq) \rightarrow \underline{CaCl_{\underline{2}}}(aq)\ \underline{+\ 2H_{\underline{2}}O}(l)$ species(2 x 1); balancing(independent)(1)	3
3 d	2	1
3 e i	$Ca(g) \rightarrow Ca^+(g) + e^-$ (1 for correct ionisation); $Ca^+(g) \rightarrow Ca^{2+}(g) + e^-$ (1 for correct ionisation); gaseous (in both) ecf (1) Must be e^- but ignore 0 and -1 if correct way round. Use of wrong elemental (*e.g.* 'X') symbol loses first mark, but then ecf	3
3 e ii	Ionization enthalpies decrease down group/ease of ion formation increases(1) More reactive down the group (1); electrons held less tightly/lost more readily/less energy to remove (1); more energy/electron shells/<u>outer</u> electrons further out (AW)(1); attraction to nucleus /protons(AW) (1); <u>more</u> shielding (from inner shells) (1) ORA	6
	Total question 3 = 22	

Question	Expected Answers	Marks
4 a i	Full structural (1) must show **all** bonds	1
4 a ii	$C_3H_8O_2$ any order (1) NOT discrete OH groups	1
4 a iii	Greater/increases (1); more ways to arrange molecules/particles/increased disorder/ more random when mixed (1) NOT more molecules/particles	2
4 b (i)	Speeds up reaction (1); NOT alters By offering an alternative pathway/lower E_A/catalyst unchanged(1); Heterogeneous – in different phases/states (1);	3
4 b ii	3	1
4 b (iii)	Ether/alkoxy (1)	1
4 b iv	109º (+/_ 2) (1); Then 2 out of 3 from…………….. Four electron regions/pairs of electrons (1) NOT bonds try to get as far away as possible /achieve lowest energy/minimize repulsion (1); NOT repel as much as possible. results in a tetrahedral arrangement (1); Diagram could score this point.	3
4 c i	Liquid (1)	1
4 c ii	-109 scores three; +109 scores two with correct working; 109 scores two if working shows minus sign has been left off but only one if working would lead to a plus; any number other than 109 can score max 1 if sign follows from working	3
	Total question 4 = 16	

(Paper total 75)

Mark Scheme 2852/01
June 2005

Explain, giving examples from the articles, what is meant by oxidation and show how oxidation reactions are important in causing explosions and outline reasons why some explosive mixtures oxidise faster than others.

1. *Oxidation*

(a) *definition*: oxidation is **gain of oxygen / electron loss / oxidation numbers increase**; [1]

(b) *example* of oxidation reaction showing **change in oxidation number** *e.g.* **carbon** or **sulphur** goes from **0 to +4** when oxidised (words or equation) [1]

2. *Oxidisers in explosives*

(a) use of an **oxidiser** makes a **faster reaction**; [1]

(b) An explosive (or named example) **carries its own oxygen supply**; [1]

(c) the **greater** the **extent of nitration / number of oxygens** available in molecule, the faster the reaction / better the explosive [1]

Give an account of the development of chemical compounds used in explosives. Describe the advantages of each new chemical explosive over its predecessors, and describe how the explosives were adapted to make them safer and more effective.

3. *Chemical compounds*

(a) **Gunpowder / black powder** is a mixture of carbon, sulphur and potassium nitrate AND **KNO_3** is the **oxidiser** [1]

(b) **cellulose nitrate** (gun cotton) made by reacting **cotton / cellulose** with **conc. sulphuric and nitric acids**; **AND nitroglycerine** by warming **glycerine** with **conc. nitric (and sulphuric acids)**; [**BOTH** needed – if scored from equation do not allow equation mark] [1]

(c) in these reactions, **hydroxyl** groups (OH) are converted to **nitrate** groups (NO_3) **OR** the reaction is **nitration** (clear statement) [1]

(d) **TNT** contains **nitro** (NO_2) groups rather than **nitrate** (NO_3) groups (clearly stated) [1]

Discuss, with reference to high and low explosives, the ideal features of an explosive reaction. Explain, using examples, how chemical reactions produce energy and how they cause increases in pressure.

4. *Features of an explosive reaction*

(a) explosive reactions must be **exothermic**; [1]

(b) must take place (very) **quickly** AND produce **gaseous products** [1]

5. *How chemical reactions produce energy*

(a) heat of explosion depends on the **amount of energy evolved** and depends on energy changes in **making and breaking bonds**; [1]

(b) for an exothermic reaction, **energy taken in to break bonds is less than energy given out when bonds are formed** (can be shown by calculation). [1]

(c) The **greater the difference** between energy formed and energy taken in, the **greater the energy of explosion** (OWTTE) [1]

6. How reactions increase pressure

(a) reactants are **solid** / **liquid** / **have a small volume** AND products are **hot gases**; [1]

(b) reactions take place in **confined space** which leads to rapid increase in **pressure** [1]

(c) the pressure increase depends on the **number of moles of gases formed** AND use of example [1]

Describe how UK methods of manufacture of propanone have changed since the beginning of the First World War.

7. Manufacture of propanone

(a) **TWO FROM**: propanone originally made by **dry distillation of wood**; then **bacterial fermentation of maize** was developed; followed by process using **conkers** any 2 [1]

(b) post-War propanone made by **reaction of propan-2-ol** (if scored from equation do not allow equation mark); [1]

(c) post-War process conditions: over **copper at 500 °C and 400 kPa**; (if scored from equation do not allow equation mark); [1]

(d) **reaction conditions** / **high temperature** / **pressure** / use of **catalyst** leads to **increased rate of reaction** [1]

8. Additional Chemical points ***(2 MAX)***

- (20%) oxygen in air limits rate of combustion;
- oxidation reactions are exothermic
- Examples of other oxidisers *e.g.* hydrogen peroxide, nitrogen peroxide and potassium chlorate
- Identifies difference between mixtures containing oxidisers *e.g.* gunpowder and molecules that contain high percentages of oxygen
- collodion is partially nitrated cellulose
- H_2SO_4 acts as a catalyst in nitration reactions
- description of cumene process reaction.

(23⇒ 14 max)

EVALUATION

Give an account of the development of chemical compounds used in explosives. Describe the advantages of each new chemical explosive over its predecessors, and describe how the explosives were adapted to make them safer and more effective.

9. Advantages of explosives

(a) gun powder / black powder caused **problems due to smoke**; plus **one named problem** from: poor visibility / shooting own men / unable to see enemy / unable to communicate / smoke gave away position [1]

(b) **cellulose nitrate** / **gun cotton / cordite** did not produce smoke; plus **one** named advantage from: detonates by percussion / allowed heavier missiles to be fired / no need for a fuse / larger quantities / explosive shells instead of cannon balls / bullets instead of musket balls [1]

10. Adaptations for safer, more effective explosions

(a) One example from: **barrels** can control **direction of explosion** / **finely divided powders** are used / **proportions of reactants** are measured exactly; [1]

(b) **nitroglycerine** was made safe by mixing with **kieselguhr** AND **did not explode until detonated** (clear statement); [1]

(c) **dynamite** detonators **used one explosion to start another**; [1]

(d) percussion **cap** ignites / detonates gunpowder **/** explosive [1]

(e) 'Dynamite 2' contains **nitroglycerine** with an **explosive mixture** instead of kieselguhr; [1]

Discuss, with reference to high and low explosives, the ideal features of an explosive reaction. Explain, using examples, how chemical reactions produce energy and how they cause increases in pressure.

11. *High and low explosives*

(a) The **rate of energy release** is **more important** than the **total energy output**; **plus example** TNT or Petrol [1]

(b) **gunpowder** or **cellulose nitrate** are **low** explosives AND**TNT** or **nitroglycerine** are **high** explosives [1]

(c) (high explosives give a **much bigger effect)** high explosives give pressure up to **275 000 atm**, low explosive **6000 atm** [1]

Describe how UK methods of manufacture of propanone have changed since the beginning of the First World War.

12. Reasons for change

(a) **PROCESS**: **one** from: post-War process uses **crude oil** as raw material / **bacterial fermentation** is a **much slower process** / **wood / conker process inefficient** / collecting plant material is difficult [1]

(b) **WAR**: **one** from **U-boats sinking ships** carrying maize / **maize** needed for **food**; [1]

Discuss how attitudes to health and safety in chemical research and industrial chemistry have changed over time. Use examples from the history of the development and manufacture of explosives and medicines.

13. Health and safety

(a) Experiments were **not under lab conditions** / experiments were carried out in **peoples' homes**; (ORA) [1]

(b) **no safety equipment** was used / **no safety rules** existed / no government regulations regarding **animal testing** / **drug testing** (ORA) [1]

(c) **TWO** examples: Schonbein **using wife's apron** to mop up spills; Sobrero **tasting chemicals**; giving unknown chemical to a **dog**; no goggles worn; Sobrero **injured by cut glass** any 2 points [1]

(d) chemicals handled in **factories** that **caused workers** to be ill; plus example nitroglycerine causes headaches / TNT causes headaches/skin allergies **one** example needed [1]

(e) **Nobel explosion** killed his brother; he had to carry out research on a **barge in a lake** / **away from homes**. [1]

14. Additional Evaluation points ***(Max 2)***

- Sources of glycerine have changed from by-product of soap manufacture to crude oil derivative.
- TNT does not react with metals / has a melting point of 81°C AND therefore can be used to fill metal shells by melting it
- fulminate of mercury, $Hg(CNO)_2$, is detonated by sharp blows and can be used as a detonator
- Blasting gelatine contains 7–8% collodion with nitroglycerine
- process of cordite manufacture
- mixture of petrol and air is explosive
- NG workers carried small amounts of NG to stop NG head / side effects

(19⇒ 12 max)

18 **Summary** Four relevant CHEMICAL points which summarise the content of the candidate's own response. [4 marks]

Possible marking points (1 mark for each) – any point from main chemical marking points plus…

- **chemical reaction or process** (*e.g*. oxidation, exothermic, nitration)
- **chemical definition** (*e.g*. oxidation)
- **chemical pattern** (*e.g*. greater oxygen content, greater rate of explosion)
- **feature** of a **chemical compound** or **reaction** (*e.g*. many explosive compounds contain nitrate groups / reactions produce hot gases)

other examples…

definition of oxidation
example of reaction involving oxidation
release of energy due to bond energies of reactants and products
pressure build up due to evolution of gases during reaction
many explosives made using reactions involving nitration / conc. nitric and sulphuric acid.
propanone manufactured by bacterial fermentation
propanone manufactured from propanol

21 **Good use of equations and structural formulae** [2 marks]

2 marks for 4 relevant and correct equations or structural formulae
1 mark for 2 or 3 relevant and correct equations or structural formulae

List of possible equations and structural formulae

combustion of carbon or sulphur;
structure of cellulose and glucose;
conversion of cumene to propanone;
conversion of glycerine to nitroglycerine (balanced equation)
conversion of glycerine to nitroglycerine (both structures)
manufacture of nitroglycerine by reaction with nitric acid;
propan-2-ol to propanone (balanced equation)
propan-2-ol to propanone (both structures)
structure of TNT

22 **Good use of appropriate illustrations (pictures, diagrams, tables, flow charts, graphs, *etc*.)** [2 marks]

2 marks for 2 relevant illustrations, well-positioned and labelled or well-linked into text; this may be from the articles in the question paper;
1 marks for 1 relevant illustration, well-positioned and labelled or well-linked into text; this may be from the articles in the question paper;

List of possible illustrations

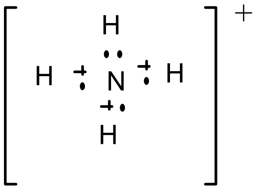
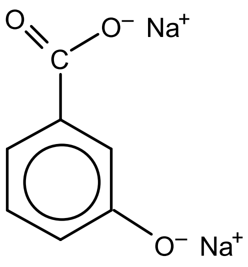
gunpowder reactants and products;
timeline;
flowchart;
structure of a shell;
fifteenth century cannon;
Table of bond energies;
nitration of cellulose;

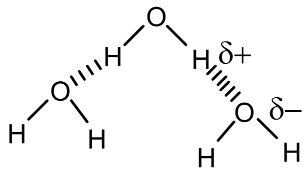
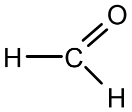
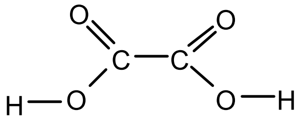
Mark Scheme 2854
June 2005

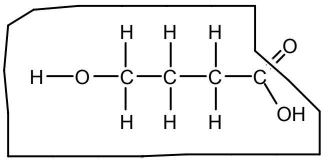
Abbreviations, annotations and conventions used in the Mark Scheme

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

Mark Scheme Page 1 of 5	**Unit Code 2854**	**Session June**	**Year 2005**	**Version Final**

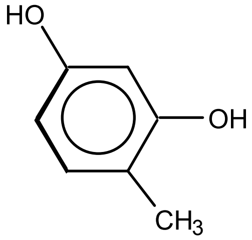
1 a i	0 (1); –3 (1) NOT 3–	2
1 a ii	gain of electrons/ oxidation state (of nitrogen) goes down (1) Mark separately from 1 a i IGNORE “gains hydrogen”.	1
1 a iii	 detail inside brackets (1); allow four pairs however displayed. plus charge shown somewhere (1) Mark separately and credit if NH_4 shown Brackets not essential	2
1 b i	**A** 106 – 110 (1); **B** 118 - 122 (1)	2
1 b ii	$CO(NH_2)_2 + H_2O \rightarrow CO_2 + 2NH_3$ / $CO(NH_2)_2 + H_2O \rightarrow H_2NCOOH + NH_3$ right-hand side (1); left hand side (1)	2
1 c i	rate constant	1
1 c ii	increases	1
1 d	acidic (1); nitrogen on right of Periodic Table (AW)/in p-block/ non-metal/ Group V(1) Second mark depends on first.	2
1 e i	phenol	1
1 e ii	 salt formed with COOH and with phenol (1) O^- Na^+ shown at least once (1) NOT with covalent bond Wrong isomer scores max. (1)	2
		16

2 a	M_r methanol 32 (1); M_r ethanediol 62 (1) (1) if A_r values correct but not added, max (1) masses 256(g), 496(g) (subsumes previous marks) (can be rounded to 1 or 2 sf)/ ratio stated of 1:2 or close(1) (Accept 1:2)	3
2 b	 At least three water molecules shown 'bent' (1); At least two hydrogen bonds between H and O in two different molecules (1); Correct δ+ and δ– across one hydrogen bond (1); at least two O–H–O straight (1);	4
2 c i		1
2 c ii	oxidation/ redox	1
2 c iii	$NaBH_4$ allow sodium tetrahydridoborate(III)	1
2 d	 One COOH group as part of a molecule (1); Completely correct (1); Allow OH but not ambiguous attachments	2
2 e i	$K_{sp} = [Ca^{2+}]\ [C_2O_4^{2-}]$ "Ca multiplied by C_2O_4" (1); completely correct (1) if $[CaC_2O_4]$ shown as divisor, can only score one. $K_{sp} = [Ca^{2+}]\ [C_2H_2O_4^{2-}]$ scores (1)	2
2 e ii	$[Ca^{2+}] = [C_2O_4^{2-}]$ stated or implied (1); $[Ca^{2+}] = \sqrt{K_{sp}}$ (1); $= 4.8 \times 10^{-5}$ (1)	3
2 f	Five from: **A** gas, liquid, solid; **B** instantaneous dipole (- induced dipole)/i.d.-i.d./Van der Waals forces in ethane/ ethane non-polar; **C** hydrogen bonding in ethanediol/ethanedioic acid; **D** more/stronger hydrogen bonding in ethanedioic acid; ignore attempts to quantify **E** diagram of this; **F** relative strengths of imfs; **G** stronger imf mean higher mpt/bpt (ora)	5
		22

Question	Expected Answers	Marks
3 a i	alcohol/hydroxy(l) (1); carboxylic acid/ carboxyl (1) NOT carboxy	2
3 a ii	4 - hydroxy (1); butanoic acid (1) ignore commas, dashes, spaces. ALLOW other material between but-anoic or butan-oic	2
3 b i	ester/lactone	1
3 b ii	hydrolysis	1
3 c i		1
3 c ii	–OH groups (1); hydrogen bond (1) indication that both groups have same shape/fit receptor site	3
3 c iii	computer (modelling)/ molecular modelling	1
3 c iv	(potassium/sodium) dichromate (1); (sulphuric) acid (1); or correct formulae (heat under) reflux if any other marks scored (1)	3
3 d	Infrared: C=O (1); and no O–H/identify C=O as ester (1); therefore GBL (1) ALLOW GHB/GBH as conclusion IF first mark scored and O–H (incorrectly) identified ALLOW nmr marks as follows for any of these by ecf GBL GHB GHB alcohol idea of different environments having different shifts (1) allow for other substances idea of heights or areas in ratio. (as right or justified) allow 1H, 2H *etc.* 1:1:1 1:2:2:2:1 or 1:6:1 1:2:2 Correct shifts (± 0.2) 1.4, 3.7, 2.49-15, 3.6, 1.4, 2.4, 0.5-4.50.5-4.5, 3.6, 1.4 QWC logical, three terms from list used correctly (2) two terms from list used correctly (1) absorption/absorbance, wavenumber/cm^{-1}, bond, proton (NOT in “proton nmr”), environment, shift, peak, (relative) intensity (nmr context)	6 2
3 e i	$HA \rightleftharpoons H^+ + A^-$(or reaction with water forming H_3O^+) products (1);equm (1) mark separately	2
3 e ii	$[H^+][A^-]/[HA]$ (2) wrong way up or no square brackets scores (1)	2
3 e iii	$[H^+] = 1.26 \times 10^{-3}$ mol dm^{-3} stated or implied, units not essential (1); allow rounded to 1.3 $[A^-] = [H^+]$ stated or implied (1); $K_a = (1.26 \times 10^{-3})^2/10^{-1}$ = 1.59/1.58/ 1.6/1.69 (rounded) $\times 10^{-5}$ (1); mol dm^{-3} mark separately (1) ALLOW ecf on K_a if it is less than 0.1	4
3 f i	minimises/ resists change in (allow maintains) pH/pH stays approximately constant (1); when small amounts (1) of acid and alkali added (1)need to maintain pH in the body (1); *e.g.* for enzyme reactions/blood (1) QWC: Two sentences; spelling, punctuation and grammar correct (1 error allowed),(1)	5 1

3 f ii	$[HA] = [A^-]$ Thus $[H^+] = K_a$ (1) pH = – lg 1.59 x10^{-5} = 4.8 (1) ignore sf. K_a = 1 x 10^{-5} gives 5.0 as pH. ecf from K_a < 0.1 in 3eiii	2

4 a	fertilizers/ to make explosives/nitric acid/azo dyes	1
4 b	nitrogen ALLOW N_2 but NOT N	1
4 c i	$p_{CO}\ p_{H2}{}^{3}/p_{CH4}\ p_{H2O}$ (2); all correct except for ONE of the following, scores (1) • hydrogen not cubed • concentrations shown ALLOW square brackets with “p”. • wrong way up NO CREDIT if + signs	2
4 c ii	$pCO = K_p\ pCH_4\ pH_2O/pH_2{}^3$ (1) stated or implied pCO = 4.22 atm (1); 3 sf mark separately provided some working if answer incorrect(1) ALLOW ecf from wrong expression in 4c(i) or first marking point.	3
4 d i	more (gas) molecules on right-hand side (1); decreasing pressure moves equilibrium (position) in direction of more molecules/to increase pressure(1); ALLOW “moves to right” IF first marking point scored. more hydrogen produced (1)	3
4 d ii	speed up reaction/ get flow through plant/compromise or optimum between speed and yield (1)	1
4e i	$CO + H_2O \rightarrow CO_2 + H_2$ left-hand side (1); right hand side (1) equm or arrow	2
4 e ii	two from: toxic /poisonous/harmful to life; causes photochemical smog can be burnt as a fuel; makes CO_2 /H_2 which are useful; NOT greenhouse gas	2
4 f i	positive must be present to score, but only scores if qualified by at least one of: more ways of arranging/more disorder (1); more molecules on right (1);	2
4 f ii	products – reactants (1); (198 + 393) – (186 + 189) = 591 – 375 3 x 131 (1); correct answer (+216) or other correctly worked out answer with sign(1)	3

5 a	C, 19 (1); H, 16 (1)	2
5 b	reflects/does not absorb/ transmits (NOT emits) yellow (1); absorbs all other/complementary colours/wavelengths (1) "reflects only yellow" scores both.	2
5 c i	(electrons are) not associated with one bond/pair of atoms (1); spread over several atoms NOT whole molecule(1)	2
5 c ii	(all) benzene rings (1); N=N (1); (O atoms of) –OH (1) AW in all parts.	3
5 c iii	lower excitation energy (NOT "easier to excite")/ first energy level lower (1); $E = hv$ /frequency decreases with decreasing distance between energy levels (ora)(1)	2
5 d i	CH_3Cl (1); $AlCl_3$ (1); anhydrous/reflux (1) formulae must be correct. Names permitted. Award last only if some other mark scored.	3
5 dii	H (on a benzene ring) (1); is replaced/substituted by CH_3 (1) mark separately	2
5 d iii	electrophilic	1
5 e i	diazonium (salt)	1
5 e ii	 nothing on crucial carbon (1); rest of structure (1) depends on first allow sodium salt	2
5 f	four from hydrogen bonding in connection with cotton; dye cannot break cotton–water bonds/water breaks dye–cotton bonds ; permanent dipole–permanent dipole in connection with polyester; instantaneous dipole–induced dipole in dye; imf of polyester and dye match better/more imf between dye and polyester (AW)(1)	4
		24

Report on the Units
June 2005

Chief Examiner's Report

Once again, it is pleasing to report an increase in numbers at both AS and A2.

At AS, unit 2848 was found hard by the candidates, probably because of the long-answer parts. The awarders took this into consideration when fixing the grade boundaries. There was a small decrease in the proportion getting the high grades in Experimental Coursework (2852/02) as this was the first year in which the revised descriptors were insisted upon. More Centres than hitherto had their marks moderated downwards and it is hoped that they will consider this carefully for next year. The Autumn feedback meetings have quite a large proportion of time designated to this area for Centres who need guidance.

At A2, Candidates showed their increased Chemical maturity by coping much better with the long answer parts. The transition between 2853 and 2849 seemed to pass without difficulty. There were mathematical problems associated with logarithms, square roots and cubes this year. The Investigation, 2855, was assessed to the revised descriptors this year, which caused a small drop in the proportion gaining high grades and more Centres moderated downwards. Again, help is at hand in the Autumn feedback meetings. Another excellent way to gain information is to volunteer as an Examiner (especially for the Open-Book) or as a Moderator.

2848 - Chemistry of Natural Resources

General Comments

The overall impression from Assistant Examiners was that the paper was slightly more difficult than last year. Although many of the questions were accessible to the candidates there were a few part questions which proved elusive to even the better candidates; as a consequence there were comparatively fewer very high scoring scripts than in recent years.

The importance of writing clear, concise and precise answers should be emphasised to candidates. There were many examples where several answers were written in the hope that one would be correct, in these circumstances an incorrect response will negate a correct one irrespective of the order of the answer. Similarly if a candidate writes a correct answer and then goes on to explain their answer further but contradicts themselves this will negate any mark awarded. Equally, emphasis on the importance of setting out calculations clearly, and logically stating what is being calculated at each stage should be stressed to candidates. All too often answers consist of a jumble of calculations (often trial and error) with no particular order or explanation, this makes it difficult for Assistant Examiners to follow and therefore to award marks if a simple error has occurred. Any incorrect working should be crossed through.

Comments on Individual Questions

1) This was intended to give the candidates a reasonable start to the paper. However, this did not appear to be the case for many candidates.
   a)
      i) This was poorly answered by the majority of candidates – the most common answers were sulphur and impurities.
      ii) The equation was written correctly by almost all candidates. Errors commonly seen were writing lead as PB or incorrectly balancing the equation.
      iii) Surprisingly many of the candidates omitted the II from the systematic name and hence did not score.
   b) Some of the weaker candidates had difficulty with the calculation of lead in the concentrate, however almost all scored a mark for correctly calculating the M_r as 239. Those that performed the whole calculation correctly often omitted to give their answer to 2 significant figures as highlighted in the question.
   c)
      i) A variety of incorrect answers, including gold, were given for the main product impurity from the blast furnace. Despite the candidates being asked to name the impurity a significant number gave the symbol Ag.
      ii) The calculation of the number of parts per million of the impurity was answered badly by the majority of candidates with only the most able scoring both marks. The majority did not know where to start and there was a definite lack of clarity in their working, although a few did score a mark for recognising that there would be 0.01% impurity present.
   d)
      i) The majority of candidates were able to give 0 as the oxidation state of elemental antimony, however fewer were able to give the oxidation state of antimony in the compound and some wrote the positive sign after the 3 which did not score.
      ii) Redox was correctly identified as the type of reaction in most cases.
      iii) There were many imprecise answers to this part of the question, many candidates missed that the reaction was on an industrial scale. A significant number of candidates talked of the reaction being flammable without identifying that the flammable substance was hydrogen. Those that did often went on to score the second mark for the precaution. Fewer candidates stated the antimony compound would be toxic.
      iv) The electron configuration of Sb commonly scored 1 of the 2 marks either for the 6 or the p^2 on a random basis.
      v) Often correct although d block was seen frequently even though candidates had written p in (iv).

   - vi) Another oxidation state for antimony proved elusive to the majority of candidates. Those that identified +5 often incorrectly stated that it loses 5 electrons. Those that stated -3 often gave a partial explanation, *e.g.* it can gain 3 electrons, without clarifying why.

- e) The standard of drawing of apparatus was generally very poor, although there were a few Centres that produced excellent diagrams with clear labels. Many candidate's answers were scribbled in pen, the apparatus was not sealed *i.e.* no bung between the funnel and the flask and with very few key labels, including where the lead would be found. Despite the candidates being told that the technique was vacuum filtration a significant number of candidates drew apparatus for reflux and some had no idea whatsoever.

2) This question was more accessible to candidates and some very good answers were seen from many Centres.
   - a)
     - i) Generally well answered.
     - ii) This was very variable with the most common errors being pentavalent carbon compounds or to include H in the formula.
     - iii) Many candidates gave correct uses of CFCs, however some omitted key words like aerosol propellants or refrigerants.
     - iv) There were some excellent answers with many candidates scoring 3 or 4 marks. The most common omission was identifying that the Cl atoms acted as catalysts. There were some misconceptions that fluorine radicals would also be produced. The vast majority of candidates scored the QWC mark.
   - b)
     - i) The labels were generally correct; those on the Hs were ignored.
     - ii) Most candidates scored a mark for correctly using electronegativity, however fewer scored the comparison mark.
     - iii) This part question proved to be elusive even to the most able. The vast majority of candidates did not appreciate that the molecule would be tetrahedral. Those that stated the molecule would have a dipole often discussed individual bonds and did not seem to appreciate that the question was about the whole molecule.
   - c)
     - i) Many candidates scored a mark for realising that the bond would be strong, considerably fewer stated that the UV radiation was not high enough to break it. Answers were often phrased in such a way that they implied the candidate was discussing the intensity of the radiation which did not score.
     - ii) The calculation was generally well done by most candidates, a few did not convert the bond energy to joules and a few were unable to use standard form correctly.
     - iii) Many correct calculations were seen here, particularly with an allowance for error carried forward from (ii). The majority of candidates scored the unit mark.
     - iv) This was poorly answered by almost all candidates with the most common answer being photodissociation, which was ignored if written with the correct answer - homolytic fission.
   - d) The greenhouse effect appeared to be poorly understood by many candidates. Most scored 1 or 2 on this question. A minority gave excellent answers scoring 3 and 4. In many instances candidates did not state that UV emitted from the Sun heats up the Earth, they also incorrectly stated that IR is reflected off the Earth. Many candidates also had a poor understanding of the effect that IR has on the greenhouse gases in terms of causing the bonds to vibrate more energetically. Many also went on to discuss emission spectra and bond breaking. Many managed to score the QWC mark.

3) This proved to be the most difficult question on the paper for most candidates.
   - a) Drawing the structure of propene should have been a straightforward question for candidates yet despite this there were a significant number of errors with the most common being a pentavalent carbon atom in the molecule.
   - b)
     - i) Very few correct answers were seen and in many cases this was left blank.

- ii) The majority of candidates were able to name a polymer discovered by accident with the most popular being polyethene.

c)

- i) Many candidates had difficulty completing the diagram and a significant number made no attempt to answer the question. A number reversed the positions of the methyl group and the H correctly but kept the same stereochemical symbol with the group that they had swapped and hence did not score.
- ii) Many candidates scored the mark for instantaneous dipole induced dipole, although a few omitted dipole and a significant number of id–id were seen, these answers did not score.
- iii) Poor phraseology often let candidates down in this part question. Many repeated the information given in the stem of the question. Many used vague descriptions such as it is in a regular pattern without trying to compare structures which was not enough to score. At the other extreme there were some well-structured answers.
- iv) The majority of candidates scored the mark for stronger intermolecular forces in the more crystalline form, fewer scored the mark for the idea of the chains being able to slide across more easily in the less crystalline structure.

d)

- i) Usually correct.
- ii) The reaction of bromine and propene was given as an example of an electrophilic addition reaction and the candidates were asked to explain the words electrophilic and addition. Many candidates did not appreciate what was being asked of them and simply explained the mechanism without reference to the terms. Most scored 1 mark for a correct explanation of electrophile. A minority scored a mark for stating that an electrophile will accept a pair of electrons and slightly more explained addition precisely.

e)

- i) A minority of candidates gave HBr as the correct reagent whilst Br_2 was the most common incorrect response.
- ii) Often correct.
- iii) Often correct.
- iv) Many correctly stated elimination although substitution was seen relatively frequently.

f)

- i) Reflux was linked to the use of a sensible reagent in this question which made it more difficult for weaker candidates to score. In general this part of the specification appears to be poorly understood by the majority of candidates. Only the better candidates were able to give the correct reagent and conditions.
- ii) Many candidates gave simple GCSE type responses stating that there was more chance of a collision without recognition that there would be more collisions per unit time.
- iii) There were many good answers that gave an excellent explanation as to why the rate of reaction increased when the temperature is raised. A considerable number of candidates stated that there would be more successful collisions rather than stating that more particles would have energy greater than the activation energy, which limited their mark to 1 out of 2.

4) This question was relatively well answered by a good proportion of candidates.
   a) A number of incorrect answers were seen which included ammonia and sulphur.
   b) Many candidates scored at least 2 marks for this part question. Common errors were writing the formula of water incorrectly or the omission of the correct partial charges on the water molecule. Credit was given for showing water molecules as triangles as shown in *Chemical Ideas*.
   c)
      i) Usually correct
      ii) NH_3 was correctly given as the base by most candidates; water was seen infrequently which was given credit. A significant number incorrectly gave NH_4^+.
   d)
      i) Most candidates scored 1 mark for this question with only the more able candidates scoring 2. The majority scored the mark for the idea of a partially positive hydrogen. Fewer stated that the lone pair of electrons is specifically on the nitrogen and a number stated that there was a big difference between the electronegativities of nitrogen and hydrogen without specifically stating that nitrogen is more electronegative.
      ii) Many candidates scored at least 2 marks for this part of the question. The most common omission was the lone pair on the nitrogen or oxygen involved in the hydrogen bond.
   e)
      i) Usually correct.
      ii) A significant minority described a colour change without stating the use of an indicator – the name of the indicator was ignored.
   f) Full marks for the calculation proved elusive to most candidates. Many had no idea of where to start. Calculations were often poorly laid out with no clarity of working. In the majority of cases there was simply a jumble of numbers, this inevitably made it difficult for Assistant Examiners to award error carried forward marks.

Teaching tip When setting out a calculation include a statement as to what is being worked out at each stage.

M_r $(NH_4)_2SO_4$
$= 2 \times (14 + 4) + 32 + (4 \times 16)$
$= 132$

Concentration of ammonium ions = 0.02 mol dm^{-3}

Therefore concentration of ammonium sulphate
= 0.02/2
= 0.01 mol dm^{-3}

Therefore number of grams of ammonium sulphate
= concentration x M_r
= 0.01 x 132
= 1.32 g dm^{-3}

An Examiner can see clearly what has been calculated at each step and can award marks if a simple mistake has been made.

2849: Chemistry of Materials

General Comments

As in January, the extra organic chemistry involved in the revamped specification for this unit did not seem to cause any undue alarm. All Assistant Examiners commented that the paper was accessible, of the appropriate standard and discriminated effectively between the most able and the weakest candidates. There remains a group of candidates, gaining single figure marks, for whom A2 level is not remotely appropriate.

The candidates' level of examination awareness and past paper practice was noticeably better than in January. Although the quality of written communication was generally very good with respect to obtaining the designated mark for the use of spelling, punctuation and grammar, the ability to express ideas throughout the paper using appropriate scientific language was generally of a poor standard. Inappropriate abbreviations, *e.g. id–id,* and phrases such as 'unhappy electrons' were rife, perhaps a sign of our times, a result of the way many communicate on a daily basis!

Again, a large number were not able to use the *Data Sheet* effectively; some confusing the various spectroscopic data and not really appreciating the information given. Since the changes to the Salters' specification, the infrared data is no longer assessed at AS, thus perhaps there is a need for a more extended approach in teaching its use at A2. Candidates need to make sure that the chemical ideas and arguments they use are appropriate to the question posed. There were many instances where correct chemistry was in the wrong place.

The ability in calculations to use the 'appropriate number of significant figures' was very much better than in January, with the stronger candidates often stating the number of figures used. It was also noticeable that we have come a long way in improving the manner in which most candidates set out their working showing symbols, equations and units. Centres are to be commended on the way they have encouraged their candidates to do this.

Comments on Individual Questions

1) (a) Many correctly identified the amide group with some adding that it was a secondary type, though amine or peptide were quite common answers.
However, few knew that the reagent was ethanoyl chloride and many other substances were seen, often concentrated sulphuric or ethanoic acid. A small number used the general term acyl chloride.

Teaching tip
Candidates are not very good at recalling reagents and reaction conditions, or indeed distinguishing between these two terms. They need to be well drilled in the relatively few reactions which apply to this paper.
E.g. 'Give the reagent and conditions for oxidising a primary alcohol' would score two marks. One for stating the reagent, the minimum response being 'acidified dichromate', and the second for 'heat under reflux' or in fact just 'reflux' would be acceptable.

(b) i-iv Generally well answered by A/B grade candidates but not so well by others. Some added the mass numbers of various peaks together; a number seen not infrequently was 356!

Misconceptions

The peaks in a mass spectrum were often attributed to negative or neutral species, whereas fragments lost by the molecular ion were often thought to be positively charged.

v-vi

Most realised that the product was an amine and many went on to correctly identify phenylamine.

Candidates did not really appreciate the function of the amine group in giving compound **A** its basic properties.

Misconception

Hydrogen atoms/ions from the acid were often stated as hydrogen bonding to compound **A**/amine group, hence the compound was soluble.

Very few gained the second mark for suggesting why the product formed in acid was soluble.

Teaching tip

Candidates need to recognise that amine or carboxylic groups in solution of the appropriate pH are soluble because the resulting ions can interact with the water molecules, and that these interactions are much stronger than hydrogen bonds. This can link the solubility of amino acids to the solubility of transition metal complexes, an application of ideas first met at AS.

(c) The correct use of the *Data Sheet* has been discussed above. Some forgot to use the information selected to draw the structure for compound **C**.

(d) Clearly the general ideas about chromatography are well known although the actual detail was Centre dependent. Common mistakes included, spotting solid compounds on paper, using ethanol as the eluting solvent and ninhydrin as a locating agent. Many failed to recognise that TLC does not involve paper.

Tip for students

The available space for an answer has been carefully selected to enable even the most able to do themselves justice. Responses using an excessive amount of extra space indicate an inability to select material that is appropriate.

In this case many used the blank page following the question. The best answers were from those who used this space to plan their response; thus they wrote clearly and with the right amount of detail in a logical order.

(e) Often very vague, with many not focusing on the term ‘chemists’ but rather going down the route of clinical toxicology and writing about tests on humans and animals.

2) (a) Many chose to discuss bonding, rusting or a property of an alloy rather than structure.

Misconception
Particles present in metals were often referred to as molecules or polymers, and thus chains are disrupted by the addition of another metal.

(b) Some very good answers but those who went down the 'electrons are being excited by light' route often failed to gain the second mark.

Misconception
Ions having had their electrons excited by light then emit a colour when the electrons fall down to a lower energy level.

Many identified the correct shape, though hexadentate and octagonal were common incorrect answers. However, the main problem here was with drawing the structure; too many tried to indicate its shape through use of a variety of 3D solid figures.

Teaching tip
Diagrams of complexes are best drawn showing the atoms donating the electron pairs bonded to the central atom. Then the usual wedge and dashed lines can be used to show the ligands not in the plane of the paper.

Some very good answers to the last part, but largely Centre dependent. Some confused geometrical and optical isomers, though this was ignored if two correct structures were drawn or described.

(c) In part (i) the units were often correctly deduced, but the calculation served to differentiate the high scorers. The commonest errors involved failure to rearrange the equation correctly and to calculate the 'square root' by 'dividing by 2'. Significant figures were usually correct, although two and four were regularly seen.

3) (a) Few candidates successfully identified the diol, rather giving the formula for ethanol or a dicarboxylic acid.

Teaching tip
Candidates generally find it easier to deduce the repeating unit from given monomers, rather than the reverse. Also using skeletal formulae seem to add considerably to the difficulty level. More practice is needed with this reverse process.

(b) The ability to name organic compounds is definitely improving with many candidates of all abilities gaining both marks. However, a few Centres must have old bottles of 'Hexane-1,6-diamine'.
There was a failure in the second part to respond to the instruction 'Use the reaction between **D** and **E**', consequently HC*l* was given as the molecule eliminated.

(c) Although many candidates appreciated that the introduction of nylon would lead to the formation of 'hydrogen bonds', few went on to discuss the effect that these forces would have on the mobility of adjacent chains or how nylon chains would be able to interact with the polyester chains.

(d) Generally the environmental issues associated with polymer disposal were well understood. However, the candidates' abilities to convey this varied enormously; often answers were very vague with the words 'cheaper', 'harmful' and 'quicker' at the heart of many too brief answers.

The reagent for hydrolysis was commonly thought to be concentrated sulphuric acid but conditions were invariably given as 'reflux'.

Most could use the half-equations given to construct a balanced equation but it was rare to see any cancelling down.

(e) Most scored well here and undoubtedly had personal experience of colorimetric experiments. Unfortunately the candidates from a few Centres had no knowledge of this technique.

(f) i Everyone attempted the data interpretation with generally good results; a few were bemused by second order reactions.

ii Most candidates were able to use their answers from part i to construct the rate equation. The commonest mistake was to leave out the rate constant.

iii It was rare for candidates to be able to deduce the units for *k* even though the rest of the question had been answered correctly. The mathematical knowledge required seemed alien to most.

4 (a) Most correctly worked out the cell voltage. However, few were able to focus on 'standard conditions' in part ii, tending to look at purity or even historical issues. Still too many associate 'electronegativity' with cell potentials, but overall there was a much better understanding of cell processes.

(b) The diagram differentiated well with only the better candidates indicating the standard concentration and temperature details.

(c) Although a large number of candidates wrote the correct equation, many across the whole ability range did not read the question carefully and introduced metal and metal ions in giving a cell reaction. Others chose the wrong direction and wrote the equation for the reverse reaction.

(d) The ability to write correct electronic structures was excellent from all grades of candidate. A few decided to give the structure for zinc ions with a variety of oxidation states, again a misreading of the question.

However in the last part, most wrote at length about 'full shells' and nefarious types of 'stability' rather than looking at energy considerations.

5 (a) Diagrams were usually labelled correctly for both parts. A few decided to forgo a 'direct route' for hydrogen bonding between the chains but rather chose a more 'scenic' approach with very long bonds covering widely scattered atoms. Some also used full charges rather than partial.

In part iii, though many got this correct, surprisingly 'double helix', DNA and RNA were common incorrect answers.

(b) Usually most candidates were able to find two scoring points, but there were those who were vague using unspecified terms such as 'dipoles' or 'dipole–dipole'.

(c) Only a few candidates scored all five marks, yet many were in the range 2–4. Many misinterpreted the question, resulting in an answer outlining the 'lock and key' mechanism for enzyme action, or a biological response based on cell replication.

(d) Most knew the apparatus required for 'reflux' and could draw a suitable diagram, yet few really understand the process and thus most were unable to describe it accurately. Many descriptions could have applied to distillation or involved 'closed systems'.

(e) This was generally well done, though the mark for 'numbers of hydrogens' was less frequently seen. Some confused NMR with infrared spectroscopy or only mentioned 'functional groups' with no reference to protons or hydrogen atoms; perhaps a result of their inexperience with the technique.

2850 - Chemistry for Life

General Comments

Candidates found the paper, in general, quite straightforward, with only a very small number of candidates scoring below 20 and an encouraging number of candidates scoring in the 65–75 mark range. Questions 1 and 2 were well answered, with question 3 proving the most challenging and, along with question 4, the most discriminating. Calculations and equations were handled much more confidently this session and time did not seem an issue.

Comments on Individual Questions

1) Parts (a) (i), (ii) and (iv) were answered well with the vast majority of candidates scoring full marks. The answers to (a) (iii) were more varied, and although the mark scheme had been opened up to allow a wider range of interpretation, some answers were just too vague to merit the second marking point, with 'the mass *(of what?)* decreases by a half' being typical.

   Part (b) was challenging for many candidates. The majority realised that diffusion of radon gas from the rock was the inherent problem but few could clearly marshal their thoughts as to why this might lead to an **underestimate** of the age of the rock. However a few sharp-eyed candidates did spot that the stem to part (c) actually gave a strong clue to the reason.

   Candidates scored highly on part (c) (i) and (ii).

   The calculation in part (d) was clearly laid out by the majority of candidates and this enabled examiners to allow 'error carried forward' marks even when the initial calculation of the number of moles of uranium and oxygen had been attempted with the figures the wrong way up (the most common error) leading to U_2O. $U_{881}O_{119}$ perhaps being the most optimistic answer!

2) Better candidates scored highly on part (i), (ii) and (iii). Common marks missed by weaker candidates included, the failure to convert their answer to kJ in part (i) and use of the wrong mass for coal and a disconcertingly significant (*sic*) number of answers not given to two significant figures in part (ii).

Tip for teachers

Sensible, justifiable levels of precision are important in science and it is worth giving students practice on dealing with 'sig figs'. There are marks available on every Salters paper for appropriate use of significant figures.

Parts (b) and (c) (i) and (ii) were generally well answered.

The expected answer to part c (iii) was in terms of reduced (not 'no') tendency for the fuel to auto ignite and the majority of candidates scored full marks, however a significant number of candidates went down the route of answering in terms of chain branching and while the stem of the question tried to steer candidates away from this approach it was felt that one mark should be awarded for such answers.

Parts (d) and (e) were high scoring.

Numerical answer Part (a) (i) 16.8/17kJ (ii) 39kJ (iii) 43%

3) This question, overall, discriminated well.
Part (a) was correctly answered by the majority of candidates although an attempted reaction with oxygen was a rather too frequent wrong response. The (correct) use of state symbols was better this session.

Parts (b) (i) and (ii) generally produced the expected answers but (b) (iii) was variable.
Few candidates realised the importance of the 'fair test' idea which forms the grounding of GCSE practical science and a small number did not give a <u>comparative</u> answer for the second marking point.

In part (c) (i) only the most able candidates were able to talk in terms of relative solubility and there were a lot of answers to part (c) (ii) which unfortunately talked in terms of the OH <u>group</u> rather than the hydroxide ion.
Part (c) (iii) had as its most common error CaCl as the formula of calcium chloride, with the knock on effect on balancing the equation.

Part (e) (i) produced many correct answers but the usual errors of, omission of state symbols, no charge on the electron and the loss of two electrons for the second ionisation were also frequently present. A few candidates did not read the question and answered in general terms instead of specifically for calcium.
In (e) (ii) candidates produced the complete spectrum of marks. Many made the same point over and over again – it really is worth candidates planning responses to extended questions particularly as time is not a significant problem on this paper.

Tip for candidates

The risk of losing marks through running out of time to complete the paper is relatively small, and time would be more profitably spent on mapping out answers to the longer questions with less risk of repetition of the same marking points.

4) Parts (a) (i) and (a) (ii) were disappointingly answered by candidates with a substantial number failing to show the O–H bond in part (i) and putting an OH group in the molecular formula. Most students realised there would be an increase in entropy on mixing water and anti-freeze but many wrongly cited an increase in the total number of molecules as the reason.

In part (b) (i) some candidates failed to explain <u>both</u> terms in italics and centres should be aware that the role of a catalyst in this specification is to speed up a reaction, with 'alter the rate' on its own not being acceptable.
Most candidates scored (b) (ii) with 3 x 24 = 72 dm^3 being the most common wrong answer and (b) (iii) yielded many correct answers with ester the wrong alternative.
The vast majority of candidates could quote the appropriate bond angle but as in previous papers the quality of the explanation was variable.
Part (c) (i) was (almost) universally answered correctly but (c) (ii) was proved discriminating. Candidates failing to score full marks yet again omitted the sign or used the idea of $\sum\Delta H_f$products – $\sum\Delta H_f$ reactants the wrong way round. Once more those candidates who clearly set out their calculation were better placed to gain the 'error carried forward' marks available.

Numerical answer part (b) (ii) 3 dm^3
part (c) (ii) –109 kJ mol^{-1}

2852/01 - Open-Book Paper

General Comments

This year, the candidates were presented with two articles about the history of explosives. This was an unfamiliar area for most candidates, but the chemistry discussed in the reports linked directly to familiar concepts covered in the AS course, for example oxidation, bond enthalpy changes and rates of reaction.

The standard and presentation of the reports was high. However, Examiners had the impression that standards of written expression and presentation were generally lower overall than in previous years. Most students present word processed reports with imported diagrams and graphs. Most are adept at using their keyboards to process chemical points, for example in the use of subscripts, superscripts and equation notation.

Candidates generally follow the *Notes for Guidance* on page 2 of the question paper. However, there continues to be a large number of candidates who lose marks by failing to follow this guidance. Specifically, this commonly applies to skills of referencing, text annotation and the inclusion of appropriate equations, formulae and diagrams to support their answers. Candidates who do not follow the guidance commonly lose both research and communication marks, which compose up to one third of the total marks for the papers. Candidates need to note that web addresses should be given in full (URLs). In simple terms, this means that the address should end in *xxx.htm* or *xxx.html* or *xxx.shtml* or *xxx.asp*, all of which would lead to a specific page on the site. Additionally, for the 'detail' of sources mark, the address should be accompanied by the name of both the website and the page, to enable tracking of the page.

There was evidence this year of poor planning and use of time or words by some candidates. Many candidates gave too much emphasis in their reports to the first bullet points, leaving insufficient words or time to properly address the later bullets.

Teacher's tip
Students should plan their word count for each bullet by dividing up the 1000 words roughly into how many words will be used per bullet, based on the marks available. Each section can then be tackled more manageably in terms of both time and space in the report.

Another outcome of poor planning is shown when sentences are 'lifted' from the articles rather than used to make clearly argued points. Candidates who draw their responses directly from the texts of the articles without any selection or interpretation cannot clearly address the bulleted tasks. The mark scheme did not allow this in the case of at least two of the bullet points. Another fault commonly shown by candidates (more so than in the recent past) was that circular thinking led to frequent repetition of a number of fundamental points (*e.g.* explosions causing rapid expansion of gases, leading to destructive pressures).

A significant proportion of candidates continue to attempt to evade the word count rules. Commonly, this happens by understating the word count or by some candidates over-annotating their diagrams with large amounts of text in text boxes. In both cases, Examiners may ignore words in excess of 1000, and penalise communication marks, leading to a significant reduction in the marks available for the candidates.

Teacher's tip
Words in equations and labels on diagrams do not count towards the word count. However, such labels should be limited to a single word or phrase. Use of text boxes in diagrams containing sentences or bullet points of additional information are against the spirit of the paper and will be penalised by the Examiner as additional word count. This could result in the last sections of the report being disqualified from scoring.

Across the whole mark range candidates scored lower on Evaluation than on Chemistry, this led to the evaluation marks and the communication marks being the main discriminators for the paper this year.

Comments on Individual Questions

Bullet point 1

This bullet asked candidates to discuss rate of oxidation in the context of explosive reactions. It was intended to be an easy 'starter', covering familiar chemistry. Unsurprisingly, therefore, candidates addressed this point well, showing a good understanding of the chemistry of oxidation and how oxidisers increase the rate of reaction in low explosive mixtures (*e.g*. gunpowder). More able candidates were able to differentiate between mixtures containing separate oxidisers (*e.g*. potassium nitrate), and molecules that contain higher percentages of oxygen within their structures (*e.g*. nitrocellulose).
Common errors seen in this bullet included…

- representation of oxidation states as ionic charges (*e.g.* C^{4+}).
- confusion over total oxidation states, (*e.g.* O in CO_2 given oxidation state –4).
- choosing examples to illustrate oxidation states that were not relevant to the context (*e.g.* metals and their ions such as Mg and Mg^{2+})

Many Examiners commented that candidates devoted too high a word count to this section, implying poor overall planning.

Bullet point 2

This section was about the history of the development of the chemical compounds used in explosives. This was less well answered for several reasons. The articles discussed the 'big four' explosives; gunpowder, nitrocellulose, nitroglycerine and TNT. Commonly, candidates did not give enough attention to the development of the *chemical compounds* in the explosives, even though the details were all available in the articles. For example,

- Some included too many unnecessary and irrelevant technical details about explosives they had researched, often from website sources.
- Many reports lacked detail about the basic chemical reaction that was used to make the main explosives. Nitration reactions to make cellulose and glycerine were often omitted. Few gave any commentary about the conversion of hydroxyl groups to nitrate groups.
- A common error was to make lengthy timelines of names, dates and lists of compounds. Such timelines gain a diagram mark, but earning chemistry marks demands that some discussion of chemistry takes place, so lists are very unlikely to score any chemistry marks.
- Candidates included equations and structures in their discussion, but often failed to check them properly. Common errors were to copy the cellulose structures, with bonds going to the wrong atoms. This lost 'technical terms' marks, marking point 20b.

Teacher's tip
Students should base their report closely on the provided articles, and try to include as much detailed chemistry as possible from the articles. The markscheme is written closely around the chemical content of the articles – including large amounts of material from outside sources will not score chemistry or evaluation marks.

Bullet point 3
This was a more difficult area, designed to stretch the more able students. Candidates were asked to discuss energy and pressure changes during reactions.

Most candidates knew that energy changes were related to bond enthalpies, but fewer linked this to breaking and making bonds during reactions. Marking point 5b demanded that three points be made; breaking bonds is endothermic, bond formation is exothermic, and for exothermic reactions, more energy is evolved than taken in. Most candidates did not give a clear explanation of this, many showing confusion between whether bond making and/or breaking was exothermic. A common poor wording was…

'more energy needed to make bonds that break them'.

Another common error was to state that…

'more bonds are made than broken'.

However, a large number of candidates gained these marks by very bravely attempting to do a full bond enthalpy calculation for the explosion of one of the compounds. Such attempts are the true spirit of the Open-Book, so minor errors in such difficult calculations were overlooked in awarding this mark.

The chemistry of pressure changes was also difficult. Only a very few candidates gave a full discussion of volume changes linked to the numbers of moles of gas evolved. Similarly, few realised that the solid or liquid state of the explosive mixtures was important in creating a large pressure increase.

Teacher's tip
Students should cross check the course text book for each chemical concept mentioned in the bullets (*e.g.* pressure/volume changes, energy changes). Additional chemical points can easily be scored by including a brief outline of the underlying chemistry.

Bullet point 4
This was a very easy few marks to score. Most gave a clear summary of the history of propanone manufacture. Article 1 contained an equation with all the conditions for the modern manufacture of propanone. The information within this equation was enough to score two chemistry marks (7b and 7c). A large number of candidates did not use this equation at all, losing a very easy two marks.

Teacher's tip
Students should use as many equations/ structures/ diagrams from the original articles as possible – these often score chemistry or evaluation points as well as going towards the 'equation and diagram' marks (21 and 22). Remember they are 'word count free' – they do not 'count' towards the word count.

Remember to include any important information in separate sentences above the equation – if marking points are scored directly from an equation, that equation does not 'count' towards the equation mark.

Bullet point 5
The last bullet point was intended to be an evaluative discussion drawing points from across both articles about health and safety. Again, a common error was that some candidates included unnecessary, irrelevant information gleaned from poorly directed research, often using websites. Commonly, this included extensive discussion of legislation about health and safety. Again, it is important to stick closely to the articles.

Some candidates did not make any attempt to address this bullet point. This was often due to poor word count planning – the report had 'run out of words'. Such an error is serious for two reasons. Firstly the marks available for the last bullet point obviously cannot be scored if the candidate has not written anything. Secondly, communication marks will be lost for poor structure, leading to a significant drop in marks for this error.

Research (marking points 15 to 17)
This is a **five mark section that every candidate can gain**. Candidates' scores tend to be Centre dependent. Some Centres clearly train their candidates very well to follow the *Notes for Guidance* on page 2 of the paper. However, too many candidates lost marks by doing at least one of the following:

1. failing to provide a list of sources;
2. failing to include in the list the two articles in the paper. It is important to note that the articles should be referenced in full. 'The Open-Book paper' does not score this mark;
3. failing to include page numbers or chapter/section titles for sources other than the Open-Book paper articles, or statements of website titles or authors or content;
4. failing to annotate the text in their reports.

The requirement to apply some simple rules in this part of the assessment is stated quite clearly in the *Notes for Guidance* in the paper.
See 'general points' at the beginning of this report for more information about referencing of websites.

Summary
The four marks available are for making four clear chemical points, but these were very rarely gained in full. It often appears that candidates write the summary in a very hurried manner, implying that they consider it to be of minor value to their main report. In fact, the reverse is true – these four marks are nearly 10% of their total score and, if earned, can tip them firmly into the next grade up. Candidates score more highly if they have redrafted their summaries several times and have worked to tighten the chemical points they have made.

Summary tips for students

- Write **chemical** points in clear statements.
- Describe reactions using **chemical terminology**.
- Write points that **cover your report** *e.g.* try to include reference to all the bullet points.
- **Redraft** your summary in rough until you are sure you have made at least four clear points with definite **chemical content**. Don't 'rush' your summary at the last minute.

Communication (marking points 19 to 22)

This area gave a spread of marks across the candidates. Those who were careful to check their reports for spelling and technical accuracy, and who included formulae, equations and diagrams scored high marks. Examiners again commented that some reports had clearly been submitted without a spell check being carried out. Candidates need to allow enough time to thoroughly check their reports before submission. Again, the lack of care shown by some candidates implies that they consider this area less important than the main report. However, these 10 marks give almost a quarter of the total score of the paper. Common errors and omissions included…

1. Candidates who had omitted to answer a whole or part of a bullet point often lost balance and structure marks.
2. Spelling and punctuation marks are deducted for two errors. Hence, mis-spelling or typos of two words leads to marks being lost. Names of the scientists were commonly mis-spelt. Some candidates align every sentence to the left hand margin and fail to use paragraphs. Similarly, technical terms are penalised after the first mistake. Subscripts or superscripts omitted from formulae or units were a common reason for failing to score.
3. A surprising number of candidates did not use diagrams or include any formulae or equations, losing up to 4 marks.

2852/02 - Experimental Skills

General Comments

The overall standard of candidates' work was similar to last year.

Most Centres used assessment activities chosen from the OCR coursework guidance booklet. The most popular of these were 'Finding out how much acid is in a solution', 'Comparing the enthalpy of combustion of different alcohols', and 'The determination of the solubility of calcium hydroxide'. Some Centres used activities that were of lower demand such as the use of an acid/base titration without the need to make up a standard solution or to dilute one of the solutions. This limited the ability of candidates to access the higher mark levels. Where a Centre designed activity is used, instructions given to candidates and a detailed mark scheme should be supplied with the moderation sample.

Very few Centres submitted candidates' work for moderation chosen from more than two different activities. For an increasing number of candidates, work from a single activity was submitted for moderation.

Not all Centres submitted the expected evidence such as a tick list of practical techniques to support the marks awarded for the manipulation strand of the implementing skill area. A small number of Centres did not submit the Centre Authentication Form (CCS 180) with the work sent for moderation.

Some Centres continued to use an older set of marking descriptors rather than the new descriptors contained within the 2nd Edition of the OCR publication, 'Teacher Support: Coursework Guidance' for teaching from September 2004. This sometimes resulted in the award of higher marks than would have been the case if the new descriptors had been used.

Some Centres annotated candidates work by indicating where descriptors had been met in particular parts of the text by using symbols such as 5a or 8b. While this may be a useful strategy for identifying where specific points within a set of descriptors have been met, it can also lead to an inappropriate award of marks where the meeting of a single point is taken as evidence of meeting the whole of the requirements at a particular descriptor level. A much better way to ensure the secure award of marks, and to assist the moderation process, is for brief comments to be added at the end of each section, or on the candidate cover sheet, to indicate where and why a descriptor had not been met which therefore explains the reason for the award of a lower mark.

Most Centres were aware of the hierarchical nature of the coursework descriptors and applied them effectively. There are still a significant number of Centres, however, who do not apply the descriptors in a hierarchical manner but use a form of 'best fit' approach. This often results in a generous application of the marking descriptors. In some cases, the annotation of candidates work was very brief, with few or no comments on cover sheets. This also increased the tendency for there to be a generous application of the coursework descriptors.

There were an increased number of cases in this session where the marks awarded by the Centre were too generous and outside of the tolerance allowed by OCR. This resulted in the marks of all candidates in these 79 Centres being reduced as a consequence of moderation. This represents about 17% of Centres and is a significant increase from the 47 Centres in this category in the June 2003 session.

Teacher support booklets

Two new booklets have been published by OCR to support teachers in setting and assessing coursework.

‘*Teacher Support: Coursework Guidance*’ provides guidance on all aspects of coursework, including exemplar assessment activities and associated detailed mark schemes to match the new assessment descriptors in the 3rd edition of the Chemistry (Salters) specification.

‘*Teacher Support: Exemplar Coursework Guidance Units 2852/02 and 2855/01*’ provides examples of candidates work with a commentary on appropriate assessment of this work using the assessment descriptors in the 3rd edition of the Chemistry (Salters) specification. These booklets contain answers to many frequently asked questions about coursework in this specification.

Comments on Individual Skill Areas

Planning

Many candidates were able to plan their activity effectively and so gain a mark of at least 8, although in some cases, marks of 10 or 11 were awarded when candidates had not justified the choices within the plan that were designed to ensure accurate results as required by the descriptors.

The new descriptors provide more precise guidance about the quality of the risk assessment and the sources consulted in devising a plan at levels 5, 8 and 11. Some Centres identified where descriptors had not been sufficiently met but the marks awarded to candidates did not always accurately reflect these observations.

There was a significant increase in candidates’ ‘cutting and pasting’ web addresses to describe sources they had consulted. It is expected that candidates’ will include a short description of the content of the website in addition to the web address to satisfy the descriptors at level 11.

Common problems in planning included:

Titrations

- Use of inappropriate equipment
- No calculation of required amount of sodium carbonate
- No description of how to make up the sodium carbonate solution
- No equation for the reaction
- No distinction between trial and accurate titrations
- No comments on why the procedure will be accurate
- Sources consulted not included or lacking sufficient detail
- Inappropriate risk assessment of dilute acid described as corrosive rather than irritant
- Insufficient explanation of the choice of concentration of sodium carbonate solution or dilution factor of acid

Enthalpy of combustion

- No indication of how the water volume is measured
- Poor choice of water volume *e.g*. 25 cm^3 or 1000 cm^3
- Heating water for a fixed time rather than for a fixed temperature change
- Heating water to a high temperature
- No stirring of water
- No comments on why the procedure will be accurate
- Sources consulted not included or lacking sufficient detail
- Brief risk assessment covers only one alcohol
- Insufficient explanation of why a temperature rise of between 10 and 20 ^{o}C is chosen

Implementing

Some Centres awarded marks which did not accurately match the descriptor requirements for the recording strand of this skill area, because they were solely based on the manipulation strand.

In the activity, ‘Comparing the enthalpy change of combustion of different alcohols’, it is expected that candidates will record all temperature measurements and not simply the temperature change.

Recording data from titrations

In assessment activities that involve titrations, candidates should record all burette readings, not just titres, and should record their readings to two decimal places, where the second figure may be a 0 or 5, in order to access the higher mark levels. The marks awarded in this skill area should reflect any omissions in recording data from titrations. It is also expected that candidates will use units of cm^3 rather than ‘mls’.

In the ‘Acid rain’ activity, candidates must record appropriate readings to find the mass of sodium carbonate in order to meet the descriptors at level 8.

Analysing

Candidates are expected to explain the steps of their calculations. If, for example, candidates use a formula to link variables such as concentration and volume of a solution, they should indicate what the symbols in the formula refer to.

If candidates carry out the activity ‘Comparing the enthalpy of combustion of different alcohols’, they need to explain the steps in their calculation for one alcohol, even if they subsequently use a spreadsheet for other alcohols.

In the activity, ‘Comparing the enthalpy of combustion of different alcohols’, many candidates did not include a minus sign in front of the values that they had calculated. In drawing conclusions from this activity, some candidates were confused about the exothermic and endothermic nature of bond breaking and bond making processes.

Calculation of average titres

Candidates are required in assessment activities involving a titration to calculate an average titre. They should clearly show how they do this by writing down and adding together all of the appropriate titres and dividing this total by the number of titres.

Candidates are required to clearly describe the outcome of their calculations rather than assuming that this is evident from the figures within a calculation.

Evaluating

Overall, candidates tended to do less well in this skill area than in the other three. Marks awarded by Centres did not always reflect this and the application of the coursework descriptors was often rather generous. The main reason continues to be that candidates include insufficient information about limitations of the experimental process or about those features of the procedure that were important in ensuring accurate and reliable data. Some Centres gave higher marks than was appropriate for brief comments on limitations of experimental procedure. Most limitations described using most appropriate detail are required to meet the descriptors at level 8.

Calculation of uncertainty associated with measurements

When considering the uncertainties associated with data, it is expected that candidates will calculate a value associated with a single representative measurement that they have recorded for each type of measurement. Some Centres may wish to teach their candidates how to calculate the uncertainty associated with the difference between two measurements such as a temperature change and this is equally acceptable.

2854 - Chemistry by Design

General Comments

Several comments were received that this was a more straightforward paper than in previous years. However, there were also comments that candidates found it harder than it looked, and this is bourn out by the statistics at the top end.

Most candidates made a good effort at the calculations, with an understanding of logarithms in the context of pH and solubility product being the most likely to trip them up. The longer answers were often done well, apart from the very final part where hardly any scored full marks. Virtually all candidates attempted every question and none seemed to have time problems.

Comments on Individual Questions

1) This provided an easy start for most, though some found it difficult and went on to score better marks elsewhere.
Most gave correct answers to part (a)(i) and part (a) (ii). However, the plus sign on the ion was occasionally missing in part (a) (iii) and sometimes extra electrons were shown. The bond angles were not as well done, with a lot of “120, 120” and quite a few 120, 109 (the wrong way round). Part (b) (ii) was intended to be more challenging and it was pleasing to see that most recognised the involvement of water on the left-hand side and quite a few could produce one of the acceptable sets of products on the right.
In part (c)(i), a number just gave “constant”, rather than “rate constant” as the answer. Most got part (c)(ii) right. Most got part (d) right, apart from those who seemed confused by the expression “acid-base character”. Again, the first part of part (e) was usually correct but, in part (e)(ii) only a few realised that both the phenol and the acid would form salts. The ionic arrangement of the salt was well done, however.

2) This was well done on the whole with candidates showing a good understanding of simple organic functional groups, and intermolecular forces in the last part. The solubility product parts varied and more could do the calculation than write the correct expression.

Most made a good start with part (a) and continued to do well with part (b), though some did not show the linearity of the O–H–O arrangements and some HO_2 molecules were seen. Methanal was usually correct, though occasionally an extra hydrogen crept in. Part (c) (ii) was nearly always right and very few wrong answers to part (c) (iii) were seen.

Tip for candidates
If the name is asked for, give the name, if the formula is asked for, give the formula! Here, in part (c) (iii), unusually, the formula is easier, as it is given on the *Data Sheet*. Those who gave the name sometimes came unstuck and lost the mark.

In part (d), just a very few candidates attached the carbon atom to the H of the OH and thereby lost the mark. In part (d), [$C_2H_2O_4$] often appeared instead of [$C_2O_4^{2-}$] in part (e)(i). However, in part (e)(ii), many candidates understood that the concentration of the calcium ions was given by the square root of the solubility product. Part (f) was quite well answered, especially in that the vast majority of candidates realised that the question was about intermolecular forces, rather than the covalent bonding within the molecules. Answers which did not score five marks (a fairly rare mark) usually fell down on lack of careful construction of the answer and not giving sufficient detail. The idea of more hydrogen bonding in ethanedioic acid was rarely appreciated.

Numerical answer: Part (e)(i) calcium ion concentration is 4.8×10^{-5} *mol* dm^{-3}

3) This was a long question but many candidates found at least parts of it possible.
Part (a)(i) was usually right and most got "butanoic acid" in part (a)(ii), though the correct number of the hydroxyl group was rarely given. Part (b)(i) was often right, but part (b)(ii) was often wrong, with "esterification" being quite common. Relatively few showed the *largest possible part* of the molecule in part (c). There was a recovery in part (c) (ii), which was often well done. Part (c)(iii) was often correct. Here, either names or formulae were acceptable but an error in a formula (*e.g.* $Cr_2O_7^-$) cost a candidate dear. Part (d) was made more difficult by the page turn. Some candidates only considered GHB and GHB alcohol and others did not read at all the line which said that the substance was one of those described in the question. GHB was often identified, as many thought that the peak around 3000 cm^{-1} was O–H. GHB was allowed as an "ecf" mark in this circumstance. Some concentrated on the fingerprint region far too much.

Tip for candidates
When analysing an infrared spectrum, look first for O–H just above 3000 cm^{-1} (usually broad, especially in acids) and C=O around 1700 cm^{-1}.

Some ignored the nmr spectrum altogether but many did quite well here. The first mark was awarded for some realisation of the fact that peaks depended on proton environment, the second that the number of protons determined the height of the peaks (with a correct, or nearly correct explanation) and the third required all the peaks to be listed correctly. GBL was relatively straightforward but ecf marks were given for GHB where this was chosen. The Quality of Written Communication marks worked well here. Candidates scored who used technical terms correctly while others who used "layman's alternatives" did not.
The question then went on to test weak acids. Parts (e)(i) and (ii) were usually right but not invariably so. In part (e)(iii), some candidates had trouble calculating $[H^+]$ from pH. Part (f)(i) had some easy marks for the taking and most candidates took them. Some answers tended to ramble on, often after a structured start, and these tended to lose the Quality of Written Communication mark for spelling or grammar errors. Our advice remains to candidates to plan out their key points before writing their answer to such questions. Part (f)(ii) was very easy for those who spotted that $[HA] = [A^-]$. However, quite a few tried to apply $[H^+] = [A^-]$.

Numerical answers: Part (e)(iii) $K_a = 1.59 \times 10^{-5}$ *mol* dm^{-3}*. Part (f)(ii) pH = 4.8*

4) This often showed a good understanding of industrial chemistry. The first two parts were very easy and candidates seldom went wrong. The K_p expression had quite a lot of square brackets (reluctantly allowed if "*p*" was also shown) and the occasional plus signs rather than multiplication. In the calculation, 12^3 was taken as 36 on quite a number of occasions. Significant figures were reasonably done this year. Part (d)(i) was well done in many cases, though, in others, the logic let candidates down. Part (d)(ii) required thought but many candidates realised that it was a stand-off between rate and yield, rather than yield and cost. Part (e)(i) was almost invariably correct as was the first mark for "toxic" in part (f)(i). However, the second response was often "greenhouse gas" which did not score. Some candidates gave a list of more than two reasons, which is not advisable.

Tip for candidates
When asked to give **two** reasons, do not give more! If you get two correct and one wrong, you will only score **one** mark!

In part (f)(i), the word “positive” did not score on its own, as it was a 50/50 chance. A complete explanation was needed, for example “more molecules in the products, hence more ways of arranging these”. Many candidates only scored one of these and some candidates lost marks by writing “more compounds formed”, for example. Many candidates scored well in part (f)(ii), the commonest errors being to forget to multiply 131 by 3 and to reverse the order “reactants minus products”. Some positive signs were omitted.

Tip for candidates
When there are several instructions in a part question, *e.g.* “with the sign” here, underline or highlight the instructions which you will need later, so you do not forget them. This often applies to questions where a specific number of significant figures is also requested .

Numerical answers: (c)(ii) 4.22 atm (f)(ii) +216 J mol^{-1} *K*$^{-1}$

5) This question was found by most candidates to be the hardest, so its position at the end of the paper was fortunate. Many candidates failed to gain both marks in part (a), whereas part (b) often showed a far better understanding of colour than hitherto. Relatively few candidates this year talked about yellow light being “emitted”.
Part (c)(i) was found difficult because of lack of precision on the part of the candidates. Many said the electrons were not associated with a (single) atom (which no bonding electrons are) and were spread over the whole molecule (rather than over several atoms). Part (c)(ii) had a suitable difficultly gradient. Almost all candidates nominated the benzene rings, over half mentioned the N=N bonds and a few mentioned the phenol groups. Part (c)(iii) again required logical writing. Most recognised that the energy levels became closer together when there was more delocalisation but did not say specifically that smaller excitation energy meant a lower frequency absorbed. This was best indicated by quoting “$E = h\nu$” in the correct context. In part (d)(i) many knew the Friedel–Crafts reagents and conditions, the main cause of error being unspecific mention of “alkyl chlorides” or, even more incorrectly, “acyl chlorides”. Most candidates who realised that part (d)(ii) needed an answer related to the actual substitution in part (b)(i) scored well here, though marks were lost for poor chemistry such as “CH_3 molecules”. Part (d)(iii) was usually correct, as were parts (e)(i) and (e)(ii). In the latter, some could not resist putting a group (*e.g.* amine) on the crucial position of the coupling reagent, which, of course, lost the marks. Part (f) was without doubt the most difficult question on the paper. Most realised, to their credit, that intermolecular forces were important. However, they came unstuck when they realised that they were being backed into a corner where they had to say that permanent dipole–permanent dipole forces seemed to be stronger than hydrogen bonds! The subtle answer lies in the facts that cotton hydrogen bonds to water better than to the dye, so that the dye will wash out (mentioned only very occasionally) and that the opportunities for hydrogen bonding between cotton and the dye are **fewer** (not weaker) than opportunities for permanent dipole–permanent dipole interactions between polyester and the dye. This was intended to be a hard part and so it proved to be.

2855 - Individual Investigation

General Comments

The standard of candidates' work was similar to last year. Some of the investigations seen during moderation were of a very high standard, but there was also considerable variation between Centres.

Investigations covered a range of topics but reaction kinetic studies continue to be the most dominant group, both overall and within many Centres. Investigations with a focus on quantitative analysis were also common. These included a comparison of methods used to investigate the concentration of vitamin C and studies of the effectiveness of different solvents used to re-crystallise aspirin. Some candidates chose investigations that were insufficiently demanding or had too little scope and this limited the marks that could be available. 'The best conditions for extraction of copper from copper ore' or 'Acid and thiosulphate' or 'Caffeine in cola' do not lend themselves to the depth of investigation expected at this level. A few candidates continue to choose to investigate the synthesis of organic compounds. Investigations of this kind generate little data and often result in low marks.

Investigations into kinetics systems were in some cases little more than extensions of standard practical procedures and had little originality since they set out to find out something which was already well known. This approach may be perceived as a 'safe' option for candidates but it tends to encourage a rather sterile approach to investigations and severely reduces the opportunity for candidates to experience a real sense of scientific exploration. Some element of uncertainty and challenge can usually be built into the development of standard practical activities, in terms of systems studied or aspect of the system that is studied, which will provide additional interest and motivation for the candidate and allow them to demonstrate higher order skills.

A minority of candidates chose investigations that were of relatively low demand. It is expected that there will be a clear and identifiable progression in candidate performance from GCSE through Experimental Skills assessment at AS level to the Individual Investigation at A2 level.

The overall approach to writing a report on the practical work should also show a clear progression from GCSE through AS to A2 investigations. It is expected that candidates will satisfy the points highlighted in the detailed mark schemes used in AS assessments and build upon this to explain and justify their approach using ideas taken from both the AS and A2 parts of the specification. Specific examples of the need to satisfy AS coursework descriptors are included in the sections on the four skill areas below.

In some cases, the limited scope of the investigation suggested that far less time had been spent on the practical work than the 15 to 20 hours indicated within the specification. This invariably reduces the marks available to candidates.

It was expected that all Centres would use the new coursework marking descriptors contained within the 3rd Edition of the OCR Chemistry (Salters) specification when awarding marks in this session. There was evidence that some Centres had continued to use the old set of coursework marking descriptors which led to the award of higher and inappropriate marks. Overall the more detailed new descriptors seemed to help many Centres award appropriate marks for candidates' work.

There were an increased number of cases this session where the marks awarded by the Centre were too generous and outside of the tolerance allowed by OCR. This resulted in the marks of all candidates in these 50 Centres being reduced as a consequence of moderation. This represents about 12% of Centres and is approximately double the number where marks were reduced in the 2003 June session.

The quantity and quality of annotation of candidates work by teachers varied considerably between Centres. In some cases comments focussed on the general performance of candidates rather than relating performance to the coursework descriptors. In a minority of cases, annotation of candidate work and comments on cover sheets were very brief and these Centres found the award of appropriate marks much more difficult. Effective application of the mark descriptors is helped considerably if brief comments are included on the candidate's work or cover sheet to indicate where particular descriptors have not been met since this explains the award of a lower mark.

New teacher support booklets

Two booklets have been published by OCR to support teachers in setting and assessing coursework.

'*Teacher Support: Coursework Guidance*' provides guidance on all aspects of coursework, iincluding examples of suitable assessment activities and the new detailed assessment descriptors in the 3rd edition of the Chemistry (Salters) specification.

'*Teacher Support: Exemplar Coursework Guidance Units 2852/02 and 2855/01*' provides examples of candidates work with a commentary on appropriate assessment of this work using the assessment descriptors in the 3rd edition of the Chemistry (Salters) specification.

These booklets contain answers to many frequently asked questions about coursework in this specification.

Comments on Individual Skill Areas

Planning

Candidates need to satisfy both strands of the descriptor requirements to be awarded marks at any level of performance. In some investigations candidates included a great deal of experimental detail but little theoretical background while in other cases they included much background but little experimental detail. It is expected at the higher mark levels that the chemical ideas used in the report will focus on the particular investigation undertaken rather than be presented as a general context.

Some candidates started their report with a hypothesis. This rarely helped the written report and often distracted the candidate and reduced the quality of the overall investigation.

To meet the descriptors at level 11, candidates are expected to explain and to justify the choices they have made in developing their plan. A strategy that did seem to help some candidates was the inclusion of sub-headings taken from the general marking descriptors such as 'Explanation of why this plan will help ensure my results are accurate and reliable'. In examples of good practice, some candidates commented on the number of points necessary to produce a useful graph, the reason for repeating or not repeating experiments and the range of data collected in the context of their specific investigation.

The quality of the risk assessment and the referencing of resources consulted during planning is expected to increase through work at the standard of levels 5, 8 and 11. At level 11, it is also expected that risk assessments will be comprehensive, realistic and selective and that the plan will include a reference section in which individual references are given in sufficient detail that another candidate could find them and are linked by a simple numbering system to specific sections in the main body of the text.

There was a significant increase this session in the use by candidates of the internet to look up supporting chemical ideas and to help devise the experimental plan. At level 11, it is expected that candidates when referencing their use of internet sites will describe the content of the site as well as providing a detailed web address that could be used to access the information.

Some useful planning strategies

The use of a preliminary experiment to determine appropriate amounts of materials or conditions can be a useful strategy that informs the rest of the investigation.

Where candidates set out to find out how much of a component is in a set of samples such as vitamin C or aspirin, it is helpful if they can obtain external benchmarking of their data by using a second method of analysis, by using one sample whose composition they know about or by analysis before and after adding a known amount of the component to a sample under investigation.

Sufficient time should be given to candidates so that they can prepare their plan in detail, including an effective risk assessment, before they begin practical work.

Implementing

It is expected that written evidence will be provided by the Centre to support the mark awarded in the manipulating strand of this skill area. This can take the form of comments or a tick list of generic skills and abilities demonstrated by candidates during their practical work. A significant number of Centres did not include this expected documentation.

The data recorded by candidates was sometimes incomplete and lacked appropriate units. All the raw data obtained by the candidate should be included in their report and not just averages. When a titration is carried out, for example, all burette readings should be recorded, not just titres. The standards applied when awarding marks in the recording strand of manipulation should at least be those used at AS level. The lack of any units attached to data, for example, means that a maximum mark of four is available in this skill area.

Quality of recorded data

The data should be of appropriate quality in order to access the higher mark levels. If, for example, candidates find that titration values are very low, they should make appropriate adjustments to the dilution of the solutions and repeat the titration so that higher values can be achieved before moving on to another aspect of their investigation. If the investigation involves the collection of a gas, candidates should ensure that the time intervals at which the volume is recorded do not mean that most of the gas is produced in the first few intervals. If a candidate is using a water bath to carry out an experiment at an elevated temperature then they should record the beginning and end temperature during the period of use. A time recorded from a stop watch of 2 minutes 15.28 seconds does not show the chemical maturity expected at level 11.

Analysing

Most candidates processed the data which they had collected in an appropriate format by carrying out calculations or drawing graphs. In a significant number of cases, however, calculations were not well explained and some Centres did not take sufficient account of this when awarding a mark in this skill area.

Candidates are also expected to draw relevant conclusions from their raw or processed data linked to the chemical ideas and understanding that had been described in the plan. This was generally much less well done than the processing of data, often being descriptive rather than evaluative, and some Centres awarded higher marks than were warranted by rather superficial comments. This is one of the key areas for improvement in many Centres.

Drawing conclusions

In examples of good practice, some candidates identified general trends in the data which they had collected or picked our clear outcomes. They then went on to calculate differences within the data set or differences from expected behaviour. This quantitative approach allowed them to comment with authority on the fine detail of the results they had collected.

Evaluating

This tended to be the lowest scoring skill area for many candidates. Many candidates calculated the uncertainty associated with some, but not all, of the types of measurements they had recorded. In investigations that involved recording times with a stop watch or stop clock, it was quite rare for candidates to estimate the uncertainty associated with this type of data.

Candidates are also required to identify key limitations of their experimental procedures. This was often done much less well with candidates tending to make general statements about the overall accuracy of their investigation instead and this significantly reduced the mark that was appropriate overall for this skill area. This is a further key area for improvement in many Centres.

Many candidates suggested at the end of their report changes they would make to the way they had carried out their investigation if they were to repeat it, but they did not always indicate how or why these changes would help produce more accurate or reliable data. The use of sub-headings to prompt responses that would meet the needs of the descriptors seemed to work well in some Centres.

Comments on the relative significance of uncertainties associated with measurements and limitations of experimental procedures

In examples of good practice, some candidates commented in detail on each aspect of their experimental methods, identifying specific points that caused them to have a lack of confidence in their data. This allowed them to consider the relative significance of both these limitations and the uncertainties associated with measurements so that they could decide on which areas should be most usefully developed further to improve their investigation in the future.

Advanced GCE Chemistry (Salters) 3887/7887
June 2005 Assessment Session

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2848	Raw	90	59	52	45	38	31	0
	UMS	120	96	84	72	60	48	0
2849	Raw	90	69	62	55	48	41	0
	UMS	90	72	63	54	45	36	0
2850	Raw	75	63	57	51	45	40	0
	UMS	90	72	63	54	45	36	0
2852A	Raw	90	75	68	62	56	50	0
	UMS	90	72	63	54	45	36	0
2852B	Raw	90	75	68	62	56	50	0
	UMS	90	72	63	54	45	36	0
2854	Raw	120	93	83	73	63	54	0
	UMS	120	96	84	72	60	48	0
2855	Raw	90	76	68	60	52	44	0
	UMS	90	72	63	54	45	36	0

Specification Aggregation Results

Overall threshold marks in UMS (*i.e.* after conversion of raw marks to uniform marks)

Unit	Maximum Mark	A	B	C	D	E	U
3887	300	240	210	180	150	120	0

The cumulative percentage of candidates awarded each grade was as follows:

Unit	A	B	C	D	E	U	Total Number of Candidates
3887	19.8	40.5	60.8	76.6	88.6	100	8997

Overall threshold marks in UMS (*i.e.* after conversion of raw marks to uniform marks)

Unit	Maximum Mark	A	B	C	D	E	U
7887	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

Unit	A	B	C	D	E	U	Total Number of Candidates
7887	27.4	53.0	73.1	88.4	96.8	100	6058

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